SCHOOLING AND OCCUPATIONAL EARNINGS*

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This paper investigates the relation between schooling and earnings across and within occupations. Across occupations earnings are positively related to mean education. Within occupations the variance in schooling levels is generally substantial, but within two thirds of the occupations no relation between schooling and earnings is observed, while in the remaining third the pattern of sensitivity varies considerably. The sensitivity of earnings to education is greater for white males than white females and substantially greater for whites than blacks. When the white sample is divided into age cohorts, the degree of sensitivity of earnings to schooling is found to be greater for younger cohorts than older ones, except for the youngest cohort in 1970. In the conclusion, a structural interpretation of the distribution of earnings is proposed to account for the findings.

In *Human Capital*, Becker [2] provided some of the earliest empirical support for human capital theory by demonstrating a systematic positive relation between schooling and earnings. More recently, Chiswick [3] and Mincer [9] have provided econometric evidence of a positive effect of education on earnings. Yet, the samples used by Chiswick and Mincer make it difficult to generalize the results of their investigation. This is for two reasons. First, their samples are restricted to males between ages 25 and 65 in some cases, white males between 25 and 65 in others, and white non-farm males in this age bracket in still others. Hanoch [7], Hanushek [8], and others found a much smaller relation between schooling and earnings for blacks than for whites, Welch [15] found this to be the case for older blacks, and Young [17] discovered little or no relation between schooling and earnings for Puerto Rican males living in New York city, except at the college level. Moreover, the labor force participation patterns of females are known to be different from those of men, and thus the effect of schooling on earnings will most likely differ between men and women. Second, the samples Chiswick and Mincer used are too aggregated and do not differentiate between different segments of the labor force. When Hansen, Scanlon, and Weisbrod [6] limited their sample to "low achievers," as defined by the grade received on an Air Force qualifying test, they found no significant relation between earnings and years of schooling, when ability and vocational training were controlled for. Ashenfelter and Moony [1], moreover, found that profession, degree level, and field explained more of the variance in earnings than years of graduate study.

Another problem arises in documenting the relation between schooling and earnings when industrial structure is controlled for. Hanushek [8] found that structural differences among regions accounted for over 80 percent of the

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variance in mean earnings between regions and that individual characteristics such as schooling played a relatively minor role. Osberg [10], moreover, found that once differences in industrial structure between counties were controlled for, schooling variables were usually insignificant in explaining differences in mean earnings and earnings inequality across counties.

In this paper I will also control for structure in investigating the relation between schooling and earnings, though differently than Hanushek or Osberg. Instead of controlling for industry, I will control for occupation, and I will do this by disaggregating the labor force into occupational groups. In so doing, I can isolate two very different effects of schooling on earnings. The first is the way it distributes the labor force over occupational slots. The second is the way it distributes workers over earnings slots within occupation. The results show that the primary effect of schooling on earnings is to funnel workers into high-paying or low-paying occupations. Within occupation, earnings are generally insensitive to years of schooling, except for a small number of professional, clerical, skilled, and semi-skilled occupations. The results show that there is a positive relation between schooling and earnings but that this relation is dependent on and circumscribed by the occupational structure.

The empirical sections of this paper will be concerned with the observed relation between schooling and earnings. This question should not be confused with the related issue of the mechanical or causal link between schooling and earnings. However, in most cases a given set of observed relations between education and earnings will give rise to a particular interpretation of the mechanical link. The human capital theorists, for example, argue that schooling increases earnings because it is productivity-augmenting. Gintis [5], on the other hand, argues that the mechanism is one of personality transformation to create a reasonably docile and obedient work force for the factory or office. Spence [12] suggests that education may serve as a signalling device for prospective employees, in a market of imperfect information. Taubman and Wales [13] argue that much of the observed returns to education (they estimate about half) may be due to a screening function performed by schooling. Based on the results of this paper, I will argue that schooling performs a sifting function of workers over a relatively fixed set of occupational slots.

In section 1 of this paper I will present some preliminary observations of the relation between schooling and earnings across and within occupations. In section 2 a statistical technique called interval analysis will be proposed for assessing the sensitivity of earnings to education within occupation. Section 3 will present the results of this analysis. Section 4 will summarize the empirical findings and will propose a structural interpretation to account for them.

I. Preliminary Observations

Table 1 presents statstics on occupational earnings and schooling.[1] In 1960 occupational mean earnings ranges from 10,400 dollars for medical doctors to

[1]1960 computations were made using the 1960 1/100 Census Public Use Sample stratified on occupation, with a sample size of 41,349, and 1970 computations were made using the 1970 1/100 Public Use Sample stratified on occupation, with a sample size of 63,661.

1,600 dollars for personal service workers, a ratio of 6.3, and in 1970 from 18,700 dollars for air pilots to 2,700 dollars for personal service workers, a ratio of 7.0. Professionals were on the top of the occupational earnings hierarchy, followed roughly by administrative workers, skilled labor, clerical and sales workers, operatives and semi-skilled workers, and unskilled and service workers. Mean schooling ranged from a high of 17.1 for lawyers to a low of 8.5 for textile workers in 1960, a ratio of 2.0, and from 16.8 for doctors to 9.3 for textile workers in 1970, a ratio of 1.8. The range in mean schooling between occupations thus fell somewhat between 1960 and 1970, though most occupational groups recorded a slight rise in average schooling. Moreover, the range in mean education between occupations was far less than the range in mean earnings. Despite this, a strong correlation is evident between mean earnings and mean schooling across occupations, since the better paid professionals were also the most highly educated and the lowest paid unskilled and service workers the least educated. A regression of mean earnings on mean schooling across occupations verifies this (Table 2). The coefficient on mean schooling was significant at the one percent level, and the percent of the variance in mean earnings across occupations explained by the variance in mean schooling across occupations was 35 for the 1960 sample and 40 for the 1970 one.

