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The Definition of College Quality and Its Impact on Earnings

ABSTRACT: This paper adds an additional variable, college quality, to the human capital earnings functions. The NBER-Thorndike sample of World War II veterans is then analyzed to see whether quality of colleges attended influences income of individuals at various stages of their working lives. ¶ We have found that the quality of institutions of higher education has an important impact on lifetime earnings of those who attend. A subjective evaluation of institutions (the Gourman Index) was used to measure quality in many of the estimated equations, but it appears that certain objective traits that contribute to these evaluations can be isolated. In particular, average student quality as measured by the average S.A.T. scores of entering freshmen, and faculty salaries, are strongly related to the Gourman Index and are the most important of the measurable institutional traits in the earnings functions of former students. ¶ The importance of college quality does not appear to vary significantly with years of college (and graduate school) attended. We have only weak evidence of an interaction between college quality and student ability. Quality does affect later incomes more than it influences incomes immediately on entering the labor force. These results hold even after controlling for certain occupational choices, individual ability, and socio-economic background.

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[1] INTRODUCTION

Many people have opinions about which colleges are good and which are poor. The bases for their judgments can range from the number of Nobel Laureates on the faculty to the national ranking of the football team. A more systematic analysis of quality would involve trying to identify the features of colleges that enable those whom the colleges are serving (students, alumni, taxpayers, or society as a whole) to best achieve their goals. In this paper we are concerned with the characteristics of colleges that serve to increase subsequent monetary incomes of those who attend them.

Usually, lifetime earnings are explained by variables such as innate ability, experience in the labor force, and years of education, although other socio-economic, demographic, and occupational data can be inserted to increase the explanatory power of the model. In this paper I attempt to add a new dimension to the earnings function analysis by hypothesizing the features of colleges that might yield financial payoffs in later life, and then testing to see which of these traits actually do add most to the explanatory power of the traditional earnings function. Several methods of identifying the mechanism by which these quality traits affect income will be discussed, including rates of return to quality estimates and tests for the interaction of school quality with individual ability and with years of schooling, as well as interactions among the various quality traits.

There is a particular timeliness to this research. Several years ago in his classic study, James Coleman argued that differences in the characteristics of elementary schools attended were unimportant in determining differential achievement rates among students, especially when compared to differences in other variables, particularly family background.[1] More recently, Christopher Jencks has minimized the effects of schooling in reducing cognitive and economic inequality.[2] Samuel Bowles,[3] an economist, and Alexander Astin,[4] a psychologist, have come to similar conclusions that differences in schools at various levels ranging from elementary to higher education have only slight effects on students, whether the effects be economic or cognitive. However, Astin[5] does find that college students demonstrate differential changes in affective behavior depending on the quality of the colleges they attended. Moreover, Spaeth and Greeley[6] found that their measures of quality affected occupational prestige even after a number of other variables that had seemed to reduce quality to insignificance in previously mentioned studies were considered.

Eric Hanushek found for a sample of elementary schools that even though differences in expenditures did not seem to affect the learning rates of children, there were certain measurable characteristics of teachers that did have an impact. In particular, Hanushek found that differences in teachers' verbal aptitudes, the newness of their training, and racial differences, which he interpreted as differences in the quality of teacher training, did significantly influence children's facility in learning.[7] An implication that can be drawn from this result is that expenditures do not matter because school monies are spent on the wrong things. If higher salaries are paid for teachers with more seniority rather than for teachers with higher verbal aptitudes or for teachers of higher quality and more recent training, then we would expect little relationship between expenditures and other quantifiable measures of the school's quality.

To jump ahead to the major conclusion of this study, we find that at the college level differences in quality have highly significant effects on differences in lifetime earnings patterns of students. These results hold even after controlling for a wide array of other factors, including individual student ability. It might be that expenditures at the college level are more likely to purchase those inputs that will be effective. During the period of our study, institutions of higher education were less restricted by unions, teacher associations, and school boards in regard to the types of inputs that they were able to purchase than were elementary and secondary schools. Hence, even if the same model were applicable to all levels of education, the input-output relationships predictably should have been more effective at the college level. It is a moot point whether the superior effectiveness of higher education expenditures will be able to continue as unionism and other restrictions grow at the college level.

Our enthusiasm for the relevance to policy of the current study must be tempered somewhat because of the nature of the sample. In social science research on microdata sets, certain desirable characteristics of a sample usually will have to be sacrificed in order to obtain data with other desirable characteristics. Some samples that have attempted to follow groups of individuals over a number of years have encountered drop-off rates in responses that create serious biases. Other groups studied have exhibited high response rates, but the representativeness of the sample has been weakened because it was selected from only one particular state or group of high schools, for example. Other data sets have of necessity lacked a number of particularly crucial variables, such as test scores of the individuals being studied. Our sample has been characterized by statistically acceptable response rates and also by the availability of virtually all the vital variables required for the models that will be specified here. However, the representativeness of the sample has had to suffer.

The data used are now known as the NBER-Thorndike sample, and although it has been described in detail in several other places,[8] we might summarize its important characteristics here. The respondents were white World War II veterans, all of whom took a battery of aptitude tests in 1942 to determine if they were qualified to be pilots. To take the test one had to have above-average IQ[9] and be in good health. Those willing were surveyed by Robert Thorndike in 1955 and by the National Bureau of Economic Research again in 1969. They provided much information on earnings history, socio-economic situation, and educational experience, including the names of colleges attended as well as aptitude test scores.[10]

This particular sample precludes us from generalizing some of our results so that they might be most relevant for current policy debates. In the first place, no blacks are included in the sample, and also there are no people from the lower half of the IQ distribution. Hence, we must continually keep in mind that our results apply primarily to white, high ability members of our population. We must constantly be cautious of the temptation to apply our results to blacks, other minorities, women, and the less able members of our society. If one argues that the models developed in the work reported here apply directly to these groups, then inferences about them might be made. However, if we feel that the factors determining the earnings functions for these groups are different from those determining the earnings functions for the ones in our sample, or if we feel the relationships between the factors and earnings would differ among these groups, then we will have to restrict our conclusions to the group studied. Rather than wait for the perfect data set, we shall present the results for the data that we have developed. The caveats just stated must be kept in mind. However, the basic result—the significance of quality of college attended on lifetime earnings patterns—is important enough to justify what follows.

Two general types of college attributes can be isolated and measured (if imperfectly). They are as follows:

1. *Student Quality* The argument is that a student benefits more from college, and hence acquires more of whatever colleges offer that enhances future earning power, when surrounded by high quality fellow students—the so-called peer effect. Intuitively, it does seem that the opportunity to interact with intelligent and motivated peers should enrich a student's college experience. We have several measures of average student quality by schools, such as the average Scholastic Aptitude Test (S.A.T.) scores of entering freshmen[11] and an index of intellectuality of students derived by Alexander Astin through factor analysis.[12] Another variable developed by Astin, an index of selectivity based on average level of S.A.T. scores, is also used as a dimension of quality.

2. *Instructional Quality* The second aspect of college quality is the excellence of faculty. The hypothesis here is that a good faculty will instill in students traits that will be beneficial to them in subsequent years. One measure of faculty quality is average faculty salary.[13] The assumption is that higher-paid faculty have either more experience (and higher rank), better teaching ability, more professional prestige from research, or greater opportunities to earn elsewhere, all of which are indicators of greater

productivity in their professorial roles.[14] Another measure of school quality is school expenditure for instruction, research, and library facilities per full-time equivalent student. Here, the argument is that high-quality faculty are attracted by expenditures beyond those on salaries alone. Also, holding these expenditures per faculty member constant, a larger expenditure per student implies a higher teacher/student ratio.[15] Thus, this measure is a test of the influence of teacher/student ratios as well. The hypothesis is that both expenditures per faculty member and faculty per student are aspects of quality.[16] Unfortunately, data of this kind ignore different definitions of "full-time faculty" at different colleges. Teaching loads range from one course to four or more per semester at different colleges and these differences may alter teacher effectiveness. Moreover, this proxy for quality ignores non-pecuniary attractions that particular colleges may hold for particular faculty members. Schools located in undesirable areas (urban ghettos with high crime rates or isolated rural areas with no cultural life) may be forced to pay high salaries for instructors. Schools with attractive surroundings (scenery, some top scholars, a stimulating cultural life, or exceptionally good research and teaching equipment and plant) may be able to attract high-quality instructors for low salaries. Top-quality teachers may accept low salaries if opportunities for lucrative outside consulting jobs abound. Of course, students may or may not benefit from "good" teachers who are away consulting much of the time. In any case, the hypothesis we will test is that schools that pay high salaries to faculty members who meet relatively small groups of students are more beneficial to students' subsequent earning power than those that pay low salaries or assign instructors large classes.

A related quality measure refers to the total incomes or expenditures per student of the colleges. It might be argued that schools that spend (or receive) larger amounts per enrollee provide a higher-quality education, an educational experience more beneficial in post-school years.

As an additional test of school quality we have a subjective measure derived by Gourman. These ratings propose to be a "consensus of reliable opinion and judgment obtained from many and various sources deemed to be dependable and accurate."[17] The study evaluates individual departments as well as administration, faculty, student services, and other general areas such as library facilities. An average of all items is calculated, resulting in an overall Gourman Index between 200 and 800. The interpretation of these ratings depends on the weights given to the various criteria. Unfortunately, these weights are not published. However, the index is one of the few quantitative ratings available for a large number of colleges.

There is a question of whether or not all the measures of quality are measuring the same dimension. Table 1 presents correlations between pairs of college characteristics. In general, these correlations exceed .5. Table 2 presents regressions with individual colleges as units of observation, which enable us to consider the relationships between the non-monetary quality measures and the expenditure data and school size. It is obvious that the non-dollar quality measures are significantly influenced (according to the *t* test) by expenditures as a whole, faculty salaries, and size of student body. Size (undergraduate enrollment) is negatively related to average S.A.T. scores; that is, better peer group influences apparently are found in smaller schools. Gourman ratings are positively influenced by size. Interestingly, our model explains about 50 percent of the variance in the peer group measures, but as much as 70 percent of the Gourman ratings.

It is also interesting to compare these relationships with those discussed by Charles Elton and Sam Rodgers in a recent paper.[18] They found that quality ratings of graduate departments made by people engaged in academic careers show a very strong relationship to the size of the departments. They correlated the quality measures obtained by Allan Cartter[19] and by Roose and Anderson[20] with the number of areas of specialization within a department, number of faculty, number of Ph.D. degrees awarded. number of full-time students, number of first-year students, and ratio of part-time to full-time students and found that tests of statistical significance indicated that these variables differentiated the departmental ratings beyond chance expectations. They concluded that in the ratings obtained from opinion-poll-type surveys, the prime determinant of the probability of a department having a high-quality rating was its size, as measured by the variables just mentioned. The Gourman ratings that we use resemble the Cartter-type ratings in that they are derived from individual opinions. It is for this quality variable that undergraduate enrollment is significantly and positively related to the institutional rating. On the other hand, enrollment or institutional size is negatively or insignificantly related to measures of average S.A.T. scores of entering freshmen, either those obtained from Cass and Birnbaum[21] or those derived by Astin.[22] The implication is that we might want to focus, at least in part, on quality measures that are based on more objective data such as the S.A.T. rather than looking only at quality variables derived by surveying opinions, such as the Gourman ratings.

