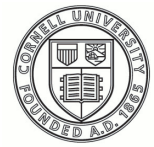

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Keywords

college quality, college choice, enrollment, graduate earnings

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Do Measures of College Quality Matter?:

The Effect of College Quality on Graduates' Earnings

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Abstract

This study reviews and explores the varying effects of college quality caused by different measure of college quality, including Barron's ratings, mean SAT scores of entering freshman class, tuition and fees, and Carnegie Classification. Data for this research come from NCES' Baccalaureate & Beyond study. Results suggest that the estimated effect of college quality is sensitive to the measure of college quality, suggesting that different measures of college quality may provide partial explanation for the varying effect of college quality in previous studies. More importantly, the current analysis shows that the common wisdom that it pays to attend high-quality colleges is robust to these measures.

Do Measures of College Quality Matter?:

The Effect of College Quality on Graduates' Earnings

Introduction

Over the last four decades, a substantial body of research has been developed exploring the relationship between college quality and graduates' earnings; this relationship has been under heated debate especially in view of the escalating tuition and fees at the nation's most prestigious institutions over the last couple of decades. Despite of myriad pressures for tuition rising (Ehrenberg, 2000), the feasibility of such an increase critically hinges on the common wisdom that it pays to attend prestigious institutions. While some studies have revealed a large and significant effect of college quality on graduates' earnings, the majority of this line of research suggests a mild economic impact of college quality.

In recent work along this line, I reframed the debate about the relationship between college quality and graduates' earnings, focusing on the reconciliation of empirical evidence and social theories. That is, on the one hand, social theories (such as human capital theory) and every day observations suggested that college quality should have a substantial economic effect; on the other hand, the majority of the empirical work suggested that college quality have a small although statistically significant effect on graduates' earnings. My effort was to examine the social role of these prestigious institutions; however, in talking with colleagues and presenting my work in various venues, I found the most frequent question was on the measure of college quality. The critique is simple and clear: Any single measure of college quality is not capable of capturing the complexity of higher education institutions; thus any conclusion based on a particular measure of college quality may be misleading.

It is necessary, then, to look closely at the measures of college quality. To that end, I pose the following questions: What were the most commonly used measures of college quality in previous studies? In using these measures, did they arrive at different empirical results? Perhaps the best way to evaluate the differences caused by different measures of college quality is to evaluate the effect of college quality by an array of quality measures using the same data set, and then to compare the results with those in previous studies which used one particular measure of college quality. Continuing, if the estimates indeed vary by different measures of college quality, the next question is whether the conclusion that it pays to attend high-quality institutions still holds, given that different measures of college quality also affect the average costs of attending institutions of varying quality.

In posing these questions, I treat college quality as a "black box," quoting one professor's critique. That is, I am not modeling the infinite characteristics of those high-quality institutions, such as smarter peers, better resources, and higher level of academic and social engagement, to name but a few; and I am not examining the detailed sources of the presumed positive effect of high-quality institutions. Further, in asking these questions, I still maintain the convenient assumption that college quality is somehow measurable. Admittedly, phrases such as college quality and high-quality colleges may sound ambiguous and suspicious to some researchers. They may suggest that other words such as selectivity, which seems more concrete and easier to measure, be used. Nonetheless, I choose to use *college quality* partly because it is used in previous studies and I attempt to reconcile the differences in those studies, and partly because students and their families do care about the *quality* of colleges they attend.

My plan is as follows. I first present an overview of previous studies on the economic effect of college quality, with an emphasis on their methodological approach, measures of

college quality, and main findings. Then I set up a baseline model using a national data set (Baccalaureate and Beyond: 93/97) and one popular measure of college quality in recent research work (Barron's ratings) to estimate the effect of college quality and further to examine whether it pays to attend high-quality colleges. After that, the same baseline model, the same data set, but different measures of college quality are used to explore the possible differences among the estimates for different measures. Three additional measures are considered: mean SAT scores of the entering freshman class, tuition and fees, and Carnegie Classifications. Based on regression results, I re-evaluate the main policy question: Does it pay to attend high-quality colleges? In the concluding section, I summarize all the findings and return to where I started: Do measures of college quality matter? I further provide some implications of this analysis to future research along this line.

Literature Review

Generally speaking, the modern literature on the economic effect of college quality began with studies by Weisbrod and Karpoff (1968), Wales (1973), Solmon and Wachtel (1975), and Wise (1975) and recently has undergone a renaissance with works by Behrman et al. (1996), Brewer and Ehrenberg (1996), Brewer et al. (1999), Dale and Krueger (2002), and Thomas (2000, 2003). Pascarella and Terenzini completed a summary and criticism in 1991. Not only were the results of studies of these issues important for academic and theoretical purposes, they were also important to prospective students and their parents who paid more of the increasing costs of higher education, especially at prestigious institutions (Ehrenberg, 2000).