The third and seventh columns of Table 1 present a different perspective. The standard deviation of schooling within occupation was fairly constant across occupations, varying from 1.7 to 3.3 years in 1960 and 1.8 to 3.4 in 1970, but with most values clustered around the (unweighted) mean. The mean standard deviation of 2.6 in 1960 and 2.5 in 1970 indicates substantial variance of schooling within occupation.[2] A similar observation was made by Eckaus [4] and Taubman and Wales [14]. A large dispersion of educational levels within occupation is corroborated by computing the range of schooling within occupation (columns 4 and 8). This averaged about five and a half years in both 1960 and 1970, with over

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"Earnings" refer to wages, salaries, commissions, bonuses, and tips, received in 1959 and 1969 respectively. In the 1960 Census earnings were recorded in $100 intervals up to $9,999; $1,000 intervals up to $24,999; $25,000 or more. The midpoint of each wage class except the last was used to compute the mean. For the last, a Pareto equation was used, with an estimated average income of the open-ended class of $38,807. In 1970 earnings were recorded in $100 intervals up to $49,999. A Pareto equation was used for the open-ended class, with a resultant estimate of $71,376.

Education refers to the highest grade completed and was coded in 20 values in 1960: no school, kindergarten, elementary 1 to 8, high school 1 to 4, college 1 to 5, and college 6 or more. In 1970, the category nursery school was added. In computing mean education, we assigned no school, nursery school and kindergarten a value of 0 and college 6 or more a value of 18.

Occupations were recorded by the respondent as of the time the Census was taken. In 1960 there were 295 raw occupational codes listed in the Public Use Sample and in 1970 there were 439. To make the occupational groups in the two years compatible and to reduce the number of groups to a more manageable size, the raw codes were aggregated into 32 occupational groups, using interval analysis (described in the next section) and in such a way that the earnings distributions of the raw occupations within each occupational group were similar (see [24] for a more complete description). The aggregation scheme is given in the Appendix.

[2]The (unweighted) mean standard deviation of schooling across the 295 raw occupations in 1960 was 2.4 and across the 439 occupations in 1970 was 2.3, very close to the mean values across the 32 occupational groups in the two years. Thus this finding of substantial dispersion of schooling within occupation is not an artificial result of the scheme used to aggregate occupations.

TABLE 1

MEAN EARNINGS, MEAN SCHOOLING, THE STANDARD DEVIATION OF SCHOOLING, AND THE RANGE OF SCHOOLING BY OCCUPATION

Occupation	1960				1970			
	Mean Earnings[a]	Mean Schooling	Std. Dev. Schooling	Range of Schooling[b]	Mean Earnings[a]	Mean Schooling	Std. Dev. Schooling	Range of Schooling[b]
1. Medical Doctors	$10,383	16.9	1.8	2	$17,659	16.8	2.3	2
2. Air Pilots	10,255	13.5	2.2	7	18,735	14.1	1.8	5
3. Deans, Lawyers, Judges	9,326	17.1	1.7	2	15.396	16.4	2.7	0
4. Professors, Engineers	7,952	16.0	2.3	6	11,894	16.2	2.2	2
5. Brokers, Advertisingmen	7,540	13.3	2.9	6	12,583	14.0	2.6	6
6. Government Officials	7,222	12.1	2.8	6	11,385	12.9	2.5	4
7. Architects	6,985	15.0	2.5	6	13,400	14.5	2.5	6
8. Railway Conductors	6,962	9.9	2.2	4	10,009	11.3	1.9	5
9. Engravers, Toolmakers	6,366	10.7	2.6	4	9,554	11.3	2.2	6
10. Writers, Accountants	5,877	14.0	2.5	6	9,505	14.3	2.6	6
11. Agents, Telegraphers	5,300	12.1	2.6	8	7,675	12.2	2.3	8
12. High School Teachers	5,279	14.1	2.8	6	7,222	14.1	2.6	6
13. Millers	5,227	9.9	2.8	5	8,327	10.8	2.4	4
14. Plumbers, Skilled Labor	5,108	9.9	2.6	5	7,944	10.8	2.4	6
15. Motormen, Welders	4,896	9.4	2.7	6	6,876	10.4	2.5	4
16. Police, Firemen	4,763	10.6	2.8	6	7,937	11.3	2.6	6
17. Mechanics, Craftsmen	4,226	9.7	2.7	5	6,771	10.6	2.5	5
18. Technicians	4,173	13.8	3.1	6	6,663	13.9	2.5	6
19. Farmers	3,847	10.5	3.3	5	7,955	12.7	3.4	10
20. Elementary Teachers	3,780	15.3	2.3	6	5,514	15.4	2.4	4
21. Apprentices, Operatives	3,638	9.6	2.7	5	5,003	10.5	2.6	5
22. Tailors, Painters	3,466	9.7	2.8	5	4,998	10.5	2.7	5
23. Barbers, Bartenders	3,371	9.6	2.7	5	4,386	10.2	2.9	4
24. Apprentices, Drivers	3,249	10.2	2.7	4	5,228	10.8	2.5	6
25. Clerks, Secretaries	3,234	11.7	2.3	6	4,563	12.2	2.2	4
26. Textile Workers	3,979	8.5	2.6	7	3,992	9.3	2.6	6
27. Typists, Cashiers, Newsboys	2,831	11.7	2.0	6	3,615	12.1	1.8	8
28. Entertainers	2,740	13.4	2.9	7	3,712	13.6	2.5	7
29. Nurses	2,610	13.1	2.4	4	5,278	13.1	2.8	6
30. Armed Forces	2,089	12.4	2.9	9	4,203	13.2	2.3	8
31. Milliners	1,988	9.2	2.5	6	2,976	9.8	2.4	6
32. Personal Services	1,641	9.2	3.0	6	2,668	10.5	3.0	6
33. Average (unweighted) Across Occupations	5,009	11.9	2.6	5.5	7,926	12.5	2.5	5.4

[a]Earnings are in current dollars. Occupations are listed in order of 1960 mean earnings.

[b]The range of schooling is defined as the difference in years between the highest and lowest levels of schooling with at least 5 percent of the occupational labor force.

