HOW COLLEGE AFFECTS STUDENTS: TOWARD THE RECONCILIATION

OF THEORY WITH EMPIRICAL EVIDENCE

by

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ABSTRACT

Previous research has generally shown a very small although statistically significant economic benefit from attending high-quality colleges. This small effect was at odds with what students' college choices and various social theories would seem to suggest. This study sought to reconcile the empirical evidence and theories. The effort was in two directions. First, the economic effect of college quality was reexamined—not only for an "average" student, but also for different students. Second, the effect of college quality was expanded from examining only the economic benefit to considering other student outcomes, including job satisfaction and graduate degree accomplishment. A new perspective regarding the social role of college quality was offered in conclusion.

CHAPTER 1

INTRODUCTION

American higher education has experienced massive expansion in the 20th century, especially over the last 40 years. 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).[1] The diversity of this large enterprise was extraordinary, ranging from two-year colleges providing mainly vocational training and preparing students for further education to large research universities offering a variety of education and research. 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.[2] This reality encouraged differentiation among college graduates, with one dimension being college quality.[3]

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[1] These institutions included 2,450 four-year colleges (enrolling approximately 9.4 million students) and 1,732 two-year colleges (with about 5.9 million students).

[2] According to National Center for Education Statistics (2003), 61.7% of the nation's high school graduates attended colleges in 2001.

[3] Phrases such as *college quality* and *high-quality colleges* may sound ambiguous to some researchers. Some may suggest that other words such as *selectivity* be used. Admittedly, *selectivity* is more concrete and easier to measure, yet *college quality* is certainly more than selectivity. In this dissertation, I chose the word *quality* but used it as a relative measure. In many cases, *high-quality colleges* may be interpreted as *colleges with relatively high quality*. The major measure of college quality in this study is Barron's index (a composite selectivity index constructed on the basis of entering students' class rank, high school grade point average, average SAT scores, and the percentage of applicants admitted). See Chapter 3 for a detailed discussion. Also, I used other measures of quality, such as mean SAT scores of the entering class, tuition and fees, and Carnegie Classifications to capture different aspects of college quality. In cases where the term *most prestigious* or *elite institutions* is used, it refers to a smaller subset of *high-quality colleges*. Finally, college quality may be interpreted as characteristics of institutions or as characteristics of students. To some extent, these two interpretations are the same.

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. 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. Behrman and Birdsall (1983) showed that quantity alone was not sufficient to capture the return of education and that quality should be incorporated into the standard Mincerian (1962, 1974) framework.[4] Recently, studies by Brewer and his colleagues (Brewer & Ehrenberg, 1996; Brewer, Eide, & Ehrenberg, 1999; Eide, Brewer, & Ehrenberg, 1998) and Thomas (2000a, 2003) have significantly improved our understanding of the economic effect of college quality.

Implicitly or explicitly recognized in these studies was that the quality of college education, in addition to college education itself, might have significant effects on graduates' earnings. Most studies along this line, however, found that college quality generally had a very small though statistically significant effect on earnings (Mueller, 1988; Solmon & Wachtel, 1975; Thomas, 2000a). A similar conclusion was drawn by

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[4] In the simplest Mincerian frame, 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 & Birdsall, 1983); other dimensions of education such as quality of education have been incorporated into the equation.

Pascarella and Terenzini (1991) in their review of the literature on the effect of college quality on earnings.

These empirical results appeared to be at great odds with decisions made by many students and their families: If college quality had such a small effect on earnings, why were so many more than willing to pay the increasingly large tuition charges at high-quality colleges? Why did so many work so hard to gain admission to high-quality colleges? For example, for the top 15 liberal arts colleges nationally, the “sticker price” or stated tuition level was $18,057 in 1994-1995, with other institutions (including 2,739 four-year institutions) charging about $5,919 (Ehrenberg, 2000). In 2000-2001 the average tuition rate of Ivy League institutions was about $25,350, while other institutions charged about $8,000, on average. Despite their extraordinarily high tuition rates, the acceptance rates at these elite institutions were surprisingly low. According to *US News and World Report*, in 2000-2001 the average acceptance rate at the top 15 liberal arts colleges was 35%, and the figure was 18% at Ivy League institutions. The high demand for these high-priced seats at prestigious institutions suggested a larger effect of college quality than has been shown by the bulk of previous research.[5]

Further, the empirical results from previous studies were inconsistent with the disproportionate representation of graduates from high-quality colleges (especially private, elite institutions) among those generally considered to be “most successful” in the United States. National leaders almost without exception held degrees from highly selective private institutions—the Adamses, Roosevelts, Tafts, Kennedys, and Bushes in

[5] Here a high-quality college eduation is regarded as an investment instead of a consumption good.

politics and the Mellons, Rockefellers, and Fords in economic affairs. This evidence was not just anecdotal. In a study investigating the predictors of executive career success, Judge, Cable, Boudreau, and Bretz (1995) found that nearly 1 in every 10 executives was from an Ivy League university, not to mention those from other high-quality institutions. This evidence suggested an enormous impact of high-quality colleges, especially the most prestigious institutions, on social status and power, if not income.[6]

Finally, the results were in conflict with what social theories would suggest. Many social theories would suggest great benefits associated with attending high-quality colleges. From the economic perspective, the decision to choose high-quality colleges, which often meant paying high tuition and fees, was based on a comparison of the financial benefits and costs of such an investment. Considering the substantial tuition difference between high-quality colleges (especially high-quality private colleges) and low-quality ones (especially low-quality public colleges), one would expect significant earnings differences between graduates of these two types of institutions. Human capital theory, a major theory in explaining success in labor markets, also argued for large economic benefits associated with a high-quality college education. The theory posits that the labor market rewards investments individuals make in themselves (e.g., their education or training) and that these investments lead to higher salaries (Becker, 1964, 1992; Schultz, 1960, 1961). High-quality colleges, which usually possess quality

[6] An alternative explanation is that these "successful" individuals would have been successful anyway, regardless of the quality of colleges they attended. Statistically speaking, being "successful" could be due to individual heterogeneity, but not state dependence. The individual heterogeneity can be controlled if it is observable (by the analyst); otherwise, it becomes the well-known problem of selection bias. Both views are entertained in subsequent chapters.

academic faculty, capable and motivated students, large libraries, well-equipped laboratories, and so on, appear to provide their students with better resources for human capital improvement than low-quality colleges.

It seems, then, that empirical evidence is not fully consistent with everyday observations and social theories. Can these observations and theories be reconciled with the empirical evidence? What is the role of college quality in society? Answering these questions is the goal of this study.

To achieve this goal, I broaden the research on the effects of college quality on earnings by examining the variability in the effect of college quality along an array of factors. Whereas previous research has evaluated the effects of college quality at the mean of the earnings distribution, I consider the effects more broadly. Implications and applications of mean results or “average” effects are based implicitly on the assumption that the monetary effect of college quality is homogenous across different students. This assumption is convenient but potentially problematic. Intuitively, it is probable that college quality may matter to some students but not to others. For example, it may be that it is more productive (greater “value added”) for a more capable student to study at an elite institution than for one who is intellectually less capable. Therefore, empirical results stated at the average may mislead many students and their families. If it can be shown that substantial differences in earnings exist among particular groups of students enrolled in colleges of varying quality, then the results of prior studies, although presumably valid on average, may lead to invalid generalizations with regard to specific individuals and specific colleges.

Also, I extend the study of the effects of college quality beyond the area of earnings differences. Most previous studies on the effect of college quality have ignored the effect of college quality on non-monetary outcomes. Bowen (1977) suggests that a college education might have effects on a variety of non-monetary outcomes. So too might college quality have effects on various non-monetary aspects of students' lives. Due to lack of data and other limitations, an inventory of such non-monetary outcomes is apparently impossible. In this dissertation, I consider the effects of college quality on two non-monetary outcomes: graduate education and job satisfaction. (Graduate education is a particularly interesting outcome in that it may in turn have positive effects on earnings.) If it can be shown that college quality has a positive effect on non-monetary outcomes, such as graduate education and job satisfaction, then focusing on economic benefits alone could understate the real effects of college quality. Significant and positive effects of college quality on non-monetary outcomes may add considerably to the relatively small, average, monetary effects of college quality and in the process bridge the gap between social theories and prior empirical results. By expanding the previous research on the effects of college quality in these two directions, my ultimate goal is to explore a new perspective on the impact of college quality, especially to certain groups of students.

The organization of this dissertation is as follows.[7] In Chapter 2, I review the literature on the effect of college quality on earnings and argue that the average effect of

[7] The organization of this dissertation deviates from the conventional five-chapter format, namely, introduction, literature review, data and methods, results, and discussion. Because this dissertation investigates a variety of research questions, I divide them into smaller chapters (Chapters 3 to 7 investigate five research questions, although these research questions are inherently related). Moreover, because a variety of methods are used to fit the analysis in each chapter, I do not tend to write an overall methods chapter; instead, methods are discussed with the actual analysis of each research question.

college quality as examined in previous studies disguises much of the variation in the effect of college quality across individuals and overlook the non-monetary outcomes. I then provide the theories that guide the inquiry into the variability in the effects of college quality. Specifically, I discuss two representative theories: human capital theory, which, from a rational perspective, accentuates the positive role of education on individual economic outcomes, and social reproduction theory, which, from a critical perspective, highlights the interaction between socioeconomic status and educational attainment. The discussion of social reproduction theory leads to three research questions and corresponding hypotheses, which are analyzed and tested in three subsequent chapters.

In Chapter 3, I focus on degree attainment by examining the variability in the probability of earning degrees at high-quality institutions. The probability may vary across individuals due to various academic and non-academic factors. Further, these academic and non-academic factors may be related to each other in certain ways. Analysis in this chapter situates the discussion of the variability in the effects of college quality across individuals in a proper context. These are two different equity issues, but both should be considered in understanding the role of college quality in particular and education in general in society. Focusing on the varying effects of college quality among individuals without examining the varying probability of earning degrees at high-quality colleges does not capture the complete relationship among socioeconomic factors, educational attainment, and graduates’ earnings.

A series of questions is posed in this chapter. For example, how is the probability of earning a degree at high-quality institutions related to students' demographic characteristics? What is the effect of family background? Does student ability play any role? If so, how is student ability related to demographic and family background characteristics? These research questions point to larger issues of post-secondary access and baccalaureate attainment; more importantly, they provide a proper context for thinking about different effects of college quality for different individuals.

In Chapter 4, I explore the variability in the effects of college quality among different individuals by gender, race/ethnicity, family income, parental education, intellectual ability, and major fields of study. Essentially, the question here is whether different students are able to realize the same amount of economic benefit from earning degrees at high-quality institutions. Examining the difference in the effect of college quality among different individuals helps explain the social role of college quality.

In this chapter, I first establish an empirical model to estimate the *average* effect of college quality on graduates' earnings. The estimated effect is *on average* in the sense that there might be variations among different groups of students and across different points of the earnings distribution. This model has been discussed and tested by other researchers and myself in previous studies of the effect of college quality (Thomas, 2003; Thomas & Zhang, 2002). Then I investigate some technical issues related to the model before it is applied to specific groups of students. These issues include correction for selection bias, Hierarchical Linear Modeling, measures of college quality, and earnings growth over time. Finally, I explore the variability in the effects of college quality among different individuals by gender, race/ethnicity, family income, parental education, intellectual ability, and major fields of study. Varying effects of college quality across different individuals are crucial in understanding the social role of college quality.

In Chapter 5, I consider the other dimension of the variations in the effect of college quality, that is, variation across the earnings distribution. For example, do high-quality colleges affect students who end up at the bottom of the earnings distribution more than those who end up at the top of the earnings distribution? In other words, does college quality compress or stretch the earnings distribution? These questions point to the different predictive power of college quality for individuals at different positions in the earnings distribution. Put simply, college quality may matter more for students who end up at the top of the earnings distribution than those at the bottom. In an era when college education becomes quite universal and, more importantly, as previous research has shown that college education tends to compress the earnings distribution (Eide & Showalter, 1999), the role of college quality as a differentiating apparatus needs to be examined properly.

The analysis of the effect of college quality on graduates' earnings would not be complete without examining the effect of college quality on graduate study. The benefit of attending colleges of higher quality is more than earnings premium; it may involve the opportunity to obtain further education, which in turn yields a positive economic effect. This idea is framed as the option value by Weisbrod (1962). If it can be shown that college quality has a positive effect on graduate education and moreover that graduate education has a positive effect on earnings, then estimates of the effects of undergraduate college quality based on earning differences among terminal baccalaureate recipients is most likely underestimated. In Chapter 6, I study the effect of college quality on graduate school enrollment and graduate degree attainment. For example, how does the quality of college attended affect a student's decision to enter and complete a graduate degree program? For those who have actually enrolled in graduate programs, how does college quality affect the program type, specifically a master's versus doctoral program? And what is the effect of college quality on the selection of graduate institutions, that is, comprehensive, doctoral, or research institutions?

In Chapter 7, I investigate the effect of college quality on another non-monetary aspect of student outcomes, job satisfaction. The effect of college quality on job satisfaction is not clear-cut. On one hand, College quality may have a positive effect on job satisfaction by raising graduates' earnings. On the other hand, college quality may be related to how well one's occupational expectations are met, possibly resulting in a negative job satisfaction effect. Whereas the small number of studies that have addressed this question suggest that college quality has little direct effect on an individual's job satisfaction (Bisconti & Solmon, 1977; Ochsner & Solmon, 1979; Solmon, Bisconti, & Ochsner, 1977), these studies have tended to suffer from several weaknesses, including inadequate job satisfaction measures, inappropriate treatment of the categorical dependent variable, and neglect of the endogeneity of earnings. My analysis seeks to overcome these shortcomings.

From Chapter 3 to Chapter 7, I provide an examination of the entire process of post-secondary attainment—from baccalaureate attainment to graduate education and to outcomes in labor market at the early stage of graduates' careers. Throughout this process, college quality is the element of particular interest. The effect of college quality and the role of high-quality institutions may be better understood in the larger frame of post-secondary attainment.

In the concluding chapter, I sum up all the findings of this study and turn back to my starting point: What have we learned about the effect of college quality from this study? In summarizing my major findings, I discuss various variations in the effect of college quality, suggesting that the average economic effect of college quality as estimated in previous studies disguises many variations of the effect across an array of factors. Moreover, I examine the social role of college quality by integrating various components of the analysis in this study, arguing that college quality plays an important role in preserving and perpetuating socioeconomic structure in American society. Finally, I explore the policy implications of this dissertation for educational practitioners and policy makers.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

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, Rosenzweig, and Taubman (1996), Brewer and Ehrenberg (1996), Brewer et al. (1999), and Dale and Krueger (1999). 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).

Table 2.1 summarized 24 previous studies of the effect of college quality on earnings. Although the list was by no means exhaustive, it included most of the published, methodologically rigorous studies. Twelve of these studies have been summarized in Brewer et al. (1999). Almost without exception, studies in Table 2.1 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,

Table 2.1

Summary of Previous Studies of the Effect of College Quality on Earnings

Study	Data source	College quality measure	Controls	Model	Findings	Notes
*Weisbrod & Karpoff (1968)	7,000 male college graduates at AT&T in 1956	4-fold rating of college by personnel office	Academic performance, years of experience	Annual earnings estimated by OLS	Larger return to more selective college if similar class rank achieved.	
*Reed & Miller (1970)	2,559 male college graduates from CPS supplement in 1967	7-fold ranking based on freshmen aptitude index	Age, major, race, father's occupation, father's education, region, urban HS	Average weekly earnings estimated by OLS	Higher earnings associated with higher rank.	
*Wales (1973)	3,700 white males with at least some college. NBER-Thorndike Air Force pilot trainees in 1943, earnings data in 1969	5-fold classification based on Gourman rating, graduate school rankings	IQ estimate, schooling dummies, religion, age, father's education, marital status, biographical variable (family income, education, and hobbies), occupational dummies	Monthly earnings estimated by OLS	Top fifth college increases earnings substantially. Quality effect varies by education level, but not by ability level.	
*Solmon (1973, 1975)	1,511 white males from NBER-Thorndike data with 1969 earnings, and 1,199 from 1955 earnings	Gourman overall and academic rating, average faculty salary, SAT score, instructional expenditures per FTE students, university income and expenditure, single overall measure in some models	IQ estimate, years of education, experience and experience squared, occupational dummies	Log annual earnings estimated by OLS	All quality measures have positive effect on earnings when entered separately. Average SATs and faculty salary are isolated as independent factors. Effect does not vary with years of college or with ability.	

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
*Solmon & Wachtel (1975)	3,489 white male college attendees in NBER-Thorndike sample as Wales (1973)	8-fold classification based on Carnegie Commission ratings	IQ estimate, years of schooling, years of experience and experience squared, occupational dummies	Log annual earnings estimated by OLS	Quality has significant effect on earnings. Rate of return also varies with quality. Quality effect does not vary by ability for those who did not attend graduate school.	Quality added separately and interactively with years of schooling.
*Wise (1975)	976 white male college graduates in a single manufacturing firm in 1968	6-fold classification based on Astin's college selectivity index	GPA, rank in class, major, years of experience before firm, average rate of salary increase, SES, indices of job security, leadership, initiative, and supervisor rating	Log monthly earnings estimated by OLS	Rate of salary increase rises with college selectivity, and selectivity effect similar across GPA.	College selectivity permitted only to affect rate of salary increase.
*Wachtel (1976)	1,633 males from NBER-Thorndike sample in 1969, including those with only high school	Expenditures per FTE student at undergraduate and graduate levels	MAT scores, father's education, years of experience and experience squared, years of schooling, college/graduate school dummies, school expenditures per pupil in high school district	Log annual earnings estimated by OLS	College expenditures per student have significant effects for non-graduate college attendees, but small effects on graduate college attendees.	

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
*Griffin & Alexander (1978)	525 male college attendees from ETS 1955 sample, 1970 follow up	Astin's selectivity index	SAT score, high school class rank, GPA, honors, mother's education, father's education and occupation, parental income, household possessions, religion, educational experiences, counseling and orientation, occupational aspirations, academic self image. HS curriculum and math/science course, major region, urban high school	Annual earnings estimated by OLS	College selectivity positively related to earnings, but effect small.	
*Morgan & Duncan (1979)	881 males and 517 females from 1974 PSID sample of college attendees	Average ACT/SAT scores of entering freshmen, college expenditure per FTE, Coleman prestige ranking	Scores on sentence completion test, years of experience, job tenure, city size, father's occupation and education, amount of college completed, annual hours worked, occupation	Log hourly wages estimated by OLS	Quality measures insignificant for females. For males, only freshman ACT significant. Effect varies by years of college.	Separately by males and females.

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
Trusheim & Crouse (1981)	4,836 males from Panel Study of Income Dynamics, with some four-year college education	Average SAT/ACT scores of the entering freshmen	Test scores, father's occupation, father and mother's education, number of siblings, dummies for non-south, non-farm, non-foreign upbringing, achievement motivation, education and occupation, weeks worked	Earnings estimated by OLS	College selectivity has a significant impact on middle-aged men's income in a single year, but not affect further growth in income.	
Mueller (1988)	3,094 male and 3,833 female students from 1971 ACE/UCLA Freshman Survey, with earnings from 1979-80 HERI follow-up survey	Average SAT scores of the entering freshmen	Mother's education, father's education, parental income, HS rank, financial aspiration, concern for financing college, academic ability, academic motivation, confidence, degree aspiration, college control, highest degree, occupational prestige	Recursive structural equation models	Quality could explain only a minute percentage of variance in income above and beyond the controls, but it had a significant indirect impact on earnings.	This study examined the direct, indirect, and non-causal effects of selectivity on earnings for both sexes.
*Kingston & Smart (1990)	1971 sample in 1980 cooperative Institutional Research Program, 2,213 college attendees with BAs or less	Public/private and selectivity categories based on SAT scores of freshmen	HS grades and class ranking, race, sex, parental income, mother's and father's education, GPA, HS type, occupational aspiration, leadership index, college GPA, science major dummies	Approximate annual income estimated by OLS	Significantly higher income from higher selectivity college, non-linear effects.	

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
Karabel & McClelland (1987)	3,144 college attendees from 1973 Occupational Changes in a Generation Survey	7-fold classification based on Astin's selectivity index	Father's education, mother's education, father's occupation, mother's occupation, education level, Duncan SEI of respondent's occupation	Log annual earnings estimated by OLS	College quality affects earnings of advantaged students more than to disadvantaged students. Aggregate models of the impact of institutional rank are problematic.	
Smart (1988)	3,357 students from 1970 and 1980 Cooperative Institutional Research Program (CIRP) survey	3-fold classification based on SAT/ACT scores, expenditures per student, and tuition	College grades, sex, SES, HS academic record, race, college size, major, highest degree earned, job complexity, organizational size and nature	Income level (a nine-point scale based on actual earnings) estimated by structural equations	College quality has a significant indirect effect only for those in public organizations, but not for those in private organizations.	Earnings are a functions of a complex series of events, including students attributes, college types, performance in college, nature of employers, and characteristics of their jobs.
*Fox (1993)	853 college graduates in 1986, HS&B seniors	Dummy for most competitive colleges based on Barron's rating	HS&B verbal and math scores, male and race/ethnicity dummies, family income, HS grades, college major, and private college dummies	Log hourly wage estimated by OLS, simulates net earnings profiles	Premium from attending elite institution higher if private.	

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
*James et al. (1989)	1,241 (1989) and 1,107 (1993) male college graduates in 1986 from NLS-72	Log instructional/general expenditures per student, average SATs of entering freshmen	SAT, HS rank, HS GPA, college GPA, Public/private dummies, research/Ph.D. dummies, % students part time, % graduate students, % liberal arts majors, own SAT minus average SAT squared, major, race, religion, number of siblings, father's education and occupation, Catholic HS, HS size, months experience, job tenure, weeks worked, marital status, occupation/industry dummies	Log annual earnings estimated by WLS. Fixed effect model with college dummies only	Average SAT has positive effects on earnings, except in models with occupation/industry dummies, expenditure variables insignificant.	Some specifications with an IV for selectivity and expenditures per students.
*Loury & Garman (1995)	2,013 male college attendees from NLS-72 in 1979 or 1986	Median SAT score of college	SAT, GPA, race, weeks worked, rural dummy, parental income, years of college, major dummies	Log weekly earnings by WLS	College quality positively affects earnings for Blacks but nor for Whites in full model' for college completers with same ability selectivity had very small effect.	Model allows effect of major, GPA, college SAT and years of college to vary by race.

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
Rumberger & Thomas (1993)	8,021 BA completers from Recent College Graduates (RCG) 1987 Survey	Astin's selectivity score	Sex, race/ethnicity, father's education, mother's education, father's occupation, mother's occupation, college major, GPA, private/public dummy, labor market conditions (including working experience, hours per week, public sector, self-employed, degree requirement, job not related to major)	Log annual earnings estimated by OLS and HLM	College quality affects initial earnings of college graduates, but the effect is small and not consistent for student of different majors.	
Behrman et al. (1996)	8,400 female twins born in Minnesota in 1936-1955	Private, Ph.D. granting, college size, average full professor salary, expenditures per student, total students per faculty	School years, working experience	Log annual earnings estimated by OLS	Higher faculty salary, granting of Ph.D., smaller college size, and private controls have significant positive effects on earnings.	This study used data on female twins to difference out common unobserved effects.
Brewer & Ehrenberg (1996)	2,549 college attendees from HS&B 1980 Senior cohort, with 1986 earnings	6-fold classification based on Barron's rating	Female, race, family size, father's education, mother's education, test scores, part-time job, undergraduate/graduate dummies	Log hourly wage estimated in the context of a structural model, correction for selection bias	Attending an elite private college does not necessarily pay off in terms of early earnings, but it increases the probability of graduate school enrollment.	The structural model allows for the correction of self-selection bias.

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
Brewer et al. (1999)	3,062 college attendees from NLS-72 and 2,165 from HS&B Sophomore cohort	6-fold classification based on Barron's rating	Female, race, family size, father's education, mother's education, test scores, part-time job, undergraduate/graduate dummies	Log hourly wage estimated in the context of a structural model, correction for selection bias	Larger premium to attending an elite private institution, smaller premium to attending a middle-rated private institution. Return to elite private college increases for 1980 cohort as compared to 1972 cohort.	It uses longitudinal data to examine the changes of labor market returns across time for a given cohort. The structural model allows for the correction of self-selection bias.
Dale & Krueger (1999)	College and Beyond (C&B) 1976 cohort, with 1995 earnings	Average SAT scores divided by 100	Race/ethnicity, SAT/100, HS top 10%, college athlete, additional applications, undergraduate percentile in class, advanced degree, public/private dummies, liberal arts, average tuition charged	Log annual earnings estimated by OLS, correction for selection bias	Quality does not affect earnings, but tuition is significantly related to earnings.	Correction for selection bias by matching sets of students who were accepted and rejected by the same groups of colleges.
Thomas (2000a)	3,832 BA completers from B&B first follow-up in 1994	Average SAT scores of the entering freshmen	Sex, race/ethnicity, first generation BA, parental occupation, GPA, number of other colleges attended, attended community college, college major, labor market characteristics, private institution, college size, urban college	Log annual earnings estimated by HLM	College quality affects initial earnings but the effect is very small. Effect of private college is also small.	The coefficient of quality college variable is 0.0001.

Table 2.1 – *Continued*

Study	Data source	College quality measure	Controls	Model	Findings	Notes
Thomas (2003)	4,604 BA completers from B&B second follow-up in 1997	Six-fold classification based on Astin's selectivity index and institutional control	Similar as in Thomas (2000a)	Log annual earnings estimated by HLM	Quality confers larger earning advantages compared with Thomas (2000a), both for public and private institutions. Academic performance and major also affect earnings significantly.	

* Studies with * are summarized in Brewer et al. (1999)

$$\ln(Y_i) = \alpha_0 + \alpha_1 Q_{ij} + \alpha_2 D_i + \alpha_3 F_i + \alpha_4 A_i + \alpha_5 J_i + \mu_i \tag{2.1}$$

Popular measures of college quality included average SAT/ACT scores of entering freshmen (Dale & Krueger, 1999; Griffin & Alexander, 1978; Morgan & Duncan, 1979; Mueller, 1988; Solmon, 1973, 1975; Thomas; 2000a, 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 the earnings equations such as equation 2.1. 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 correction for selection bias. Thomas (2000a, 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.[8] 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

[8] This might be partially due to the different measures of college quality and estimating frameworks used in these studies. I examined these issues in more detail in Chapter 4 where technical issues of the model are discussed.

found that students who attended private elite institutions enjoyed a large salary premium. This finding was echoed by Thomas (2003) who also found substantial economic benefits from attending high-quality colleges five years after college graduation. In contrast, other studies have indicated either statistically non-significant or even negative effects of college quality on earnings. For example, Dale and Krueger (1999) 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 (2000a) found that college quality had a small ($\beta = 0.0001$) but statistically significant ($\alpha = 0.10$) effect on earnings one year after college graduation.[9] Findings of most studies in Table 2.1 belonged to this category: College quality had a small although statistically significant effect on college graduates' earnings.

These empirical results appeared to be at great odds with the increasing cost gap among colleges of varying quality; neither were they consistent with the disproportionate representation of graduates from high-quality colleges (especially private, elite institutions) among those who were generally considered to be "most successful" in the United States. Apparently, a re-interpretation of the economic data and re-examination of the effect of college quality was warranted. In the remaining chapters of this dissertation, I broadened the research on the effects of college quality on earnings by examining the variability in the effect of college quality along an array of factors. I also extended the study of the effects of college quality beyond the area of earnings differences.

What theories might guide the inquiry into these issues? If it was generally recognized in previous studies that a college education in general and college quality in particular have impacted graduates' economic status, how would we interpret this effect? What theory (or theories) would help us understand the mechanism through which college quality takes effect? Further, in re-interpreting and re-examining the effect of college quality in this dissertation, how should we proceed with such an analysis? What theory (or theories) would guide us through the analysis and helps us understand the role of college quality in society?

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[9] In a later study, he found that college quality had a substantial effect on graduates' earnings four to five years after graduation. Further, in comparing the effect of college quality at two points in time, Thomas and Zhang (2001) found that graduates from high-quality colleges increased their earnings substantially relative to those from low-quality colleges during the period.

Previous studies relied heavily on human capital theory in interpreting the effect of college quality on earnings. Human capital theory advocated investment in human capital as analogous to investment in physical capital and claimed a positive role for education in enhancing one's labor productivity (hence income). Intensive economic analysis of human capital began with the work of Theodore Schultz (1960, 1961), Jacob Mincer (1962), and Gary Becker (1964). (More recently human capital theory has been widely used in explaining economic growth among nations and income distribution among individuals.) In most early work, education was presented merely by years of schooling. Later, thanks to studies examining the effect of educational quality (including those studies listed in Table 2.1), the quality of education has become a standard element in what has come to be called the Mincerian (1974) framework.

According to human capital theory, the labor market rewards investments individuals make in themselves (e.g., their education or training) and these investments lead to higher salaries (Becker, 1964). High-quality colleges, which usually possess quality academic faculty, capable and motivated students, large libraries, well-equipped laboratories, and so on, would appear to provide their students with better resources for human capital improvement than low-quality colleges. Thus, most previous studies proceeded with the proposition that college quality may have significant effects on graduates' earnings although the bulk of these studies have only shown a relatively small effect on those earnings.[10]

[10] Human capital theory provides a perspective to interpret the effect of college quality but does not suggest the magnitude of such an effect. However, considering the increasing gap between the costs of a college education among colleges of varying quality, we expect that college quality has a significant effect on graduates' earnings if larger investments in human capital lead to higher income.

Whereas human capital theory acknowledges the positive role of education (in this particular case, college quality) in raising one's income, it ignores many related issues. For example, previous studies have shown that college quality has a positive effect on graduates' earnings, but does everyone have the same chance of earning degrees at high-quality colleges? Moreover, is the effect of college quality invariant across individuals with different backgrounds? Because human capital usually assumes that markets are free, rational, and impartial, and individuals are evaluated solely on their educational credentials, regardless of their gender, race/ethnicity, or social origins, it attributes labor market outcomes to individual choices. Therefore, human capital theory helps little in understanding the relationship among family backgrounds, educational attainment, and graduates' earnings. As Bowles and Gintis (1975) critiqued,

> The theory of human capital . . . ultimately locates the sources of human happiness and misery in an interaction of human nature (preferences and "ability") with nature itself (technologies and resources). This framework provides an elegant apology for almost any pattern of oppression or inequality…. It provides, in short, a good ideology for the defense of the status quo. But it is a poor science for understanding either the workings of the capitalist economy or the way towards an economic order more conducive to human happiness. (p. 82)

To understand how class-related variables influence one's educational attainment and how the effect of college quality varies across individuals, other theories that underscore the relationship between class and education are called for.

A major theory that highlights the interaction between class and education is social reproduction theory.[11] Social reproduction theorists, from a critical perspective,

[11] Other useful frameworks are the signaling (Spence, 1973, 1974) and screening (Rothschild & Stiglitz, 1976) hypotheses. Whereas in principle these two hypotheses involve two types of games and equilibria in the context of asymmetric information, in higher education research they are conveniently referred to as sorting hypotheses: students are sorted according to their educational credentials. For this type of sorting

recognize the positive role of education on labor market outcomes, but they proceed with the assumption that pedagogical practices are related to social practices and highlight the impact of class, race, and gender in determining the distribution of educational credentials among individuals (Blau & Duncan, 1967; Duncan, Featherman, & Duncan, 1972; Sewell & Hauser, 1975). Social reproduction theory (Bourdieu & Passeron, 1977; Cookson & Persell, 1985; McLeod, 1987; Willis, 1981), suggests that the distribution of educational credentials is largely determined by one's social class, and institutions such as high-quality colleges help preserve and reproduce the existing social structure.

Perhaps the earliest work on the issue of social reproduction through education came from two French scholars, Pierre Bourdieu and Jean-Claude Passeron (1977). Drawing partially on Marxist tradition, they claimed that education produced certain understandings and perceptions that allowed the dominant class to maintain its status. Social reproduction theory shed light on the intergenerational transmission of social inequality and attempted to show how and why the United States could be depicted more accurately as the place where "the rich get richer and the poor stay poor" than as "the land of opportunity" (McLeod, 1987, p. 7). McLeod and Cookson and Persell (1985) explored how class was socially reproduced through education in American society. McLeod studied educational programs (such as the Occupational Education Program, the

mechanism to work in the particular case of college quality, there must be some costs associated with attending high-quality colleges. Moreover, these costs are higher for some individuals than for others, and those with lower costs have certain traits favored by the labor market. For example, if certain traits of the upper-class are favored in market, college quality may serve as a sorting device because the cost of attending high-quality colleges (tuition and fees, living expense, and otherwise) is relatively lower for students from upper-class families than for others. Interpreted in this way, the signaling and screening hypotheses are in fact consistent with social reproduction theory.

Enterprise Co-op Program, and the Building and Trades Services Programs) offered to working-class students in high school and illustrated that the system of education in the United States teaches working-class students to be working-class adults. The theme of social reproduction was also animated in a drastically different educational environment by Cookson and Persell, who documented how the philosophies, programs, and lifestyles of boarding schools helped transmit power and privilege of the elite class.

If, according to social reproduction theory, education is the tunnel through which social value is reproduced and perpetuated, then how are students from different social classes sorted into different paths? In the minds of most, education seems to be the great equalizer; it provides a playing field where the rich and the poor are seen to compete on an equal basis—on the principle of meritocracy. Quite the contrary, according to social reproduction theory; education actually reinforces social inequality. For example, recent economic studies on the relationship between family income and college enrollment suggest that family income affects college enrollment in at least two ways: short-term credit constraints and long-term factors crystallized in ability (e.g., Carneiro & Heckman, 2002; Kane, 1994). Short-term credit constraints make students from poor families more sensitive to the price of a college education (Kane, 1994). Family income also exerts long-term influence on educational credentials through its effect on individuals' cognitive and non-cognitive abilities (Carneiro & Heckman, 2002). The debate on which effect, short-term or long-term, dominates in the family income-educational credentials relationship is not particularly relevant to the current study; both suggest that family income gives upper-class students enormous leverage to obtain more prestigious educational credentials, which subsequently help preserve and perpetuate their advantageous social positions.

In cases where students from lower classes enter elite institutions, they might have to downplay their social class background to be successful. In studying working-class students attending Harvard Law School, Granfield (1988) poignantly observed that working-class students were taught that unless they downplayed their social class background, the most lucrative opportunities would be denied them. Willis (1981) depicted how working-class students resisted in school, but only in a self-defeating way. These observations suggest that graduating from elite colleges might benefit upper-class students more than working-class students. This conclusion urges us to examine the effect of college quality across students from different social classes. This can be accomplished by segmenting students according to class-related variables and then examining the effects of college quality for different groups of students.

Social reproduction theory suggests that we may examine how educational credentials are distributed among individuals and how the effects of these credentials differ across different groups of individuals. Consequently, three research questions are proposed; hypotheses for these research questions as implied by social reproduction theory are presented in Table 2.2. Because the theory is not relevant to some research questions, in cases where no hypothesis is generated from the theory, the null hypothesis is tested instead.

Research Question 1 (RQ1): Do different students have the same probability of earning degrees at high-quality colleges?

Table 2.2

Research Questions and Hypotheses

<table>
<tr><th colspan="2">Research Questions</th><th>Hypotheses</th></tr>
<tr><td colspan="2">(RQ1) Do different students have the same probability of earning degrees at high-quality colleges?</td><td>Both social class variables and individual ability variables will be strong predictors of graduating from high-quality colleges; social class variables also influence ability variable.</td></tr>
<tr><td rowspan="6">(RQ2) Does the effect of college quality differ across different groups of students?</td><td>By family wealth</td><td>College quality benefits students from wealthy families more than those from poor families.</td></tr>
<tr><td>By parental education</td><td>College quality benefits students from well-educated families more than those from low-educated families.</td></tr>
<tr><td>By race</td><td>College quality benefits White students more than non-White students.</td></tr>
<tr><td>By intellectual ability</td><td>College quality benefits high-ability students more than others.</td></tr>
<tr><td>By gender</td><td>N/A</td></tr>
<tr><td>By field of study</td><td>N/A</td></tr>
<tr><td colspan="2">(RQ3) What is the effect of college quality at different points of earnings distribution?</td><td>College quality would be an especially strong predictor of earnings for those individuals ending up at the top of earnings distribution.</td></tr>
</table>

Social reproduction theory entails the relationship between class and educational credentials. Although my focus is on examining the effect of college quality across individuals, the question of who graduates from high-quality colleges is essential to understanding the social role of high-quality colleges. For example, empirical work has consistently found that Blacks earn less than Whites, yet this earnings penalty may result from lower educational credentials of Blacks or from labor market discrimination. If it can be shown that the effects of college quality are the same for Blacks and Whites but only the probabilities of graduating from high-quality colleges differ, then it is reasonable to draw the conclusion that high-quality colleges preserve the economic statuses of Blacks and Whites. In contrast, if it can be shown that probabilities of graduating from high-quality colleges are the same for Blacks and Whites but the effects of college quality differ, then we may conclude that it is not educational institutions but other forces (such as taste discrimination and statistical discrimination) that create the income gap between Blacks and Whites.[12] The same logic also applies to the income difference between males and females and between lower and higher income students.

Hypothesis 1 (H1): Social class variables such as family income and parental education have a strong effect on graduating from high-quality colleges; they also exert indirect influence through individual ability.

Arguably, from children's early days of life, the quality of educational institutions selected by upper-class families, especially those with the highest income, probably is superior to the quality of institutions selected by lower-class families, especially those with the lowest income. Upper-class families, through choosing high-quality education for their children, are able to transmit their socioeconomic status to the next generation.

[12] Taste discrimination and statistical discriminations are ways to explain the earnings gap between groups, especially racial groups. To explain the Black-White earnings gap, taste discrimination assumes that employers, fellow workers, or customers have a desire to avoid Black workers (Becker, 1957). Statistical discrimination explains the earnings gap by assuming that the observed signal of productivity such as educational attainment is less reliable for Black workers than for White workers, leading to lower wages for Black workers if employers are risk averse (Aigner & Cain, 1977).

Social reproduction theory highlights such a family-education relationship and suggests that social class variables (such as family wealth and parental education) are strong predictors of graduating from high-quality colleges. The theory also suggests that individual abilities (usually measured by test scores) play an important positive role because part of family factors has been crystallized in individual abilities through the quality of education in students' early days of life. As a result, high correlations exist among college quality, individual ability, and family wealth.

Research Question 2 (RQ2): Does graduating from a high-quality college yield the same level of earnings advantage across different groups of students by gender, race, family wealth, parental education, intellectual ability, and major field of study?

This second research question examines the effects of college quality across different individuals, i.e., the interactions among college quality and individual characteristics. As discussed above, social reproduction theory sheds light on such interactions. My analysis examines the effect of college quality across different groups of students by various criteria, such as family wealth, parental education, intellectual ability, race, gender, and major field of study. The effect of college quality across these groups is examined separately. For example, do high-quality colleges affect wealthy students more than poor students? Do high-quality colleges yield more earnings advantages to students from highly educated families than to others?

Hypothesis 2 (H2): Graduating from a high-quality college benefits students from wealthy families more than students from poor families, students from well-educated *families more than those from poorly educated families, students of high ability more than students of low ability, and perhaps White students more than non-White students.*

Social reproduction theory suggests that students from lower-class families have less chance to earn degrees at high-quality colleges; it also suggests that even when students from lower-class families successfully graduate from high-quality colleges, they have extra obstacles to overcome in converting their educational credentials into economic benefits. Thus, graduating from high-quality colleges would benefit students from the upper class more than students from the lower class. Among the above six factors, family income, parental education, ability, and race are unambiguously class related.

Research Question 3(RQ3): What is the effect of college quality at different points of the earnings distribution?

The third research question examines the variations in the effect of college quality in another dimension. Not only can the effects of college quality be evaluated for different groups of individuals as in RQ2, the effects of college quality can also be evaluated at different points in the earnings distribution. In other words, given graduates' realized earnings—especially for those at the very top of the earnings distribution—how has college quality helped them reach that position?

Hypothesis 3 (H3): The effects of college quality evaluated at the top of the earnings distribution (e.g., 75th, 90th, and 95th percentiles) are larger than the effect evaluated at lower points of the earnings distribution (e.g., 10th, 25th, and 50th percentiles).

Consistent with H2, the effect of college quality is mediated by class variables. Other factors should be supportive for college quality to exert large effects on graduate earnings. Following this logic, the effect of college quality is larger at the top of the earnings distribution than at the lower part of the distribution. In other words, college quality may in fact stretch the earnings distribution. This hypothesis is consistent with the reality that as the majority of high school graduates attend colleges, college quality increasingly serves as a differentiating apparatus among college graduates.[13]

The above three research questions not only point to the equity issue regarding the educational attainment among different students, but also the equity issue with respect to the benefit of such educational attainment among different students. Answers to these questions will provide more complete understanding of the interactions among socioeconomic factors, educational attainment, and graduates' earnings. These three research questions are analyzed in Chapters 3 to 5.

Although the above three research questions examine the economic effect of college quality in great detail, they ignore the option value of college quality and the non-monetary effect of college quality. The option value of college quality is very important in this analysis because graduate education is an important period of human capital

[13] It should be cautioned here that treatment effects on distributions and distributions of treatment effects are two different concepts. In this study, graduating from high-quality colleges is the treatment. Because only the earnings distribution after treatment is observable (but not the distribution before treatment), we can only estimate treatment effects on distributions (but not distributions of treatment effects). In other words, we can only examine whether college quality matters more to those ending up at the top of the earnings distribution than others but may not know whether college quality matters more to those who would have been at the top of the earnings distribution than others if there had been no such treatment (because the distribution before treatment is unobserved). To apply social reproduction theory, the assumption of rank preservation, also known as perfect positive dependence (which is weaker than the assumption of constant treatment effects) is needed. For detailed discussion, see Abadie, Angrist, and Imbens (2002), Imbens and Rubin (1997), and Heckman, Smith, and Clements (1997).

improvement (thus graduate education could also be seen as an economic outcome). Social reproduction theory would suggest that social class variables such as family income and parental education have a strong effect on graduate education, and because part of the social class factors have crystallized into college quality and ability, these variables also have strong effects on graduate education. Moreover, human capital theory would suggest that graduate education has a strong effect on earnings because graduates' human capital is further improved and enhanced in graduate school. These hypotheses are tested in Chapter 6.

Job satisfaction is another important non-monetary outcome to be considered. Unfortunately, neither human capital theory nor social reproduction theory tells us how college quality would impact job satisfaction. Thus I proceed with the null hypothesis. Presumably, graduates' earnings have some influences on job satisfaction; it is instructive to examine the interaction between college quality, graduates' earnings, and job satisfaction. These issues are examined in Chapter 7.

To sum up, in reviewing the literature on the effect of college quality on graduates' earnings, I found that the average effect of college quality on earnings greatly simplifies the analysis and disguises much of the variation across individuals. Further, previous analyses relied heavily on human capital theory, thus separating the analysis of the effect of college quality from the analysis of college destination. I attempted to tie these analyses together from another theoretical framework: social reproduction theory. In doing so, I emphasized the centrality of social class in the analysis of the effect of college quality. Finally, I argued that previous analyses may overlook some non-monetary effects of college quality. I remedied this weakness by incorporating the analysis of graduate education and job satisfaction into the analysis of the effect of college quality.

CHAPTER 3

WHO COMPLETES AT HIGH-QUALITY COLLEGES?

3.1 Perspective

In this chapter, I focus on the first research question; that is, I examine the variability in the probability of earning degrees at high-quality institutions among different students. For example, how is the probability of earning degrees at high-quality institutions related to students' demographic characteristics? What is the effect of family background characteristics? Does the student's ability play any role? If so, how is the student's ability related to demographic and family background characteristics? At first sight, these questions might not seem to be germane to the study of the effect of college quality. They are in fact highly relevant in a couple of ways.

First, the answer to who graduates from high-quality colleges situates the effect of high-quality colleges in a proper context. To understand the effect of educational attainment in terms of college quality across individuals is to first understand the distribution of such educational attainment across individuals. For example, if it can be shown that the effects of college quality are the same (or even larger) for lower-class students and for upper-class students but only the probabilities of earning degrees from high-quality colleges differ, then it is reasonable to conclude that high-quality colleges preserve and perpetuate the economic status of different social classes. In contrast, if it can be shown that probabilities of earning a degree at high-quality colleges are the same for lower-class students and upper-class students but the effects of college quality differ, then we may conclude that it is not educational institutions but other forces (such as discrimination in the labor market) that create the income gap. Thus, both the variability in the probability of earnings degree at high-quality colleges and the variability in the effect of college quality across individuals are necessary in order to understand the stratification among individuals more completely.