Representative studies along this line included 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), Trusheim and Crouse (1981), Mueller (1988), Kingston and Smart (1990), Karabel and McClelland (1987), Smart (1988), Fox (1993), James et al. (1989), Loury and Garman (1995), Rumberger and Thomas (1993), Behrman et al. (1996), Brewer and Ehrenberg (1996), Brewer et al. (1999), Dale and Krueger (2002), and Thomas (2000, 2003). Although the list was by no means exhaustive, it included most of the published, methodologically rigorous studies. Brewer et al. (1999) provided an excellent overview and summary of some of the studies listed above. Almost without exception, these studies used more or less the same methods: Individual i's log earnings or hourly wage rate ($\ln(Y_i)$) was a function of the quality of institution j he or she actually attended (Q_{ij}), demographic characteristics (D_i), family background (F_i), academic background (A_i), job market conditions (J_i), and an individual disturbance term (μ_i). In mathematical notation,

$$\ln(Y_i) = \alpha_0 + \alpha_1 Q_{ij} + \alpha_2 D_i + \alpha_3 F_i + \alpha_4 A_i + \alpha_5 J_i + \mu_i \qquad \text{(Equation 1)}$$

Popular measures of college quality included mean SAT scores of entering freshmen (Dale & Krueger, 2002; Griffin & Alexander, 1978; Morgan & Duncan, 1979; Mueller, 1988; Solmon, 1973, 1975; Thomas; 2000, 2003; Wise, 1975), Gourman rating (Solmon, 1973, 1975; Wales, 1973), Carnegie Classification (Solmon & Wachtel, 1975), tuition (Smart, 1988), expenditure per FTE student (Morgan & Duncan, 1979; Wachtel, 1976), and Barron's ratings (Brewer & Ehrenberg, 1996; Brewer et al., 1999).

Early research usually used the conventional Ordinary Least Squares (OLS) technique (e.g., Wales, 1973; Weisbrod & Karpoff, 1968). Structural equation models were sometimes employed to examine the direct and indirect effect of college quality on earnings (e.g., Mueller, 1988). Recent studies paid more attention to the econometric problems in estimating the earnings equation such as Equation 1. For example, Behrman et al. (1996) used data on female twins to

control for common unobserved effects, and Brewer and Ehrenberg (1996) and Brewer et al. (1999) used structural models to allow for the correction of selection bias. Thomas (2000, 2003) employed a Hierarchical Linear Modeling (HLM) technique to entertain the multi-level structure of the survey data.

Findings of these studies were not totally unequivocal. Some studies, for example, demonstrated significant and handsome economic benefits from attending high-quality colleges. A recent exemplary study was Brewer et al. (1999). After controlling for gender, race/ethnicity, family size, parental education, test scores, and part-time job, they found that students who attended private elite institutions enjoyed a large salary premium. In contrast, other studies have indicated either statistically non-significant or even negative effects of college quality on earnings. For example, Dale and Krueger (2002) found that college quality had either non-significant or negative effects on earnings after controlling for some salient, confounding variables.

Putting aside those studies with "extreme" results (both strong positive effects and negative effects), most studies suggested that college quality had a statistically significant though generally very small effect on earnings (Pascarella & Terenzini, 1991). For example, a study by Solman and Wachtel (1975) analyzed a sample of white male college attendees in the 1943 NBER-Thorndike survey, which reported 1969 earnings and found that after controlling for IQ estimates, years of schooling, years of experience and experience squared, and occupations, college quality, assessed at the mean, had a statistically significant but economically very small effect on earnings: only about an additional 1% of the variance in 1969 earnings above and beyond control variables. A similar conclusion was reached by Mueller (1988), who confirmed that college quality could explain only a minute percentage of variance in earnings above and

beyond the controls. In a more recent study, using a nationally representative sample of 4,061 college graduates in 1992, Thomas (2000) found that college quality had a small but statistically significant effect on earnings one year after college graduation. Findings of most studies belonged to this category: College quality had a small although statistically significant effect on college graduates' earnings.

It is note worthy is that different measures of college quality might be partially responsible for the varying magnitudes of the estimated effects of college quality. For example, studies using mean SAT scores usually found a relatively small effect of college quality (e.g., Dale & Krueger, 2002; Mueller, 1988; Thomas, 2000), and those using Barron's ratings often resulted in a relatively large effect of college quality (e.g., Brewer & Ehrenberg, 1996; Brewer et al, 1999). Of course, these differences could also be resulted from other factors such as different data sets and estimation strategies. Thus to replicate their findings in a single data set using a uniform estimation strategy but different measures of college quality would be ideal to show whether measures of college quality contribute to the differences among previous results. Further, because attending a high-quality institution usually means higher costs relative to attending other colleges, it would be important to show whether the earnings premium of college quality is large enough to offset the corresponding cost differences among colleges of varying quality.

The Baseline Model

Data set. The major data set used in this analysis is the second follow-up of the Baccalaureate and Beyond study (B&B: 93/97). B&B is a national longitudinal study designed to provide information concerning education and work experiences after completion of the

baccalaureate degree. It provides cross-sectional information one year after bachelor's degree completion and longitudinal data concerning entry into and progress through graduate level education and the work force. The second follow-up of B&B is surveyed in the April of 1997, with more than 10,000 baccalaureate recipients who completed their degrees between July 1992 and June 1993. The restricted data set is used to enable the connection of students and institutions. All analyses reported in this paper have been weighted by the B&B second follow-up weights, normalized on final samples.

Variables. The outcome of interest in this study is earnings, measured as the annualized self-reported earnings in the graduates' primary job in April of 1997. The main independent variable is college quality, and other control variables include various demographic, family backgrounds, academic, labor market variables. Demographic variables consist of gender and race/ethnicity, consisting of several dummy variables such as Female, Hispanic, Black, and Asian. Family background variables consist of family income and first generation college graduate. Academic variables include college majors (divided into Business, Education, Engineering, Health, Public Affairs, Biology Science, Social Science, Math/Science, History, Humanity, Psychology, and other majors) and student academic performance (measured as merged SAT/ACT quartiles). Finally, labor market variables include age, tenure, and their square terms. Because B&B only reports annual earnings instead of hourly wage rate, the number of work hours per week is used as an adjustment.