TABLE 2

REGRESSION OF MEAN EARNINGS ON MEAN SCHOOLING ACROSS OCCUPATIONS

	Constant	Mean Schooling	R^2
1960	−1727.	552.	0.346
	(−1.0)	(4.0)	
1970	−7289.	1206.	0.404
	(−2.2)	(4.5)	

Note: t-ratios are shown in parentheses.

half the ranges six or more years and very few under five years.[3] The standard deviation of schooling for the whole labor force was 3.5 in 1960 and 3.2 in 1970, higher than the average occupational standard deviations of schooling of 2.6 and 2.5 respectively. This indicates a tendency for occupations to attract workers within a narrower range of schooling than that of the whole labor force, but a tendency that is considerably weaker than one might expect *a priori.*

Given the presence of a wide range of schooling levels within an occupation, the next question that arises is whether any systematic relation exists between earnings and schooling within occupation. Previous work [16] had indicated only eight occupational groups out of the 32 with a clear upward tend in earnings with respect to schooling in 1960—lawyers, high school teachers, motormen and welders, police and firemen, mechanics and craftsmen, elementary school teachers, barbers and bartenders, and entertainers—and nine in 1970—government officials, railway conductors, writers and accountants, high school teachers, police and firemen, farmers, elementary school teachers, entertainers, and the armed forces. The other occupational groups had either a flat schooling-earnings profile, one with an early peak of earnings followed by a flat or declining profile, a downward-sloping profile, or a fluctuation of earnings with schooling.

These results, however, were based on computing mean earnings by schooling level for each occupational group and were not subjected to any statistical test. Moreover, the analysis did not control for age, sex, race, or hours worked, which may have biased downward the profiles.[4] The issue then arises as to the best way to test the relation between earnings and schooling within occupation. One possibil-

[3]This finding too does not seem to depend on the occupational aggregation scheme, since the two occupational groups with only one raw occupation, air pilots (2) and railway conductors (8), had schooling ranges close to the overall average.

[4]The downward bias might have occurred for the following reasons: (1) The secular rise of schooling levels over the last 40 years and the tendency of earnings to rise with age may introduce a negative correlation of earnings and schooling. (2) Sex discrimination in pay within an occupation may cause women to earn less than men at the same educational level. If mean schooling is higher for women than men within an occupation, a negative correlation may be introduced between schooling and earnings. (3) The tendency of women, particularly those with children, to work fewer hours than men with the same education will also introduce a negative bias into the profile if women are better educated than men within an occupation.

Racial discrimination, on the other hand, might introduce an upward bias in the schooling profiles, if blacks at the same schooling level receive less pay than whites within an occupation and blacks have less schooling than whites.

ity is to compute the rates of return to schooling within occupation, as Eckaus did in [4] for 70 Census occupations. Eckaus found a wide dispersion in the rates of return to schooling, with the net gains from additional schooling quite small and in some cases negative for many occupations. The problem with the rate of return approach is that the effect of schooling on earnings may not be continuous or even incremental. In some occupations there may be a "threshold" level of schooling where earnings jump but at other levels of schooling there may be no incremental effect on earnings. In other occupations earnings may rise with schooling up to a certain point and then level off. In still others the schooling profile may be flat up to a certain point and then rise with schooling. Thus, the rate of return measure may understate the effect of schooling on earnings in certain ranges of schooling and overstate it in other ranges. A more appropriate statistical technique may be "interval analysis" which would allow us to determine whether earnings are sensitive to schooling within an occupation and, if so, at what levels of schooling.[5]

II. Interval Analysis

Interval analysis was originally developed for matching micro-datasets [11] and has also been used to categorize demographic variables [16]. The technique measures the sensitivity of one variable, earnings in the present application, to another variable, schooling in this application. Unlike regression analysis, which also measures the sensitivity of one variable to another, the form of the relation does not have to be pre-specified in interval analysis. In fact, the output of interval analysis is precisely the shape of the relation between the two variables. This can be seen in the two statistics that result from this technique. The first is the number of intervals, which indicates in this application whether earnings show any sensitivity to education (the number of intervals greater than one) or are insensitive to education (the number of intervals equal to one). If there is more than one interval, the second statistic is the intervals themselves, which shows through what ranges of schooling earnings are insensitive to education and at what levels of schooling (the "break points") a significant shift occurs in the relation between earnings and schooling.

The sensitivity of earnings to education is measured by comparing conditioned earnings distributions of adjacent schooling levels. If the conditional distributions are not statistically different (based on a Chi-square test), the schooling levels are combined in the same interval; if they are statistically different, the schooling levels are placed in different intervals. In this way interval analysis "parses" education into a set of intervals so that the conditional distribution of earnings for each level of schooling within the interval is statistically similar

[5]Another problem with Ecklaus' technique is that instead of computing the net addition to earnings from an additional year of schooling for those in the occupation, Eckaus calculated the difference in earnings between those in the occupation and those in a "similar" occupation at a lower level of education. However, his choice of benchmark occupation affects the rate of return, and his method thus fails to give a unique result.

but the conditional distribution of earnings for schooling levels in different intervals is statistically different.[6]

III. Interval Analysis Results

The 1960 and 1970 Census samples were partitioned into the 32 occupational groups listed in Table 1 and within each occupational group subdivided into white males, white females, black males, and black females. Interval analysis was then applied to the joint distribution of earnings and schooling within each of these subsamples and for all members (the pooled sample) of the occupational group at a Chi-square significance level of one percent. The resulting number of schooling intervals is shown in Table 3. Of the 32 occupational groups in 1960, 21 showed no sensitivity of earnings to schooling for the pooled sample and 11 showed some sensitivity. None of the occupational groups in the top third of the occupational hierarchy, mainly the higher-paid professionals, had more than one schooling interval. Those with more than one interval were mainly in the middle third of the occupational hierarchy. These consisted of the lower-paid professionals—high school and elementary school teachers, technicians, and police and firemen—craft and skilled labor, farmers, operatives, typists, and personal service workers. The list of occupational groups with more than one interval for white males was almost identical to that of the pooled sample. An important addition was that of professors and engineers. Among white females there were only three occupational groups showing any sensitivity of earnings to education, and these were "traditional" female occupations—technicians, elementary school teachers, and nurses.