Quality variables used in this paper are based either on undergraduate evidence, like the S.A.T. score data, or on university-wide characteristics, such as expenditure data and the Gourman ratings. In other words, a school is evaluated equally regardless of whether an individual attended it as a graduate or an undergraduate student. An implicit assumption in these cases is that the quality rankings of an institution in its undergraduate schools do not differ from the quality rankings based on its graduate programs.

TABLE 1 Simple Correlations Between Various Pairs of College Attributes

College Attributes	1	2	3	4	5	6	7	8	9	10	11
1. S.A.T. verbal		.9069	.6592	.7667	.6295	.5603	.5649	.6101	.5888	.5545	−.0978
2. S.A.T. math			.7205	.7758	.6540	.6068	.6093	.6613	.6169	.5927	−.0888
3. Astin intellectuality				.7399	.6141	.6247	.5977	.6576	.6674	.6615	.3318
4. Astin selectivity					.6530	.6312	.6193	.6759	.6976	.6811	.0114
5. Average faculty salary						.7460	.6870	.7364	.8016	.7746	.2535
6. Departmental expenditures per student for research, instruction, and library							.8178	.9555	.7540	.7262	.0482
7. Basic income per student								.8413	.6738	.6390	.0211
8. Basic expenditures per student									.7127	.6764	−.0803
9. Gourman overall										.9827	.3084
10. Gourman academic											.3318
11. 1960 enrollment											—

TABLE 2 Regression Relationships Among Quality Variables

Quality Variables	S.A.T.		Gourman		Astin	
	Verbal	Math	Overall	Academic	Intellectual	Selective
Constant	339.9	355.1	94.9	97.5	28.1	31.0
Basic expenditures	.0149 (2.4495)[a]	.0232 (3.7548)	.0491 (6.8916)	.0495 (6.1135)	.0055 (5.4403)	.0045 (5.2771)
Undergraduate enrollment	−.0039 (−4.0248)	−.0036 (−3.6735)	.0063 (5.5849)	.0075 (5.8327)	−.0001 (−.5674)	−.0001 (−.8106)
Average faculty salary	.0031 (6.7456)	.0200 (6.4415)	.0269 (7.5304)	.0274 (6.7516)	.0019 (3.7439)	.0020 (4.7070)
Adj. R^2	.4740	.5206	.7114	.6700	.4629	.5043
Mean quality	540.8	563.7	442.5	454.4	54.01	56.02
S.D.	60.99	64.87	96.4	102.4	10.1	8.8
Coefficient on basic expenditures when used alone	.0474	.0547	.0876	.0882	.0085	.0075
Adj. R^2	.3694	.4348	.5058	.4551	.4299	.4544
Coefficient on expenditures for library, departmental research and instruction when used alone	.0724	.0834	.1541	.1576	.0134	.0117
Adj. R^2	.3109	.3654	.5665	.5253	.3875	.3958

NOTE: The units of observation are 226 schools with all data.
[a]Students t values in parentheses.

We do have ratings of graduate schools that have been prepared by specific departments, but we were hesitant to make use of these graduate ratings for a number of reasons. If we could specify not only the institution attended for graduate training by the individual in our sample but also the department, then the departmental ratings by graduate schools would be optimal. However, since we do not know what departments our respondents attended, we would be forced to weight the ratings of the different departments and combine them into one rating of the graduate institution as a whole. In addition, most of the departmental ratings of graduate schools are available for only a certain restricted number of schools, particularly the best schools. Although the Roose-Anderson ratings have been expanded to cover well over 100 graduate schools, many of those graduate schools attended by our respondents were not included. In our sample only 775 people attended graduate schools for which there were Roose-Anderson ratings. One thousand and ninety-two people attended graduate schools that had a Gourman rating.

However, we did want to make sure that the strategy of using university-wide ratings (Gourman) was not significantly inferior to using the Roose-Anderson ratings. Table 3 shows the appropriate comparisons. In our earnings function, which is developed below, we insert in the first column the quality of the undergraduate and graduate schools attended, as measured by Gourman, and in the second column, the quality of the undergraduate school as measured by Gourman and of the graduate school as measured by Roose and Anderson. The explanatory power of the model is virtually identical to two decimal places, as are the *t* values of the graduate quality variables. Other variables have similar effects. Comparing column 1 and column 4 reveals that the results using Gourman quality measures for both the undergraduate and graduate institution do not vary significantly due to the sample size, the larger sample embracing all individuals who attended graduate schools with Gourman ratings and the smaller sample including all those who attended graduate schools with Roose-Anderson ratings.

Finally, it is evident from column 3 that the use of the Roose-Anderson rating of graduate schools along with the Gourman rating of graduate schools does not significantly improve the power of the model. Indeed, when the two graduate-quality variables enter together, the high degree of correlation between them reduces their individual coefficients to statistical insignificance.

Given these results, it was decided that the Roose-Anderson ratings of graduate schools would not be used in this study. So the rating of a school is the same whether an individual attended it as an undergraduate or as a graduate student. If the other approach had been used, the results would not have been significantly different.

TABLE 3 A Comparison of Earnings Functions for Graduate Students Using Roose-Andersen and Gourman Quality Measures

Function	Small Sample[a] GRGOVA	Small Sample[a] Roose-Andersen	Small Sample[a] Both	Large Sample GRGOVA[b]
Constant	.56564	.69477	.60464	1.00504
Years of education	.08216 (5.5439)	.08156 (5.4812)	.08199 (5.5287)	.06625 (5.3256)
Experience	.01485 (3.6131)	.01799 (.8290)	.01491 (3.6277)	.0023973 (.140637)
Experience²	—	.00007757 (.1355)	—	.00021845 (.4761)
IQ	.02691 (3.2422)	.02652 (3.1837)	.02653 (3.1925)	.03319 (4.7145)
UG Gova[c]	.00040131 (2.7119)	.00040505 (2.7254)	.0003913 (2.6350)	.00044106 (3.4038)
GR Gova	.00068568 (4.7256)		.00047334 (1.6158)	.0006202 (5.2342)
Roose-Andersen		.08875 (4.5074)	.03310 (.8344)	
Pilot	.42605 (1.4776)	.42801 (1.4814)	.42600 (1.4771)	.27234 (1.3383)
Teacher	−.30310 (−8.1720)	−.30441 (−8.1919)	−.30375 (−8.1873)	−.26573 (−8.5006)
M.D.	.69471 (6.3265)	.69507	[illegible]	[illegible]
Lawyer	[illegible]	[illegible]	[illegible]	[illegible]

	(−8.1720)	(−8.1919)	(−8.1873)	(−8.5006)
M.D.	.69471	.69507	.69622	.77554
	(6.3265)	(6.3171)	(6.3379)	(9.8644)
Lawyer	.17040	.17759	.17396	.24722
	(3.0234)	(3.1387)	(3.0773)	(5.4743)
Observations	761	761	761	1075
R^2	.2799	.2781	.2805	.3115

NOTE: t values in parentheses.
[a]Eliminate an individual if he attended a graduate school without a Roose-Andersen rating.
[b]Not eliminating when R/A absent, that is, include if attended a graduate school with a Gourman rating only.
[c]UG Gova is Gourman overall rating of undergraduate institution attended.

[2] FORMULATION OF A TESTABLE MODEL

Investments in human capital serve to increase people's skills, knowledge and similar attributes, which, in turn, enhance their capabilities to do productive work. One function of schools is to increase the productive capacities of those who attend—to enhance their human capital. Of course, there are other ways of augmenting human capital besides formal schooling (e.g., investments in health and on-the-job training).

A student acquires human capital in school by combining his own time and abilities with the resources provided by the institution. Formally, we can think of a production function for human capital through schooling in any period as:

$$(1) \quad \Delta H_i = f(R_i, T_i, B)$$

where ΔH_i is the number of units of productive capital acquired by a person while attending school during period i, R_i is the school's rate of input of market resources, T_i is the rate of input of the investor's time per unit of calendar time, and B is the individual's physical and mental powers. We would expect the three variables on the right side of (1) to interact with one another.

Up to period t, assuming no depreciation or obsolescence, total human capital acquired from schooling would be:[23]

$$(1') \quad H_t = \sum_{i=1}^{t} f(R_i, T_i, B)$$

Equation 1′ is specified as a linear relationship at each level of H, so:

$$(2) \quad H_t = \sum_{i=1}^{t} f(R_i, T_i, B) = \alpha \Sigma R_i + \beta \Sigma T_i + \gamma B$$

It is assumed that the individual's skills, B, do not change. We allow for interactions among R, T, and B later by adding additional cross-product terms and also by subdividing the sample. For the empirical specification of equation 2 for people having completed their schooling, B is measured in terms of IQ, ΣT_i by years of schooling, and ΣR_i, market inputs of the school, by the measures of quality of the colleges attended. The quality measures represent features of educational institutions that are costly. It is difficult to measure the output units of this "human capital production function," which are really units of productive skills acquired in school although we will see later that this difficulty poses no problem.

According to the human capital earnings function, current period income (Y_t) equals the sum of those earnings obtainable without any investment in human capital (Y_0) and those earnings acquired up to that point in the individual's life as a return on human capital. Formally:

$$(3) \quad \ln Y_t = \ln Y_0 + rH_t + u$$

In equation 3, *ln* is the natural logarithm and *r* is the constant rate of return to units of human capital accumulated in all periods up to *t*.

This study focuses on the relationship between earnings and the human capital production function relevant to schooling, which can be explored by estimating empirically the reduced form obtained by substituting equation 2 in equation 3 to get:

$$(4) \quad \ln Y_t = \ln Y_0 + r(\alpha \Sigma R_i + \beta \Sigma T_i + \gamma B)$$

Notice that we cannot interpret the coefficients on years, IQ, and quality as rates of return since the coefficients are equal to *r* times a weighting factor. The formulation of equation 4 used in the empirical section below to study people no longer in school is:

$$(5) \quad \ln Y_t = \ln Y_0 + a\,\text{EXP} + b\,\text{EXPSQ} + c\,\text{YRS} + d\,\text{IQ} + e\,\text{QUAL} + f_i V_i + u$$

$\ln Y_t$ is the log of 1969 earnings, EXP is years of experience in the full-time labor force (years since first job), and EXPSQ is the squared value of EXP to take account of the nonlinear influence of on-the-job training on earnings.[24] YRS is years of schooling, IQ is a measure of the level of ability (presumably affected by a combination of genetics and environment), and QUAL is a measure of the quality of college attended (institutional inputs or traits of one kind or another). If more than one undergraduate college was attended, the quality measure of the last college attended was used. The last three factors are important since in part they determine the amount of human capital acquired through schooling and hence (indirectly) affect earnings.[25] V_i represents several occupational dummies. The occupational dummies were particularly necessary, since teachers are traditionally paid less than other people with the same education (sometimes allegedly because of non-pecuniary benefits) and doctors receive more. The overrepresentation of highly paid but relatively low educated pilots was also controlled for. The V_i's can also stand for other variables like health, location, socio-economic background, etc., in some of the estimates.

