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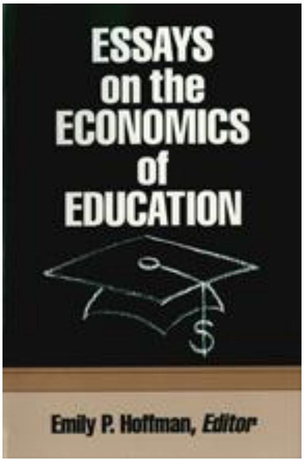

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College Choice, Academic Achievement and Future Earnings

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A major issue in the literature on the economics of education is: Do schools make a difference? Do different schools produce different outcomes, and if so, why? Numerous studies have analyzed this question at the primary and secondary levels, usually using cognitive learning as the output variable. Only a small number of studies have tackled this issue at the college level, where the research interest has largely focused on the returns to quantity rather than quality. These studies have used future earnings or occupational status as the output variable, consistent with the premise that an important function of education is to improve one's position in the labor market. Colleges can enhance productivity and earnings by imparting general or specific skills, or information that helps students make good choices about their future career directions. Studies of college quality, like those of the quality of primary and secondary schools, have come up with ambiguous and contradictory results.

For example, in his analysis of the NBER Thorndike earnings data (for a group of World War II veterans whose earnings were measured in 1969), Wales (1973) found that graduates of top colleges (as measured by the Gourman rating, which is related to selectivity) received significantly higher earnings. Using the same data, Wachtel (1976) found that college expenditures per student exert a positive effect on earnings, and Solmon and Wachtel (1975) found that college type, as measured by Carnegie classification, also matters. According to Reed and Miller (1970), college rank (as measured by the average verbal and mathematical aptitude of entering freshmen) had a positive effect on the weekly earnings of a sample of men surveyed by the Census Bureau in 1967. However, most of the students covered by these studies were in college prior to the vast expansion of the 1960s, which changed the nature of the higher education industry. In these regressions, usually only one college characteristic is specified as an indicator of quality. And only a small set of student background variables is included. Astin and others have argued that the impact of college quality is minimal once these are controlled (Astin 1968; Griffin and Alexander 1978). Indeed, a study by Alwin (1974) found only a small relationship between occupational success and college characteristics, after controlling for student composition.

One key problem encountered by all these studies has been the difficulty in obtaining detailed information about student characteristics, in order to control for ability, family influence, and prior education, which is essential if the purpose is to calculate the value added by the school. Longitudinal data tracking the individuals in a cohort are particularly scarce. Another problem has been the difficulty in obtaining disaggregated information about schools. A final problem is that we rarely have data about the student's college experience and academic achievement, such as choice of courses, major and GPA, that may influence earnings. (See Hanushek 1986, for a thorough analysis of these and other problems that beset the "school effectiveness" and "educational productivity" literature.)

In this paper we exploit a uniquely rich data set, the National Longitudinal Study of the High School Class of 1972 (NLS-72) and the Postsecondary Education Transcript Study (PETS), to overcome these problems and answer the questions: Does it matter which college a student attends? If it matters, which college characteristics lead to higher earnings? Do higher expenditures or a more selective student body imply superior results? Which is better, a large research university or a small liberal arts college? Does the public/private typology make a difference, as some feel it does at the secondary level? We also examine the impact on earnings of student behavior while at college. Are academic achievement and curriculum choice harbingers of future achievement? (For a preliminary analysis of these issues see James, Alsalam, Conaty, and To 1989.)

We begin by setting forth our methodology, including our model, data sources, choice of variables, and statistical technique. In the second part of this paper we present our findings concerning the effects of college characteristics, and in the third we give our results concerning the effects of other aspects of the college experience, particularly choice of major. The fourth section is a summary of our results and their limitations.

Briefly, our fixed-effects model shows that the particular college attended does indeed make a difference, explaining 17 to 29 percent of the variance in earnings. However, we are unable to tie this college effect down to observable college characteristics, which taken as a group explain only 1 to 2 percent of the variance in earnings. These effects exist, but they are very small.

Moreover, whether fixed effects or observable characteristics are measured, the college effect becomes statistically insignificant once family background, labor market experience, and major are controlled. To a large extent the world perceives a differential college effect because it is perceiving "gross output" rather than "value-added" and is not taking account of the many other factors that affect earnings, some of which are correlated with choice of college.

In contrast to these negative findings about college effects, we find that what a student does while in college strongly affects future earnings, even after all the other variables in our model are controlled. Apparently, direct measures of skill acquisition matter more than indirect screening by college characteristics.

Methodology

The Model

As is well known, there are multiple outputs of higher education, including knowledge gained, earning power enhanced, values formed, amenities consumed, and research undertaken, all of which enter into student and social utility functions. In this paper we concentrate on one output of education—future earnings—as a function of all the jointly supplied inputs.