In 1970 there were also 11 occupational groups with more than one schooling interval for the pooled sample, and this list overlapped considerably with that for 1960. Eight occupational groups remained in the list from 1960, two of the craft and skilled labor group fell out, as did farmers, but three groups in the top third of the occupational ladder were added—professors and engineers, government officials, and writers and accountants. Among white males there were again nine

[6]For computational reasons, the algorithm is slightly different. Instead of comparing conditional distributions at different schooling levels, the technique compares conditional distributions at different quantile levels. The education variable is initially divided into octiles (a range of schooling levels comprising one eighth of the observations) and conditional earnings distributions are computed for each octile. Octiles were chosen to ensure a sufficient number of observations in each division to accurately capture the shape of the conditional earnings distribution and a sufficient number of divisions to capture the shape of the joint distribution between earnings and schooling. Using a Chi-square test, the conditional earnings distributions in adjacent octiles are compared. If the conditional distributions are statistically different, each octile is split into sixteenth-tiles, and the conditional earnings distributions in the two sixteenth-tiles are compared. If the conditional distributions are not statistically different, the sixteenth-tiles are combined; if not, each sixteenth-tile is split into half and the process continued. If the conditional earnings distributions in the two octiles are not statistically different, they are combined to form a quartile. If the two adjacent octiles are also combined into a quartile, the two quartiles are compared. If their conditional earnings distributions are statistically different, the quartiles become final intervals; if not, they are combined into a semi-tile and compared with the other semi-tile if the other half of the distribution aggregates to a semi-tile. In general, quantiles are combined if their conditional earnings distributions are not statistically different and split if they are statistically different. Moreover, the Chi-square test can be set at different significance levels, yielding different sets of intervals at different levels of confidence.

TABLE 3

THE NUMBER OF SCHOOLING INTERVALS RESULTING FROM APPLYING INTERVAL ANALYSIS TO EARNINGS BY OCCUPATIONAL GROUP AND DEMOGRAPHIC CLASS[a]

	1960			1970		
	All	White Males	White Females[b]	All	White Males	White Females[b]
1. Medical Doctors	1	1	1	1	1	1
2. Air Pilots	1	1	—	1	1	—
3. Deans, Lawyers, Judges	1	1	1	1	1	1
4. Professors, Engineers	1	3	1	4	4	2
5. Brokers, Advertisingmen	1	1	1	1	1	1
6. Government Officials	1	1	1	3	3	1
7. Architects	1	1	1	1	2	1
8. Railway Conductors	1	1	—	1	1	—
9. Engravers, Toolmakers	1	1	1	1	1	1
10. Writers, Accountants	1	1	1	2	2	2
11. Agents, Telegraphers	1	1	1	1	1	1
12. High School Teachers	2	2	1	2	4	2
13. Millers	1	1	1	1	1	—
14. Plumbers, Skilled Labor	2	2	1	1	1	1
15. Morormen, Welders	2	2	1	3	3	1
16. Police, Firemen	2	2	1	3	1	1
17. Mechanics, Craftsmen	2	2	1	1	1	1
18. Technicians	2	1	2	2	1	2
19. Farmers	2	1	1	1	1	1
20. Elementary Teachers	4	2	3	4	2	3
21. Apprentices, Operatives	2	1	1	2	1	1
22. Tailors, Painters	1	1	1	2	1	2
23. Barbers, Bartenders	1	1	1	1	1	1
24. Apprentices, Drivers	1	1	1	1	1	1
25. Clerks, Secretaries	1	1	1	1	1	1
26. Textile Workers	1	1	1	1	1	1
27. Typists, Cashiers, Newsboys	4	2	1	4	3	1
28. Entertainers	1	1	1	1	1	1
29. Nurses	1	1	2	1	1	1
30. Armed Forces	1	1	—	1	1	—
31. Milliners	1	1	1	1	1	1
32. Personal Services	2	2	1	1	6	2

[a]Only one schooling interval was recorded for black males and black females in every occupational group except personal services in 1960.

[b]A dash (—) indicates fewer than 10 observations in the group.

occupational groups in which earnings were sensitive to schooling. Of these nine in 1970, six repeated from 1960, two craft groups and police and firemen fell out, and three groups in the top third of the occupational ladder were new—government officials, architects, and writers and accountants. Among white females there was a sizeable increase in the number of occupational groups with more than one schooling interval from three to seven. Included in the new additions were three groups in the top part of the occupational ladder—professors and engineers, accountants and writers, and high school teachers. Thus, for white males, white females, and the pooled group, there was a moderate shift between

1960 and 1970 in the occupational groups showing some sensitivity of earnings to schooling from those in the bottom half of the occupational ladder to those in the top half. For black males and black females, however, there were no groups in which earnings were sensitive to schooling, except personal service workers in 1960. This is consistent with findings referenced in the Introduction of a relatively low rate of return to schooling for blacks.

For those groups with more than one schooling interval, the "break points"—that is, the schooling levels at which the conditional distribution of earnings shifts significantly—are listed in Table 4. Among professional and clerical groups in 1960, the break points occurred primarily in the college years, while among skilled and craft groups, farmers, operatives and service workers the breaks fell in the high school years. For occupational groups with more than one schooling interval appearing in the pooled and white male samples or the pooled and white female samples, the break points were very similar. In 1970 the same pattern held. For professional and administrative groups the breaks occurred in the college years, whereas for the other occupational groups the break points were in the high school years. The break points were similar across the pooled example and the demographic groups. Moreover, those occupational groups with more than one schooling interval in 1960 that repeated in 1970 had break points that were very similar, with white male personal service workers the outstanding exception. On the surface, the fact that most occupational groups had the same earnings structure in 1970 as in 1960 is surprising, in light of the secular increase in schooling levels over the decade. However, occupational groups in 1970 had on average more schooling intervals than those in 1960, suggesting more sharply defined institutional pay scales based on educational attainment in the latter year.

Since interval analysis measures the change in the entire conditional distribution of earnings, the existence of a break point does not necessarily signify an increase in mean earnings with schooling. Instead, a break may, in principle, occur from a falling mean, a change in the variance or skewness of earnings or a change in the other moments of the conditional distribution. Additional analysis was therefore undertaken to determine the cause of each break listed in Table 4 by computing the conditional mean, variance and skewness of earnings in each interval. In every case, mean earnings rose between successive intervals, except among white male personal service workers in 1970 where the mean fluctuated up and down. In many cases, the variance of earnings changed between intervals (in most cases rising) and in some cases the skewness changed. However, the dominant effect for the occurrence of a break point was a rise in mean earnings.