[3] THE EMPIRICAL ESTIMATES

This study considers only those men with at least some college education. For purposes of some of the work reported below, individuals were included in the regressions only if they attended colleges for which all the quality measures were available, so that comparisons between different quality measures in the regressions would not be clouded by varying degrees of freedom. (We would have to eliminate individuals in particular regressions if the quality measure was not available for their schools.) There were 1,511 people in this sample.

The question arises whether these omissions are systematically related to any of the explanatory variables. The colleges remaining in our sample range from the very top to the very bottom of each of the quality measures. However, the 1,511 individuals left for our study do appear to have somewhat higher incomes, years of schooling, and ability than the full sample with 13 or more years. Some implications of this finding and comparisons with less restricted samples will be described below.

A potentially more serious problem with the quality data is that most of the information on schools is for the post-1960 period, whereas the respondents attended these colleges around 1950. Unfortunately, earlier data on college quality is not available; schools have been willing and able to use computers to make information available only in recent times. The assumption is that the relative quality of colleges does not change much over time.

One of the few sets of data on college attributes available over a reasonable period of time is that on average salary of faculty. Data for 36 schools were made available for the years 1939–1940, 1953–1954, 1959–1960, and 1969–1970.[26] Several tests were performed and these revealed significant serial rank correlation. Analysis of variance revealed that the variation of rank across schools at each point in time was significantly greater than the variance of rank of a school over time.[27] Table 4 reveals the Spearman Rank Correlation Coefficients and tests of significance for values of average salary in particular years. Both tests indicate a strong tendency for schools to be of roughly the same rank quality over time.

For graduate departments there have been periodic ratings of quality since 1925. We selected studies made in 1925, 1957, and 1969, and then

TABLE 4 Tests of Serial Correlation of Average Faculty Salary

Years Compared	Spearman Rank Correlation Coefficient	Significance[a] (26 DF)
1939–1940 and 1953–1954	.6759	4.6772
1939–1940 and 1959–1960	.8100	7.0447
1939–1940 and 1969–1970	.5500	3.3586
1953–1954 and 1959–1960	.8752	9.2251
1953–1954 and 1969–1970	.7099	5.1396
1959–1960 and 1969–1970	.7777	6.3097

SOURCE: See Reference note 26.
[a]According to the students t test for differences in means.

aggregated department rankings to provide each of the schools that appeared in all three rankings an overall institutional ranking for each year. We then took rank correlations of the school standings over time. It appears that the correlation between rankings in 1969 and 1957 and the correlation between rankings in 1957 and 1925 both were approximately .7. The correlation between rankings in 1969 and 1925 was .54. Hence, it appears that even over long periods of time relative institutional quality has been roughly constant. These rankings of graduate schools over time appear in Table 5.

Table 6 provides the estimation of earnings functions using different quality measures. It appears that regardless of how quality is measured, the characteristics of one's school significantly affect the log of subsequent earnings (i.e., log of 1969 earnings), after controlling for the individual's IQ, years of education, and experience. The t values on quality (ten measures) range from 3.744 to 6.049 with 1,506 degrees of freedom. Here we use a single variable—the quality of last college attended (graduate or undergraduate where appropriate).

TABLE 5 Rankings of Graduate Institutions Over Time

	Total Overall Rankings[a]			Serial Correlations		
Institution	1969	1957	1925	1969–1957	1957–1925	1969–1925
Harvard	1	1	2	.69822	.69286	.53572
California, Berkeley	2	2	9			
Yale	3	3	5			
Stanford	4	13	14			
Chicago	5	6	1			
Princeton	6	7	6			
Michigan	7	5	8			
Wisconsin	8	8	4			
Cornell	9	9	10			
Columbia	10	3	3			
Johns Hopkins	11	15	7			
Illinois	12	10	11			
Pennsylvania	13	11	12			
Indiana	14	14	15			
Minnesota	15	12	13			

SOURCES: 1925: R. Hughes. "Report of the Committee on Graduate Instruction." *Educational Record*, April: 192–234.
1957: K. Keniston. 1959. *Graduate Study and Research in the Arts and Sciences at the University of Pennsylvania*. Philadelphia: University of Pennsylvania Press.
1969: See Reference Note 20.

[a] The list of schools includes only those fifteen that were ranked in all three of the years.

TABLE 6 Earnings Functions Using Different Definitions of College Quality

Function	Gourman Overall	Gourman Academic	Average Salary	S.A.T. Verbal	S.A.T. Math
Constant	1.722	1.720	1.512	1.340	1.264
	(9.970)[a]	(9.939)	(8.366)	(6.781)	(6.256)
IQ	.03536	.03560	.03232	.03352	.03209
	(4.911)	(4.946)	(4.467)	(4.634)	(4.418)
Years of education	.03142	.03174	.03052	.03420	.03473
	(4.347)	(4.347)	(4.198)	(4.750)	(4.838)
Experience	.03523	.03573	03927	.03441	.03454
	(2.630)	(2.665)	(2.935)	(2.571)	(2.584)
Experience^2	−.0008265	−.0008403	−.0009354	−.0008216	−.0008233
	(−2.506)	(−2.547)	(−2.839)	(−2.495)	(−2.502)
Quality	.0005812	.0005576	.0004822	.001189	.001259
	(5.124)	(5.047)	(6.049)	(5.520)	(5.778)
R^2_5	.07632	.07584	.08251	.07885	.08060
R^2_4	.06020	.06020	.06020	.06020	.06020
Quality mean	519.664	538.447	10339.5	555.124	576.404
Elasticity	.3020	.3002	.4985	.6600	.7256
R^2	.01612	.01564	.02231	.01865	.02040

TABLE 6 (concluded)

TABLE 6 (concluded)

Function	Instruction, Departmental Research, and Library Expenses	Basic Income	Basic Expenditures	Astin Intellectual	Astin Selective
Constant	1.859 (11.00)	1.847 (10.87)	2.036 (11.78)	1.517 (8.359)	1.403 (7.233)
IQ	.03431 (4.745)	.03556 (4.913)	.03543 (4.859)	.03252 (4.487)	.03355 (4.629)
Years of education	.03176 (4.356)	.03370 (4.632)	.02448 (3.000)	.03147 (4.337)	.03327 (4.600)
Experience	.03667 (2.736)	.03430 (2.554)	.03657 (2.716)	.03649 (2.729)	.03479 (2.598)
Experience²	−.0008651 (−2.622)	−.0008042 (−2.433)	−.0008622 (−2.601)	−.0008708 (−2.645)	−.0008167 (−2.478)
Quality	.0001324 (5.175)	.00008250 (4.373)	.00004069 (3.744)	.008721 (5.808)	.01011 (5.297)
R^2_5	.07663	.07199	.06887	.08080	.007740
R^2_4	.06020	.06020	.06020	.06020	.06020
Quality mean	115.108	1877.32	2270.97	580.304	59.5592
Elasticity	.1524	.1548	.0924	.5060	.6021
R^2	.01643	.01179	.00867	.02060	.01720

NOTE: R^2_4 is the R^2 after the fourth step (only YRS, IQ, EXP, and EXPSQD).
R^2_5 is the R^2 with all five variables included. ΔR^2 is $(R^2_5 - R^2_4)$ and is the additional explanatory power provided by the quality variable.

[a]t values in parentheses.

Notice that the regression coefficient on years of schooling is only slightly over .03 in all the earnings functions of Table 6. These coefficients should *not* be interpreted as the rate of return from years of education. According to the theory of human capital, the rate of return from years of schooling equals the coefficient on years, *r*, times 1/*k*, where

$$k = \frac{\text{actual opportunity costs} + \text{direct costs}}{\text{annualized opportunity cost}}$$

Hence the coefficient on years is the (private) rate of return only if $k = 1$. Actual opportunity costs equal annualized opportunity costs less the amount that a student earns, perhaps when schools are closed during the summer. If direct costs exactly equal student earnings, exactly 100 percent of potential income would be invested in obtaining human capital, *k* would equal 1 since both numerator and denominator have been reduced to annualized opportunity costs, and *r* would be the rate of return per year of attendance at a school of average quality by a student of average ability.

The majority of people in our sample went to college under the G.I. Bill of Rights. These students had no direct costs of schooling and received subsistence payments as well. As an approximation we assume that, as students, our sample members received $100 per month plus tuition under the G.I. Bill.[28] From the 1950 Census we can deduce that an average white high school graduate between the ages of 25 and 29 earned an average of $3,008 per year.[29] This was assumed to be the foregone earnings of people in the sample. Hence, it appears that *k* equals roughly .35106 and 1/*k* equals 2.85.[30]

In order to estimate rates of return from years in college, we should multiply the years' coefficient by 2.85. The rate of return so estimated appears to be roughly 9.7 percent. Becker estimated the returns to a white male college graduate to be 13 percent in 1949.[31]

There are several reasons why the present estimates are less than those of other studies. First, our sample includes only people who have at least some college education and so our coefficients reflect the return from an extra year of college, *not* the return from college training compared to the return from high school attendance. The second reason is the large number of teachers in our sample. Teachers are highly educated and receive relatively low annual earnings. This exception is noted explicitly in some of the later regression estimates. Finally, an examination of the dropouts in our sample indicates that they were usually pulled out of school by good earnings opportunities, not pushed out because of poor achievement. That is, they had relatively high incomes.

Another reason for the apparent low payoff to extra "raw years" in school is that we are controlling for college quality. It is probable that those with more years of schooling also attended higher-quality institutions.[32] Thus part of the return from extra years of schooling is reflected in returns from quality rather than returns from years in school. In calculations not shown here, the regression coefficient on years rises to slightly over .04 when quality variables are omitted from the earnings functions; and this result would imply a rate of return from years of schooling, not controlling for quality, of about 12 percent. Of course, the ability variable also detracts from the coefficient on years, since there is a positive relationship between innate ability and educational attainment.[33]

After establishing that quality is important, however measured, the task of inferring which aspect of quality is most important is more difficult. The question we are raising here is not the rate of return from different types of college quality, but, more simply, the effect of certain aspects of school quality on income. Here we are looking at the significance of the coefficients on quality in regressions that explain differences in individual incomes. Table 6 shows that average faculty salary has the highest t values, closely followed by the average S.A.T. scores of entering freshmen and Astin's measures of intellectuality and selectivity. One is tempted to conclude that faculty quality and peer group effects are the most important (in terms of subsequent earnings) features of college quality. The peer group effects are in line with the conclusions of Coleman's study of lower levels of education.[34]

The R^2 in the earnings function before adding the quality variable was .0602. The addition of the average salary variable raises the R^2 by .0223 to .0825. Once again, the quality variables measuring student characteristic add the next largest amounts to R^2. Interestingly, according to the t test and addition to R^2 criteria, the income and expenditures for a full-time equivalent student seem to make the least difference. The Gourman statistics, which purport to take all factors into account, fall somewhere between the power of the faculty and student quality measures, and the expenditure measures.