We model earnings *(Y)* as a function of four sets of variables:

X_1 = a set of individual characteristics including family background and prior academic achievement;
X_2 = a set of institutional characteristics, including college expenditures, college organization, and student body composition, which determine the value added by the college;
X_3 = higher educational experience variables that are chosen by the student but may be influenced by the college;
X_4 = labor market variables, such as experience and weeks worked per year.

Our focus here is on the impact on earnings of institutional characteristics and other aspects of the higher educational experience.

Before presenting our results we outline the data and expected direction of causal relationships, and discuss our treatment of several methodological problems.

Data Sources and Sample

Information about student characteristics, earnings, and other labor market variables comes from the National Longitudinal Study of the High School Senior Class of 1972, which follows this cohort through further education and into the labor market. This survey gives detailed information about family background, education, and academic achievement prior to entering college, as well as subsequent labor market experience. The fifth follow-up in 1986 includes 12,841 men and women. Two-thirds of the total had some postsecondary education and one-fourth had received their college degree. We deal in this paper with a subset of the latter group, the 1,321 males whose graduating institution was identified, who took at least sixty credit hours in that institution, and who worked for an employer at least twenty hours per week in 1985. Most of them had been out of college for seven to nine years.

There are 499 colleges and universities in our subsample. Over half are Ph.D.-granting institutions, three-quarters are public, and enrollment size varies from 288 to 50,011. Many of the smaller colleges enrolled only one member of our sample, but 285 institutions (typically the larger ones) had two or more observations, totaling 1,107 male students; we used these as a subsample for the fixed-effects models. We obtained most of our data about the characteristics of these colleges and universities from the Higher Education General Information Survey (HEGIS), which conducts annual surveys of postsecondary four-year institutions; we chose 1975 as a representative year for our cohort. This was supplemented by data from Cass and Birnbaum (1975).

Finally, the Postsecondary Education Transcript Study gave us the college transcripts of each student, from which we derived the college experience variables. None of the previous studies on college quality has had access to such detailed information about curriculum choices and achievement in college. All financial data were inflated to 1986 prices using the Consumer Price Index.

Institutional Characteristics

We view the college consumer as purchasing a set of characteristics that is experienced uniformly by all students at a given institution. In our fixed-effects model we identify each college by a dummy variable that captures all its observable plus unobservable characteristics. In our ordinary least squares (OLS) models we examine the observable characteristics in greater detail. This section describes some of the observable variables we use.

The school effectiveness literature has been particularly interested in the influence of "expenditures per student." If colleges were competitive, privately financed, profit-maximizing institutions, and if consumers cared primarily about future earnings and had full information about educational production functions, higher costs would have to be covered by higher prices which would be sustainable only if they led to higher future earnings. However, the institutions in our sample are public or nonprofit, much of their revenues coming from state legislators or donors, and devices such as accreditation procedures and reputation limit entry. Under these circumstances, colleges may have potential profits with which to pursue their own discretionary goals, their nonconsumer funders may support multiple objectives, and students may be uninformed about college effects or may care about many outputs of education besides future productivity. As a result of all these factors, we do not have a strong *a priori* reason to expect a systematic relationship between college expenditures and future earnings.

To investigate the expenditure effect, we started with the idea of decomposing college spending into its separate components—expenditures on instruction, research, institutional support services, and financial aid. However, strong multi-collinearity precluded this strategy. Therefore we used, alternatively, the most inclusive measure, logged educational and general spending per student (LXPS); the most directly relevant measure, logged instructional expenditures per student (LINSXPS); and a combination of inputs—the student-faculty ratio (S/F) and average faculty salaries (FACSAL). Ideally, we would have adjusted our measures of monetary inputs for regional cost differences, but unfortunately we did not have access to the detailed city-by-city, education-relevant cost-of-living index that would be necessary to convert these monetary inputs into real inputs. However, our experiments with S/F captured the basic idea. As it turned out, the results for all the cost variables were very similar, and those with LXPS are presented in this paper.

We wanted to investigate whether institutions under public versus private control, with research versus teaching missions, and with predominantly graduate versus undergraduate student bodies, behave differently. Theory suggests that such differences exist, but the direction and magnitude are ambiguous. For example, private institutions may utilize their resources more efficiently than public ones and may benefit from a halo effect in the labor market or on the other hand may have to devote substantial resources to fundraising (see James 1989). The presence of doctoral students may lead to a diversion of resources away from undergraduates or conversely may add a pool of cheap labor available to teach undergraduates. And similarly, research may enhance or detract from the undergraduate teaching function (see James 1978; James and Neuberger 1981). These possible effects were captured by entering private colleges, Ph.D.-awarding institutions, and Research Type I Universities (Carnegie classification) as dummies (PRIV, PRIV*E, PHD, RES) or, alternatively, as interactions with expenditures per student, and by including the percent of graduate students in total enrollment (PGRAD). The total number of FTE students (LFTE) was entered to allow for economies or diseconomies of scale.

