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Does it Pay to Attend an Elite Private College?

Cross-Cohort Evidence on the Effects of College Type on Earnings

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ABSTRACT

Although a substantial and rising labor market premium is associated with college attendance in general, little is known about how this premium varies across institutions of different types and across time. In this paper we explicitly model high school students' choice of college type (characterized by selectivity and control) based on individual and family characteristics (including ability and parental economic status) and an estimate of the net costs of attendance. We estimate selectivity-corrected outcome equations using data from both the National Longitudinal Study of the High School Class of 1972 and High School and Beyond, which permit us to determine the effects of college quality on wages and earnings and how this effect varies across time. Even after controlling for selection effects, strong evidence emerges of a significant economic return to attending an elite private institution, and some evidence suggests this premium has increased over time.

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I. Introduction

Previous research has shown that the labor market return to college overall has fluctuated. For example, between the mid-1970s and the mid-1980s the proportionate difference in mean wages between male college graduates and male high school graduates grew by 15 to 30 percentage points (Bound and Johnson 1992; Katz and Murphy 1992; Levy and Murnane 1992). It is not known whether this higher return applies uniformly to attendees of all types of four-year college or only to those at certain types of institutions. In particular, there is limited evidence on the relationship between college quality and labor market outcomes,[1] and none on how the return to college attendance has changed for different cohorts of students or how the return varies over time for individuals in a given cohort. In this paper, using data from the National Longitudinal Study of the High School Class of 1972 and High School and Beyond, we examine the effects of college type on hourly wages and annual earnings of college attendees from the high school graduating classes of 1972, 1980, and 1982 at various stages in the life cycle: six years after high school (for the 1972 and 1980 cohorts), ten years after high school (for the 1982 cohort), and 14 years after high school (1972 cohort).

In addition to standard wage/earnings regressions, we estimate the return to college type in the context of a reduced-from model in which choice of college is determined in part by the net costs (tuition costs minus financial aid) that individuals face at different types of colleges. Estimation of this model permits calculation of selectivity terms which reflect the probability that the college type observed for any individual was in fact chosen (Lee 1983). These selectivity terms are used to ''correct'' models predicting the wage rates or earnings of college attendees, estimated separately for each college quality type.

We find evidence of a large labor market premium to attending an elite private institution and a smaller premium to attending a middle-rated private institution, relative to a bottom-rated public school. The evidence is weaker of a return to attending an elite public university. Our analysis suggests the return to elite private colleges increased significantly for the 1980s cohorts as compared to the 1972 cohort. We also find that controlling for selection effects in wage models does not affect our estimates of the return to different college types. These are important findings in light of the large tuition increases concentrated at elite institutions during the past 15 years—a trend which, combined with declining federal student financial aid, has heightened concern about how to finance a college education (McPherson and Schapiro 1991).

1. Studies on this topic include: Weisbrod and Karpoff (1968), Reed and Miller (1970), Wales (1973), Solmon (1973, 1975), Solmon and Wachtel (1975), Wise (1975), Wachtel (1976), Griffin and Alexander (1978), Morgan and Duncan (1979), James et al. (1989), Kingston and Smart (1990), Fox (1993), Loury and Garman (1995), Berhman et al. (1995), and Daniel et al. (1995). A summary of each of these papers may be found in Brewer and Ehrenberg (1996).

II. Modeling the Effects of College Type on Labor Market Outcomes

Prior analyses examining the relationship between college quality and wages or earnings employ the same basic methodology. The logarithm of individual i's (weekly or annual) earnings or hourly wage rate ($\ln W_i$) is regressed on a set of his or her characteristics (X_i), a set of college characteristics for the school j he or she actually attended (C_{ij}), and a normally distributed error term (μ_i):

$$(1) \quad \ln W_i = \beta_0 + \beta_1 X_i + \beta_2 C_{ij} + \mu_i.$$

College quality measures are included in C, often in the form of a single variable or set of dummy variables indicating college type, with the estimated β_2 interpreted as the effect of college quality on earnings. Alternatively, college "quality" is proxied by indicators of selectivity of the undergraduate body (such as the average SATs of entering freshmen) or by resource measures (instructional expenditures per student, library size, and faculty per student).[2] This research finds that attending a higher-quality college raises wages/earnings, ceteris paribus, though the magnitude of the estimated effect varies from negligible to large. There is little evidence that particular college characteristics are systematically associated with differences in earnings, although the effect of any individual variable is shown to be small (James et al. 1989).