Measure of College Quality. The college quality variables in the baseline model are constructed from two sources including the Integrated Postsecondary Education Data System 1992-93 (IPEDS) and Barron's *Profiles of American Colleges*. I extract the variable of types of institutional control (i.e., publics versus private) from IPEDS. College selectivity data are from

Barron's *Profiles of American Colleges*. Barron's rating categorizes institutions into six selectivity groups on the basis of entering students' class rank, high school grade point average, average SAT scores, and the percentage of applicants admitted. In the baseline model, I follow the conventional approach by collapsing six selectivity categories into three based on a rating of most competitive or highly competitive (with Barron's rating of 5 or 4), very competitive or competitive (with Barron's rating of 3 or 2), and less competitive or non-competitive (with Barron's rating of 1 or 0). Because perceptions of public and private institutions are quite different, I further distinguish between privately and publicly controlled institutions in each selectivity group, yielding six college types: high-quality privates, high-quality publics, middle-quality privates, middle-quality publics, low-quality privates, and low-quality publics. This measure of college quality was used in Brewer and Ehrenberg (1996) and Brewer et al. (1999).

Sample. I take the full sample of the second follow-up of B&B and limit it to graduates who (1) received bachelor's degrees during the period between July 1992 and June 1993, (2) were working full-time, as of April 1997, with annual earnings between $1,000 and $500,000 per year, (3) were not enrolled in school full-time, (4) had institutional-level data available. These criteria limit the final sample to 3,965 students across 500 institutions. For this final sample, the descriptive statistics of variables used in the baseline model are presented in Table 1. And the distribution of students in each type of institutions is presented in Table 2. For this particular measure of college quality, only about 11% of all graduates in the final sample are from high-quality institutions. I will come to this point later when comparing different measures of college quality.

Estimating Strategy. I estimate Equation 1 using conventional OLS technique. This model has been tested in several recent studies by Thomas (2000, 2003) and Thomas and Zhang

(2001). It is used in this study as the baseline model for several reasons. First, it is desirable to maintain consistency with previous research (provided it is good) so that results can be compared without confusion due to the method. Second, although it is interesting to employ statistically more advanced methods such as correction for selection and HLM, it is my intention to keep the technical aspect of this study as parsimonious as possible. Finally, I experiment with other methods, and results do not differ substantially from the baseline model. See Appendix A for the results using HLM estimation. Results from Heckman type self-selection models are also available from the author upon request.

Results. Table 3 presents OLS estimates of the effects of various demographic, family backgrounds, education, labor market, and college characteristics on graduates' log earnings. Because my focus is on the effect of college quality on graduates' earnings, I will not discuss the impact of other variables in detail. An overview of the results confirms that the estimated effects of other variables are consistent with a large body of earlier work.

Clearly, College quality has a large and significant impact on graduates' earnings. For example, holding all student characteristics constant, graduates from high-quality institutions—both public and private—enjoy a nearly 20% earnings premium over those from low-quality public colleges. Even graduating from middle-quality institutions yields about a 10% earnings advantage over graduating from low-quality colleges. There does not seem to have an earnings advantage for students graduating from private colleges over for those graduating from public colleges in the same quality category. The estimated effect of high-quality institutions is comparable to what Brewer and Ehrenberg (1996) and Brewer et al. (1999) have discovered by using several other data sets including National Longitudinal Study of the High School Class of 1972 and High School and Beyond.

An immediate question from analyzing the effect of college quality on graduates' earnings is whether the benefits are worth the associated costs because high-quality institutions arguably cost more to attend. Researchers have been very cautious about conducting such cost-benefit analyses, partly because the real costs of a college education are too complex to measure. It is widely held that the costs of college education should include not only the direct costs (such as tuition and fees, and living expenses) but also the indirect costs (such as forgone income). Fortunately, because the present question is whether the benefits are worth the costs in attending a high-quality college relative to attending a low-quality college, many components of the cost which are probably common to attending both types of colleges can be omitted, making it more feasible to carry out a simple cost-benefit analysis.

To illustrate, suppose a high school graduate faces the following three choices: to join the labor market, to attend a low-quality college, or to attend a high-quality college. And further assume that tuition and fees, living expenses, and forgone income are the only three components of costs of attending college, the following calculation illustrates the cost-benefit analysis:

	Costs	Benefits
Option 1. Joining the labor market	L	B
Option 2. Attending a low-quality college	$T_l + L_l + F_l$	B_l
Option 3. Attending a high-quality college	$T_h + L_h + F_h$	B_h

Where T refers to tuition and fees, L refers to living expenses, F refers to forgone income, and B refers to benefits. Subscript l refers to attending low-quality colleges, and h refers to attending high-quality colleges. Due to the inability to estimate L's, F's, and B's, it is difficult to make a decision between Options 1 and 2 and between Options 1 and 3; however, it is possible, with an additional assumption which is not very strong, to make a comparison between Options 2 and 3. The additional assumption is that living expenses and forgone income are the same whether

attending a low-quality college or attending a high-quality college for the same individual. Intuitively, individuals would incur the same amount of foregone earnings and living expenses as long as they choose to attend college regardless of college quality. That is, $L_l = L_h$ and $F_l = F_h$. Then, Option 3 is preferred if and only if $B_h - (T_h + L_h + F_h) > B_l - (T_l + L_l + F_l)$, which is equivalent to $B_h - B_l > T_h - T_l$ under the above assumption. In other words, the decision of which type of college to attend hinges on the relative magnitude of the benefit difference, which is readily available from the analysis of the effect of college quality, and the cost difference, which boils down to the difference in tuition and fees. It should be noted that adding more cost components to the table does not change the results as long as they are incurred when attending both types of colleges. More complicated analysis of net present value that may require discounting factors does not change the main point either.