Regional dummies were included to capture regional fixed effects. Only East (E) had any impact and was left in the final regression.

We were particularly interested in the impact of the average SAT score of entering freshmen as an index of institutional selectivity (SEL). Selectivity may influence earnings in several ways: it may raise the amount of learning, hence the acquisition of general human capital at the institution through the peer group effect; it may be an informational signal to employers about the probable aptitude of individual students (a version of the screening hypothesis); and students from a more selective institution may benefit from its prestige or from the social network that it generates.

Higher Educational Experience

While in college the student makes a number of choices—concerning major, curriculum, how hard to work to obtain a high GPA, and whether to proceed to a postgraduate degree. How do these choices influence future earnings? We examine the impact of choosing majors in Engineering (ENG), Business (BUS), Humanities and Fine Arts (HUM), Social Science (SOCSCI), Math plus Physical Science (M&SCI), Biological Science (BIO), Health Professions (HEALTH), and all others (OTHER), relative to education, the omitted category. The choice of major influences the range of occupational options that will be open to a student later in life; therefore we would expect some of these dummies to be positive and others to be negative. We also included the number of college math credits and Math GPA; our final specification uses the interaction of these two terms (MATH*GPA). Finally, we introduce the college GPA as an independent variable, on grounds that this may signal cognitive skills and traits such as discipline and perseverance, to the employer. Postgraduate degrees are broken down into MA and all others (HIDEG); the latter, in particular, is expected to have a positive effect.

Background Characteristics

A voluminous literature documents the fact that family background and prior academic achievement strongly influence future earnings, much of this operating through their impact on the choice of college and probability of completing college. We would expect background effects on earnings to be much smaller in this study, where everyone has a college degree and characteristics of the college are explicitly included. However, some background variables may still be important, in part because they serve as proxies for unobserved productivity-enhancing student characteristics such as ambition, learning acquired in the household, and access to labor market information. Including these variables should therefore increase the explanatory power of our model and reduce the potential bias in the estimated coefficients of the college variables with which they may be correlated. Student background variables included as controls were race or nationality (BLACK, BLK-SOUTH, HISP), religion (CATH, JEW), parental income (FAMINC), father's education (FAED), attendance at Catholic high school (CATHHS) and other private high schools (OTHPVT), percentile rank in high school (PRANK), a dummy for playing a leadership role in high school newspaper, student government, or athletics (XCURR), and the individual's verbal plus mathematics SAT score or a transformation of ACT scores into SAT (SAT). (For the method used to convert ACT to SAT, see Astin 1971.)

Labor Market Experience

While our focus is on undergraduate education, in some equations we control for a host of basic market variables that influence earnings: total months of employment since degree (EXP), tenure on current job (TEN), weeks worked in 1985 (LWW), hours worked per week (LHW, which we treat as a two-part spline allowing for the possibility that returns per hour may differ for hours worked under or over 35 per week), and a dummy for career interruptions that exceeded one year (INTERR). Marital status and number of children in 1985 were included as variables that might influence unobservable labor market choices such as effort.

Specification Problems and Alternative Models

A problem that always arises in the school effects literature concerns biases that may be introduced by unobserved elements of student and institutional characteristics, and by the endogeneity of elements of some college and labor market variables. For example:

1. The omission of some institutional characteristics may understate the total college effect. We deal with this problem by including a dummy variable for each college, which captures its full observable and unobservable characteristics in the fixed-effects model.

2. The correlation between unobserved student characteristics and observed institutional characteristics may bias the college effect. Suppose that, as a result of student choice and college admissions procedures, ambitious, hard working students end up in colleges with a high selectivity index and expenditure rate. These colleges would appear to increase the earnings of their students, whereas actually they were simply choosing students who would have earned a lot anyway due to their ambition. We have tried to minimize this problem by including numerous observable student variables (such as high school rank and extracurricular activities), and college experience variables (such as curriculum and GPA) that may be correlated with and therefore proxy the unobserved characteristics. In some equations, we used instrumental variables for SEL and LXPS.

3. Some colleges may have policies that induce their students to enter remunerative majors and to acquire postgraduate degrees (for example, these colleges may not offer low-paid education majors, may require math, and may help their students gain entry to graduate and professional schools). If so, controlling for the higher educational variables understates the college effect. We deal with this problem, in part, by running our regressions with and without the higher educational variables. If college policies determine curriculum choice, the college effect on earnings should decline when curriculum is controlled.

4. The effect of the higher educational experience variables may also be biased by their correlation with unobserved student characteristics; e.g., students who choose to take math courses may be smart and hard working and hence earn high wages because of these characteristics, not because of the skills they acquired while taking math. We considered using two-stage techniques here, but it is difficult to find instruments that are clearly exogenous, can confidently be excluded from the wage equation, and are good predictors of curriculum choice. Thus, we have not been able to eliminate the possibility that the large

effects found for the college experience variables are due, in part, to their correlation with unobserved student attributes.