This simple methodology has a potential weakness in that it does not take account of the systematic selection of college type on the basis of the expected labor market payoff. Tuition costs vary considerably with colleges of different quality; in general, more-selective private institutions charge higher tuition than their less-selective private counterparts, and private institutions are more expensive than public ones of similar quality. Why do students choose to attend higher-quality institutions despite these higher charges? Why do they attend high-cost private institutions when public institutions of comparable quality are available? Presumably, the answer is partly that attendance at these colleges is expected to yield a greater economic payoff in the labor market, net of higher attendance costs, after college. If individuals invest in college quality on the basis of expected returns, college type cannot be treated as an exogenous determinant of earnings.[3]

In this paper we apply the framework developed by Lee (1983), for analyzing polychotomous choice models with selectivity, to college selection. The approach is a generalization of the well-known model of Willis and Rosen (1979). The model consists of a choice equation and an estimated outcome equation for each choice. Individuals are assumed to select a public or private college in an observable quality category j (= 1, . . . , K) which yields them the highest utility over the life cycle. The outcome of interest is the log wage rate of individual i in college type j,

2. Kingston and Smart (1990) note that there is little change across time in institutional rankings, and Solmon (1975) shows the high degree of correlation among numerous alternative measures. Conrad and Blackburn (1985) discuss the various methods by which departments and institutions have been classified in prior research.

3. There are numerous other problems with prior studies. See Brewer and Ehrenberg (1996) for a discussion.

$$(2) \quad \ln W_{ji} = \beta_0 + \beta_f X_i + \upsilon_{ji} \quad j = 1 \ldots K$$

where X_i is a vector of individual characteristics, the υ_{ji} are normally distributed error terms, and the β_j are parameters to be estimated.[4]

We represent individual i's maximum attainable utility given each of the j alternatives as

$$(3) \quad I^*_{ji} = Z_i\delta_j + \eta_{ij}$$

where Z_i is a vector of variables assumed to influence choice of college quality type, and includes the expected net costs of attendance for each individual in each college type, as well as a vector of individual characteristics. Net costs in this context refers to the difference between the tuition and financial aid an individual student would face were they to attend college type j. College category j is chosen according to the indicator function

$$(4) \quad I_i = j \textit{ iff } I^*_{ji} > \text{Max } I^*_{ki} \ (k \neq j).$$

We define, following Lee (1983),

$$(5) \quad \varepsilon_{ji} = \text{Max } I^*_{ki} - \eta_{ji}.$$

After combining Equations 3 and 5 with Equation 4, it follows that

$$(6) \quad I_i = j \textit{ iff } \varepsilon_{ji} < Z_i\delta_j.$$

Assuming that the η_{ji}'s are independently and identically distributed and have a type I extreme value distribution, our choice model can be estimated as a multinomial logit model,

$$(7) \quad Pr(\varepsilon_{ji} < Z_i\delta_j) \equiv Pr(I_i = j) = \frac{\exp(Z_i\delta_j)}{\Sigma \exp(Z_i\delta_j)}.$$

Since wages are observed only for those who actually chose each type of college, the estimated coefficients of a standard wage equation like 2 will not be consistent. The appropriate selection correction term for each individual (λ), which reflects the predicted probability that an individual selects a particular college type, derived from the reduced-form choice model, may be used to obtain selectivity corrected estimates of log wages for each choice.[5]

4. In the context of a structural model of college choice, in which schooling decisions are based in part on expected lifetime earnings from each alternative, this model represents expected lifetime earnings. Empirically, we follow the conventional methodology and specify actual wages as a function of observed individual characteristics (Willis and Rosen 1979; Gyuorko and Tracy 1988; Trost and Lee 1984; Berger 1988). As Dominitz and Manski (1996) and Manski (1993) have pointed out, however, this formulation implicitly assumes rational expectations formation on the part of students.

5. The selection correction term is defined as (dropping individual subscripts for convenience):

$$\lambda_j = \frac{\phi\,(H_j)}{\Phi\,(H_j)} \text{ where } H_j = \Phi^{-1}\,(P_j)$$

where $\phi(.)$ and $\Phi(.)$ are the probability density function and cumulative distribution function (CDF) of the standard normal; H is the inverse of the standard normal CDF evaluated at $\Pr(I_i = j)$ and P_j is the predicted probability that individual i chooses college type j.

(8) $\ln W_{ji} = b_0 + b_{ji}X_i + b_{j2}\lambda_{ji} + \upsilon_{ji} \quad j = 1, \ldots, k.$

These selectivity terms are identified by the inclusion of net costs in the college choice Equation 7, and also by functional form. (A complete list of identifiers used in the empirical formulation of the model may be found in Table A1.) In Equation 8, the estimated b's are consistent and may be used to calculate the labor market returns to college type, controlling for selection of college type. We discuss this further in Section IV.