Table 4 shows the average tuition and fees for each type of institution. The tuition and fees are much lower and less dispersed in public institutions than in private institutions. From Table 4, the difference in tuition and fees among different types of colleges can be calculated. For example, the average difference in tuition and fees between low-quality public institutions and high-quality private institutions is $10,633 (that is, $12,201 minus $1,568) per year. The benefit difference can be calculated by taking the coefficient in Table 3 and evaluating it at the mean of the earnings distribution. For example, the earnings difference between low-quality public institutions and high-quality private institutions is 0.1754 log points, which is about $5,890 per year when it is evaluated at the mean of the earnings distribution. With reasonable estimates for the length of a college education and the length of a career, the comparison is quite clear: The benefit difference over one's career well exceeds the cost difference. A question raised by this comparison is whether the benefit, i.e., the effect of college quality, is stable over

an individuals' career time. Thomas and Zhang (2001) showed that in the early stage of graduates' career, the earnings differences among graduates from different types of colleges grow significantly. This result strengths the current argument. The cost-benefit analyses can be carried out similarly among other categories of colleges. The results seem clear: It pays to attend a high-quality college versus a low-quality college.

One interesting observation from this exercise is that public institutions appear to be a better investment than private institutions because the tuition level at public institutions is much lower than while the earnings advantages are comparable to private ones in each quality category. This could have provided a base for recent tuition skyrocketing in good public institutions. Certainly this simple comparison possibly amplifies the advantage of attending public institutions than attending private ones because many cost components have been suppressed from the analysis. Adding other components (which are assumed to be the same for both types of institutions) would make the relative magnitude of their costs much similar.

The above calculation is on a *ceteris paribus* basis in that the comparison is based on the coefficients from multivariate regression. Admittedly, college choice may affect other variables in the equation that in return would change the comparison. For example, college choice could affect academic performance and undergraduate majors. It is possible that attending a high-quality college might lower one's academic performance, thus the positive effect associated with college quality could be partly offset by the negative impact associated with lower academic performance. Similarly, lucrative majors could be more competitive at high-quality colleges than at low-quality colleges. Nevertheless, given the substantial earnings advantage provided by high-quality colleges, it is safe to conclude that it pays to attend a high-quality college versus a low-quality college, on average.

Other Measures of College Quality

In the baseline model, the quality measures are constructed from the Barron's ratings. Previous studies on the effect of college quality on earnings have used different measures of college quality, such as mean SAT score, Carnegie Classification, and tuition and fees. Yet little is known about whether the estimated effect of college quality is sensitive to measures of college quality. I use these three additional measures of college quality to explore the sensitivity of the estimated effect of college quality on earnings.

These three measures are constructed from IPEDS. The 1992-93 IPEDS data is used because that is the year when students graduate from colleges, although the measures of college quality are fairly stable over the years. The first set of college quality variables is based on the average SAT scores of the entering freshman class. Following the method used in Thomas (2000, 2003), I break up the colleges into three groups: Colleges with an average SAT score higher than 980 are classified as high-quality colleges, those between 980 and 885 are classified as middle group, and the remaining colleges with average SAT scores lower than 885 belong to the low-quality group. For detailed discussion of these thresholds, see Thomas (2000, 2003). Similar to the college quality measures constructed from Barron's ratings, the privately and publicly controlled institutions are distinguished in each SAT group, yielding six college types of college quality measure. The distribution of graduates among categories of colleges is presented in Table 5. The final sample when the SAT score is used as a quality measure is slightly smaller than the sample when the Barron's rating is used because of missing values. Clearly, under this measure of college quality, more students are classified as graduates from high-quality colleges than under the measure of college quality constructed from Barron's ratings. For example, Table 5

shows that about one-third of graduates are now classified as graduates from high-quality colleges, while with Barron's ratings only about 11% of all graduates are classified as high-quality. One would expect, then, that the effect of college quality as measured by SAT scores should be smaller than that as measured by Barron's ratings.

The second measure of college quality is the 1994 Carnegie Classification. The Carnegie Classification is based on degree programs and research funds, both of which measure some dimensions of institutional quality. Table 6 shows that in the final sample, the largest group of students is from Comprehensive I institutions, and graduates from Research I institutions constitute the second largest group. The final sample when the Carnegie Classification is used as a quality measure is slightly larger than the sample when the Barron's rating is used because the Carnegie Classification variable is available for more institutions. The reference group in the following regression analysis is graduates from Liberal Arts II institutions.

The last measure of college quality is the undergraduate tuition and fees. Although it is a very crude measure of college quality, it provides a direct and intuitive way to compare the costs of attending different types of colleges. The accuracy of tuition and fees being a measure of college quality might be different for public and private institutions. Because of government support in the way of block grants at public institutions, the tuition and fees at public institutions are much lower and less dispersed than that at private institutions. Moreover, because state funding for public higher education varies across different states, the accuracy of tuition and fees being a measure of college quality for public institutions is further limited. Admittedly, a few high-quality public institutions attract a substantial proportion of their undergraduates nationally and thus charge out-of-state tuition and fees that are arguably highly relevant to college quality. However, because the number of high-quality institutions that are able to attract a large number

of out-of-state students is relatively small, I only use in-state tuition and fees as a measure of college quality for public institutions in order to maintain consistency across institutions. Generally speaking, private institutions behave more like competitive firms than their public counterparts. If college education is regarded as an investment in human capital, then I would hypothesize that tuition and fees are more correlated with returns at private institutions than at public institutions.

