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Keywords
graduate education, undergraduate majors, college quality, academic performance

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Advance to Graduate Education:

The Effect of College Quality and Undergraduate Majors*

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Abstract

Using a nationally representative sample of baccalaureate graduates from 1993, we examine the effect of college quality and undergraduate majors on a variety of graduate education outcomes including graduate school enrollment, graduate degree attainment, and the quality of graduate programs. Other things being equal, college quality has a significant effect on graduate education. More importantly, because part of socioeconomic factors has been crystallized into academic performance and educational credentials, socioeconomic factors exert significant direct and indirect effects on graduate education.

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Introduction

American higher education has experienced massive expansion since World War II. In 2000 there were approximately 4,200 institutions of higher education in the United States and its territories, enrolling about 15.3 million students (National Center for Education Statistics, 2003). In 2001, over 60% of the nation's high school graduates attended colleges. On the other hand, American higher education has been increasingly stratified. Hoxby (1997) showed that during the period between 1940 to 1991, the between-college variation in student quality has been increased while the within-college variation in student quality has been decreased. The expansion and stratification of American higher education system encouraged finer differentiation among college graduates instead of the dichotomy of college graduates versus non-college graduates. As a result, institutional quality has been brought into the discussion of educational attainment.

During the same period, knowledge growth and technological innovation have made college education increasingly inadequate for many occupations. Indeed, Kingston and Clawson (1985) suggested that graduate education provided a fast track to the most powerful and prestigious positions in the occupational distribution. According to General Social Survey conducted in 1989, the vast majority of the top ranked occupations require graduate or professional degrees (Bowen and Bok, 1998). There might also be a credentialing aspect of this increasing importance of graduate education. As college education became quite a universal

phenomenon, many individuals sought to distinguish themselves from others through graduate education.

This study focuses on the nexus between these two dimensions of stratification and differentiation. Specifically, I examine the effect of college quality, among other academic and non-academic factors, on educational continuation for college graduates. Results of this study add two important points to the ongoing debate of the role of high-quality college education. First, by examining the effect of college quality on graduate education, I extend the study of the effect of college quality beyond the area of earnings differences, adding considerably to the overall effect of college quality on students' outcomes. Second, by explicating the relationship among socioeconomic factors, college quality, and graduate education, I am able to examine the role of college quality and graduate education in the broad context of social stratification.

Literature Review

Whereas college quality appeared to have profound effects on some student outcomes, graduates' earnings have long been the particular interest of the research community in the finance of higher education and in labor economics. Many researchers, in one way or another, have made the case that college quality was an element in the formation of human capital and thus had an important effect on earnings.[1] Weisbrod and Karpoff (1968), Reed and Miller (1970), Solmon (1973, 1975), and Wise (1975) were among the first to explore the effect of college quality on graduates' earnings. Recent studies by Brewer and his colleagues (Brewer and Ehrenberg, 1996; Brewer, Eide, and Ehrenberg, 1999; Eide, Brewer, and Ehrenberg, 1998) and Thomas and his colleagues (Thomas, 2000, 2003; Thomas and Zhang, 2001, 2002) have significantly improved our understanding of the economic effect of college quality. The bulk of

this line of research has shown that college quality has a positive and significant effect on graduates' earnings, on average (e.g., Solman and Wachtel, 1975; Pascarella and Terenzini, 1991; Mueller, 1988; Thomas, 2000, 2003). The strength of such a focus is partially due to the popular (mis)perception that greater economic rewards are the single most important outcome of college education and partially due to the fact that employment and wage data are readily available in many national data bases of college graduates. Exclusive focus on the economic outcomes of college education neglects a host of other outcomes, however. In this paper, I extend the study of the effects of college quality beyond the area of earnings differences. Specifically, I consider the effects of college quality on graduate education.

Graduate education is valuable both individually and socially. From individual viewpoint, graduate education is an integral stage of human capital accumulation, and usually it is a prerequisite to many desirable and prestigious professions with great economic rewards and high social status (e.g., physician, professor, lawyer, and scientists). And especially since 1970s, earnings of highly successful professionals have increased sharply, attracting more and more college graduates into graduate and professional schools (Bok, 1993). Certainly, many individuals pursue graduate education yet for another reason: These individuals have deep interest in a particular subject matter and consider graduate education as a consumption good, thus obtaining an advanced degree itself may be considered as a triumph to them. So too does society have a large stake in graduate and professional education. Graduate and professional schools are critical links in the chain of institutions that transmit and codify the most complex information in modern societies (Bourdieu, 1977, 1984). As the amount of knowledge increases, each individual can know only a decreasing fraction of what can be known (Metzger, 1987). As a result, society becomes more and more dependent upon professionals.

Given the increasing importance of graduate education, we would speculate that students would consider enhanced opportunity of graduate education, besides direct monetary concerns, as a major element in choosing a college to attend or a major field of study. For example, previous research suggests that many students choose their major fields never intending to terminate their education with an undergraduate degree, but rather intending to enroll in professional or academic graduate programs (Eide and Waehrer, 1998). Similarly, because of the option value for further education, students may choose to attend colleges that provide greater possibilities for advancing to the graduate level. In fact, Thomas (2000) suggests that terminal baccalaureate graduates of more prestigious colleges may be viewed as "damaged goods" and hence may not receive the economic returns one might expect. These results suggest we need to include the effect of college quality and various factors on graduate education in the analysis of the effect of college quality on students.