III. Data

To our knowledge, no previous study of labor market outcomes has utilized data that permit a comparison of the differential effects of college quality over time. However, in light of changes in the overall labor market return to college and in costs of college attendance, this is an important issue. We use two sources for our data on college students: The National Longitudinal Study of the High School Class of 1972 (NLS72) and High School and Beyond (HSB), both conducted by the National Center for Education Statistics. These data were explicitly designed for cross-cohort analysis.[6] They contain detailed individual, family, and schooling characteristics for three cohorts of students: approximately 21,000 who graduated high school in 1972, and over 10,000 who graduated high school in 1980, and in 1982 (1980 high school sophomores). Information regarding college attendance, graduate school attendance, and post-high school wages and/or earnings was collected in a series of subsequent surveys.

In examining labor market outcomes, we utilize three cohort samples from NLS72 and HSB. We use the fourth (1979) and fifth (1986) NLS72 follow-ups, which provide up to three and ten years of labor market experience for those students who initially attended a four-year college after high school and subsequently completed college in four years. For HSB we concentrate our attention on the 1982 cohort for whom the restricted 1992 (fifth follow-up) survey covers up to six years in the labor market.[7] In some instances, we also use the 1986 (third follow-up) survey for the 1980 cohort, providing a maximum of two years labor market experience for those completing college; similar results for this cohort only were previously reported in Brewer and Ehrenberg (1996). In principle, use of more than one cohort permits us to determine if there are systematic differences in the college-type/outcome relationship in the 1970s and 1980s. We confine our attention to those students who attended a four-year college upon completion of high school, regardless of final graduation.[8]

6. There are some minor differences in the definition and construction of several variables across cohorts, such as the composite test score, high school GPA, and high school athletic status.

7. The NLS72 fourth follow-up was conducted in the fall of 1979, and the fifth follow-up was conducted in the spring of 1986. The latter is a nonrandom subsample of the original 1972 sample (college graduates, Hispanics, teachers, and other groups were oversampled). The HSB surveys were conducted in the spring of each year.

8. Our estimates of the return to college type partly reflect the increased likelihood of graduating from an elite institution. Prima facie evidence for this may be seen for the 1980 cohort. By 1986, 28 percent

Characteristics of colleges are obtained from various components of the Higher Education General Information Survey. This includes the state in which the college is located, its form of control (public/private), tuition levels, and undergraduate enrollment. Throughout our analyses, we employ a sixfold classification of college type based on selectivity and control. Our measure of selectivity is derived from various editions of Barron's *Profiles of American Colleges.* Colleges are grouped into six categories on the basis of entering students' class rank, high school grade point average, average SAT scores, and the percentage of applicants admitted (see Fox 1993, and Barron's). We divide institutions into three groups based on a rating of most competitive or highly competitive (''top'' or ''elite''), very competitive or competitive (''middle''), and less competitive or noncompetitive (''bottom''). We distinguish between privately and publicly controlled institutions in each category, yielding six college types (elite publics, elite privates, middle publics, middle privates, bottom publics, and bottom privates).

Our samples consist of all four-year institutions for which nonmissing enrollment and tuition data and a Barron's rating are available. In 1972 (1982), there were 79 (56) elite institutions, 72 (51) of which were under private control. Tuition was about four times higher at private schools than at publics in 1972 and 1982. The largest percentage increase (118 percent) in tuition occurring between 1972 and 1982 was at top private schools; over the same period the Consumer Price Index rose by 117 percent. In contrast, tuition rose at top publics by 87.5 percent, and by just 71.2 percent at bottom publics. The large increases in college tuition and fees occurred during the 1980s, which are *not* captured in our data.

After eliminating missing values and merging all necessary data, our sample sizes are a maximum of 3,062 for the 1972 cohort and 2,165 for the 1982 cohort. In each case slightly under half of all students attended middle-rated public institutions (1,416 in 1972, 954 in 1982). One noteworthy feature of our samples is that relatively few students attended top public schools (22 in 1972 and 35 in 1982) (and similarly for bottom privates in 1982), leading to difficulties in estimation. Characteristics of our 1972 and 1982 samples, by type of college attended, are shown in Table 1.

The patterns within a cohort are clear. Students with higher family incomes and more highly educated parents are more likely to attend higher-quality colleges. Not surprisingly, those with greater academic talent (higher high school GPAs and test scores) predominate at high-quality schools. Females, Hispanics, and blacks are much more likely to be attending top-and middle-quality schools, both public and private, in 1982 than in 1972. Finally, financial aid (from any source) is about twice as high for students attending private institutions than public.

(30 percent) of those 1980 high school seniors initially attending top private (public) colleges had not received a bachelors degree; the figures were 50 percent and 55 percent for middle private and public schools, and 59 percent and 70 percent for bottom privates and publics. In principle, one could include final education level in wage models, but since it is likely an endogenous variable, this makes estimation problematic (there are no obvious instruments). Similarly, confining attention to graduates only reduces sample sizes dramatically, making implementation of our model difficult with these data. Eide et al. (1998) report evidence that attending an elite undergraduate institution increases the probability of attending an elite graduate school.