Earnings equation similar to the baseline model is estimated for each of the above three measures of college quality. For simplicity, only the regression coefficients for college quality variables are presented below and results from full models are available upon request. Table 7 presents the OLS estimates for the effect of college quality measured by SAT scores. As expected, the estimated effects are generally smaller than those in the baseline model where Barron's ratings are used. Results suggest that other things being equal, graduates from high-quality public institutions enjoy about a 6% earnings advantage over those from low-quality public institutions; this figure is 20% when Barron's ratings are used (see Table 3). Similarly, the earnings advantage for graduates from high-quality private institutions over graduates from low-quality institutions is about 10% in Table 7, and the advantage is about 20% in Table 3. The effects of other types of colleges such as middle-quality publics, low-quality privates, and middle-quality privates are also smaller than the corresponding estimates in Table 3. These results are consistent with Thomas (2000, 2003) where the mean SAT scores are used as the measure of college quality.

It appears that the effect of college quality constructed from mean SAT score is much smaller than the effect of college quality measured by Barron's ratings. Meanwhile, as one would expect, the cost differentials among different colleges are smaller when the SAT score is used.

Are the relatively small earnings differentials sufficient to cover the relatively small cost differentials? To answer this question, I tabulate the average tuition and fees level for each category of college in Table 8. The numbers show that the average tuition and fees for high-quality colleges measured by mean SAT score are lower than the corresponding tuition and fees at high-quality institutions measured by Barron's ratings. From Table 8, the difference in tuition and fees can be calculated. For example, the differential between low-quality public institution and high-quality private institution is $9,445 per year. The benefit differential can be calculated by taking the coefficient in Table 7 and evaluating it at the mean of earnings distribution. For example, the benefit differential between low-quality public institutions and high-quality private institutions evaluated at the mean of the earnings distribution is $3,248 per year. With reasonable estimates for the length of college education and the length for career time, the conclusion that it pays to attend high-quality colleges still holds. The same pattern of the difference between public and private institutions within each quality category is also notable.

Table 9 presents the OLS estimates for the effect of college quality measured by Carnegie Classification. The results show that graduates from other types of colleges enjoy consistent earnings advantages relative to graduates from Liberal Arts II institutions, arguably the least selective institutions. However, the effects vary by college type greatly. For example, it appears that Research I and Doctoral II institutions confer the largest economic benefits to their graduates among all types of institutions. Research II, Doctoral II, and Comprehensive I and II institutions also provide significant benefits to their graduates. Surprisingly, the Liberal Arts I institutions, arguably the most selective type among all Carnegie categories, have virtually no effects on graduates' earnings. This result contradicts Grubb's (1992) findings. Using a nationally representative sample of high school graduate in 1972 (with 1986 earnings data), he finds that

the economic effect of graduating from a Liberal Arts I institution is among the highest of all Carnegie categories. The contradictory finding in the current analysis may be due to the relatively short period of time since one's graduation. If most of graduates from Liberal Arts I institutions obtain post-graduate degrees, then the comparison between baccalaureate holders between Liberal Arts I and Liberal Arts II institutions likely underestimates the effect of Liberal Arts I institutions. Another possibility is that graduates from different types of institutions may have different earnings trajectories over their careers (e.g., Thomas and Zhang, 2001), thus the earnings profile 10 years after graduation (as in Grubb's study) could be quite different from the profile 4 to 5 years after graduation (as in the current analysis).

Similarly, I ask the question of whether the cost differentials are offset by the earnings differentials among institutions of Carnegie categories. Table 10 shows that there exists a generally pattern of positive association between average costs and benefits. For example, average Research I institutions charge higher tuition and fees than Research II institutions (see Table 10), and the estimated effect of the former is also larger than that of the latter (see Table 9). The same results hold for Doctoral I and II institutions. More interestingly, Table 10 shows that the average tuition and fees of Comprehensive II institutions is higher than that of Comprehensive I institutions, and somehow, surprisingly, the estimated effect of Comprehensive II institutions is larger than that of Comprehensive I institutions. As an exception, the earnings differential between graduates from Liberal Arts I institutions and Liberal Arts II institutions does not appear to be sufficiently large to cover the differential in tuition and fees.

Finally, Tables 11 presents the estimates for the effect of college quality measured by tuition and fees (in $1,000) by types of institutional control. The first row presents a pooled model with a dummy variable indicating types of institutional control. Results show that tuition

and fees are positively related to graduates' earnings. The results in the first row, however, do not reveal potential different patterns of the effect of college quality (as measured by tuition and fees) between private and public institutions. It is clear from Tables 4 and 8, that the tuition and fees charged at private institutions are generally higher and more dispersed than at public institutions. My hypothesis is that the effect of college quality as measured by tuition and fees should be larger at private institutions than at public institutions. To test this hypothesis, separate regressions are fitted for private and public institutions, and the results are shown in the second and third rows. For private institutions, a $1,000 increase in tuition and fees is associated with about a 2.4% increase in graduates' earnings, which in dollar terms is about $733 evaluated at the mean of the log earnings. For public institutions, the effect is lower: A $1,000 increase in tuition and fees is associated with about a 1.8% increase in graduates' earnings, which in dollar terms is about $570 evaluated at the mean of the log earnings. For both private and public institutions, however, the benefit is large enough to cover the tuition and fees differentials. The insignificance of the estimated effect of tuition and fees at public institutions suggests that tuition and fees might not be a good measure for public institutions, as expected.