A few studies have examined the effect of college quality on graduate education. Tinto (1980), Smart (1986), and Ethington and Smart (1986) have shown that college quality has a small though statistically significant effect on graduate school enrollment. Further, Henson (1980) and Lang (1987) suggest that graduating from high-quality undergraduate colleges increases the probability of attending high-quality graduate schools. Recently, Eide, Brewer, and Ehrenberg (1998), using NLS-72 and HSB, find that attendance at an elite private college significantly increases the probability of attending graduate school, and more specifically, graduate school at a major research institutions. This study differs from previous ones in a number of ways. First, I used a national representative sample of recent college graduates, thus results from this analysis are more generalizable and up-dated. Second, I examine not only graduate program enrollment but also graduate degree attainment whenever the data permit such

an analysis. Most importantly, I explore the relationship socioeconomic factors, college quality, and graduate education, thus enabling me to put the current analysis in the broad context of social stratification and in the process understand the role of high-quality college education in society.

In this analysis, I first examine the extent to which college quality affects college graduates' enrollment in graduate programs within four to five years after college graduation.[2] Second, by differentiating master's and doctoral programs, I study the effect of college quality on the levels of graduate programs in which students enrolled. Third, I consider the extent to which college quality may have affected the quality of graduate schools in which students enrolled. The same questions may be examined for graduate degree attainment. For example, what is the effect of college quality on graduate degree attainment within four to five years after BA receipt? Does college quality affect the level of graduate program and quality of graduate school? Finally, I remark on how to integrate the results of this analysis into the conventional research on the effect of college quality on earnings.

Analysis

Data Set

My analysis draws data from two levels: the individual level and the institutional level. The individual-level data come from the 1997 second follow-up of the Baccalaureate and Beyond (B&B) study. The B&B is a national longitudinal study designed to provide information concerning education and work experiences after completion of the bachelor's 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 restricted B&B: 93/97 data set is used to enable the connection of students and institutions.[3] The second follow-up survey includes more than 10,000 baccalaureate recipients who completed their degrees between July 1992 and June 1993. Because B&B data set over samples students intending careers in public service occupations and particularly those intending careers in teaching, sampling weights are necessary to obtain unbiased estimates. As a result, all analyses reported in this paper have been weighted appropriately, normalized on the final sample.[4]

School-level data come from two sources including the Integrated Postsecondary Education Data System 1992-93 (IPEDS) and various editions of 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 (with ratings from 0 to 5) 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).

Sample and Variables

The sample of students for this analysis is limited to those who (1) were in BB: 93/97 (N = 11,192), (2) never received a bachelor's degree before 1992 or 1993 (N = 9,438), (3) had valid data on graduate enrollment and degree attainment (N = 9,410), and (4) had school-level data available (N = 8,610). A detailed distribution of their graduate enrollment and degree attainment is presented in Table 1.

INSERT TABLE 1 ABOUT HERE

Among the 8,610 college graduates in the sample, 4,157 (48.3%) have not been enrolled since their graduation; and 2,504 (29.1%) students have enrolled in master's programs, including MBA and first professional programs. Another 306 (3.6%) have enrolled in doctoral programs. The term *graduate enrollment* in this analysis is restricted to enrollment in the master's (including MBA and first professional) programs and doctoral programs but does not include any certificate or licensing programs. By this definition, a total of 2,810 (32.6%) students in the final sample have attended various graduate programs.

Certainly, enrollment in graduate programs before April 1997 did not necessarily guarantee graduate degree completion in 1997. Among the 2,504 students enrolled in master's programs, 1,382 had not received degrees by 1997; that is, only 978 (39.1% of 2,504) had completed their master's degrees. Students enrolled in other degree programs could also receive master's degrees. For example, 119 students who enrolled in doctoral programs had completed their master's degree by the second follow-up. Altogether, up to April 1997, 1,105 (12.8% of 8,610) students had finished their master's degrees, and 30 had completed their doctoral degrees. Similarly, the term *graduate degree* in this analysis was restricted to master's and doctoral degrees but excluded certificates and licenses.

Several dependent variables are of interest in this analysis. The first is graduate enrollment, indicating whether one has been involved in any type of graduate enrollment, including master's and doctoral programs (GRDENR = 1 if ever enrolled in a graduate program, GRDENR = 0 otherwise). A second outcome variable used in this analysis identifies those BA graduates who have enrolled in a doctoral program (PHDENR = 1 if enrolled in a doctoral program, PHDENR = 0 if enrolled in a master's program). A third variable captures the Carnegie Classification of the institution in which a student enrolled for graduate study (CCENR = 0 if

enrolled in comprehensive universities, CCENR = 1 if enrolled in doctoral universities, and CCENR = 2 if enrolled in research universities). In this analysis, I do not differentiate Type I and Type II institutions in each Carnegie category.

Two other variables describe students' completion of graduate degrees in 1997. One of these indicates whether a student has obtained a graduate degree by 1997 (GRDDGR = 1 if attained graduate degree, GRDDGR = 0 otherwise). Unlike in the analysis of graduate enrollment, I do not attempt to differentiate between master's degrees and doctoral degrees because of the small number of doctorates awarded. The final outcome variable used in this analysis captures the Carnegie Classification of the institution conferring the advanced degree (CCDGR = 0 if received degree from comprehensive universities, CCDGR = 1 if received degree from doctoral universities, and CCDGR = 2 if received degree from research universities).

Independent variables include college quality, demographic characteristics, family backgrounds, and academic variables. In this analysis, 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 public perceptions of public and private institutions are quite different, I further distinguish between privately and publicly controlled institutions in each group, yielding six college types: high-quality privates, high-quality publics, middle-quality privates, middle-quality publics, low-quality privates, and low-quality publics. Besides this set of college quality variables, I also include a dummy to indicate historically black colleges and universities (HBCU).

Demographic variables capture aspects of gender (a categorical dummy indicating whether the student is female), race/ethnicity (categorical dummies indicating Native American, Asian, Black, and Hispanic with the omitted group being White), and age (in years). Family backgrounds are characterized by two variables: family income (in thousands of dollars) and whether the student is a first-generation college graduate.[5] Academic variables include academic performance (measured by undergraduate GPA) and undergraduate majors (categorical dummies indicating business, education, engineering, health, public affairs, biology science, social science, math/science, history, humanity, psychology, and other majors). In all subsequent analyses, education majors are treated as the reference group. The rationale for including these variables is discussed in Thomas (2000, 2003) and Thomas and Zhang (2001, 2002). A detailed description of these variables is provided in Table 2.