We can calculate a school-quality elasticity of income—the percentage change in income for a percentage change in school quality. However, these elasticities cannot be used to compare impacts of school quality. A 1 percent change in average S.A.T. level is not comparable to a 1 percent change in average faculty salary. These elasticities are presented in Table 6 (second line from the bottom). If we could calculate the cost of a 1 percent change in each of the quality measures, only then could we see the returns to each.

Table 7 presents two specifications of the earnings equation that include more than one quality variable. In the first, average salary and S.A.T. scores appear to have separate and statistically significant effects on income. The second version shows that when additional types of quality measures are added, the importance of faculty salaries and average S.A.T. scores still

TABLE 7 Earnings Functions With Several Quality Variables

Function	Variables	
Constant	1.332 (6.761)	1.300 (5.665)
IQ	.03105 (4.285)	.03099 (4.265)
Years of education	.03053 (4.206)	.03055 (4.190)
Experience	.03781 (2.827)	.03766 (2.310)
Experience²	−.0009073 (−2.756)	−.0009029 (−2.736)
Average salary	.00003392 (3.343)	.00003342 (2.108)
S.A.T. verbal	.0006215 (2.272)	.0005807 (1.848)
Expenditures: instruction, departmental research, library		−.00001069 (−0.2147)
Astin selectivity		.001087 (0.3269)
Gourman academic		.00001541 (.07664)
R^2	.08564	.08573

stand out, but the other variables add nothing extra statistically. It seems that two separate and important aspects of quality can be identified—namely, faculty quality (measured by average salaries) and peer group (student) effects.[35]

[4] THE INTERACTION BETWEEN YEARS OF SCHOOLING AND COLLEGE QUALITY

To measure college quality's impact in terms of the characteristics of the last college attended by an individual is a useful technique for investigating the relative importance of various college attributes and changes in the importance of these attributes over an individual's life cycle. However, it appears that quality does indeed have a differential effect depending on the number of years of schooling obtained. Since this is the case, we must give more attention to the particular specification of the earnings functions that includes measure of college quality.

In Table 8 I reestimate the earnings functions for specific groups with specific definitions of school quality.[36] In only one case reported in the table (Gourman—larger, less exclusive sample) was undergraduate quality statistically significant for those who went on to graduate school.[37] But in almost all cases, impact of the last college attended appears greater (or equal) for those with more years of schooling. However, an approximate chi-square test leads us to conclude that there are no significant differences in the impact of quality among groups with different levels of attainment.[38]

The question arises whether it is necessary to separate individuals by schooling attainment in order to estimate earnings functions—whether or not there are statistically significant differences in the functional forms according to the number of years of schooling obtained. To consider this question, tests were performed on pairs of earnings functions presented in Table 9 by comparing the structure of earnings functions of those with less than 16 years of schooling with those people having attended school for 16 years, and also by comparing those groups with those who attended school for more than 16 years. In each case the null hypothesis is that the structures of the two functions being compared are not statistically different. Comparing the function of those individuals with fewer than 16 years of schooling to those with exactly 16 years we cannot reject the null hypothesis, so we conclude that these two functions have the same structures in a statistical sense. However, when comparing those individuals with 16 or fewer years of schooling with those with more than 16 years, the F value exceeds its critical level, and hence we are led to reject the hypothesis that the structures are the same. This suggests that the two earnings functions estimated for individuals with 16 or fewer years of schooling and those with more than 16 years do indeed differ statistically.[39]

[5] RESULTS AT DIFFERENT POINTS ON THE LIFE CYCLE

College quality, no matter how defined, does appear to affect earnings 20 years after a person leaves school. An interesting question that arises at this point is whether or not quality of college has an increasing or decreasing effect on earnings over time. To this end, we estimated earnings functions separately for individuals who attended school for 16 or fewer years and for individuals who attended graduate school to explain log of 1969 income, log of 1955 income, and log of real initial income in the first year

TABLE 8 Separate Earnings Functions for Those With Undergraduate Training Only and for Those With Graduate Work (dependent variable log of 1969 earnings)

							Generally Poorer Students at Poorer Schools			
	S.A.T. Math		Average Faculty Salary		Gourman	Overall	Gourman	Overall	Expenditures for Faculty, Research, Library	
Function	UG Only (1)	GRADS Only (2)	UG Only (3)	GRADS Only (4)	UG Only (5)	GRADS Only (6)	UG Only (7)	GRADS Only (8)	UG Only (9)	GRADS Only (10)
Constant	.9672 (3.463)	1.142 (1.733)	1.063 (4.019)	1.157 (1.852)	1.334 (5.347)	1.412 (2.278)	1.414 (8.650)	.6265 (1.842)	1.520 (9.539)	1.009 (3.027)
Years of education	.0602 (4.292)	.0349 (1.289)	.0602 (4.299)	.0410 (1.551)	.0594 (4.226)	.0378 (1.417)	.0593 (6.390)	.0827 (5.818)	.0602 (6.512)	.0804 (5.639)
Experience	.0281 (1.861)	.0328 (.8828)	.0353 (2.327)	.0247 (.6847)	.0307 (2.028)	.0185 (.5054)	.0178 (1.794)	.0066 (.3346)	.0189 (1.909)	.0097 (.4888)
Experience²	−.0006 (−1.757)	−.0006 (−.6581)	−.0008 (−2.197)	−.0005 (−.4916)	−.0007 (−1.883)	−.0003 (−.2578)	−.0003 (−1.352)	.0002 (.2935)	−.0004 (−1.468)	.00006 (.1094)
IQ	.0227 (2.497)	.0397 (2.854)	.0215 (2.367)	.0376 (2.800)	.0249 (2.755)	.0414 (3.112)	.0243 (4.035)	.0299 (3.828)	.0246 (4.108)	.0331 (4.229)
Undergraduate quality	.0012 (4.476)	.0002 (.4338)	.00005 (4.891)	−.0000008 (−.0505)	.0006 (4.170)	.0002 (.7166)	.0006 (5.415)	.0004 (2.979)	.0002 (5.780)	.00003 (1.014)

uate quality	.0012 (4.476)	.0002 (.4328)	.00005 (4.891)	−.0000008 (−.0505)	[illegible] (4.170)	[illegible] (.7166)	[illegible] (5.415)	[illegible] (2.979)	[illegible] (5.780)	[illegible] (1.014)
Graduate quality		.0012 (2.610)		.00007 (5.042)		.0009 (4.247)		.0007 (5.357)		.0002 (5.531)
Pilot	.4336 (3.278)	.2743 (.6075)	.4137 (3.135)	.2894 (.6599)	.4236 (3.200)	.1116 (.2502)	.4946 (4.934)	.4140 (1.435)	.4949 (4.940)	.5067 (1.748)
Teacher	−.3311 (−1.713)	−.2781 (−3.789)	−.3423 (−1.775)	−.2907 (−4.087)	−.3254 (−1.680)	−.2791 (−3.877)	−.3115 (−2.818)	−.2938 (−8.471)	−.3172 (−2.873)	−.3030 (−8.712)
M.D.		.6930 (4.020)		.7056 (4.232)		.7407 (4.372)		.6258 (6.173)		.5951 (5.849)
Lawyer		.1967 (2.039)		.2281 (2.446)		.2270 (2.401)		.2238 (4.362)		.2253 (4.378)
R^2	.0760	.2317	.0793	.2750	.0737	.2604	.0730	.3119	.0746	.3037
Observations	1074	320	1074	320	1074	320	2241	856	2241	856

TABLE 9 Earnings Functions for More Finely Separated Levels of Schooling Attainment

Function	Years of Education < 16	Years of Education = 16	Years of Education > 16	Years of Education ≤ 16
Constant	1.735 (5.758)	2.344 (.3109)	.6265 (1.842)	1.414 (8.650)
Years of education	.04055 (2.060)		.08268 (5.818)	.0593 (6.390)
Experience	.10722 (1.290)	.01269 (.7818)	.006618 (.3346)	.0178 (1.794)
Experience²	−.0003489 (1.093)	−.0001129 (.2634)	.0001546 (.2935)	−.0003 (−1.352)
IQ	.02792 (2.870)	.02049 (2.685)	.02988 (3.828)	.0243 (4.035)
Undergraduate quality	.0004807 (2.689)	.0006584 (4.932)	.0004390 (2.979)	.0006 (5.415)
Graduate quality			.0007075 (5.357)	
Pilot	.5146 (4.479)	.4229 (1.792)	.4140 (1.435)	.4946 (4.934)
Teacher	−.2344 (1.106)	−.3464 (2.717)	−.2938 (8.471)	−.3115 (−2.818)
M.D.	.00	.00	.6258 (6.173)	

Lawyer	.00	1.248 (2.645)	.2238 (4.362)	
R^2	.05060	.05165	.31190	.0730
Observations	999	1242	856	2241
R^2 prior to occupations	.04366	.03292	.26857	.0608

of full-time employment. These estimates appear in Table 10. Moreover, in these estimates, education for the initial year of real income and for the 1955 regression is defined as that education possessed by the individuals in 1955, and occupational categories are based on 1955 responses rather than responses obtained in 1969. Four occupational dummies are inserted to account for exceptional income-schooling relationships. Pilots generally had high earnings considering their comparatively few years of education. Teachers usually devote many years to schooling yet receive low incomes because they work fewer hours and enjoy alleged non-pecuniary rewards. Doctors have high incomes, partly because of monopoly elements in their profession; however, the reason why lawyers receive high incomes is less clear.

The years of education variable is significant throughout the period, and IQ is significant in explaining 1955 and 1969 income, with roughly the same size coefficients in each year. However, college and graduate school quality is not significant for either group in their first year in the labor force, but most recent school quality becomes statistically significant by 1955 for both those with 16 or fewer years of schooling and those with 17 or more, and it exhibits an even larger coefficient in the 1969 earnings function. That these differences are significant is confirmed by chi-square tests (see note 38). The importance of college quality seems to grow with experience in the labor force. One speculation might be that students in better colleges are, for some reason, more able to benefit from on-the-job training in their post-school lives.

The IQ variable in the initial income regressions is either significantly negative or insignificant. This might indicate that the more able men invest more in on-the-job training during their initial years in the labor force and so forego earnings at that time. Thus, although high IQ generally is rewarded with higher pay, this income increment might be unrealized (reinvested) by those who would be able to benefit most from their ability. Mincer suggests that there is a positive relationship between years of education and investment in on-the-job training.[40] It is likely that those with more years of schooling had been foregoing more earnings while investing on the job in the first few years of employment. However, after six years of work (1955 approximately) returns from all human capital acquired appear, and so differences in income by education are clouded. On the one hand, more earnings are foregone by the more highly educated as they obtain more training. On the other hand, this group begins to reap returns from their human capital. The less-educated group invests less in on-the-job training (less income is foregone), but their earnings are lower. This might explain the lower coefficients on schooling in 1955 compared to 1969.