Summary and Discussion

The critique is unambiguous. In studying the relationship between college quality and graduates' earnings, researchers often measure college by a single index, which is not capable of capturing the complexity of higher education institutions; thus any conclusion based on a particular measure of college quality may be misleading. My defense is also clear. Instead of judging what the best measure of college quality is, I focus on understanding how different measures of college quality may lead to different estimated effects of college quality on

graduates' earnings. If it is the case that the estimated effect of college quality is sensitive to the measures of quality used, then those different measures may provide partial explanation for the different estimated effects of college quality in previous studies. Further, if the estimated effect of college quality is sensitive to the measures of college quality, it is also important to examine whether the common wisdom that it pays to attend high-quality colleges is robust to different measures of college quality.

I start with using Barron's ratings, a popular measure of college quality in recent work on the relationship between college quality and graduates' earnings, to estimate an established earnings model by conventional OLS technique. Then I re-estimate the earnings equation using three different measures of college quality, namely, average SAT score of the entering class, Carnegie Classification, and tuition and fees. Several observations can be drawn from this series of analyses. First, no matter what measures of college quality are used, the effect of college quality on earnings is generally positive and significant. For example, when the college quality measure constructed from mean SAT scores of entering class is used, the effect of high-quality private institutions is about 10%, and graduating from other categories of institutions (high-quality publics, middle-quality privates, and middle-quality publics) is also associated with 4-8% earnings advantages relative to low-quality public institutions. When the Carnegie Classification is used as a college quality measure, research institutions and doctoral institutions are associated with higher earnings relative to Liberal Arts II institutions, with the only exception being that graduating from Liberal Arts I institutions does not seem to provide significant earnings advantages relative to Liberal Arts II institutions. Finally, when the college quality is approximated by tuition and fees, it is highly associated with graduates' earnings, especially at private institutions.

Second, it appears that the estimated effect of college quality is sensitive to the measure of college quality. For example, the estimated effects of college quality constructed from Barron's ratings and mean SAT scores of entering class are quite different. At each quality level (especially for high-quality colleges), the estimated effect of college quality is much higher with Barron's ratings than mean SAT scores. This observation helps reconcile some of the discrepancies in previous studies. For example, using the same college quality measure constructed from Barron's ratings, Brewer et al. (1999) find that the effect of private elite colleges is in the order of 20-40% relative to low-quality public institutions. Thomas (2003), however, using the college quality measure constructed from the mean SAT scores of entering class, finds that the effect of private elite colleges is in the order of 10% relative to low-quality institutions. The varying effects of college quality should not be a surprise. My analyses show that under different measures, the same institution (or the same group of graduates) may be classified to different quality category. To the extent that the estimated effect of college quality is nothing more than the differences among the mean earnings of graduates in different quality categories after controlling for some other factors, it is straightforward that the differences among the mean earnings will change when institutions (or graduates) are categorized in different ways.

Third, the main point of this analysis is that no matter what measures of college quality are used, the earnings differentials among colleges of varying qualities are sufficiently large to compensate for the difference in tuition and fees among institutions. The most direct comparison is provided by the regression with tuition and fees as the college quality measure. A $1,000 increase in tuition and fees at private institutions is associated with a $733 earnings increase annually, and at public institutions a $1,000 increase in tuition and fees is associated with a $570

earnings increase annually. Similar cost-benefit analyses are carried out for different measures of college quality, and the conclusion of the baseline model (i.e., it pays to attend a high-quality college versus a low-quality college) is quite robust.

Results of the current study have several important implications. First, in the future discussion of college quality, we need to be very explicit about how the college quality is measured and defined. Assuming that every higher education institution has its own effect on graduates earnings, then how to classify institutions into quality categories has a direct impact on the effect of quality category because statistically speaking the latter is the average (sometimes weighted) of the institutional effects within each quality category. This is especially crucial in comparing results across different studies. Some of the discrepancies among the results from previous studies may be caused by the different measures of college quality employed.

Second, because the current analysis compares the earnings of terminal baccalaureate recipients from different types of institutions, a host of other effects of high-quality institutions are ignored. For example, graduating from certain types of institutions (such as Liberal Arts I) may not have immediate significant effects on earnings, but the longer term effect may operate through graduate education and different life-time earnings profiles than those from other institutions. As more longitudinal data are collected, the study on the long-term effect of college quality will be possible.

Third, the common wisdom that it pays to attend high-quality institutions seems to be quite robust over an array of measures of college quality. This is reassuring that high-quality college education appears to be a good investment, although educational researchers are having a difficult time to figure out the sources of such advantages provided by those high-quality institutions. Possible explanations include peer effects, better resources, higher level of

engagement, sorting effects, and possibly favoritism; however, the empirical evidence is rather thin for each one of the possible explanations. Future research should look into these characteristics which contribute to the positive effects of high-quality institutions on students' outcomes such as graduates' earnings, with an eye to improve those aspects at other institutions.

Finally, the large and significant effect of college quality may not be good news because it provides an excuse for high-quality institutions to continue to raise their high tuition and fees in their pursuit of academic excellence. This becomes an equity concern especially in view of the increasing socioeconomic stratification among college participants. As the majority of high school graduates in the United States attended colleges, the differentiation of educational attainment increasingly went beyond the dichotomy of college graduates versus non-college graduates. We also know that the largest increase of college-going population will be from the low-income families in the foreseeable future. If prestigious institutions continue to increase their tuition and fees, college quality may become an apparatus to increase the socioeconomic stratification. Future research should focus on the college choice behaviors of students from poor families, paying more attention to promoting their participation at high-quality institutions. Future research should also redirect its emphasis on the social returns to high quality college education as an incentive for the society to provide it at a reasonable price for individuals.