Second, from a statistical point of view, estimating who completes at colleges of varying quality is important in obtaining consistent estimates of the effect of college quality on students. Econometricians call it the selection bias problem (Heckman, 1979). In simple language, students are not randomly selected into different types of colleges; they self-select by optimizing certain individual utility functions. Due to the endogeneity of college quality, the effect of college quality estimated by the conventional OLS technique includes both the true effect of college quality and the return to optimizing behavior in choosing a particular type of institution. To estimate the true effect of college quality consistently, the usual technique involves a selectivity term by estimating a selection equation (Heckman, 1979; Lee, 1983).[14] The selection equation, which estimates the probability of earning degrees at different types of colleges, provides the first step in the well-known two-step or structural approach of estimating the effect of college quality.

Educational researchers have a vested interest in exploring how various social and individual factors determine one's educational attainment. Roughly speaking, this line of literature can be divided into two branches: those focusing on college choice/access and

[14] Detailed discussion of the selection bias problem is provided in Chapter 4, where the effect of college quality is estimated.

those on retention/graduation. The choice/access literature explores various tasks students must accomplish to realize college enrollment. Among those tasks are academic qualification, graduation from high school, and applying to college (Adelman, 1999; Berkner & Chavez, 1997; Hossler, Braxton, & Coopersmith, 1989). A recent study by Cabrera and La Nasa (2001) finds that upper-class students are favored at each of the three tasks on the path to college. For example, the lowest SES students are about 51% less likely than the highest SES students to secure academic qualification; controlling for school-level and family background variables still leaves 15% net difference unaccounted for. Further, the lowest SES students are about 25% less likely than the highest-SES students to graduate from high school, even after controlling for other salient variables. Finally, *ceteris paribus*, there is a considerable gap (25%) in the college application rate between the lowest SES students and the highest SES students. All of these gaps put those socioeconomically disadvantaged high school students in a hazardous position in accessing a college education.

The branch of research examining college retention and graduation is dominated by Astin's (1975, 1984) theory of involvement and Tinto's (1975, 1993) concept of integration. These theories have been reconceptualized and elaborated by educational researchers (Braxton, Sullivan, & Johnson, 1997; Cabrera et al., 1992; Milem & Berger, 1997; Thomas, 2000b). The most stripped-down finding is that being female, white, high ability, and from high-SES families is associated with higher probability of retention (Berger & Milem, 1999; Elkins, Braxton, & James, 2000). Research focusing on the "Baccalaureate Gap" and students' transferring from two-year colleges to four-year institutions also finds similar disadvantages for low-ability and low-SES students (Dougherty, 1992; Lee & Frank, 1990).

In short, great stratification exists in postsecondary access and attainment among students. This stratification, however, should move beyond college graduates versus non-college graduates in an era when the majority of high school graduates go to college and the majority of them obtain college degrees. In this respect, the question of who completes at high-quality colleges extends and complements the above literature.

3.2 Analysis

My analysis draws data from two levels: the individual level and the institutional level.[15] The individual-level data come from the 1994 first 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[16]. The restricted BB: 93/97 data set is used to enable the connection of students and institutions.[17] The first follow-up survey includes more than 10,000 baccalaureate recipients who completed their degrees between July

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[15] Due to the variety of research questions asked in this dissertation, data used in different chapters are slightly different in samples and variables, although the same data sources are used throughout the study. Variables are discussed in detail when first introduced, and they are mentioned briefly when used in later analyses.
[16] For more information about the B&B study, see http://www.nces.ed.gov.
[17] 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 (NCES).

1992 and June 1993. All analyses reported in this paper have been weighted appropriately, normalized on the final sample, if not specified otherwise.[18]

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*.[19] 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 (see Fox, 1993). 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.

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[18] 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. The multilevel modeling is discussed in detail in Chapter 4, and the results are very similar to OLS estimates.
[19] In this chapter, only Barron's rating is used. In Chapter 4, different measures of college quality (such as average SAT score of entering class, Carnegie Classification, and tuition and fees charged by the institution) are experimented in estimating the effect of college quality on earnings.

The initial sample includes 10,080 baccalaureate recipients who completed their degrees between July 1992 and June 1993. Because I am interested in estimating the variability of earning degrees at colleges of varying quality, only those students with institutional information are included. This criterion limits the sample to 8,642 students (about 15% of the initial sample is left out) and 516 institutions. Table 3.1 provides the distribution of these 8,642 students across different types of institutions.[20] In the final sample, about 15% of students graduate from high-quality institutions, which have a Barron's rating of 4 or 5. About 6% are from public institutions and another 9% from private institutions. The majority (67%) are from middle-quality institutions (Barron's rating of 2 or 3), with public 47% and private 20%. The remaining 18% are from low-quality institutions, with public 13% and private 5%.

Table 3.1

Distribution of Students across Colleges of Varying Quality

	Public institutions	Private institutions	Total
High-quality institutions	538 (6.2%)	747 (8.6%)	1,285 (14.9%)
Middle-quality institutions	4,072 (47.1%)	1,724 (19.9%)	5,796 (67.1%)
Low-quality institutions	1,137 (13.2%)	424 (4.9%)	1,561 (18.1%)
Total	5,747 (66.5%)	2,895 (33.5%)	8,642 (100%)

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

The outcome of interest in this analysis is the quality of institutions from which students graduate (0, 1, and 2 for low-, middle-, and high-quality institutions, respectively). Endogenous variables include various demographic, family backgrounds,

[20] Weighted by B&B first follow-up weight, normalized on the final sample of 8,642.

intellectual ability, and educational aspiration variables. 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). Individual ability is captured by the merged SAT and ACT quartile (with 1 indicating the lowest and 4 the highest quartile).[21] Educational aspiration is measured by the highest degree expected (categorical dummies indicating whether the highest expected degree is a Master or Doctor with the omitted group being a Bachelor). Family background characteristics include mother's education (categorical dummies indicating whether the mother has high school education, some college education, college degree, or advanced degrees with the omitted group being less than high school education) and family income (in ten thousand dollars). A detailed definition and description of these variables is provided in Table 3.2.

The results of analysis are arranged as follows. First, the differences in student profile by gender, race/ethnicity, family background, intellectual ability, and educational aspirations are examined descriptively. I then use regression analysis to examine the impact of various individual and family characteristics on students' college destination. Results from OLS, multinomial logit, and ordered logit regressions are presented. The final part of the analysis explores the relationship among independent variables.

[21] Due to data limitations, I was unable to obtain other popular measures of individual ability such as Armed Forces Qualification Test (AFQT) scores.

Table 3.2

Descriptive Statistics of Independent Variables, by College Quality

	All		Low quality	Middle quality	High quality
	Mean	S.D.	Mean	Mean	Mean
Female	0.5441	0.4981	0.5890	0.5414	0.5016
Native American	0.0059	0.0764	0.0065	0.0060	0.0043
Asian	0.0418	0.2000	0.0229	0.0371	0.0859
Black	0.0628	0.2426	0.1037	0.0587	0.0313
Hispanic	0.0423	0.2013	0.0522	0.0405	0.0387
Age	26.9755	6.6227	28.8741	27.0106	24.5103
Expect MA	0.5795	0.4937	0.6137	0.5790	0.5399
Expect PhD	0.1911	0.3932	0.1695	0.1836	0.2511
Mother high school graduate	0.3152	0.4646	0.3622	0.3285	0.1980
Mother some college	0.1600	0.3666	0.1734	0.1604	0.1421
Mother college graduate	0.1804	0.3846	0.1388	0.1718	0.2699
Mother advanced degree	0.1084	0.3109	0.0649	0.1038	0.1822
SAT/ACT quartile	1.9985	1.3845	1.4959	1.9250	2.9407
Family income ($10,000)	4.8335	5.4866	3.7233	4.7147	6.7188
N	8642		1561	5796	1285

Notes:
Female: 1 = female; 0 = male.
Native American: 1 = Native American; 0 = otherwise.
Asian: 1 = Asian American; 0 = otherwise.
Black: 1 = Black; 0 = otherwise.
Hispanic: 1 = Hispanic; 0 = otherwise.
White (omitted category): 1 = white; 0 = otherwise.
Age: Age as of 12/31/1994.
Expect MA: 1 if the highest expected degree is Master; 0=otherwise.
Expect PhD: 1 if the highest expected degree is Doctor; 0=otherwise.
Expect BA (omitted category): 1 if the highest expected degree is Bachelor or less; 0=otherwise.
Mother high school graduate: 1 if mother is a high school graduate; 0=otherwise.
Mother some college: 1 if mother has some college education; 0=otherwise.
Mother college graduate: 1 if mother is a college graduate; 0=otherwise.

Table 3.2 – *Continued*

	Public			Private		
	Low quality	Middle quality	High quality	Low quality	Middle quality	High quality
Female	0.5808	0.5296	0.4880	0.6108	0.5693	0.5114
Native American	0.0056	0.0071	0.0026	0.0090	0.0035	0.0055
Asian	0.0216	0.0441	0.1139	0.0262	0.0204	0.0657
Black	0.0674	0.0552	0.0308	0.2009	0.0671	0.0316
Hispanic	0.0514	0.0449	0.0341	0.0543	0.0300	0.0421
Age	28.2487	26.5848	24.8565	30.5517	28.0160	24.2608
Expect MA	0.6145	0.5760	0.5862	0.6116	0.5862	0.5066
Expect PhD	0.1616	0.1783	0.2298	0.1907	0.1962	0.2664
Mother high school graduate	0.3600	0.3310	0.2282	0.3682	0.3228	0.1762
Mother some college	0.1765	0.1601	0.1627	0.1650	0.1611	0.1273
Mother college graduate	0.1443	0.1668	0.2473	0.1242	0.1835	0.2862
Mother advanced degree	0.0660	0.1029	0.1420	0.0620	0.1058	0.2111
SAT/ACT quartile	1.6484	1.9561	2.7125	1.0867	1.8517	3.1051
Family income ($10,000)	3.8195	4.4397	5.8132	3.4651	5.3641	7.3715
N	1137	4072	538	424	1724	747

Mother advanced degree: 1 if mother has a graduate degree; 0=otherwise.
Mother less than high school graduate (omitted category): 1 if mother has less than high school education; 0=otherwise.
SAT/ACT quartile: Merged SAT or ACT quartile. 1=the lowest quartile; 2=the second lowest quartile; 3=the second highest quartile; 4=the highest quartile.
Family income: Family income in $10,000 increments.

Student Profiles at Colleges of Varying Quality

The most intuitive way to understand how student characteristics differ at colleges of varying quality is to look at descriptive statistics. Table 3.2 presents the mean statistics of students' characteristics by college quality and types of institutional control. The first column (All) of Table 3.2 provides the means and standard deviations of the demographic and family background variables for the whole sample of 8,642 students, and the remaining three columns in the upper panel of Table 3.2 give the means of students' characteristics at low-, middle-, and high-quality colleges.

Differences in student profiles at colleges of varying quality emerge by comparing the means across these three columns. For example, Native Americans represent a very small proportion of the student body at each category (e.g., 0.59% for the "All" category in the first column); they represent an especially small proportion among those who graduate from high-quality colleges (0.43%). This observation is also generally true for Hispanic students. It should be cautioned, however, because the numbers of Native Americans or Hispanic students in the sample are very small, it is difficult to draw any conclusions from this simple comparison. The differences in the proportion of Black students (non-Native Americans, non-Hispanics) at different types of colleges are quite dramatic. Although Black students only represent about 3-5% of the entire student body at middle- and high-quality colleges (5.9% at middle-quality colleges and 3.1% at high-quality colleges), they constitute more than 10% of the student population at low-quality colleges. This could be explained by the large enrollment of Black students at Historically Black Colleges and Universities that are often classified as low-quality institutions. For example, among the 516 institutions in the sample, 24 are Historically Black Colleges and Universities, with 12 classified as low-quality institutions and the other 12 as middle-quality institutions. In contrast, Asian students are more represented at high-quality institutions (8.6%) than at low- and middle-quality institutions (2.3% and 3.7%, respectively).

There are also differences in gender and age composition among colleges of varying quality. For example, the proportion of female students exceeds one half at all three types of colleges, but their representation is greatest at low-quality colleges (58.9%). The proportion of female students at high-quality colleges is only slightly above one-half (50.2%). In terms of age, students who graduated from high-quality colleges are younger than those from low-quality colleges.[22]

Students from high-quality colleges seem to be intellectually more capable than those from low-quality colleges. The average merged SAT and ACT quartile of students (Row 13, Table 3.2) from high-quality colleges is roughly 1.5 quartiles higher than that of students from low-quality colleges (2.94 versus 1.50) and also one quartile higher than that of students from middle-quality colleges (2.94 versus 1.93). Students from high-quality colleges also seem to have higher educational aspirations (Row 8). For example, about a quarter of students (25.1%) from high-quality colleges expect to obtain doctoral degrees, while only 17.0% of the students from low-quality colleges and 18.4% of the students from middle-quality colleges expect to obtain doctoral degrees.

Family backgrounds in terms of family income and mother's education also differ among students graduating from different types of colleges. For example, the average family income (the last row) for the whole sample is $48,335, but this figure is $37,233 for students graduating from low-quality colleges and $67,188 for those graduating from

[22] Note that students graduated between July 1992 and June 1993, and the age is reported as of 12/31/1994, so they graduated roughly one year younger than the age reported in Table 3.2.

high-quality colleges. Mother’s education is also higher for students graduating from high-quality colleges. In the pooled sample, about 32% of students have mothers with only a high school education, 16% have some college, 18% hold college degrees, and 11% have post-graduate education. These figures are more or less the same for those students graduating from middle-quality colleges (33%, 16%, 17%, and 10%, respectively).[23] Obviously, students graduating from high-quality colleges are more likely than those graduating from low- and middle-quality colleges to have mothers with college degrees (including college degrees and advanced degrees). Roughly 45% (27% plus 18%) of students from high-quality colleges have their mothers with a college degree; this figure is about 27% (17% plus 10%) for students from middle-quality colleges and 20% (14% plus 6%) for students from low-quality colleges.

The lower panel of Table 3.2 distinguishes public institutions from private ones and reports the mean statistics for each quality category by types of control. The qualitative observations are almost identical to those in the last three columns at the upper panel of the table; there are, however, some minor quantitative differences between students graduating from public and private institutions at the same college quality level. For example, students from high-quality private colleges appear to have wealthier and better-educated families than students from high-quality public institutions.

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[23] Due to missing values in the reported mothers’ education, the sum of these percentages does not add to 100%. Assuming that students with low-educated mothers were less likely to report this variable (about 74% of students attending low-quality colleges reported their mothers’ education, 76% for those attending middle-quality colleges, and more than 79% for those attending high-quality colleges), the actual difference in mothers’ education among students attending different types of colleges could be larger than the difference reported in Table 3.2.

Regression Estimate for Graduating from Colleges of Varying Quality

Descriptive statistics as presented in Table 3.2 are not on a *ceteris paribus* basis. For example, descriptive statistics suggest that female students are less well represented at high-quality colleges; however it could have been the case that female students had lower test scores and that being female *per se* did not reduce the probability of earning a degree at high-quality colleges. To evaluate the impact of various individual and family characteristics on the probability of earning a degree at high-quality colleges, I turn to regression analysis.[24] Because the dependent variable is a discrete variable, the multinomial logit technique is employed. Further, because college quality could be inherently ordered, an ordered logit technique is also used.[25] Table 3.3 presents multinomial estimates for the impact of various individual and family characteristics on college quality, and Table 3.4 presents the estimates from the ordered logit regression. In both tables, the estimated marginal effects represent the impact of one unit increase in the corresponding independent variable on the probability that a student earns a baccalaureate degree from a certain type of college relative to other types. For example,

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[24] In the regression analysis, pubic and private institutions at each quality level were pooled together. At the descriptive level, students' characteristics at public and private institutions for a given quality level were quite similar. For this reason, when public and private institutions were separated in the choice model, the prediction was very poor.

[25] A natural question is raised by estimating both the multinomial logit and ordered logit models: Which one is better (or right), the multinomial logit or the ordered logit model? It depends on whether one is willing to impose the assumption of the ordered characteristic of college quality. That is, when one fails to be admitted into high-quality colleges, is his/her next choice middle-quality colleges? Statistically, there is a criterion to determine which model is "better." Vuong (1989) showed a way to test non-nested MLEs. He proposed a test statistic based on the difference of two log-likelihood functions (multiplied by –2 to produce a chi-square distributed random variable). In this case, the chi-square statistics was 151 with 19 degrees of freedom. So, the multinomial logit model won the race. It is safe, however, to report results from both models, because many possibilities (e.g., model misspecification and measurement error) may lead to the rejection of the ordered logit even if the dependent variable is indeed inherently ordered.

Table 3.3

Multinomial Logit Estimates for College Quality

	Marginal Effects					
	Low quality		Middle quality		High quality	
Female	0.0116	(1.41)	-0.0145	(1.54)	0.0029	(0.47)
Native American	-0.0197	(0.43)	0.0315	(0.55)	-0.0119	(0.29)
Asian	-0.0790	(4.90)	-0.0551	(2.14)	0.1340	(5.71)
Black	0.0558	(3.13)	-0.0546	(2.55)	-0.0012	(0.07)
Hispanic	0.0001	(0.01)	-0.0467	(1.84)	0.0466	(2.17)
Age	0.0045	(6.67)	0.0039	(3.80)	-0.0084	(8.71)
Expect MA	0.0076	(0.64)	-0.0304	(2.14)	0.0229	(2.23)
Expect PhD	-0.0138	(0.98)	-0.0385	(2.14)	0.0523	(3.55)
Mother high school graduate	-0.0338	(2.16)	0.0220	(0.95)	0.0118	(0.57)
Mother some college	-0.0260	(1.56)	-0.0019	(0.07)	0.0278	(1.18)
Mother college graduate	-0.0526	(3.33)	-0.0143	(0.52)	0.0669	(2.48)
Mother advanced degree	-0.0824	(5.59)	-0.0121	(0.38)	0.0945	(2.93)
SAT/ACT quartile	-0.0453	(9.87)	-0.0250	(4.78)	0.0703	(20.3)
Family income ($10,000)	-0.0074	(5.94)	0.0043	(3.61)	0.0031	(6.28)
N	8642					
χ^2	1438					

Notes:
1. Also included in the model are a constant term and dummies indicating missing values of independent variables.
2. Graduating from low-quality colleges is the comparison group in estimating the index function.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for discrete change from 0 to 1.
4. Absolute value t statistics are included in parentheses.

Table 3.4

Ordered Logit Estimates for College Quality

	Marginal Effects					
	Low quality		Middle quality		High quality	
Female	0.0018	(0.30)	-0.0003	(0.31)	-0.0015	(0.30)
Native American	-0.0111	(0.31)	0.0011	(0.76)	0.0100	(0.29)
Asian	-0.0865	(11.12)	-0.0469	(3.32)	0.1334	(6.24)
Black	0.0306	(2.21)	-0.0082	(1.60)	-0.0223	(2.55)
Hispanic	-0.0177	(1.31)	0.0012	(1.86)	0.0165	(1.19)
Age	0.0046	(8.53)	-0.0007	(4.42)	-0.0039	(8.45)
Expect MA	-0.0059	(0.67)	0.0009	(0.64)	0.0049	(0.67)
Expect PhD	-0.0307	(3.28)	0.0017	(1.43)	0.0290	(2.92)
Mother high school graduate	-0.0212	(1.64)	0.0025	(2.11)	0.0187	(1.57)
Mother some college	-0.0213	(1.59)	0.0017	(2.49)	0.0196	(1.46)
Mother college graduate	-0.0576	(4.96)	-0.0039	(0.87)	0.0616	(3.93)
Mother advanced degree	-0.0765	(7.43)	-0.0216	(2.16)	0.0981	(4.95)
SAT/ACT quartile	-0.0706	(21.61)	0.0111	(4.97)	0.0596	(21.16)
Family income ($10,000)	-0.0052	(8.44)	0.0008	(4.37)	0.0043	(8.41)
N	8642					
χ^2	1287					

Notes:
1. Also included in the model are a constant term and dummies indicating missing values of independent variables.
2. For the ordered logit estimation, 0 = low-quality colleges, 1 = middle-quality colleges, 2 = high-quality colleges.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for discrete change from 0 to 1.
4. Absolute value t statistics are included in parentheses.

the first coefficient 0.0116 in Table 3.3 suggests that on average female students are 1.16% more likely to graduate from low-quality colleges than their male counterparts.

Results from both tables suggest that intellectual ability and educational aspirations impact the probability of earning a degree at high-quality colleges in significant and powerful ways. These results also suggest that individuals’ ascribed and socioeconomic background characteristics play a very significant role. Other things being equal, Black students, older students, students who have lower educational aspirations, students who have lower test scores, students whose mothers have lower educational attainment, and students whose family has a lower income are all somewhat less likely to earn degrees at high-quality colleges.

Not surprisingly, the multinomial logit and ordered logit models yield quite similar results, although slight differences exist in some non-significant coefficients. In both tables, mothers’ educational attainment emerges as one of the most powerful and significant predictors for earning degrees at high-quality colleges. For example, both models estimate that having mothers with post-graduate degrees increases the probability of earning a degree at high-quality colleges by almost 10% (9.45% in last column of Table 3.3 and 9.81% in last column of Table 3.4) compared with students whose mothers have less than high school education, and having mothers with a college education also increases the probability by 6-7% (6.69% Table 3.3 and 6.16% in Table 3.4) compared with having mothers with less than high school education.

Naturally, having mothers with high educational attainment reduces the probability of earning degrees at low-quality colleges significantly. For example, having mothers with post-graduate degrees reduces the probability of earning a degree at low-quality colleges by about 8% (8.24% in first column of Table 3.3 and 7.65% in first column of Table 3.4) compared with students whose mothers have less than high school education. Another indicator of socioeconomic status, family income, has a smaller impact on the probability of earning a degree at high-quality colleges than one would expect, although the effect is statistically significant (see the last row in both tables). This may be because family income varies over time and thus is not a good measure of family wealth.[26]

Individual ability as measured by SAT/ACT quartile is another influential factor in determining college quality.[27] For example, the multinomial logit model predicts a 7% marginal impact for one quartile advance in SAT/ACT scores (e.g., from the second-highest quartile to the highest quartile) on the probability of graduating from high-quality colleges, and the ordered logit suggests a 6% margin. Educational aspirations also matter, although the impact is smaller than for intellectual ability. Having educational aspirations for a doctoral degree increases the probability of earning baccalaureate degrees at high-quality colleges by 5% compared with having educational aspiration for a master's degree.

In the context of various controls, female students do not seem to have any advantage or disadvantage in earning degrees at high-quality institutions. The observation of fewer female students at high-quality colleges in Table 3.2 is indeed due to individual

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[26] Perhaps due to the same reason, in the model estimating the effect of college quality on graduates' earning, the effect of family income was very small.
[27] The variable of SAT/ACT quartile has much missing data. In the actual analysis, these missing values were all coded into 0 with a dummy variable to indicate the missing value.

heterogeneity. After other variables are controlled for, the gender gap disappears. For example, both the logit and ordered logit models do not reveal any significant effect of gender on the probability of graduating from high-quality colleges (the first rows in Tables 3.3 and 3.4).

Similarly, being Native American or Hispanic *per se* does not reduce the probability of graduating from high-quality colleges. However, even after other variables are controlled for, Black students are still more likely to earn degrees at low-quality colleges and less likely at high-quality colleges. For example, the logit model suggests that Black students are 5.58% (Row 4, Table 3.3) more likely than their White counterpart to earn a degree from low-quality colleges. This result is likely influenced by the large enrollment of Black students in Historically Black Colleges and Universities that are disproportionately lower in quality. In contrast, both the multinomial logit and ordered logit models show that Asian students are about 13% more likely to earn degrees at high-quality colleges than are White students. In terms of age, younger students are more likely to graduate from high-quality colleges than older students. It seems, then, that individual ascribed characteristics including gender, race/ethnicity, and age do affect the probability of earning degrees at high-quality colleges.

Financial factors have an obvious impact on access and have been the focus of a large number of studies. For example, Hearn (1984) uses tuition as a proxy for college quality. To examine this, an OLS model is also estimated with dependent variable being tuition and fees. The results are reported in Table 3.5, which presents the effect of one unit increase in the corresponding independent variable on the college quality measured

Table 3.5

OLS Estimates for Tuition and Fees

	Coefficient	t
Constant	1.7547	9.48
Private institution	7.1429	146.09
Female	0.0600	1.30
Native American	-0.0162	0.05
Asian	0.2327	2.03
Black	-0.8058	8.35
Hispanic	-0.0333	0.29
Age	-0.0392	9.10
Expect MA	0.1232	1.79
Expect PhD	0.2913	3.56
Mother high school graduate	0.0074	0.07
Mother some college	-0.0371	0.32
Mother college graduate	0.1308	1.13
Mother advanced degree	0.2866	2.30
SAT/ACT quartile	0.3164	13.03
Family income ($10,000)	0.0316	7.27
N	8642	
R^2	0.7302	

Notes:
1. The dependent variable is tuition and fees in thousand dollars.
2. Also included in the model are dummies indicating missing values of independent variables.
3. Absolute value t statistics are included.

by tuition and fees in thousand dollars. For example, the coefficient (0.3164) for the SAT/ACT quantile can be interpreted that other things being equal, if a student increases his/her SAT/ACT scores by one quartile, then he/she is able to earn a degree from an institution charging about $316 more tuition and fees. The major qualitative results from Table 3.3 and 3.4 hold. For example, intellectual ability and educational aspirations exert large and significant influences on college quality as measured by the level of tuition and fees. Socioeconomic factors such as family income and mothers' education also significantly affect the quality of college attended.

The above analyses suggest that certain individual characteristics including gender, race/ethnicity, age, family income, and intellectual ability affect the probability of earning degrees at high-quality colleges. Although this might be one's intuitive interpretation of the analyses, an alternative interpretation, which treats college quality as the characteristics of the individuals attending the college, could also be illuminating. As a matter of fact, these two interpretations are one and the same: If students and colleges are viewed as participating in a matching game, then the equilibrium can be described by the characteristics of either side. More importantly, both interpretations reassure the social reproduction theory that posits a tight connection between socioeconomic factors and educational credentials.

Impact of Socioeconomic Factors on Intellectual Ability

The above analysis suggests that both academic (such as measured intellectual ability) and non-academic factors (such as demographic and socioeconomic variables) influence where to earn one's baccalaureate degree. The analysis in this section takes one step further to examine the relationships among these academic and non-academic factors. In particular, I am interested in understanding how intellectual ability measured by test score and educational aspiration are affected by socioeconomic background and ascribed characteristics. Specifically, in Table 3.6, the SAT/ACT quartiles are regressed on socioeconomic background and ascribed characteristics. And in Table 3.7, educational aspirations are regressed on the same set of variables as in Table 3.6.[28]

Table 3.6 shows that intellectual ability as measured by test scores is significantly affected by socioeconomic background and ascribed characteristics. For example, relative to having a mother with less than high school education (the left-out category in the regression), having a mother with college degree or advanced degree increases test scores by about one-half quartile (0.49 quartile for having a mother with college degree and 0.50 quartile for having a mother with advanced degree). Family income also affects test scores, although the magnitude is not as large as mothers' educational attainment. On average a $10,000 increase in family income only moves SAT/ACT scores up by 0.0159 quartile. Being female, Black, or Hispanic is negatively related to test scores. On average the SAT/ACT scores of Black students are almost one quartile (0.8114) lower that those of White students. Female students' relatively lower test scores explain some of the discrepancies among Tables 3.2, 3.3, and 3.4. Female students are less represented at high-quality colleges in Table 3.2 without controlling for other covariates, but being female does not seem to lower the probability of earning degrees at high-quality colleges

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[28] This analysis, however, begs several questions. For example, is there a possibility of multicollinearity in the analysis of college quality determination if there are correlations among independent variables? The small R-squared in Table 3.6 does not seem to cause multicollinearity in the previous analysis. However, the relatively low R-squared is not contradictory to the relatively large marginal impact of socioeconomic factors on intellectual ability and academic aspiration. The second concern is that if certain independent variables are functions of other independent variables, is it necessary to use a structural approach? Perhaps a better way to view the effect of socioeconomic factors on college quality in Table 3.3 is as direct effect, while their effect through intellectual ability and educational aspirations are viewed as indirect effect.

Table 3.6

OLS Estimates for Merged SAT and ACT Quartile

	Coefficient	t
Constant	2.5354	22.00
Female	-0.2899	11.73
Native American	0.3727	2.07
Asian	0.1168	1.83
Black	-0.8114	15.42
Hispanic	-0.3613	5.60
Age	-0.0091	2.73
Mother high school graduate	0.1123	1.65
Mother some college	0.2856	4.01
Mother college graduate	0.4901	6.90
Mother advanced degree	0.5023	6.77
Family income ($10,000)	0.0159	7.08
N	7118	
R^2	0.1025	

Notes:
1. The dependent variable is merged SAT/ACT quartile; observations with missing values for the dependent variable are excluded.
2. Also included in the model are dummies indicating missing values of independent variables.
3. Absolute value t statistics are included.

when other variables such as test scores are controlled for in Tables 3.3 and 3.4. Exactly, Table 3.6 shows that being female has a negative indirect effect on college quality through academic factors. Table 3.7 suggests that educational aspiration is also affected by socioeconomic background and ascribed characteristics. Socioeconomic factors such as family income and mothers' education is positively related with the educational aspiration of doctoral degree.

Table 3.7

Logit Estimates for Educational Aspiration

	Marginal Effects	
	Coefficient	t
Female	-0.1230	3.66
Native American	-0.0060	0.65
Asian	0.1400	2.81
Black	0.0070	0.31
Hispanic	0.0841	4.88
Age	0.0745	3.61
Mother high school Graduate	-0.0041	5.00
Mother some college	-0.0051	0.23
Mother college graduate	0.0179	0.77
Mother advanced degree	0.0295	1.26
Family income ($10,000)	0.0547	2.22
N	7787	
χ^2	100	

Notes:
1. The dependent variable is Expect PhD; observations with missing values for the dependent variable are excluded.
2. Also included in the model are dummies indicating missing values of independent variables.
3. Marginal effects are evaluated at the mean of the variables for continuous variables; marginal effects for dummy variables are for discrete change from 0 to 1.
4. Absolute value t statistics are included.

3.3 Chapter Summary

The analysis of the variability in the probability of earning degrees at high-quality colleges goes beyond earlier studies of college destination and college retention and examines finer differentials among college graduates in terms of college quality. Yet, the major themes from previous studies are supported in the current analyses: The academically and socioeconomically "rich" become richer while the academically and socioeconomically "poor" become poorer (Hearn, 1984). It seems that not only does the rich-poor gap increase in terms of the quantity of education, as previous studies have shown (Adelman, 1999; Berkner & Chavez, 1997; Cabrera & La Nasa, 2001; Hossler et al., 1989), but also in terms of the quality of education. Academically and socioeconomically advantaged students are more likely to attend and obtain degrees at colleges that possess more intellectual and material resources.

Socioeconomic factors such as family income and mothers' education take effect in two ways: a direct impact on students' educational attainment and an indirect influence through academic factors. The analysis of the determination of individuals' intellectual ability confirms that some of the socioeconomic factors have been crystallized in one's intellectual ability. It is not difficult to imagine a scenario when more socioeconomic variables are included in this type of analysis; academic factors can be largely determined and thus become equivalent to socioeconomic factors. Indeed, Rothstein (2002), in studying the determination of undergraduate academic performance, finds that after controlling for various socioeconomic factors and high school characteristics, test scores have virtually no predictive power in determining academic performance in college.[29] In studying the family income-schooling relationship, Carneiro and Heckman (2002) distinguish short-run liquidity constraints from the long-term factors that promote ability

[29] Considering its potential impact on the admission criteria, this reality may be disturbing to many.

and find that long-run factors crystallized in ability are the major determinants of the family income-schooling relationship.

Clearly, the above results support the social reproduction hypothesis associated with the first research question. Socioeconomic factors exert great influence on college quality both directly and indirectly through academic factors. Many researchers have suggested that the expansion of post-secondary educational opportunity might be a false promise, with massive expansion of American higher education system resulting in increasing differentiation within the system (Bourdieu, 1977; Hoxby, 1997; Karabel, 1972; Karabel & Astin, 1975). In the minds of many, education promises to be the great equalizer; it provides a playing field where the rich and the poor are seen to compete on an equal basis—on the principle of meritocracy, as human capital theory would suggest. However, it is in many ways a false promise, as the current analysis shows, not only in that non-meritocratic tendencies still prevail, but more importantly in that meritocratic factors are largely determined by non-meritocratic forces.

CHAPTER 4

VARIABILITY IN THE EFFECT OF COLLEG E QUALITY

In Chapter 3, I examined the variability in the probability of earning degrees at high-quality institutions among different students. There the outcomes of higher education were considered equitable if students had the same probability of earning degrees at high-quality institutions, regardless of their demographic characteristics and socioeconomic status. Analysis in Chapter 3 indicated considerable variations among individuals in the probability of earning degrees at high-quality institutions.

In this chapter, I explore another equity issue related to college quality. This equity issue relates to the variability in the effect of college quality across individuals. Here the outcomes of higher education are considered equitable if students with the same educational attainment are able to enjoy similar advantages, regardless of their demographic characteristics and socioeconomic status. That is, I explore the effects of college quality for college graduates—not only the average effect, but the effect across different individuals, i.e., interactions among college quality and individual characteristics, such as family wealth, parental education, intellectual ability, race, gender, and major fields of study.

A series of research questions are posed. For example, do high-quality colleges affect the earnings of wealthy students more than poor students? Do high-quality colleges provide more of an earnings advantage to students from highly educated families than to others? Do high-quality colleges raise earnings more for intellectually less capable students than for the more capable? Do high-quality colleges matter more to White students than non-White students? Do high-quality colleges benefit female students more than male students? Do high-quality colleges provide more competitive edge to certain major fields of study than to others?

As spelled out in Chapter 2, social reproduction theory sheds light on such interactions. Hypothesis 2 (H2) suggests that graduating from high-quality colleges would benefit socioeconomically advantaged students more than disadvantaged students. This hypothesis is tested in the remaining part of this chapter. The organization of this chapter as follows: First, a baseline model that pools all students together estimates the average effect of college quality. Then, several technical issues (including correction for selection bias, Hierarchical Linear Modeling, measures of college quality, etc.) are investigated before the baseline model is applied to different groups of individuals. Finally, the different effects of college quality across students are examined sequentially.

4.1 The Baseline Model

Previous studies exploring the effect of college quality on individual earnings (or hourly wage rate) use more or less the same method: Individual i's log earnings ($\ln(Y_i)$) is a function of 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,

$$\ln(Y_i) = \alpha_0 + \alpha_1 Q_{ij} + \alpha_2 D_i + \alpha_3 F_i + \alpha_4 A_i + \alpha_5 J_i + \mu_i \qquad (4.1)$$

This model has been tested in several recent studies by Thomas (2000a, 2003) and Thomas and Zhang (2001, 2002). The same model 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.

The data used in this chapter are from the same source as in the last chapter. Indeed, all the variables of college quality, demographic characteristics, and family background are defined in exactly the same fashion.[30] The outcome of interest in this chapter is earnings, measured as the annualized self-reported earnings in the graduates' primary job in April of 1997. Additional individual level independent variables, besides various demographic and family background variables as in the last chapter, include undergraduate major and labor market variables. Undergraduate major variables (categorical dummies) indicate 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. Labor market variables include tenure at present job (in years), its square term, and

[30] To keep the model comparable to the model in Thomas (2000a, 2003) and Thomas and Zhang (2001, 2002), a dummy variable that indicates whether the student is a first-generation college graduate is used instead of several dummy variables indicating mothers' education as in Chapter 3.

number of hours worked per week. The rationale for including these variables is discussed in Thomas (2000a, 2003) and Thomas and Zhang (2001, 2002).

The sample of 8,642 students in last chapter serves as the initial sample in this chapter. To examine the relationship between college quality and earnings, the sample of student is further limited to students who are working full-time as of April 1997, earning between $1,000 and $500,000 per year, and not enrolled in school full-time. These criteria limit the final sample to 3,965 students across 500 institutions. A detailed description of the variables is presented in Table 4.1. The variables are broken out into several conceptual categories that include institutional characteristics, demographic characteristics, family background, educational background, and labor market variables.

Table 4.2 presents OLS estimates of the effects the various demographic, family background, education, labor market, and college characteristics on graduates' log earnings.[31] Demographic variables have a significant impact on earnings. Net of all other factors in the full model, female graduates on average earn about 10% (0.0936 in log points) less than male graduates.[32] The earnings penalty, in fact, is larger in partial

[31] For the purpose of simplicity, only the results from the full model are presented here; stepwise results are not reported. The results of this baseline model are discussed briefly in this section; however, because the focus of this study is on the effect of college quality on students' outcomes, the effects of other variables are presented but not discussed in later analyses.

[32] In the log-linear model such as the baseline model in this study, the estimated effects are in log points. To convert the log points to percentage points, we need to assess the log points at certain point in the distribution of the dependent variable, usually the mean. When the log points are small, they are very similar to the percentage points. For example, an increase of 0.05 in the log income represents a 5.13% increase in income when evaluated at the mean of the income distribution. When the log points are relatively large, the percentage points can be substantially larger than the log points. For example, an increase of 0.18 (the estimated effect of high-quality public colleges) in the log points represents a 19.72% increase evaluated at the mean; an increase of 0.3 in the log points is approximately a 35% increase in income. An alternative way is to convert the log points into dollar amount directly. For example, an increase of 0.05 in the log income represents about $1,575 when evaluated at the mean of the distribution.

Table 4.1

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

Table 4.1 – *Continued*

Variable	Mean	SD	Acronym
Public affairs major	0.0367	0.1880	PUBAFFR
Biological science major	0.0275	0.1634	BIOSCI
Math science major	0.0560	0.2300	MATHSCI
Social science major	0.0910	0.2876	SOCSCI
History major	0.0170	0.1291	HISTORY
Humanity major	0.0720	0.2586	HUMAN
Psychology major	0.0292	0.1683	PSYCH
Other major	0.1423	0.3494	OTHER
Labor Market			
Age	29.9966	6.4937	AGE97
Age squared / 100	9.4195	5.0196	AGE972
Tenure	2.8057	3.2974	TEN97
Tenure squared / 100	0.1874	0.6677	TEN972
Number of hours per week	45.3744	9.1568	NUMHRS97
N	3965		

models where other factors such as undergraduate majors are not controlled for.[33] This gender gap in pay is consistently documented in labor economics. After controlling for other variables, minority graduates (except for Asians) have earnings comparable to those of their White counterparts. This finding is consistent with a large body of earlier work (e.g., Berger, 1988; Thomas, 2003).

[33] This is so because female students are generally more likely to major in low-paying majors such as education, history, and humanities.

Table 4.2

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

Table 4.2 – *Continued*

Variable	Coefficient	t
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
R^2	0.2247	

Note: Standard errors are corrected for heteroscedasticity.

Family background variables do not seem to have a large and significant effect on graduates' earnings. For example, an increase in family income by $10,000 only increases graduates' earnings by 0.55% (Table 4.2), which is about $170 evaluated at the sample mean salary. Being a first-generation college graduate (i.e., neither parent is a college graduate) is associated with a small and statistically non-significant earnings penalty. Block-wise regressions show that effects of those family background variables diminish as other blocks of variables are added. This observation is consistent with the bulk of research examining the relationship between earnings and family characteristics: Family background tends to have indirect effects on earnings through its impact on individuals' propensity to invest in education rather than to have direct effects on earnings (Hearn, 1984, 1991; Karabel & Astin, 1975; Rumberger, 1983).

The results show that, net of all other variables in the model, the intellectual ability variable measured by SAT/ACT quartiles does not appear to affect graduates' earnings significantly, although there is a small, positive effect. Previous studies (Jones & Jackson, 1990; Rumberger & Thomas, 1993; Thomas, 2000; Wise, 1975) find that academic performance measured by GPA has a positive and significant effect on earnings. This is probably due to the relative independence between GPA and college quality variables.

The earnings differentials among graduates from different academic majors are substantial, even after controlling for all other variables in the model. For example, relative to education majors, engineering and health majors enjoy an earnings advantage of over 40%. Math science and business majors also have substantial earnings advantages over education majors. Graduates from other majors including public affairs, biological science, social science, humanity, and psychology also have some earnings advantages over education majors, with the lowest paid major being history. Very similar earnings patterns among college graduates of different majors have been observed in a number of other studies (Berger, 1988; Rumberger, 1984; Rumberger & Thomas, 1993). Earlier studies (e.g., Thomas, 2000a) also find that when detailed labor market variables (such as employment sector, whether job has career potential, whether college degree is required, and number of job offers) are introduced into the model, the direct effect of college major diminishes, suggesting that college majors are correlated with different labor market conditions. Because many labor market variables are partially determined by educational background, they are left out in the current study to avoid the problem of endogeneity.

Graduates' earnings are also found to be a concave function of both age and tenure at the current job, which is generally explained by the accumulation and depreciation of general and specific human capital in labor economics. Due to the inability to obtain hourly wage rate data required for the standard Mincerian framework, the number of hours worked per week is controlled in the model as a partial adjustment. On average, a one standard deviation (9.2 hours, Table 4.1, last row) increase in hours worked yield a 12% earnings advantage.

Finally, graduates' earnings are significantly impacted by institutional characteristics. 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 exist an earnings advantage for students graduating from private colleges over for those graduating from public colleges in the same quality category.[34]

An immediate question from analyzing the effect of college quality on graduates' earnings is whether the benefits are worth the associated costs. Researchers have been very cautious about conducting such cost-benefit analyses, partly because the real costs of a college education are too complex, if not impossible, to measure. It is widely held

[34] These estimates are obvious larger than what most previous research has found. This may be due to various reasons including different measures of college quality and different stages of graduates' career. See the next section for details.

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-benefit analysis are differenced out, making it feasible to carry out a cost-benefit analysis for those attending different types of colleges. 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:[35]

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

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 high-quality colleges. Due to the inability to estimate Ls, Fs, and Bs, 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 that is not very strong, to make a comparison

[35] 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 specific utility function and discounting factors) for each choice does not change the main point either.

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 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.[36] 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 and the cost difference that boils down to the difference in tuition and fees. The benefit difference, $B_h - B_l$, is readily available from the analysis of the effect of college quality and the cost difference can be estimated from the average tuition and fees for each type of institutions.

Table 4.3 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 4.3, 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 4.2 and evaluating it at the mean of the earnings distribution. For example, the benefit difference between low-quality public institutions

[36] The signaling model assumes that individuals incur different costs (both financial and psychological) in attending different types of college. Clearly in the model proposed here, tuition and fees are the only element considered to differ in choosing different types of colleges, and psychological costs are not considered here.

Table 4.3

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.

and high-quality private institutions evaluated at the mean of the earnings distribution is $5,890 per year.[37] 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.[38] 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. Admittedly, the above analysis resolves the choice between Options 2 and 3; other analyses would be required to resolve the choices among all the options. In other words, if an individual has decided to attend college at all, it is worthwhile to pay high tuition and attend a high-quality college; however, we need to rely on other research to decide whether to attend college at all.

[37] The estimated effect of high-quality private colleges relative to low-quality public colleges is 0.1754 log points, which can be converted into dollar amount by assessing the log points at the mean of the distribution.

[38] A question raised by this comparison is whether the benefit, i.e., the effect of college quality, is stable over an individuals' career time. I explore this point in the following section.

Admittedly, the above calculation is on a *ceteris paribus* basis in that the comparison is based on the coefficients from a multiple regression. College choice may affect other variables in the equation that in return would change the comparison. For example, time to degree, attendance pattern, academic performance, and undergraduate majors can be all affected by college choice. It may take less time to complete a degree at high-quality colleges than at low-quality ones; it also could be the case that students have higher academic performance (higher GPA for instance) at low-quality colleges than at high-quality institutions. Similarly, lucrative majors could be more competitive at high-quality colleges than at low-quality colleges. Finally, the amount of financial aid could be very different at different colleges. Nevertheless, given the substantial earnings advantage provided by high-quality college, it is still safe to conclude that it pays to attend a high-quality college versus a low-quality college.