If the suggested relationship between ability and investment in on-the-

TABLE 10 Earnings Functions at Different Times in the Life Cycle Using Per Student Expenditures on Faculty, Research, and Library and Dividing the Sample Into Those With Only Undergraduate Training and Those With Some Graduate Work

	Years of Education ≤ 16			Years of Education > 16		
Function	Initial Real Income[a]	Income 1955[a]	Income 1969	Initial Real Income[a]	Income 1955[a]	Income 1969
Constant	1.149 (8.463)	1.185 (9.025)	1.520 (9.539)	−.6360 (1.799)	.1886 (.6351)	1.009 (3.027)
Years of education	.02132 (2.394)	.02539 (3.259)	.06022 (6.512)	.1111 (5.890)	.07666 (5.171)	.08042 (5.639)
Experience		.04153 (4.838)	.01891 (1.909)		.03390 (1.904)	.009719 (.4888)
Experience²		−.001763 (4.171)	−.0003591 (1.468)		−.0007280 (.6615)	.00005794 (.1094)
IQ	−.02175 (3.589)	.02442 (5.239)	.02457 (4.108)	.01454 (1.252)	.03510 (4.143)	.03311 (4.229)
Undergraduate quality[b]	.00002737 (1.036)	.0001162 (5.620)	.0001521 (5.780)	.00004765 (.9499)	.00002114 (.5667)	.00003456 (1.014)
Graduate quality[b]				.00001057 (.2529)	.00008467 (2.839)	.0001549 (5.531)
Pilot		−.01479 (.09911)	.4949 (4.940)		−.06360 (.1813)	.5067 (1.748)

TABLE 10 (concluded)

Function	Years of Education ≤ 16: Initial Real Income[a]	Years of Education ≤ 16: Income 1955[a]	Years of Education ≤ 16: Income 1969	Years of Education > 16: Initial Real Income[a]	Years of Education > 16: Income 1955[a]	Years of Education > 16: Income 1969
Teacher	−.2578 (3.767)	−.2913 (5.251)	−.3172 (2.873)	−.1451 (1.832)	−.2113 (3.651)	−.3030 (8.712)
M.D.				.1562 (.9805)	.6379 (4.282)	.5951 (5.849)
Lawyer	.1799 (.3513)	.05596 (.1533)	1.133 (2.328)	−.2523 (2.463)	−.1469 (1.665)	.2253 (4.378)
R^2	.01169	.07080	.07462	.07785	.18832	.30365
Observations	2436	2074	2241	568	485	856
R^2 prior to occupations	.00586	.05837	.05877	.06066	.12532	.17303

[a]Education and occupations in 1955 used in regression.
[b]Quality here is defined as per student expenditures on faculty, research, and library.

job training is stronger than that between years of education and on-the-job training, this might explain why the coefficient on years remains significantly positive in the initial year earnings functions. Moreover, to the extent that years of schooling serves as a credential, or screening device, to allocate those with more years into better paying first jobs (which still might provide on-the-job training), we would also expect a positive coefficient on years.

Another problem in comparing the earnings functions at different points in the life cycle is the differences in data reliability. The 1969 income data were obtained in a 1970 survey and the 1955 income data were gathered from a survey in 1955. However, the initial year's income was obtained by asking a "recall" question in 1969. The implication is that the initial year earnings figures are inferior to those from the other two years studied.

It is also interesting that about 6 percent of the variance for those who had 16 or fewer years of education can be explained in each of the years. However, for those with some graduate education the R^2 rises from roughly .06 in the initial year of earnings to .12 in 1955 and to .19 in 1969. It appears that the variables in our earnings function become progressively more important determinants of earnings over time for those with the highest levels of education, whereas the factors not included play a larger and constant role over time for those with 16 or fewer years of schooling.[41]

[6] HOW QUALITY MAKES ITS IMPACT

The assumption implicit in the regression analysis above is that school quality affects earnings linearly and continuously. Not only do good schools mean more in terms of lifetime earnings than do lower-quality schools, but also each additional increment of one school quality point adds the same amount to lifetime earnings. In this section I ask whether quality is linearly related to earnings.

I mentioned above that institutional variables relating to student quality and some relating to faculty salaries were separate and significant determinants of college quality. I have, however, used the Gourman ratings as my measure of quality since they are highly correlated with the S.A.T. and salary data and are available for a larger number of institutions. In this section as well I will continue to employ the Gourman ratings.

I separated the sample into those individuals with 16 or fewer years of schooling and those with 17 or more years, and within each of those two subgroups I estimated the earnings function separately for each of the four school quality quartiles. That is, I estimated the earnings function given by column 3 or column 6 in Table 10 for each of the school quality quartiles separately. The results are not reported here in detail, but they suggest that variations in school quality within a school quality quartile appear to be significant only for individuals who attended schools in the top-quality quartile. It also appears that the effect of years of schooling on income is higher at the top-quality quartile than at the low-quality quartile. This suggests a positive interaction between years of schooling and school quality.

It appears that although extreme differences in college quality are significant, once we have subdivided individuals according to gross differences in the types of college attended, slight differences within these categories do not much matter. As a test, we developed a set of dummy variables that for any individual equaled zero in three cases and one for the variable representing that quality quartile in which the school he attended fell. We then estimated an earnings function for all those with 16 or fewer years of schooling and then estimated one for all those with more than 16 years, inserting dummy variables representing three of the four quality quartiles. This estimate appears as Table 11. It appears that to be in the top-quality quartile of schools implies a higher income, and to be in the bottom quartile implies a lower income than average, but the two middle quartiles basically yield average coefficients.

Another way to look at the same type of question is to examine the significance of quality, as measured by the Gourman ratings, for schools within a particular categorization of institutions. The categorization we selected is that of the Carnegie Commission on Higher Education. They place institutions into categories such as "leading" and "other research" universities (codes 10 and 20), "large" and "small doctoral-granting" universities (codes 30 and 40), four-year colleges with "large" and "small program selections" (codes 50 and 60), and "liberal arts" colleges, "highly selective" colleges and "others" (codes 70 and 80). We have combined certain of these categories and looked at the effects of Gourman quality on earnings of individuals who attended particular categories of institutions.[42]

Table 12 reveals that for those individuals without graduate training, differences in expenditures per student, as well as differences in Gourman ratings, were significant factors in income determination, even when students were initially categorized into those who attended one of the four university types and those who attended one of the four college types.[43] When individuals were further separated into finer classifications, as determined by Carnegie (that is, research universities, doctoral-granting universities, four-year colleges, and liberal arts colleges), it appeared that quality became progressively less important as the Carnegie codes increased for undergraduates as well as for graduates. However, for those with 16 or fewer years of schooling and for those with more than 16 years of schooling, differences in quality appeared to be most significant for

TABLE 11 Earnings Functions With Quality Quartiles in Single Regressions By Attainment

Function	≤ 16 Years of Education	> 16 Years of Education
Constant	1.690 (10.58)	1.345 (3.991)
Years of education	.05901 (6.373)	.07653 (5.324)
Experience	.01776 (1.790)	.008451 (.4229)
Experience^2	−.0003273 (1.335)	.00008836 (.1662)
IQ	.02433 (4.045)	.03534 (4.595)
Pilot	.4940 (4.928)	.4707 (1.618)
Teacher	−.3190 (2.887)	−.3079 (8.861)
M.D.	0	.6202 (6.067)
Lawyer	1.203 (2.471)	.2431 (4.707)
Gourman—1st Quartile	−.06193 (2.219)	−.1531 (3.630)
Gourman—2nd Quartile	−.001570 (.05707)	−.05969 (1.551)
Gourman—4rd Quartile	.1353 (4.262)	.1190 (2.584)
R^2	.07576	.30083
Observations	2241	856

those at research institutions and for those at doctoral-granting institutions, although even this statement is blurred by the differences in sample size. When average S.A.T. scores of entering freshmen and average faculty salary variables were used as measures of quality within Carnegie classes, they were significant primarily at the leading research universities and doctoral institutions. These results are not presented.

We have established that small differences in quality of institutions attended do not explain income differences among individuals categorized

TABLE 12 Earnings Functions for Groups of Individuals Sorted Into Carnegie Type Institutions (Carnegie Code Regressions)

	Education ≤ 16				Education > 16			
	Gourman Carnegie Codes		Library Carnegie Codes		Gourman Carnegie Codes		Library Carnegie Codes	
Function	10–40	50–80	10–40	50–80	10–40	50–80	10–40	50–80
Constant	1.196 (5.766)	1.481 (4.594)	1.343 (6.711)	1.719 (6.009)	.4733 (1.211)	1.418 (1.664)	.9152 (2.401)	1.656 (2.140)
Years of education	.06545 (5.672)	.05060 (3.077)	.06725 (5.845)	.05085 (3.092)	.08649 (5.531)	.07277 (1.876)	.08295 (5.280)	.06920 (1.799)
Experience	.02079 (1.746)	.01616 (.8331)	.02232 (1.872)	.01535 (.7902)	.008734 (.3903)	−.02150 (.4554)	.01274 (.5665)	−.02070 (.4374)
Experience^2	−.0003592 (1.215)	−.0003577 (.7580)	−.0003962 (1.339)	−.0003388 (.7167)	.0001418 (.2410)	.0008482 (.6213)	.00001947 (.03293)	.0008135 (.5948)
IQ	.02216 (3.095)	.02519 (2.132)	.02311 (3.243)	.02589 (2.201)	.02831 (3.257)	.03608 (1.945)	.03184 (3.661)	.03907 (2.091)
Undergraduate quality	.0007053 (5.027)	.0009192 (2.145)	.0001622 (5.178)	.0001832 (2.081)	.0004802 (2.989)	.0002079 (.5298)	.00004638 (1.252)	−.00003344 (.3633)
Graduate quality	0	0	0	0	.0007669 (4.991)	.00005739 (.07230)	.0001552 (5.027)	−.00004860 (.2958)
Pilot	.4964 (3.814)	.4884 (3.026)	.4979 (3.828)	.4898 (3.034)	.4045 (1.373)	0	.4986 (1.684)	0

Teacher	−.1570	−.4237	−.1656	−.4250	−.3127	−.2185	−.3184	−.2287
	(.9039)	(2.855)	(.9540)	(2.863)	(8.034)	(2.829)	(8.150)	(2.991)
M.D.	0	0	0	0	.6245	.6718	.6135	.7066
					(5.191)	(3.463)	(5.074)	(3.409)
Lawyer	1.258	0	1.143	0	.1921	.3745	.1966	.3861
	(2.600)		(2.365)		(3.373)	(2.948)	(3.441)	(3.040)
R^2	.07370	.06642	.07460	.06602	.29365	.41431	.28471	.41435
Observations	1563	644	1563	644	719	134	719	134
R^2 prior to occupations	.06050	.04069	.06199	.04014	.16936	.27501	.15468	.26536

according to the broad type of institution attended. Not surprisingly, the variation in quality of institutions categorized into two broad Carnegie classifications is greater than is the variance in quality among institutions classified by the four school quality quartiles themselves.