INSERT TABLE 2 ABOUT HERE

Methods

The method employed in this analysis is straightforward binomial logit and multinomial logit (three discrete outcomes) models. Specifically, for binomial choices (graduate enrollment or not, master's program or doctoral program, and graduate degree or not), binomial logit models are used, and for multinomial outcomes (comprehensive, doctoral, or research institutions), multinomial logit are employed.[6] The estimated logit coefficients show how graduating from undergraduate colleges of varying quality affect the log odds of various choice variables. For the convenience of interpretation, only the marginal effects are reported.

Results

Graduate Program Enrollment

I first estimate a logit model of the impact of college quality on the probability of graduate program enrollment with the dependent variable GRDENR. The marginal effects from this analysis are reported in Table 3. The predictive power of the model is fairly good; overall, it predicts 70 percent of the binomial choices correctly. College quality emerges as a strong predictor for graduate program enrollment. Relative to BA graduates from low-quality public colleges, BA recipients from high-quality colleges are about 16% (private) and 18% (public) more likely to enroll in some kind of graduate program within four to five years after BA receipt. Students from middle-quality institutions also enjoy about 10% advantages in graduate school attendance over low-quality institutions. It appears that in terms of graduate school attendance, institutional control has little effect. This pattern is very much like the pattern for the effect of college quality on earnings as reported as previous studies (Thomas, 2000, 2003; Thomas and Zhang, 2001).

INSERT TABLE 3 ABOUT HERE

The probability of graduate school attendance also varies by undergraduate major. Business graduates are least likely to attend graduate school among all major areas. Compared with education graduates, business graduates are 22% less likely to attend graduate schools. This may have been because of the high opportunity costs associated with graduate school attendance for business majors. Another possibility is that a substantial period of working experience is

usually required to enter graduate programs in business. In contrast, students from the relatively low-paid majors (education, bio-science, math science, social science, history, and psychology) are among the group who are most likely to attend graduate school. Following from the logic above, the latter's attendance may have been because of low opportunity costs relative to business majors. This finding is consistent with the notion of option value in college major choice (Eide and Waehrer, 1998). Majoring in relatively low-paid fields is associated with greater opportunity to obtain further education and the rewards accompanying such higher level of education.

Results of the effect of other variables are consistent with findings from previous research in this area. For example, academic performance is a strong predictor of graduate school attendance. On average, one unit increase in undergraduate GPA is associated with almost a 22% increase in the likelihood of enrolling in a graduate program. On average, female graduates are less likely to attend graduate school. It seems that although female students were able to close the gender gap in terms of college education (for example, female students account for 54.67% of the final sample in this analysis), they nevertheless still lagged behind their male counterparts in terms of graduate education.[7] Further, the analysis shows that the probability of graduate school attendance is a convex function of age. Considering that salary is a concave function of age, this result is understandable because higher opportunity cost is associated with lower probability of graduate school attendance.

Finally, higher family income is associated with a higher probability of graduate school attendance and being a first-generation college graduate is associated with a lower probability of graduate school attendance, although the estimated effect is rather small. For example, a $10,000 increase of family income is only associated with a 0.37% increase in the likelihood of enrolling

in a graduate program, and being a first-generation college graduate is associated with a 2.8% decrease in the likelihood of enrolling in a graduate program. Previous research (e.g., Mare, 1980) indicates that although the probability of enrolling in a graduate school is affect by socioeconomic factors, its conditional probability (given that one has completed college) is not substantially affected by one's socioeconomic status. This could be due to less financial dependence of college graduates upon their parents (Berenson, 1990) and/or the attenuation of the link between parental socioeconomic status and educational continuation aspiration through college education (Stolzenberg, 1994).

Enrollment in Master's or Doctoral Program

In the next step, I sample those students who actually have enrolled in graduate programs within four to five years after college graduation and estimate the effect of college quality on their choice of degree program. In effect, I estimate the impact of college quality on the probability of enrolling in a doctoral program relative to enrolling in a master's program.

Table 4 reports the marginal effects from the binomial logit model with the dependent variable PHDENR. The prediction of this binomial model is quite good; overall, it predicts 89% of the binomial choice classified correctly. College quality, except for those graduating from high-quality public institutions, does not have a significant effect on the probability of enrolling in doctoral programs. Students from high-quality public colleges are more likely to enroll in doctoral programs, relative to students from low-quality publics; nonetheless, the effect is small. Undergraduate majors, on the other hand, have a strong effect on the probability of enrolling in a doctoral program. In the final sample, none of the students from public affairs majors attended doctoral programs (this dummy is dropped from the regression). Not only are business majors

less likely to attend graduate school, they are also less likely to enroll in doctoral programs. Bio-science, math/science, social science, humanity, and psychology majors are among those who are most likely to enroll in doctoral programs. Opportunity costs could serve as a reasonable explanation for different probabilities of attending doctoral programs among these fields of major. Another possible explanation is that master's degrees are often regarded as the terminal degree for some fields such as business while in other fields such as social sciences a large proportion of students enroll in doctoral programs. In fact, certain social programs such as economics rarely accept applicants who only intend to get a master's degree. Admittedly, the variation in the probability of enrolling in doctoral programs across different major fields of study may have reflected individual heterogeneity among those who major in those undergraduate fields. For example, it could be the case that bio-science and math/science undergraduate majors are more research oriented; thus, they are more likely to enroll in doctoral programs.[8]

INSERT TABLE 4 ABOUT HERE

Other variables also impact enrollment in doctoral programs. Better academic performance increases the probability of attending doctoral programs. Surprisingly, family income has a negative impact on the probability of attending doctoral programs. It could be the case that students from high-income families are more likely to enroll in professional degrees, such as business and law. It could also be the case that doctoral programs are relatively inexpensive because of various financial aids such as fellowships, teaching assistantships, and research assistantships. Being a first-generation college graduate not only lowers the probability

of enrolling in graduate programs as Table 3 shows, but also lowers the probability of enrolling in doctoral programs for those going on to graduate school. The effect of age on enrollment in doctoral programs is similar to its effect on enrollment in graduate programs generally; that is, the probability of enrolling in a doctoral program is a convex function of age. Again, opportunity costs could be the explanation.