5. Similar specification problems could be outlined with respect to the labor market variables.

Despite all these limitations, we believe that a clear picture does emerge of the impact of college characteristics and college experience variables, since our basic results are robust with regard to the various specifications explored.

College Effects

Tables 1 and 2 present our estimate of logged annual earnings for 1985 (LY 85) as a function of college characteristics (X_2) and higher educational experience (X_3), in some cases controlling for student's background (X_1), which precedes college, and labor market choices (X_4), which follow college. Lifetime earnings would obviously have been a preferable but unavailable dependent variable. Our indicator of earnings seven to nine years after college is a much better indicator than starting wages, which have sometimes been used in studying school effects.

We present a series of equations that starts with X_2 and sequentially adds X_1, X_3, and X_4. Table 1 uses fixed college effects and is based on a subsample of 1,107 students in 285 colleges with two or more students. Table 2 uses OLS with observable college characteristics in place of the institutional dummies and is based on the full sample of 1321 students and 499 colleges. In addition to giving the individual variables, we also calculate the proportion of variance explained by the individual, institutional, higher educational experience, and labor market variables as a group. When all the variables are included, we are able to explain over half the variance in earnings of this cohort of college graduates.

Fixed Effects

Column (1) of table 1 presents a "gross output" fixed-effects model that replicates "what the world sees." Each college is represented by a

Table 1. 1985 Annual Earning Regressions for Males with Fixed College Effects Explanatory Power of Groups of Variables (2+ sample)

	College dummies (1)	College + background (2)	College + background + LM (3)	College + background + LM + higher ed (4)
R^2				
Entire model	.333[a]	.365[a]	.507[a]	.56[a]
College dummies	.333[a]	.286[b]	.211[c]	.171
Background		.032[a]	.022[b]	.015[c]
Labor market			.142[a]	.124[a]
Higher ed. exp.				.053[a]

NOTES: Each regression is estimated for a sample of 1,107 males from the High School Class of 1972 who eventually received a bachelor's degree, from 285 colleges, each of which had two or more students in our sample.

a. Significant at .1% level

b. Significant at 1% level

c. Significant at 5% level

Background variables that were significant in at least one equation in Tables 1 or 2 are family income, SAT score, Black, Black*South interaction, Catholic, Catholic H.S., other private high school. See text for other background variables that were included.

Labor Market variables are experience, tenure on current job, log weeks worked last year, hours worked per week, marital status, number children, career interruption.

Higher Education variables are dummies for different majors (Business, Engineering, Math-Science, Humanities, Social Science, Biology, Health Science, Other, Education as omitted category), GPA, Math*GPA, MA degree, higher degree.

Table 2. Annual Earnings Regressions for Males with Observable College Characteristics (full sample)

	College characteristics (1)	College + background + LM (2)	College + background + LM (3)	College + background + higher ed (4)
College characteristics				
SEL	.051	.026	.017	.012
	(2.93)[b]	(1.42)	(1.06)	(.8)
LFTE	.08	.064	.048	.037
	(3.48)[a]	(2.74)[b]	(2.32)[c]	(1.84)[d]
PRIV	.004	-.029	-.05	-.005
	(.08)	(.54)	(1.04)	(.11)
EAST	-.025	-.04	-.052	-.008
	(.55)	(.9)	(1.3)	(.20)
PRIV*E	.149	.136	.182	.106
	(2.1)[c]	(1.94)[c]	(2.93)[b]	(1.76)[d]
PGRAD	-.001	-.002	-.001	-.001
	(.5)	(.81)	(.59)	(.38)
LXPS	.003	.011	.035	-.009
	(.05)	(.21)	(.76)	(.21)
LXPS*RES	-.003	-.005	-.003	-.003
	(.62)	(.94)	(.6)	(.74)
Higher education experience				
BUSMAJ				.326
				(6.89)[a]
ENGMAJ				.484
				(7.75)[a]
M&SCI				.273
				(4.05)[a]
HUM				.051
				(.82)
SOCSCI				.259
				(5.32)[a]

Table 2 (continued). Annual Earnings Regressions for Males with Observable College Characteristics (full sample)

	College characteristics (1)	College + background + LM (2)	College + background + LM (3)	College + background + higher ed (4)
BIO				.238
				(3.78)[a]
HEALTH				.243
				(3.35)[a]
OTHER				.189
				(3.83)[a]
GPA				.066
				(2.0)[c]
MATH*GPA				.002
				(3.45)[a]
MA				.05
				(1.45)
HIDEG				.151
				(2.59)[b]
Constant	9.013	8.984	-1.018	-.67
	(20.96)[a]	(20.8)[a]	(.83)	(.22)
R^2				
Entire model	.038[a]	.09[a]	.301[a]	.382[a]
College characteristics	.038[a]	.014[c]	.013[b]	.005
Background		.039[a]	.03[b]	.025[b]
Labor market			.211[a]	.202[a]
Higher ed. exp.				.079[a]

NOTES: Each regression is estimated for a sample of 1321 males from the High School Class of 1972 who eventually received a bachelor's degree from 499 colleges. See Table 1 for significance levels and other variables that were included in regressions.

a. Significant at .1% level

b. Significant at 1% level

c. Significant at 5% level

d. Significant at 10% level.

dummy that captures its fixed effect. Consistent with conventional wisdom, the college that a student attends makes a significant difference in this model, explaining 33 percent of the variance. This specification maximizes the college effect, since it subsumes both observable and unobservable college characteristics (including 285 dummy variables) and does not control for anything else.