Table 1
Sample Characteristics of College Attendees, means (standard deviations)

	1972 Cohort					
	Private			Public		
	Top	Middle	Bottom	Top	Middle	Bottom
Female	.43	.50	.57	.18	.53	.53
Hispanic	.00	.01	.02	.05	.02	.04
Black	.09	.04	.30	.14	.05	.16
Family size	2.6 (1.5)	2.4 (1.5)	2.6 (1.6)	1.8 (.94)	2.4 (1.4)	2.6 (1.6)
Family income $	18,127 (7,268)	15,570 (7,273)	11,105 (6,868)	16,474 (7,536)	14,551 (6,949)	12,182 (7,174)
High school athlete	.60	.58	.50	.68	.54	.54
Father's education	15.63 (4.6)	14.30 (4.5)	11.42 (5.7)	14.80 (5.0)	13.48 (4.70)	11.97 (5.3)
Mother's education	14.67 (2.9)	13.38 (3.3)	12.34 (3.8)	14.60 (2.5)	12.86 (3.5)	11.78 (4.4)
Test score	7,194 (876)	6,043 (1,289)	4,885 (1,595)	6,978 (843)	6,034 (1,257)	5,080 (1,599)
High school GPA	3.62 (.4)	3.24 (.6)	3.01 (.6)	3.57 (.3)	3.23 (.5)	3.14 (.6)
Rural high school	.08	.13	.18	.05	.14	.25
Urban high school	.30	.23	.36	.14	.28	.29
Public high school	.88	.80	.92	.95	.90	.90
Financial aid	1,000 (2,015)	492 (1,163)	494 (981)	311 (1,370)	212 (695)	226 (688)
Sample size	127	678	155	22	1,416	664

	1982 Cohort					
	Private			Public		
	Top	Middle	Bottom	Top	Middle	Bottom
Female	.45	.54	.56	.34	.51	.53
Hispanic	.09	.17	.21	.09	.15	.16
Black	.13	.12	.19	.11	.12	.14
Family size	3.13 (1.4)	3.41 (1.6)	3.08 (.5)	2.91 (1.4)	3.30 (1.5)	3.41 (1.6)
Family income $	41,509 (22,693)	36,095 (19,101)	31,986 (19,346)	45,091 (20,950)	34,061 (18,727)	29,955 (17,790)
High school athlete	.48	.45	.40	.49	.46	.45
Father's education	14.15 (6.8)	13.45 (5.4)	13.21 (5.1)	15.88 (5.7)	12.88 (5.8)	12.50 (5.2)
Mother's education	15.04 (3.3)	13.58 (3.4)	13.14 (2.9)	14.61 (4.0)	13.58 (3.1)	12.97 (3.2)
Test score	63.73 (4.5)	58.18 (6.5)	54.67 (7.1)	64.80 (4.2)	57.91 (6.9)	54.78 (7.2)
High school GPA	3.20 (.5)	2.96 (.6)	2.72 (.6)	3.46 (.4)	3.03 (.6)	2.93 (.6)
Rural high school	.10	.15	.34	.03	.22	.37
Urban high school	.22	.20	.15	.11	.19	.21
Public high school	.47	.45	.68	.51	.71	.79
Financial aid	2,792 (3,260)	1,594 (2,215)	1,036 (1,377)	1,499 (2,076)	760 (1,364)	584 (1,053)
Sample size	127	494	80	35	954	475

IV. Results

A. Pooled Wage/Earnings Models

We now turn to our estimates of the effect of college quality/sector on labor market outcomes. The preferred measure of labor market performance is the logarithm of the hourly wage rate for those employed. For the 1972 cohort, this is available for those working in 1979 and for those working in 1986. However, for the 1982 HSB cohort, data on hourly wage rates were not collected in the 1992 follow-up; rather, annual earnings information was gathered. Unfortunately, no information on hours or weeks worked was collected, so it is impossible to separate labor supply decisions from wages. Since college quality may be positively correlated with hours worked and weeks worked, as well as with wage rates, we might expect the estimated effects of college quality on earnings to be larger than the estimated effects of college quality on wages. We use the logarithm of annual earnings in 1992 for the 1982 cohort.[9] To reduce possible errors arising from this earnings measure, we also estimate all the models separately for men only, and as an additional point of comparison we also utilize information on 1986 hourly wages for the 1980 cohort of high school graduates and report annual earnings models for the 1972 cohort. (NLS72 contains sufficient information to construct an earnings measure comparable to the 1992 HSB earnings variable.)

The simplest way to analyze the effects of college quality on labor market outcomes is to estimate pooled models as given by Equation 1, in which dummy variables indicating the college selectivity/sector each student attended are included in standard log wage/earnings models. We estimate such models for college attendees, regressing log wages or earnings on a set of individual characteristics (dummies indicating female, Hispanic, black; family size; family income; father's education; mother's education; ability proxied by a test score; dummies indicating if the individual was employed part time, was still an undergraduate, or was a graduate student.).[10] Results of this exercise are shown in Table 2 (complete results are available from the authors).