Quality of Graduate School Enrolled

For those students who actually have enrolled in graduate programs, I also analyze the effect of undergraduate college quality on the probability of attending different types of graduate institutions. In effect, I examine the extent to which undergraduate college quality affects the quality of graduate schools. As is true for the quality of undergraduate colleges, the quality of graduate schools is also difficult to measure. In this analysis, the Carnegie Classification is used to characterize the quality of graduate schools.[9]

I estimate a multinomial logit model with three outcomes: attendance at comprehensive, doctoral, and research institutions. The marginal effects are reported in Table 5. Undergraduate college quality appears to have dominating effects in determining graduate school destination. For example, on average, students from high-quality undergraduate institutions, relative to those from low-quality undergraduate colleges, are about 40% less likely to enroll in comprehensive universities and more than 50% more likely to enroll in research universities. Students from middle-quality colleges are more than 10% less likely to enroll in comprehensive universities and about 20% more likely to enroll in research universities relative to those from low-quality undergraduate colleges. Again, institutional control of undergraduate colleges does not seem to affect the destination of graduates pursuing advanced degrees.

INSERT TABLE 5 ABOUT HERE

Graduate school destinations also vary across academic majors. Compared with education majors, students from the fields of engineering, bio-science, and math/science are more likely to enroll in research universities. Given that some of those programs are the most expensive graduate programs and thus are disproportionately hosted in research universities, this finding is not a surprise. Academic performance is positively associated with the probability of attending research universities. This could be a result of higher admission standards in research universities.

Family income does not seem to impact graduate school destination while being a first-generation college graduate does decrease the probability of attending research universities significantly. Compared with their counterparts, first-generation college graduates are less well paid in the labor market (Thomas and Zhang, 2001) and less likely to enroll in graduate programs. Even when they actually attend graduate programs, they are less likely to enroll in doctoral programs and to attend research universities. Being female and/or Black also reduces the probability of attending a research university. It seems that female graduates are not only less likely to enroll in a graduate program, they also lag behind their male counterparts in attending good quality programs.

Graduate Degree Attainment

Having examined the effect of college quality on graduate enrollment, I further look at the effect of college quality on graduate degree completion within four to five years after college

graduation. It must be cautioned, however, that less than half of college graduates who have ever enrolled in graduate programs completed their study within that time period.[10] In particular, for those who enrolled in doctoral programs, fewer than 1 out of 10 obtained a doctorate. I estimate a logit model of the impact of college quality on the probability of graduate degree completion with dependent variable GRDDGR. The marginal effects are reported in Table 6. It should be cautioned that because the dependent variable is not conditional on graduate school enrollment, the estimated effect represents the overall effect of college quality on graduate degree attainment.

INSERT TABLE 6 ABOUT HERE

Table 6 is analogous to Table 3 with the only difference being that the dependent variables in Table 6 are graduate degree attainment instead of graduate enrollment. The qualitative results are also very similar. For example, college quality has a significant effect on graduate degree attainment. Relative to graduates from low-quality public colleges, graduates from high-quality private and public colleges are about 7% more likely to receive graduate degrees within four to five years after graduation. Business majors are least likely to receive graduate degrees. For one reason, business majors are less likely to attend graduate programs as Table 3 shows. Moreover, there is the working experience usually required for graduate level business-related programs.

Results of the effect of other variables are also similar to those in Table 3. For example, academic performance is a strong predictor of graduation degree receipt within four to five years after college graduation. On average, one unit increase in GPA is associated with a 10% increase in the probability of receiving a graduate degree. On average, female graduates are less likely

and graduates of minority groups are more likely to complete graduate study within four to five years of college graduation. Higher family income increases the probability and being a first-generation college graduate lowers the probability of completing graduate study. Again, the effect of these socioeconomic factors on degree attainment is not substantial either.

Quality of Graduate School Conferring Degrees

Finally, for those students who actually received a graduate degree, I analyze the effect of college quality on the probability of receiving graduate degrees from different types of institutions. I again estimate a multinomial logit model with three outcomes: attendance at comprehensive, doctoral, and research institutions. The marginal effects are reported in Table 7. The model predicts 59% of the trinomial choices correctly. Table 7 is analogous to Table 5, with the only difference being that in Table 7 the dependent variable is the Carnegie Classification of the graduate school conferring the degree, and in Table 5 the dependent variable is the Carnegie Classification of the graduate school in which a graduate enrolled. The results in Table 7 are also very similar to those found in Table 5. For example, undergraduate college quality has a large effect on the type of institution conferring the degree. On average, students from high-quality undergraduate institutions, relative to those from low-quality public colleges, are about 40% more likely to earn graduate degrees from research universities. The effects of other variables such as demographic characteristics, family background, and major fields of study are also similar to those in Table 5.

INSERT TABLE 7 ABOUT HERE

Economic Effect of Graduate Education

The above analysis shows that graduating from high-quality undergraduate institutions increases the probability of attending graduate school and, more specifically, increases the probability of enrolling in doctoral programs and at research universities. These positive effects add substantially to the economic effect of undergraduate college quality when graduate education is viewed as an integral part of human capital accumulation. A very natural extension of the above analysis is to examine the subsequent economic effect of graduate education, taking into account of the effect of college education on graduate education. If graduate education has a positive effect on earnings, then comparing the earnings differences among terminal BA holders would most likely understate the economic effect of college quality because part of the economic effect of college quality is through the effect of graduate education. From the human capital perspective, graduate education further enhances one's human capital and thus leads to additional economic benefits.