4.2 Some Issues in the Baseline Model

In the above section, a baseline model was established for the estimation of the effect of college quality on graduates' earnings. I also constructed a cost-benefit analysis based on differences in benefits and costs. The analysis was meaningful because many immeasurable elements in the cost structure of a college education were differenced out in the comparison between attending a high-quality college and a low-quality college. The baseline model developed above is used to examine the different effect of college quality among different students in the remainder of this chapter.

Several technical issues, however, have been raised in the baseline model. To keep our focus on the analysis instead of technical issues, the detailed discussion of these issues is carried out in appendices. Appendix A discusses the problem of self-selection bias in the baseline model; Appendix B examines the hierarchical dimension of the data; Appendix C investigates other commonly used quality measures and estimates the effect of college quality by different measures; and Appendix D explores the effect of college quality on wage growth in the early stage of graduates' careers. A summary of these appendices follows.

The leading econometric problem in studies on the effect of college quality is the potential for self-selection bias. In simple language, students self select different types of colleges partially based on the expected labor market payoff and many other factors. Thus, the estimated effect of college quality includes not only the true effect of college quality, but also the payoff from the self-selection process. In this sense, selection bias is a model specification error (Heckman, 1979). By definition, individual heterogeneity in observed characteristics is not the source of selection bias. For example, students with higher measured abilities stand a better chance of graduating from high-quality colleges, and those with lower measured ability are more likely to graduate from low-quality colleges. Controlling for observed characteristics effectively eliminates the bias caused by individual heterogeneity, but not by self selection.

Correction for selection bias usually involves a system of two equations: a selection equation and a usual outcome equation with a Heckman-type selection term as one independent variable.[39] Appendix A follows the standard Heckman-type (1979) approach to re-estimate the baseline model with selection bias corrected. First, a selection model identical to that in Chapter 3 is estimated using the sample in the baseline model (i.e., 3,965 graduates). Then, Lee's (1983) generalized method is employed to calculate the selection term for each individual in each group (low-quality, middle-quality, and high-quality colleges). After that, the baseline model is re-estimated for each type of college quality with the selection term as one independent variable. Because types of control (i.e., public versus private) do not seem to matter in the baseline model, public and private colleges of the same quality are pooled together in re-estimating the baseline model for each college quality type. A total of three OLS regressions are estimated. Finally, the unconditional earnings differentials (i.e., the effect of college quality after removing the selection bias) are calculated. As expected, the estimated effects after removing selection bias are smaller than the estimated effects in the baseline model.

Although correction for selection bias is important in principle and appealing in theory, the method is not adopted as the major estimating framework in this study for the following reasons. First, in studies of this type, it is very difficult to develop a system of two equations with different sets of independent variables in each. Because most variables are correlated with each other, those in the selection equation tend to enter the usual outcome equation. As a result, the non-linear functional form of the selection term is usually used as the last resort to identify the system, which causes other problems such

[39] Strictly speaking, the Heckman (1979) selection term is constructed from a probit model. Other types of discrete choice models, such as logit and linear probability models, are also able to generate the selection term. Robinson's (1988) propensity score is an alternative approach to solving the selection bias problem without an explicit assumption of the error structure in the selection equation.

as multicollinearity. Second, the estimation of the effect of college quality with selection bias corrected is very sensitive to the specification of the selection equation. Changes in the variables included in the selection equation sometimes alter the results completely. Third, in previous studies on the effect of college quality on graduates' earnings, researchers have found little evidence that correction for selection bias significantly changes the results (Brewer & Ehrenberg, 1996; Brewer et al, 1999). In the current analysis, the selection term is only marginally significant for the sample of students from low-quality colleges, and it is not significant for the remaining two groups of graduates. For the above reasons, the usual OLS approach is adopted in the remaining part of the dissertation.

A second econometric problem of this type of study is usually phrased as the inconsistency between the data structure and the OLS method. 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 that characterize this nature, such as the hierarchical linear modeling (HLM) technique are often recommended (Bryk & Raudenbush, 1992; Heck & Thomas, 2000). The rationale of the HLM model is to allow individual characteristics to explain the variation among individuals within each unit and institutional characteristics to explain the variation in the effects of individual variables on outcome variables among institutions. In other words, in the framework of multilevel modeling, the estimated effects (intercept or coefficients) are allowed to vary across groups, and the variations are explained by institutional characteristics. In this sense, the regular OLS model is a special case of the HLM model in that the OLS model keeps the effects (intercept or coefficients) constant across groups.

The application of the HLM model in educational research has become popular recently, based on the belief that the HLM is *the* appropriate way to capture the multilevel nature of most data in educational research.[40] The application of the HLM model, however, does not seem to produce results much different from the OLS model.[41] Appendix B discusses the theory and estimation of the HLM for the same data used in estimating the baseline model. Not surprisingly, the estimated effects of college quality on graduates' earnings are very similar to the OLS estimates as in the baseline model. In light of the ongoing debate between these two methods and of the similar results produced by both methods for this particular study, the OLS model is employed throughout the remaining part of this dissertation.

The third controversial issue in studies on the effect of college quality is how the college quality should be measured if it is measurable at all. In the baseline model above, the quality measures are constructed from the Barron's ratings. Previous studies on similar topics have used other measures, such as the mean SAT score of the entering freshmen, Carnegie Classification, and tuition and fees (see Table 1.1 for details). These

[40] Other researchers believe that the data arrangement in the OLS model has already captured the multilevel structure of the data. Thus, OLS can also entertain the multilevel nature of the data, only in a different way as does HLM (de Leeuw & Kreft, 1995).

[41] Admittedly, the HLM model is much more flexible in modeling the effect of explanatory variables from different levels on the outcome variable. For example, the HLM framework helps us understand how the effect of an individual-level variable varies by institutional-level variables. Because we are interested in estimating the effect of institutional characteristics on outcomes, the HLM model is simplified to intercepts-as-outcomes model (Bryk & Raudenbush, 1992, p. 21), which usually produces very similar results to the OLS model.

measures are examined individually, and the results are discussed in detail in Appendix C.

My primary interest, however, is not to judge which is the best measure of college quality, but to understand how different measures of college quality may lead to different estimated effects of college quality on 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. It is also important to see whether conclusions from the baseline model are robust to different measures of college quality. For example, the results from the baseline model suggest that the earnings difference between attending high-quality colleges and low-quality colleges is worth the higher costs for attending high-quality colleges. Yet we do not know whether this result holds only for the quality measure used in the baseline model or is robust to different measures of college quality.

In Appendix C, 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.[42] Several observations can be drawn from the analyses in Appendix C. 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

[42] The Carnegie Classifications were not devised as a quality measure and recently have changed the classification itself. However, the hierarchy in Carnegie Classifications is correlated with other measures of quality and historically it was used as a measure of college quality (see Table 2.1). In this analysis, the 1994 Carnegie Classification is used.

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. Table 4.4 compares the estimated effect of college quality for these two different measures. 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.

Third, no matter what measures of college quality are used, the earnings differentials among colleges of varying qualities are sufficiently large to compensate for

Table 4.4

The Effect of College Quality Measured by Barron's Ratings and SAT Scores

	Barron's ratings		SAT scores	
Low-quality, private institution	0.0530	(1.42)	-0.0018	(0.06)
Middle-quality, public institution	0.0920	(4.41)	0.0457	(2.31)
Middle-quality, private institution	0.1066	(4.61)	0.0793	(3.16)
High-quality, public institution	0.1800	(5.46)	0.0608	(2.67)
High-quality, private institution	0.1754	(4.47)	0.1005	(4.13)

Note: Absolute value t statistics in parentheses. The full model for the effect of college quality measured by Barron's ratings is presented in Table 4.2, and the full model for the effect of college quality measured by SAT scores is presented in Appendix C, Table C.3.

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 (see Appendix C for details).

It seems that different measures of college quality yield different estimated effects of college quality. The analysis here helps us understand the discrepancies in the findings among previous studies where different measures of college quality are used.[43] The qualitative findings from the baseline, however, seem consistent across different

[43] See Table 2.1 for a detailed description of the different measures of college quality used in previous studies.

measures of college quality. For the purpose of simplicity and convenience, I only use the college quality measure constructed from the Barron's ratings in the remaining part of this chapter.

The final issue relates to the effect of college quality on individuals' lifetime income. Most work on economic returns has focused on the modest returns to college quality at discrete points in time (usually one to five years after graduation), and very little is known about how college quality influences individuals' lifetime income. Although the data availability prevent a mapping of the trajectory of the economic effect of college quality over one's lifetime, comparing the estimated effect of college quality at two different points in time is sufficient to test the hypothesis of whether the effect of college quality changes over time. In Appendix D, I compare the effect of college quality on graduates' earnings one to two years and four to five years after graduation.

The analysis in Appendix D suggests that significant wage growth attributable to college quality occur among graduates from high-quality public and private institutions. For example, the estimated effect of high-quality private institutions is 7.5% (0.0723 log points) in 1994 and 22.7% (0.2043 log points) in 1997, representing a 15 percentage points increase in the estimated effect in 1997 (Table D.2). Put in another way, the wage gap between graduates from high-quality private college and those from low-quality public institutions triples between 1994 and 1997 (a 22.7% gap versus a 7.5% gap). A significance test suggests that this increase in the wage gap between these two points in time is statistically significant with a t value of 3.19. Similarly, the wage gap between graduates from high-quality public and low-quality public institutions increases from about 9.5% to 21.8%, suggesting that the wage gap has more than doubled between 1994 and 1997. The estimated effects of middle-quality institutions have also increased more than five percentage points in 1997 compared with 1994. Thomas (2003) shows that, on average, although earnings of graduates from all types of colleges grow significantly between these two time periods, those graduates from high-quality private institutions increased their earnings the most.

Because college quality has different effects on earnings at different points of individuals' careers, the relatively small effect of college quality usually estimated at the early stage of graduates' careers may be valid on its own, but problematic if it is generalized to lifetime income. In particular, my analysis suggests that the effect of college quality at one's early stage of career may significantly understate the effect of college quality on one's lifetime earnings.

4.3 Variability in the Economic Effect of College Quality

The above section explored some important issues in estimating the effects of college quality on graduates' earnings. The qualitative results found in the baseline model (multivariate OLS model) have been shown to be robust not only to different estimating techniques (e.g., correction for selection bias and HLM), but also to different measures of college quality. In the spirit of simplicity and consistency, only the baseline model is used in examining variations of the effects of college quality across different individuals.

In this section, I start by examining the variation in the effect of college quality by two demographic factors, gender and race/ethnicity. Then, I study how socioeconomic factors such as family income and parental education impact the effect of college quality on earnings. Finally, two academic factors, ability and major field of study, are considered for their influence on the effect of college quality. Because race/ethnicity and ability are unambiguously linked to socioeconomic status, I also use these analyses in mapping out the interaction between socioeconomic factors and the effect of college quality, which is the main task of this chapter.

Variations by Gender

The examination of the variability in the effects of college quality on graduates' earnings by gender falls in the broader discussion of earnings inequality by gender, that is, what accounts for the earnings difference between men and women? Decomposition methods in labor economics suggest that aside from gender discrimination, the earnings gap could be explained by at least two observable and estimable factors.[44] The first is the observed heterogeneity between women and men. For example, the earnings difference between women and men may partially be explained by the relatively lower educational attainment of women. The other factor is the variation in the returns to various work-related resources by gender. For example, educational attainment may have different effects on earnings for women and men due for example to different career choices. The inequality in the education attainment in terms of college quality has been explored in

[44] For a detailed discussion on decomposition methods, see Oaxaca (1973), Blinder (1973), Neumark (1988), and Juhn, Murphy, and Pierce (1991).

Chapter 3. Here I consider differences in the effect of college quality on earnings between male and female graduates.

Previous studies on different effects of educational attainment by gender have not yielded unequivocal results. Bibb and Form (1977) show that blue-collar women receive lower earnings in relation to their educational attainment, even after controlling for other salient variables. Treiman and Terrell (1975), McClendon (1976), and Rosenfeld (1980) do not find significant differences in the returns to educational attainment (in terms of the highest grade) between women and men. Other studies focusing on the effect of college quality on earnings find that college quality has somewhat greater effects for women. For example, Mueller (1988) finds that college selectivity has significant direct and indirect effects for both men and women. The direct effects are similar for both genders, while the indirect effect is almost twice as large for women as for men. Solmon (1985) finds stronger evidence that college quality matters less for white men than for White women, even after controlling for undergraduate major, GPA, tenure, and sector. In reviewing the evidence on different returns to educational attainment by gender, Anderson and Hearn (1992) conclude that both the quantity and the quality of education have a greater impact on women than on men and that the marginal payoff to further education is greater for women than for men.

Conclusions such as those drawn by Anderson and Hearn (1992) create problems in relating the return of college quality to individuals' college choices. If the return to college quality were higher for female students than for male students, then the former should have greater incentive to attend high-quality colleges.[45] Quite the contrary, the analysis in the previous chapter (Tables 2.4, 2.5, and 2.6) has shown that female students are somehow less likely to earn degrees from high-quality colleges, although the difference is not statistically significant after controlling for other covariates. From this evidence, we would expect that college quality should have more or less the same if not a smaller impact for female than for male students.

To examine whether the return to college quality differs by gender, one can either add interaction terms of college quality and gender variables in the baseline model or estimate separate equations for each gender group. Adding interaction terms, however, restricts the estimated effect of other variables to be the same for male and female students. Further, because many interaction terms need to be created (6 categories of college quality and 2 categories of gender yield a total of 12 interaction terms), the results of such a model with many interaction terms are not easily interpretable. Thus, in the following analyses, I estimate the baseline model separately for male and female students.[46] Differences between the estimated effects of college quality for males and females can then be computed from the results of these separate regressions.[47] Results

[45] Alternatively, conclusions drawn by Anderson and Hear (1992) could be explained by the different discount rate between male and female students. Because women might have higher discount rate than men, the former would not push their investment as far.

[46] This strategy is used in the remaining part of this chapter in estimating different effects of college quality across different groups of students.

[47] Let β_f and $\text{var}(\beta_f)$ denote the estimated effect of college quality for female students and its variance and β_m $\text{var}(\beta_m)$ for male students. The difference between the effect of college quality for female and male is then $\beta_f - \beta_m$. Assuming β_f and β_m are not correlated (that is, the residual terms from separate regressions are not correlated), then the variance for the difference term $\beta_f - \beta_m$ is $\text{var}(\beta_f) + \text{var}(\beta_m)$. Statistical testing follows as usual.

from separate regressions also provide insight into different effects of other variables on the earnings of male and female graduates.[48]

Table 4.5 presents the results of separate regressions for male and female students. For the convenience of discussion, only the estimated effects of college quality are included in the table. The first column in Table 4.5 presents the estimated effect of college quality for the pooled (male and female students) sample, the second column provides the estimates for the sample of female graduate, and the last column shows the sample of male students.

Table 4.5

OLS Estimates for Earnings Equations, by Gender

College quality	Pooled	Female	Male
Low-quality, private institution	0.0530 (1.42)	0.0363 (0.89)	0.0715 (1.07)
Middle-quality, public institution	0.0920 (4.41)	0.0519 (2.28)	0.1317 (3.67)
Middle-quality, private institution	0.1066 (4.61)	0.0734 (2.92)	0.1510 (3.70)
High-quality, public institution	0.1800 (5.46)	0.1678 (4.65)	0.1779 (3.19)
High-quality, private institution	0.1754 (4.47)	0.1612 (3.65)	0.2039 (3.15)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.1.

A couple of observations may be made from Table 4.5. First, both female and male students enjoy significant benefits (statistically and economically) from earning degrees at institutions of higher quality. For both public and private institutions, the

[48] For example, Solmon (1985) find that academic variables such as GPA and fields of study may have different effects on earnings for male and female students. Although this analysis only discusses different effects of college quality on earnings for male and female students, readers who are interested in the effects of other variables may refer to Appendix E for the estimates of the full baseline model.

higher the measured quality of an institution, the higher the benefits it provides. Second, the estimated effects of college quality for female students are uniformly lower than that in the pooled regression, and most of the estimated effects of college quality for male students are higher than those in the pooled regression, although the differences are not statistically significant at the 5% level. When the estimated effects for female students and male students are compared, a pattern opposite to that in Anderson and Hearn (1992) is revealed: The estimated effects of college quality in each category are uniformly smaller for female students than for male students, although the differences are not statistically significant at the 5% level.[49] In other words, although graduating from high-quality colleges clearly improves the life chances of both female and male students, outcomes for female students are somewhat less advantageous than they are for male students. The relatively smaller effect of college quality (not statistically significant) for female than for male students as found here, however, are consistent with the relatively smaller proportion of female students (also not statistically significant) at high-quality institutions as shown in the previous chapter.

Do high-quality colleges benefit female students more than male students? It appears the answer is "No." Social reproduction theory is not particularly helpful in explaining the relationship between gender and the returns to educational attainment because gender is not an important parameter of social class. The relatively lower returns to college quality for female students may be better explained by labor market conditions.

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[49] Because statistical significance partially reflects the sample size, as sample size becomes smaller in separate regression, the significance test becomes less informative. As a result, in the remaining part of this chapter, I am more concerned with point estimates, especially when the pattern is quite clear as in this case.

For example, in studying labor market segregation, Rosenfeld (1980) suggests that because credentials could be evaluated differentially for women and men in the core sector of the labor market, women would have to be over-qualified to get the same position as men. In other words, because women are less likely to be selected into the primary and competitive sector than men with equal educational attainment, the returns to educational attainment in terms of college quality are lower for women.

Variations by Race

Like gender, race and ethnicity also figure into patterns of economic status. Farley (1980) shows that the average Black family's income then is less than 60% of that of the average White family. A recent study by Kominski and Adams (1994) suggest that in 1993 earnings among 25-34-year-old Black males are only 83% of that of White males of the same age. Educational attainment has been identified as the primary explanation of this considerable earnings gap. For example, Kominski and Adams show that in the same year of 1993, the percentage of 25-29-year old Black males who are college graduates is only half that of White males of the same age (12.6% relative to 24.4%). Considering the influential impact of college education on earnings, we would reasonably expect that earnings differences by race should be much smaller, if not eliminated, among college graduates. Indeed, results from the baseline model do not reveal a significant earnings gap between White and non-White graduates after controlling for college quality.[50]

[50] In the baseline (Table 4.2), Asian is the only race/ethnicity variable with a positive effect on earnings. In discussing racial difference, Asian graduates (N = 122) are not included in the non-White category. That is, the non-White category aggregates Native Americans, Blacks, and Hispanics, with a total of 445 graduates.

However, this type of *ceteris paribus* comparison has obscured much of the inequity among racial groups. For example, being Black not only has a negative direct effect on the probability of earning degrees from high-quality colleges, but it also has a negative indirect effect through significantly lower academic achievement. This type of inequity regarding educational attainment in terms of college quality was discussed in the previous chapter; the question here is whether college quality affects graduates' earnings in the same way for individuals of different races and ethnicities. That is, do high-quality colleges yield more economic advantages to White students than non-White students?

In studying market segregation, Rosenfeld (1980) suggests that the return to educational attainment is lower for non-White than for White individuals because Whites are more likely to be selected into the primary and competitive sector that yields greater returns. In contrast, in reviewing previous studies on different returns to educational attainment by race and ethnicity (e.g., Chiswick, 1987; Featherman & Hauser, 1978; Jencks et al., 1979; Murphy & Welch, 1989), Anderson and Hearn (1992) conclude that educational attainment in terms of years of schooling has a greater impact on Blacks than it does on Whites. A recent study by Dale and Krueger (1999) reveals similar results. These results are consistent with higher discount rates faced by Black students. In this analysis, differences in the effect of educational attainment in terms of college quality between white and non-white students are examined.

Table 4.6 displays the mean annual earnings for White and non-White (including Native Americans, Blacks, and Hispanics) graduates by types of college quality. Among college graduates, the mean earnings of White graduates are slightly higher than that of

Table 4.6

Means of Annual Earnings, by College Quality and by Race/Ethnicity

College quality	White	Non-White
All	$ 34,425	$ 32,447
Low-quality, public institution	$ 30,965	$ 31,148
Low-quality, private institution	$ 36,408	$ 28,785
Middle-quality, public institution	$ 33,974	$ 32,152
Middle-quality, private institution	$ 35,213	$ 32,927
High-quality, public institution	$ 37,769	$ 36,696
High-quality, private institution	$ 39,298	$ 47,517

College quality	White	Non-White
All	10.3324	10.2767
Low-quality, public institution	10.2246	10.2346
Low-quality, private institution	10.3742	10.0974
Middle-quality, public institution	10.3270	10.2817
Middle-quality, private institution	10.3607	10.3243
High-quality, public institution	10.4504	10.4666
High-quality, private institution	10.4121	10.6519

Note: The upper panel represents the means of annual earnings in dollars and the lower panel in logged value.

non-White graduates, and the difference is not statistically significant. However, the mean earnings by college quality suggest that the effect of college quality may differ between White and non-White graduates. For example, for low-quality and middle-quality institutions, the mean earnings of White graduates appear higher than that of non-White graduates, yet the relationship reverses for high-quality institutions. It seems that the earnings of non-White graduates from different colleges are more dispersed than those of whites. These simple descriptive statistics suggest that the effect of college quality could be greater for non-White students than for White students.

To control for other covariates that may also have contributed to the differences in the effect of college quality on earnings for White and non-White graduates, separate regressions are estimated for White and non-White graduates, and the results are presented in Table 4.7. The first column presents the estimated effect of college quality for the pooled (White and non-White graduates) sample, the second column provides the estimates for the sample of non-White graduates, and the last column shows that for the sample of White graduates.

The regression results in Table 4.7 confirm and further amplify the observations from the simple descriptive statistics in Table 4.6. The effect of college quality on earnings displays quite different patterns for White and non-White graduates. For non-white graduates, earning degrees from middle-quality institutions has a very small and statistically non-significant effect on earnings relative to graduating from low-quality public colleges. The effect of graduating from low-quality private colleges is negative, although it is not statistically significant. However, substantial earnings advantages are provided to non-White graduates from high-quality institutions. For example, compared with earning a degree from low-quality public college, a degree from high-quality public college yields almost 30% (0.2639 log points evaluated at the mean of earnings distribution for non-White graduates) earnings advantages, and even more (43%, 0.3585 log points evaluated at the mean of the earnings distribution for non-White graduates)

Table 4.7

OLS Estimates for Earnings Equation, by Race

College quality	Pooled	Non-White	White
Low-quality, private institution	0.0530 (1.42)	-0.0813 (0.97)	0.1242 (2.91)
Middle-quality, public institution	0.0920 (4.41)	0.0527 (0.84)	0.1028 (4.66)
Middle-quality, private institution	0.1066 (4.61)	0.0441 (0.64)	0.1198 (4.86)
High-quality, public institution	0.1800 (5.46)	0.2639 (2.18)	0.1999 (5.62)
High-quality, private institution	0.1754 (4.47)	0.3585 (2.63)	0.1610 (3.86)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.2.

advantages are associated with obtaining a degree from high-quality private institutions. Clearly, graduating from high-quality colleges provides enormous earnings advantages for non-White students relative to other non-White students at low-quality and middle-quality institutions. Moreover, it is probably true that non-White students usually have larger financial aid packages and hence lower net costs, which would greatly increase the net advantages for non-White students. For White graduates, earning a degree from all categories of colleges yields large and statistically significant earnings advantages relative to obtaining a degree from low-quality public institution, and having a degree from a high-quality college does not seem to provide the same earnings advantage for Whites as for non-Whites.

The above analyses reveal a pattern of the effect of college quality on earnings by race/ethnicity more complex than what Rosenfeld (1980) and Anderson and Hearn (1994) report. Rosenfeld's hypothesis is partially supported in that middle-quality institutions and low-quality private institutions seem to provide greater earnings advantages for

White graduates than for non-White graduates relative to low-quality public institutions. But clearly, statistical discrimination and market segregation do not appear to explain the large effect of high-quality institutions for non-White graduates.[51] So too, Anderson and Hearn's (1994) conclusion has obscured the complexities of the effect of different types of colleges on graduates' earnings by race.

The complexity in the pattern of different effects of college quality on earnings for White and non-White graduates cannot be easily explained by social reproduction theory although it does provide some insights into the effects of college quality for different racial groups. For example, White students may be more likely to take full advantage of the resources at better institutions. This explains the greater effect of middle-quality colleges for White students than for non-White students; however, the huge earnings advantage provided by high-quality colleges to non-White graduates is in need of other interpretation. One possible explanation is the special halo effect provided by high-quality colleges. For example, a non-White student who graduated from Harvard may be perceived first as a Harvard graduate and then as non-White, and a non-White student who graduated from low-quality or middle-quality colleges may be perceived first as non-White and then as a college graduate. Another possible explanation, from the screening hypothesis, may argue that the large effect of high-quality colleges for non-White graduates may reflect the fact that non-White graduates from high-quality colleges constitute a special group of individuals. Then the larger effect of college quality for non-

[51] Statistical discrimination would argue in this case that because the educational credential in terms of college quality is less reliable for non-White than for White graduates, race is used as a screening device.

White students than for White students may reflect that non-White students are more dispersed in productivity related traits than white students. Finally, a typical demand-supply argument may suggest that because the number of non-White graduates from high-quality colleges is so small, the interplay of demand and supply may drive up their earnings. In this regard, affirmative action in the labor market might have played a role in opening up more opportunities for minority students.

Variations by Family Income

The previous two sections examined the effect of college quality by demographic characteristics such as gender and race/ethnicity. In this section and the next, I study the effect of college quality across social classes. We have learned, whether through empirical evidence or everyday observations, that education may be the best avenue for upward mobility in society. College quality, as one dimension of educational attainment, clearly contributes to upward mobility on average, as various previous studies and the current research have shown. The subsequent question is whether college quality contributes uniformly for students of different social classes.

Analysis in the two previous sections suggests that college quality may have different effects on earnings for graduates from different racial and gender groups. While race and ethnicity have certain connotations of social class (e.g., non-Whites are more likely to be from lower social classes than Whites), the link between these demographic characteristics and social classes are not direct. To explicate the effect of college quality across students from different social classes, I examine the pattern in the effect of college quality by two major elements of social class: family income and parental education. The general question is whether students from different social classes can benefit equally from earning degrees from high-quality colleges.

In higher education research, the evidence of the positive effect of socioeconomic factors on outcomes in the next generation is overwhelming (both direct effect and indirect effect mainly through education); yet little research has been conducted on the interplay among those socioeconomic factors and other factors such as college quality. These two are different types of equity issues: The former speaks to how socioeconomic factors figure into the educational attainment of the next generation, and the latter focuses on how socioeconomic factors influence the ability to realize socioeconomic mobility from educational attainment. The effect of socioeconomic factors on educational attainment and on the effect of educational attainment could be in different directions. For example, high socioeconomic status may lead to high educational attainment, and high educational attainment may matter more to the socioeconomically less advantaged than to the more advantaged.

As in the previous sections, I estimate separate baseline models for students of different family income, which is divided into three groups of the same size according to the distribution of family income. Table 4.8 presents the estimated effect of college quality for each group of students. The first three columns present the estimated effect of college quality for graduates with lowest, middle, and highest family income,

Table 4.8

OLS Estimates for Earnings Equation, by Family Income

College quality	Bottom 1/3	Middle 1/3
Low-quality, private institution	-0.1271 (2.46)	0.0925 (1.59)
Middle-quality, public institution	0.0375 (1.19)	0.1188 (3.70)
Middle-quality, private institution	0.0316 (0.86)	0.1583 (4.30)
High-quality, public institution	0.1214 (2.33)	0.2431 (3.44)
High-quality, private institution	0.1163 (1.57)	0.3544 (5.71)

College quality	Top 1/3	Top 10%
Low-quality, private institution	0.1960 (2.28)	0.0301 (0.20)
Middle-quality, public institution	0.0887 (2.08)	-0.0361 (0.57)
Middle-quality, private institution	0.0833 (1.77)	-0.1025 (1.44)
High-quality, public institution	0.1451 (2.78)	-0.0254 (0.30)
High-quality, private institution	0.1240 (1.95)	-0.0386 (0.36)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.3.

respectively. The last column is the estimated effect of college quality for the group of students in the top 10% of family income.[52]

A couple of important observations can be drawn. First, the effects of college quality across family income are far from uniform. For example, earning degrees at high-quality private institutions provides about 12%, 43%, 13%, and -4% (i.e., 0.1163, 0.3544,

[52] I tried dividing students into different numbers of groups (3, 4, and 5), and the patterns in the effect of college quality across family income were more or less the same as that presented in Table 4.8. I also estimated the effect of college quality for the group of students with the top 5% of family income, and the results are provided in Appendix E. It should be cautioned, however, that the number of observations for the top 5% group was just slightly above 200.

0.1240, and -0.0386 in log points in Table 4.8, last row) earnings premiums for students from the bottom third, middle third, top third, and top 10% of family income, respectively. Clearly, the average 20% earnings advantage as estimated in the baseline model disguises such uneven effects of college quality for different groups of students. Second, it appears that the middle group benefits most from earning degrees from high-quality colleges. For example, relative to graduating from low-quality public colleges, graduating from high-quality colleges provides about 12-13% (i.e., 0.1214 log points for high-quality public institutions and 0.1163 log points for high-quality private institutions) earnings advantages for the bottom third group and about 13-15% (i.e., 0.1451 log points for high-quality pubic institutions and 0.1240 log points for high-quality private institutions) for the top third group. For the middle third group, graduating from high-quality public colleges yields about a 27% (0.2431 log points) earnings advantage and an even larger effect when graduating from high-quality private institutions (43%). Interestingly, the estimated effect of college quality is negative (although not statistically significant) for graduates from the top 10% of families.

The above results suggest that although, on average, earning degrees from high-quality colleges improves graduates' earnings, outcomes for students from middle-income families are somewhat greater than they are for other students. In particular, the earnings of those who are from the very top of the family income distribution are not very sensitive to college quality. This observed pattern seems to be contradictory to what social reproduction theory would suggest. Clearly, social reproduction theory provides some insights in explaining the relatively higher effect of college quality for students from middle-income families than for low-income families, but it seems not to be capable of explaining the declining effect of college quality for students from high-income families. To have a deeper understanding of the interplay between the effect of college quality and socioeconomic factors, I examine the effect of college quality across other dimensions of social class (i.e., parental education) in the following section.

Variations by Parental Education

Parental education is another important factor that characterizes one's socioeconomic status. Parental education clearly impacts the economic status of the next generation. As the results of the baseline model show (Table 4.2), first-generation college graduates receive lower earnings than those whose parents are college graduates. Not only does parental education have a direct effect on graduates' earnings, it also exerts indirect influence through individuals' educational attainment. For example, the results in the last chapter suggest that college quality is positively correlated with mothers' education. In this section, I examine the interplay between parental education and the effect of college quality. That is, do high-quality colleges yield more earnings advantages to students from highly educated families than to others?

Graduates are divided into five groups according to their mothers' education: less than high school, high school graduates, some college, college graduates, and advanced degrees. Separate regressions are estimated for each group. Because the estimated effects of college quality are very similar for the first three groups (namely, less than high school, high school graduates, and some college education), a new category of less than college degree is created to include all three groups. The results of separate regressions for each of the three groups (namely, less than a college degree, a college degree, and an advanced degree) are presented in Table 4.9.

Table 4.9

OLS Estimates for Earnings Equation, by Mother's Education

College quality	Less than BA	BA	Advanced degree
Low-quality, private institution	0.0642 (1.36)	0.1032 (0.71)	0.0358 (0.26)
Middle-quality, public institution	0.0821 (2.99)	0.1747 (3.85)	0.0876 (1.46)
Middle-quality, private institution	0.1128 (3.71)	0.1308 (2.57)	-0.0021 (0.03)
High-quality, public institution	0.2013 (4.15)	0.2195 (3.35)	0.0779 (0.76)
High-quality, private institution	0.1481 (2.64)	0.2844 (3.74)	0.0228 (0.21)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.4.

Regression results suggest that the effects of college quality are not uniform across different levels of parental education. For example, earning degrees at high-quality private institutions provides about 16% (i.e., 0.1481 log points in last row of Table 4.9), 32%, and 2% earnings advantages for students with mothers having less than a college degree, a college degree, and an advanced degree, respectively. The average 20% earnings advantage as estimated in the baseline model disguises these uneven effects of college quality across students with different parental education. Table 4.9 also reveals a pattern of small effects for children of mothers having a higher level of education. For example, the estimated effect of high-quality public institutions is more than 20% (0.2195 log points) for students with mothers having a BA or less, but the corresponding effect is less than 10% (0.0779 log points) for students with mothers having advanced degrees.

To check the robustness of the above findings, fathers' education and parental education (mother's or father's education, whichever is higher) are used to replicate the above analyses. The results are presented in Table 4.10 (by father's education) and Table 4.11 (by parental education). Because fathers' education and mothers' education are highly correlated, examining the effect of college quality across fathers' education or parents' education yields similar qualitative results.[53] That is, the effect of college quality is negatively correlated with fathers' education and parental education.

The above results suggest that although, on average, earning degrees from high-quality colleges improves graduates' earnings, the positive effect is more evident for students from families of low and middle level of education. In particular, the earnings of those who are from the best educated families are not very sensitive to college quality. Social reproduction theory does not seem to explain the declining effect of college quality for students from well-educated families.

Variations by Ability

Finally, in this section and the next I examine the variations in the effect of college quality by two academic factors: ability and major field of study. Both are perhaps linked to social class. For example, the quality of schools chosen by upper-class families is arguably higher than that chosen by lower-class families. If educational

[53] The high correlation between fathers' education and mothers' education is illustrated by the size of the sample in separate regressions. For example, a total of 1,028 students have mothers with bachelor degrees or higher, and 1,490 students have fathers with bachelor degrees or higher. The number of students whose parents have bachelor degree or higher is 1,739.

Table 4.10

OLS Estimates for Earnings Equation, by Father's Education

College quality	Less than BA	BA	Advanced degree
Low-quality, private institution	0.0973 (2.09)	-0.0646 (0.74)	0.1373 (0.87)
Middle-quality, public institution	0.0947 (3.26)	0.0764 (2.06)	0.1025 (2.10)
Middle-quality, private institution	0.1407 (4.39)	0.0622 (1.48)	0.0564 (0.99)
High-quality, public institution	0.2660 (5.92)	0.0820 (1.46)	0.1316 (1.59)
High-quality, private institution	0.2461 (5.24)	0.1582 (2.01)	0.1108 (1.35)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.5.

Table 4.11

OLS Estimates for Earnings Equation, by Parental Education

College quality	Less than BA	BA	Advanced degree
Low-quality, private institution	0.1006 (2.13)	-0.0974 (1.15)	0.1364 (1.00)
Middle-quality, public institution	0.0920 (2.98)	0.0743 (2.09)	0.0843 (2.17)
Middle-quality, private institution	0.1426 (4.23)	0.0711 (1.79)	0.0364 (0.79)
High-quality, public institution	0.2684 (5.48)	0.1130 (2.04)	0.1248 (1.86)
High-quality, private institution	0.1949 (3.43)	0.2047 (2.90)	0.0858 (1.19)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.6.

quality matters at all to cultivate students' intellectual ability, then students from upper-class families should have higher measured intellectual ability (such as test scores) than those from low-class families. Chapter 3 has shown that social class variables such as family income and parental education have a large and significant effect on students' SAT/ACT scores. Other studies focus on the class bias of tests such as the SAT: The content and format of such tests favor upper-class students. Given the linkage between social class and measured intellectual ability, examining the variability in the effect of college quality for students with different measured intellectual abilities would be helpful in understanding the variability in the effect of college quality across social classes.

Because SAT/ACT scores are coded in quartiles in the original data set, I conveniently divide the sample into four groups by quartile: the lowest, the second lowest, the second highest, and the highest group. Separate baseline models are estimated for each group of students, and the results pertaining to the effect of college quality are presented in Table 4.12.

Table 4.12

OLS Estimates for Earnings Equation, by SAT/ACT Quartile

College quality	Lowest quartile	Second lowest quartile
Low-quality, private institution	-0.0441 (0.65)	0.0165 (0.17)
Middle-quality, public institution	0.0705 (1.85)	0.0314 (1.01)
Middle-quality, private institution	0.1083 (2.42)	-0.0409 (1.12)
High-quality, public institution	0.3119 (2.52)	0.1369 (2.46)
High-quality, private institution	0.2859 (2.44)	0.0871 (1.16)

College quality	Second highest quartile	Highest quartile
Low-quality, private institution	0.2338 (2.30)	-0.1188 (0.98)
Middle-quality, public institution	0.1934 (3.28)	0.0381 (0.67)
Middle-quality, private institution	0.2449 (3.85)	0.0260 (0.40)
High-quality, public institution	0.3153 (3.90)	0.0472 (0.68)
High-quality, private institution	0.3342 (4.04)	0.0600 (0.79)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.7.

The pattern revealed here is similar to that in the last two sections. For example, the effects of college quality for students with different intellectual abilities do not seem to be uniform. Earning degrees at high-quality private institutions provides about 33%, 9%, 40%, and 6% (i.e., 0.2859, 0.0871, 0.3342, and 0.06 log points) earnings advantage for students from the lowest, the second lowest, the second highest, and the highest quartile of SAT/ACT scores, respectively. Clearly, the average 20% earnings advantage as estimated in the baseline model disguises the uneven effects of college quality for different groups of students.

The interaction between ability quartile and the effect of college quality is not very clear. It appears that the highest effect of college quality appears for students in the lowest and second highest quartiles, and students in the highest quartile are the most insensitive to college quality. Especially for the lowest quartile, graduating from high-quality colleges seems to provide a special boost relative to graduating from middle-quality colleges. The relatively small effect of college quality for students in the highest quartile might be explained by the fact that most of the students in this group are still enrolling in graduate programs. For example, in the B&B sample, the highest quartile consists of 1596 students. In April 1997, among the 673 students who were working full time, only 80 students had enrolled in graduate programs.[54] In contrast, among 922 students who were not working full time (hence not in the analysis of the effect of college quality), 609 students attended graduate schools. More importantly, among those 609

[54] The number of students who were working is slight smaller here than 673 in the regression analysis because 4 of them do not have valid graduate enrollment information.

students who attended graduate schools and were not working, 275 (45%) of them are from high-quality colleges. Thus, the immediate monetary return of attending high-quality colleges most likely under estimates the total economic effect of college quality for these student in the top quartile of test scores. The effect of college quality through further education is explored in Chapter 6.

Although the pattern in the effect of college quality by SAT/ACT quartiles as revealed in this section is not totally clear, it is safe to conclude that students with low and middle abilities benefit the most from attending high-quality colleges, and students with the highest measured intellectual ability are most insensitive to college quality. This pattern seems to confirm the findings in the last two sections.

Variations by Field of Study

The final element considered in this section is major field of study. Previous studies have shown that major field of study is an important factor affecting graduates' earnings (e.g., Berger, 1988; Griffen & Alexander, 1978; James et al, 1989; Rumberger, 1984; Rumberger & Thomas, 1993; Thomas, 2000a). This line of research has consistently shown that certain major fields of study such as business, engineering, and health have a very large positive effect on graduates' earnings. Math science and social science majors also earn substantially more than education and history majors who are at the bottom of the earnings hierarchy. The analysis for the baseline model reveals similar patterns in the effect of college majors on graduates' earnings. The average effect of college major on graduates' earnings covers the possible interaction between college quality and college major, however. For example, it is highly plausible that college quality matters more to certain majors than to others. Hence, if the return to college quality varies by major field of study, then the interaction between college quality and college major must be considered simultaneously to make optimal college choice decisions.

How might college quality and major interact with each other? Unfortunately, we do not have good theories at hand that would guide us in this inquiry. Intuitively, assuming individuals are rewarded by being selected into certain sectors of the economy because of their relatively high credentials, we would expect that in these sectors of the economy, educational credentials should have large effects for those who have been selected into these sectors. That is, if we view both college quality and major as educational credentials, then the effect of college quality should be positively related to the effect of college majors. For example, graduating from high-quality colleges may matter a great deal for business majors but may matter little for history and education majors. It should be cautioned, however, that the distribution of majors could be quite different across institutions. High-quality institutions usually have large business, engineering, and science programs but small or no education programs.

In the data set, fields of study are coded into 12 categories (see the baseline model for these 12 major fields of study; the omitted category is education). Six major fields of study are chosen for the current analysis, namely, business, engineering, health, social science, humanity, and education. Those fields have the largest number of observations

(28.9%, 6.4%, 6.1%, 9.1%, 7.2%, and 11.5%, respectively. See Table 4.1).[55] Among these six fields, business, engineering, and health are usually regarded as the most lucrative majors; social science is in the middle; and humanity and education are at the bottom of the earnings hierarchy. Separate regressions are estimated for each field, and the results are presented in Table 4.13.

Table 4.13

OLS Estimates for Earnings Equation, by Field of Study

College quality	Business	Engineer	Health
Low-quality, private institution	-0.0406 (0.57)	0.1169 (0.70)	0.2527 (2.78)
Middle-quality, public institution	0.0666 (1.40)	0.0159 (0.35)	0.0092 (0.16)
Middle-quality, private institution	0.0996 (1.94)	0.1337 (2.33)	0.0748 (1.29)
High-quality, public institution	0.1720 (1.46)	0.0668 (1.17)	0.2197 (2.35)
High-quality, private institution	0.2576 (2.15)	0.1686 (1.96)	0.1572 (1.82)

College quality	Soc. Sci.	Humanity	Education
Low-quality, private institution	-0.2849 (2.11)	0.2026 (1.52)	0.0990 (0.93)
Middle-quality, public institution	0.1010 (1.58)	-0.0254 (0.46)	0.0692 (1.50)
Middle-quality, private institution	0.0888 (1.24)	-0.0421 (0.57)	0.0034 (0.06)
High-quality, public institution	0.2851 (3.18)	0.1154 (1.39)	0.0756 (1.10)
High-quality, private institution	0.0951 (0.77)	0.0312 (0.32)	0.2266 (2.14)

Note: Absolute value t statistics are included in parentheses. The estimates for the full model are provided in Appendix E, Table E.8.

[55] Six percent of the whole sample (3,965 students) is about 240 observations. Giving this relatively small sample, most of the estimated effects in Table 4.13 are not significant. So, caution must be taken in interpreting the results.

Some observations can be drawn from the results. First, substantial variations exist in the effect of college quality across graduates of different majors, suggesting that where to go and what to study should be considered simultaneously in making college and major choices. Second, the interaction between major field of study and college quality is not very clear. For business majors, college quality is a strong determinant of their earnings. This result confirms our intuition. For engineering majors, college quality does not seem to be a particularly important factor in determining their earnings. Although it appears that graduates from private institutions have some advantages over those from public institutions, college quality does not matter much within each sector. It seems that for engineering majors, where to go is not as important as for business majors. For health majors, college quality appears to matter, with the exception that low-quality private institutions have the largest estimated effect. It might be the case that both students and curricula in low-quality private institutions are more career/market oriented. The pattern for social science majors is quite clear, with high-quality public colleges providing the most advantages and low-quality private institutions the least. The estimated effects of middle-quality and high-quality private institutions are small and not statistically significant. For the two lowest-paid majors, humanities and education, only low-quality private institutions are shown to affect graduates earnings positively for humanity majors, and only high-quality private colleges stand out for education majors.

Due to relatively small sample size in each regression, I hesitate to make a strong statement regarding the interaction between college quality and college major. Nevertheless, two general observations might be drawn from the above analysis. First, the variation in the effect of college quality across different major fields of study suggests the importance of considering the college quality and college major simultaneously in making college choices. Second, these results suggest that college quality matters more for more lucrative majors than for others. Two exceptions are noteworthy. College quality does not seem to matter much for engineering majors, and for some majors such as health and humanities, low-quality private institutions seem to provide special earnings advantages.

4.4 Chapter Summary

This chapter first set up a baseline model to estimate the effect of college quality on graduates' earnings. Results from the pooled model showed a large effect of college quality on graduates' earnings. Other things being equal, graduates from high-quality institutions enjoyed nearly 20% earnings premium relative to those from low-quality public colleges. Graduating from middle-quality institutions also yielded about a 10% earnings advantage over graduating from low-quality colleges. This substantial earnings premium was consistent with what recent studies have found (Brewer et al., 1999; Thomas, 2003). More importantly, the cost-benefit analysis suggested that on average the benefit associated with attending higher-quality institutions was sufficient to cover the cost associated with it. That is, it paid to attend high-quality colleges, on average.