[7] THE TRADE-OFF BETWEEN QUANTITY AND QUALITY OF EDUCATION

Can we say that two years at Harvard are better than more years at a lower-quality institution? The results discussed so far imply only that more years at Harvard are worth more than fewer years at Harvard and that a given number of years at a high-quality school is worth more than the same number of years at a low-quality school. Table 13 divides those who attended school for 17 or more years according to the quality of their undergraduate institution. The purpose here is to see if the quality of a graduate school and the impact of more years attended varies systematically with the quality of the undergraduate institution attended. It does appear that the years' coefficient is significantly greater for those who attended undergraduate schools ranked in the lowest two quality quartiles. The years' coefficient is not even statistically significant according to the *t* test for those in the top half of the undergraduate quality distribution. Hence, it appears that extra years are more important for those who went to a lower-quality undergraduate school than for those who went to a good one. Moreover, it appears that the payoff from quality of graduate school rises continuously as we move from individuals who attended the lowest-quality undergraduate schools to those who attended the next-to-highest quality. However, for those who attended the highest-quality undergraduate schools the payoff to quality of graduate school is almost as low as that in any quartile. It appears that there is a complementarity between the quality of undergraduate school and the quality of graduate school. Once again, even though a student can partially compensate for going to a lower-quality school by attending school for more years, the payoff from going to a good school is higher for those whose earlier education was also gained at a good school.

[8] THE DISTINCTION BETWEEN EFFECTS OF QUALITY IN PUBLIC AND IN PRIVATE INSTITUTIONS

The reasons for looking at the effects of institutional quality on students who attended private and public institutions are numerous. For example,

TABLE 13 Earnings Functions for Those With Graduate Training Sorted According to Quality Quartile of Undergraduate Institutions

	Low 1st Quartile		2nd Quartile		3rd Quartile		High 4th Quartile	
Function	Gourman	Library	Gourman	Library	Gourman	Library	Gourman	Library
Constant	.6859	.3343	−.6487	−.04605	1.999	1.896	2.265	3.019
	(.9813)	(.5814)	(.8357)	(.08071)	(2.176)	(2.903)	(1.835)	(2.784)
Years of education	.09790	.09205	.1448	.1552	.04311	.04229	.02430	.02121
	(3.812)	(3.614)	(5.913)	(6.482)	(1.604)	(1.537)	(.5420)	(.4794)
Experience	.04942	.05151	.01930	.01807	.03110	.02232	.04914	.05877
	(1.562)	(1.649)	(.5074)	(.4878)	(.7837)	(.5496)	(.6723)	(.8193)
Experience²	.001010	−.001042	.0003381	−.0002550	.001357	.001168	.001619	.001795
	(1.236)	(1.292)	(.3143)	(.2441)	(1.313)	(1.105)	(.8018)	(.9046)
IQ	.03818	.03889	.01133	.002896	.01620	.01441	.04812	.05421
	(2.700)	(2.772)	(.7957)	(.2033)	(1.068)	(.9289)	(2.193)	(2.460)
Pilot	0	0	0	0	.7182	.7418	.1454	.2350
					(1.858)	(1.878)	(.2937)	(.4834)
Teacher	−.2608	−.2714	−.3483	−.3424	−.2249	−.2096	−.3086	−.3048
	(4.696)	(4.928)	(5.566)	(5.577)	(3.369)	(3.071)	(2.183)	(2.176)
M.D.	.6381	.5719	.4561	.4306	.7166	.7332	.9537	1.017
	(2.597)	(2.362)	(3.554)	(3.447)	(3.121)	(3.121)	(2.636)	(2.822)
Lawyer	.2685	.2848	.1221	.1223	.3214	.3145	.1908	.2209
	(2.694)	(2.886)	(1.415)	(1.462)	(3.281)	(3.140)	(1.282)	(1.510)

TABLE 13 (concluded)

Function	Low 1st Quartile Gourman	Low 1st Quartile Library	2nd Quartile Gourman	2nd Quartile Library	3rd Quartile Gourman	3rd Quartile Library	High 4th Quartile Gourman	High 4th Quartile Library
Undergraduate quality	−.001239 (1.087)	.00002652 (.1563)	.0006726 (.6182)	−.0003563 (3.021)	−.001059 (.7897)	−.00004871 (.4231)	.0004654 (.7311)	−.0001441 (1.523)
Graduate quality	.0004672 (2.203)	.0001744 (3.263)	.0007324 (2.810)	.0001561 (3.527)	.001413 (4.744)	.0002320 (3.686)	.0005526 (1.443)	.000196 (2.469)
R^2	.28636	.30186	.41942	.43960	.31822	.28858	.18902	.20268
Observations	260		226		219		151	
R^2 steps[8]	.27040		.39702		.24210		.16795	

this question might be raised: Can a private institution allocate its expenditures more effectively than a public institution, and, hence, make a given expenditure per full-time equivalent student more effective in terms of lifetime benefits for that student? Here I refer to the multitude of constituencies that, of necessity, are served by a public institution. If one looks at athletic programs, for example, the public institutions generally engage in these most extensively.[44] A public institution might have more diverse objectives than a private institution, regardless of its quality.

"Eyeballing" regression estimates not shown suggested that basic expenditures per student and expenditures on faculty, research, and library facilities have a greater effect on those with 16 or fewer and those with more than 16 years of schooling when they attend a private rather than a public institution. This finding might have implied that any level of expenditures by a private institution will be directed toward activities more beneficial in terms of future lifetime earnings. Similarly, it appeared that the returns to quality, as measured by the Gourman Index, were higher for those attending private rather than public institutions.

I hypothesized that the private-public differentiation is a significant way to subdivide the quality measures. However, in almost all cases, the chi-square test of significant differences between the quality coefficients in the public and private institutions indicated *no* statistically significant differences. This troublesome result led us to severely temper the conclusion based on "eyeballing" the different effects of quality in private and public institutions. Apparently private institutions are no more effective than public institutions in obtaining higher lifelong earnings for students when other factors are controlled. The results imply that if one had to choose between two institutions with the same quality ratings, the private institution would not necessarily be more effective, particularly if one considers private rates of return, since tuition costs are larger in the private sector.

[9] THE INTERACTION BETWEEN SCHOOL QUALITY AND THE ABILITY OF THE INDIVIDUALS WHO ATTEND

So far we are able to conclude that an individual's lifetime earnings pattern will vary depending on the nature of the institutions of higher education he attends. The characteristics of universities we observe to be important include subjective evaluations, objective data on institutional differences, and perhaps college type as defined by the Carnegie Commission. Although we have controlled for certain characteristics of the individuals in our sample, the focus so far has been to determine the average impacts of different aspects of institutional quality on incomes of all members of our sample considered together.

It is possible that the impacts of college quality differ depending on the nature of the individuals who attend them. That is, differences in college quality might be more important, or less important, in a sample of individuals with exceptionally high, or exceptionally low, ability. If the relationship between quality of college attended and subsequent earnings of an individual depends on the level of the individual's ability, then there is an interaction between individual ability and school quality in the earnings relationship.[45]

First, separate regressions similar to those presented in Table 6 (i.e., including IQ, YRSED, EXP, and EXPSQD, along with quality of the last institution attended) were estimated for individuals in our sample with IQ's above the sample mean (700 observations) and below the mean (811 observations). The question is whether the effect of quality differed according to the ability of those who attend. Table 14 presents the elasticities derived as the product of the coefficient on quality ($d \ln Y/dQ$) and the sample mean values of quality. According to the t test, the impact of quality is significantly greater for the higher ability subsample for all definitions of quality but one.[46] (For S.A.T. math, the elasticities were not significantly different.) These regressions, from which Table 14 is derived, reveal that coefficients on IQ were generally smaller for the high-ability group; the coefficients on years in school and experience were generally larger for the high-ability group. The model explains 9 to 10 percent of the variance in 1969 income for those with ability above the mean, but only 4 to 5 percent of the variance of income of the lower-ability group.[47]

These results led us to subdivide the sample further into IQ quartiles, separately for those with 16 or fewer years of schooling and for those with more than 16 years of schooling. These regressions appear in Table 15. For the first group the Gourman measure of the quality of the undergraduate institution attended was used, and for those with some graduate training the measure of both undergraduate and graduate institution quality was inserted. For the undergraduate group, the effect of college quality was greatest for the lowest IQ quartile. The lowest IQ quartile revealed a large, and statistically the most significant, effect on 1969 earnings. Notice also that undergraduate quality was not statistically significant except in the top IQ quartile for those who had graduate training. The chi-square test indicates no statistically significant differences in quality coefficients across ability quartiles. This result, along with the unsystematic sequence of the coefficients, leads us to conclude that although we may expect "good" students to benefit more than "bad" students (defined by IQ) from attending better colleges, we cannot say much more about the relative impacts on students more finely divided by ability.

TABLE 14 Income Elasticities of Quality by IQ Above or Below the Mean[a]

Item	Gourman: Overall	Gourman: Academic	Average Salary	S.A.T.: Verbal	S.A.T.: Math	Expenditures: Instruction, Departmental Research, and Library	Basic Income	Basic Expenditures	Astin Intellectual	Astin Selective
All observations	.3020	.3002	.4985	.6600	.7256	.1524	.1548	.0924	.5060	.6021
High IQ	.3563	.3654	.5761	.7703	.6937	.1744	.2143	.1217	.5762	.6862
Low IQ	−.2492	.2375	.4328	.5636	.7579	.1283	.0850	.0480	.4470	.5207
t[b]	5.003	5.9337	3.3917	2.9093	.8230	5.6336	13.1944	8.8326	2.8618	2.5765

NOTE: The sample was divided into those with IQ above the mean and those below the mean of the whole sample of 1,511.

[a]Controlling for YRSED, EXPER, EXPERSQD, and IQ.

[b]The tests are whether there are significant differences in the elasticities for the high and low IQ parts of the sample. Differences are significant where t values exceed 2.0 (approximately).

TABLE 15 Regressions for Undergraduates and Graduates by IQ Quartiles

Function	Years of Education ≤ 16: First Quartile	Second Quartile	Third Quartile	Fourth Quartile	Years of Education > 16: First Quartile	Second Quartile	Third Quartile	Fourth Quartile
Constant	.8700 (2.494)	2.167 (7.376)	1.260 (3.951)	1.264 (3.154)	.2425 (.3766)	.7318 (1.121)	−.1502 (.2221)	2.306 (2.537)
Years of education	.06656 (3.607)	.0473 (2.906)	.07295 (4.048)	.04009 (2.010)	.1030 (3.710)	.1001 (3.867)	.09749 (3.421)	.01642 (.4669)
Experience	.05278 (2.707)	−.0219 (−1.192)	.01990 (.9565)	.02502 (1.161)	.02459 (.6963)	−.02856 (.8171)	.05056 (1.266)	−.04174 (.7118)
Experience^2	−.001206 (2.510)	.00041 (.9133)	−.0003257 (.6428)	−.0001798 (.3293)	−.0005161 (.5283)	.001093 (1.185)	−.0007555 (.7105)	.001297 (.8571)
IQ	.006043 (.2018)	.1013 (2.114)	−.06784 (1.467)	.05825 (2.338)	.05129 (1.565)	.01066 (.1521)	.05240 (.8591)	−.04323 (1.134)
Undergraduate quality	.0007393 (2.939)	.00049 (2.488)	.0005431 (2.600)	.0005840 (2.739)	.0002865 (.9261)	.0003608 (1.144)	.0002564 (.8956)	0008045 (2 646)
Graduate quality					.0007894 (3.305)	.0005402 (1.938)	.0008210 (3.259)	.0008671 (2.732)
Pilot	.3821 (1.678)	.5347 (2.906)	.3772 (2.160)	.6834 (2.879)	0	0	.1451 (.3499)	.5761 (1.288)
Teacher	−.2582 (1.217)	−.3410 (−1.548)	−.4369 (1.977)	−.2357 (.9942)	−.2893 (4.915)	−.2871 (4.584)	−.2777 (3.895)	−.3550 (3.477)
M.D.	0	0	0	0	.4934 (2.234)	.6358 (3.528)	.7610 (3.552)	.5826 (2.684)

Lawyer	0	0	0	1.319 (2.811)	.09371 (.9178)	.2057 (2.119)	.2959 (3.157)	.2829 (2.133)
R^2	.07680	.0527	.06076	.10390	.31049	.27955	.34029	.26047
Observations	513	672	610	446	198	254	232	172

NOTE: First quartile = lowest.