Previous studies have not examined this issue adequately. Some studies have limited the sample of students to those with only a baccalaureate degree (e.g., Thomas, 2000, 2003). These studies have failed to consider the extent to which institutional quality affects graduate education, which may in turn have affected subsequent earnings. Other studies have included the effects of graduate education on earnings (e.g., Brewer and Ehrenberg, 1996; Brewer, Eide, and Ehrenberg, 1999); however, they have treated final undergraduate and graduate degree status as independent of college quality. We need to consider the effects of attending a high-quality undergraduate college on graduate education and the effect of graduate education on subsequent

labor market outcomes simultaneously to better understand the full impact of education on earnings and labor market outcomes.

Unfortunately, due to data limitations, I am not able to address this issue in this analysis. Because most of individuals with graduate education have a very short time in the labor market when the second follow-up of B&B takes place, comparing their earnings with those terminal BA recipients with four to five years of working experience probably underestimates the effect of graduate education.[11] Further, if individuals with BA degrees and advanced degrees have different earnings trajectories over their career, focusing on the very early stage of career could be misleading. Another possibility is that graduate education might not have positive effect on earnings but have a positive effect on occupational status.

Conclusion and Discussion

In this paper, the effect of college quality was extended to include its effect on graduate education. Generally speaking, graduates from high-quality colleges were more likely to enroll in graduate programs; among those who actually enrolled in graduate programs, graduates from high-quality colleges were more likely to enroll in doctoral programs and in research universities. Similarly, graduates from high-quality colleges were more likely to finish their graduate degree within four to five years of college graduation; among the graduates who had actually obtained their graduate degree within four to five years, those from high-quality colleges were more likely to have received their degrees from research universities. It seems, then, that undergraduate college quality increased the probability of enrolling in graduate programs and helped determine the quality of graduate schools selected.

In a recent study, Bowen and Bok (1998) studied graduate degree attainment for college graduates from a group of 28 selective institutions in the College and Beyond data set.[12] Interestingly, even within this set of selective institutions, institutional selectivity plays a significant role in predicting graduate degree attainment. Further, in examining graduate degree attainment at top-rated professional schools, they found that 26% of the black law school graduates and 18% of the white law school graduates from these 28 institutions received graduate degrees from one of the eight most highly ranked law schools. Similarly, a very large proportion of college graduates from these institutions received degrees from the most highly ranked medicine and business schools (p. 102). It appears that the empirical result from the current study, i.e., the significant and positive effect of college quality on graduate education, still holds when different quality measures of undergraduate colleges and graduate schools are used.

Higher education researchers have noticed this "chain" effect in educational outcomes. For example, in studying college graduation rates, Adelman (1999) discovered that the most significant predictor of the probability of college graduation was not college quality but the "academic resources" (this measure was dominated by the intensity and quality of secondary school curriculum) the student brought forward from secondary school into higher education. Bringing all these results together, the pattern becomes clear: Students are not randomly rearranged after graduating from each educational level. The quality of institutions at the previous level helped determine the quality of institutions chosen at the following levels and also influenced the educational outcomes of the following levels.

I also examined different patterns of graduate enrollment and degree attainment among different majors. Quite contrary to the findings in the earnings equation, students from low-paid

majors were more likely to attend graduate schools and attain graduate degrees. In studying college major choice, Eide and Warhrer (1998) operationalized the idea of the "financial option return" to education. They argued that the benefit from college education was distinct from the standard expected income gain from investing in a college education; it also involved the opportunity to obtain further education and thus the rewards accompanying such further education. The extra utility gained from such opportunity was operationalized as the option value of a college education. This framework provided motivation for students to choose undergraduate majors that yielded relatively low economic return in the labor market. The concept of option value is also applicable to college choice. High-quality colleges not only yield immediate economic benefits, but also provided the option value of going further and going to better places for graduate education. Although the reason college quality affects graduate school quality so strongly is not entirely clear, families and students who are serious about their academic career need to ponder this evidence when making college choices.

Analyses in this study extended those in the previous research on the economic effect of college quality. First, graduating from high-quality undergraduate colleges was shown to increase the probability of graduate school enrollment and degree attainment, and more importantly, it had a large and significant impact on the quality of graduate school attended. Considered as a non-monetary outcome, graduate education added significantly to the total effect of college quality. Second, graduate education was an integral part of human capital accumulation and it was a necessary step toward some desirable professions. In this sense, there were option values that accrued to college quality, in that it increased the probability of graduate education, and the latter yielded further earnings premium. Thus, considered as an economic outcome, graduate education enhanced the effect of college quality on earnings.

The results regarding the effect of socioeconomic factors generally support the critical view of American education system. Socioeconomic factors such as family income and parental education continue to have an important impact on graduate school enrollment and the type of graduate school. Everything being equal, family income usually has positive effect on graduate education, although the effect of family income is small. It could be the case that family income is not a good measure of family wealth. It could also be the case that because graduate studies usually provide various financial supports, college graduates are less financially dependent upon their parents. And finally it could be due to the attenuation of the link between parental socioeconomic status and educational continuation aspiration through college education. Being a first-generation college graduate lowers the probability of attending graduate school; more importantly, it lowers the probability of enrolling in doctoral programs and/or research universities.