After resolving a couple of technical issues in the baseline model, I checked the robustness of the findings in the face of different measures of college quality. Although the analysis showed that the main conclusion from the baseline model, that it paid to attend high-quality colleges, still held when different measures of college quality were used, the estimated effect of college quality did appear to be sensitive to the measure of college quality. For example, in the baseline model when mean SAT score of the entering class and Carnegie category were used, the estimated effect of college quality was much smaller than when the Barron's rating was used. This relatively small effect of college quality was consistent with what some earlier studies found (Mueller, 1988; Pascarella & Terenzini, 1991; Thomas, 2000). It appeared that the measure of college quality served as a partial explanation of the discrepancy in the estimated effect of college quality in previous research.

The bulk of this chapter contributed to exploring the different effects of college quality across different groups of students. The equity issue discussed here was quite different from the one I studied in Chapter 3, where the equity issue related to educational attainment. The outcomes of higher education might be considered equitable if students had the same probability of earnings degrees from high-quality institutions, regardless of their demographic characteristics and socioeconomic status. Higher education was not viewed as an equitable system, from the results in Chapter 3. In Chapter 4, the equity issue spoke to the effects of educational attainment (college quality) on graduates' outcomes (earnings). The outcomes of higher education might be considered equitable if students with same educational attainment were able to enjoy similar advantages, regardless of their demographic characteristics or socioeconomic status. Higher education was not an equitable system, either. However, the inequity here seemed to be in favor of students from lower- and middle-class families.

I examined the interplay of the effect of college quality with six variables: gender, race/ethnicity, family income, parental education, ability, and major field of study. As far as gender was concerned, female graduates appeared to benefit less from earning degrees at high-quality colleges than did male graduates although the difference was not statistically significant. Nor was the effect of college quality uniform by race/ethnicity. Counter-intuitively, graduating from high-quality colleges provided a special boost to non-White students although the effect of college quality was also substantial for White students. Examining the effect of college quality by two major parameters of socioeconomic status yielded more or less the same counter-intuitive results. The effect of college quality appeared to be larger for students from low- and middle-income families than for those from the top-income families. So too, the effect of college quality was larger for students from low- and middle-educated families than for those from highly educated families. The pattern in the effect of college quality by students' ability further confirmed the above conclusion. Finally, analysis of the effect of college quality for different majors suggested that college quality might matter more for lucrative majors than for others and that college quality and college major should be considered simultaneously in deciding college choices.

Four of these six factors either directly characterized or are indirectly linked with one's socioeconomic status. Results from these analyses, namely, the different effect of college quality by race/ethnicity, family income, parental education, and ability suggested a pattern that was very counter-intuitive. In many ways, the results represented here do not follow the logic of critical reasoning. If college quality has a smaller effect for the more advantageous class than for the less advantageous class, why are there more upper-class students at high-quality institutions? Certainly, most researchers are skeptical, if not cynical, about results of this sort. At a recent professional conference, a presenter, who was White and clearly a critical researcher, bemoaned that some researchers found that the effect of education was greater for Black than for White students.

The social reproduction theory, which is powerful in interpreting the role of education in society, seems incapable of explaining the results if one interprets the social reproduction theory as I have done in Chapter 2. Whether the above results contradict or enhance the social reproduction interpretation needs to be carefully considered. I return to this in the concluding chapter.

CHAPTER 5

COLLEGE QUALITY AND EARNINGS DISTRIBUTION

5.1 Perspective

In Chapter 4, I examined the effect of college quality on graduates’ earnings, on average and by different groups of students. The analyses suggested that graduating from high-quality colleges had positive and significant effects on earnings although substantial variations existed across different groups of students. These positive effects, by the design of econometric models used, were all evaluated at the mean of the earnings distribution (of the whole sample or of specific sub-samples). Although the finding of a positive average effect of college quality on earnings is convincing and important, it is plausible that the effect of college quality differs across graduates’ final positions in the earnings distribution. Put in a slightly different way, the predictive power of college quality may be different for students at the top of the earnings distribution than it is for students at the bottom. Intuitively, if one ends up in a low-paid job, a degree from a high-quality college might not help much. On the other hand, if one ends up in a high-paid job, a degree from a high-quality college should matter much more.

Clearly, the above question extends the effect of college quality in another direction as in the last chapter, where the average effect of college quality was detailed into specific effects of college quality for different groups of graduates by individual characteristics. By examining the effect of college quality at different points of the earnings distribution, the average effect of college quality is detailed into specific effects of college quality for graduates by their final positions in the earnings distribution. In effect, the question here is very much like the one Judge et al. (1995) explore, where they sample a group of executives and find that these successful individuals disproportionately hold degrees from Ivy League universities and other prestigious institutions. That is, in the language consistent with this chapter, college quality has a very large effect at the top of the earnings distribution.

A simple way to look at the problem is to examine the earnings distribution for each type of college. In order to control for the effect of other variables, I use quantile regression. Quantile regression is a technique to estimate the effects of independent variables at different points in the distribution of the dependent variable. The technique has more flexibility than OLS regression in that the latter only estimates the effects of independent variables on the conditional mean of the dependent variable. Quantile regression aims at minimizing the following objective function:

$$\underset{\beta \in R^K}{Min} \sum_{t \in \{t: y_t \geq x_t \beta\}} \theta \left| y_t - x_t \beta \right| + \sum_{t \in \{t: y_t < x_t \beta\}} (1-\theta) \left| y_t - x_t \beta \right|$$

where y_t is the dependent variable, x_t is a vector of independent variables, β is a vector of coefficients, and θ is an arbitrary distributional point to be estimated, e.g., 10th percentile, median, 90th percentile, etc. Typically, the coefficient vector β will differ depending on the particular quantile being estimated.

The literature related to quantile regressions can be traced back to Koenker and Bassett (1978), where the authors use quantile regressions to get a robust estimation when the standard normality assumption fails. Other authors use this regression method to analyze censored data (e.g., Powell, 1986). One study which is particularly relevant to this analysis is done by Eide and Showalter (1999). In that study, the authors use quantile regression to examine intergenerational earnings mobility at different points of sons' earnings distribution. They find that intergenerational earnings mobility is more rigid at the bottom of sons' earnings distribution than at the top. They also suggest that education is relatively more valuable at the bottom of the conditional earnings distribution and that a college education tends to both raise and compress the earnings distribution. These findings are very important from a policy perspective: It seems that college education functions more like an equalizer. Eide and Showalter's study also raises a question regarding the effect of college quality across different points of the earnings distribution. If it is true that a college education tends to compress the earnings distribution, what is the effect of college quality on earnings distribution?

5.2 Analysis

In this analysis, I take the sample of graduates as in the baseline model (i.e., 3,965 graduates) and examine the effect of college quality at different points in earnings distribution. I present some descriptive statistics first before turning to quantile regressions. Looking at descriptive statistics helps understand what quantile regression is actually estimating in this particular analysis. The logic is essentially the same as in OLS regression: If we are to estimate the average effect of college quality on earnings, we will probably first calculate the average earnings for students from each college type to see whether there exist suggestive patterns among them. In fact, what OLS quantifies is precisely the differences among these conditional means, with the only exception being that OLS takes other control variables into consideration. Because in this analysis we are interested in the effect of college quality at different points in the earnings distribution, we first look at earnings at different percentile points across college types. Although this simple tabulation does not control for other variables that may affect earnings, it nonetheless gives us some insight for more advanced econometric analysis. These distributions are presented in Table 5.1.

Table 5.1 reports the minimum, 10^{th} percentile, 25^{th} percentile, 50^{th} percentile, 75^{th} percentile, 90^{th} percentile, and maximum values of graduates' earnings for students graduating from each college type. A couple of observations can be drawn from the descriptive statistics. First, except for the tails of the earnings distribution, earnings are positively related to college quality for both public and private institutions. For example, for public institutions, the medians of log earnings distribution for graduates from low-quality, middle-quality, and high-quality institutions are 10.24, 10.34, and 10.44, respectively. For private institutions, those medians are 10.31, 10.34, and 10.46, respectively. This pattern of positive relation between college quality and earnings generally holds at all of the distributional points listed in Table 5.1. It suggests that college quality has a positive effect on graduates at most points in the earnings distribution.

Second, the earnings differences by college types vary widely at different points of earnings, suggesting that the average earnings difference (calculated as the differences in means) may have disguised important variations in earnings differences at different

Table 5.1

Annual Earnings for Each Type of College by Distributional Points

College quality	N	Min.	10%	25%	50%	75%	90%	Max	Mean
Low-quality, public	599	$1,534	$17,056	$22,000	$28,000	$36,900	$49,964	$140,000	$31,215
Low-quality, private	209	$2,700	$15,561	$19,500	$30,000	$40,000	$59,100	$198,000	$34,157
Middle-quality, public	1883	$1,000	$18,200	$24,000	$31,000	$40,000	$50,000	$280,000	$34,076
Middle-quality, private	824	$5,328	$18,086	$24,000	$31,000	$40,600	$53,000	$206,002	$35,085
High-quality, public	193	$12,000	$20,900	$28,800	$34,320	$41,600	$55,000	$175,000	$37,392
High-quality, private	257	$2,400	$20,000	$25,000	$34,800	$48,000	$65,000	$500,000	$40,423

College quality	N	Min.	10%	25%	50%	75%	90%	Max	Mean
Low-quality, public	599	7.34	9.74	10.00	10.24	10.52	10.82	11.85	10.23
Low-quality, private	209	7.90	9.64	9.88	10.31	10.60	11.00	12.20	10.29
Middle-quality, public	1883	6.91	9.81	10.09	10.34	10.60	10.82	12.54	10.33
Middle-quality, private	824	8.58	9.80	10.09	10.34	10.62	10.88	12.24	10.36
High-quality, public	193	9.39	9.94	10.26	10.44	10.64	10.92	12.07	10.45
High-quality, private	257	7.78	9.90	10.13	10.46	10.78	11.08	13.12	10.45

Note: The upper panel represents the means of annual earnings in dollars and the lower panel in logged value.

points of distribution. For example, the difference between graduates from low-quality public institutions and high-quality private institutions at mean is 0.22 (10.45-10.23). This difference is 0.44, 0.16, 0.13, 0.22, 0.26, 0.26, and 1.27 at the minimum, 10 percentile, 25th percentile, 50th percentile, 75th percentile, 90th percentile, and the maximum of the log earnings distribution.

The above descriptive statistics suggest that the effect of college quality on earnings may differ across the whole earnings distribution. To control for other covariates which may affect the earnings at different points in the earnings distribution, I turn to quantile regression. The observed differences at particular percentile points of log earnings distribution across each college type resemble the estimates for the effect of college quality at those percentile points as evaluated by quantile regression, with the exception that quantile regression is able to take the effect of other factors into consideration and quantifies these differences more precisely.

Quantile regressions are estimated at 0.05, 0.10, 0.25, 0.50, 0.75, 0.90, and 0.95 quantiles of the earnings distribution, and the results are presented in Table 5.2. As in log-earnings models in Chapter 4, the estimates in Table 5.2 are in log points. Again, those log points can be converted into percentage points by evaluating them at the mean of the earnings distribution. For the convenience of reference, I use the estimated log points in the following discussion. Column 1 gives OLS estimates, and Column 2 through Column 8 present estimates of quantile regressions evaluated at the above points. Because I am especially interested in the effect of college quality at the tails of log earnings distribution, more regressions are estimated at the tails than in the middle of log

Table 5.2

Quantile Estimates for the Earnings Equation

	(1) OLS	(2) 0.05	(3) 0.10	(4) 0.25
Low-quality, private institution	0.0530 (1.42)	0.0089 (0.11)	-0.1054 (1.91)	-0.0287 (0.58)
Middle-quality, public institution	0.0920 (4.41)	0.0532 (0.94)	0.0750 (2.14)	0.0727 (2.53)
Middle-quality, private institution	0.1066 (4.61)	0.0383 (0.54)	0.0429 (0.96)	0.0701 (2.08)
High-quality, public institution	0.1800 (5.46)	0.0666 (0.83)	0.1830 (3.00)	0.1504 (3.03)
High-quality, private institution	0.1754 (4.47)	0.1011 (1.33)	0.0445 (0.75)	0.1499 (3.44)

	(5) 0.50	(6) 0.75	(7) 0.90	(8) 0.95
Low-quality, private institution	-0.0121 (0.37)	0.0726 (2.10)	0.1268 (1.78)	0.0308 (0.38)
Middle-quality, public institution	0.0696 (3.64)	0.0727 (3.66)	0.0954 (2.20)	0.0482 (0.90)
Middle-quality, private institution	0.0624 (2.80)	0.0848 (3.53)	0.0996 (1.91)	0.1329 (2.11)
High-quality, public institution	0.1577 (4.68)	0.1536 (4.40)	0.0958 (1.45)	0.1407 (1.56)
High-quality, private institution	0.1421 (4.71)	0.2098 (6.65)	0.2597 (3.71)	0.2962 (3.47)

Note: In estimating the quantile model, the procedure *qreg* in STATA is used. Ideally, other procedures such as *iqreg* and *sqreg* should be used instead to test whether there is statistical difference among the estimated coefficients at different points of the distribution. Unfortunately, weights cannot be applied for those procedures. As a check, I run another set of quantile regressions without weights and find that the estimated effect for private high-quality institutions at different points of distribution is statistically different. Absolute value t statistics in parentheses. The estimates for the full model are provided in Appendix E, Table E.9.

earnings distribution. All quantile regressions have exactly the same specifications as the baseline model in last chapter.

The OLS estimates in Column 1 provide a benchmark for quantile regressions in Column 2 through Column 8. By construction, the OLS results are more or less the same as the results by median regression (i.e., regression at 50th percentile) because both regressions calculate coefficients at the “middle” of earnings distribution although the minimization problems are different for OLS and quantile repression. For example, the effect of high-quality public institutions as given by the median regression is 0.1577 (Column 5), which is similar to that provided by OLS regression, 0.1800 (Column 1). And the effects of high-quality private colleges are 0.1421 and 0.1754 by median and OLS regressions.

The observations from descriptive statistics have suggested that high-quality colleges would probably stretch the log earnings distribution upward. That is, earning degrees at high-quality colleges has a larger effect at the top of the earnings distribution than at the bottom. This hypothesis is confirmed by the results of the quantile regressions. Although it is generally true that at most points of the earnings distribution, college quality has a positive effect on graduates’ earnings, this effect is by no means uniform across the whole distribution. Specifically, at the low end of log earnings distribution, i.e., 5th, 10th, and 25th percentiles, there exist either non-significant or insubstantial differences among the coefficients for different types of colleges. Thus, it appears that college quality does not seem to matter much if one ends up in a low-paying job.

In contrast, at the high end of the earnings distribution, the estimated effects among college types are substantial. For example, evaluated at the 95th percentile, the coefficients for middle-quality publics, high-quality publics, low-quality privates, middle-quality privates, and high-quality privates are 0.0482, 0.1407, 0.0308, 0.1329, and 0.2962, respectively. The positive effect of college quality is also clear at the 75th and 90th percentiles. In particular, graduating from private high-quality institutions provides very large advantage at the 90th and 95th percentiles. It implies that college quality is a stronger determinant of earnings at the top of the earnings distribution than at the bottom. Intuitively, if one ends up with a high-paying job, a degree from a prestigious institution will help a great deal.

5.3 Chapter Summary

In this chapter, I used quantile regressions to examine the effect of college quality across the earnings distribution. Results indicated that at the bottom of log earnings distribution (e.g., 5th, 10th, and 25th percentiles), the effect of graduating from other types of colleges relative to low selective publics was either insubstantial or insignificant. The earnings gap became substantial when moving toward the top of earnings distribution. The largest divergence occurred at the very top of the earnings distribution (e.g., the 90th and 95th percentiles). For example, this advantage exceeded 30% for graduates from private high-quality colleges relative to low-quality institutions. Taken together, the results suggested that graduating from high-quality colleges, especially private elite institutions, would both lift and stretch the earnings distributions.

The above patterns implied that *conditional on* graduating from colleges, students who ended up at the bottom of log earnings distribution would not have benefited from graduating from high quality institutions. However, graduating from high-quality institutions, especially from private elite institutions, would disproportionately benefit students who ended up at the top of log earnings distribution. Taken together, the results suggested that graduating from high-quality colleges, especially private high-quality institutions, would both lift and stretch the log earnings distributions. In reaching the above conclusion, I could emphasis the term *conditional on graduating from colleges* enough because previous research (Eide & Showalter, 1999) has shown that attendance in colleges would lift and compress log earnings distribution.

This conclusion is broadly consistent with what social reproduction theory would suggest. When going to college becomes a relatively universal phenomenon, it cannot serve as a mechanism to differentiate the most capable and wealthy students from others. Attending an elite college, then, becomes such a differentiating apparatus. Graduating from an elite institution may not guarantee higher economic return (e.g., the effect of high-quality college is not substantial at the low end of log earnings distribution); however, if one ends up near the top of earnings distribution, a degree from an elite institution becomes extremely important.

CHAPTER 6

COLLEGE QUALITY AND GRADUATE EDUCATION

6.1 Perspective

In previous chapters, I studied the variability in the effect of college quality across different groups of students. Like many previous studies exploring the effect of college quality on career outcomes of college graduates, the effect of college quality in previous chapters was evaluated as the earnings differences among graduates from different types of colleges. 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 graduating from college 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 neglects a host of other outcomes, however. In this chapter and the next, 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 two outcome variables: graduate education and job satisfaction.

Graduate education may enhance the effect of college quality in two ways. First, obtaining an advanced degree itself may be considered as a triumph to many individuals. Second, graduate education is an integral stage of human capital accumulation, and usually it is a prerequisite to many desirable professions (e.g., lawyer, physician, and professor). Thus, if it can be shown that college quality has a positive effect on graduate education, then estimates of the effects of college quality based on earning differences among terminal baccalaureate recipients is likely underestimated.[56]

Analysis in Chapter 4 showed that college quality had a positive and significant effect on graduates' earnings, on average. Certainly, when choosing a college to attend and a major field to study, one important factor that students consider is the expected earnings from different types of college and different major fields. Although the findings from previous chapters and other similar studies are convincing, they do not typically describe the decision-making process of students and families. For example, early 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 & 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 (2000a) 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

[56] The direction of bias is not certain in that some students might attend graduate school due to non-pecuniary reasons. For example, Ph.D. in English could earn less than B.A. in English. Generally speaking, if graduate education has positive effects on earnings, then comparing earnings among students only with college education could underestimate the effect of college quality on earnings.

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 et al. (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.

It seems, then, that undergraduate college quality may have effects on various aspects of graduate education. In this section, I first examine the extent to which college quality affects college graduates' enrollment in graduate programs within four to five years after college graduation.[57] 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?

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[57] Although the time span from BA receipt to the second follow-up of B&B is not long enough to expose the complete pattern of graduate enrollment for baccalaureate recipients, previous research shows that the majority of graduate students enroll in graduate school during the time period covered by the second follow-up of the B&B survey, i.e., four to five years after college graduation. For example, in studying the enrollment pattern of doctoral students, Bowen, Turner, and Witte (1992) find that a typical time span from BA receipt to Ph.D. receipt is nine years. Given the typical length of a doctoral program (usually five to six years), it is reasonable to assume that the majority of doctoral students enroll in graduate programs within a couple of years of BA receipt. Admittedly, for some professional degrees such as the MBA, which typically requires 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.

Finally, I remark on how to integrate the results of this section into the results of the conventional research on the effect of college quality on earnings.

6.2 Analysis

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 6.1.

Table 6.1

Distribution of Post-Baccalaureate Enrollment and Degree Attainment

		Degrees Earned				
		No degree	Other degrees	Master's degrees	Doctoral degrees	Total
Enrollment	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

Among the 8610 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 chapter 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 school 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 school 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).

The method employed in this section 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.[58] The estimated logit coefficients show how graduating from undergraduate colleges of varying quality affect

[58] 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. The discussion of selection bias in Appendix A is also applicable to these discrete choice models. As a partial remedy, I control for the selection bias by including various demographic and family background variables in these discrete choice models.

the log odds of various choice variables. For the convenience of interpretation, only the marginal effects are reported.

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 6.2. 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 in Chapter 4.

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. In contrast, students from the relatively low-paid majors (education, bio-science, math science, social science, history,

Table 6.2

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
Family Background		
Family income (in $10,000)	0.0037	3.83
First-generation college graduate	-0.0283	2.61
Age	-0.0226	3.93
Age squared / 100	0.0244	3.32
Academic Background		
Merged SAT/ACT quartile	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

Table 6.2 – *Continued*

Variable	Coefficient	t-ratio
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.

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.

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 quartile increase in the SAT/ACT scores 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 and graduates of minority groups are more likely to attend graduate school. 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. Finally, 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.

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 6.3 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; however, the effect is small. "Academic majors," on the other hand, has 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

Table 6.3

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
Family Background		
Family income (in $10,000)	-0.0025	2.49
First-generation college graduate	-0.0215	2.37
Age	-0.0137	2.41
Age squared / 100	0.0001	1.96
Academic Background		
Merged SAT/ACT quartile	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		

Table 6.3 – *Continued*

Variable	Coefficient	t-ratio
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.

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, economics graduate programs 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.[59]

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 6.1 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

[59] To test heterogeneity or 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.

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.[60]

I estimate a multinomial logit model with three outcomes: attendance at comprehensive, doctoral, and research institutions. The marginal effects are reported in Table 6.4. The prediction of the model is reasonably good; overall, it predicts 58% of the trinomial choices correctly. 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.

Graduate school destinations also vary across academic majors. Compared with education majors, students from the fields of engineering, bio-science, and math/science

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

Table 6.4

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
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
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
Academic Background						
Merged SAT/ACT quartile	-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

Table 6.4 – *Continued*

	Comprehensive		Doctoral		Research	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
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.

are more likely to enroll in research universities. Some of those 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. The impact of being a first-generation college graduate is enormous throughout this analysis. Compared with their counterparts, first-generation college graduates are less well paid in the labor market 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.

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.[61] 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 6.5. The prediction of the model is fairly good; overall, it predicts 87% of the binomial choices correctly. It should be cautioned that because the dependent variable is not conditional on graduate school enrollment, the estimated effect represent the overall effect of college quality on graduate degree attainment.

[61] Obviously, the information on graduate degree attainment is right censored. Due to this data limitation, I can only examine the effect of college quality on the probablility of obtaining graduate degrees within four to five years after graduation.

Table 6.5

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
Family Background		
Family income (in $10,000)	0.0021	4.40
First-generation college graduate	-0.0130	1.98
Age	-0.0087	2.43
Age squared / 100	0.0085	1.84
Academic Background		
Merged SAT/ACT quartile	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

Table 6.5 – *Continued*

Variable	Coefficient	t
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 6.5 is analogous to Table 6.2 with the only difference being that the dependent variables in Table 6.5 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 6.2 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 6.2. For example, academic performance is a strong predictor of graduation degree receipt within four to five years after college graduation. On average, a one quartile increase in the SAT/ACT scores 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.

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 6.6. The model predicts 59% of the trinomial choices correctly. Table 6.6 is analogous to Table 6.4, with the only difference being that in Table 6.6 the dependent variable is the Carnegie Classification of the graduate school conferring the degree, and in Table 6.4 the dependent variable is the Carnegie Classification of the graduate school in which a graduate enrolled. The results in Table 6.6 are also very similar to those found in Table 6.4. 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

Table 6.6

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						
Merged SAT/ACT quartile	-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

Table 6.6 – *Continued*

	Comprehensive		Doctoral		Research	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
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.

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 6.4.

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. A very natural extension of the above analysis is to examine the subsequent economic effect of 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. 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 considered the effects of graduate education on earnings; however, they have treated final undergraduate and graduate degree status as exogenous and 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 study.[62] 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. 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[63]. Another possibility is that graduate education might not have positive effect on earnings but have a positive effect on occupational status.

6.3 Chapter Summary

In this chapter, 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

[62] I explored this issue in a separate analysis. Basically, I used the sample in Chapter 4, 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.

[63] We have learned from Appendix D that college quality has time variant effects on earnings. Similarly, graduate degree holders and terminal BA holders could have quite different earnings trajectories.

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.

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.[64] 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 chapter extended those in the previous three chapters. 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 effect of college quality on earnings. 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.

[64] Although obtaining an advanced degree generally helps increase one's income, many students who get master's degree gain very little, as they earn those degrees in low-paying fields. Nonetheless, they can still derive extra utility from earning an advanced degree *per se*.

Clearly, the results in this chapter further support the social reproduction hypothesis. Socioeconomic factors such as family income and parental education continue to have an impact on graduate school enrollment and the type of graduate school (although the effect of family income is small; it may be because family income is not a good measure of family wealth, or that graduate studies usually provide various financial supports). Being a first-generation college graduate, however, lowers the probability of attending graduate school; more importantly, it lowers the probability of enrolling in doctoral programs and/or research universities. Academic variables such as test scores and undergraduate college quality have strong effects on graduate education. Socioeconomic factors also exert influences on graduate education through these academic factors.

CHAPTER 7

COLLEGE QUALITY AND JOB SATISFACTION[65]

7.1 Perspective

Graduate education can be seen as both an economic and a non-economic outcome of a college education. In this chapter, another non-economic outcome of college education, job satisfaction, is considered. The effect of college quality on individuals' job satisfaction has been controversial. Perhaps most obviously, it may have a positive effect on job satisfaction by raising not only one's earnings but also one's professional status. There are, however, other possibilities. For example, college quality (and the high tuition and fees paid) may increase one's occupational expectations more than one's skill to achieve those expectations, resulting in a negative effect on job satisfaction. In either case, it is useful to investigate the relationship among college quality, earnings, and job satisfaction.

Despite the wealth of research addressing the impact of college on labor market rewards, little is known about the ways in which different types of college impact non-pecuniary outcomes such as graduates' job satisfaction. This is not to say that we know little about job satisfaction. On the contrary, job satisfaction constitutes a very important focus in the areas of human relations and personnel management. However, the majority

[65] An earlier version of this analysis was presented at the 27th ASHE conference in Sacramento, CA in November 2002 (Thomas & Zhang, 2002). In that paper, we used one sample from the first follow-up of the B&B and another sample from the second follow-up to study the determination of graduates' job satisfaction. In this chapter, I use half of the sample from the co-authored paper and highlight the effect of college quality on job satisfaction and the relationship among college quality, earnings, and job satisfaction.

of work in this area is more general, and the impact of college on job satisfaction is relatively less examined. Among the fewer studies addressing this issue, most focused on the effect of a college education on job satisfaction among workers with different educational credentials, especially between college graduates and high school graduates. Studies of this kind have generally shown a positive link between a college education and job satisfaction (Glenn & Weaver, 1982; Quinn & Baldi de Mandilovitch, 1975, 1980; Quinn & Staines, 1979).

Implicit in much of this work focusing on the relationship between job satisfaction and quantity of education is the notion that there may also be a relation between job satisfaction and the quality of college education received or the prestige of the institution from which one graduated. The reasons are numerous. It could be the case that students from high-quality institutions find it easier than graduates from institutions of lesser quality to find well-paying jobs that yield high satisfaction. It could also be the case that graduates from more prestigious institutions are given more training opportunities that also yield higher satisfaction. Conversely, it could be the case that more prestigious colleges produce graduates expecting greater labor market rewards. To the degree that this is true, lower levels of satisfaction might be reported when such heightened expectations are not met. In extreme cases, graduating from a higher-prestige college could prove a pressure in working with graduates from institutions that might be perceived as “lesser” in nature. This too could also result in lower levels of satisfaction for graduates from more prestigious institutions.

Only a very small number of studies have explicitly addressed the relationship between job satisfaction and college prestige. The most comprehensive work of this type is by Solmon and his colleagues (Bisconti & Solmon, 1977; Ochsner & Solmon, 1979; Solmon, Bisconti, & Ochsner, 1977). Results from these early studies show that after controlling for salient variables, college selectivity has a statistically non-significant direct impact on job satisfaction. Work conducted by Sharp and Weidman (1987) examines the effect of college quality on job satisfaction for majors in the humanities. Their results suggest that college quality has no statistically significant impact on the satisfaction of women, but it has a negative and significant effect on job satisfaction for men. McClelland (1990) explains that this negative relationship might be a result of the higher occupational expectations of graduates from high-quality colleges.

Throughout the 1990s, college pricing policies and the broader public discussion of the value of a college education encouraged an emphasis on the private returns of college education. Graduates and their families paid an increasingly greater share of the rapidly escalating costs of higher education during this period. Escalating costs borne by students and the evolving public discourse emphasizing college as a private good resulted in a sense of increasing commoditization of higher education and served to fuel the “student as consumer” mentality that many observers of higher education bemoaned in recent years. Embedded in this consumerism may be a heightened expectation that college confers distinct advantages that can be translated into a quantifiably better set of life circumstances immediately after graduation (regardless of inevitable fluctuations in the labor market and the broader economy). Thus to the degree that McClelland’s observations were true in 1990, I might expect an even stronger negative relationship between college prestige and job satisfaction today.

7.2 Analysis

I use the sample in Chapter 4 as the initial sample and further limit it to students who reported their satisfaction toward their jobs, resulting in a sample of 3,870 students. The dependent variable in this study is job satisfaction, which is measured by nine indicators, capturing graduates' satisfaction with various aspects of their jobs. Indicators include measures of respondents' satisfaction with (1) pay, (2) fringe benefits, (3) job challenge, (4) working conditions, (5) promotion opportunity, (6) job security, (7) relations with superiors, (8) relations with co-workers, and (9) educational benefits. Each of these outcome variables is measured by three choices: not satisfied, somewhat satisfied, and very satisfied. The frequency distributions for each of the nine satisfaction indicators are provided in Table 7.1, and the correlations between these satisfaction indicators are in Table 7.2.

Most previous studies on related outcomes suffer from two potential problems. The first problem is raised by the nature of the dependent variable. Job satisfaction is usually measured in a discrete manner with three to five inherently ordered categories such as very dissatisfied, somewhat dissatisfied, moderately satisfied, and very satisfied. More often than not, previous studies have used either simple OLS or multinomial logit/probit regression techniques. OLS models are not appropriate when modeling categorical outcomes because the technique treats ranks as interval data. Moreover,

Table 7.1

Frequencies of Job Satisfaction Indicators

Satisfaction with	Not Satisfied	Somewhat Satisfied	Very Satisfied
(1) Pay	12.8	55.0	32.1
(2) Promotion opportunity	18.7	41.9	39.4
(3) Educational benefits	18.8	36.2	45.1
(4) Fringe benefits	8.3	35.3	56.4
Average	14.6	42.1	43.2
Material benefits	11.2	40.7	48.0
(5) Job challenge	8.2	36.4	55.4
(6) Working condition	8.1	36.5	55.3
(7) Job security	7.1	28.1	64.8
(8) Supervisor	10.1	30.7	59.2
(9) Co-worker	1.4	18.1	80.4
Average	7.0	30.0	63.0
General working conditions	6.7	31.1	62.3

Notes
1. Numbers are in percentage points.
2. Average is the simple average of the percentages within each group.
3. *Material benefits* and *General Working Conditions* are two constructed variables for each group. For the actual coding strategy, please refer to Footnote 67.

results from such models are difficult to interpret when the dependent variable is categorical. Thus, these studies rely on the percentage of variance explained by college selectivity variables and the significance levels of regression coefficients instead of estimating the magnitude of the effect of college quality on job satisfaction. Nor are multinomial logit or probit models appropriate because they fail to account for the ordinal nature of the dependent variable. Given the ordered, categorical nature of dependent

Table 7.2

Pearson Correlation between Nine Aspects of Job Satisfaction

Satisfaction with	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Pay [1]									
Promotion opportunities [2]	0.40								
Educational benefits [3]	0.29	0.40							
Fringe benefits [4]	0.36	0.30	0.31						
Job challenge [5]	0.29	0.44	0.32	0.24					
Working condition [6]	0.26	0.35	0.29	0.23	0.32				
Job security [7]	0.20	0.32	0.26	0.23	0.25	0.29			
Supervisor [8]	0.20	0.33	0.27	0.16	0.27	0.39	0.26		
Co-workers [9]	0.08	0.17	0.16	0.11	0.18	0.24	0.15	0.24	

Note: All estimates are significant at 0.01 level. In calculating the above correlation table, I treated job satisfaction as interval data, that is, 0 = not satisfied, 1 = somewhat satisfied, and 2 = very satisfied.

variables used here, ordered logit techniques are employed in estimating the job satisfaction equations in this analysis. The adoption of this approach remedies the key challenges in previous analyses outlined above.

A second problem that has gone unaddressed in previous research is the indirect effect of college quality on job satisfaction via graduates' earnings. In reviewing studies on the effect of college quality on job satisfaction, Pascarella and Terenzini (1991) pointed out that previous research often addressed the direct impact of college quality on job satisfaction and no attempt was made to examine possible indirect effects. For example, while college quality appeared to have a negative direct effect on job satisfaction, it might have an indirect positive effect on job satisfaction through its positive impact on earnings as the analysis in Chapter 4 has shown. My analysis is based on a system of two simultaneous equations. The first equation assumes that individual i's job satisfaction (S_i) is 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), log earnings ($\ln(Y_i)$), and an individual disturbance term (ε_i).

$$S_i = \beta_0 + \beta_1 Q_{ij} + \beta_2 D_i + \beta_3 F_i + \beta_4 A_i + \beta_5 J_i + \beta_6 \ln(Y_i) + \varepsilon_i \qquad (7.1)$$

In Chapter 4, I showed that individual i's log earnings ($\ln(Y_i)$) is a function of the same set of variables, that is,

$$\ln(Y_i) = \alpha_0 + \alpha_1 Q_{ij} + \alpha_2 D_i + \alpha_3 F_i + \alpha_4 A_i + \alpha_5 J_i + \mu_i \qquad (7.2)$$

Then the indirect effect of college quality on job satisfaction can be represented as $\beta_6 \cdot \alpha_1$, which is most likely to be positive. In subsequent analyses, I estimate a reduced form of equation 7.1 to obtain the total effect of college quality on job satisfaction.

$$S_i = \gamma_0 + \gamma_1 Q_{ij} + \gamma_2 D_i + \gamma_3 F_i + \gamma_4 A_i + \gamma_5 J_i + \upsilon_i \qquad (7.3)$$

By comparing the direct effect in equation 7.1 and the total effect in equation 7.3, I am able to examine the extent to which the negative direct effect of college quality is eased by its positive indirect effect through earnings.

There are two distinct steps in my analysis. In the first step, models are estimated for each of the nine satisfaction indicators, and the results are then arrayed to allow an inventory of the effects of various factors on job satisfaction. In a second step, I attempt to synthesize the findings from these nine models by creating factor analytic satisfaction composite indices. The factor structure of the nine satisfaction items suggests that they define two distinct dimensions of job satisfaction: satisfaction with *material benefits* and satisfaction with *general working conditions*. I conclude this step by estimating 2 additional models using these two constructs. While my primary interest is in assessing the relationship between college quality and a number of dimensions of job satisfaction, net of salient characteristics of the graduates themselves, this approach allows me to also comment on the net impact of a number of these individual characteristics.

First, on a descriptive level, graduates report being quite satisfied with their jobs in general. Table 7.1 shows that, on average, over 50% of the graduates report that they are very satisfied their jobs. Conversely, the percentage of students who report being “not satisfied” is quite low. Second, a general pattern emerges in graduates’ evaluation of the different aspects of job satisfaction. Part of this pattern can be seen in the higher percentages of graduates who report being “not satisfied” with pay, promotion opportunity, and educational benefits. Not surprisingly, lower percentages of graduates report being “very satisfied” with pay, promotion opportunity, and educational benefits. Inter-correlations among the nine items are also noteworthy, and these are considered subsequently.

In the first step of the analysis, I estimate ordered logit regressions for each of the nine satisfaction indicators with and without the earnings variable in the model. Because the literature has shown that earnings are the major component of job satisfaction, the results from the models with the earnings variable can be understood to represent the direct effect of the other indicators of job satisfaction. Results from the series of models that exclude the earnings variable can then be understood to represent the total effects of the other indicators of job satisfaction—including any indirect effect operating through earnings. A total of 18 ordered logit models are estimated using this strategy (9 with earnings and 9 without earnings).[66] The direction and significance of the estimated coefficients in those 18 models are inventoried in Table 7.3.

There are a number of noteworthy findings from this series of models. Consistent with the corpus of literature in this area, earnings are the most consistent determinant of every job satisfaction outcome I analyze, having a strong and significant effect on job satisfaction in most of the models. Among those nine aspects of job satisfaction, earnings have a large and significant impact on satisfaction with pay, promotion opportunities, educational benefits, fringe benefits, and job challenge. However, the effect of earnings on working conditions, job security, relations with superiors, and relationships with co-workers is relatively small and sometimes non-significant. It suggests that there is more to satisfaction than the amount of earnings. Another financial variable measuring the total educational debt an individual still hold does not seems to affect one's job satisfaction significantly.

Generally speaking, in regard to job satisfaction college quality does not seem to matter for graduates from public institutions, but graduates from private institutions are generally less satisfied. This is true for both the direct and total effects. For example, graduating from middle- and high-quality public institutions has a statistically non-significant effect on most of the nine indicators (relative to low-quality public

[66] The estimates for these 18 models are presented in Appendix E, Table E.10.

Table 7.3

Count of Significant and Non-significant Coefficients

Direct Effects	Positive & Significant	Negative & Significant	Positive & Non-sig.	Negative & Non-sig.
Log earnings	8	0	0	1
Educational debt (in $1,000)	0	0	5	4
Low-quality, private institution	0	4	1	4
Middle-quality, public institution	0	0	6	3
Middle-quality, private institution	0	3	2	4
High-quality, public institution	0	1	1	7
High-quality, private institution	0	5	0	4
Historically black coll. and inst.	0	0	2	7
Female	5	0	4	0
Native American	0	0	7	2
Asian	0	4	0	5
Black	0	4	2	3
Hispanic	3	0	5	1
Family income (in $10,000)	1	0	8	0
First generation college graduate	3	0	5	1
Merged SAT/ACT quartile	1	0	7	1
Business major	5	1	0	3
Engineering major	1	0	5	3
Health major	1	1	5	2
Public affairs major	0	0	6	3
Biological science major	0	0	3	6
Math science major	2	0	4	3
Social science major	0	1	2	6
History major	2	0	3	4
Humanity major	0	2	5	2
Psychology major	1	0	3	5
Other major	1	2	4	2
Age	0	3	1	5
Age squared / 100	3	0	4	2
Tenure	2	3	2	2
Tenure squared /100	2	0	4	3
Number of hours per week	3	1	2	3

Table 7.3 – *Continued*

Total Effects	Positive & Significant	Negative & Significant	Positive & Non-sig.	Negative & Non-sig.
Educational debt (in $1,000)	0	0	4	5
Low-quality, private institution	0	3	1	5
Middle-quality, public institution	1	0	6	2
Middle-quality, private institution	0	2	4	3
High-quality, public institution	0	1	3	5
High-quality, private institution	0	2	0	7
Historically black coll. and inst.	0	2	2	5
Female	4	0	3	2
Native American	0	0	8	1
Asian	0	3	1	5
Black	0	4	2	3
Hispanic	3	0	5	1
Family income (in $10,000)	4	0	5	0
First generation college graduate	2	0	6	1
Merged SAT/ACT quartile	1	0	7	1
Business major	5	1	1	2
Engineering major	3	0	4	2
Health major	3	1	4	1
Public affairs major	1	0	6	2
Biological science major	1	0	4	4
Math science major	4	0	2	3
Social science major	1	1	2	5
History major	0	0	4	5
Humanity major	2	2	4	1
Psychology major	1	0	3	5
Other major	3	1	2	3
Age	0	3	3	3
Age squared / 100	2	0	4	3
Tenure	2	3	3	1
Tenure squared /100	2	0	4	3
Number of hours per week	5	0	3	1

Note: Significant at 0.05 level.

institutions). On the other hand, graduating from private institutions appears to create some negative job satisfaction. High-quality private institutions have negative effects on all nine indicators, and five of them are significant. Similarly, for low- and middle-quality private institutions, most of the estimated effects are negative, and some significantly negative. This could be explained by the higher tuition and fees charged at private institutions than at public institutions of comparable quality (see Table 4.3 for the average tuition and fees).

The second step of this analysis synthesizes the findings reported in the above 18 regression models by creating factor analytic composite indices from the nine indicators used as outcomes in the previous step. A cursory review of Table 7.2 suggests a general pattern of correlations among these nine indicators. For example, satisfaction with pay, promotion opportunities, educational benefits, and fringe benefits are relatively highly correlated with each other. The high correlation between satisfaction with working conditions and relations with superiors is also worthy of attention. While these correlations raise a number of interesting questions about the inter-correlation of various indicators of job satisfaction, they do not provide a direct tool to tie these indicators into conceptually meaningful groups. To accomplish this, I separate the nine items into two distinct groups using factor analysis (I chose principal axis factoring with an oblique rotation to retain the correlation between these two groups of items). The results of this factor analysis confirm the observation about potential inter-correlations among these items and suggest that these nine indicators define two distinct dimensions of job satisfaction (see Table 7.4). The first of these dimensions is labeled satisfaction with

Table 7.4

Factor Structure of Nine Satisfaction Indicators

	Factor 1	Factor 2
Satisfaction with pay	0.6199	
Satisfaction with fringe benefits	0.5689	
Satisfaction with promotion opportunities	0.5406	
Satisfaction with education benefits	0.4309	
Satisfaction with job challenge		0.2585
Satisfaction with supervisor		0.6196
Satisfaction with working conditions		0.5431
Satisfaction with co-workers		0.4048
Satisfaction with job security		0.2911

Note:
1. Factors derived using Principal Axis Factoring with oblique rotation.
2. Factor 1 is labeled as satisfaction with *material benefits*, and Factor 2 as satisfaction with *general working condition*.

material benefits (including satisfaction with pay, promotion opportunity, educational benefits, and fringe benefits). The second dimension (that includes satisfaction with working conditions, relations with superiors, co-worker, job security, and job challenge) is called satisfaction with *general working conditions*. Additive scales were created using the variables defining each of these dimensions. The scales were then recoded into three categories (“Not Satisfied,” “Somewhat Satisfied,” and “Very Satisfied”) to render them comparable to those used on the individual items used as outcomes in the first stage of the analysis.[67]

[67] The actual coding scheme is as follows. First, I code “Not satisfied” = 0, “Somewhat satisfied” = 1, and “very satisfied” = 2 for each satisfaction indicator. These numbers are then added for each of the two composite satisfaction indices. That is, for satisfaction with *material benefits*, the range is from 0 to 8, and

After constructing these two composite indices of job satisfaction, I estimate ordered logit models for each index. Following the modeling strategy used in the first step, I estimate the direct and total effect of salient variables on each index. Detailed results from these models are reported in Table 7.5. This approach essentially synthesizes the results from the nine individual indicators of job satisfaction reported in the first step. Some major findings are presented as follows.

Consistent with the findings from the first step, earnings have a strong and significant positive effect on the two constructed indices of job satisfaction. However, this effect seems to be much larger on satisfaction with *material benefits* than with *general working conditions*. This suggests that higher-paid respondents are more satisfied with the material aspects of their jobs than they are with working conditions in general.

The main interest in this section is the presumed ability of high-quality colleges to benefit their graduates in the labor market. Decades of research has demonstrated the wage premiums associated with graduation from more prestigious schools. Although no research to date has focused on job satisfaction as a function of college quality, a general sense exists that better colleges do indeed graduate students who wind up in better jobs with higher satisfaction. This analysis however calls this assumption into question. I find that college quality generally exerts a negative direct influence on satisfaction with *material benefits* and on satisfaction with *general working conditions*. These results show

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for satisfaction with *general working conditions*, the range is from 0 to 10. Finally, I recode these scales back to three categories, making the distribution similar to the average of each group. In particular, for satisfaction with *material benefits*, I code 0-2 as “Not satisfied,” 3-5 as “Somewhat satisfied,” and 6-8 as “Very satisfied.” For satisfaction with *general working conditions*, I code 0-4 as “Not satisfied,” 5-7 as “Somewhat satisfied,” and 8-10 as “Very satisfied.” The distribution of these constructed indices and the average for each group is presented in Table 7.1.