Of course, much of this effect stems from the background of the students, which is not randomly distributed across colleges. Thus, in column (2) we include both institutional dummies and student background, in an effort to measure "value added" by the college. Although the proportion of variance explained by the college dummies declines (to 29 percent), their effect remains highly significant. In column (3) we enter the basic labor market variables, and column (4) adds the higher educational experience variables. As discussed above, these explanatory variables may in part be capturing college policies or correlated student characteristics that determine earnings. Therefore, their inclusion should increase the explanatory power of our model and at the same time decrease the apparent college effects. Indeed this is what happens. In the last equation, the fixed college effects as a group explain only 16 to 17 percent of the variance in earnings, half of the original amount, and given the large number of degrees of freedom used up, this is no longer significant. For reasons given earlier, we believe the "true" size of the effect is smaller than that in equation (1), but larger than that in equation (4); i.e., it explains between 17 and 29 percent of the variance in earnings and is marginally significant.

Observable College Characteristics

Table 2 replicates these results using observable college characteristics in place of the separate dummy variables for each institution. These equations attempt to ascertain where the college effect is coming from. We are not very successful in that regard, since the observed characteristics as a group explain only 1 to 2 percent of the variance in earnings, once other variables are controlled.

Column (1) includes college characteristics only, and column (2) adds family background. Column (3) is closest in spirit to earlier estimations by Wachtel (1976), Solmon and Wachtel (1975), and Reed and Miller (1970), and our results are similar (positive but small college effects)—increasing our confidence in these findings. The differences in our overall conclusions, then, stem from the richer set of variables we have been able to use. When both higher educational experience and labor market variables are included, as in column (4), neither the individual college characteristics nor their sum has a significant effect.

To the extent that observable college variables matter, it appears that characteristics associated with size, control, and possibly student body composition matter most. A doubling in enrollments increases earnings 4 to 6 percent, an indication of economies of scale in producing future earnings that may stem from greater program variety (enabling better student-major matches) or from greater visibility and access to labor market information. We obtain ambiguous results on the advantages of attending a private college, consistent with our ambiguous predictions: this has a positive effect (of 10 to 13 percent) in the East (where private colleges have long-standing labor market connections), but not in the rest of the country. As expected, SEL has a positive effect in columns (1)–(3)—a 100-point increase in SAT of freshman class increases earnings 3 to 5 percent)—but its size declines and significance disappears when higher educational experience and labor market variables are in the equation, as in column (4).

In contrast to the college variables that matter, expenditure per student (LXPS) has a small coefficient that is never close to significance. This contradicts Wachtel's earlier finding but is consistent with Morgan and Duncan's (1979) and with much of the literature on primary and secondary school effectiveness.

We thought that the high-spending institutions might be universities that allocate much of their resources to graduate programs and research. To test this possibility, we tried specifications in which LXPS was interacted with Ph.D.-granting or Research Type I universities and/or dummies added for Ph.D.-granting institutions, research institutions, and percentage of graduate students. The interaction terms were always negative, and the main LXPS effect became more positive (or less negative), but nothing we did ever made it significant. Apparently research and graduate programs do not increase or decrease future undergraduate earnings, and they also do not explain the unimportance of LXPS. We obtained similar results when instructional expenses, faculty salaries, and S/F ratios were used instead of LXPS. Based on the experience of this sample, it appears that attending a higher-spending college is not the way to increase future earnings.

Alternative Specifications

Because these negative findings about selectivity and expenditures per student run counter to the conventional wisdom, we explored alternative specifications to see whether and under what conditions positive effects might emerge (see table 3).

1. We attempted to deal with the endogeneity problem by using instrumental variables to predict the selectivity of a student's college; the predicted selectivity value was then used in place of the actual value in column (1). We did the same for expenditures per student. The coefficients on SEL and LXPS rise when instrumental variables are used, but neither equation changes our basic conclusion that LXPS is always insignificant, and SEL is insignificant when higher educational experience and labor market variables are in the equation.

2. We considered the possibility that multi-collinearity among college characteristics was hiding the true significant effect of SEL, so we omitted all other institutional variables from the equation. We did the same for LXPS. As expected, the size of the SEL and LXPS coefficients increased in these specifications, but they remained insignificant when higher educational experience and labor market variables were both in the equation; and, of course, the total college effect declined.