An objection to the results presented in Tables 3 and 4 might be made that we have not controlled for age. As mentioned above, a secular increase in educational levels will bias downward the rise of earnings with schooling if earnings tend to rise with age. Therefore, we repeated the same analysis for four ten-year age cohorts for white males (Table 5).[7] We chose white males, since this is the sample most

[7]We also lowered the Chi-square significance level to 0.10 to overstate, if anything, the sensitivity of earnings to schooling.

TABLE 4

BREAK POINTS OF SCHOOLING INTERVALS BY OCCUPATIONAL AND DEMOGRAPHIC GROUP

	1960			1970		
	All	White Males	White Females	All	White Males	White Females
4. Professors, Engineers	—	Col. 4, 5	—	Col. 2, 5, 6	Col. 2, 5, 6	Col. 6
6. Government Officials	—	—	—	Col. 1, 4	Col. 1, 4	—
7. Architects	—	—	—	—	Col. 4	—
10. Writers, Accountants	—	—	—	Col. 3	Col. 4	Col. 3
12. High School Teachers	Col. 3	Col. 3	—	Col. 3	Col. 3, 5, 6	Col. 4
14. Plumbers, Skilled Labor	HS 3	HS 3	—	—	—	—
15. Motormen, Welders	HS 2	HS 3	—	HS 1, 4	HS 2, 4	—
16. Police, Firemen	HS 4	Col. 1	—	HS 3; Col. 1	—	—
17. Mechanics, Craftsmen	HS 3	HS 3	—	—	—	—
18. Technicians	Col. 3	—	Col. 3	Col. 3	—	Col. 3
19. Farmers	HS 4	—	—	—	—	—
20. Elementary Teachers	Col. 3, 5, 6	Col. 5	Col. 3, 5	Col. 3, 5, 6	Col. 6	Col. 3, 5
21. Apprentices, Operatives	HS 3	—	—	HS 4	—	—
22. Tailors, Painters	—	—	—	HS 4	—	HS 4
27. Typists, Cashiers	HS 4; Col. 1, 2	Col. 1	—	HS 4; Col. 1, 2	HS 3, Col. 1	—
29. Nurses	—	—	Col. 2	—	—	—
32. Personal Services	HS 2	HS 2	—	—	HS 1, 2, 4; Col. 1, 2, 3	Col. 1

Key: HS: High School; Col: College.

TABLE 5

NUMBER OF SCHOOLING INTERVALS RESULTING FROM APPLYING INTERVAL ANALYSIS TO EARNINGS FOR WHITE MALE AGE COHORTS BY OCCUPATIONAL GROUPS

	1960				1970			
	25–34	35–44	45–54	55–65	25–34	35–44	45–54	55–65
1. Medical Doctors	1	1	1	1	1	1	1	1
2. Air Pilots	1	1	1	1	1	1	1	1
3. Deans, Lawyers, Judges	1	1	1	1	1	1	1	1
4. Professors, Engineers	2	1	1	1	3	4	3	3
5. Brokers, Advertisingmen	1	1	1	1	1	1	1	1
6. Government Officials	2	1	1	1	2	2	1	1
7. Architects	1	1	1	1	1	1	1	1
8. Railway Conductors	1	1	1	1	1	1	1	1
9. Engravers, Toolmakers	1	1	1	1	1	1	1	1
10. Writers, Accountants	1	1	1	1	1	2	1	1
11. Agents, Telegraphers	1	1	1	1	1	1	1	1
12. High School Teachers	2	2	2	1	2	2	2	1
13. Millers	1	1	1	1	1	1	1	1
14. Plumbers, Skilled Labor	1	3	2	1	1	1	2	2
15. Motormen, Welders	2	2	2	1	1	3	2	1
16. Police, Firemen	1	1	2	1	1	1	1	2
17. Mechanics, Craftsmen	3	3	3	1	1	2	2	2
18. Technicians	1	1	2	1	2	1	1	1
19. Farmers	1	1	1	1	1	1	1	1
20. Elementary Teachers	1	1	1	1	1	1	1	1
21. Apprentices, Operatives	3	2	1	1	1	2	2	1
22. Tailors, Painters	1	2	2	1	1	2	1	1
23. Barbers, Bartenders	1	1	1	1	1	1	1	1
24. Apprentices, Drivers	3	2	1	1	1	1	1	1
25. Clerks, Secretaries	1	1	1	1	1	1	1	1
26. Textile Workers	2	1	1	1	1	1	1	1
27. Typists, Cashiers, Newsboys	1	1	1	1	1	1	1	1
28. Entertainers	1	1	1	1	1	1	1	1
29. Nurses	1	1	—	—	1	1	1	1
30. Armed Forces	1	1	1	—	1	—	—	—
31. Milliners	1	1	—	—	—	—	—	—
32. Personal Services	2	2	1	1	2	2	2	1

often used in assessing the effect of schooling on earnings in the human capital literature (see [3] and [9], for example). Of the nine occupational groups showing some sensitivity of earnings to schooling for the pooled white sample in 1960 (Table 3), all except elementary school teachers and typists and cashiers, primarily female occupations, showed some significant relation between earnings and schooling for at least one age cohort among white males (Table 5). Of the nine occupational groups in 1970 with more than one schooling interval among the pooled white male sample, all except architects, elementary school teachers, and typists and cashiers showed a significant relation between earnings and education for at least one white male age cohort. Thus, a positive bias was introduced into the relation between earnings and schooling for the pooled white male sample for grade school teachers and typists and cashiers by aggregating across age cohorts,

perhaps because older white males were better educated in these traditionally female occupations than younger white males or perhaps because sex discrimination acted more greatly in favor of younger males than older males. On the other hand, in 1960 there were six occupations, primarily skilled and semi-skilled ones in the bottom half of the occupational ladder, with more than one schooling interval in at least one white male age cohort that did not appear for the pooled white male sample, and six new occupations in 1970, primarily skilled and semi-skilled occupations in the middle third of the occupational ladder. For these new groups, some negative bias may have been introduced by combining white males of different age levels in the schooling-earnings profile.