It should be stressed again that no matter what one's ability is, he will be better off attending a good school rather than one of lower quality. We should also remember that the sample being studied contains individuals falling in the upper half of the IQ distribution for the nation as a whole. This implies that our top IQ quartile resembles the top eighth in the nation and our bottom IQ quartile probably contains people with IQ's slightly above the national norm.

So far within IQ quartiles we have inserted college quality as a separate variable. The question arises whether the explanatory power of the model would be increased significantly if we insert the measure of quality explicity as an interactive variable with ability. To this end we have estimated the four equations that appear in Table 16. In equation 1, I attempt to explain earnings differences among all those with less than 16 years of schooling by our traditional set of variables, including a measure of the quality of the undergraduate institution attended. In equation 3, I replace the single variable measure of undergraduate quality with a set of four variables. First, we create four dummy variables—the first being one if an individual falls in the lowest IQ quartile and zero otherwise, the second being one if the individual falls in the second lowest IQ quartile and zero otherwise, and so on. For any one individual three of the dummies will be zero and only one will equal one. Each of the four dummies are then multiplied by the quality of the individual's institution. Hence for each individual we have four variables, one being the quality of the college the individual attended and the other three being zero. This method allows us to see whether quality has a differential impact depending on which ability quartile the individual falls into. Similarly, in equation 2, I estimate the generalized earnings function for those with some graduate work and column 4 is the same equation, but with quality measures for the graduate institutions attended sorted into four IQ groups.

In equations 3 and 4 we are asking the same question that we asked when the sample was subdivided and equations estimated separately for individuals falling into different IQ quartiles. However, in the equations currently being considered we constrain coefficients on years of schooling, experience, IQ, and the occupational effects to be the same for all individuals within a schooling attainment category. Hence, in one respect these latest estimates are less general and more restrictive than the ones in the previous tables. It is interesting that for undergraduates in this case the coefficients on quality fall continuously from the lowest to the highest IQ quartile. Indeed, the coefficient on the quality variable multiplied by the highest IQ dummy is not even statistically significant. On the other hand, the quality coefficients for those individuals with some graduate work rise continually from the lowest to the highest IQ quartile.

Table 16 was prepared to see if the total power of the model increased

TABLE 16 Regressions With Quality Interacting With IQ Quartiles in Single Regressions by Attainment

Function	Years of Education ≤ 16 (1)	Years of Education > 16 (2)	Years of Education ≤ 16 (3)	Years of Education > 16 (4)
Constant	1.414	.8393	1.412	.8469
	(8.635)	(2.512)	(8.610)	(2.530)
Years of education	.05924	.07882	.05941	.07910
	(6.387)	(5.544)	(6.401)	(5.550)
Experience	.02776	.007497	.01768	.007227
	(1.789)	(.3773)	(1.780)	(.3632)
$Experience^2$	−.0003306	.0001151	−.0003305	.0001274
	(1.350)	(.2175)	(1.348)	(.2405)
IQ	.02425	.03488	.03366	.01940
	(4.034)	(4.555)	(2.278)	(1.013)
UG GOVA	.0005810			
	(5.515)			
GR GOVA		.0008332		
		(6.628)		
$A_1 \times$ Quality[a]			.0002331	.0002081
			(2.494)	(1.838)
$A_2 \times$ Quality			.0002047	.0002390
			(4.133)	(3.731)
$A_3 \times$ Quality			.0001900	.0003059
			(3.753)	(5.250)

TABLE 16 (concluded)

Function	Years of Education ≤ 16 (1)	Years of Education > 16 (2)	Years of Education ≤ 16 (3)	Years of Education > 16 (4)
A_s × Quality[a]			.0001201 (1.282)	.0003719 (3.168)
Pilot	.4946 (4.932)	.4524 (1.562)	.4932 (4.915)	.4467 (1.540)
Teacher	−.3116 (2.817)	−.3064 (8.861)	−.3094 (2.796)	−.3060 (8.838)
M.D.	.00	.6272 (6.158)	.00	.6278 (6.156)
Lawyer	1.228 (2.518)	.2392 (4.664)	1.235 (2.531)	.2365 (4.597)
R^2	.07290	.30468	.07323	.30542
Observations	2240	856	2240	856
R^2 prior to occupations	.05679	.16503	.05720	.16673

[a]The quality measures used in column 3 are for the undergraduate institutions and the quality measures used in column 4 are for the graduate institutions attended by the individuals.

when interaction was explicitly introduced. The R^2 in equation 1 when quality was introduced as a single variable for undergraduates was .0729 and the R^2 in equation 3 when quality was interacting with four IQ dummies was .0732. An F test to determine whether or not there was a significant difference in R^2s between the two equations revealed very clearly that there was no significant difference. Similarly, when comparing equation 2 and equation 4, there was no significant difference between R^2s of .0347 and .3054.[48]

We can conclude that institutional quality is a significant factor in determining an individual's lifetime earnings. Moreover, some tests indicate that the impact of quality is somewhat greater for individuals with more ability compared to individuals with less. However, it does appear that the least able in our sample (who resemble the average individual in the society as a whole) are affected by the quality of the institution they attended by roughly the same amount as are the top people in terms of ability in our sample. The differences in impacts of institutional quality on individuals of different levels of ability do not appear to be major. Our model's explanatory power is not strengthened when we introduce college quality as a variable explicitly interacting with ability. If there is an interaction, the joint influence of quality and ability does not add much to the separate effects of the two factors on income.

[10] THE INTRODUCTION OF FAMILY BACKGROUND VARIABLES

The "proper" method of measuring socio-economic status (SES) is still being debated. Karabel and Astin[49] have recently argued that socio-economic status is positively correlated with college quality. If this is so, then omission of SES as an explanatory variable has biased upward the effects we attribute to quality. Moreover, Hauser[50] and Bowles[51] have attempted to prove that father's income (rather than education or occupations) is the appropriate measure of SES.

Our data set contains measures of father's educational attainment and father's occupational status, the latter being composed of three dummies (indicating high, medium, and low). We also have a measure of wife's father's education. Each of these has been used to stand for SES and are probably correlated with father's income, which we do not have.

Table 17 introduces the SES variable available in our sample into our standard earnings functions separated by those individuals with and without graduate training. Several facts stand out. The introduction of SES measures reduces the size and statistical significance of the quality variables only very slightly and these quality variables are still powerful in

TABLE 17 Earnings Functions Including Socio-economic Background Variables

Function	Years of Education ≤ 16	Years of Education > 16
Constant	1.327	.6285
	(8.049)	(1.835)
Years of education	.05343	.08074
	(5.776)	(5.653)
Experience	.01607	.002790
	(1.632)	(.1405)
Experience²	−.0002880	.0002585
	(1.185)	(.4889)
IQ	.02260	.02935
	(3.774)	(3.752)
Undergraduate quality	.0005142	.0004266
	(4.802)	(2.866)
Graduate quality		.0006879
		(5.192)
Father's SES high	.08156	.01462
	(2.531)	(.3394)
Father's SES medium	.03953	04322
	(1.209)	(.9994)
Father's education	.002872	−.001611
	(.9008)	(.4187)
Wife's father's education	.01350	.007247
	(4.200)	(1.862)
Pilot	.4987	.3948
	(5.010)	(1.365)
Teacher	−.2851	−.2925
	(2.596)	(8.418)
M.D.	.00	.6245
	.00	(6.151)
Lawyer	1.136	.2226
	(2.346)	(4.332)
R^2	.08906	.31581
Observations	2241	856
R^2 prior to occupations	.07373	.19162

explaining individual income differences.[32] It is also interesting that for those individuals who did no graduate work, incomes were significantly positively affected by the educational attainment of wife's father, and one's own father, if he was in an occupation in the top third of the status scale. However. none of the SES measures was significant in explaining income differences among those with graduate training. Despite the power of the SES variables in the lower educational attainment group, we can explain only 9 percent of the variance for those with more than 16 years of school. These results do not change when the occupational dummies are dropped except that wife's father's education becomes significant for the graduate group as well. In this, the differences in proportion of variance of income explained are smaller.

Unless our SES measures are grossly inadequate, which is doubtful, it appears that college quality has impacts above those that might really be reflecting family background. Once again, it appears that quality of schools attended has a real effect and is not merely a proxy for other factors.

[11] IMPLICATIONS

We have found that the quality of institutions of higher education has an important impact on lifetime earnings of those who attend. A subjective evaluation of institutions (the Gourman Index) was used to measure quality in many of the estimated equations, but it appears that certain objective traits that contribute to these evaluations can be isolated. In particular, average student quality as measured by the average S.A.T. scores of entering freshmen, and faculty salaries, are strongly related to the Gourman Index and are the most important of the measurable institutional traits in the earnings functions of former students.

The importance of college quality does not appear to vary significantly with years of college (and graduate school) attended. We have only weak evidence of an interaction between college quality and student ability. Quality does affect later incomes more than it influences incomes immediately on entering the labor force. These results hold even after controlling for certain occupational choices, individual ability, and socioeconomic background.

There are certain limitations on the usefulness of these results. Although we have made statements about the statistical relationship between school quality and later earnings, we have been unable to do muct cost-benefit or rate of return analysis. That is, although the average S.A.T. scores of entering freshmen is a significant factor in later earnings of individuals who attend college, we do not know (1) how a school might go about improving the average S.A.T.'s, (2) how much it would cost to raise average S.A.T.'s by any amount or percentage, and hence, (3) the rate of return to students (and presumably the school) from the school that successfully raised the average S.A.T. scores of its students. Almost all our measures of quality cannot easily be considered in cost terms, and so rates of return from these aspects of quality are impossible to estimate.

Choice of institutions depends on many factors. It should be stressed that this study has focused only on lifetime income maximization. This approach does not intend to minimize the importance of non-monetary outcomes of higher education. These have not been discussed or related to institutional quality. However, the powerful effects that emerged from the single dimension studied would lead us to predict that quality is related to non-income variables as well.

Although several psychologists have found effects of college quality to be small, they have been constrained by data sets that, unlike ours, lack the longitudinal perspective of twenty years. Perhaps the non-monetary impacts are more affected by college quality over time as well.