We show five alternative labor market outcome measures for our three cohorts. The results are striking. In all cases, attendance at an elite private institution is associated with a statistically significant and sizable wage premium relative to bottom publics, the omitted group. There is some evidence that this premium increases over time for a given cohort. For those in the 1972 cohort attending a top private school,

9. We do not restrict the range of possible earnings values; our results are insensitive to this decision. Restricting the sample is essentially arbitrary and further reduces sample sizes, which makes estimation of our model difficult.

10. The models are estimated for those individuals in our sample with positive wages/earnings. Both males and females have high levels of employment across college types and years. For example, for the 1972 cohort in 1979, 88 percent of males and 84 percent of females were employed; in 1986 the figures were 85 percent and 71 percent. For the 1982 cohort, 87 percent of males and 84 percent of females were employed in 1986, and 92 percent of males and 90 percent of females were employed in 1992. Since we later use selectivity terms for college type, it is problematic to include an employment selection term simultaneously, so we do not attempt to control for employment selectivity in any of our models. Brewer et al. (1996) report similar results to those shown here when an employment correction is included in wage/earnings models.

Table 2
Labor Market Outcomes (Relative to Bottom Publics), by College Sector and College Quality, By Cohort (absolute value t statistics)

	1972 Cohort			1980 Cohort	1982 Cohort
	Hourly Wage Rate 1979	Hourly Wage Rate 1986	Annual Earnings 1986	Hourly Wage Rate 1986	Annual Earnings 1992
Top private	.09 (2.0)	.15 (2.8)	.19 (2.3)	.20 (4.3)	.39 (3.6)
Middle private	.04 (1.8)	.10 (3.5)	.14 (3.0)	.10 (3.7)	.10 (1.5)
Bottom private	.004 (.10)	.04 (.9)	.10 (1.3)	.01 (.3)	−.15 (1.2)
Top public	−.19 (2.3)	.17 (1.6)	.25 (1.5)	.12 (1.7)	.26 (1.4)
Middle public	.05 (2.4)	.05 (2.0)	.05 (1.2)	.09 (4.2)	.06 (1.1)
Adjusted R^2	.08	.08	.12	.08	.06
Sample size	2439	2378	2172	2172	1786

Notes: All models include female, Hispanic, black, family size, family income, father's education, mother's education, test score, and dummy variables indicating if the individual was in a part-time job (wage models only), or was an undergraduate or graduate student at the final survey date. Omitted category is bottom public.

hourly wages were 9 percent higher in 1979 but 15 percent higher in 1986; however this change is not statistically significant. A similar pattern is also exhibited for other college types for the 1972 cohort; the within-cohort change is statistically significant for middle privates and top publics. With less certainty (since one is forced to compare wage and earnings models) this pattern holds for the 1980/1982 cohorts.

Evidence also suggests that the premium to attending an elite institution increased for the cohort that attended college in the 1980s compared to those who attended in the 1970s.[11] For example, at comparable points in the life cycle (six years after high school graduation) the premium to a top private college was 20 percent for the 1980 cohort and 9 percent for the 1972 cohort. Despite having fewer potential years in the labor market, those in the 1982 cohort who attended elite privates enjoyed annual earnings an estimated 39 percent higher in 1992 than those attending bottom publics, while those attending elite private colleges in 1972 received a 19 percent premium in 1986. There is weak evidence that a similar story applies to top publics, although the small numbers attending these institutions suggest that these results should be treated with caution. The pattern of increasing labor market returns is not, however, replicated for middle-and bottom-rated institutions.[12]

B. Selectivity Corrected Wage/Earnings Differentials

The estimates reported in Table 2 do not control for the fact that students systematically select college type. Our framework involves the estimation of a reduced-form multinomial logit college quality choice model, calculation of selection correction terms from this model, and the inclusion of these in wage/earnings models estimated separately for each college quality/sector group. Here, since our primary focus is on the resulting predicted wage/earnings derived from this procedure, we describe our methodology only briefly. (Complete results are available from the authors on request.)

1. Calculation of Net Costs

Initially we calculate the net costs of all six college types that an individual might attend. These net cost variables are needed for inclusion in our college choice model. For tuition, we rely on the fact that a majority of individuals attend a college in the state in which they went to high school.[13] For each state we calculate the mean tuition

11. Across cohorts, the change for 1979 wages/1986 wages is statistically significant for top privates, middle privates, and top publics. The result for the latter is partly driven by the anomalous negative, statistically significant coefficient on top publics in 1979, which is likely due to the small sample size. For 1986 earnings/1992 earnings, the change is statistically significant for top and bottom privates.