Table 7.5

<u>Ordered Logit Models of Job Satisfaction, Marginal Effect</u>

Satisfaction with Material Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0990	12.81	-0.1773	12.45	0.2763	13.77
Educational debt (in $1,000)	0.0007	1.19	0.0012	1.19	-0.0018	1.19
Institutional Characteristics						
Low-quality, private institution	0.0509	2.60	0.0656	3.43	-0.1165	3.04
Middle-quality, public institution	-0.0003	0.04	-0.0006	0.04	0.0009	0.04
Middle-quality, private institution	0.0132	1.29	0.0223	1.29	-0.0355	1.29
High-quality, public institution	0.0304	1.65	0.0445	1.94	-0.0749	1.83
High-quality, private institution	0.0361	2.04	0.0514	2.43	-0.0875	2.27
Historically black coll. and inst.	0.0162	0.69	0.0258	0.78	-0.0420	0.74
Demographic Characteristics						
Female	-0.0196	3.12	-0.0348	3.18	0.0545	3.19
Native American	-0.0149	0.40	-0.0298	0.36	0.0446	0.37
Asian	0.0564	2.53	0.0692	3.97	-0.1256	3.20
Black	0.0280	1.77	0.0420	2.15	-0.0700	1.99
Hispanic	-0.0378	3.64	-0.0884	2.89	0.1263	3.11
Family Background						
Family income (in $10,000)	-0.0008	1.12	-0.0014	1.12	0.0021	1.12
First generation college graduate	-0.0099	1.61	-0.0177	1.61	0.0276	1.62
Academic Background						
Merged SAT/ACT quartile	-0.0004	0.12	-0.0007	0.12	0.0010	0.12

Table 7.5 – *Continued*

Satisfaction with Material Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0179	1.85	-0.0338	1.78	0.0517	1.81
Engineering major	-0.0122	0.91	-0.0237	0.85	0.0359	0.87
Health major	-0.0171	1.36	-0.0344	1.23	0.0515	1.27
Public affairs major	-0.0132	0.88	-0.0259	0.80	0.0390	0.83
Biological science major	-0.0018	0.10	-0.0032	0.10	0.0050	0.10
Math science major	-0.0405	3.83	-0.0954	3.10	0.1359	3.27
Social science major	0.0101	0.74	0.0170	0.78	-0.0270	0.77
History major	-0.0066	0.30	-0.0124	0.29	0.0190	0.29
Humanity major	-0.0050	0.38	-0.0092	0.37	0.0142	0.38
Psychology major	-0.0131	0.79	-0.0257	0.72	0.0388	0.74
Other major	-0.0031	0.28	-0.0057	0.28	0.0088	0.28
Labor Market						
Age	0.0086	2.22	0.0153	2.22	-0.0239	2.23
Age squared / 100	-0.0001	1.93	-0.0002	1.93	0.0003	1.93
Tenure	0.0023	1.12	0.0041	1.12	-0.0064	1.12
Tenure squared /100	-0.0001	0.85	-0.0002	0.85	0.0002	0.85
Number of hours per week	-0.0008	2.27	-0.0014	2.27	0.0022	2.28
N	3,870					
χ^2	378					

Table 7.5 – *Continued*

Satisfaction with Material Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0007	1.26	0.0012	1.27	-0.0019	1.27
Institutional Characteristics						
Low-quality, private institution	0.0469	2.29	0.0568	3.19	-0.1037	2.71
Middle-quality, public institution	-0.0085	0.95	-0.0138	0.95	0.0223	0.95
Middle-quality, private institution	0.0038	0.36	0.0060	0.36	-0.0098	0.36
High-quality, public institution	0.0128	0.73	0.0191	0.80	-0.0319	0.77
High-quality, private institution	0.0134	0.82	0.0200	0.89	-0.0335	0.86
Historically black coll. and inst.	0.0303	1.14	0.0402	1.41	-0.0705	1.28
Demographic Characteristics						
Female	-0.0107	1.65	-0.0172	1.66	0.0279	1.66
Native American	-0.0244	0.68	-0.0471	0.57	0.0715	0.61
Asian	0.0402	1.93	0.0503	2.57	-0.0904	2.25
Black	0.0268	1.65	0.0370	1.96	-0.0638	1.82
Hispanic	-0.0431	4.12	-0.0929	3.19	0.1360	3.46
Family Background						
Family income (in $10,000)	-0.0015	2.04	-0.0024	2.03	0.0039	2.04
First generation college graduate	-0.0090	1.39	-0.0146	1.40	0.0236	1.40
Academic Background						
Merged SAT/ACT quartile	-0.0018	0.54	-0.0029	0.54	0.0046	0.54

Table 7.5 – *Continued*

Satisfaction with Material Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0440	4.77	-0.0805	4.35	0.1244	4.52
Engineering major	-0.0476	4.77	-0.1039	3.70	0.1515	4.00
Health major	-0.0514	5.47	-0.1155	4.18	0.1669	4.51
Public affairs major	-0.0261	1.84	-0.0502	1.57	0.0762	1.65
Biological science major	-0.0179	1.06	-0.0327	0.94	0.0506	0.98
Math science major	-0.0649	7.73	-0.1599	5.64	0.2248	6.14
Social science major	-0.0110	0.89	-0.0190	0.84	0.0300	0.86
History major	0.0001	0.00	0.0001	0.00	-0.0002	0.00
Humanity major	-0.0166	1.33	-0.0298	1.21	0.0464	1.25
Psychology major	-0.0257	1.64	-0.0495	1.39	0.0752	1.47
Other major	-0.0183	1.74	-0.0325	1.59	0.0509	1.65
Labor Market						
Age	0.0052	1.28	0.0084	1.28	-0.0135	1.28
Age squared / 100	-0.0001	1.06	-0.0001	1.06	0.0001	1.06
Tenure	0.0006	0.26	0.0009	0.26	-0.0014	0.26
Tenure squared /100	-0.0001	0.66	-0.0001	0.66	0.0002	0.66
Number of hours per week	-0.0021	6.01	-0.0034	5.94	0.0055	6.08
N	3,870					
χ^2	170					

Table 7.5 – *Continued*

Satisfaction with General Working Conditions, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0185	4.01	-0.0567	4.05	0.0752	4.08
Educational debt (in $1,000)	-0.0004	1.04	-0.0012	1.04	0.0016	1.04
Institutional Characteristics						
Low-quality, private institution	0.0358	2.55	0.0880	3.20	-0.1238	3.04
Middle-quality, public institution	0.0007	0.12	0.0021	0.12	-0.0028	0.12
Middle-quality, private institution	0.0170	2.20	0.0484	2.38	-0.0653	2.38
High-quality, public institution	0.0238	1.73	0.0628	2.03	-0.0867	1.96
High-quality, private institution	0.0462	2.98	0.1074	3.99	-0.1535	3.71
Historically black coll. and inst.	0.0068	0.47	0.0200	0.50	-0.0268	0.49
Demographic Characteristics						
Female	-0.0094	2.21	-0.0287	2.25	0.0381	2.24
Native American	-0.0224	1.11	-0.0811	0.95	0.1035	0.98
Asian	0.0167	1.28	0.0458	1.43	-0.0625	1.39
Black	0.0523	3.69	0.1179	5.27	-0.1702	4.69
Hispanic	-0.0151	1.87	-0.0512	1.70	0.0663	1.74
Family Background						
Family income (in $10,000)	-0.0008	1.70	-0.0024	1.71	0.0032	1.71
First generation college graduate	-0.0075	1.78	-0.0228	1.79	0.0303	1.78
Academic Background						
Merged SAT/ACT quartile	-0.0052	2.39	-0.0160	2.40	0.0212	2.41

Table 7.5 – *Continued*

Satisfaction with General Working Conditions, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0035	0.49	0.0106	0.50	-0.0141	0.50
Engineering major	0.0000	0.00	0.0000	0.00	0.0000	0.00
Health major	0.0181	1.52	0.0495	1.68	-0.0676	1.65
Public affairs major	-0.0034	0.31	-0.0107	0.30	0.0141	0.31
Biological science major	0.0036	0.27	0.0108	0.28	-0.0144	0.27
Math science major	-0.0020	0.20	-0.0062	0.20	0.0082	0.20
Social science major	0.0101	1.04	0.0293	1.10	-0.0394	1.09
History major	-0.0208	1.72	-0.0740	1.50	0.0948	1.54
Humanity major	0.0035	0.37	0.0105	0.37	-0.0140	0.37
Psychology major	0.0094	0.67	0.0271	0.71	-0.0366	0.70
Other major	0.0021	0.26	0.0063	0.27	-0.0084	0.27
Labor Market						
Age	0.0102	3.92	0.0312	3.97	-0.0414	3.99
Age squared / 100	-0.0001	3.48	-0.0004	3.51	0.0005	3.53
Tenure	0.0012	0.86	0.0036	0.86	-0.0048	0.86
Tenure squared /100	-0.0001	1.55	-0.0003	1.55	0.0004	1.56
Number of hours per week	-0.0006	2.42	-0.0017	2.43	0.0023	2.44
N	3,870					
χ^2	187					

Table 7.5 – *Continued*

Satisfaction with General Working Conditions, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	-0.0004	0.99	-0.0011	0.99	0.0015	0.99
Institutional Characteristics						
Low-quality, private institution	0.0350	2.51	0.0859	3.14	-0.1209	2.97
Middle-quality, public institution	-0.0008	0.14	-0.0025	0.14	0.0034	0.14
Middle-quality, private institution	0.0150	1.97	0.0428	2.12	-0.0577	2.11
High-quality, public institution	0.0203	1.53	0.0542	1.75	-0.0745	1.70
High-quality, private institution	0.0406	2.73	0.0967	3.55	-0.1373	3.33
Historically black coll. and inst.	0.0095	0.64	0.0272	0.68	-0.0367	0.67
Demographic Characteristics						
Female	-0.0077	1.83	-0.0235	1.85	0.0312	1.85
Native American	-0.0231	1.16	-0.0833	0.98	0.1064	1.02
Asian	0.0137	1.09	0.0380	1.19	-0.0517	1.16
Black	0.0524	3.68	0.1172	5.25	-0.1695	4.67
Hispanic	-0.0159	1.99	-0.0539	1.80	0.0698	1.84
Family Background						
Family income (in $10,000)	-0.0009	1.95	-0.0028	1.95	0.0038	1.95
First generation college graduate	-0.0072	1.70	-0.0219	1.72	0.0291	1.71
Academic Background						
Merged SAT/ACT quartile	-0.0054	2.46	-0.0164	2.47	0.0217	2.47

Table 7.5 – *Continued*

Satisfaction with General Working Conditions, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0017	0.25	-0.0053	0.25	0.0070	0.25
Engineering major	-0.0075	0.83	-0.0239	0.80	0.0314	0.80
Health major	0.0083	0.79	0.0241	0.83	-0.0324	0.82
Public affairs major	-0.0060	0.57	-0.0190	0.55	0.0250	0.55
Biological science major	0.0002	0.02	0.0006	0.02	-0.0008	0.02
Math science major	-0.0085	0.93	-0.0272	0.88	0.0357	0.90
Social science major	0.0066	0.70	0.0192	0.73	-0.0258	0.72
History major	-0.0188	1.47	-0.0652	1.30	0.0840	1.34
Humanity major	0.0013	0.14	0.0039	0.14	-0.0052	0.14
Psychology major	0.0068	0.50	0.0198	0.52	-0.0266	0.52
Other major	-0.0006	0.08	-0.0018	0.08	0.0024	0.08
Labor Market						
Age	0.0095	3.66	0.0288	3.70	-0.0383	3.71
Age squared / 100	-0.0001	3.23	-0.0003	3.26	0.0004	3.27
Tenure	0.0009	0.63	0.0027	0.63	-0.0035	0.63
Tenure squared /100	-0.0001	1.51	-0.0003	1.51	0.0004	1.51
Number of hours per week	-0.0008	3.58	-0.0025	3.61	0.0033	3.63
N	3,870					
χ^2	170					

Notes:
1. Also included in the model are dummies indicating missing values of independent variables.
2. Absolute value t statistics included.

that, all else being equal, compared with students graduating from low-quality public institutions, graduates from high-quality private institutions are about 9% and 15% (last Column of Table 7.5) less likely to be “very satisfied” with *material benefits* and *general working conditions*, respectively. The estimated direct effects of other types of colleges are usually negative and sometimes significant relative to low-quality public institutions.

In some cases, the positive relationship between college quality and earnings alleviates the negative effect of college quality on job satisfaction to a certain extent. For example, graduating from high-quality private institutions has strong negative direct effects on satisfaction with *material benefits*; however, the total effects are small and non-significant. In other cases, the indirect effect of college quality on job satisfaction through earnings does not alleviate the negative effect of college quality on job satisfaction. This could happy in two ways. First, the positive relation between college quality and earnings is not strong. For example, graduating from low-quality private institutions has strong negative effects on satisfaction with *material benefits,* both directly and indirectly. Second, the positive relation between earnings and satisfaction is not strong. For example, graduating from private institutions has negative and significant effects on satisfaction with *general working conditions*, both directly and indirectly.

In both direct effect models, job satisfaction is consistently shown to be a convex function of one’s age. But after taking the effect of earnings into consideration, age does not seem to have a significant total effect on satisfaction with *material benefits* although the total effect on satisfaction with *general working conditions* still exists. If it is true that middle-aged respondents hold higher career expectations, then their expectations for pay and other benefits are generally met by their realized earnings. Non-material aspects of their jobs seem to fall short of their expectations however.

Women express higher levels of job satisfaction with both *material benefits* and *general working conditions* than their male counterparts. This could be due to their different vocations. For example, in the second follow-up of B&B cohort, about 15.6% of male graduates have their primary jobs in manufacture industry while this figure is 7.2% for female graduates. Female graduates, on the other hand, are more likely to have jobs in health care (14.5% versus 5.8%) and education (18.4% versus 6.7%). After adding the indirect effect through earnings, the satisfaction level of female graduates is reduced, especially with *material benefits*. This finding informs our understanding of the effect of gender on job satisfaction. Previous studies have consistently documented the positive link between being female and job satisfaction. For example, Bisconti and Solmon (1977), arriving at a finding consistent with those reported here, namely that women have notably higher satisfaction than men, suggest that this result might be an artifact of their decision to use women as their reference group (a reference group that apparently contained a large number of homemakers). However, this positive link is based on a convenient assumption of “other things being equal” (most importantly here is pay), which we know from previous research is anything but a safe assumption. After taking women’s realized earnings into consideration, the positive link between being female and job satisfaction is reduced by the large salary difference between men and women.

Consistent with the analyses from the first step, Asian and Black graduates are found to be less satisfied with their jobs compared with White graduates. The relative dissatisfaction of Asians is found to be attenuated by their marked earnings advantages. Family background variables such as family income and parental education do not appear to affect graduates' job satisfaction significantly, nor do test scores have large effects on job satisfaction. College majors do not have direct effects on job satisfaction when earnings are controlled in the model; however, students of high-paid majors such as business, engineering, and health are more satisfied than their counterparts in other majors when the total effect is examined. It illustrates that the effect of college majors on satisfaction is mainly operated through their impact on earnings.

7.3 Chapter Summary

In this chapter, I further extended the effect of college quality to include its impact on more psychological aspects of graduates' life. More importantly, the relationship among college quality, earnings, and job satisfaction was examined. Consistent with earlier research, I found earnings to emerge as the strongest predictor of job satisfaction. Although earnings drove a large part of one's assessment of job satisfaction, I have shown that there were other dimensions of satisfaction that operated quite independently of earnings and that were influenced by a variety of individual and college-level factors.

Other things being equal, college quality generally had a negative direct effect on graduates' job satisfaction; this was especially true for private institutions; however, this negative direct effect of college quality was attenuated by its positive indirect effect through earnings, resulting in non-significant effects in some cases. For example, the negative effect of high-quality private institutions on graduates' satisfaction with *material benefits* was greatly reduced by the positive effect of high-quality private institutions on earnings. In cases where the link between earnings and satisfaction was weak, the negative direct effect of college quality could not be attenuated by its positive effect on earnings. The negative effect of college quality on graduates' satisfaction with *general working conditions* was not alleviated when earnings were excluded from the model.

The findings pointing to a negative relationship between college prestige and job satisfaction raised many questions. Was this relative dissatisfaction among graduates from more prestigious colleges a function of their presumably higher costs? Higher costs might result in higher expectation, and higher expectations would exacerbate dissatisfaction in jobs that were considered to be inferior in quality or "not good enough." Or perhaps this negative relationship could be explained by the reality that although these colleges placed their graduates in high-prestige jobs, many of these jobs were inherently stressful. All of this is to suggest that much more work needs to be done in this area. As students and families pay an ever-increasing share of the cost of college and these costs continue to rise, decisions directly impacting extrinsic realities such as those explored in this chapter will become more important.

CHAPTER 8

SUMMARY AND DISCUSSION

American higher education has experienced massive expansion in the 20th century, especially over the last 40 years. As the majority of high school graduates in the United States came to attend college, the differentiation of educational attainment increasingly went beyond the dichotomy of college graduates versus non-college graduates. This reality encouraged greater attention to other bases on which employers could and apparently did discriminate: bases that include perceived quality of undergraduate institutions. As Fussell (1983) poignantly observed, despite the massive expansion of the American higher education system, the same percentage of students attended “colleges” today as 100 years ago. His observation pointed to the distinct hierarchy and stratification among American universities and colleges.

Many researchers in finance of higher education and in labor economics, in one way or another, have made the case that college quality was an important element in the formation of human capital and transmission of socioeconomic status. 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. Behrman and Birdsall (1983) suggested that quantity alone was not sufficient to capture the return of education and that quality should be incorporated into the standard Mincerian (1962, 1974) framework. Recently, studies by Brewer and his colleagues (Brewer & Ehrenberg, 1996; Brewer et al., 1999; Eide et al., 1998) and Thomas (2000a, 2003) have significantly improved our understanding of the effect of college quality on an array of student outcomes. Implicitly or explicitly recognized in these studies was that the quality of college education, in addition to a college education itself, might have significant and profound effects on student outcomes. These scholars, however, did not emphasize the context in which college quality took effect (e.g., they did not underscore the centrality of socioeconomic status in determining college quality) and did not extend the analysis of the effect of college quality to other aspects of students' life (except Eide et al., 1998).

My study drew heavily on the work of these scholars, especially through an ongoing conversation and collaborative work with some of them. In return, my analysis expanded previous work in a couple of important ways. First, I explored the discrepancies between the empirical findings of the relatively small effect of college quality on graduate' earnings and what social theories would suggest about the effect of college quality. This was achieved by examining the variability in the estimated effect of college quality among individuals and by extending the effect of college quality into non-pecuniary aspects of students' outcomes. Second, I moved on to examine the role of college quality in society by linking the analysis of the effect of college quality with the analysis of the effect of socioeconomic status on college quality, thus enabling me to tie these elements together and paint a more complete picture. Indeed, this study was mainly inspired by Professor Larry Leslie's statement that elite institutions "enable" class to work its advantage (Personal communication, May, 2001).

In this chapter, I structure the major findings of my study around two issues. First, the findings presented here help reconcile empirical results and social theories regarding the effect of college quality on students' outcomes. In summarizing my major findings in the first half of this chapter, I discuss variations in the effect of college quality, suggesting that the average economic effect of college quality as estimated in previous studies disguises many variations of the effect across an array of factors. And more importantly, in the second step, findings presented here help us better understand the role of college quality in society. In the second half of this chapter, I examine the social role of college quality by integrating various components of the analysis in this study, arguing that college quality, while providing an important mechanism for economic and social mobility, at the same time plays a significant role in preserving and perpetuating socioeconomic structure in American society.

Previous research generally found a relatively small although statistically significant positive effect of college quality on graduates' earnings. Two types of discrepancies were noteworthy. First, findings of these studies were not totally unequivocal. Studies by Solman and Wachtel (1975), Mueller (1988), and Dale and Krueger (1999) have shown very small effects of college quality on earnings, yet Brewer et al. (1999) and Thomas (2003) revealed quite a substantial effect of college quality on graduates' earnings. Second, the majority of findings that college quality had a relative small effect on earnings run against our every day observations and social theories. As tuition and fees at elite institutions have been rising in recent decades, we had every reason to expect that college quality should pay off. The major findings of this study that helped reconcile these discrepancies were inventoried as follows.

First, the estimated effect of college quality on earnings is sensitive to the measure of college quality although the conclusion that it pays to attend high-quality colleges is robust to different measures of college quality. Whenever the effect of college quality is discussed, a primary concern of researchers is how to measure college quality. Many have argued that measures of quality such as those used in this dissertation are actually measuring “selectivity” instead of “quality.” Ignoring any potential profound differences between these two concepts, implicit in the suggestion are a couple of important points: College quality is multidimensional, and there has yet been no agreed-to way to measure college quality. In fact, this study shows that the effect of college quality may be sensitive to how college quality is measured.

Previous research uses a host of measures of college quality, including the Carnegie Classification system, mean or median SAT score of entering freshmen class, tuition and fees, per FTE educational expenditure, Gourman ratings, and recently Barron’s ratings. Some of them (Barron’s ratings, mean SAT score of entering freshmen class, tuition and fees, and Carnegie Classification) are experimented with in this study to examine the sensitivity of the estimated effect of college quality to different measures. If it turns out that the estimated effect of college quality is sensitive to these different measures, then the various measures of college quality used in previous studies may explain some of the discrepancies among the different estimated effects reported.

My analysis shows that great variation in the effect of college quality exists across different measures although the estimated effect of college quality is generally positive and statistically significant regardless of its measure. For example, the estimated earnings advantage of graduating from high-quality institutions (both public and private) is about 20% relative to graduating from low-quality institutions when Barron's ratings are used. However, this figure reduces by half when the mean SAT score is used instead. Because the Carnegie Classification system is based on number of doctoral programs and federal research funds (both criteria emphasize faculty research and graduate program more than undergraduate education), it does not seem to capture the "quality" of undergraduate education well. For example, earning a degree from a Liberal Arts I institution does not appear to provide particular earnings advantages relative to graduating from a Liberal Arts II institution. Or, in view of later findings in this study, it is safe to say that students graduating from Liberal Arts I institutions fail to convert institutional quality into immediate economic benefits. Tuition and fees appear to be highly correlated with graduates' earnings, especially for private institutions. My general sense is that the smaller the proportion of institutions tagged as high-quality, the larger the estimated effect of college quality.

The sensitivity of the estimated effect of college quality to how it is measured helps resolve some of the discrepancies among previous studies. For example, using the college quality measure constructed from Barron's ratings, Brewer et al. (1999) found that the effect of private elite colleges was in the order of 20-40% relative to low-quality public institutions. I find an effect of college quality with similar magnitude to that in Brewer et al. in the current analysis when Barron's ratings are used. Thomas (2003), however, using the college quality measure constructed from the mean SAT scores of the entering class, found that the effect of private elite colleges was in the order of 10%

relative to low-quality institutions. Other studies using mean SAT score as college quality usually end up with a relatively small or no effect of college quality on earnings (e.g., Dale & Krueger, 1999; Griffin & Alexander, 1978; Loury & Garman, 1995; Morgan & Duncan, 1979; Mueller, 1988; Rumberger & Thomas, 1993; Trusheim & Crouse, 1981).

Despite the sensitivity of the estimated effect of college quality to its measures, the general conclusion that it pays to attend high-quality college holds. My sense is that when a small proportion of institutions are tagged as high-quality and the estimated effect is relatively large, the average cost differences between high-quality and low-quality colleges are also large. Similarly, when a relatively large proportion of institutions are tagged as high-quality and the estimated effect is relatively small, the average cost differences between high-quality and low-quality colleges are also small. The most intuitive comparison is provided by the regression where tuition and fees are used as a measure of college quality. The analysis indicates that a $1,000 increase in tuition and fees annually at private institutions is associated with $733 earnings increase annually, and at public institutions the same amount increase in tuition and fees is associated with a $570 earnings increase annually. Put in a slightly different way, assuming an average of four-year period of college education and no discounting factor, on average it takes less than six years for students from the private institutions and about seven years for students from the public institutions charging higher tuition and fees to break even on the differences in tuition and fees.

Second, graduates from colleges of varying quality may have different earnings trajectories over their careers, so comparing earnings differences at the early stage of *graduates' careers may be misleading*. Due to the lack of available longitudinal data, most work on economic returns has focused on the returns to college quality at discrete points in time. Because extensive national data on labor market outcomes of college graduates are still a recent phenomenon, most studies can only compare the earnings differences at the early stage of graduates' career. For example, the B&B: 93/97 has earnings data only four to five years after college graduation. Many studies on this subject examine the 1986 earnings for the well-known NLS-72 cohort, a span of about 10 years since college graduation.[68] However, college quality may have different effects over one's lifetime. That is, college quality influences earnings trajectories; focusing on one point in time could well be misleading.

Studies such as Brewer et al. (1999) have noted a trend of increasing impact of college quality during the early stage of graduates' careers. Yet to date, no serious consideration of modeling and testing has been given to this issue. Due to the same data limitation, I am unable to examine the effect of college quality over one's lifetime. To test the hypothesis that college quality may have different effects over time, however, earnings data at two points several years apart are instructive. In this study, I compare the effect of college quality on graduates' earnings one to two years and four to five years after graduation.

My analysis shows that the earnings gap between graduates from low-quality and high-quality colleges has significantly increased between the two points in time. For

[68] It is noteworthy here that the B&B is representative of baccalaureate recipients whereas most surveys such as HSB, NLS-72, and NELS-88 are not.

example, the wage gap between graduates from high-quality private college and those from low-quality public institutions has more than tripled between 1994 and 1997 (a 22% gap versus a 7% gap). Similarly, the wage gap between graduates from high-quality and low-quality public institutions has increased from about 9% to 20%, suggesting a more than doubled gap in 1997 relative to 1994. Thomas (2003) showed that, on average, earnings of graduates from all types of colleges have grown significantly between these two time periods, but those graduates from high-quality institutions, especially high-quality private colleges, increased their earnings the most.

Considering that the earnings gap examined here is the relative gap, the increasing earnings dispersion among graduates from colleges of varying quality is indeed an important finding. Given that graduates from low-quality colleges earn less than those from high-quality colleges, it is not surprising that the absolute earnings gap (in actual dollar terms) widens over time, assuming that all graduates share the same growth rate. It is perhaps more than that, however. My analysis shows that the earnings of those from high-quality institutions grow at a faster pace than those from low-quality institutions, resulting in a widening relative gap (in terms of logged earnings) among graduates from colleges of different quality. If earnings partially reflect one’s occupational position, this increasing earnings gap would probably suggest quite different career paths among graduates from colleges of varying quality. I do not attempt to identify the mechanism through which college quality plays a role in one’s career development; however, it appears that college quality has an influential impact not only on one’s initial occupational position but also on one’s career paths.

College quality may have different effects on earnings over individuals' career spans. Therefore, the relative small effect of college quality on earnings usually examined at the early stage of graduates' career may be valid but problematic if it is generalized over one's lifetime.

Third, there exists variability in the effect of college quality among students with different characteristics such as gender, race/ethnicity, family income, parental education, ability, and major field of study; the average effect of college quality disguises much of the variation. Previous studies have consistently shown that demographic characteristics, family backgrounds, and educational experience all figure into patterns of economic status (e.g., James et al., 1989). For example, females and minorities earn significantly less in the labor market; socioeconomic variables have both direct and indirect effects on earnings; and academic performance and major fields of study affect earnings significantly. Yet less is known about how these factors figure into the relation between college quality and earnings. Essentially, the question here is whether different groups of students are able to realize the same economic advantage from earning degrees at high-quality colleges. The research on this issue is rather thin, and the recent existing evidence is ambiguous. Based on a few studies, Anderson and Hearn (1992) reached some vague conclusions with regard to the interaction between individual characteristics and the effect of educational attainment.

My analysis explores this interaction on a larger scale by examining the different effects of college quality on various dimensions. As far as gender is concerned, female students benefit less from earning degrees at high-quality colleges than do male students although the difference is not statistically significant. This finding is consistent with the observation that female students are somehow less likely to attend high-quality colleges than male students (although the difference is not statistically significant either). Because earning a degree at a high-quality college is worth slightly less for female students, they have less incentive to do so. My conclusion with regard to the interaction between gender and the effect of college quality seems to run against what Anderson and Hearn (1992) conclude in their review of previous studies although they caution that the complexity of measuring returns and the different career and family patterns of men and women make definitive conclusions difficult.

If the variation in the effect of college quality on earnings by gender is not all that clear, the variation by race/ethnicity is much more obvious. For non-White graduates (technically defined as Native Americans, Hispanics, and Blacks), earning degrees from middle-quality institutions and low-quality private institutions has very small and statistically non-significant effects on earnings relative to graduating from low-quality public colleges; however, substantial earnings advantages are provided to non-White graduates of high-quality institutions. A degree from a high-quality public college yields an almost 30% earnings advantage, and even greater advantages (43%) are associated with receiving a degree from a high-quality private institution. That is, for non-White students, all that matters is high-quality institutions. For White graduates, all categories of college provide large and statistically significant earnings advantages relative to low-quality public institution; however, having a degree from a high-quality college does not provide the same level of boost to their earnings that non-Whites enjoy. In short, college quality matters more for non-White graduates than for White graduates.

I also examine the interaction between the effect of college quality and socioeconomic status. In particular, effects of college quality among students of different family income and parental education level are studied. In terms of family income, it seems that earnings of students from low- and middle-income (especially middle-income) families are more sensitive to college quality than those from the top-income families. That is, college quality matters more for students from low- and middle-income families than for those from upper-income families. The results with regard to the other dimension of socioeconomic status, parental education, are very similar to those shown for family income. That is, although, on average, earning degrees from high-quality colleges improves graduates' earnings, the positive effect is more evident for students from families of low and middle levels of education than for those from well-educated families. In fact, my results suggest that the earnings of those who are from the best-educated families are not very sensitive to college quality.

Finally, variability in the effect of college quality exists along academic dimensions such as intellectual ability (measured as SAT/ACT quartile) and undergraduate major. The interaction between ability and the effect of college quality is not very clear. It seems that the highest effect of college quality appears for students in the lowest and second-highest quartiles (the estimated effect of graduating from a high-quality college is near 40% for these two groups), and earnings of students in the highest quartile are the most insensitive to college quality (the estimated effect of graduating from a high-quality college is about 6%). If a pattern exists, it would suggest that students with low and middle abilities benefit the most from earning degrees at high-quality colleges, and students with the highest measured intellectual ability are most insensitive to college quality. Given the intricate relation between ability and socioeconomic factors, this pattern seems to confirm what I have concluded with regard to the effect of college quality along socioeconomic dimensions.

The interaction between undergraduate major and college quality has been less often examined in higher education research (see Rumberger & Thomas, 1993 for such a study). Usually, college quality and college major enter earnings equation independently, explicitly assuming that college quality would affect students of different majors in much the same way. Yet great variation in the effect of college quality exists among different major fields of study. For example, for business majors, college quality is a strong determinant of their earnings, and for engineering majors, college quality does not seem to be a particularly important factor in determining their earnings. For social science majors, only high-quality public institutions matter. And for education majors, only high-quality private colleges matter.[69] Low-quality private institutions provide large benefits for certain majors such as health, perhaps due to their more career-oriented programs.

The above analyses point to the variability in the effect of college quality among different groups of graduates. Hence the relatively small effect of college quality on

[69] One possible explanation is that education majors from high-quality colleges may not hold education related jobs. In the full sample, Among the 456 (11.5% of the full sample 3,965 students) education majors, 39 of them are from high-quality colleges, with the remaining from other categories. About 40% of the 39 education majors from high-quality colleges and 62% of the education majors from other categories hold education related jobs in April 1997.

earnings documented in previous studies disguises much of the dynamics of the impact of college quality across individuals. In short, the average effect of college quality might not be generalizable to a particular group of students.

Fourth, the effect of college quality on earnings is not homogenous across the earnings distribution. College quality has little impact at the bottom of the earnings distribution but has a larger impact at the top of the distribution. The relatively small effect of college quality shown in previous studies not only disguises its dynamics among individuals but also masks its variation across the earnings distribution. Examining the effect of college quality across the earnings distribution helps resolve the discrepancy between two basic observations: (1) the relatively small effect of college quality on average, and (2) the disproportionate representation of individuals from high-quality institutions (especially private elite institutions) among the most successful group in American society. Taking these two observations as given, one may come up with a hypothesis that college quality may have a large effect at the top of the earnings distribution (which results in the high proportion of graduates from high-quality colleges among the most successful group) and a small effect at other places in the distribution (which results in relatively small average effect).

My analysis using quantile regression confirms this hypothesis. Results indicate that at the bottom of log earnings distribution (e.g., 5^{th}, 10^{th}, and 25^{th} percentiles), the effect of graduating from high-quality colleges relative to low selective publics is either insubstantial or non-significant. The earnings gap becomes substantial when moving toward the top of the earnings distribution, with the largest divergence occurring at the very top of the earnings distribution (e.g., 90^{th} and 95^{th} percentiles), where the advantage exceeds 30% for graduates from private high-quality colleges relative to low-quality institutions. It seems, then, that although graduating from a high-quality college may not have large effects on average, it is a key in reaching the very top of the earnings distribution.

Fifth, the non-economic effect of college quality may add substantially to the effect of college quality on students' outcomes. Not only does college quality have a positive effect on earnings, it also has a significant non-economic effect as well. Since it can be shown that college quality has a positive effect on non-monetary outcomes, then focusing on economic benefits alone understates the effects of college quality. In this study, I analyze the effect of college quality on two non-economic outcomes: graduate education and job satisfaction.

College quality has a large and significant positive effect on graduate education in several important ways. First, students from high-quality colleges are more likely to enroll in graduate programs within four to five years after college graduation. For example, relative to students from low-quality public colleges, students from high-quality private and public colleges are about 16-18% more likely to enroll in some kind of graduate program within four to five years of baccalaureate graduation.

Second, among those students who actually enroll in graduate programs, students from high-quality public colleges are more likely to enroll in doctoral programs although the effect is relatively small. This relatively small effect could be explained by the fact that, in the current analysis, MBA and first professional programs are considered as master's programs.

Third, among those students who actually enroll in graduate programs, students from high-quality colleges are more likely to attend research universities. The correlation between the quality of undergraduate colleges and the quality of graduate schools is very strong. For example, on average students from high-quality undergraduate institutions, relative to those from low-quality 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.

Finally, I consider the effect of college quality on graduate degree attainment. Although the time span is not long enough to expose the effect of college quality completely, my analysis confirms the strong positive effect of college quality on graduate degree attainment. For example, students from high-quality colleges are more likely to complete their graduate degree within four to five years after college graduation; among those students who have actually received their graduate degree within four to five year, those from high-quality colleges are also more likely to have received their degrees from a research university.

The positive effect of college quality on graduate education adds significantly to the relatively small effect of college quality on earnings in a couple of important ways. First, earning degrees at high-quality colleges not only provides direct economic benefits, it also provides extra utility by enhancing the opportunity to obtain further education. Second, graduate education may in return further enhance individuals' economic status. That is, college quality may have an indirect economic effect through its impact on graduate education. As such, in those studies where terminal BA recipients and advanced degrees holders are pooled together (i.e., the total effect of college quality is examined), the effect of college quality is usually larger than comparing the earnings differences among terminal baccalaureate holders.

The non-economic outcome analyzed in this study, job satisfaction, seems to be negatively affected by college quality. Other things being equal, college quality generally has a negative direct effect on graduates' job satisfaction; this is especially true for graduates from private institutions. However, this negative direct effect of college quality is attenuated by its positive indirect effect through earnings, resulting in a non-significant total effect in some cases. For example, the negative effect of high-quality institutions on graduates' satisfaction with benefits is greatly reduced by the positive effect of high-quality institutions on earnings. In cases where the link between earnings and satisfaction is weak, the negative direct effect of college quality cannot be attenuated by its positive effect on earnings. For example, the negative effect of college quality on graduates' satisfaction with general working conditions is not lessened when earnings are excluded from the model.

This negative effect of college quality on job satisfaction points to the interaction among increased college costs, heightened expectation, and realized economics benefits. Bowen (1968) observed that tuition at a set of high-quality private institutions rose on average two to three percentage points more than inflation each year during the 1905 to 1965 period, and this trend continued during the period from 1966-67 to 1997-98 (Ehrenberg, 2000). The increasing cost of attending colleges may not be a problem as long as family income keeps the same pace of growth, which is the case for most years before the 1980s. Since then family income has stagnated for various reasons, but the cost of attending college has kept increasing at a pace two to three percentage points more than inflation each year. The same period also witnesses a shift in public discussion from emphasizing a college education as a public good to a private good. All these trends have heightened students' career expectation from attending colleges, especially high-quality colleges. The direct negative effect of college quality might be an indication that the realized benefits from attending high-quality colleges fall short of career expectations. In fact, Thomas and Zhang (2002) compared the effect of college quality on job satisfaction at two points in time and reported that as the effect of college quality became larger, the negative effect of college quality became smaller (in absolute value).

In conclusion, previous economic studies on the effect of college quality have either ignored the variation in the economic effect of college quality across various dimensions (such as measures of college quality, different points in time over one's career, students of different demographic characteristics and family backgrounds, and different points in the earnings distribution) or overlooked the non-economic aspect of the effect. Thus, the relatively small effect of college quality noted in previous studies is somewhat misleading or, at best, incomplete. Although it is important to identify the discrepancies among previous studies and between empirical results and social theories, it is more constructive, from a sociological perspective, to formulate the social role of college quality from the analysis of this study. That is, what have we learned from this study about the role of college quality in society?

Five major themes from this study are particularly important in understanding the role of college quality. First, college quality has a significant effect on graduates' earnings although great variation in the effect of college quality exists along various dimensions. For example, graduating from a high-quality college provides a roughly 20% earnings advantage relative to graduating from a low-quality college. Further, this earnings advantage appears to increase over the early stage of graduates' career. On the other hand, social class variables such as family income and parental education do not seem to have a large direct effect on graduate earnings. For example, an increase in family income by $10,000 only increases graduates' earnings by less than 1%. Being a first-generation college graduate is associated with a small and usually statistically non-significant earnings penalty. Apparently, socioeconomic factors such as family income and parental education do not tend to have direct effects on earnings.

Second, socioeconomic factors such as family income and parental education have a positive and significant effect on the probability of earning a degree at a high-quality college. This effect is both direct and, more importantly, indirect. Other things being equal, students from wealthier and better-educated families are more likely to hold degrees from high-quality colleges. But things are not equal. The analysis of the determination of individuals' intellectual ability reveals that part of the socioeconomic factors have been crystallized in one's intellectual ability. This indirect effect, through the tight connection between socioeconomic factors and ability and between ability and college quality, is substantial. Indeed, Carneiro and Heckman (2002) found that family income crystallized in 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 tend to exert indirect effects on earnings through their impact on individuals' propensity to invest in education rather than to have a direct effect on earnings (Hearn, 1984; Karabel & Astin, 1975; Rumberger, 1983).

Clearly, in terms of earning degrees at high-quality colleges, social reproduction theory is strongly supported by the current analysis. It is supported not only by the strong effect of socioeconomic factors on the probability of earning degrees at high-quality colleges, but also more subtly by the strong connections among socioeconomic factors, ability, and college quality. The latter indirect connection disguises social reproduction by the principle of meritocracy. In essence, 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 (Hearn, 1984).

Third, the emphasis on educational inequality among social classes should not dwarf the positive role of college quality in promoting economic and social mobility in American society. Graduating from high-quality colleges provides a special boost to non-White students relative to White student although the effect of college quality is also substantial for White students. Examining the effect of college quality by two major parameters of socioeconomic status yields more or less the same results. The effect of college quality appears to be larger for students from low- and middle-income families than for those from the top-income families. So too, the effect of college quality is larger for students from low- and middle-educated families than for those from highly educated families. The pattern in the effect of college quality by students' ability further confirms the above conclusion.

The relatively larger effect of college quality for lower-class students suggests that graduating from high-quality colleges provides them with great upward mobility in economic and social status. Social reproduction theory suggests that lower-class students might not have the necessary cultural capital to take full advantage of high-quality education; my analysis indicates otherwise. Bowen and Bok (1998), using data from College and Beyond, showed that attending selective institutions "pays off for individuals of all races, from all backgrounds" (p. 276) although due to data constraints they were unable to compare the magnitude of benefits from attending high-quality institutions among different students. These results suggest that disadvantaged students can equally or even better benefit from receiving high-quality college education if they are given the opportunities.

Fourth, the relatively larger effect of college quality for lower-class students, however, does not suggest the advantageous position of lower-class students in American higher education. Certainly, most researchers in higher education are skeptical, if not cynical, about results that college quality has a larger effect for disadvantaged students. At a recent professional conference, one presenter, who was clearly a critical researcher, bemoaned that some researchers even found that effect of education was greater for

Black than for White students. My analysis and other work suggest that it is greater (see Anderson & Hearn, 1992, for a literature review and Dale & Krueger, 1999, for a recent study); however, the larger effect does not necessarily suggest that disadvantaged students are in an advantageous position in higher education.

The key here is to distinguish the inequality in the educational attainment and the difference in the effect of educational attainment among social classes. In fact, my finding that lower-class students are less likely than upper-class students to attend high-quality colleges yet at the same time lower-class students may benefit more from attending high-quality colleges is consistent with the human capital argument. From the human capital perspective, students equate the return of investing in high-quality education to the price of such an investment. Because lower-class families have fewer resources to finance a high-quality college education, the price of investing in high-quality education is necessarily higher for lower-class families than for upper-class families.[70] In other words, because a high-quality education is relatively more expensive for lower-class students than for upper-class students, the former tend to under-invest in it and at the same time the return to such an investment is higher for the former than for the latter.[71] Thus, the empirical finding that the less advantaged student can actually benefit

[70] Note that the argument here is different from the typical human capital argument with credit constraints (e.g., Card, 2001) where the lifetime income is maximized by choosing the quantity of education. By choosing different types of college education, the quantity of education is assumed to be the same (although many may argue that it takes less time to graduate at high-quality colleges than at lower-quality colleges).

[71] The return of receiving a high-quality education is analogous to the effect of college quality when the cost of a high-quality education is the same across individuals. Arguably, the absolute cost of attending high-quality colleges is less for low-class students than for upper-class students because the former usually receive substantial financial aid at those institutions; however, the relative price of a reduced cost of attending a high-quality college could still be higher for students from lower-class families than for those from upper-class families. In other words, despite the financial aid available at high-quality colleges, they are still less affordable for lower-class students than for upper-class students.

more from high-quality education does not contradict the fact that lower-class students are less likely to attend high-quality colleges than upper-class students.

Fifth, having a degree from a high-quality college, especially a private elite institution, has a large effect at the top of the earnings distribution, suggesting that a high-quality education is very important for individuals who wish to reach the very top positions. In this study, I use quantile regression to examine the effect of college quality across the earnings distribution and find that a larger divergence in earnings among students from colleges of varying quality occurs at the top of the earnings distribution rather than at the bottom of the distribution. The current analysis suggests that college quality may not have a large effect on average, but it provides special advantages to those who have reached the very top of the distribution.

From all five major themes taken together, my conclusion is simple. College quality, while providing important opportunities for economic and social mobility, at the same time plays an important role in preserving and perpetuating the socioeconomic status in American society. The American politics of democracy and ideology of meritocracy endorse a social norm that stresses achievement, more so than ascribed advantages. In other words, the criterion for success is *what you achieve* rather than *who you are*. Thus high-quality college education provides a small yet important pipeline through which lower-class children are able to attend high-quality colleges and capture the associated rewards. In this sense, America can be pictured as the land of opportunity.

Nevertheless, the emphasis on achievement by no means denies intergenerational transmission of socioeconomic status. Given the achievement criteria, members of the upper class devote their wealth to providing the high-quality education necessary for their children in order to *demonstrate/obtain* achievement. College quality (as well as educational quality in general) serves well as an apparatus to convert wealth and social status into achievement. Arguably, from children's early days of life, the quality of educational institutions selected by upper-class families, especially those with the highest income, in most cases is superior to the quality of institutions selected by lower-class families, especially those with the lowest income. Upper-class families, through choosing high-quality education for their children, are able to transmit their socioeconomic status to the next generation. In short, the elites are about achievement, but the accomplishments they triumph are easier to reach for those of status and wealth than for those lacking such advantages. In this sense, the United States can also be described as the place where the rich get richer and (most of) the poor stay poor. Indeed, college quality "enables" class to work its advantages.

In sum, I see conflicting roles of high-quality colleges in American society. They offer mobility while preserving the status quo; they promote (some) equality while perpetuating inequality. As a result, theories often succeed in predicting and explaining some findings but not all of them. Human capital theory, which perhaps explains the positive effect of a high-quality college education, ignores the intricacy among social class, intellectual ability, and educational attainment. In contrast, social reproduction theory, which better captures the intertwining relationship among these factors, fails to recognize the substantial economic mobility enjoyed by lower-class students graduating from high-quality colleges.