Certainly, the above effect only represents the direct effect of socioeconomic factors on graduate education. *Ceteris paribus*, students from wealthier and better-educated family have advantages in obtaining graduate education. Nonetheless, things are not equal. Previous research has shown that students from wealthier and better-educated families generally have higher test scores and are more likely to hold degrees from high-quality colleges (e.g., Cabrera and La Nasa, 2001; Zhang, 2003). In other words, part of the socioeconomic factors has been crystallized in one's intellectual ability and educational credentials. This indirect effect, through the tight connection between socioeconomic factors and educational attainment, is also substantial. Indeed, Carneiro and Heckman (2002) found that ability, instead of family income *per se*, was the major determinant of the family income-schooling relationship. It appears that socioeconomic factors such as family income and parental education exert great indirect effects

on graduate education through their impact on individuals' intellectual ability and educational credentials.

In conclusion, the current analysis explores the nexus college quality and graduate education within the broad context of post-secondary access and opportunities. In particular, I look at the interactions between socioeconomic and academic factors. Findings suggest that socioeconomic factors and academic factors are not all that separated; they work in tandem. The academically and socioeconomically "rich" become richer while the academically and socioeconomically "poor" become poorer in the face of massive expansion of higher education in the United States. As more longitudinal data resources are available, future studies will be able to examine these interactions throughout one's life.

Notes:

1. In the simplest Mincerian frame (1962, 1974), the return of education is estimated by $\ln W=\beta_0+\beta_1 X+\beta_2 EDUC+\varepsilon$, where $\ln W$ is the logarithm of earnings or hourly wage rate, X is a set of individual characteristics typically including race, gender, and family background variables, and $EDUC$ is the quantity of education, usually measured in years of schooling. In this framework, β_2 is the return of one additional year of education. More recent research has suggested that quantity alone is not sufficient to capture the return of education (e.g., Behrman and Birdsall, 1983); other dimensions of education such as quality of education have been incorporated into the equation.

2. Admittedly, for some professional degrees such as the MBA, which typically require three to five years of working experience, four to five years after BA receipt may not be long enough to observe the complete enrollment pattern.

3. The restricted B&B: 93/97 data is obtained through the restricted data license at the University of Arizona authorized by National Center for Education Statistics. For more information about the B&B study, see http://www.nces.ed.gov.

4. Because a multistage cluster sample is used in B&B: 93/97, there may exist homogeneity within clusters (colleges in this case) that leads to under-estimation of the standard errors if this multistage clustering is ignored. Thomas and Heck (2001) suggested using the design effect to adjust the estimated standard errors or multilevel modeling to capture the multistage clustering.

5. In detailed analysis, I experimented with father's education, mother's education, or the highest level of parental education, the qualitative results of my analysis are the same.

6. I do not attempt to model the potential nested structure among these choices. For example, it could be the case that students first decide to enroll in a graduate program and then decide which program or which school to attend, resulting in nested discrete choice structures. Although statistical tools dealing with these nested choice structures are readily available, I do not intend to use them because these nested structures are not all that clear. Similarly, one may argue that some of the choices could be inherently ordered; I ignore the potential ordered structure of these choices due to the same ambiguity. Finally, these models suffer from potential selection bias. As a partial remedy, I control for the selection bias by including various demographic and family background variables in these discrete choice models.

7. Another dimension of gender gap is disguised by this analysis. That is, the gender gap observed in this study could be exacerbated by gender segregation in graduate education, where female students are increasingly concentrated in "female" fields such as Education, English, Psychology, and Anthropology. Charles and Bradley (2002) show that the education level achieved by female students has little correlation with the gender segregation of fields.

8. To test heterogeneity versus statistical dependence, we need to model students' choice of undergraduate major first. Research along this line brings together the individual choice of undergraduate major and the effect of undergraduate major on graduate education.

9. The Carnegie Classifications emphasize graduate programs (doctoral programs and federal research funds) more than undergraduate programs.

10. Obviously, the information on graduate degree attainment is right censored. Without complicating the model too much, I only examine the effect of college quality on the probability of obtaining graduate degrees within four to five years after graduation.

11. I explored this issue in a separate analysis. Basically, I used a sample of terminal BA recipients who work full time in April 1997 and added another sample of individuals who had completed their graduate education and were in the labor market in April 1997. Then, a structural model was set up to estimate both the effect of college quality on graduate education and the effect of graduate education on earnings. As expected, the analysis did not reveal a positive effect of graduate education on earnings. If anything, the effect is negative. Because most of students who enrolled in graduate program have not graduated before the second follow-up of the B&B survey and for those who have completed their graduate education, the time is not long enough to expose the effect of graduate education fully; it would be more appropriate to address this issue when more waves of B&B data are available.

12. The 28 colleges and universities included in the College and Beyond databases are Barnard College, Bryn Mawr College, Columbia University, Denison University, Duke University, Emory University, Hamilton College, Kenyon College, Miami University (Ohio), Northwestern University, Oberlin College, Pennsylvania State University, Princeton University, Rice University, Smith College, Stanford University, Swarthmore College, Tufts University, Tulane University, University of Michigan at Ann Arbor, University of North Carolina at Chapel Hill, University of Pennsylvania, Vanderbilt University, Washington University, Wellesley College, Wesleyan University, Williams College, and Yale University.