12. A similar pattern is observed when the estimating samples are confined to males only, although the returns to elite privates are higher for women than for men.

13. HSB does not directly identify the state of each individual's high school; it is possible to infer the state with an algorithm used in Ehrenberg and Brewer (1994). The extent to which students attend a college in the state in which they went to high school varies across college type. For example, 85 percent of those at public colleges in the 1980 cohort [86 percent in the 1982 cohort] came from within the state (67 percent [67 percent] at top, 83 percent [84 percent] at middle, and 88 percent [89 percent] at bottom rated schools) compared to 58 percent [54 percent] of students at private schools (40 percent [29 percent] at top, 62 percent [50 percent] at middle and 57 percent [58 percent] at bottom-rated schools).

(weighted by enrollment) in the relevant year for each type of college, that is, in top public institutions, middle public, etc., and match this figure to the student's high school state. For public colleges we use in-state tuition figures. If no institution exists in a particular quality/sector group (typically top public and top private) for a state, we use a regional mean instead.[14]

Financial aid, disbursed through a variety of federal, state, and institutional programs, is determined largely by academic and/or athletic merit, and by family financial status.[15] The aid an individual with given characteristics receives is determined by the policies an individual institution pursues, including its tuition policies. NLS72 and HSB contain the (self-reported) financial aid a student received at the college in which he or she actually enrolled in the initial year of attendance. We use this information to construct estimates of annual predicted financial aid each individual in the sample would have received in each of the six types of college. For those attending each type of institution, this was done by regressing actual aid received on individual characteristics including sex, race/ethnicity, academic ability (proxied by high school GPA and a test score measure), high school athletic status, parental income, and family size. We also included in the models a set of state dummies to reflect price variation and differences in state aid policy. (Variables included in the aid model, but not in the college choice model, are high school athletic status and state dummy variables. See Table A1). These results are discussed in Brewer et al. 1996.[16] Since many individuals receive zero aid, a maximum likelihood tobit specification is used to obtain these predictions.

Coefficient estimates from these models are then used to construct predicted aid in that college type for all individuals in our sample. In other words, while the models are estimated separately for each college type, the coefficient estimates are used to generate out-of-sample predictions for those who actually attended other types of institutions. (In all cases we use predicted aid.) Estimates of tuition and financial aid are combined to produce the predicted net costs each individual would face in each college type for each of our cohorts. While we have no way to judge the accuracy of these net cost variables—since we cannot observe the net costs for any given individual, nor for colleges not chosen—they are robust to numerous changes in specification.

2. *Reduced-Form College Choice Multinomial Logit Model*

High school students are assumed to select a college from the six college types on the basis of the net costs associated with each type of institution and individual characteristics such as sex, race/ethnicity, family income and parental education lev-

14. We experimented with various definitions for the relevant tuition facing each student—for example, regional means for the elite institutions, and out-of-state tuition for top public schools. The reported results are not sensitive to use of these alternatives.

15. We restrict attention to direct current income received from federal, state, institutional, and private sources. This includes scholarships, fellowships, grants, and benefits, but excludes loans.

16. Strictly speaking, these financial aid models should also be corrected for potential selectivity bias, but for simplicity we do not attempt to do this here. The aid models are reasonably robust to changes in model specification, although one referee speculated that our aid model is likely to overpredict aid since students are likely to attend an institution (and here we have actual aid) which offers most aid.

els, high school GPA, and ability (test score). Although formally we assume that any individual can attend any institution, admission is clearly restricted at some institutions on the basis of ability. We include two additional variables in our college choice model to proxy for the likelihood of being admitted to a particular institutional type: the availability of college openings (''slots'') in each college type in the state in which the student went to high school,[17] and the student's own NLS72/HSB test score minus the mean test score in the institution type actually attended squared (the ''test score difference''). This approach is similar to that used by James et al. (1989) with SAT scores and is designed to capture in part the difficulty of admittance to some schools.

Although one must treat the reduced-form college choice multinomial logit model estimates cautiously, they do a reasonable job of predicting an individual's choice of college. For example, the NLS72 choice models correctly predict about 58 percent of college choices, and the HSB models about 61 percent. Coefficient estimates from the choice model (not shown) suggest that higher family income, parental education, and measured ability are associated with a greater likelihood of attending any institution relative to bottom public, holding other characteristics constant. For the college cost variables, one would expect that as the net costs of attending a college in the jth category rise, a student would be less likely to choose to attend an institution in the jth group relative to bottom publics. In fact, the evidence on this is mixed both within and across cohorts. The number of slots variable is generally positive and statistically significant for both cohorts, as one would expect (the greater the number of slots in the jth category, the higher the probability a student will attend a college in the jth category relative to bottom publics). (These results are available from the authors.)