In concluding my study, I look at the implications of my data and theory for the future of finance in American higher education. The findings of my analysis suggest that high-quality colleges have made certain successes in providing economic benefits to lower-class students, thus promoting the social and economic equality importantly. On other hand, my data and theory also suggest that not many lower-class students were given equal opportunities to receive a high-quality education. The bias is both directly through relatively higher costs and indirectly through relatively lower ability. For sure, were it not for the huge amount of need-based student aid, the situation would have been much worse. I suggest that equality could further be promoted at two levels.

First, need-based aid especially need-based grants should be increased to take down the financial barrier of attending high-quality colleges for students from low-income families. Despite the fact that these high-quality colleges put an enormous money and effort in providing equal opportunities for students from all class, my analysis in Chapter 3 still shows that everything being equal, students from upper-class families are more likely to earn degrees from high-quality colleges than those from lower-class families. The relatively larger effect of college quality for lower-class students is also suggestive that the relative price of attending high-quality colleges is higher for lower-class students than for upper-class students. In many high-quality institutions, need-based financial packages still include a substantial proportion of loans that effectively create financial barriers for lower-class students.[72]

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[72] When resources are relatively plentiful, these high-quality institutions are able to eliminate need-based loans. Unfortunately, till now I am aware of only one institution (Princeton University) that is able to do so.

Second, students of disadvantaged classes should not only have the same opportunity in terms of college admission and choice as others (that is good but not enough), but this equal opportunity should be provided much earlier. Removing the financial barriers for students from lower-class families is likely to provide them with equal opportunities in attending high-quality colleges. Yet, as I have argued, because social reproduction is also through crystallized family factors in the form of individual ability, financial aid policies of postsecondary education are not likely to solve the long-term inequality issue. Putting it simply, because not many students from poor families are qualified for high-quality institutions, even if financial barriers were completely removed, they would still represent a small proportion of students at high-quality institutions. Thus policies of postsecondary education are not effective in uprooting the causes of the realized inequality.

This second policy implication clearly goes beyond the realm of higher education. Given the amount of public resources available to promote the social equality, policy makers should decide where and when best to allocate these resources. A recent study by Dearing, McCartney, and Taylor (2001) found that a small amount of money could make a big difference for young children from poor families in early stage of their academic career. The well-known Tennessee's Project STAR provided further evidence that smaller class size (more financial resources) had a significant positive effect on students' achievement during grades K-3 and this positive effect was much larger for minority students than for others. Furthermore, after the students had returned to regular size classes, achievement effects tended to persist in higher grades (Finn & Achilles, 1999;

Krueger, 1999; Krueger & Whitmore, 2001; Nye, Hedges, & Konstantopoulos, 1999). Considering the large and persistent effect of financial resources on students' achievement at their young age, perhaps that is the best time when educational policies can make a real difference to those from poor families.

The value of equality should be emphasized especially in view of the changing demographics of student body and increasing costs of high-quality education. Due to immigration and high birth rate, the under-represented minority population is growing at a faster rate than the White population. Non-White students represent an increasingly larger proportion in younger student cohort. For example, my own calculation from the published NCES Common Core data indicates that from school year 1997-98 to 2001-02 the percentage of non-White high school graduates has steadily increased from 28.5% to 30.7%. It also reveals that in school year 2001-2002, non-White students represent 32.2% of the 12th graders, 38.0% of the 8th graders, and 42.8% of the first graders. Another NCES survey shows that in 2000-2001 only less than half (49%) of the public school pre-kindergarten children are White, 24% are Hispanics, and 23% are Blacks (Smith et al. 2003). Meanwhile, due to stagnate median family income and rising tuition at high-quality colleges in last couple of decades, high-quality college education became less affordable for more American families. For example, Ehrenberg (2000) documented that the tuition and fees at Cornell University as a share of median family income in the United States rose from 28% in early 1980s to 49% in later 1990s. These dynamics urge a continued and expanded attention on the equality issue in American higher education.

It should be cautioned, however, that equality is not the single value pursued by high-quality institutions (higher education in general). In fact, other values such as efficiency and liberty are equally essential to high-quality colleges.[73] For example, high-quality institutions should take the responsibility for educating the best students in the nation and around the world, especially in the current political economy of global competition. Therefore, some preferential packaging and merit-based aid are necessary to encourage and attract the best students into fields of great importance to national economy. Because my data and theory in this study do not yield much insight into these issues, I leave those to future studies.

[73] For a detailed discussion on some of the core values pursued by educational policy, see Garms, Guthrie, & Pierce (1978).

APPENDIX A

SELF-SELECTION BIAS

Theory

The leading econometric problem in the baseline model is the self-selection bias. Arguably, students self-select colleges partially on the basis of students' characteristics and the expected labor market payoff. That is, college type cannot be treated as an exogenous determinant of earnings. Correction for self-selection bias has been well known in econometrics since Heckman (1979) and Lee (1983)[74]. Yet, there has been no agreed upon way to achieve this goal. One way would be to use data for comparable groups to eliminate unobserved effects (1996; Dale and Krueger, 1999). A second way would be to find an instrumental variable to take care of the endogeneity problem (Berhmen et al., 1996). A third way would be the Heckman-type selection correction model. Usually, this type of selection model consists of two equations:

$$Y_s^* = X_s \beta_s + \varepsilon_s \tag{A.1}$$

$$Y_0 = X_0 \beta_0 + \varepsilon_0 \tag{A.2}$$

(A.1) is often called the selection equation, and (A.2) is the outcome regression, where Y_0 is only observed when $Y = 1$ (i.e., $Y_s^* > 0$ in the probit model). Various assumptions are imposed on the error terms (after normalizing $V(\varepsilon_s) = 1$),

[74] Amemiya (1973) derived a Heckman-type selection correction element in a regression model when the dependent variable was truncated normal.

$$\begin{pmatrix} \varepsilon_s \\ \varepsilon_0 \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \sigma_{0s} \\ \sigma_{0s} & \sigma_0^2 \end{pmatrix}\right) \tag{A.3}$$

Because Y_0 is only observed when $Y_s^* > 0$, the expectation of Y_0 is conditional on $Y_s^* > 0$:

$$E(Y_0) = X_0\beta_0 + E(\varepsilon_0 | Y_s^* > 0) \tag{A.4}$$

From (A1), we have

$$E(\varepsilon_0 | Y_s^* > 0) = E(\varepsilon_0 | \varepsilon_s > -X_s\beta_s) \tag{A.5}$$

By applying the joint normality of error terms, we get

$$E(\varepsilon_0 | \varepsilon_s > -X_s\beta_s) = \sigma_{0s}E(\varepsilon_s | \varepsilon_s > -X_s\beta_s) = \sigma_{0s}\frac{\phi(X_s\beta_s)}{\Phi(X_s\beta_s)} = \sigma_{0s}\lambda \tag{A.6}$$

In theory, if λ can be estiamted consistently, it is possible to remove the selection bias in (A2) by adding $\hat{\lambda}$ in the regression. There are several ways to estimate λ by different assumptions for the error term (such as normal, uniform, and logistic distribution) in the selection equation. Due to the multinomial nature of the selection process in this study (i.e., more than two categories of colleges), Lee's (1983) utitlity maximazing framework (i.e., multinomial logit model for the selection model) is used here. This approach has been employed to estimate the effect of college quality by Brewer and Ehrenberg (1996) and Brewer et al. (1999). It consists of the following equations:

$$I_{ji} = Z_i\delta_j + \mu_{ji} \tag{A.7}$$

Equation (A.7) defines a linear utility function for individual *i* in college type *j*.[75]

$$I_i = j \text{ iff } I_{ji} > MaxI_{kj}(k \neq j) \tag{A.8}$$

Equation (A.8) suggests that the individual *i* chooses college type *j* if and only if his or her utility is maximized in college type *j*. After we define $\varepsilon_{ji} = MaxI_{kj} - \mu_{ji}$, Equation (A.8) is transformed into Equation (A.9).

$$I_i = j \text{ iff } \varepsilon_{ji} < Z_i\delta_j \tag{A.9}$$

Equation (A.9) can be estimated as a multinomial logit model:

$$\Pr(\varepsilon_{ji} < Z_i\delta_j) = \Pr(I_i = j) = \frac{\exp(Z_i\delta_j)}{\sum \exp(Z_i\delta_j)} \tag{A.10}$$

Having estimated the choice model of Equation (A.10), we can construct the selectivity correction term for each individual, using the method developed by Lee (1983):

$$\lambda_{ji} = \frac{\phi(H_{ji})}{\Phi(H_{ji})}, \text{ where } H_{ji} = \Phi^{-1}(P_{ji}) \tag{A.11}$$

where $\phi(.)$ and $\Phi(.)$ are the probability density function (PDF) and cumulative distribution function (CDF) of the standard normal. Finally, the estimated λ is added to the original earnings equation (Equation 2.1 in the baseline model) and re-estimate it by omitting the college quality variables.

$$\ln(Y_{ij}) = \beta_0 + \beta_1 D_{ij} + \beta_2 F_{ij} + \beta_3 A_{ij} + \beta_4 J_{ij} + \beta_5 \hat{\lambda} + \varepsilon_{ij} \tag{A.12}$$

[75] The linear utility function may not be as restrictive as it appears to be, because in theory polynomial terms can always be added to the equation to approximate any smooth utility functions.

Estimation

As laid out above, the estimation of a selection model involves two stages: a selection model to obtain the selection term $\hat{\lambda}$ and a usual regresssion model with the selection term. In the baseline model, there does not seem to exist significant differences in the effect of college quality by types of control; I simplify the model by using three categories instead of six categories of college quality. As a result, the first-stage selection model is identical to the multinomial logit model in the previous chapter. The only difference is that in this analysis, the sample is restricted to 3,965 students. Because the first stage multinomial estimates are not much different from that in Chapter 3, only the regression results from the second stage is presented here. Table A.1 shows the estimates of Equation (A.12) for each category of college. I use these three regressions to calculate earning differentials among graduates from different types of colleges. First, the mean predicted log earnings for each category is calculated using the following formula:

$$\ln(\hat{Y}_{ij}) = \hat{\beta}_0 + \hat{\beta}_1 D_{ij} + \hat{\beta}_2 F_{ij} + \hat{\beta}_3 A_{ij} + \hat{\beta}_4 J_{ij} + \hat{\beta}_5 \hat{\lambda} \tag{A.13}$$

The differences among the mean predicted log earnings can computed. This difference is conditional on individual’s actual choice, and sometimes it is named as the conditional differential. The unconditional differential, with selection bias removed, is calculated by differencing the mean predicted log earnings without the selection term:

$$\ln(\hat{Y}_{ij}) = \hat{\beta}_0 + \hat{\beta}_1 D_{ij} + \hat{\beta}_2 F_{ij} + \hat{\beta}_3 A_{ij} + \hat{\beta}_4 J_{ij} \tag{A.14}$$

The means of predicted log earnings, both conditional and unconditional, are presented in Table A.2. For example, the conditional predicted log earnings are 10.2477, 10.3391, and 10.4480 for graduates from low-quality, middle-quality, and high-quality

Table A.1

OLS Estimates for Earnings Equation, Selection Corrected (absolute value t statistics)

	Low-quality		Middle-quality		High-quality	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Constant	8.7379	25.29	8.7489	41.84	10.8142	14.26
Institutional Characteristics						
Historically Black coll. and inst.	-0.1087	1.46	-0.0908	1.32		
Demographic Characteristics						
Female	-0.0413	1.17	-0.1148	6.24	-0.0850	1.98
Native American	0.1685	0.97	0.0887	1.05	0.1500	1.61
Asian	0.1673	1.64	0.1355	2.92	0.0996	1.44
Black	-0.0676	1.18	-0.0029	0.07	0.0974	0.85
Hispanic	0.0121	0.12	0.0340	0.79	0.2241	2.12
Family Background						
Family income (in $10,000)	0.0206	4.59	0.0066	3.06	-0.0008	0.44
First-generation college graduate	-0.0036	0.11	-0.0303	1.77	-0.0415	0.88
Academic Background						
Merged SAT/ACT quartile	0.0236	1.36	0.0168	1.82	-0.0458	1.81
Business major	0.2165	4.30	0.2871	9.49	0.3422	3.81
Engineering major	0.4983	7.74	0.4258	11.24	0.4169	5.02
Health major	0.4851	7.90	0.4185	11.06	0.3947	4.41
Public affairs major	0.0294	0.37	0.1973	4.27	0.3501	2.21
Biological science major	0.1874	1.81	0.1611	2.77	0.0692	0.57
Math science major	0.4636	5.97	0.3931	8.71	0.1549	1.57
Social science major	0.1104	1.59	0.2182	5.41	0.1751	1.68
History major	-0.8250	3.42	0.1540	2.65	0.0364	0.20
Humanity major	0.1874	3.15	0.1306	3.24	0.0472	0.51

Table A.1 – *Continued*

	Low-quality		Middle-quality		High-quality	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Psychology major	0.0237	0.28	0.1693	3.58	-0.0144	0.15
Other major	0.1418	2.40	0.1606	4.53	0.0722	0.85
Labor Market						
Age	0.0347	1.88	0.0397	3.65	-0.0461	1.11
Age squared / 100	-0.0455	1.90	-0.0455	3.25	0.0533	1.06
Tenure	0.0011	0.11	0.0184	3.36	0.0309	1.10
Tenure squared /100	0.0356	0.79	-0.0087	0.36	-0.2548	1.02
Number of hours per week	0.0153	6.56	0.0125	8.77	0.0094	2.82
Lamda (i)	-0.0861	2.82	-0.0387	1.09	-0.0075	0.29
N	811		2671		483	
R^2	0.3361		0.2190		0.1893	

colleges, respectively. So the conditional log earnings differential between graduates from middle-quality and low-quality colleges is about 0.09, and that between high-quality and low-quality colleges is about 0.20. These estimates are very similar to what we have obtained in the pooled baseline model. The unconditional log earnings differentials, with selection bias accounted for, are smaller than the conditional differentials. For example, the unconditional predicted log earnings are 10.3323, 10.3526, and 10.4530 for graduates from low-quality, middle-quality, and high-quality colleges, respectively. So the unconditional log earnings differential between graduates from middle-quality and low-quality colleges is about 0.02, and that between high-quality and low-quality colleges is about 0.12.

Table A.2

Conditional and Unconditional Earnings Differentials

	Low-quality		Middle-quality		High-quality	
	Earnings	S.E.	Earnings	S.E.	Earnings	S.E.
Predicted earnings (conditional)	10.2477	0.302	10.3391	0.218	10.448	0.216
Earnings differentials (conditional)			0.0914	0.373	0.2003	0.371
Predicted earnings (unconditional)	10.3323	0.307	10.3526	0.218	10.4530	0.216
Earnings differentials (unconditional)			0.0203	0.377	0.1211	0.375

Although this Heckman-type selection model is theoretically very appealing, empirical researchers have often encountered difficulties in implementing the model. The leading problem of this model is the identification problem. Models in economics and more generally in social science usually have very similar explanatory variables in both stages of regression. That is, equations A.1 and A.2 have very similar explanatory variables . In theory, $\hat{\lambda}$ in equation A.2 is identified even if equation A.2 has identical explanatory variables as in equation A.1 because the functional form of $\hat{\lambda}$ is non-linear in explanatory variables, although doing so generally creates serious problem of multicollinearity. As a result, researchers make great effort in justifying including some variables in the selection equation while at the same time excluding them in the outcome equation, either by referring to social theories or making up stories. For example, in the current analysis, I use individuals' educational aspiration in the selection equation but not in the outcome equation. The story here is that educational inspiration affects students' choice of colleges but may not affect graduates' earnings. However, because most variables in economics and social science are related with each other, it is very difficult to justify including some of them in one equation but not in the other. In recent empirical work, the geographic distance to colleges or the number of colleges near one's high school are frequently used as factors affecting the selection process but not the outcome. These factors, after a second thought, can also be endogeous to the outcome equation.

The second practical problem is that the unconditional earnings differentials are very sensitive to the variables included in the selection equation. Studies using this technique have resulted in different conclusions. For example, in a study examining the effect of a college education on earnings by Strayer (2002) finds that the effect of a college education is reduced when individuals' systematic selection of college education is taken into account. Other studies of the effect of college quality, however, do not find strong evidence that the Heckman-type correction for self-selection significantly affects the results (Brewer et al., 1999).

APPENDIX B

HIERARCHICAL LINEAR MODELING

Theory

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). Data with hierarchical structures are common in a variety of disciplines.[76] 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. In other words, multilevel modeling allows individual characteristics to explain the variation among individuals within each unit and institutional characteristics to explain the variations in the effects of individual variables on the outcome variable among institutions. A formal HLM model consists of following equations:

$$\ln(Y_{ij}) = \beta_{0j} + \beta_{1j} X_{ij} + \eta_{ij} \tag{B.1}$$

[76] The multilevel model has other names such random effects model and mixed effect model in other fields of social sciences.

where X_{ij} is the matrix of individual-level variables. Equation B.1 can be estimated for each institution. The regression coeffcients are further assumed to be functions of institutional-level variables:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} Z_{0j} + \mu_{0j} \tag{B.2}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} Z_{0j} + \mu_{1j} \tag{B.3}$$

By substituting equations B.2 and B.3 into B.1, the full estimating equation appears as

$$\ln(Y_{ij}) = \gamma_{00} + \gamma_{01} Z_{0j} + \gamma_{10} X_{ij} + \gamma_{11} Z_{0j} X_{ij} + \mu_{0j} + \mu_{1j} X_{ij} + \eta_{ij} \tag{B.4}$$

In equation B.4, the term $\gamma_{00} + \gamma_{01} Z_{0j} + \gamma_{10} X_{ij} + \gamma_{11} Z_{0j} X_{ij}$ is usually referred to as the fixed component and the term $\mu_{0j} + \mu_{1j} X_{ij} + \eta_{ij}$ the random component. Hence, equation B.4 is also referred to as a mixed effect model in econometrics. The complexity in the error structure and interaction terms make this model very difficult to estimate and intepret. As a result, in empirical research, only a very small number of the coefficients in equation B.1 are allowed to vary across institutions. Typically, the effect of individual characteristics is restricted to be the same across institutions. That is,

$$\beta_{1j} = \gamma_{10} \tag{B.3'}$$

With assumption B3', the full equation is simplified as

$$\ln(Y_{ij}) = \gamma_{00} + \gamma_{01} Z_{0j} + \gamma_{10} X_{ij} + \mu_{0j} + \eta_{ij} \tag{B.4'}$$

Estimation

The estimation of HLM usually consists of two steps. The first step is to estimate a model with no predictor variables in order to partition the total variance in outcomes within and between colleges in the sample. The model is usually referred to as the "null model" or one-way ANOVA model. In statistical terms, the model appears as

$$\ln(Y_{ij}) = \beta_{j0} + \varepsilon_{ij} \quad \text{(B.5)}$$

$$\beta_{j0} = \gamma_{00} + \mu_{ij} \quad \text{(B.6)}$$

The information of the variance components is used to determine whether an HLM analysis is necessary, with the rationale that if the proportion of between variance is large, then the HLM analysis is necessary.[77] The result of this simple one-way ANOVA analysis is presented in Table B.1: The majority of variance (78%) in log earnings is within colleges, and between variance makes up the remaining 22%.

Table B.1

Variance Components for Earnings

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

After the estimation of variance components, the formal HLM model (equation B.4') is estimated using the same data as in the pooled baseline model.[78] Table B.2 presents HLM estimates of the effects of the various demographic, family background,

[77] Because the proportion of between variance is very sensitive to the number of observations in each unit, this rationale is problematic. I discuss this further after the estimation.
[78] The estimation is done by the MIX procedure in SAS. The actual estimation method is Restricted Maximum Likelihood.

Table B.2

HLM Estimates for Earnings Equation (absolute value t statistics)

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

Table B.2 – *Continued*

Variable	Coefficient	t-ratio
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 B.3

Comparison between the OLS and HLM Estimates (absolute value t statistics)

	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

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 B.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.[79]

Although recently the use of HLM has become fashionable, there are still debates on whether the HLM is superior to the OLS model. Admittedly, the HLM model has many attracting features. For a detailed discussion of those features, see Bryk and Raudenbush (1992) and Heck and Thomas (2000). In this dissertation, the OLS is used for a number of reasons. First, the OLS estimates also take the multilevel nature of the data into consideration. Most supporters of the HLM model advocate that only the HLM is capable of characterizing the multilevel data structure. The arrangement of the individual and institutional variables in OLS, however, also entertains the multilevel structure, only in a different way than that in HLM. For example, individuals within the same unit have different individual characteristics but same institutional characteristics.

Second, the proportion of between variance is very sensitive to the sample size in each unit. In an extreme scenario where each institution only has one individual, the between variance and the within variance become one and the same. In typical empirical research in social science, the sample size of the unit is in the order of hundreds, and the

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[79] The phenomenon that the HLM estimates are usually smaller than the OLS estimates is due to the so-called shrinkage factor in HLM estimation (James & Stein, 1961; Morris, 1983; Raudenbush, 1988). The relatively larger standard errors are due to the assumptions of particular error structures in HLM.

sample size of individual is in the order of thousands. In the current analysis, 3,965 students are from 500 institutions, with only 8 observations for each unit on average. The proportion of between variance can easily be driven up by the small sample size for each unit (even if there is no systematic difference between units at all).

Third, when the sample size of each unit is small, the estimation of separate equations (i.e., equation B.2) for each institution is highly unreliable, if not impossible. As a result, researchers usually exclude those institutions with less than a certain number of individuals (5 or 10). This type of exclusion may, in the best scenario, toss away useful information and, in the worst scenario, cause sample selection problems and other consequent problems. For example, if institutions with small numbers of observations happen to have individuals with certain characteristics, then excluding those institutions results in a sub-sample of individuals that is not representative.

Fourth, the HLM technique puts strong assumptions on the error terms of regression equations. To illustrate, the full model of HLM can always be written as

$$Y = X\beta + \Lambda\mu + \varepsilon \tag{B.7}$$

In the full model, Λ may include explanatory variables; in simple models such as equation B.4’, Λ is a matrix mapping individuals to institutions. That is

$$\Lambda = \begin{bmatrix} 1 & & & \\ 1 & & & \\ 1 & & & \\ & 1 & & \\ & 1 & & \\ & & \dots & \\ & & & 1 \\ & & & 1 \end{bmatrix}_{K \times J}$$

where K is the number of individuals and J the number of institutions. The error terms in equation B.7 are assumed to distributed as

$$\begin{pmatrix} \mu \\ \varepsilon \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} G & 0 \\ 0 & R \end{pmatrix}\right)$$

where $G = \sigma_{\mu}^{2} I$ and $R = \sigma_{\varepsilon}^{2} I$. So the variance matrix for Y is

$\mathrm{var}(Y) = \Lambda G \Lambda' + R = diag(\Sigma_j)$, where

$$\Sigma_j = \begin{bmatrix} \sigma_{\mu}^2 + \sigma_{\varepsilon}^2 & \sigma_{\mu}^2 & \sigma_{\mu}^2 & \dots \\ \sigma_{\mu}^2 & \sigma_{\mu}^2 + \sigma_{\varepsilon}^2 & \sigma_{\mu}^2 & \dots \\ \sigma_{\mu}^2 & \sigma_{\mu}^2 & \sigma_{\mu}^2 + \sigma_{\varepsilon}^2 & \dots \\ \dots & \dots & \dots & \dots \end{bmatrix}$$

The Σ_j matrix is a square matrix with number of rows equal to number of individuals in institution j. This variance matrix for Y, which is very much like the Chamberlain equi-correlated variance matrix in panel data, puts many restrictions on the error structure. To test a structure like this and other similar structures is beyond the scope of this study; however, econometricians are generally suspicious of such a restricted structure. An unpleasant feature of this error structure is that in statistical inference, increasing the total number of individuals (K) alone does not help much to reduce the variance of the estimates if the number of institutions (J) does not increase. This provides partial explanation for the relatively larger standard errors for the HLM estimates in Table B.2 than that for the OLS estimates in Table 4.2.

APPENDIX C

MEASURES OF COLLEGE QUALITY

Studies on the effect of college quality on earnings have used different measures of college quality, such as Barron's rating, 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. This appendix uses three additional measures of college quality other than Barron's rating in the baseline model, namely mean SAT score, Carnegie Classification, and tuition and fees, to explore the sensitivity of the estimated effect of college quality on earnings.

These three measures are constructed from data in the Integrated Postsecondary Education Data System (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 (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.[80] 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

[80] For a detailed discussion of these thresholds, see Thomas (2003).

(high-quality privates, high-quality publics, middle-quality privates, middle-quality publics, low-quality privates, and low-quality publics), with the reference group being low-quality publics. The distribution of graduates among categories of colleges is presented in Table C.1.[81] 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 C.1 shows that about one-third of graduates are now classified as graduates from high-quality colleges, while with Barron's ratings only about 10% of all graduates are classified as high-quality. One would expect, from this fact, that the effect of college quality as measured by SAT scores should be smaller than that as measured by Barron's ratings.

Table C.1

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.

The second measure of college quality is the 1994 Carnegie Classification. The Carnegie Classification is based on degree programs and research volume, both of which measure some dimensions of institutional quality. Students are not evenly distributed

[81] 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.

among different types of Carnegie institutions. Table C.2 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.[82] The reference group in the following analysis is graduates from Liberal Arts II institutions.

Table C.2

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.

The final measure of college quality is the undergraduate tuition and fees. Although it is a very crude measure of college quality, it does provide a direct and intuitive way to compare the costs and benefits of attending colleges with different levels of tuition and fees.

[82] 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.

Earning equations similar to the baseline model are estimated for each of the above three measures of college quality. The sample size for each equation is determined by the number of institutions which have institutional data available. Results from these analyses are presented in Table C.3 to C.9. Table C.3 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 18% when Barron's ratings are used (see Table 4.2). Similarly, the earnings advantage for graduates from high-quality private institutions over graduates from low-quality institutions is about 10% in Table C.3, and the advantage is about 18% in Table 4.2. 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 4.2.

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 C.4. 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

Table C.3

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

Variable	Coefficient	t-ratio
Constant	8.7745	52.82
Institutional Characteristics		
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
Historically Black colleges and institutions	-0.1426	2.98
Demographic Characteristics		
Female	-0.0854	5.49
Native American	0.1044	1.58
Asian	0.1423	3.88
Black	0.0181	0.60
Hispanic	0.0471	1.04
Family Background		
Family income (in $10,000)	0.0065	3.95
First-generation college graduate	-0.0198	1.35
Academic Background		
Merged SAT/ACT quartile	0.0113	1.46
Business major	0.2871	11.22
Engineering major	0.4478	14.33
Health major	0.4357	13.88
Public affairs major	0.1432	3.29
Biological science major	0.1548	3.28
Math science major	0.3773	9.97

Table C.3 – *Continued*

Variable	Coefficient	t-ratio
Social science major	0.1961	5.73
History major	-0.1429	1.41
Humanity major	0.1314	3.97
Psychology major	0.1251	3.14
Other major	0.1402	4.75
Labor Market		
Age	0.0355	4.07
Age squared / 100	-0.0423	3.78
Tenure	0.0164	3.44
Tenure squared /100	-0.0106	0.51
Number of hours per week	0.0128	11.09
N	3869	
R^2	0.2265	

Table C.4

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	

ratings. From Table C.4, the difference in tuition and fees can be easily 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 C.3 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 comparison is quite clear: The benefit differential well exceeds the cost differential. The cost-benefit analyses can be carried out among other categories of colleges, and similar results hold.

Table C.5 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

Table C.5

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

Variable	Coefficient	t-ratio
Constant	8.7972	53.69
Institutional Characteristics		
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
Historically Black colleges and institutions	-0.1148	2.38
Demographic Characteristics		
Female	-0.0927	6.16
Native American	0.0948	1.45
Asian	0.1234	3.53
Black	-0.0081	0.27
Hispanic	0.0042	0.11
Family Background		
Family income (in $10,000)	0.0067	4.26
First-generation college graduate	-0.0223	1.58
Academic Background		
Merged SAT/ACT quartile	0.0158	2.10
Business major	0.2807	11.66
Engineering major	0.4266	14.20
Health major	0.4267	13.95
Public affairs major	0.1268	3.13

Table C.5 – *Continued*

Variable	Coefficient	t-ratio
Biological science major	0.1510	3.27
Math science major	0.3782	10.69
Social science major	0.2013	6.19
History major	-0.1268	1.28
Humanity major	0.1354	4.31
Psychology major	0.1267	3.27
Other major	0.1414	5.04
Labor Market		
Age	0.0315	3.67
Age squared / 100	-0.0371	3.38
Tenure	0.0179	3.89
Tenure squared /100	-0.0137	0.69
Number of hours per week	0.0131	11.36
N	4131	
R^2	0.2232	

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.

Similarly, I ask the question of whether the cost differentials are worth the earnings differentials among institutions of Carnegie categories. Table C.6 shows that there exists a generally pattern of positive association between average costs and benefits.

Table C.6

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	

For example, average Research I institutions charge higher tuition and fees than Research II institutions (see Table C.6), and the estimated effect of the former is also larger than that of the latter (see Table C.5). The same results hold for Doctoral I and II institutions. More interestingly, Table C.6 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 C.7 to C.9 present the estimates for the effect of college quality measured by tuition and fees (in $1,000) by types of institutional control. Table C.7 presents a pooled model with a dummy variable indicating types of institutional control.

Table C.7

OLS Estimates for Earnings Equation (quality measured by tuition and fees)

Variable	Coefficient	t-ratio
Constant	8.7297	53.65
Institutional Characteristics		
Tuition (in $1,000)	0.0179	4.15
Private institution	-0.0951	2.95
Historically Black colleges and institutions	-0.1130	2.29
Demographic Characteristics		
Female	-0.0977	6.53
Native American	0.1075	1.53
Asian	0.1384	4.44
Black	-0.0067	0.23
Hispanic	0.0079	0.20
Family Background		
Family income (in $10,000)	0.0060	3.88
First-generation college graduate	-0.0123	0.90
Academic Background		
Merged SAT/ACT quartile	0.0126	1.76
Business major	0.2746	11.33
Engineering major	0.4371	14.76
Health major	0.4578	15.64
Public affairs major	0.1226	3.05
Biological science major	0.1372	2.89
Math science major	0.3708	10.78
Social science major	0.1943	5.90
History major	-0.1061	1.11
Humanity major	0.1156	3.63

Table C.7 – *Continued*

Variable	Coefficient	t-ratio
Psychology major	0.1288	3.26
Other major	0.1553	5.61
Labor Market		
Age	0.0379	4.42
Age squared / 100	-0.0455	4.15
Tenure	0.0176	3.87
Tenure squared /100	-0.0145	0.75
Number of hours per week	0.0130	11.81
N	4187	
R^2	0.2286	

Results show that tuition and fees are positively related to graduates' earnings. Other things being equal, graduating from private institutions is associated with significant earnings disadvantages. This finding reflects the fact that at equivalent levels of college quality, private institutions usually charge higher tuition and fees than public institutions.

The results in Table C.7, 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 4.3 and C.4, that the tuition and fees charged at private institutions are generally more dispersed than at public institutions. One would reasonably expect 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 Tables C.8 and C.9. For private institutions (see Table C.8), a $1,000 increase in tuition

Table C.8

OLS Estimates for Earnings Equation (quality measured by tuition and fees), Private Institutions

Variable	Coefficient	t-ratio
Constant	8.3213	35.76
Institutional Characteristics		
Tuition (in $1,000)	0.0236	4.96
Historically Black colleges and institutions	-0.2634	3.44
Demographic Characteristics		
Female	-0.1117	4.49
Native American	-0.3445	2.34
Asian	0.1626	2.69
Black	0.0236	0.49
Hispanic	-0.0179	0.30
Family Background		
Family income (in $10,000)	0.0055	2.86
First-generation college graduate	0.0294	1.16
Academic Background		
Merged SAT/ACT quartile	0.0070	0.55
Business major	0.2739	6.27
Engineering major	0.4334	7.01
Health major	0.4953	9.57
Public affairs major	0.1068	1.55
Biological science major	0.1694	2.32
Math science major	0.3327	5.11
Social science major	0.1122	1.69
History major	0.0011	0.02
Humanity major	0.0477	0.79

Table C.8 – *Continued*

Variable	Coefficient	t-ratio
Psychology major	0.0599	0.92
Other major	0.1831	3.57
Labor Market		
Age	0.0517	4.65
Age squared / 100	-0.0579	4.47
Tenure	0.0299	4.77
Tenure squared /100	-0.0651	2.65
Number of hours per week	0.0120	6.38
N	1387	
R^2	0.2755	

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 (see Table C.9), 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.

Table C.9

OLS Estimates for Earnings Equation (quality measured by tuition and fees), Public Institutions

Variable	Coefficient	t-ratio
Constant	8.6435	32.57
Institutional Characteristics		
Tuition (in $1,000)	0.0184	1.66
Historically Black colleges and institutions	0.0173	0.28
Demographic Characteristics		
Female	-0.0931	4.98
Native American	0.1902	3.03
Asian	0.1257	3.52
Black	-0.0282	0.77
Hispanic	0.0202	0.40
Family Background		
Family income (in $10,000)	0.0074	2.93
First-generation college graduate	-0.0295	1.81
Academic Background		
Merged SAT/ACT quartile	0.0143	1.64
Business major	0.2634	9.01
Engineering major	0.4367	12.89
Health major	0.4426	12.56
Public affairs major	0.1350	2.69
Biological science major	0.1237	2.03
Math science major	0.3765	9.38
Social science major	0.2185	5.83
History major	-0.1954	1.29
Humanity major	0.1494	4.17

Table C.9 – *Continued*

Variable	Coefficient	t-ratio
Psychology major	0.1445	2.94
Other major	0.1409	4.29
Labor Market		
Age	0.0448	3.08
Age squared / 100	-0.0598	3.05
Tenure	0.0110	1.71
Tenure squared /100	-0.0026	0.08
Number of hours per week	0.0135	9.99
N	2800	
R^2	0.2228	

APPENDIX D

COLLEGE QUALITY AND EARNINGS GROWTH

The purpose of this appendix is to examine the rate of wage growth attributable to college quality that is experienced by baccalaureate recipients four years after graduation. Most work on economic returns has focused on the modest returns to college quality at discrete points in time (usually one to five years after graduation), and very little is known about how institutional factors such as college quality influence the wage growth of college graduates in the early stages of their careers. This analysis extends previous research in this area by focusing not only on comparative earnings of graduates from different types of colleges but, more importantly, providing a detailed examination of divergence in the earnings of graduates from colleges of different quality across a four-year window shortly after graduation.

Knowledge of the relationship between college quality and earnings trajectories is vital to the understanding of decisions students and their families make about investing in higher education. To the degree that a human capital framework (e.g., Becker, 1964; Schultz, 1961) can guide my inquiries in this area, we would expect individuals to be willing to bear a greater economic burden to attend colleges that are believed to subsequently confer greater labor market rewards. Although the corpus of work examining returns to college quality supports this general belief, most studies have been limited to making statements about these returns at discrete points in time, with little knowledge about these effects over time. What may look like a small return at one period may grow exponentially shortly thereafter. While I cannot, through the analysis in this paper, make statements about growth over a long period, I can nonetheless speak to significant changes at two very important time periods in the early career. Students and their families often make great financial sacrifices to attend higher prestige institutions—sacrifices often predicated on the belief that such an “investment” will pay off in the post-graduation labor market. This highlights the importance of accurate knowledge about the returns to college at different point in graduates’ lives.

This analysis addresses earnings at two points in time and allows for direct comparisons of these by academic major, type of institution, and levels of academic performance. This examination of earnings trajectories related to students’ choices of institution and major advances the understanding of the economic returns to the baccalaureate degree by providing a more complete picture of these returns and placing them in a more accurate and longer-term perspective.

Methods

The main goal is to determine if there exist substantively and statistically significant differences in the economic return to various factors, especially college quality, across two points in time, net of other factors included in the models. In other words, is there a significant change in the salary determination structure (i.e., the combination of effects of independent variables on how much one earns at any given point in time) across the two points in time? If so, to what degree does college quality play a role among the factors that initiated the structural change? In effect, I estimate separate models of earnings determination at two points in time.

$$Y_{i97} = X_{i97}\beta_{97} + \varepsilon_{i97} \quad \text{(D.1)}$$

$$Y_{i94} = X_{i94}\beta_{94} + \varepsilon_{i94} \quad \text{(D.2)}$$

where Y_{i97} and Y_{i94} represent log annual salary in 1997 (roughly four years after graduation) and in 1994 (roughly one year after graduation) respectively, and X_{i97} and X_{i94} represent vectors of exogenous variables capturing graduates' demographic characteristics, family background, academic experiences, labor market experiences, and college characteristics at these two points in time respectively. After the two models are estimated separately, I have the estimated β_{97}, the estimated β_{94}, and their estimated variance terms. Assuming the error terms are not correlated between the two models, it is possible to construct the difference between these two estimates (β_{97} - β_{94}) and the estimated variance term ($Est.Asy.Var(\hat{\beta}_{97}) + Est.Asy.Var(\hat{\beta}_{94})$). Based on these estimates, we can test whether each independent variable has a different effect on earnings between 1994 and 1997.

Although the above method is appealing, it makes a strong assumption on the error terms because the error terms in Model 1 and Model 2 are likely to be correlated. The easiest way to understand this is to rewrite the models as

$$Y_{i97} = X_{i97}\beta_{97} + \theta_i + \mu_{i97} \quad \text{(D.3)}$$

$$Y_{i94} = X_{i94}\beta_{94} + \theta_i + \mu_{i94} \quad \text{(D.4)}$$

Equations D.3 and D.4 assume that the error terms in equation D.1 and D.2 are composed of two components: an individual specific time-invariant term, θ_i, and time-variant terms, μ_{i97} and μ_{i94}. Clearly, the existence of time-invariant component creates the correlation between the error terms in Equations D.1 and D.2. Ignoring this correlation results in two immediate consequences to the analyses. First, the OLS estimation of Equations D.1 and D.2 is inefficient. Second, the variance of $\beta_{97} - \beta_{94}$ is incorrect because the covariance between β_{97} and β_{94} is left out. The appropriate estimating strategy would be GLS to incorporate the error strucutre into the analysis.[83] Effectively, I estimate the following system of equations

$$\begin{bmatrix} Y_{i97} \\ Y_{i94} \end{bmatrix} = \begin{bmatrix} X_{i97} & 0 \\ 0 & X_{i94} \end{bmatrix} \begin{bmatrix} \beta_{97} \\ \beta_{94} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i97} \\ \varepsilon_{i94} \end{bmatrix} \tag{D.5}$$

The sample of students used in the study consists of two overlapping subsets. The first subset is based on the BB:93/94 sample (the first BB follow-up one to two years after graduation) students who (1) received bachelor’s degrees during the period between July 1992 and June 1993; (2) were working full-time, as of April 1994, earning between $1,000 and $500,000 per year; (3) were not enrolled in school full-time and had valid GPA data; and (4) had institutional-level data available. This results in a sample of 4,961 graduates from 512 colleges. The second subset of students is based on the BB:93/97 sample (the second BB follow-up four to five years after graduation). Using the exact criteria as described for the first subset, the second subset is limited to 3,965 students

[83] For a detailed discussion of Seemingly Unrelated Regression (SUR), see Greene (1999).

from 500 institutions. The union of these two samples, 2,990 graduates from 488 colleges, is used for the current analysis.

Results

As a starting point, Equations D.1 and D.2 are estimated by OLS. Assuming the error terms between these two equations are not correlated, the differences in the estimated effect of independent variables errors are computed. The results of this exercise are reported in Table D.1. I then use the Seemingly Unrelated Regression to estimate Equation D.5. The results of this exercise are presented in Table D.2. Because the estimated variance structure rejects the assumption that the error terms are not correlated, I focus on Table D.2 in interpreting the estimated effects.[84] Nonetheless, efficiency gains by GLS can be observed from comparing the results in these two tables.

The estimated effect of college quality in the 1994 earnings equation (one to two years after graduation) confirms Thomas' (2000a) earlier findings. Net of all other variables in the model, the effects of college quality are small although statistically significant. For example, relative to graduates from low-quality public institutions, graduates from high-quality public colleges enjoy a roughly 9% earnings advantage. This earnings advantage is about 7% for graduates from high-quality public institutions relative to those from low-quality public colleges. Graduating from middle-quality

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[84] The likelihood ration statistic $\lambda_{LR} = T\left(\sum_{i=1}^{M}\log\hat{\sigma}_i^2 - \log\left|\hat{\Sigma}\right|\right) = 555$ with one degree of freedom, where $\hat{\Sigma}$ is the estimated variance structure.

Table D.1

OLS Estimates for Earnings Equations in 1994 and in 1997

	1997		1994		Differences	
Variable	Coeff.	T	Coeff.	t	Coeff.	t
Constant	8.6294	40.75	8.1618	46.99	0.4676	1.71
Institutional Characteristics						
Low-quality, private institution	0.0507	1.17	-0.0020	0.05	0.0526	0.94
Middle-quality, public institution	0.1069	4.29	0.0471	2.20	0.0598	1.82
Middle-quality, private institution	0.1214	4.48	0.0665	2.71	0.0549	1.50
High-quality, public institution	0.1972	5.21	0.0889	2.37	0.1083	2.03
High-quality, private institution	0.2017	4.70	0.0712	2.04	0.1306	2.36
Historically black colleges and institutions	-0.1168	1.95	-0.1025	1.93	-0.0142	0.18
Demographic Characteristics						
Female	-0.1050	6.05	-0.0553	3.63	-0.0497	2.15
Native American	0.1449	1.72	0.1097	1.11	0.0352	0.27
Asian	0.1036	2.76	0.0550	1.40	0.0486	0.89
Black	-0.0392	1.12	0.0396	1.15	-0.0788	1.60
Hispanic	0.0484	1.03	0.0973	2.74	-0.0489	0.83
Family Background						
Family income (in $10,000)	0.0064	3.63	0.0059	3.69	0.0005	0.19
First generation college graduate	-0.0406	2.47	-0.0037	0.24	-0.0368	1.65
Academic Background						
Merged SAT/ACT quartile	0.0047	0.55	0.0214	2.74	-0.0166	1.43
Business major	0.2819	10.01	0.2048	7.91	0.0771	2.02
Engineering major	0.4246	12.11	0.4010	10.94	0.0236	0.47
Health major	0.4441	12.59	0.4395	11.91	0.0046	0.09
Public affair major	0.1379	2.84	0.1235	2.82	0.0144	0.22

Table D.1 – *Continued*

	1997		1994		Differences	
Variable	Coeff.	T	Coeff.	t	Coeff.	t
Biological science major	0.0656	1.10	0.0761	1.49	-0.0105	0.13
Math science major	0.4137	9.90	0.2596	6.90	0.1540	2.74
Social science major	0.2173	5.76	0.0919	2.79	0.1254	2.50
History major	-0.2274	1.72	-0.0137	0.22	-0.2137	1.46
Humanity major	0.1382	3.69	0.0618	1.77	0.0764	1.49
Psychology major	0.1142	2.60	0.0343	0.75	0.0799	1.26
Other major	0.1444	4.39	0.0999	3.46	0.0445	1.02
Labor Market						
Age	0.0461	3.99	0.0448	4.53	0.0014	0.09
Age squared / 100	-0.0548	3.63	-0.0458	3.34	-0.0090	0.44
Tenure	0.0145	2.78	0.0323	5.46	-0.0179	2.27
Tenure squared /100	-0.0059	0.27	-0.0570	1.93	0.0511	1.38
Number of hours per week	0.0116	9.12	0.0154	17.73	-0.0038	2.44
N	2990		2990			
R^2	0.2375		0.2925			

Table D.2

SUR estimates for Earnings Equations in 1994 and in 1997

	1997		1994		Differences	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Constant	8.6744	39.93	8.2379	47.90	0.4366	1.94
Institutional Characteristics						
Low-quality, private institution	0.0528	1.35	-0.0010	0.03	0.0537	1.26
Middle-quality, public institution	0.1059	4.53	0.0468	2.20	0.0591	2.34
Middle-quality, private institution	0.1227	4.58	0.0661	2.71	0.0566	1.95
High-quality, public institution	0.1976	4.82	0.0911	2.44	0.1066	2.40
High-quality, private institution	0.2043	5.35	0.0723	2.08	0.1320	3.19
Historically black colleges and institutions	-0.1159	2.00	-0.1033	1.96	-0.0126	0.20
Demographic Characteristics						
Female	-0.1099	6.63	-0.0613	4.05	-0.0486	2.69
Native American	0.1461	1.36	0.1112	1.13	0.0349	0.30
Asian	0.1005	2.34	0.0531	1.36	0.0474	1.02
Black	-0.0397	1.05	0.0357	1.04	-0.0754	1.85
Hispanic	0.0445	1.15	0.0929	2.63	-0.0483	1.15
Family Background						
Family income (in $10,000)	0.0066	3.74	0.0060	3.75	0.0006	0.30
First generation college graduate	-0.0408	2.45	-0.0042	0.28	-0.0366	2.03
Academic Background						
Merged SAT/ACT quartile	0.0039	0.46	0.0206	2.67	-0.0167	1.82
Business major	0.2845	10.12	0.2070	8.05	0.0775	2.54
Engineering major	0.4284	10.70	0.4011	11.00	0.0273	0.63
Health major	0.4430	11.00	0.4374	11.92	0.0057	0.13
Public affair major	0.1377	2.89	0.1205	2.77	0.0172	0.33

Table D.2 – *Continued*

Variable	1997 Coeff.	1997 t	1994 Coeff.	1994 t	Differences Coeff.	Differences t
Biological science major	0.0676	1.21	0.0775	1.53	-0.0099	0.16
Math science major	0.4149	10.12	0.2594	6.93	0.1556	3.50
Social science major	0.2186	6.10	0.0925	2.83	0.1262	3.25
History major	-0.2322	3.37	-0.0144	0.23	-0.2178	2.92
Humanity major	0.1377	3.62	0.0628	1.81	0.0749	1.81
Psychology major	0.1131	2.28	0.0325	0.72	0.0806	1.50
Other major	0.1467	4.66	0.1012	3.52	0.0455	1.33
Labor Market						
Age	0.0478	4.17	0.0450	4.58	0.0029	0.24
Age squared / 100	-0.0563	3.81	-0.0459	3.38	-0.0104	0.64
Tenure	0.0096	1.92	0.0340	6.14	-0.0243	3.45
Tenure squared /100	0.0059	0.25	-0.0681	2.46	0.0740	2.17
Number of hours per week	0.0101	12.10	0.0136	16.83	-0.0035	3.21
N	2990		2990			
F statistic	11.61		22.97			

colleges provides even smaller earnings advantages. It appears that graduating from high-quality colleges does not yield huge earnings advantages immediately after college graduation.