In 1960 the number of occupational groups with some sensitivity of earnings to schooling declined by age cohort from nine in the 25 to 34 cohort to eight in the next to seven in the next and to zero in the 55 to 65 cohort. Of the eight occupational groups in the 35 to 44 cohort, six were the same as in the 25 to 34 cohort; and of the seven groups in the 45 to 54 cohort, five were the same as in the 35 to 44 cohort. Thus, in 1960 there was a lesser effect of schooling on earnings the older the cohort and this was chiefly due to a diminishing impact of education on earnings within occupational group. In 1970 the pattern was somewhat altered. The number of occupational groups with more than one schooling interval increased between age cohorts 25 to 34 and 35 to 44 from five to nine and then declined to seven in age cohort 45 to 54 and four in the 55 to 65 cohort. There was again considerable overlap in the occupational groups with more than one interval appearing in successive age cohorts. There was thus a decreased effect of schooling on earnings across age cohorts in the 35 to 65 bracket, but a much smaller impact of education on earnings in the entry level cohort in 1970 than in 1960. Comparing the results for 1960 and 1970, we find that of the 13 occupational groups with more than one interval in 1960 and of the 12 in 1970, 11 were identical. Moreover, following the age cohorts over the decade, we discover that there were nine occupational groups with more than one interval for the age cohort that was 25 to 34 in 1960 (and thus 35 to 44 in 1970) in both years, of which seven were the same; eight groups in 1960 and seven groups in 1970 for the next age cohort, of which six were the same; and seven groups in 1960 and four in 1970 for the next age cohort, of which three were the same. Thus, it appears that an age cohort "carries" its schooling-earnings structure with it as it ages, at least until age 55.

This result is reinforced by considering the actual break points of the schooling intervals across the decade for a given age cohort and across age cohorts in a given year (Table 6). As in Table 4, the breaks occurred at higher schooling levels for occupational groups that were higher in the occupational ladder. For occupational groups that remained with an age cohort as it aged between 1960 and 1970, the break points were very similar. This further confirms the hypothesis of a stable schooling-earnings structure for a given age cohort as it grows older. However, when we compare the break points for occupational groups that showed up in successive age cohorts in a given year, we notice that they occurred at slightly lower schooling levels for older cohorts. This not only reflects the negative correlation of schooling and age but raises the issue of the causal link between education and earnings, which shall be addressed in the next section.

TABLE 6

BREAK POINTS OF SCHOOLING INTERVALS FOR WHITE MALE AGE COHORTS BY OCCUPATIONAL GROUP

	1960			1970			
Ages:	25–34	35–44	45–54	25–34	35–44	45–54	55–65
4. Professors, Engineers	Col. 6	—	—	Col. 5, 6	Col. 2, 5, 6	Col. 3, 5	Col. 3, 6
6. Government Officials	Col. 2	—	—	Col. 3	Col. 2	—	—
10. Writers, Accountants	—	—	—	—	Col. 4	—	—
12. High School Teachers	Col. 3	Col. 3	Col. 3	Col. 3	Col. 3	Col. 2	—
14. Plumbers, Skilled Labor	—	HS 1, 4	HS 2	—	—	HS 4	HS 2
15. Motormen, Welders	HS 4	HS 3	HS 2	—	HS 2, 4	HS 3	—
16. Police, Firemen	—	—	HS 2	—	—	—	HS 2
17. Mechanics, Craftsmen	HS 2, 4	HS 1, 3	HS 1, 4	—	HS 4	HS 4	HS 2
18. Technicians	—	—	Col. 3	Col. 3	—	—	—
21. Apprentices, Operatives	HS 1, 4	HS 2	—	—	HS 3	—	—
22. Tailors, Painters	—	HS 3	HS 2	—	HS 3	HS 3	—
24. Apprentices, Drivers	HS 2, 4	HS 3	—	—	—	—	—
26. Textile Workers	HS 3	—	—	—	—	—	—
32. Personal Services	HS 2	HS 1	—	HS 4	HS 3	HS 2	—

Key: HS: High School; Col: College.

IV. Summary and Interpretation

Occupational mean earnings were found to be significantly related to mean schooling across occupations. Within almost all occupational groups, however, the variance in schooling and the range in educational attainment levels was substantial. Moreover, within only approximately one-third of the occupational groups were earnings significantly and positively related to schooling.[8] The sensitivity of earnings to education within occupation was greater for white males than white females, though greater for white females in 1970 than in 1960, and far greater for whites than blacks. The occupational groups showing a positive relation between earnings and schooling overlapped considerably in 1960 and 1970, though a modest shift in the list of occupations did occur from the bottom part to the top part of the occupational ladder between the two years. When the sample of white males was divided into two groups, the older age cohorts in 1960 showed less sensitivity of earnings to schooling than the younger ones. The same pattern held in 1970, except for the youngest age cohort which had relatively few occupational groups with more than one schooling interval. Moreover, the cohorts' earnings-schooling structure remained stable across the decade, at least until age 55, where a marked attenuation in the sensitivity of earnings to schooling occurred.

The actual schooling levels at which the breaks between schooling intervals occurred varied systematically across occupational groups. The break points fell mainly in the college years among professional and administrative groups, and in the high school years among skilled, semi-skilled and service workers. The break points were very similar across demographic groups and across the decade by occupational group, and remained stable as the cohorts aged across the decade. However, the schooling levels at which the breaks occurred declined somewhat by occupational group across age cohorts in both the 1960 and 1970 period.

The occupational groups themselves fell into four different classes: (1) A small number, like doctors and lawyers, with high mean education, a very small range in education and hence little sensitivity of earnings to schooling. (2) A set of professional and administrative occupations, like high school and elementary school teachers, technicians and government officials, where earnings rise with schooling after a critical number of years of college. (3) A group of skilled and semi-skilled occuapations, like plumbers, mechanics and operatives, where earnings increase with schooling after a critical number of years of high school, though the effect of education on earnings diminishes with age. (4) The majority of occupations, with a substantial dispersion of schooling levels, with no detectable relation between earnings and schooling.