3. Finally, we interacted SEL (and LXPS) with several student, college, higher education, and occupational variables to ascertain whether our uniform-effects model is understating the true effect (e.g., see Summers and Wolfe 1977). Perhaps SEL (or LXPS) has a higher payoff to students with higher SAT scores, or for those entering science majors, professional or managerial occupations, or going on to higher degrees. In general these interaction terms were insignificant. We conclude that if an interactive model is appropriate, these data are simply not strong enough to detect it.

Through all these specifications, our best estimate remains that the college a student chooses does make a marginal difference, that this difference becomes insignificant as additional explanatory variables are added to the model, and that only a very small fraction can be ascribed to college characteristics readily observed and measured.

Table 3. Alternative Specifications with SEL LXPS, and X_3

	SEL (1)	LXPS (2)	SEL only (3)	LXPS only (4)
R^2	.383[a]	.382[a]	.378[a]	.377[a]
SEL	.069	.011	.017	-
	(1.48)	(.75)	(1.48)	
LFTE	.037	.037	-	-
	(1.88)[d]	(1.83)[d]		
PRIV	-.007	-.007	-	-
	(.17)	(.16)		
E	-.049	-.009	-	-
	(.97)	(.24)		
PRIV*E	.116	.109	-	
	(1.91)[d]	(1.79)[d]		
PGRAD	-.001	-.001	-	-
	(.25)	(.43)		
LXPS	.002	.043	-	.022
	(.06)	(.28)		(.59)
LXPS*RES	-.004	-.004	-	-.001
	(.84)	(.96)		(.21)

Notes: Columns (1) and (2) use instrumental variables to predict SEL and LXPS, respectively, and then use the predicted values in place of the actual values. The full equation includes College Characteristics, Background, Labor Market, and Higher Education Experience, as in equation (4), Tables 1 and 2. Columns 3 and 4 omit all college characteristics except SEL and LXPS, respectively; full equation includes Background, Labor Market and Higher Education Experience.

a. Significant at .1% level.
b. Significant at 1% level.
c. Significant at 5% level
d. Significant at 10% level.

Table 4. Means and Standard Deviations of Variables

	Mean	Standard deviation
LY85	10.26	.52
Institutional variables		
SEL	9.87	1.16
LFTE	9.031	1.046
PRIV	0.248	
EAST	0.202	
PRIV*E	0.091	
PGRAD	12.267	8.800
LXPS	8.840	0.430
LXPS*RES	1.630	3.558
Higher educational experience		
MATH*GPA	23.785	33.444
GPA	2.914	0.464
BUSMAJ	0.230	
ENGMAJ	0.103	
M&SCI	0.058	
HUM	0.061	
SOCSCI	0.178	
BIO	0.062	
HEALTH	0.027	
OTHER	0.166	
MA	0.140	
HIDEG	0.054	

The Higher Educational Experience

Explanatory Power

While institutional characteristics do not explain a large proportion of the variance in earnings, other aspects of the higher educational experience, such as choice of major, number of math credits taken, GPA, and postgraduate degree matter a great deal. All of these variables are highly significant, add substantially to the R^2 of the model and, as a group, explain 3 to 8 percent of the variance in earnings in the OLS regressions, more than the observable college and student characteristics put together. They explain somewhat less—2 to 5 percent—in the fixed-effects model, consistent with the hypothesis that the higher education variables are determined, in part, by unobserved college policies. (See tables 1 and 2.)

Students with a higher GPA have higher expected earnings; when GPA increases from *C* to *B* or from *B* to *A*, annual earnings rise 7 to 8 percent. (Also see Wise 1975.) While GPA indicates, in part, that students have acquired specific knowledge, we prefer to think of it as a proxy for unobservable characteristics such as ability combined with inputs of time and effort, general human capital characteristics that also lead to higher productivity in the labor market. This interpretation is supported by the behavior of the student's SAT, which has a positive effect in equations (2) and (3) that becomes negative when GPA enters in equation (4). Suppose that the SAT is a proxy for academic ability or potential achievement, which must be combined with inputs of time and effort to produce actual achievement. If the combination is present it produces achievement in college and thereafter; but if the input of effort is not forthcoming in college, it probably will not be forthcoming at work either. By this interpretation, ability alone does not generate significantly higher grades or earnings; the payoff to GPA is a payoff to the combination of ability and effort.

The positive return to college math is also noteworthy for educational policy. Taking three additional math credits (usually one course) and receiving an *A* increases earnings 1 to 2 percent. This is not surprising since math governs entry to certain highly-paid occupations such as engineering. (For a further discussion of the impact of math, see Alsalam 1989a.)

A higher degree, particularly the Ph.D., LL.D or M.D., also has a significantly positive effect, raising earnings 10 to 15 percent (and probably more at a later point in the age-earnings life cycle).