The estimated reduced-form college choice model is used to generate selectivity terms for each type of college. These lambdas are identified primarily by net costs, slots, high school GPA, and functional form (see Table A1). We performed a number of statistical tests to verify that these identification variables are valid statistically. First, we computed likelihood ratio tests of the hypothesis that our group of identification variables should not be included in the college choice model. We easily reject this hypothesis at the 1 percent level for both 1972 and 1982 cohorts. Second, we tested the hypothesis that our group of identification variables were jointly equal to zero in our wage equations and should therefore be excluded. In only two of 12 cases could the hypothesis that these were jointly equal to zero in the wage models be rejected. These two results suggest that our instruments are reasonable.

3. Wage Models and Differentials

The logarithm of the hourly wage rate/annual earnings is regressed on the same set of standard wage equation explanatory variables used in Table 2, with the addition of a selectivity term for the appropriate college type generated from the reduced-form college choice multinomial logit model. Since these wage/earnings models are estimated separately for each college quality type, they have the advantage of not

17. The number of slots in each sector/quality group in the student's region rather than state were used in some specifications, but this does not affect the pattern of results reported in the paper.

constraining the coefficients of the control variables to be identical across college types. (Complete results are available from the authors.) The models are broadly consistent with standard cross-section wage equation results. The selectivity terms are statistically significant in seven of the estimated models (with five outcomes measures and six college types, there are 30 separate models). These results may be in part due to small sample sizes. Our college choice and wage models control for family background (including parental education and family resources) and individual ability, both of which are strong predictors.

We use these models to calculate wage/earnings differentials in two ways. First, we find predicted log wages/earnings for each individual for each college type as given by

$$(9)\quad \ln\hat{W}_{ji} = \hat{b}_0 + \hat{b}_{j1}X_{ji} + \hat{b}_{j2}\lambda_{ji} \quad j = 1 \ldots 6$$

and then take the difference between the predicted log wages/earnings in each college type and bottom publics. This is sometimes referred to as a "conditional" wage differential, and is identical to a standard ordinary least squares (OLS) wage differential.

Second, we calculate *selectivity-corrected* wage/earnings differentials (sometimes called "unconditional" differentials) as given by

$$(10)\quad \ln\hat{W}_{ji} = \hat{b}_0 + \hat{b}_{j1}X_{ji} \quad j = 1 \ldots 6$$

where the estimated *b*'s are identical to those in Equation 9. This measure "corresponds to an experiment in which an individual, having observable characteristics that are the same as the average [*j*th college type attendee], is taken at random from the population. Since we do not observe this individual's choice of sectors, the [predicted wage] reflects only the varying returns for his or her characteristics" (Gyuorko and Tracy 1988, p. 241). On the other hand, in calculating the conditional predicted wage we know the individual's choice of college type such that the prediction reflects the varying returns to both observable and unobservable characteristics. One is not able to determine which of these measures is "best," but they may be viewed as two polar cases. The appropriateness of each "depends on whether the estimated selection effects primarily reflect differences in levels of or returns to unobserved [student]characteristics" (Gyuorko and Tracy 1988, p. 249). We present estimates of each differential in Table 3, along with *t*-statistics calculated from appropriate standard errors for each estimate.

Focusing first on the conditional estimates, the patterns found in the pooled model are replicated here. Specifically, for the 1972 cohort the premium to attending each college quality type increases with labor market experience. In general, the return to college quality increases faster in these sector-specific models relative to the pooled models. This pattern does not hold across all college quality types for the unconditional differentials, however. Similarly, the premium to college attendance increases across cohorts for recent graduates (wages about six years after high school graduation). The result also holds when comparing the earnings of the 1972 cohort with the 1982 cohort, but only for private schools. The unconditional results for the bottom privates and top publics should be interpreted cautiously due to small sample sizes. Comparing the selectivity-corrected estimates with those of the pooled models suggests that the pattern of results is similar, although the magnitudes of the estimated

Table 3
Predicted Wage/Earnings Differentials (Relative to Bottom Publics), by College Sector and College Quality, by Cohort (absolute value t-statistics)