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Table 1: Descriptive Statistics of Variables in the Earnings Equation

Variable	Mean	SD
Log earnings	10.3328	0.4841
Institutional Characteristics		
Low-quality, public institution	0.1511	0.3582
Low-quality, private institution	0.0526	0.2233
Middle-quality, public institution	0.4749	0.4994
Middle-quality, private institution	0.2078	0.4058
High-quality, public institution	0.0487	0.2153
High-quality, private institution	0.0648	0.2462
Historically Black colleges and institutions	0.0258	0.1585
Private institution	0.3252	0.4685
Demographic Characteristics		
Female	0.5188	0.4997
White	0.8453	0.3616
Native American	0.0049	0.0701
Asian	0.0340	0.1811
Black	0.0694	0.2541
Hispanic	0.0413	0.1991
Family Background		
Family income (in $10,000)	4.6576	4.7764
First generation college graduate	0.5100	0.5000
Academic Background		
Merged SAT/ACT quartile	1.9381	1.3389
Business major	0.2885	0.4531
Engineering major	0.0643	0.2452
Health major	0.0607	0.2388
Public affairs major	0.0367	0.1880
Biological science major	0.0275	0.1634
Math science major	0.0560	0.2300
Social science major	0.0910	0.2876
History major	0.0170	0.1291
Humanity major	0.0720	0.2586
Psychology major	0.0292	0.1683
Other major	0.1423	0.3494
Labor Market		
Age	29.9966	6.4937
Age squared / 100	9.4195	5.0196
Tenure	2.8057	3.2974
Tenure squared / 100	0.1874	0.6677
Number of hours per week	45.3744	9.1568
N	3965	

Table 2: Distribution of Students across Colleges of Varying Quality (Barron's Ratings)

	Public institutions	Private institutions	Total
High-quality institutions	193 (4.87%)	257 (6.48%)	450 (11.35%)
Middle-quality institutions	1,883 (47.49%)	824 (20.78%)	2,707 (68.27%)
Low-quality institutions	599 (15.11%)	209 (5.26%)	808 (20.38%)
Total	2,675 (67.47%)	1,290 (32.53%)	3,965 (100.00%)

Note: The percentages may not compute due to rounding.

Table 3: OLS Estimates for the Earnings Equation

Variable	Coefficient	t
Constant	8.7298	51.72
Institutional Characteristics		
Low-quality, private institution	0.0530	1.42
Middle-quality, public institution	0.0920	4.41
Middle-quality, private institution	0.1066	4.61
High-quality, public institution	0.1800	5.46
High-quality, private institution	0.1754	4.47
Historically black colleges and institutions	-0.1167	-2.31
Demographic Characteristics		
Female	-0.0936	-6.04
Native American	0.1040	1.47
Asian	0.1268	3.46
Black	-0.0109	-0.35
Hispanic	0.0438	1.07
Family Background		
Family income (in $10,000)	0.0055	3.55
First generation college graduate	-0.0233	-1.61
Academic Background		
Merged SAT/ACT quartile	0.0081	1.06
Business major	0.2752	11.08
Engineering major	0.4321	14.15
Health major	0.4429	14.28
Public affairs major	0.1473	3.67
Biological science major	0.1493	3.15
Math science major	0.3818	10.39
Social science major	0.1944	5.88
History major	-0.1340	-1.38
Humanity major	0.1231	3.80
Psychology major	0.1290	3.31
Other major	0.1471	5.09
Labor Market		
Age	0.0362	4.15
Age squared / 100	-0.0433	-3.90
Tenure	0.0160	3.37
Tenure squared /100	-0.0058	-0.28
Number of hours per week	0.0130	10.95
N	3,965	
R^2	0.2247	

Note: Standard errors are corrected for heteroscedasticity.

Table 4: Average Tuition by College Quality and Types of Control

Institutional Type	N	Tuition
Low-quality, public institution	78	$1,568
Low-quality, private institution	46	$6,020
Middle-quality, public institution	155	$1,824
Middle-quality, private institution	159	$8,531
High-quality, public institution	15	$2,171
High-quality, private institution	47	$12,201
Total	500	

Note: Average tuition is not weighted.

Table 5: Distribution of Students across Colleges of Varying Quality by Mean SAT Scores

	Public institutions	Private institutions	Total
High-quality institutions	738 (19.1%)	565 (14.6%)	1,303 (33.7%)
Middle-quality institutions	1,045 (27.0%)	425 (11.0%)	1,470 (38.0%)
Low-quality institutions	795 (20.6%)	301 (7.8%)	1,096 (28.3%)
Total	2,578 (66.7%)	1,291 (33.3%)	3,869 (100%)

Note: The percentages may not compute due to rounding.

Table 6: Distribution of Students across Colleges of Varying Quality by Carnegie Category

Carnegie classification	N	Proportion
Research I institution	858	20.8%
Research II institution	305	7.4%
Doctoral I institution	265	6.4%
Doctoral II institution	333	8.1%
Comprehensive I institution	1,585	38.4%
Comprehensive II institution	111	2.7%
Liberal Arts I institution	186	4.5%
Liberal Arts II institution	488	11.8%
Total	4,131	100%

Note: The percentages may not add to 100% due to rounding.