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Table 1: Distribution of Post-Baccalaureate Enrollment and Degree Attainment

		Degrees Attainment				
		No degree	Other degrees	Master's degrees	Doctoral degrees	Total
Enroll-ment	No enrollment	4,157				4,157
	Other programs	1,233	402	8		1,643
	Master's program	1,382	144	978		2,504
	Doctoral program	150	7	119	30	306
	Total	6,922	553	1,105	30	8,610

Table 2: Means and Standard Deviations of Independent Variables

Variable	Mean	SE
Institutional Characteristics		
Low-quality, public institution	0.1325	0.3391
Middle-quality, public institution	0.4697	0.4991
High-quality, public institution	0.0625	0.2420
Low-quality, private institution	0.0494	0.2166
Middle-quality, private institution	0.2017	0.4013
High-quality, private institution	0.0843	0.2778
Historically Black colleges and institutions	0.0243	0.1541
Demographic Characteristics		
Female	0.5467	0.4978
Native American	0.0060	0.0771
Asian	0.0387	0.1928
Black	0.0613	0.2398
Hispanic	0.0431	0.2030
Age	30.0413	6.6636
Age squared / 100	946.8789	516.7912
Family Background		
Family income (in $10,000)	4.7935	5.2902
First-generation college graduate	0.4646	0.4988
Academic Background		
Undergraduate GPA	2.9656	0.7265
Business major	0.2213	0.4152
Engineering major	0.0576	0.2330
Health major	0.0667	0.2495
Public affairs major	0.0349	0.1836
Biological science major	0.0459	0.2093
Math science major	0.0568	0.2316
Social science major	0.1012	0.3016
History major	0.0204	0.1415
Humanity major	0.0881	0.2835
Psychology major	0.0383	0.1920
Other major	0.1367	0.3435
N	8,610	

Table 3: Binomial Logit Estimates of Graduate Enrollment, Marginal Effects

Variable	Coefficient	t-ratio
Constant	-0.4100	3.65
Institutional Characteristics		
Low-quality, private institution	-0.0334	1.12
Middle-quality, public institution	0.0843	5.00
Middle-quality, private institution	0.1057	5.67
High-quality, public institution	0.1768	7.31
High-quality, private institution	0.1576	7.05
Historically Black colleges and institutions	0.0933	2.60
Demographic Characteristics		
Female	-0.0528	4.95
Native American	0.0544	0.84
Asian	0.0589	2.36
Black	0.1017	4.18
Hispanic	0.0648	2.68
Age	-0.0226	3.93
Age squared / 100	0.0244	3.32
Family Background		
Family income (in $10,000)	0.0037	3.83
First-generation college graduate	-0.0283	2.61
Academic Background		
Undergraduate GPA	0.2187	20.02
Business major	-0.2244	12.37
Engineering major	-0.0347	1.43
Health major	-0.0917	3.95
Public affairs major	-0.0858	2.83
Biological science major	0.0898	3.66
Math science major	0.0213	0.92
Social science major	-0.0285	1.44
History major	-0.0155	0.44
Humanity major	-0.0772	3.73
Psychology major	0.0677	2.58
Other major	-0.1145	6.05
N	8,610	
χ^2	1,074	
Prediction	70%	

Notes:
1. Also included in the model are dummies indicating missing values of independent variables.
2. Education major is the left-out group in the regression.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for a discrete change from 0 to 1.
4. Absolute value t statistics included.

Table 4: Binomial Logit Estimates of Doctoral Enrollment, Marginal Effects

Variable	Coefficient	t-ratio
Constant	-0.0825	0.74
Institutional Characteristics		
Low-quality, private institution	-0.0033	0.11
Middle-quality, public institution	0.0112	0.69
Middle-quality, private institution	-0.0060	0.33
High-quality, public institution	0.0679	3.67
High-quality, private institution	0.0253	1.40
Historically Black colleges and institutions	-0.0389	1.00
Demographic Characteristics		
Female	-0.0349	4.09
Native American	0.0239	0.51
Asian	-0.0463	2.41
Black	-0.0127	0.50
Hispanic	-0.0104	0.52
Age	-0.0137	2.41
Age squared / 100	0.0001	1.96
Family Background		
Family income (in $10,000)	-0.0025	2.49
First-generation college graduate	-0.0215	2.37
Academic Background		
Undergraduate GPA	0.0634	6.24
Business major	-0.0722	2.47
Engineering major	0.0324	1.64
Health major	0.0300	1.31
Public affairs major		
Biological science major	0.1122	6.68
Math science major	0.1105	6.53
Social science major	0.0364	2.15
History major	0.0214	0.74
Humanity major	0.0401	2.21
Psychology major	0.0642	3.17
Other major	0.0221	1.17
N	2,810	
χ^2	328	
prediction	89%	

Notes:
1. Also included in the model are dummies indicating missing values of independent variables.
2. Education major is the left-out group in the regression.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for a discrete change from 0 to 1.
4. Absolute value t statistics included.

Table 5: Multinomial Logit Estimates of Graduate School Enrolled, Marginal Effects

	Comprehensive		Doctoral		Research	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Constant	-0.0726	0.29	0.4067	1.54	-0.3341	1.11
Institutional Characteristics						
Low-quality, private institution	-0.0248	0.33	-0.0124	0.20	0.0373	0.40
Middle-quality, public institution	-0.1333	3.37	-0.1377	4.18	0.2710	5.47
Middle-quality, private institution	-0.1410	3.25	-0.0410	1.17	0.1820	3.42
High-quality, public institution	-0.3309	5.61	-0.2357	4.59	0.5666	9.04
High-quality, private institution	-0.4164	7.34	-0.0840	2.01	0.5004	8.45
Historically Black coll. and inst.	0.1768	2.35	0.0482	0.74	-0.2250	2.35
Demographic Characteristics						
Female	0.0659	2.74	0.0195	0.96	-0.0855	3.33
Native American	0.3069	1.88	-0.2142	0.99	-0.0927	0.47
Asian	0.0043	0.07	-0.1283	2.08	0.1239	2.06
Black	-0.0117	0.22	-0.0291	0.62	0.0408	0.66
Hispanic	0.0988	1.88	-0.0645	1.27	-0.0343	0.57
Age	0.0363	2.74	-0.0047	0.33	-0.0316	1.98
Age squared / 100	-0.0299	1.74	0.0016	0.09	0.0283	1.35
Family Background						
Family income (in $10,000)	-0.0006	0.29	0.0020	1.39	-0.0014	0.68
First-generation college graduate	0.0619	2.57	0.0200	0.97	-0.0820	3.13
Academic Background						
Undergraduate GPA	-0.1536	5.89	-0.0951	4.29	0.2487	8.69
Business major	-0.0088	0.22	0.0523	1.45	-0.0435	0.91
Engineering major	-0.2763	4.89	0.0319	0.71	0.2444	4.44
Health major	-0.1294	2.50	0.0214	0.47	0.1080	1.90
Public affairs major	-0.1189	1.75	-0.0174	0.28	0.1363	1.80
Biological science major	-0.2990	4.84	-0.0408	0.80	0.3399	5.80
Math science major	-0.2615	5.28	-0.0344	0.79	0.2959	5.82
Social science major	-0.0550	1.33	0.0223	0.60	0.0328	0.72
History major	-0.1781	2.24	0.0515	0.83	0.1266	1.58
Humanity major	-0.1631	3.49	0.0410	1.04	0.1221	2.48
Psychology major	-0.0851	1.57	0.1000	2.19	-0.0149	0.24
Other major	-0.1356	3.34	0.0222	0.62	0.1135	2.51
N	2,242					
χ^2	625					
Prediction	58%					