Although the economic returns to college quality are small immediately after graduation, differences do emerge several years later. The results from Table D.2 show that graduates from high-quality public and private colleges enjoy more than 20% earnings advantage relative to those graduates from public low-quality colleges (log coefficients of 0.1976 and 0.2043 respectively). Graduating from middle-quality colleges also shows considerable earnings advantages in 1997 earnings. For example, the relative earnings advantages of graduates from middle-quality colleges over those from low-quality public colleges is about 11-12% in 1997, while this advantage is only 5-6% in 1994. Interestingly, the estimated effect of low-quality colleges relative to low-quality public colleges is negative in 1994 and positive in 1997, although both are insignificant.

Testing the hypothesis that there are no differences in returns to sector and selectivity between 1994 and 1997, the last column of Table D.2 suggests that significant wage growth attributable to college quality occurred among graduates from high-quality public and private institutions. For example, the estimated effect of high-quality private institutions is 0.0723 in 1994 and 0.2043 in 1997, representing a 0.1320 increase in the estimated effect in 1997. Put in another way, the wage gap between graduates from high-quality private college and those from low-quality public institutions has almost tripled in 1997 than in 1994 (a 20% gap versus a 7% gap). Significance test suggests that this increase in the wage gap is statistically significant with a t value of 3.19. Similarly, the wage gap between graduates from high-quality and low-quality public institutions has increased from about 9% to 20%, suggesting that the wage gap has more than doubled between 1994 and 1997. The estimated effects of middle-quality institutions have also increased more than 5 percentage points in 1997 compared with 1994. So while Thomas (2003) showed that, on average, graduates from all types of colleges grow significantly between these two time periods, those graduates from highly selective private institutions increased their earnings most.

Thus distinct pictures emerge when examining returns to college quality at different post-graduation time periods. Other, non-college differences are also revealed in Table D.2. The results point to the changing nature of returns associated with a number of individual level characteristics. These individual level changes include widening wage gap between male and female graduates and increasing earnings penalty for first-generation graduates. College graduates in the field of business, math science, and social science have enjoyed increasing return relatively to education major. In contrast, graduates from history majors are lagged further behind. A brief discussion of these findings is provided below.

Demographic variables have strong effects on earnings in both 1994 and 1997. Race and gender have significant impacts on earnings during at least one of the time periods under consideration. Consistent with earlier findings, women are experiencing a consistent and significant earnings penalty, with about 6% in 1994 and 11% in 1997. The significance test for the difference between these two estimated effects suggests that the gender gap in earnings is increasing over the time period considered. Other things being equal, there does not seem to have large earnings gap among racial groups, with the except that Hispanics and Asians enjoy a slight earnings premium on average. The incomes of Blacks, net of all other variables in the model, are statistically indistinguishable from those of whites. None of these effects are found to have shifted across the two time periods.

Family background is also shown to have a significant impact on earnings in both 1994 and 1997. As suggested by the bulk of research examining the relationship between earnings and family background, family background variables have strong effects on income. More interestingly, two family background variables in the models reveal different patterns in their effect on income over time. Family income has strong and significant impact on income in both 1994 and 1997, while the last column of Table D.2 detects no significant change of the effect between these two points in time. It seems that family income, like racial variables, has quite consistent effects on earning over years. A second family background variable in the model, capturing family educational capital in terms of first generation college graduate status, warrants more attention. While being a first generation college graduate had little effect on earnings in 1994, these same graduates were shown to be experiencing a significant earning disadvantage by 1997. The last column also detected a significant change in its effect on earnings. Whether first generation college graduates will close the salary gap with others or they will fall further behind is another interesting research question for future study.

Educational experiences have important impacts on earnings at both time periods. Graduates from fields in business, math/science, and social sciences enjoy significant increases in their net advantage over peers graduating from education related majors. These majors start out with large earnings premium and continue to enjoy high growth momentum. In contrast, history majors start with similar earnings with education majors but are lagged behind after 4-5 years. Also interesting are those majors displaying a constant earnings advantage. These include graduates from health and engineering majors who start out with largest earnings advantages over graduates from most other fields while the earnings trajectory emerging over time is relatively flat. Thus we see distinct earnings trajectories beginning to emerge among graduates across different academic majors. Focusing on either point in time would have disguised this important dynamics of the effect of college major in earnings determination.

Consistent with the large literature in labor economics, earnings are found to be a concave function of both age and tenure in most cases. From human capital perspective, this could largely be explained by the accumulation and depreciation of general and specific human capital. The number of hours worked per week has a significant impact on earnings in both time periods but this has much less of an impact in 1997 than it does in 1994. This is somewhat intuitive as the number of hours worked per week has a larger impact in determining earnings at the beginning of one’s career than at later points in time after the graduate has been able to actually demonstrate the value of more important characteristics such as productivity. In essence, the valuation of a worker’s contribution can be based more on the employer’s perception of quality rather than quantity of hours worked alone. It is therefore not surprising that this effect starts to wane in the later time period. Similarly, tenure in the position is valued more in 1994 than in 1997.

The findings serve to demonstrate the partial source of differences in findings informing earnings returns to college quality. The results suggest that some of the controversy about the effect of college quality may be an artifact of the post-graduation time periods on which different studies have focused. It is entirely possible that college quality does not have an important effect on earnings in the early career whereas its strong effects eventually emerge over the years.

APPENDIX E

TABLES

Table E.1

OLS Estimates for Earnings Equations (full model) by Gender

	Female		Male	
Variable	Coeff.	t	Coeff.	t
Constant	8.8028	44.82	8.2197	24.32
Institutional Characteristics				
Low-quality, private institution	0.0363	0.89	0.0715	1.07
Middle-quality, public institution	0.0519	2.28	0.1317	3.67
Middle-quality, private institution	0.0734	2.92	0.1510	3.70
High-quality, public institution	0.1678	4.65	0.1779	3.19
High-quality, private institution	0.1612	3.65	0.2039	3.15
Historically black coll. and inst.	-0.1489	3.14	-0.0417	0.36
Demographic Characteristics				
Native American	0.0954	1.03	0.1260	1.48
Asian	0.2055	3.49	0.0678	1.49
Black	0.0339	1.11	-0.0848	1.35
Hispanic	0.0218	0.44	0.0651	1.00
Family Background				
Family income (in $10,000)	0.0059	2.56	0.0052	2.41
First generation college graduate	-0.0160	0.83	-0.0294	1.35
Academic Background				
Merged SAT/ACT quartile	0.0093	0.96	0.0041	0.34
Business major	0.2016	7.06	0.4181	7.97
Engineering major	0.5203	12.88	0.5352	9.91
Health major	0.4204	12.68	0.4896	6.85

Table E.1 – *Continued*

	Female		Male	
Variable	Coeff.	t	Coeff.	t
Public affair major	0.0767	1.64	0.3056	4.06
Biological science major	0.1511	2.29	0.2101	2.86
Math science major	0.2592	5.47	0.5467	8.59
Social science major	0.1181	3.10	0.3385	5.29
History major	0.0173	0.30	-0.1351	0.88
Humanity major	0.0861	2.26	0.2247	3.52
Psychology major	0.0803	1.88	0.2423	2.83
Other major	0.0831	2.52	0.2979	5.10
Labor Market				
Age	0.0286	2.90	0.0603	3.17
Age squared / 100	-0.0352	2.90	-0.0765	2.93
Tenure	0.0198	3.08	0.0116	1.60
Tenure squared /100	-0.0176	0.57	0.0133	0.44
Number of hours per week	0.0137	8.71	0.0126	7.55
N	2128		1837	
R^2	0.2089		0.2013	

Note:
1. Table E.1 corresponds to Table 4.5 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.2

OLS Estimates for Earnings Equations (full model) by Race

	Non-white		White	
Variable	Coeff.	t	Coeff.	t
Constant	8.6450	18.36	8.7344	43.96
Institutional Characteristics				
Low-quality, private institution	-0.0813	0.97	0.1242	2.91
Middle-quality, public institution	0.0527	0.84	0.1028	4.66
Middle-quality, private institution	0.0441	0.64	0.1198	4.86
High-quality, public institution	0.2639	2.18	0.1999	5.62
High-quality, private institution	0.3585	2.63	0.1610	3.86
Historically black coll. and inst.	-0.1196	2.17	0.1503	1.08
Demographic Characteristics				
Female	-0.0882	1.75	-0.0974	5.83
Family Background				
Family income (in $10,000)	0.0155	1.83	0.0052	3.28
First generation college graduate	0.0173	0.31	-0.0306	2.02
Academic Background				
Merged SAT/ACT quartile	0.0452	1.56	0.0043	0.53
Business major	0.1561	1.31	0.2967	11.88
Engineering major	0.1464	0.83	0.4732	15.80
Health major	0.3895	2.67	0.4470	14.56
Public affair major	-0.0996	0.72	0.2004	4.84
Biological science major	0.1953	1.34	0.1458	2.85
Math science major	0.3658	2.84	0.3824	9.56
Social science major	0.1428	1.10	0.2098	5.97
History major	0.0367	0.21	-0.1635	1.56
Humanity major	0.0733	0.59	0.1323	3.90

Table E.2 – *Continued*

	Non-white		White	
Variable	Coeff.	t	Coeff.	t
Psychology major	0.1211	0.87	0.1283	3.15
Other major	0.1578	1.23	0.1568	5.38
Labor Market				
Age	0.0310	1.57	0.0366	3.46
Age squared / 100	-0.0396	1.74	-0.0437	3.16
Tenure	0.0174	1.40	0.0171	3.29
Tenure squared /100	-0.0163	0.31	-0.0099	0.44
Number of hours per week	0.0170	3.57	0.0125	10.04
N	445		3376	
R^2	0.2478		0.2304	

Note:
1. Table E.2 corresponds to Table 4.7 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.3

OLS Estimates for Earnings Equations (full model) by Family Income

Variable	Bottom 1/3 Coeff.	t	Middle 1/3 Coeff.	t	Top 1/3 Coeff.	t
Constant	8.7323	24.06	8.5020	35.91	8.9962	17.33
Institutional Characteristics						
Low-quality, private institution	-0.1271	2.46	0.0925	1.59	0.1960	2.28
Middle-quality, public institution	0.0375	1.19	0.1188	3.70	0.0887	2.08
Middle-quality, private institution	0.0316	0.86	0.1583	4.30	0.0833	1.77
High-quality, public institution	0.1214	2.33	0.2431	3.44	0.1451	2.78
High-quality, private institution	0.1163	1.57	0.3544	5.71	0.1240	1.95
Historically black coll. and inst.	-0.1767	2.84	-0.0273	0.33	-0.0631	0.55
Demographic Characteristics						
Female	-0.0823	2.82	-0.0756	2.95	-0.1146	4.48
Native American	0.1134	2.14	0.1143	0.63	0.1438	1.11
Asian	0.1319	2.42	0.1091	1.49	0.1915	3.27
Black	0.0870	2.14	-0.1106	2.16	0.0267	0.31
Hispanic	0.0174	0.25	0.0652	1.14	0.0475	0.55
Family Background						
First generation college graduate	-0.0806	3.22	0.0055	0.22	-0.0055	0.21
Academic Background						
Merged SAT/ACT quartile	0.0140	0.92	-0.0020	0.15	0.0146	1.24
Business major	0.2510	5.45	0.2900	7.16	0.2450	6.15
Engineering major	0.4855	8.85	0.3863	7.62	0.4252	7.95
Health major	0.4323	7.48	0.4267	8.33	0.4304	9.22
Public affair major	0.1366	1.93	0.1651	2.55	0.2342	3.61
Biological science major	0.2221	2.39	0.0135	0.20	0.1876	2.69
Math science major	0.3626	6.34	0.3764	5.27	0.4114	6.64

Table E.3 - *Continued*

	Bottom 1/3		Middle 1/3		Top 1/3	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Social science major	0.2067	3.60	0.1340	2.18	0.2334	4.57
History major	0.2273	2.80	-0.5621	3.04	0.0543	0.49
Humanity major	0.1968	3.46	0.0824	1.37	0.0798	1.54
Psychology major	0.1730	2.16	0.0439	0.65	0.1448	2.53
Other major	0.1964	3.54	0.1536	3.19	0.0996	2.31
Labor Market						
Age	0.0473	2.42	0.0375	3.24	0.0284	0.99
Age squared / 100	-0.0648	2.47	-0.0382	2.65	-0.0365	1.01
Tenure	0.0257	2.30	0.0103	1.67	0.0284	2.79
Tenure squared /100	-0.2097	2.56	-0.0017	0.07	-0.0651	1.32
Number of hours per week	0.0105	5.36	0.0170	7.56	0.0115	6.21
N	1309		1323		1314	
R^2	0.2170		0.3186		0.2174	

Table E.3 - *Continued*

	Top 10%		Top 5%	
Variable	Coeff.	t	Coeff.	t
Constant	9.2332	8.35	5.8759	2.21
Institutional Characteristics				
Low-quality, private institution	0.0301	0.20	-0.0675	0.22
Middle-quality, public institution	-0.0361	0.57	-0.0887	0.93
Middle-quality, private institution	-0.1025	1.44	-0.1062	0.98
High-quality, public institution	-0.0254	0.30	-0.0457	0.35
High-quality, private institution	-0.0386	0.36	-0.0961	0.67
Historically black coll. and inst.	0.6276	2.59	0.5543	3.04
Demographic Characteristics				
Female	-0.0757	1.71	-0.1477	2.16
Native American				
Asian	0.2136	2.39	0.0239	0.24
Black	-0.4198	1.92	-0.2076	1.74
Hispanic	-0.2058	1.79	-0.0513	0.37
Family Background				
First generation college graduate	-0.0601	0.97	-0.0754	0.72
Academic Background				
Merged SAT/ACT quartile	-0.0141	0.64	-0.0182	0.60
Business major	0.2717	3.17	0.2575	1.79
Engineering major	0.4300	3.57	0.5301	2.95
Health major	0.3074	3.29	0.1382	0.95
Public affair major	0.1334	1.13	0.3844	1.10
Biological science major	0.1050	0.82	0.1504	0.75
Math science major	0.2751	1.93	0.2351	1.04
Social science major	0.2200	2.09	0.1161	0.73
History major	0.1424	0.85	0.2072	0.75

Table E.3 - *Continued*

	Top 10%		Top 5%	
Variable	Coeff.	t	Coeff.	t
Humanity major	0.1600	1.62	0.2562	1.57
Psychology major	0.2379	2.28	0.2122	1.28
Other major	0.0870	0.87	0.0552	0.26
Labor Market				
Age	0.0116	0.19	0.2093	1.31
Age squared / 100	-0.0015	0.02	-0.2772	1.23
Tenure	0.0677	2.60	0.1024	0.96
Tenure squared /100	-0.4375	2.18	-0.9020	0.38
Number of hours per week	0.0148	4.91	0.0167	3.53
N	421		207	
R^2	0.2338		0.3059	

Note:
1. Table E.3 corresponds to Table 4.8 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.4

OLS Estimates for Earnings Equations (full model) by Mother's Education

Variable	Less than BA		BA		Advanced deg.	
	Coeff.	t	Coeff.	t	Coeff.	t
Constant	8.7354	42.93	9.1781	17.99	8.0827	6.05
Institutional Characteristics						
Low-quality, private institution	0.0642	1.36	0.1032	0.71	0.0358	0.26
Middle-quality, public institution	0.0821	2.99	0.1747	3.85	0.0876	1.46
Middle-quality, private institution	0.1128	3.71	0.1308	2.57	-0.0021	0.03
High-quality, public institution	0.2013	4.15	0.2195	3.35	0.0779	0.76
High-quality, private institution	0.1481	2.64	0.2844	3.74	0.0228	0.21
Historically black coll. and inst.	-0.1489	2.08	-0.2511	1.53	0.0225	0.16
Demographic Characteristics						
Female	-0.1111	5.18	-0.0659	1.86	-0.1276	2.56
Native American	0.0946	1.14	0.0657	1.37	0.2063	1.95
Asian	0.1328	2.50	0.0283	0.50	0.3564	2.21
Black	-0.0062	0.16	0.2251	1.90	-0.1033	0.95
Hispanic	0.0095	0.19	0.1502	1.00	-0.0775	0.24
Family Background						
Family income (in $10,000)	0.0123	4.99	0.0043	1.23	0.0026	0.58
Academic Background						
Merged SAT/ACT quartile	0.0056	0.54	0.0116	0.69	0.0119	0.48
Business major	0.2651	8.32	0.1358	2.07	0.2766	3.37
Engineering major	0.4173	10.80	0.3412	4.03	0.5999	4.77
Health major	0.4844	12.51	0.2450	2.98	0.4974	5.14
Public affair major	0.1387	2.62	0.1490	1.53	0.2379	1.65
Biological science major	0.1926	2.91	-0.0182	0.20	0.2409	1.67
Math science major	0.3694	7.85	0.2983	2.86	0.3910	3.70

Table E.4 - *Continued*

Variable	Less than BA Coeff.	t	BA Coeff.	t	Advanced deg. Coeff.	t
Social science major	0.1861	4.78	0.1558	1.70	0.2821	2.49
History major	-0.3259	2.06	0.0412	0.33	0.0461	0.25
Humanity major	0.1841	4.63	0.0035	0.05	0.1770	1.65
Psychology major	0.1221	2.32	-0.0534	0.46	0.0803	0.69
Other major	0.1332	3.57	0.0198	0.27	0.1859	2.25
Labor Market						
Age	0.0368	3.55	0.0056	0.21	0.0907	1.13
Age squared / 100	-0.0464	3.46	-0.0027	0.08	-0.1270	1.08
Tenure	0.0123	2.13	0.0371	2.22	0.0737	2.80
Tenure squared /100	0.0148	0.60	-0.2314	1.34	-0.2487	1.41
Number of hours per week	0.0127	8.27	0.0148	5.49	0.0063	1.65
N	2283		657		371	
R^2	0.2445		0.2328		0.2615	

Note:
1. Table E.4 corresponds to Table 4.9 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.5

OLS Estimates for Earnings Equations (full model) by Father's Education

	Less than BA		BA		Advanced deg.	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Constant	8.6600	39.19	8.4746	18.13	9.1240	19.54
Institutional Characteristics						
Low-quality, private institution	0.0973	2.09	-0.0646	0.74	0.1373	0.87
Middle-quality, public institution	0.0947	3.26	0.0764	2.06	0.1025	2.10
Middle-quality, private institution	0.1407	4.39	0.0622	1.48	0.0564	0.99
High-quality, public institution	0.2660	5.92	0.0820	1.46	0.1316	1.59
High-quality, private institution	0.2461	5.24	0.1582	2.01	0.1108	1.35
Historically black coll. and inst.	-0.1436	1.93	0.1681	1.72	0.0687	0.55
Demographic Characteristics						
Female	-0.0822	3.62	-0.1162	3.94	-0.1004	2.89
Native American	0.1013	1.24	0.3344	1.76	0.1231	0.99
Asian	0.1464	2.62	-0.0107	0.17	0.2864	3.62
Black	0.0249	0.66	-0.0931	1.25	-0.1814	1.83
Hispanic	0.0071	0.13	0.1176	1.17	0.0557	0.49
Family Background						
Family income (in $10,000)	0.0103	2.81	0.0065	1.83	0.0021	1.15
Academic Background						
Merged SAT/ACT quartile	-0.0075	0.68	0.0182	1.23	0.0084	0.51
Business major	0.2845	8.44	0.2868	5.91	0.1259	2.06
Engineering major	0.4397	10.36	0.4245	6.42	0.3241	4.50
Health major	0.4628	11.12	0.4383	7.27	0.2370	3.43
Public affair major	0.1867	3.39	0.0861	1.00	0.0268	0.28
Biological science major	0.1628	2.37	0.1620	2.03	0.0001	0.00
Math science major	0.4038	7.95	0.4634	6.59	0.1218	1.28

Table E.5 – *Continued*

	Less than BA		BA		Advanced deg.	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Social science major	0.1801	4.11	0.1876	3.01	0.1145	1.30
History major	-0.2214	1.72	0.1004	0.61	-0.1647	0.92
Humanity major	0.1762	3.72	0.0564	0.76	-0.0143	0.22
Psychology major	0.1430	2.63	0.1561	1.76	-0.0756	0.87
Other major	0.1476	3.64	0.1583	2.87	-0.0267	0.43
Labor Market						
Age	0.0384	3.50	0.0491	1.87	0.0318	1.33
Age squared / 100	-0.0471	3.37	-0.0608	1.73	-0.0430	1.53
Tenure	0.0170	2.72	0.0351	2.37	0.0258	1.32
Tenure squared /100	-0.0094	0.36	-0.1921	1.36	-0.0679	0.35
Number of hours per week	0.0129	7.89	0.0134	5.22	0.0103	3.70
N	2185		802		688	
R^2	0.2266		0.3015		0.1903	

Note:
1. Table E.5 corresponds to Table 4.10 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.6

OLS Estimates for Earnings Equations (full model) by Parental Education

Variable	Less than BA Coeff.	Less than BA t	BA Coeff.	BA t	Advanced deg. Coeff.	Advanced deg. t
Constant	8.6044	38.23	8.7029	18.72	9.1213	22.18
Institutional Characteristics						
Low-quality, private institution	0.1006	2.13	-0.0974	1.15	0.1364	1.00
Middle-quality, public institution	0.0920	2.98	0.0743	2.09	0.0843	2.17
Middle-quality, private institution	0.1426	4.23	0.0711	1.79	0.0364	0.79
High-quality, public institution	0.2684	5.48	0.1130	2.04	0.1248	1.86
High-quality, private institution	0.1949	3.43	0.2047	2.90	0.0858	1.19
Historically black coll. and inst.	-0.1697	2.52	0.0628	0.59	0.0123	0.12
Demographic Characteristics						
Female	-0.0911	3.86	-0.1198	3.98	-0.1013	3.38
Native American	0.0537	0.59	0.3657	1.42	0.1711	1.70
Asian	0.1437	2.38	0.0384	0.65	0.2378	3.03
Black	0.0128	0.33	-0.0725	1.06	-0.0989	1.27
Hispanic	0.0307	0.59	0.0772	0.83	0.0621	0.59
Family Background						
Family income (in $10,000)	0.0107	2.60	0.0084	2.19	0.0013	0.72
Academic Background						
Merged SAT/ACT quartile	-0.0041	0.34	0.0064	0.45	0.0155	1.06
Business major	0.2912	8.59	0.2232	4.33	0.1969	3.70
Engineering major	0.4476	10.39	0.3548	5.21	0.3840	5.87
Health major	0.4845	11.24	0.3221	5.13	0.3523	5.83
Public affair major	0.2025	3.64	0.0044	0.05	0.1277	1.42
Biological science major	0.1934	2.64	0.0506	0.63	0.0621	0.73
Math science major	0.4137	7.82	0.3742	5.00	0.2328	2.93

Table E.6 – *Continued*

Variable	Less than BA Coeff.	t	BA Coeff.	t	Advanced deg. Coeff.	t
Social science major	0.1792	4.10	0.1483	2.28	0.1842	2.44
History major	-0.2685	1.88	0.0151	0.10	-0.0434	0.29
Humanity major	0.1790	3.56	0.0131	0.19	0.0724	1.23
Psychology major	0.1454	2.61	0.0941	1.06	0.0166	0.23
Other major	0.1602	3.75	0.0799	1.38	0.0543	0.99
Labor Market						
Age	0.0420	3.83	0.0383	1.47	0.0249	1.15
Age squared / 100	-0.0520	3.73	-0.0418	1.23	-0.0367	1.42
Tenure	0.0152	2.39	0.0365	2.75	0.0401	2.24
Tenure squared /100	0.0001	0.00	-0.2373	1.93	-0.1434	0.77
Number of hours per week	0.0127	7.45	0.0135	5.60	0.0115	4.66
N	2057		891		848	
R^2	0.2291		0.2844		0.2139	

Note:
1. Table E.6 corresponds to Table 4.11 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.7

OLS Estimates for Earnings Equations (full model) by SAT/ACT Quartile

	Lowest Quartile		Second lowest Quartile	
Variable	Coeff.	t	Coeff.	t
Constant	8.2403	13.67	10.6870	20.30
Institutional Characteristics				
Low-quality, private institution	-0.0441	0.65	0.0165	0.17
Middle-quality, public institution	0.0705	1.85	0.0314	1.01
Middle-quality, private institution	0.1083	2.42	-0.0409	1.12
High-quality, public institution	0.3119	2.52	0.1369	2.46
High-quality, private institution	0.2859	2.44	0.0871	1.16
Historically black coll. and inst.	-0.0455	0.64	0.0504	0.60
Demographic Characteristics				
Female	-0.0949	2.65	-0.1286	4.68
Native American	-0.3460	1.73	0.0573	0.59
Asian	0.1366	2.43	0.2351	1.95
Black	-0.0383	0.79	-0.0038	0.08
Hispanic	-0.0524	0.66	0.0363	0.40
Family Background				
Family income (in $10,000)	0.0116	3.64	0.0010	0.44
First generation college graduate	0.0071	0.23	-0.0376	1.48
Academic Background				
Business major	0.2035	3.70	0.2497	5.54
Engineering major	0.4256	5.04	0.4327	8.02
Health major	0.2693	4.22	0.4910	8.09
Public affair major	0.1145	1.41	0.1798	2.69
Biological science major	0.1499	1.57	0.1225	1.46
Math science major	0.3621	3.87	0.3630	5.33

Table E.7 - *Continued*

	Lowest Quartile		Second lowest Quartile	
Variable	Coeff.	t	Coeff.	t
Social science major	0.2025	3.08	0.2277	3.68
History major	0.3308	3.30	0.1234	1.90
Humanity major	0.1205	1.74	0.1403	2.42
Psychology major	0.1992	2.44	0.0330	0.39
Other major	0.2283	3.75	0.1532	3.39
Labor Market				
Age	0.0612	1.77	-0.0791	2.52
Age squared / 100	-0.0594	1.25	0.1165	2.53
Tenure	0.0361	3.15	0.0246	2.74
Tenure squared /100	-0.1693	2.67	-0.0438	1.01
Number of hours per week	0.0101	3.87	0.0156	8.54
N	888		911	
R^2	0.1991		0.2926	

Note:
1. Table E.7 corresponds to Table 4.12 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.7 - *Continued*

Variable	Second highest quartile Coeff.	Second highest quartile t	Highest quartile Coeff.	Highest quartile t
Constant	8.8121	10.94	9.2974	12.76
Institutional Characteristics				
Low-quality, private institution	0.2338	2.30	-0.1188	0.98
Middle-quality, public institution	0.1934	3.28	0.0381	0.67
Middle-quality, private institution	0.2449	3.85	0.0260	0.40
High-quality, public institution	0.3153	3.90	0.0472	0.68
High-quality, private institution	0.3342	4.04	0.0600	0.79
Historically black coll. and inst.	-0.2014	1.09	0.1364	1.13
Demographic Characteristics				
Female	-0.1083	2.97	-0.1125	3.24
Native American	0.0425	0.74	0.3256	3.36
Asian	0.0310	0.34	0.1599	2.19
Black	-0.0664	0.38	0.0305	0.34
Hispanic	-0.1057	0.85	0.1933	1.23
Family Background				
Family income (in $10,000)	0.0026	1.22	0.0026	0.72
First generation college graduate	-0.0485	1.54	-0.0562	1.46
Academic Background				
Business major	0.2472	4.25	0.3861	6.26
Engineering major	0.3974	5.95	0.4468	6.81
Health major	0.4113	6.12	0.4549	4.89
Public affair major	0.1414	1.50	-0.0797	0.74
Biological science major	0.1095	1.17	0.1397	1.56
Math science major	0.3145	3.72	0.4037	5.12
Social science major	0.2108	3.04	0.1082	1.17
History major	-0.6693	3.07	-0.0930	0.54

Table E.7 - *Continued*

	Second highest quartile		Highest quartile	
Variable	Coeff.	t	Coeff.	t
Humanity major	0.0283	0.35	0.1609	2.32
Psychology major	0.2200	2.14	0.0742	0.75
Other major	0.0959	1.55	0.1254	1.42
Labor Market				
Age	0.0310	0.66	0.0126	0.30
Age squared / 100	-0.0414	0.63	-0.0116	0.20
Tenure	0.0288	1.91	0.0250	1.64
Tenure squared /100	-0.0346	0.34	-0.0090	0.10
Number of hours per week	0.0136	5.32	0.0112	3.92
N	823		669	
R^2	0.3012		0.2434	

Table E.8

OLS Estimates for Earnings Equations (full model) by Field of Study

Variable	Business Coeff.	Business t	Engineering Coeff.	Engineering t	Health Coeff.	Health t
Constant	9.2498	23.95	9.6822	17.62	9.4072	26.17
Institutional Characteristics						
Low-quality, private institution	-0.0406	0.57	0.1169	0.70	0.2527	2.78
Middle-quality, public institution	0.0666	1.40	0.0159	0.35	0.0092	0.16
Middle-quality, private institution	0.0996	1.94	0.1337	2.33	0.0748	1.29
High-quality, public institution	0.1720	1.46	0.0668	1.17	0.2197	2.35
High-quality, private institution	0.2576	2.15	0.1686	1.96	0.1572	1.82
Historically black coll. and inst.	-0.2237	2.05	0.0777	0.42	0.8467	3.61
Demographic Characteristics						
Female	-0.1289	4.02	0.0760	1.90	0.0031	0.05
Native American	0.1445	1.37	0.1834	4.02	0.1971	2.17
Asian	0.1101	2.08	-0.0159	0.24	0.1659	1.12
Black	0.0065	0.08	-0.2144	1.12	-0.0285	0.24
Hispanic	-0.0016	0.02	-0.0883	0.62	0.1584	1.42
Family Background						
Family income (in $10,000)	0.0042	1.37	0.0068	1.15	0.0035	0.65
First generation college graduate	0.0031	0.10	-0.0337	0.81	0.0110	0.27
Academic Background						
Merged SAT/ACT quartile	0.0524	2.95	-0.0038	0.19	0.0674	2.77
Labor Market						
Age	0.0117	0.57	0.0258	0.94	0.0240	1.46
Age squared / 100	-0.0132	0.52	-0.0226	0.63	-0.0281	1.42
Tenure	0.0247	2.69	-0.0209	1.26	0.0066	0.46
Tenure squared /100	-0.0235	0.66	0.1717	1.62	0.0480	0.74

Table E.8 – *Continued*

	Business		Engineering		Health	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
Number of hours per week	0.0152	7.25	0.0082	2.24	0.0081	2.42
N	664		288		268	
R^2	0.2387		0.1445		0.2500	

Note:
1. Table E.8 corresponds to Table 4.13 in Chapter Four.
2. Standard errors are corrected for heteroscedasticity.
3. Absolute value t statistics included.

Table E.8 – *Continued*

Variable	Social Sciences Coeff.	Social Sciences t	Humanity Coeff.	Humanity t	Education Coeff.	Education t
Constant	10.4168	13.73	7.5887	13.49	8.1257	12.79
Institutional Characteristics						
Low-quality, private institution	-0.2849	2.11	0.2026	1.52	0.0990	0.93
Middle-quality, public institution	0.1010	1.58	-0.0254	0.46	0.0692	1.50
Middle-quality, private institution	0.0888	1.24	-0.0421	0.57	0.0034	0.06
High-quality, public institution	0.2851	3.18	0.1154	1.39	0.0756	1.10
High-quality, private institution	0.0951	0.77	0.0312	0.32	0.2266	2.14
Historically black coll. and inst.	0.0647	0.52	-0.4724	3.30	0.0321	0.35
Demographic Characteristics						
Female	-0.1547	3.41	-0.0502	1.03	0.0630	1.15
Native American	0.3077	2.49	-0.0761	0.37	-0.0620	0.53
Asian	0.1434	1.71	0.1620	1.61	0.5873	1.24
Black	-0.0546	0.57	0.1327	2.07	0.1686	2.76
Hispanic	0.1467	1.23	0.1145	1.06	0.0001	0.00
Family Background						
Family income (in $10,000)	-0.0028	1.09	0.0067	1.25	0.0065	0.86
First generation college graduate	-0.0848	1.78	0.0070	0.16	-0.1098	2.55
Academic Background						
Merged SAT/ACT quartile	-0.0409	1.65	0.0203	0.95	0.0097	0.42
Labor Market						
Age	-0.0588	1.55	0.1124	4.46	0.0673	1.90
Age squared / 100	0.0806	1.77	-0.1319	4.62	-0.0847	1.81
Tenure	-0.0086	0.42	0.0449	1.33	0.0096	0.67
Tenure squared /100	0.0024	0.02	-0.3742	0.87	0.0265	0.41
Number of hours per week	0.0233	5.74	0.0089	1.88	0.0138	4.39
N	413		344		573	

Table E.8 – *Continued*

	Social Sciences		Humanity		Education	
Variable	Coeff.	t	Coeff.	t	Coeff.	t
R^2	0.2503		0.1680		0.1634	

Table E.9

Quantile Estimates for the Earnings Equation (full model)

	(1) OLS		(2) 0.05	
Variable	Coefficient	t	Coefficient	t
Constant	8.7298	51.72	8.3354	19.76
Institutional Characteristics				
Low-quality, private institution	0.0530	1.42	0.0089	0.11
Middle-quality, public institution	0.0920	4.41	0.0532	0.94
Middle-quality, private institution	0.1066	4.61	0.0383	0.54
High-quality, public institution	0.1800	5.46	0.0666	0.83
High-quality, private institution	0.1754	4.47	0.1011	1.33
Historically black coll. and inst.	-0.1167	2.31	0.0314	0.26
Demographic Characteristics				
Female	-0.0936	6.04	-0.0365	0.84
Native American	0.1040	1.47	0.3305	1.58
Asian	0.1268	3.46	0.1344	1.75
Black	-0.0109	0.35	-0.1022	1.13
Hispanic	0.0438	1.07	-0.0999	1.42
Family Background				
Family income (in $10,000)	0.0055	3.55	0.0067	1.40
First generation college graduate	-0.0233	1.61	-0.0528	1.48
Academic Background				
Merged SAT/ACT quartile	0.0081	1.06	0.0278	1.52
Business major	0.2752	11.08	0.2801	3.82
Engineering major	0.4321	14.15	0.5302	6.55
Health major	0.4429	14.28	0.4076	4.50
Public affair major	0.1473	3.67	0.2141	2.46
Biological science major	0.1493	3.15	0.0330	0.33

Table E.9 – *Continued*

Variable	(1) OLS Coefficient	(1) OLS t	(2) 0.05 Coefficient	(2) 0.05 t
Math science major	0.3818	10.39	0.2968	3.53
Social science major	0.1944	5.88	0.1120	1.52
History major	-0.1340	1.38	-1.4704	16.24
Humanity major	0.1231	3.80	0.0626	0.84
Psychology major	0.1290	3.31	0.0546	0.62
Other major	0.1471	5.09	0.0523	0.72
Labor Market				
Age	0.0362	4.15	0.0343	1.61
Age squared / 100	-0.0433	3.90	-0.0605	2.20
Tenure	0.0160	3.37	0.0251	1.70
Tenure squared /100	-0.0058	0.28	-0.0139	0.27
Number of hours per week	0.0130	10.95	0.0119	3.86
R^2 / Pseudo R^2	0.2247		0.1398	

Note:
1. Table E.9 corresponds to Table 5.2 in Chapter Five.
2. Absolute value t statistics included.

Table E.9 – *Continued*

	(3) 0.10		(4) 0.25	
Variable	Coefficient	t	Coefficient	t
Constant	8.5847	30.96	8.5837	34.81
Institutional Characteristics				
Low-quality, private institution	-0.1054	1.91	-0.0287	0.58
Middle-quality, public institution	0.0750	2.14	0.0727	2.53
Middle-quality, private institution	0.0429	0.96	0.0701	2.08
High-quality, public institution	0.1830	3.00	0.1504	3.03
High-quality, private institution	0.0445	0.75	0.1499	3.44
Historically black coll. and inst.	-0.0431	0.50	-0.2191	2.94
Demographic Characteristics				
Female	-0.0264	0.92	-0.0428	2.08
Native American	0.1457	1.26	0.1071	1.10
Asian	0.1068	1.57	0.1079	1.97
Black	-0.0987	1.75	0.0381	0.82
Hispanic	-0.0304	0.51	0.0737	1.51
Family Background				
Family income (in $10,000)	0.0046	1.55	0.0053	2.03
First generation college graduate	-0.0235	0.91	-0.0130	0.64
Academic Background				
Merged SAT/ACT quartile	0.0225	1.75	0.0093	0.93
Business major	0.3074	6.64	0.2538	7.59
Engineering major	0.5363	9.94	0.5312	12.30
Health major	0.4166	7.11	0.4409	10.61
Public affair major	0.2019	3.60	0.1198	2.13
Biological science major	0.1779	2.68	0.1338	2.46
Math science major	0.3273	6.07	0.3090	7.13
Social science major	0.1143	2.17	0.1873	4.91

Table E.9 – *Continued*

	(3) 0.10		(4) 0.25	
Variable	Coefficient	t	Coefficient	t
History major	-1.6015	29.55	0.0994	0.99
Humanity major	0.1267	2.51	0.1614	4.23
Psychology major	0.2197	3.25	0.1345	2.28
Other major	0.1191	2.52	0.0959	2.74
Labor Market				
Age	0.0204	1.40	0.0311	2.42
Age squared / 100	-0.0279	1.49	-0.0370	2.22
Tenure	0.0258	2.61	0.0316	4.60
Tenure squared /100	0.0059	0.16	-0.0488	1.71
Number of hours per week	0.0122	6.67	0.0129	10.53
Pseudo R^2	0.1276		0.1399	

Table E.9 – *Continued*

	(5) 0.50		(6) 0.75	
Variable	Coefficient	t	Coefficient	t
Constant	8.9492	48.61	8.9969	54.22
Institutional Characteristics				
Low-quality, private institution	-0.0121	0.37	0.0726	2.10
Middle-quality, public institution	0.0696	3.64	0.0727	3.66
Middle-quality, private institution	0.0624	2.80	0.0848	3.53
High-quality, public institution	0.1577	4.68	0.1536	4.40
High-quality, private institution	0.1421	4.71	0.2098	6.65
Historically black coll. and inst.	-0.1571	3.33	-0.1359	2.66
Demographic Characteristics				
Female	-0.0766	5.54	-0.1184	8.17
Native American	0.1354	1.82	0.1268	2.15
Asian	0.0565	1.58	0.1278	3.76
Black	0.0154	0.49	0.0258	0.73
Hispanic	0.1004	3.04	0.0386	1.15
Family Background				
Family income (in $10,000)	0.0042	2.87	0.0097	7.26
First generation college graduate	-0.0104	0.76	-0.0045	0.31
Academic Background				
Merged SAT/ACT quartile	0.0059	0.83	0.0100	1.31
Business major	0.2841	12.89	0.2590	11.19
Engineering major	0.4754	15.94	0.3769	12.19
Health major	0.4352	14.64	0.4126	14.17
Public affair major	0.1410	4.11	0.1468	4.03
Biological science major	0.2353	6.00	0.2266	4.51
Math science major	0.4223	14.66	0.3822	12.57
Social science major	0.1673	6.49	0.1836	6.56

Table E.9 – *Continued*

	(5) 0.50		(6) 0.75	
Variable	Coefficient	t	Coefficient	t
History major	0.0936	1.74	0.0652	1.23
Humanity major	0.1413	5.23	0.0692	2.54
Psychology major	0.1221	3.01	0.1221	2.66
Other major	0.1572	6.86	0.1624	6.72
Labor Market				
Age	0.0279	2.84	0.0312	3.73
Age squared / 100	-0.0333	2.63	-0.0334	3.23
Tenure	0.0161	3.58	0.0090	1.91
Tenure squared /100	0.0005	0.03	0.0034	0.14
Number of hours per week	0.0120	17.13	0.0137	18.64
Pseudo R^2	0.1535		0.1586	

Table E.9 – *Continued*

	(7) 0.90		(8) 0.95	
Variable	Coefficient	t	Coefficient	t
Constant	8.8614	26.18	9.2035	24.71
Institutional Characteristics				
Low-quality, private institution	0.1268	1.78	0.0308	0.38
Middle-quality, public institution	0.0954	2.20	0.0482	0.90
Middle-quality, private institution	0.0996	1.91	0.1329	2.11
High-quality, public institution	0.0958	1.45	0.1407	1.56
High-quality, private institution	0.2597	3.71	0.2962	3.47
Historically black coll. and inst.	-0.0623	0.52	-0.1009	0.77
Demographic Characteristics				
Female	-0.2082	6.66	-0.2779	7.02
Native American	0.0444	0.31	0.1056	0.61
Asian	0.1043	1.65	0.1975	2.56
Black	-0.0033	0.04	-0.0064	0.07
Hispanic	0.0326	0.44	0.0422	0.49
Family Background				
Family income (in $10,000)	0.0039	1.43	0.0071	2.37
First generation college graduate	0.0304	0.97	0.0100	0.27
Academic Background				
Merged SAT/ACT quartile	0.0343	2.09	0.0147	0.73
Business major	0.2526	5.46	0.2047	3.51
Engineering major	0.2616	4.45	0.1230	1.64
Health major	0.4752	7.80	0.4272	5.97
Public affair major	0.1391	1.71	0.0951	1.14
Biological science major	0.1800	1.71	0.0685	0.81
Math science major	0.3886	6.12	0.3420	3.77
Social science major	0.2742	4.43	0.2677	3.31

Table E.9 – *Continued*

	(7) 0.90		(8) 0.95	
Variable	Coefficient	t	Coefficient	t
History major	-0.0178	0.20	-0.0731	0.72
Humanity major	0.1200	1.87	-0.0137	0.20
Psychology major	0.0826	0.88	-0.0501	0.53
Other major	0.2145	4.10	0.2128	3.25
Labor Market				
Age	0.0469	2.75	0.0538	2.88
Age squared / 100	-0.0545	2.60	-0.0630	2.72
Tenure	-0.0075	0.83	-0.0266	2.39
Tenure squared /100	0.0545	1.36	0.1128	2.24
Number of hours per week	0.0159	8.74	0.0134	4.93
Pseudo R^2	0.1549		0.1589	