Table 7: OLS Estimates for Earnings Equation (quality measured by mean SAT scores)

Variable	Coefficient	t-ratio
Low-quality, private institution	-0.0018	-0.06
Middle-quality, public institution	0.0457	2.31
Middle-quality, private institution	0.0793	3.16
High-quality, public institution	0.0608	2.67
High-quality, private institution	0.1005	4.13

Note: Also controlled for other variables as in Table 3. Standard errors are corrected for heteroscedasticity.

Table 8: Average Tuition and Fees by College Quality (quality measured by mean SAT scores)

Institutional Type	N	Tuition
Low-quality, public institution	108	$1,519
Low-quality, private institution	65	$5,716
Middle-quality, public institution	80	$1,895
Middle-quality, private institution	80	$8,130
High-quality, public institution	53	$2,128
High-quality, private institution	106	$10,964
Total	492	

Table 9: OLS Estimates for Earnings Equation (quality measured by Carnegie category)

Variable	Coefficient	t-ratio
Research I institution	0.1043	3.96
Research II institution	0.0846	2.87
Doctoral I institution	0.1481	4.79
Doctoral II institution	0.0873	2.69
Comprehensive I institution	0.0614	2.77
Comprehensive II institution	0.0923	2.03
Liberal Arts I institution	0.0068	0.16

Table 10: Average Tuition by College Quality (quality measured by Carnegie category)

Institutional Type	N	Tuition
Research I institution	61	$4,957
Research II institution	24	$3,973
Doctoral I institution	24	$6,878
Doctoral II institution	35	$6,176
Comprehensive I institution	212	$3,936
Comprehensive II institution	30	$5,711
Liberal Arts I institution	44	$10,685
Liberal Arts II institution	100	$5,092
Total	530	

Table 11: Effect of Tuition and Fees (in $1,000) on Graduates' Earnings

Model	coeff.	t
Pooled	0.0179	4.15
Private	0.0236	4.96
Public	0.0184	1.66

Appendix A: HLM Estimation of the Baseline Model

Due to the multilevel nature (i.e., institutional and individual) of the factors shown to have effects on the outcome of interest (i.e., earnings) in the current analysis, econometric techniques which characterize this nature such as hierarchical linear modeling (HLM) are often recommended (Bryk & Raudenbush, 1992; Heck & Thomas, 2000). The HLM model characterizes the multilevel nature of the data by simultaneously estimating two sets of equations, a within-unit set and a between-unit set. Taking the current analysis as an example, the within-unit set estimates the relationship between individual earnings and individual-level variables and the between-unit set estimates the relationship between the coefficients estimates from the with-in set and institutional-level variables.

As a routine for HLM estimation, I first decompose the total variance into within and between variances. The result of this simple one-way ANOVA analysis is presented in Table A.1: The majority of variance (78%) in log earnings is within colleges, and between variance makes up the remaining 22%.

After the estimation of variance components, the formal HLM model is estimated using the same data as in the pooled baseline model. Table A.2 presents HLM estimates of the effects of the various demographic, family background, educational background, and labor market variables on graduates' earnings. For comparison purposes, the OLS estimates and HLM estimates for college quality are presented in Table A.3. The comparison between OLS and HLM estimates shows that the HLM estimates are very similar to the OLS estimates, although the point estimates are generally smaller and standard errors are generally larger in HLM than their counterparts in OLS.

Table A.1: Variance Components for Log Earnings

	Variance
Total	928.8
Amount within colleges	725.5
Amount between colleges	203.3
Proportion between colleges	21.89%

Table A.2: HLM Estimates for the Baseline Model

Variable	Coefficient	t-ratio
Constant	8.7110	48.75
Institutional Characteristics		
Low-quality, private institution	0.0352	0.82
Middle-quality, public institution	0.0719	2.60
Middle-quality, private institution	0.0950	3.18
High-quality, public institution	0.1728	3.36
High-quality, private institution	0.1601	3.80
Historically Black colleges and institutions	-0.1014	-1.79
Demographic Characteristics		
Female	-0.0956	-6.48
Native American	0.1056	1.09
Asian	0.1081	2.78
Black	-0.0258	-0.81
Hispanic	0.0349	0.98
Family Background		
Family income (in $10,000)	0.0056	3.60
First-generation college graduate	-0.0166	-1.13
Academic Background		
Merged SAT/ACT quartile	0.0060	0.78
Business major	0.2685	11.00
Engineering major	0.4183	11.76
Health major	0.4263	12.33
Public affairs major	0.1460	3.58
Biological science major	0.1373	3.01
Math science major	0.3681	10.38
Social science major	0.1858	6.07
History major	-0.1220	-2.18
Humanity major	0.1015	3.12
Psychology major	0.1043	2.34
Other major	0.1373	5.06
Labor Market		
Age	0.0386	4.17
Age squared	-0.0465	-3.95
Tenure	0.0157	3.23
Tenure squared	-0.0024	-0.10
Number of hours per week	0.0131	17.10

Table A.3: Comparison between the OLS and HLM Estimates

	OLS		HLM	
	Coeff.	t	Coeff.	t
Low-quality, private institution	0.0530	1.42	0.0352	0.82
Middle-quality, public institution	0.0920	4.41	0.0719	2.60
Middle-quality, private institution	0.1066	4.61	0.0950	3.18
High-quality, public institution	0.1800	5.46	0.1728	3.36
High-quality, private institution	0.1754	4.47	0.1601	3.80