How then can we reconcile a significant relation between earnings and schooling across occupations with substantial intra-occupational variance in

[8]This result may, in fact, overstate comparable regression results, since shifts in the relation between earnings and schooling at the top of the schooling distribution will be picked up in interval analysis but may not in regression analysis if the earnings profile is flat throughout the bottom part of the schooling distribution. Moreover, the aggregation of raw occupations into occupational groups does not seem to have biased downward the relation between earnings and schoolings, since the two occupational groups with only one raw occupation (air pilots and railroad conductors) had only one schooling interval when interval analysis was applied.

schooling, little sensitivity of earnings to schooling in most occupations, and different patterns of sensitivity in the others? The interpretation of the results will rest on the causal link ascribed between schooling and earnings. Within a human capital framework, schooling is viewed primarily as a productivity-augmenting mechanism to account for the positive relation between education and earnings. Yet skills acquired in education can hardly increase productivity if they are used in work contexts for which they are irrelevant. The evidence presented in this paper shows that a college education does not increase earnings in skilled and semi-skilled occupations and in most clerical ones, and a high school education does not increase earnings in most service and unskilled occupations. Yet, a substantial proportion of the labor force is employed precisely in those occupations where their education is unrelated to earnings. Thus, on the surface, our results seem at odds with the human capital model.

Eckaus' [4] two proposed explanations of the large dispersion of schooling levels within occupation likewise seem inadequate. First, he argues that the occupational categories, even at the raw Census level, represent, in fact, a mixture of tasks. Therefore, different educational levels may be associated with different jobs, as, for example, for accountants and auditors, and therefore the more educated within an occupation will be assigned the more productive task and receive the higher earnings. Yet, our finding is that in most occupational groups, including the two single occupation ones (air pilots and railroad conductors), earnings do not tend to rise with schooling. Second, he argues that the labor market may not be in equilibrium and that the mixture of educational levels within occupations may represent a transitional stage. Yet, the degree of educational dispersion by occupational group remained stable between 1960 and 1970.

An alternative model that might explain the findings of this paper is one that might be called a "structural sifting" model. In it we assume that the occupational composition of the labor force is relatively fixed in the short-run, or at least relatively independent of the schooling and skill distribution of the labor force in the short-run, and responds very slowly to the changes in schooling and skill levels of the labor force in the long-run. Moreover, we assume that the distribution of earnings slots within an occupation is relatively fixed by the mixture of tasks found within the occupation and the institutional structure of the occupation (the federal civil service, for example). Schooling then functions primarily to sort individuals into occupations. In some cases the sorting is direct, as for doctors and lawyers, where education services to certify new entrants. For other occupations, like teachers and engineers, a college education may be necessary to gain the requisite skills, and a college diploma serves as a requirement for entry. In many others, like clerical and skilled jobs, a high school education may transmit required verbal and mathematical skills and thus serve to screen new workers. In these cases education would be directly productivity-augmenting, and this would serve to explain the significant positive relation between mean schooling and mean earnings across occupations.

However, given a fixed occupational structure, as higher-paying occupations fill up, higher-educated individuals will sift down the occupational ladder to lower slots. This would explain the large dispersion of schooling levels within occupation. In this case, a secondary function of schooling would come into play—

namely, to sort individuals within occupation. However, this is a much weaker effect of schooling, as evidenced by the small proportion of occupational groups with some observed sensitivity of schooling to earnings. In most occupations the higher levels of schooling of those who sift down do not seem to benefit the individuals. This is further confirmed by the very low sensitivity of schooling to earnings in the youngest age cohort in 1970. The large secular increase in schooling levels in the decade between 1960 and 1970 caused an oversupply of highly educated workers to develop, and they filtered down to the lower-paying occupations, upsetting the positive relation between schooling and earnings.

One further "anomaly" can be explained by our model. It is the reduction in schooling levels of break points between schooling intervals observed across age cohorts in a given year. On the surface, it would appear that schooling has become increasingly less efficient in transmitting productivity-augmenting skills, since more years of schooling are required in younger cohorts to increase relative earnings within occupation than in older cohorts. However, in our model schooling performs a sorting function and the relative benefits to schooling thus depend on relative schooling level rather than on the absolute level of schooling. A high school or college degree may thus have been a more effective way of gaining entry into higher-paying earnings slots 30 years ago than today.

The causal link between schooling and earnings would thus seem to depend on the occupational composition of the economy. For those occupations that require school-related skills, education will be productivity-augmenting, and the degree to which it increases productivity will depend on the relative size of these occupations. On the other hand, for those occupations where schooling-related training is irrelevant education will not be productivity-augmenting. A positive relation between schooling and earnings may or may not be observed. If it is, it may be due to institutional or signalling reasons. The effect of schooling on earnings can not be understood, in any case, without a consideration of the occupational structure of the economy.

APPENDIX

Occupational Groupings

Occupation 1
Chiropractors
Dentists
Physicians, surgeons
Optometrists
Osteopaths
Veterinarians
Podiatrists*
Health practitioners*

Occupation 2
Airline pilots

Occupation 3
University presidents & deans
Lawyers, judges

Occupation 4
Agriculture professors
Biology professors
Medical Science professors
Chemistry professors
Geology professors
Physics professors
Natural science professors
Engineering professors
Economists
Geologists
Physicists
Economics professors
Sociology professors
Social science professors
Mathematics professors
Statistics professors
Humanities professors
Professors n.e.c.†
Psychologists
Misc. social scientists
Mathematicians
Misc. natural scientists
Aeronautical engineers
Chemical engineers
Mining engineers
Sales engineers
Civil engineers
Elec. engineers
Industrial engineers
Mechanical engineers
Metallurgical engineers
Engineers n.e.c.†
Systems analysts*
Computer specialists*
Petroleum engineers*
Environmental scientists*
Marine scientists*
Environmental professors*
Air traffic controllers*
University administrators*
School administrators*

Occupation 5
Advertising agents
Auctioneers
Stock brokers
Real estate appraisers*

Occupation 6
Public administration inspectors
Public administration officials
Postmasters
Farm buyers
Creditmen
Union officials
Store buyers
Misc. buyers
Misc. managers
Ship pilots
Public administration controllers*
Bank officers*
Construction inspectors
Office managers*
Manufacturing sales representatives*
Wholesale sales representatives*
Clerical supervisors*