NOTES

1. J. S. Coleman, E. Q. Campbell, C. J. Hobson, J. McPartland, A. M. Mood, F. D. Weinfeld, and R. L. York, *Equality of Educational Opportunity* (Washington, D.C.: U.S. Department of Health, Education, and Welfare, 1966).
2. C. Jencks, et al, *Inequality, A Reassessment of the Effect of Family and Schooling in America* (New York: Basic Books, 1972).
3. S. Bowles, "Schooling and Inequality from Generation to Generation," *Journal of Political Economy*, May/June 1972, Part II, pp. S219–S251.
4. A. W. Astin, "Undergraduate Achievement and Institutional 'Excellence'," *Science*, August 1968, pp. 661–668.
5. Astin, 1968. (see note 4.)
6. J. S. Spaeth, and A. M. Greeley, *Recent Alumni and Higher Education, A Survey of College Graduates*, report prepared for the Carnegie Commission on Higher Education (New York: McGraw-Hill, 1970).
7. E. A. Hanushek, *Education and Race, An Analysis of the Educational Production Process* (Lexington, Mass.: D.C. Heath and Company, 1972).
8. For example, P. Taubman and T. Wales, *Higher Education as a Screening Device* (New York: National Bureau of Economic Research and the Carnegie Foundation for the Advancement of Teaching, 1974).
9. The IQ variable used is a combination constructed by factor analysis of several of the AFQT tests and has a mean of .30 and a standard deviation of 1.86.
10. Ten thousand of these World War II veterans were surveyed by Thorndike, and his work resulted in a book, *Ten Thousand Careers*. The same 10,000 people were surveyed by the National Bureau of Economic Research in 1969, and approximately 6,000 of these people provided usable information to us.
11. Of course, an individual's IQ will be highly correlated with his S.A.T. scores. However, here we are looking at the effect of *average* S.A.T.s of *all* students at a college on an individual's subsequent income, controlling for the individual's IQ.

12. S.A.T. scores given by: J. Cass and M. Birnbaum, *Comparative Guide of American Colleges* (New York: Harper and Row, 1969); intellectuality and selectivity indices given by: A. Astin, *Who Goes Where to College?* (Chicago: Science Research Associates, 1965).
13. AAUP, "The Econonic Status of the Profession," *AAUP Bulletin*, Summer 1964. Data are for 1963–1964.
14. One might ask about the relationship between these traits and academic salaries, and also which of these has more important effects on students' later incomes. However, data limitations enable us here to look only at the gross relationship between faculty salaries and student incomes.
15. This is true if we assume contact hours per faculty member are constant. Obviously:

$$\frac{\text{Expenditures}}{\text{Students}} = \frac{\text{Expenditures}}{\text{Faculty}} \times \frac{\text{Faculty}}{\text{Contact Hours}} \times \frac{\text{Contact Hours}}{\text{Students}}$$

16. Quality can be thought of as attributes of colleges that increase learning, which, in turn, enable students to earn larger incomes in later life.
17. J. Gourman, *The Gourman Report* (Phoenix: The Continuing Education Institute, 1967).
18. Charles F. Elton and Sam A. Rodgers, "The Departmental Rating Game: Measure of Quantity and Quality?" *Higher Education*, No. 4, 1973.
19. A. M. Cartter, *An Assessment of Quality in Graduate Education* (Washington, D.C.: American Council on Education, 1966).
20. K. D. Roose and C. J. Andersen, *A Rating of Graduate Programs* (Washington, D.C.: American Council on Education, 1970).
21. Cass and Birnbaum, 1969. (see note 12.)
22. Astin, 1965. (see note 12.)
23. That is,

$$\sum_{i=1}^{t} \Delta H_i = H_t$$

24. See B. Chiswick, *Income Inequality: Regional Analyses Within A Human Capital Framework* (New York: National Bureau of Economic Research, 1974), for the development of a model that required the dependent variable to be log of earnings and both EXP and EXPSQ as independent variables. Also see J. Mincer, "The Distribution of Labor Incomes: A Survey with Special Reference to the Human Capital Approach," *Journal of Economic Literature*, March 1970, pp. 1–26.
25. Obviously,

$$\frac{\partial Y_t}{\partial Q} = \frac{\partial Y_t}{\partial H} \cdot \frac{\partial H}{\partial Q}$$

We are able to estimate

$$\frac{\partial Y_t}{\partial Q}$$

but not

$$\frac{\partial Y_t}{\partial H} \text{ or } \frac{\partial H}{\partial Q}$$

26. These were obtained through the generous cooperation of Mrs. M. Eymonerie of the American Association of University Professors, Washington, D.C. The 36 schools were not identified specifically but represent a cross section of American colleges.
27. The F ratio was 12.43 and the critical F for the given degrees of freedom for significance at the 1 percent level is 1.99.
28. President's Commission on Veterans Payments, *The Historical Development of Veterans Benefits in the U.S.* (Washington, D.C.: Government Printing Office, 1956), p. 156. The

Servicemen's Readjustment Act, known as the G.I. Bill of Rights, passed in the 78th Congress 1944, paid up to $500 per year tuition plus $50 per month with no dependents or $75 per month with one or more dependents. In 1945 the monthly payments with one or more dependents were raised to $90 and in 1948 were raised to $105 with one dependent and $120 with more than one dependent.

29. Census of Population, 1950. Special Report P.E. 5b *Education* (Washington, D.C.: Government Printing Office, 1953).

30. Assuming a nine month school year, $k = \frac{(3/4 \cdot 3{,}008) - 1{,}200}{3{,}008} = .35106$. The crudeness of this assumption should be obvious.

31. G. S. Becker, *Human Capital* (New York: National Bureau of Economic Research, 1964). Although Becker acknowledges the crudeness of his estimate, it has been widely cited. Although there is some reason to believe that the present estimate is more accurate, since we were able to control explicitly for more factors, we should not argue too strongly on this point except perhaps to say that Becker's estimates of the returns to a college degree might be a bit too high. Our estimates also are very crude.

32. The correlation between years and quality of the last school attended is about .25.

33. Taubman and Wales (see note 8) estimate an upward bias in the coefficient on years when the IQ is omitted of about 30 percent. This depends on the specification of their model and on the particular measure of IQ used.

34. Coleman, et al. 1966.

35. As stated earlier, the significance of the average S.A.T. scores might be measuring the effects of students' own abilities not captured by IQ. However, there seems to be no reason why 1963 S.A.T. scores would better represent ability than would the ability measures taken in the Air Force usually before college attendance. Other variables used to measure quality apparently relate to income only as proxies for the same effects measured by faculty salaries and average S.A.T. scores. Of course, it might be that other aspects of quality are important but are omitted from our model or are inadequately measured.

36. Several individuals attended graduate schools for which average faculty salary and average S.A.T. scores were not available. In those cases, the Q_{GRAD} appears as 0 and this tends to lower the slope of the graduate quality coefficients in these two cases. The seriousness of the bias created thereby has not been investigated.

37. Columns 1 through 6 in Table 8 contain only respondents who had data for all three quality measures—S.A.T., average faculty salary, and Gourman—for their undergraduate schools and for their graduate school, if they attended. Columns 7 through 10 contain a larger sample, omitting only those without Gourman and expenditure data. The larger sample has individuals with lower mean IQs and who attended lower average "Gourman" quality schools. It is interesting that the lower-quality sample revealed smaller impacts of college quality than did the more exclusive groups. This will lead us into our study of the interaction between ability and quality in the next section.

The second change in the specification of Table 8 is that four dummy variables were inserted to account for "occupations." These serve to increase the coefficient on years for reasons elaborated elsewhere. Pilots had low education and high earnings, whereas teachers generally had the reverse.

38. For this test a weighted mean was constructed from the quality coefficients of the regressions in Table 8. Let $W_i = (1/\sigma\beta_i)/\Sigma_j(1/\sigma\beta_j)$, where $\sigma\beta_i$ is the estimated error of β_i, the quality coefficient of attainment 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 two attainment classes). (see Hause, *American Economic Review*, May 1971, p. 294.)

39. When comparing those with less than 16 years of schooling to those with exactly 16 years, the calculated F was .3576 and the critical F was 1.84 at the 5 percent level. When comparing those with 16 or fewer years to those with 17 or more, the calculated F is 3.790 and the critical F is 2.25 at the 1 percent level.

40. Jacob Mincer, "On The Job Training: Costs, Returns and Some Implications," *Journal of Political Economics*, Supplement, October 1972.
41. Christopher Jencks attributes the large amount of variance in individual earnings not explainable by traditional variables to the fact that luck and random forces predominate and are the main influences on individual income differences. Certainly there are random elements involved in lifetime earnings streams. I would like to stress the things we do know about income determination rather than the things we don't know. However, it does appear from these regressions at different points in the life cycle that random elements are a weaker force for those people who attend graduate school, and this luck or randomness seems to decline over time for those who have attended graduate school. On the other hand, the unexplainable portion of income differences among individuals is the same for those with 16 or fewer and those with more than 16 years of schooling when they initially enter the labor force. However, the role of these random forces does not seem to decline over time for those who do not go to graduate school, contrary to what happens to those who do go on.
42. The Carnegie classifications are described in more detail by: Carnegie Commission, *Dissent and Disruption* (Berkeley, California: The Carnegie Commission on Higher Education, 1971), Appendix C.
43. Apparently, 134 people who went to graduate school went to institutions with codes between 50 and 80. Presumably, these were people who got only a master's degree, and for them differences in Gourman ratings or expenditures were not significant factors in the earnings function.
44. For example, in *Playboy* magazine's predictions of the 1973 top 20 college football teams in the nation, they anticipate that 17 of the top 20 teams will be from public institutions. (September, 1973, p. 172.)
45. The relationship that includes interaction between ability and college quality may be written

$$(1) \quad ln\, Y = a + bQ + cA + gQ \cdot A$$

where *ln* Y is log of income, Q is college quality, and *A* is the individual's ability. Hence

$$(2) \quad \frac{d\, ln\, Y}{dQ} = b + gA$$

If g is greater than zero, then the effect of any level of school quality is greater, the higher the ability of the individual concerned. A negative g implies an inverse relationship. This specification assumes a *linear* interaction between the two continuous dependent variables. Another type of test can be suggested that does not constrain the interaction to be linear. The method involved grouping the sample by similar IQ levels (e.g., IQ quartiles) and estimating earnings functions separately for each IQ quartile. Comparisons can be made of quality coefficients across groups.
46. The *t* test was $H_0 : B_H = B_L$. B_H is the coefficient of quality for the high-ability half of the sample and B_L is the quality coefficient for the low-ability half.
47. When S.A.T. and average salaries are inserted together, their effects are both more significant (t test) and larger (size of coefficient) for the high-IQ half of the sample.
48. In both cases the significant *F* level of 5 percent was 2.60 and the *F* for undergraduates was .32 and for graduates, .57.
49. J. Karabel and A. W. Astin, "Social Class, Academic Ability, and College 'Quality'," (unpublished) Office of Research, American Council on Education, June 1972.
50. R. M. Hauser, K. G. Lutterman, and W. H. Sewell, "Socio-Economic Background and the Earnings of the High School Graduates," paper presented at the meeting of the American Sociological Association, Denver, August 1971.
51. Bowles, 1972. (see note 3.)
52. For comparison, see the 1969 regressions in Table 10.