This leads us to the important issue of returns to major. Which majors are worth more in the marketplace—those imparting general or specific skills? While there are large differences in the returns to different majors, in general we cannot say that either vocational or liberal arts majors have an advantage. For example, Education (which is the omitted category) is one of the least remunerative majors, but Engineering and Business, also vocational majors, are on top, 30 to 40 percent higher than Education. The Physical and Social Sciences are in between, 20 to 30 percent higher than the other liberal arts subjects, Humanities and Fine Arts.

Equilibrium Wage Differentials by Major and Social Efficiency

How are these differences in returns to majors sustainable, and would society be better off if students were induced to move to the higher-paying (and presumably higher-productivity) majors? The answers to these two questions are interrelated.

One well-known explanation for why this can be an equilibrium situation is that different majors lead to jobs with different combinations of pecuniary and nonpecuniary benefits, and different students have different preferences between these and hence make different choices. (For example, this might explain the low return to Humanities majors and the high return to Business majors who become managers.) In this case the differential returns to majors reflect differential tastes, are sustainable in the long run, and as long as students have accurate information, it would not be efficient to shift more of them involuntarily into higher-paying majors.

A second explanation is that students differ in innate ability and/or work effort, that these differences lead them to choose "hard" or "easy" majors and to earn high or low wages. (For example, the entry and exit requirements are probably more demanding for Engineering majors than Education majors.) As a variant on this explanation, some majors may have "gatekeeping" courses, such as math, which some people find hard, others easy; those with math aptitude are more likely to choose these majors and to earn a rent on their scarce aptitude. According to this interpretation, we cannot assume that people who choose different courses and majors are otherwise similar in ability or effort or attribute their earnings differential to their choice of major or to specific skills they have acquired in college; furthermore, if more students entered higher-paying majors, they may well have lower productivity and earnings than current students.

A third explanation focuses on the reasons why some majors are "hard" and others "easy" and interprets these differences as an institutional response to situations where large differences in the real cost of training students exist across majors, and "society" believes that ability or effort, rather than price, should be used to ration space in high-cost fields in order to avoid myopic choices of majors and jobs. If price is the same for all programs of study (as tends to be the case at the undergraduate level), but barriers to entry and exit vary, monetary returns will also vary; and this may be both sustainable and efficient. Under this scenario, we would expect majors with the highest training costs to have the greatest restrictions and hence the highest private monetary returns. Impressionistically, we seem to observe this relationship at the extremes (for example, this may explain the entry and exit difference between Engineering and Education), but there does not seem to be a good fit among fields in the middle.

Conclusion

In conclusion, we have defined college quality as a multidimensional concept, and this paper has concentrated on one dimension—value added to future earnings, a proxy for future labor market productivity. Our rich longitudinal data source has allowed us to control for an unusually wide range of incoming student characteristics, thereby yielding better estimates than previously possible of the impact of college and curriculum choice on future earnings.

Briefly, our fixed-effects model indicates that a student's choice of college does make a difference, explaining 17 to 29 percent of the variance in earnings. However, we are unable, using OLS, to tie this college effect down to observable college characteristics, which, taken as a group, explain only 1 to 2 percent of the variance. Thus, prospective students and the families who make their decisions based on these readily accessible indicators will not be getting much pecuniary return; on the other hand, investing time and effort to collect information about the "unobservable" characteristics of colleges may pay off.

The observable characteristics, as well as the total college fixed effect, become insignificant once curriculum choice and labor market experience are included in the equation. While controlling for all these variables may lead us to underestimate the total college contribution, omitted student variables may have the opposite effect. If the former bias exceeds the latter, we may conclude that the true size of the college effect is greater than that in column (4) of table 1 but less than that in column (1) and is marginally significant. Experiments with random-effects models and instrumental variables did not change this basic conclusion.

In particular, expenditures per student never have a large or significant effect, and college selectivity, which is widely believed to predict success, has effects that are both small and insignificant once other variables are in the equation. Findings concerning college selectivity cast some doubt on the screening hypothesis, since this is a logical candidate for employers to use as a proxy for ability. According to these results, they do not do so.

In contrast to the limited effects of college choice, what a student does while in college (which is presumably related to the human capital acquired there), strongly affects future earnings, even after all other variables in our model are controlled. Grades, major, math courses, and further degree are all highly significant and, taken as a group, explain 3 to 8 percent of the variance in earnings, more than measured college and student characteristics put together. This finding casts further doubt on the screening hypothesis.

Several caveats are in order at this point. First of all, part of the large effect of the higher educational experience variables probably stems from the unobservable productivity-enhancing student and college characteristics with which they are correlated, but which we could not capture. Second, the relative returns to different majors and occupations may change through time as a function of supply and demand, so it is impossible to generalize from this cohort to all cohorts. Third, the relative earnings of different majors and occupations may change over the lifetime of this cohort as a function of their training and its returns. For example, the doctors and lawyers in our sample had relatively little experience and are probably at the start of a steeply rising age-earnings profile, while the opposite is true for nurses and teachers.