Occupation 7
Designers
Architects
Sales managers*

Occupation 8
Railroad conductors

Occupation 9
Locomotive engineers
Photoengravers
Foremen n.e.c.†
Electrotypers
Engravers
Stationary engineers
Toolmakers
Pattern makers

Occupation 10
Authors
Draftsmen
Photographers
Accountants
Farm and home management advisors
Personnel workers
Publicity writers
Programmers*
Tool programmers*
Educational counsellors*
Health administrators*
Misc. administrators*

Occupation 11
Vehicle dispatchers
Insurance adjusters
Misc. agents
Baggagemen
Ticket agents
Mail carriers
Railway mail clerks
Postal clerks
Telegraph messengers
Telegraph operators
Insurance agents

Occupation 12
High school teachers
Agricultural scientists
Biological scientists
Staticians
Pharmacists
Undertakers
Technicians n.e.c.†
Radio operators
Electrical technicians
Physical science technicians

Occupation 13
Millers
Millwrights
Inspectors n.e.c.†

Occupation 14
Airplane mechanics
Office machine mechanics
Machinists
Plumbers
Electricians
Blacksmiths
Cranemen
Excavating machine operators
Metal rollers
Sheet metal workers
Boilermakers
Printers
Structural metal workers
Heat treaters
Metal molders

*1970 only.
†n.e.c.: not elsewhere classified.

Stonemasons
Cement finishers
Forgemen and hammermen
Telephone servicemen
Locomotive firemen
Metal job setters
Production controllers*
Bulldozer operators*
Earth drillers*
Dry wall installers*
Grinding machine operators*

Occupation 15
Railroad brakemen
Boatmen and canalmen
Bus conductors
Streetcar motormen
Railroad switchmen
Asbestos workers
Powdermen
Metal heaters
Power station operators
Furnacemen
Factory motormen
Welders
Metal grinders
Greasers
Stationary firemen
Shipfitters*
Lathe operators*
Mixing operators*
Fork lift operators*

Occupation 16
Firemen
Marshals
Policemen
Sheriffs
Longshoremen and stevedores
Warehousemen

Occupation 17
Appliance mechanics
Radio and TV mechanics
Misc. mechanics
Auto mechanics
Railroad mechanics
Glaziers
Opticians
Plasterers
Cabinetmakers
Carpenters
Misc. craftsmen
Roofers and slaters
Loom fixers
Bakers
Lumber inspectors
Meter readers*
Farm implement mechanics*
Heavy equipment mechanics*
Carpet installers*
Stamping press operators*
Metal platers*
Precision machine operators*

Occupation 18
Therapists
Medical or dental technicians
Foresters
Surveyors
Misc. technicians
Artists, art teachers
Editors, reporters
Clergymen
Social workers

Occupation 19
Farmers (owner and tenant)
Farm managers
Store floor managers
Building managers
Researchers, n.e.c.†*

Occupation 20
Librarians
Elementary teachers
Curators*

Occupation 21
Apprentice electricians
Apprentice machinists
Apprentice plumbers
Painters
Sawyers
Cab drivers
Miners
Misc. operatives
Assemblers
Manufacturing inspectors
Dyers
Textile knitters
Riveters*
Cutting operators*
Furniture finishers*
Winding operators*

Occupation 22
Furriers
Jewellers
Stonecutters
Upholsterers
Tailors
Shoemakers
Bookbinders
Decorators
Painters
Paper hangers
Movie projectionists
Canning operators*
Sign painters*

Occupation 23
Barbers
Bartenders
Farm foremen
Garbage collectors*
Freight

Occupation 24
Apprentice printers
Auto apprentices
Apprentice masons
Apprentice carpenters
Apprentice mechanics
Apprentice builders
Apprentice metal workers
Other apprentices
Meat cutters
Photographic processing workers
Bus drivers
Sailors
Truck drivers
Deliverymen
Parking attendants
Surveying assistants
Manufacturing graders
Laundry operators
Packers n.e.c.†
Vegetable packers
Auto installers*
Dental laboratory technicians*
Apprentice pressmen*
Clothing pressers*
Drill press operators*
Transport equipment operators*

Occupation 25
Bill collectors
Bank tellers
Bookkeepers
Payroll clerks
Shipping clerks
Storekeepers
Secretaries
Stenographers
Officemachine operators
Billing clerks*
Social welfare assistants*
Proofreaders*
Statistical clerks*
Weighers*

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*1970 only.
†n.e.c.: not elsewhere classified.

Occupation 26
Textile spinners
Textile weavers
Solderers*
Carding operators*
Textile operators n.e.c.†*

Occupation 27
Cashiers
File clerks
Office boys
Misc. clerks
Library assistants
Doctors' attendants
Receptionists
Typists
Telephone operators
Demonstrators
Peddlers
Newsboys
Real estate agents
Misc. sales clerks
Retail sales clerks
Retail sales clerks*
Retail salesmen*
Misc. sales workers*
Counter clerks*
Teacher aides*

Occupation 28
Actors
Dancers, dance teachers
Musicians, music teachers
Group workers
Athletes
Misc. entertainers
Religious workers
Radio, TV announcers
Interviewers*

Occupation 29
Dietitians
Nurses
Student nurses
Restaurant, bar managers*

Occupation 30
Armed forces

Occupation 31
Dressmakers
Milliners
Manufacturing sewers
Shoe machine operators*

Occupation 32
Household baby sitters
Housekeepers
Household laundresses
Other household workers
Personal service workers
Recreation attendants
Recreation ushers
Waiters
Cooks
Hairdressers
Watchmen
Maids
Housekeepers
Bootblacks
Charwomen
Fountain workers
Kitchen workers
Misc. service workers
Hospital attendants
Midwives
Practical nurses
Elevator operators
Janitors and sextons
Porters
Farm laborers
Carpenters' helpers
Garage laborers
Gardeners
Lumbermen
Teamsters
Truck drivers' helpers
Fishermen
Laborers n.e.c.†
Animal caretakers*
Construction workers*
Dental assistants*
Childcare workers*
Personal service apprentices*
School monitors*

*1970 only.
†n.e.c.: not elsewhere classified.

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