		1972 Cohort			1980 Cohort	1982 Cohort
		Hourly Wage Rate 1979	Hourly Wage Rate 1986	Annual Earnings 1986	Hourly Wage Rate 1986	Annual Earnings 1992
Top privates	(1)	3.7 (2.8)	23.4 (4.8)	30.3 (3.7)	27.1 (5.8)	40.8 (4.3)
	(2)	3.0 (0.6)	13.9 (2.8)	21.4 (2.6)	26.9 (5.7)	41.7 (4.3)
Middle privates	(1)	5.4 (2.3)	15.0 (5.4)	19.3 (4.2)	12.1 (4.8)	9.6 (1.5)
	(2)	−3.0 (1.3)	22.2 (7.9)	13.4 (2.9)	25.5 (10.2)	31.7 (4.8)
Bottom privates	(1)	−.9 (0.2)	1.6 (0.4)	5.9 (0.9)	2.6 (.6)	−15.4 (1.1)
	(2)	−8.8 (2.4)	−10.1 (2.2)	−27.9 (4.4)	55.4 (12.6)	40.9 (3.0)
Top publics	(1)	−8.0 (1.1)	23.5 (2.8)	39.3 (2.6)	15.9 (1.9)	29.7 (2.2)
	(2)	6.0 (0.8)	−25.8 (3.4)	−70.6 (5.4)	19.3 (2.2)	−58.2 (4.7)
Middle publics	(1)	6.2 (3.1)	8.4 (3.5)	8.2 (2.1)	11.6 (5.5)	5.8 (1.0)
	(2)	11.1 (5.6)	13.3 (5.5)	6.9 (1.7)	26.8 (12.7)	9.6 (1.7)

Notes: Differentials are for college group shown relative to bottom publics.
(1) Differential based on conditional predicted wages/earnings (standard OLS differential).
(2) Differential based on unconditional predicted wages/earnings (selectivity-corrected differential).

rates of return vary. For example, the premium to attending an elite private college in the selectivity-corrected model is larger than in the pooled model.

V. Conclusions

In this paper we have presented estimates of the effect of attending colleges of different quality on labor market outcomes. Unlike previous studies, we are able to utilize longitudinal data which permit us to examine how the labor market return changes across time for a given cohort, and how the return changed for those cohorts that attended college in the early 1970s and the early 1980s. In addition, unlike previous attempts to determine the impact of college quality type on labor market outcomes, we allow for the fact that students systematically select the college quality type they attend on the basis of the net costs they face. Although we find little evidence that this correction for selectivity significantly affects our results, it is important in principle. We find that a large premium to attending an elite private institution and a smaller premium to attending a middle-rated private institution, relative to a bottom-rated public school. Evidence is weaker of a return to attending an elite public university. Our analysis suggests the return to elite private colleges increased significantly for the 1980s cohorts as compared to the 1972 cohort. We do not attempt to determine the *cause* of this change, but it is a potentially important finding in light of the large tuition increases concentrated at these institutions during the past two decades. These results suggest that the rising tuition at these elite private institutions was at least partially made possible by the increasing returns to quality that took place.

Table A1
Variable Definitions and Model Specification

Variable	Definition	Wage	College	Aid
Female	Dummy variable = 1 if female	X	X	X
Hispanic	Dummy variable = 1 if Hispanic	X	X	X
Black	Dummy variable = 1 if black	X	X	X
Family size	Number of persons in household	X	X	X
Family income	Family income in dollars	X	X	X
Father's education	Years of father's education	X	X	
Mother's education	Years of mother's education	X	X	
Test Score	Test score composite	X	X	X
Employed part time	Dummy variable = 1 if employed part-time in outcome year	X	X	
Undergraduate	Dummy variable = 1 if an undergraduate student in outcome year	X	X	
Graduate student	Dummy variable = 1 if a graduate student in outcome year	X	X	
Lambda college choice	Selection correction term generated from college choice model for each type of college	X		
High school GPA	Grade point average in high school		X	X

Public high school	Dummy variable = 1 if attended public high school	X	
Test difference squared	Square of own test score minus mean test score for college type	X	
Net costs (6 variables)	Mean tuition minus mean predicted financial aid for each college type	X	
Slots (6 variables)	Number of enrollment slots for each college type	X	
High school athlete	Dummy variable = 1 if a varsity athlete in high school		X
State	State dummy variables		X

Wage Models (OLS): used to generate wage differentials
Dependent variable: natural logarithm of wages/earnings.
Independent variables: female, Hispanic, black, family size, family income, father's education, mother's education, test score, employed part time, undergraduate student, graduate student, lambda for college choice.
College Choice Model (multinomial logit): used to generate lambda for college choice
Dependent variable: type of college chosen (top private, top public, middle private, middle public, bottom private, bottom public).
Independent variables: female, Hispanic, black, family size, family income, father's education, mother's education, test score, employed part time, high school GPA, public high school, slots, own test score minus mean college type test score squared, slots in each college type in student's state, *net costs* in each college type for each student.
Net Cost Variables: used in college choice model
Net costs = tuition minus financial aid, calculated for each individual were they to attend each college type.
Tuition = mean tuition of all institutions in college type in state/region matched to student's high school state.
Financial aid = predicted financial aid generated from coefficients from tobit aid model.
Aid Model (tobit): used to generate predicted financial aid, run separately for each college type.
Dependent variable: actual financial aid.
Independent variables: female, Hispanic, black, family size, family income, test score, high school GPA, high school athletic status, state dummy variables.

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