Fourth, we have assumed uniform college effects; if a thoroughly interactive model is more appropriate, we may have underestimated college effects. (This sample is not suitable for analyzing such a model.) Finally, these results apply to men only; a paper on women is now in process, and the picture appears quite different. But at this point, we would have to conclude that if quality and output are defined in terms of future earnings and productivity, high inputs do not necessarily lead to high outputs, and indeed there is no easy way to identify high-quality colleges.

Can it be inferred that students who spend long hours trying to get accepted into selective colleges, that parents who pay high tuition, and that colleges with large expenditures are all wasting their time and money? Not necessarily. As we said at the beginning, colleges produce many outputs, and higher future earnings is but one of them. Institutions may be interested in research as well as teaching, parents may be interested in the cognitive development and/or value formation of their children, students may be interested in the social ambience of their college, and all of these may be important to society at large. Indeed, much of the expenditures of higher-spending institutions may be directed toward these other ends, some of which may have a diffuse long-run impact on productivity. Therefore, it is imperative to undertake other studies with alternative output measures to get a complete picture of the determinants and consequences of college quality.

NOTES

1. There may be substantial multi-collinearity among these variables. We did not consider this a big problem since we are not trying in the paper to identify the separate effects of each student background variable, but rather to control them to avoid overestimating the value added by the college. We also included an *F* test for the joint significance of the group as a whole.

2. Switching to OLS in table 2 allows us to use the entire sample of colleges and students as well as to weight student differentially in order to adjust for the stratified sample design used by NLS and make them representative for the sample as a whole. Using the unweighted subsample to replicate table 2 indicates that the coefficients and significance of our variable are largely unchanged by the weighting procedure. We also used a random-effects or generalized least-

squares model, to take account of the fact that all the people who attend the same school are subject to a common component and therefore have less independent variation than OLS would presume. It turned out that the variance component due to the unobserved college effect is negligible; the size and significance levels of some variables increase, but most are unchanged. Therefore we present the fixed effects and OLS results in this paper.

3. Economies of scale were also found in Cohn, Rhine, and Santos 1989, who used student enrollments and research as outputs; i.e., average costs fall as a composite of these outputs rises.

List of Symbols and Data Sources

College Characteristics

SEL	Mean SAT Score of Incoming Freshman Class 1976.
LFTE	The log of the full-time equivalent enrollment.
PRIV	Dummy variable indicating private institutional control.
EAST	Dummy variable indicating attendance at a Northeastern college.
PRIV*E	Dummy variable indicating attendance at a Private Northeastern college.
PGRAD	Proportion of full-time-equivalent students who are graduate students.
LXPS	The log of total educational and general expenditures per full-time equivalent student, including expenditures on instruction, research, public services, libraries, academic support, student services, institutional support, operation and maintenance of plant, scholarships and fellowships, and educational and general mandatory transfers.
LXPS*RES	Interaction of LXPS and the Carnegie Classification of Type 1 institutions. Carnegie Institution "A Classification of Institutions of Higher Education." 1988 p. 1.

Higher Educational Experience

MATH*GPA	Total number of math, statistics, and computer science credits earned in college multiplied by the grade point average the student earned in these courses. Math credits are calculus level and above; i.e., precollegiate and collegiate math are excluded.
GPA	Grade point average at first undergraduate degree-granting institution.
BUSMAJ	Dummy variable indicating business major.
ENGMAJ	Dummy variable indicating engineering major.

M&SCI	Dummy variable indicating a physical science or mathematics major.
HUM	Dummy variable indicating humanities or fine arts major.
SOCSCI	Dummy variable indicating social science major.
BIO	Dummy variable indicating a life science major.
HEALTH	Dummy variable indicating a health science major.
OTHER	Dummy variable for all other major except education which is the omitted category.
MA	Dummy variable indicating receipt of a Master's degree.
HIDEG	Dummy variable indicating the receipt of a Ph.D. or professional degree above the master's level, such as law or medicine.

SOURCES: Riccobono, J., L. B. Henderson, G. J. Burkheimer, C. Place, J. R. Levinsohn *National* Longitudinal Study: Base Year (1972) through Fourth Follow-Up (1979) Data File Users Manual. Vols. 1-4 C. D. Carroll, et al., *The National Longitudinal Study of the High School Class of 1972* (NLS-72) Fifth Follow-Up (1986) Data File User's Manual. Higher Education General Information Survey (HEGIS), 1975. Tuition and selectivity taken from Cass, James and Max Birnbaum, *Counselors' Comparative Guide to American Colleges: 1976 Edition* (New York: Harper and Row, 1975). Jones, C., R. Baker, and R. Borchers, *National Longitudinal Study of the High School Class of 1972*: Postsecondary Education Transcript Study Data File User's Manual, National Center for Educational Statistics, August 1986.

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