Notes:
1. Also included in the model are dummies indicating missing values of independent variables.
2. Education major is the left-out group in the regression.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for a discrete change from 0 to 1.
4. Absolute value t statistics included.

Table 6: Binomial Logit Estimates of Graduate Degree Attainment, Marginal Effects

Variable	Coefficient	t
Constant	-0.3599	5.13
Institutional Characteristics		
Low-quality, private institution	-0.0131	0.65
Middle-quality, public institution	0.0346	3.13
Middle-quality, private institution	0.0459	3.85
High-quality, public institution	0.0730	5.07
High-quality, private institution	0.0688	5.14
Historically Black colleges and institutions	-0.0010	0.04
Demographic Characteristics		
Female	-0.0160	2.48
Native American	0.0742	2.23
Asian	0.0313	2.25
Black	0.0441	2.88
Hispanic	0.0360	2.53
Age	-0.0087	2.43
Age squared / 100	0.0085	1.84
Family Background		
Family income (in $10,000)	0.0021	4.40
First-generation college graduate	-0.0130	1.98
Academic Background		
Undergraduate GPA	0.1057	16.27
Business major	-0.0531	4.59
Engineering major	0.0241	1.68
Health major	0.0122	0.90
Public affairs major	0.0040	0.22
Biological science major	0.0144	0.97
Math science major	-0.0029	0.20
Social science major	0.0164	1.38
History major	0.0032	0.15
Humanity major	-0.0098	0.77
Psychology major	0.0369	2.36
Other major	-0.0119	1.00
N	8,610	
χ^2	506	
Prediction	87%	

Notes:
1. Also included in the model are dummies indicating missing values of independent variables.
2. Education major is the left-out group in the regression.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for a discrete change from 0 to 1.
4. Absolute value t statistics included.

Table 7: Multinomial Logit Estimates of Graduate School Conferring Degree, Marginal Effects

	Comprehensive		Doctoral		Research	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Constant	-0.3815	0.77	0.3943	0.81	-0.0128	0.02
Institutional Characteristics						
Low-quality, private institution	0.1748	1.32	0.0871	0.81	-0.2619	1.42
Middle-quality, public institution	-0.0377	0.61	-0.1800	3.44	0.2177	2.81
Middle-quality, private institution	-0.0307	0.46	-0.0418	0.77	0.0726	0.88
High-quality, public institution	-0.1048	1.29	-0.2905	3.74	0.3953	4.16
High-quality, private institution	-0.3615	4.35	-0.0712	1.17	0.4326	4.79
Historically Black coll. and inst.	-0.0436	0.33	0.1171	1.05	-0.0734	0.43
Demographic Characteristics						
Female	0.1289	3.52	-0.0028	0.09	-0.1261	3.08
Native American	0.2537	1.32	-0.1260	0.57	-0.1277	0.50
Asian	-0.0317	0.37	-0.1376	1.49	0.1693	1.80
Black	0.0273	0.32	-0.0859	1.06	0.0586	0.54
Hispanic	0.1003	1.26	0.0268	0.39	-0.1271	1.32
Age	0.0451	1.63	0.0050	0.18	-0.0501	1.33
Age squared / 100	-0.0388	1.04	-0.0056	0.15	0.0444	0.86
Family Background						
Family income (in $10,000)	-0.0020	0.51	0.0060	2.45	-0.0039	1.09
First-generation college graduate	0.1192	3.20	0.0016	0.05	-0.1208	2.80
Academic Background						
Undergraduate GPA	-0.1600	3.77	-0.1399	3.70	0.2999	6.00
Business major	-0.0642	1.05	0.0167	0.30	0.0475	0.62
Engineering major	-0.2070	2.34	-0.2047	2.26	0.4117	4.32
Health major	-0.1404	1.98	-0.0289	0.44	0.1693	2.01
Public affairs major	-0.1412	1.35	-0.1717	1.46	0.3129	2.54
Biological science major	-0.0755	0.91	-0.1441	1.74	0.2196	2.25
Math science major	-0.2889	3.39	-0.0721	0.98	0.3610	3.91
Social science major	-0.1002	1.60	-0.0190	0.34	0.1191	1.63
History major	-0.4867	2.49	0.0182	0.15	0.4686	2.75
Humanity major	-0.2190	2.88	-0.0078	0.13	0.2269	2.74
Psychology major	-0.1279	1.53	0.0955	1.35	0.0325	0.31
Other major	-0.1592	2.53	-0.0037	0.07	0.1629	2.19
N	940					
χ^2	329					
Prediction	59%					

Notes:

1. Also included in the model are dummies indicating missing values of independent variables.
2. Education major is the left-out group in the regression.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for a discrete change from 0 to 1.
4. Absolute value t statistics included.