Table E.10

Ordered Logit Estimates for 9 Job Satisfaction Indicators

Satisfaction with Pay, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.1646	17.58	-0.2040	14.15	0.3686	20.11
Educational debt (in $1,000)	-0.0001	0.18	-0.0001	0.18	0.0002	0.18
Institutional Characteristics						
Low-quality, private institution	0.0196	1.09	0.0198	1.37	-0.0395	1.22
Middle-quality, public institution	0.0057	0.63	0.0070	0.63	-0.0127	0.63
Middle-quality, private institution	0.0141	1.25	0.0159	1.39	-0.0300	1.32
High-quality, public institution	0.0217	1.15	0.0214	1.48	-0.0431	1.30
High-quality, private institution	0.0592	2.75	0.0399	6.33	-0.0991	3.68
Historically black coll. and inst.	0.0102	0.43	0.0113	0.48	-0.0216	0.46
Demographic Characteristics						
Female	-0.0211	3.19	-0.0258	3.21	0.0470	3.24
Native American	-0.0120	0.31	-0.0171	0.27	0.0291	0.28
Asian	0.0725	2.88	0.0402	9.39	-0.1127	4.15
Black	0.0505	2.68	0.0376	5.15	-0.0881	3.48
Hispanic	0.0276	1.49	0.0255	2.10	-0.0530	1.74
Family Background						
Family income (in $10,000)	-0.0011	1.51	-0.0013	1.51	0.0024	1.51
First generation college graduate	-0.0154	2.36	-0.0190	2.36	0.0345	2.37
Academic Background						
Merged SAT/ACT quartile	-0.0032	0.97	-0.0040	0.97	0.0072	0.97

Table E.10 – *Continued*

Satisfaction with Pay, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0237	2.33	-0.0331	2.08	0.0568	2.20
Engineering major	-0.0315	2.63	-0.0541	1.97	0.0856	2.19
Health major	-0.0355	3.13	-0.0640	2.26	0.0994	2.53
Public affairs major	-0.0284	2.04	-0.0482	1.54	0.0766	1.70
Biological science major	-0.0258	1.63	-0.0429	1.26	0.0687	1.38
Math science major	-0.0315	2.61	-0.0547	1.94	0.0863	2.15
Social science major	-0.0024	0.17	-0.0030	0.17	0.0054	0.17
History major	-0.0451	2.88	-0.0957	1.83	0.1408	2.08
Humanity major	-0.0250	2.09	-0.0400	1.66	0.0650	1.82
Psychology major	0.0274	1.15	0.0251	1.62	-0.0525	1.33
Other major	-0.0187	1.71	-0.0271	1.48	0.0457	1.57
Labor Market						
Age	0.0022	0.54	0.0027	0.54	-0.0048	0.54
Age squared / 100	0.0000	0.02	0.0000	0.02	0.0000	0.02
Tenure	0.0026	1.21	0.0032	1.20	-0.0058	1.21
Tenure squared /100	-0.0001	1.07	-0.0001	1.07	0.0003	1.07
Number of hours per week	0.0010	2.88	0.0013	2.87	-0.0023	2.89
N	3,870					
χ^2	647					

Table E.10 – *Continued*

Satisfaction with Pay, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0000	0.07	0.0000	0.07	-0.0001	0.07
Institutional Characteristics						
Low-quality, private institution	-0.0085	0.83	-0.0086	0.84	0.0171	0.84
Middle-quality, public institution	-0.0064	0.37	-0.0069	0.35	0.0134	0.36
Middle-quality, private institution	0.0119	0.63	0.0108	0.70	-0.0227	0.66
High-quality, public institution	-0.0011	0.09	-0.0011	0.09	0.0022	0.09
High-quality, private institution	0.0222	1.16	0.0183	1.44	-0.0405	1.26
Historically black coll. and inst.	0.0400	1.27	0.0271	2.13	-0.0671	1.52
Demographic Characteristics						
Female	-0.0046	0.64	-0.0047	0.64	0.0093	0.64
Native American	-0.0220	0.54	-0.0281	0.43	0.0501	0.47
Asian	0.0484	2.04	0.0303	3.88	-0.0787	2.52
Black	0.0499	2.45	0.0319	4.41	-0.0817	3.02
Hispanic	0.0174	0.91	0.0149	1.10	-0.0323	0.99
Family Background						
Family income (in $10,000)	-0.0024	2.90	-0.0024	2.87	0.0048	2.91
First generation college graduate	-0.0142	1.92	-0.0143	1.92	0.0284	1.93
Academic Background						
Merged SAT/ACT quartile	-0.0058	1.55	-0.0059	1.54	0.0117	1.55

Table E.10 – *Continued*

Satisfaction with Pay, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0676	6.57	-0.0907	5.33	0.1583	5.92
Engineering major	-0.0807	9.12	-0.1738	5.43	0.2545	6.39
Health major	-0.0840	10.01	-0.1892	5.96	0.2733	7.01
Public affairs major	-0.0507	3.77	-0.0847	2.51	0.1353	2.89
Biological science major	-0.0496	3.34	-0.0829	2.21	0.1324	2.54
Math science major	-0.0753	8.07	-0.1565	4.82	0.2318	5.67
Social science major	-0.0341	2.73	-0.0463	2.13	0.0805	2.36
History major	-0.0297	1.33	-0.0408	1.02	0.0706	1.14
Humanity major	-0.0429	3.52	-0.0640	2.55	0.1068	2.88
Psychology major	0.0009	0.04	0.0009	0.04	-0.0018	0.04
Other major	-0.0429	3.92	-0.0598	3.01	0.1027	3.36
Labor Market						
Age	-0.0036	0.82	-0.0037	0.81	0.0073	0.82
Age squared / 100	0.0001	1.23	0.0001	1.23	-0.0001	1.23
Tenure	-0.0004	0.16	-0.0004	0.16	0.0008	0.16
Tenure squared /100	-0.0001	0.79	-0.0001	0.79	0.0002	0.79
Number of hours per week	-0.0012	3.21	-0.0013	3.17	0.0025	3.22
N	3,870					
χ^2	175					

Table E.10 – *Continued*

Satisfaction with Promotion Opportunity, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.1236	11.27	-0.0825	9.50	0.2062	11.45
Educational debt (in $1,000)	0.0009	1.02	0.0006	1.02	-0.0014	1.02
Institutional Characteristics						
Low-quality, private institution	0.0505	1.86	0.0232	3.00	-0.0737	2.10
Middle-quality, public institution	-0.0013	0.10	-0.0009	0.10	0.0022	0.10
Middle-quality, private institution	0.0133	0.84	0.0083	0.90	-0.0216	0.86
High-quality, public institution	0.0420	1.55	0.0206	2.26	-0.0626	1.72
High-quality, private institution	0.0378	1.47	0.0193	2.02	-0.0570	1.61
Historically black coll. and inst.	0.0199	0.56	0.0114	0.66	-0.0314	0.60
Demographic Characteristics						
Female	-0.0049	0.51	-0.0033	0.51	0.0081	0.51
Native American	-0.0028	0.04	-0.0019	0.04	0.0047	0.04
Asian	0.0195	0.77	0.0113	0.90	-0.0308	0.81
Black	0.0336	1.45	0.0178	1.90	-0.0514	1.59
Hispanic	-0.0517	2.98	-0.0495	2.20	0.1012	2.55
Family Background						
Family income (in $10,000)	-0.0003	0.25	-0.0002	0.25	0.0004	0.25
First generation college graduate	-0.0121	1.27	-0.0080	1.27	0.0201	1.28
Academic Background						
Merged SAT/ACT quartile	-0.0047	0.97	-0.0032	0.97	0.0079	0.97

Table E.10 – *Continued*

Satisfaction with Promotion Opportunity, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0347	2.33	-0.0259	2.14	0.0606	2.28
Engineering major	-0.0102	0.46	-0.0073	0.43	0.0175	0.45
Health major	-0.0137	0.65	-0.0101	0.59	0.0238	0.63
Public affairs major	-0.0202	0.82	-0.0156	0.72	0.0358	0.77
Biological science major	-0.0090	0.32	-0.0064	0.30	0.0154	0.31
Math science major	-0.0243	1.16	-0.0192	1.00	0.0435	1.09
Social science major	-0.0132	0.70	-0.0096	0.65	0.0227	0.68
History major	-0.0084	0.24	-0.0060	0.22	0.0144	0.23
Humanity major	-0.0271	1.44	-0.0217	1.23	0.0488	1.34
Psychology major	-0.0050	0.17	-0.0034	0.17	0.0084	0.17
Other major	-0.0122	0.73	-0.0087	0.69	0.0210	0.71
Labor Market						
Age	0.0166	2.90	0.0111	2.87	-0.0276	2.91
Age squared / 100	-0.0002	2.14	-0.0001	2.12	0.0003	2.14
Tenure	0.0087	2.80	0.0058	2.76	-0.0145	2.80
Tenure squared /100	-0.0003	1.77	-0.0002	1.76	0.0005	1.77
Number of hours per week	-0.0030	5.55	-0.0020	5.27	0.0049	5.56
N	3,870					
χ^2	380					

Table E.10 – *Continued*

Satisfaction with Promotion Opportunity, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0010	1.17	0.0006	1.17	-0.0016	1.17
Institutional Characteristics						
Low-quality, private institution	-0.0126	0.94	-0.0080	0.94	0.0206	0.95
Middle-quality, public institution	0.0181	0.72	0.0101	0.83	-0.0282	0.75
Middle-quality, private institution	0.0400	1.51	0.0189	2.12	-0.0589	1.65
High-quality, public institution	-0.0010	0.06	-0.0006	0.06	0.0016	0.06
High-quality, private institution	0.0105	0.45	0.0062	0.48	-0.0167	0.46
Historically black coll. and inst.	0.0367	0.96	0.0175	1.35	-0.0542	1.06
Demographic Characteristics						
Female	0.0067	0.70	0.0042	0.70	-0.0110	0.70
Native American	-0.0168	0.27	-0.0120	0.24	0.0288	0.26
Asian	0.0043	0.18	0.0027	0.18	-0.0070	0.18
Black	0.0309	1.33	0.0158	1.69	-0.0467	1.43
Hispanic	-0.0556	3.18	-0.0513	2.32	0.1070	2.72
Family Background						
Family income (in $10,000)	-0.0011	1.00	-0.0007	1.00	0.0017	1.00
First generation college graduate	-0.0116	1.20	-0.0073	1.20	0.0189	1.20
Academic Background						
Merged SAT/ACT quartile	-0.0060	1.21	-0.0038	1.21	0.0098	1.21

Table E.10 – *Continued*

Satisfaction with Promotion Opportunity, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0666	4.81	-0.0515	3.95	0.1182	4.47
Engineering major	-0.0578	3.32	-0.0530	2.40	0.1108	2.83
Health major	-0.0623	3.75	-0.0590	2.68	0.1213	3.17
Public affairs major	-0.0361	1.55	-0.0293	1.24	0.0654	1.40
Biological science major	-0.0278	1.06	-0.0214	0.89	0.0491	0.98
Math science major	-0.0640	3.76	-0.0614	2.64	0.1254	3.14
Social science major	-0.0350	2.02	-0.0274	1.66	0.0624	1.85
History major	0.0015	0.04	0.0009	0.04	-0.0024	0.04
Humanity major	-0.0415	2.32	-0.0342	1.82	0.0758	2.07
Psychology major	-0.0235	0.88	-0.0175	0.76	0.0410	0.83
Other major	-0.0292	1.82	-0.0216	1.58	0.0508	1.72
Labor Market						
Age	0.0119	2.05	0.0075	2.04	-0.0194	2.05
Age squared / 100	-0.0001	1.33	-0.0001	1.33	0.0002	1.33
Tenure	0.0067	2.11	0.0042	2.10	-0.0109	2.11
Tenure squared /100	-0.0003	1.60	-0.0002	1.59	0.0004	1.60
Number of hours per week	-0.0047	8.76	-0.0030	7.75	0.0076	8.80
N	3,870					
χ^2	241					

Table E.10 – *Continued*

Satisfaction with Educational Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0916	8.45	-0.0617	7.77	0.1533	8.50
Educational debt (in $1,000)	0.0011	1.31	0.0008	1.31	-0.0019	1.31
Institutional Characteristics						
Low-quality, private institution	0.0593	2.10	0.0282	3.24	-0.0875	2.38
Middle-quality, public institution	-0.0195	1.46	-0.0132	1.45	0.0328	1.46
Middle-quality, private institution	0.0330	1.96	0.0197	2.24	-0.0527	2.06
High-quality, public institution	0.0245	0.94	0.0144	1.09	-0.0389	0.99
High-quality, private institution	0.0227	0.92	0.0135	1.05	-0.0363	0.97
Historically black coll. and inst.	-0.0385	1.37	-0.0324	1.13	0.0709	1.25
Demographic Characteristics						
Female	-0.0297	3.01	-0.0198	3.01	0.0495	3.03
Native American	0.0077	0.11	0.0049	0.11	-0.0126	0.11
Asian	0.0417	1.44	0.0219	1.93	-0.0636	1.58
Black	-0.0074	0.35	-0.0052	0.34	0.0125	0.34
Hispanic	-0.0512	2.77	-0.0459	2.16	0.0971	2.45
Family Background						
Family income (in $10,000)	-0.0019	1.80	-0.0013	1.79	0.0031	1.80
First generation college graduate	-0.0245	2.50	-0.0164	2.49	0.0409	2.50
Academic Background						
Merged SAT/ACT quartile	0.0055	1.10	0.0037	1.09	-0.0092	1.10

Table E.10 – *Continued*

Satisfaction with Educational Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0150	0.89	0.0097	0.92	-0.0248	0.90
Engineering major	0.0253	0.99	0.0148	1.15	-0.0401	1.04
Health major	0.0233	0.91	0.0138	1.05	-0.0371	0.96
Public affairs major	0.0116	0.41	0.0073	0.44	-0.0189	0.42
Biological science major	0.0102	0.33	0.0064	0.35	-0.0166	0.33
Math science major	-0.0168	0.75	-0.0124	0.69	0.0293	0.73
Social science major	0.0401	1.73	0.0219	2.18	-0.0619	1.86
History major	0.0431	1.01	0.0222	1.39	-0.0653	1.11
Humanity major	0.0370	1.52	0.0203	1.90	-0.0573	1.63
Psychology major	0.0313	0.95	0.0175	1.17	-0.0488	1.02
Other major	0.0467	2.27	0.0254	2.87	-0.0721	2.43
Labor Market						
Age	0.0000	0.00	0.0000	0.00	0.0000	0.00
Age squared / 100	0.0000	0.39	0.0000	0.39	0.0001	0.39
Tenure	-0.0019	0.60	-0.0013	0.60	0.0032	0.60
Tenure squared /100	0.0001	0.47	0.0001	0.47	-0.0001	0.47
Number of hours per week	-0.0002	0.43	-0.0002	0.43	0.0004	0.43
N	3,870					
χ^2	172					

Table E.10 – *Continued*

Satisfaction with Educational Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0012	1.37	0.0008	1.37	-0.0020	1.37
Institutional Characteristics						
Low-quality, private institution	-0.0282	2.08	-0.0185	2.10	0.0467	2.10
Middle-quality, public institution	0.0096	0.38	0.0059	0.40	-0.0155	0.39
Middle-quality, private institution	0.0561	2.00	0.0264	2.98	-0.0826	2.24
High-quality, public institution	0.0231	1.40	0.0138	1.51	-0.0369	1.44
High-quality, private institution	0.0033	0.14	0.0021	0.14	-0.0053	0.14
Historically black coll. and inst.	-0.0278	0.93	-0.0213	0.80	0.0491	0.87
Demographic Characteristics						
Female	-0.0208	2.11	-0.0135	2.11	0.0343	2.12
Native American	-0.0026	0.04	-0.0017	0.04	0.0043	0.04
Asian	0.0270	0.97	0.0150	1.16	-0.0420	1.03
Black	-0.0090	0.43	-0.0062	0.41	0.0152	0.42
Hispanic	-0.0545	2.96	-0.0479	2.28	0.1024	2.61
Family Background						
Family income (in $10,000)	-0.0023	2.18	-0.0015	2.17	0.0038	2.18
First generation college graduate	-0.0231	2.33	-0.0150	2.33	0.0382	2.34
Academic Background						
Merged SAT/ACT quartile	0.0045	0.90	0.0030	0.90	-0.0075	0.90

Table E.10 – *Continued*

Satisfaction with Educational Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0114	0.71	-0.0077	0.69	0.0191	0.71
Engineering major	-0.0158	0.73	-0.0112	0.67	0.0271	0.71
Health major	-0.0197	0.92	-0.0143	0.83	0.0341	0.88
Public affairs major	-0.0017	0.06	-0.0011	0.06	0.0028	0.06
Biological science major	-0.0030	0.10	-0.0020	0.10	0.0051	0.10
Math science major	-0.0484	2.50	-0.0408	2.01	0.0892	2.26
Social science major	0.0183	0.84	0.0109	0.92	-0.0292	0.87
History major	0.0483	1.11	0.0233	1.60	-0.0716	1.23
Humanity major	0.0234	0.99	0.0134	1.13	-0.0368	1.04
Psychology major	0.0173	0.55	0.0102	0.61	-0.0275	0.57
Other major	0.0302	1.53	0.0172	1.74	-0.0474	1.59
Labor Market						
Age	-0.0032	0.51	-0.0021	0.51	0.0053	0.51
Age squared / 100	0.0000	0.08	0.0000	0.08	0.0000	0.08
Tenure	-0.0035	1.09	-0.0023	1.09	0.0059	1.09
Tenure squared /100	0.0001	0.57	0.0001	0.57	-0.0002	0.57
Number of hours per week	-0.0014	2.70	-0.0009	2.67	0.0023	2.70
N	3,870					
χ^2	97					

Table E.10 – *Continued*

Satisfaction with Fringe Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0421	7.51	-0.1026	7.59	0.1447	7.79
Educational debt (in $1,000)	0.0004	1.01	0.0011	1.01	-0.0015	1.01
Institutional Characteristics						
Low-quality, private institution	0.0190	1.34	0.0412	1.51	-0.0603	1.45
Middle-quality, public institution	0.0045	0.64	0.0109	0.64	-0.0153	0.64
Middle-quality, private institution	0.0112	1.30	0.0261	1.36	-0.0373	1.34
High-quality, public institution	0.0025	0.19	0.0060	0.20	-0.0084	0.20
High-quality, private institution	0.0275	1.85	0.0569	2.20	-0.0844	2.08
Historically black coll. and inst.	0.0345	1.52	0.0674	1.94	-0.1019	1.77
Demographic Characteristics						
Female	-0.0152	3.01	-0.0368	3.04	0.0520	3.04
Native American	-0.0329	1.49	-0.1021	1.19	0.1350	1.25
Asian	0.0571	2.90	0.0977	4.35	-0.1548	3.71
Black	-0.0037	0.36	-0.0093	0.35	0.0130	0.35
Hispanic	-0.0300	3.54	-0.0894	2.96	0.1193	3.11
Family Background						
Family income (in $10,000)	-0.0007	1.27	-0.0017	1.28	0.0024	1.28
First generation college graduate	-0.0022	0.44	-0.0054	0.44	0.0076	0.44
Academic Background						
Merged SAT/ACT quartile	-0.0016	0.62	-0.0038	0.62	0.0054	0.62

Table E.10 – *Continued*

Satisfaction with Fringe Benefits, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0232	3.11	-0.0604	2.99	0.0836	3.01
Engineering major	-0.0172	1.75	-0.0468	1.59	0.0640	1.62
Health major	-0.0148	1.48	-0.0398	1.36	0.0546	1.39
Public affairs major	-0.0131	1.13	-0.0349	1.04	0.0481	1.06
Biological science major	0.0016	0.10	0.0038	0.11	-0.0054	0.10
Math science major	-0.0265	2.96	-0.0766	2.55	0.1032	2.64
Social science major	0.0105	0.94	0.0241	0.99	-0.0346	0.98
History major	-0.0178	1.21	-0.0491	1.07	0.0669	1.10
Humanity major	-0.0043	0.40	-0.0107	0.39	0.0149	0.40
Psychology major	-0.0396	4.40	-0.1275	3.46	0.1671	3.67
Other major	-0.0141	1.75	-0.0369	1.65	0.0511	1.67
Labor Market						
Age	0.0046	1.46	0.0113	1.46	-0.0159	1.46
Age squared / 100	0.0000	1.14	-0.0001	1.14	0.0002	1.14
Tenure	-0.0032	1.96	-0.0078	1.96	0.0111	1.96
Tenure squared /100	0.0001	1.30	0.0002	1.30	-0.0004	1.30
Number of hours per week	0.0004	1.28	0.0009	1.29	-0.0012	1.29
N	3,870					
χ^2	175					

Table E.10 – *Continued*

Satisfaction with Fringe Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0005	1.03	0.0011	1.03	-0.0016	1.03
Institutional Characteristics						
Low-quality, private institution	0.0004	0.06	0.0010	0.06	-0.0014	0.06
Middle-quality, public institution	-0.0049	0.41	-0.0120	0.40	0.0170	0.40
Middle-quality, private institution	0.0173	1.21	0.0366	1.34	-0.0539	1.31
High-quality, public institution	0.0064	0.75	0.0146	0.76	-0.0210	0.76
High-quality, private institution	0.0174	1.25	0.0370	1.39	-0.0544	1.35
Historically black coll. and inst.	0.0441	1.79	0.0789	2.43	-0.1230	2.16
Demographic Characteristics						
Female	-0.0119	2.33	-0.0280	2.36	0.0399	2.35
Native American	-0.0351	1.61	-0.1066	1.27	0.1417	1.34
Asian	0.0493	2.61	0.0858	3.67	-0.1352	3.21
Black	-0.0042	0.39	-0.0101	0.38	0.0143	0.38
Hispanic	-0.0312	3.64	-0.0900	3.04	0.1212	3.18
Family Background						
Family income (in $10,000)	-0.0009	1.68	-0.0022	1.68	0.0032	1.68
First generation college graduate	-0.0012	0.24	-0.0029	0.24	0.0041	0.24
Academic Background						
Merged SAT/ACT quartile	-0.0020	0.75	-0.0046	0.75	0.0066	0.75

Table E.10 – *Continued*

Satisfaction with Fringe Benefits, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0342	4.61	-0.0883	4.52	0.1225	4.54
Engineering major	-0.0317	3.76	-0.0907	3.24	0.1223	3.39
Health major	-0.0302	3.57	-0.0858	3.09	0.1159	3.21
Public affairs major	-0.0190	1.71	-0.0506	1.53	0.0696	1.58
Biological science major	-0.0052	0.36	-0.0127	0.35	0.0179	0.35
Math science major	-0.0379	4.79	-0.1136	4.01	0.1515	4.22
Social science major	0.0012	0.12	0.0029	0.12	-0.0041	0.12
History major	-0.0116	0.71	-0.0295	0.66	0.0411	0.67
Humanity major	-0.0093	0.90	-0.0232	0.86	0.0325	0.87
Psychology major	-0.0436	4.94	-0.1387	3.91	0.1823	4.15
Other major	-0.0202	2.56	-0.0527	2.39	0.0729	2.42
Labor Market						
Age	0.0032	0.99	0.0075	0.99	-0.0107	0.99
Age squared / 100	0.0000	0.71	-0.0001	0.71	0.0001	0.71
Tenure	-0.0039	2.31	-0.0091	2.32	0.0130	2.32
Tenure squared /100	0.0001	1.30	0.0002	1.30	-0.0003	1.30
Number of hours per week	-0.0002	0.90	-0.0006	0.90	0.0008	0.90
N	3,870					
χ^2	113					

Table E.10 – *Continued*

Satisfaction with Job Challenge, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0337	6.21	-0.0872	6.28	0.1209	6.38
Educational debt (in $1,000)	-0.0004	1.00	-0.0012	1.00	0.0016	1.01
Institutional Characteristics						
Low-quality, private institution	0.0303	2.01	0.0645	2.47	-0.0948	2.32
Middle-quality, public institution	0.0048	0.71	0.0125	0.71	-0.0173	0.71
Middle-quality, private institution	0.0202	2.27	0.0478	2.47	-0.0680	2.42
High-quality, public institution	-0.0010	0.09	-0.0027	0.09	0.0037	0.09
High-quality, private institution	0.0263	1.81	0.0576	2.14	-0.0839	2.04
Historically black coll. and inst.	-0.0226	1.88	-0.0688	1.61	0.0914	1.67
Demographic Characteristics						
Female	-0.0209	4.18	-0.0534	4.29	0.0742	4.29
Native American	-0.0373	1.95	-0.1291	1.49	0.1664	1.57
Asian	0.0026	0.21	0.0067	0.21	-0.0093	0.21
Black	0.0423	2.87	0.0844	3.82	-0.1267	3.46
Hispanic	-0.0153	1.61	-0.0439	1.46	0.0592	1.50
Family Background						
Family income (in $10,000)	-0.0016	2.76	-0.0041	2.76	0.0057	2.77
First generation college graduate	-0.0210	4.24	-0.0538	4.34	0.0748	4.34
Academic Background						
Merged SAT/ACT quartile	-0.0016	0.67	-0.0042	0.67	0.0059	0.67

Table E.10 – *Continued*

Satisfaction with Job Challenge, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0307	3.22	0.0716	3.54	-0.1022	3.49
Engineering major	0.0215	1.50	0.0485	1.72	-0.0700	1.65
Health major	-0.0052	0.46	-0.0140	0.45	0.0192	0.45
Public affairs major	-0.0027	0.21	-0.0071	0.20	0.0099	0.20
Biological science major	0.0227	1.21	0.0504	1.42	-0.0732	1.35
Math science major	0.0261	1.73	0.0571	2.05	-0.0832	1.94
Social science major	0.0444	3.09	0.0886	4.03	-0.1330	3.71
History major	0.0033	0.16	0.0084	0.17	-0.0117	0.17
Humanity major	0.0416	2.73	0.0835	3.55	-0.1251	3.27
Psychology major	0.0329	1.65	0.0683	2.07	-0.1012	1.92
Other major	0.0263	2.37	0.0593	2.71	-0.0856	2.62
Labor Market						
Age	0.0050	1.63	0.0129	1.63	-0.0178	1.63
Age squared / 100	-0.0001	1.63	-0.0002	1.63	0.0002	1.63
Tenure	0.0038	2.39	0.0099	2.39	-0.0137	2.40
Tenure squared /100	-0.0002	2.03	-0.0004	2.03	0.0006	2.03
Number of hours per week	-0.0018	6.44	-0.0047	6.52	0.0066	6.63
N	3,870					
χ^2	230					

Table E.10 – *Continued*

Satisfaction with Job Challenge, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	-0.0004	0.95	-0.0011	0.95	0.0015	0.95
Institutional Characteristics						
Low-quality, private institution	0.0019	0.27	0.0047	0.27	-0.0065	0.27
Middle-quality, public institution	-0.0065	0.57	-0.0173	0.55	0.0238	0.55
Middle-quality, private institution	0.0292	1.94	0.0614	2.36	-0.0906	2.22
High-quality, public institution	0.0164	1.86	0.0386	2.00	-0.0550	1.98
High-quality, private institution	0.0184	1.34	0.0414	1.51	-0.0598	1.46
Historically black coll. and inst.	-0.0190	1.48	-0.0550	1.30	0.0740	1.34
Demographic Characteristics						
Female	-0.0177	3.54	-0.0442	3.62	0.0619	3.60
Native American	-0.0390	2.06	-0.1332	1.56	0.1721	1.65
Asian	-0.0013	0.10	-0.0032	0.10	0.0044	0.10
Black	0.0420	2.83	0.0822	3.74	-0.1241	3.39
Hispanic	-0.0161	1.69	-0.0454	1.52	0.0615	1.57
Family Background						
Family income (in $10,000)	-0.0018	3.12	-0.0047	3.13	0.0065	3.15
First generation college graduate	-0.0207	4.14	-0.0518	4.22	0.0724	4.22
Academic Background						
Merged SAT/ACT quartile	-0.0020	0.78	-0.0049	0.78	0.0069	0.78

Table E.10 – *Continued*

Satisfaction with Job Challenge, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0205	2.26	0.0484	2.41	-0.0689	2.39
Engineering major	0.0052	0.42	0.0126	0.44	-0.0178	0.43
Health major	-0.0191	2.00	-0.0546	1.79	0.0736	1.83
Public affairs major	-0.0073	0.58	-0.0195	0.55	0.0268	0.56
Biological science major	0.0167	0.93	0.0376	1.04	-0.0542	1.00
Math science major	0.0111	0.84	0.0261	0.90	-0.0371	0.88
Social science major	0.0357	2.62	0.0732	3.24	-0.1089	3.05
History major	0.0078	0.37	0.0188	0.39	-0.0266	0.39
Humanity major	0.0366	2.47	0.0741	3.11	-0.1107	2.90
Psychology major	0.0274	1.42	0.0576	1.72	-0.0850	1.62
Other major	0.0209	1.94	0.0473	2.16	-0.0682	2.10
Labor Market						
Age	0.0037	1.20	0.0094	1.20	-0.0131	1.21
Age squared / 100	0.0000	1.24	-0.0001	1.24	0.0002	1.24
Tenure	0.0033	2.07	0.0085	2.07	-0.0118	2.08
Tenure squared /100	-0.0002	2.01	-0.0004	2.01	0.0006	2.01
Number of hours per week	-0.0023	8.10	-0.0059	8.25	0.0082	8.49
N	3,870					
χ^2	188					

Table E.10 – *Continued*

Satisfaction with Working Condition, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0169	3.12	-0.0420	3.13	0.0589	3.15
Educational debt (in $1,000)	-0.0001	0.20	-0.0002	0.20	0.0003	0.20
Institutional Characteristics						
Low-quality, private institution	0.0356	2.27	0.0706	2.88	-0.1061	2.66
Middle-quality, public institution	-0.0010	0.15	-0.0026	0.15	0.0036	0.15
Middle-quality, private institution	-0.0018	0.23	-0.0046	0.23	0.0064	0.23
High-quality, public institution	0.0104	0.76	0.0241	0.81	-0.0345	0.80
High-quality, private institution	0.0316	2.09	0.0645	2.56	-0.0961	2.40
Historically black coll. and inst.	0.0131	0.69	0.0297	0.76	-0.0427	0.74
Demographic Characteristics						
Female	-0.0028	0.58	-0.0070	0.58	0.0099	0.58
Native American	-0.0036	0.11	-0.0092	0.11	0.0129	0.11
Asian	0.0283	1.76	0.0583	2.14	-0.0866	2.00
Black	0.0362	2.50	0.0721	3.16	-0.1083	2.91
Hispanic	-0.0003	0.03	-0.0008	0.03	0.0011	0.03
Family Background						
Family income (in $10,000)	-0.0010	1.87	-0.0026	1.87	0.0037	1.87
First generation college graduate	0.0046	0.92	0.0113	0.92	-0.0159	0.92
Academic Background						
Merged SAT/ACT quartile	-0.0071	2.78	-0.0176	2.79	0.0246	2.80

Table E.10 – *Continued*

Satisfaction with Working Condition, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0176	2.35	-0.0460	2.26	0.0636	2.26
Engineering major	-0.0051	0.46	-0.0130	0.44	0.0180	0.45
Health major	0.0095	0.75	0.0222	0.79	-0.0316	0.78
Public affairs major	0.0075	0.53	0.0178	0.56	-0.0253	0.55
Biological science major	-0.0059	0.41	-0.0152	0.39	0.0210	0.40
Math science major	-0.0149	1.47	-0.0408	1.34	0.0557	1.37
Social science major	0.0031	0.30	0.0076	0.30	-0.0107	0.30
History major	-0.0312	2.52	-0.0978	2.04	0.1290	2.13
Humanity major	-0.0141	1.51	-0.0384	1.39	0.0525	1.41
Psychology major	0.0083	0.50	0.0196	0.53	-0.0279	0.53
Other major	-0.0166	2.12	-0.0449	1.97	0.0614	1.99
Labor Market						
Age	0.0095	2.99	0.0236	3.00	-0.0330	3.01
Age squared / 100	-0.0001	3.14	-0.0003	3.15	0.0004	3.16
Tenure	0.0064	3.83	0.0158	3.84	-0.0222	3.87
Tenure squared /100	-0.0002	2.98	-0.0006	2.99	0.0009	3.00
Number of hours per week	0.0001	0.46	0.0003	0.46	-0.0004	0.46
N	3,870					
χ^2	146					

Table E.10 – *Continued*

Satisfaction with Working Condition, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	-0.0001	0.19	-0.0002	0.19	0.0003	0.19
Institutional Characteristics						
Low-quality, private institution	-0.0026	0.38	-0.0064	0.38	0.0090	0.38
Middle-quality, public institution	0.0073	0.56	0.0173	0.58	-0.0246	0.58
Middle-quality, private institution	0.0346	2.22	0.0688	2.81	-0.1033	2.60
High-quality, public institution	-0.0035	0.46	-0.0088	0.45	0.0124	0.45
High-quality, private institution	0.0273	1.87	0.0570	2.24	-0.0842	2.11
Historically black coll. and inst.	0.0154	0.80	0.0344	0.89	-0.0498	0.86
Demographic Characteristics						
Female	-0.0012	0.24	-0.0029	0.24	0.0041	0.24
Native American	-0.0047	0.15	-0.0121	0.14	0.0169	0.14
Asian	0.0256	1.62	0.0534	1.95	-0.0790	1.83
Black	0.0358	2.47	0.0712	3.13	-0.1070	2.89
Hispanic	-0.0009	0.08	-0.0023	0.08	0.0033	0.08
Family Background						
Family income (in $10,000)	-0.0012	2.04	-0.0029	2.04	0.0040	2.05
First generation college graduate	0.0049	0.99	0.0121	0.99	-0.0170	0.99
Academic Background						
Merged SAT/ACT quartile	-0.0073	2.85	-0.0179	2.86	0.0252	2.87

Table E.10 – *Continued*

Satisfaction with Working Condition, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0220	2.93	-0.0579	2.91	0.0799	2.90
Engineering major	-0.0118	1.15	-0.0314	1.09	0.0431	1.10
Health major	0.0013	0.12	0.0032	0.12	-0.0046	0.12
Public affairs major	0.0050	0.36	0.0119	0.37	-0.0168	0.37
Biological science major	-0.0081	0.58	-0.0213	0.55	0.0294	0.56
Math science major	-0.0204	2.16	-0.0577	1.94	0.0781	1.98
Social science major	-0.0002	0.02	-0.0004	0.02	0.0006	0.02
History major	-0.0300	2.34	-0.0926	1.93	0.1226	2.02
Humanity major	-0.0160	1.72	-0.0437	1.59	0.0596	1.62
Psychology major	0.0057	0.36	0.0136	0.37	-0.0194	0.37
Other major	-0.0187	2.40	-0.0511	2.26	0.0698	2.28
Labor Market						
Age	0.0089	2.83	0.0221	2.84	-0.0311	2.85
Age squared / 100	-0.0001	2.99	-0.0003	2.99	0.0004	3.00
Tenure	0.0061	3.66	0.0150	3.67	-0.0211	3.69
Tenure squared /100	-0.0002	2.96	-0.0006	2.97	0.0009	2.98
Number of hours per week	-0.0001	0.38	-0.0002	0.38	0.0003	0.38
N	3,870					
χ^2	136					

Table E.10 – *Continued*

Satisfaction with Job Security, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0113	2.36	-0.0310	2.37	0.0423	2.37
Educational debt (in $1,000)	-0.0003	0.74	-0.0008	0.74	0.0011	0.75
Institutional Characteristics						
Low-quality, private institution	0.0156	1.25	0.0390	1.37	-0.0546	1.34
Middle-quality, public institution	-0.0020	0.33	-0.0055	0.33	0.0075	0.33
Middle-quality, private institution	0.0269	3.08	0.0664	3.47	-0.0933	3.37
High-quality, public institution	0.0168	1.25	0.0418	1.38	-0.0586	1.34
High-quality, private institution	0.0285	2.03	0.0667	2.39	-0.0952	2.28
Historically black coll. and inst.	0.0119	0.72	0.0304	0.78	-0.0423	0.76
Demographic Characteristics						
Female	-0.0141	3.08	-0.0383	3.14	0.0524	3.14
Native American	-0.0101	0.36	-0.0293	0.34	0.0394	0.34
Asian	0.0034	0.29	0.0092	0.30	-0.0127	0.30
Black	0.0477	3.34	0.1014	4.44	-0.1491	4.04
Hispanic	-0.0105	1.14	-0.0306	1.08	0.0411	1.10
Family Background						
Family income (in $10,000)	-0.0007	1.47	-0.0020	1.47	0.0028	1.47
First generation college graduate	-0.0029	0.64	-0.0079	0.64	0.0107	0.64
Academic Background						
Merged SAT/ACT quartile	-0.0043	1.86	-0.0118	1.86	0.0161	1.86

Table E.10 – *Continued*

Satisfaction with Job Security, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0052	0.67	0.0140	0.68	-0.0192	0.68
Engineering major	0.0191	1.47	0.0471	1.62	-0.0663	1.58
Health major	-0.0025	0.24	-0.0071	0.24	0.0096	0.24
Public affairs major	-0.0016	0.13	-0.0044	0.13	0.0061	0.13
Biological science major	0.0274	1.53	0.0639	1.79	-0.0914	1.71
Math science major	-0.0006	0.05	-0.0016	0.05	0.0021	0.05
Social science major	0.0135	1.26	0.0343	1.34	-0.0478	1.32
History major	-0.0198	1.46	-0.0612	1.30	0.0810	1.34
Humanity major	0.0002	0.02	0.0006	0.02	-0.0008	0.02
Psychology major	-0.0054	0.42	-0.0153	0.41	0.0208	0.41
Other major	0.0084	0.94	0.0221	0.97	-0.0305	0.96
Labor Market						
Age	0.0114	4.04	0.0311	4.07	-0.0425	4.10
Age squared / 100	-0.0001	3.59	-0.0004	3.61	0.0005	3.63
Tenure	-0.0039	2.64	-0.0106	2.64	0.0144	2.65
Tenure squared /100	0.0001	0.97	0.0002	0.97	-0.0003	0.97
Number of hours per week	-0.0007	2.67	-0.0018	2.68	0.0025	2.69
N	3,870					
χ^2	200					

Table E.10 – *Continued*

Satisfaction with Job Security, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	-0.0003	0.71	-0.0008	0.71	0.0011	0.71
Institutional Characteristics						
Low-quality, private institution	-0.0030	0.49	-0.0082	0.49	0.0112	0.49
Middle-quality, public institution	0.0146	1.12	0.0367	1.22	-0.0513	1.19
Middle-quality, private institution	0.0152	1.23	0.0381	1.34	-0.0534	1.31
High-quality, public institution	0.0254	2.95	0.0628	3.29	-0.0882	3.20
High-quality, private institution	0.0255	1.87	0.0605	2.17	-0.0859	2.08
Historically black coll. and inst.	0.0133	0.80	0.0336	0.86	-0.0470	0.84
Demographic Characteristics						
Female	-0.0130	2.87	-0.0353	2.91	0.0483	2.92
Native American	-0.0109	0.39	-0.0317	0.37	0.0426	0.37
Asian	0.0020	0.17	0.0053	0.17	-0.0073	0.17
Black	0.0476	3.34	0.1009	4.42	-0.1484	4.01
Hispanic	-0.0110	1.21	-0.0321	1.14	0.0432	1.15
Family Background						
Family income (in $10,000)	-0.0008	1.61	-0.0023	1.61	0.0031	1.61
First generation college graduate	-0.0028	0.62	-0.0076	0.62	0.0104	0.62
Academic Background						
Merged SAT/ACT quartile	-0.0044	1.92	-0.0121	1.92	0.0165	1.92

Table E.10 – *Continued*

Satisfaction with Job Security, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0019	0.25	0.0051	0.25	-0.0069	0.25
Engineering major	0.0129	1.08	0.0329	1.15	-0.0458	1.13
Health major	-0.0075	0.77	-0.0213	0.74	0.0288	0.75
Public affairs major	-0.0033	0.27	-0.0090	0.27	0.0123	0.27
Biological science major	0.0248	1.42	0.0586	1.64	-0.0834	1.57
Math science major	-0.0048	0.46	-0.0133	0.45	0.0181	0.45
Social science major	0.0110	1.05	0.0282	1.11	-0.0392	1.09
History major	-0.0185	1.34	-0.0567	1.20	0.0753	1.23
Humanity major	-0.0013	0.13	-0.0035	0.13	0.0048	0.13
Psychology major	-0.0070	0.55	-0.0198	0.53	0.0267	0.53
Other major	0.0065	0.73	0.0171	0.75	-0.0236	0.75
Labor Market						
Age	0.0109	3.89	0.0298	3.92	-0.0408	3.95
Age squared / 100	-0.0001	3.45	-0.0003	3.47	0.0005	3.49
Tenure	-0.0040	2.75	-0.0110	2.76	0.0150	2.77
Tenure squared /100	0.0001	0.98	0.0002	0.98	-0.0003	0.98
Number of hours per week	-0.0008	3.39	-0.0022	3.41	0.0030	3.42
N	3,870					
χ^2	194					

Table E.10 – *Continued*

Satisfaction with Supervisor, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	-0.0175	2.63	-0.0301	2.63	0.0476	2.64
Educational debt (in $1,000)	0.0000	0.04	0.0000	0.04	-0.0001	0.04
Institutional Characteristics						
Low-quality, private institution	-0.0166	1.31	-0.0310	1.21	0.0476	1.24
Middle-quality, public institution	-0.0041	0.49	-0.0072	0.49	0.0113	0.49
Middle-quality, private institution	-0.0046	0.48	-0.0080	0.47	0.0126	0.47
High-quality, public institution	0.0047	0.30	0.0080	0.31	-0.0127	0.30
High-quality, private institution	0.0104	0.67	0.0171	0.70	-0.0276	0.69
Historically black coll. and inst.	0.0440	1.64	0.0606	2.10	-0.1047	1.88
Demographic Characteristics						
Female	-0.0006	0.10	-0.0010	0.10	0.0016	0.10
Native American	-0.0124	0.33	-0.0229	0.31	0.0354	0.32
Asian	0.0161	0.90	0.0255	0.98	-0.0416	0.95
Black	0.0260	1.68	0.0396	1.91	-0.0656	1.81
Hispanic	-0.0139	1.09	-0.0258	1.02	0.0397	1.04
Family Background						
Family income (in $10,000)	0.0000	0.05	-0.0001	0.05	0.0001	0.05
First generation college graduate	-0.0047	0.76	-0.0081	0.76	0.0128	0.76
Academic Background						
Merged SAT/ACT quartile	-0.0015	0.48	-0.0026	0.48	0.0042	0.48

Table E.10 – *Continued*

Satisfaction with Supervisor, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0192	1.69	0.0316	1.75	-0.0508	1.75
Engineering major	-0.0066	0.45	-0.0117	0.44	0.0183	0.44
Health major	0.0643	2.97	0.0817	4.13	-0.1459	3.58
Public affairs major	0.0042	0.23	0.0071	0.24	-0.0113	0.24
Biological science major	0.0103	0.49	0.0168	0.52	-0.0271	0.51
Math science major	0.0110	0.66	0.0180	0.70	-0.0291	0.69
Social science major	0.0106	0.75	0.0174	0.78	-0.0280	0.77
History major	0.0247	0.88	0.0374	1.00	-0.0621	0.95
Humanity major	0.0327	1.92	0.0484	2.23	-0.0812	2.12
Psychology major	0.0390	1.62	0.0551	1.99	-0.0941	1.82
Other major	0.0139	1.10	0.0227	1.15	-0.0366	1.14
Labor Market						
Age	0.0001	0.04	0.0002	0.04	-0.0004	0.04
Age squared / 100	0.0000	0.20	0.0000	0.20	0.0000	0.20
Tenure	0.0023	1.10	0.0039	1.10	-0.0062	1.10
Tenure squared /100	-0.0001	0.86	-0.0002	0.86	0.0002	0.86
Number of hours per week	0.0006	1.92	0.0011	1.92	-0.0018	1.93
N	3,870					
χ^2	69					

Table E.10 – *Continued*

Satisfaction with Supervisor, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	0.0000	0.04	0.0000	0.04	-0.0001	0.04
Institutional Characteristics						
Low-quality, private institution	-0.0061	0.71	-0.0104	0.72	0.0165	0.71
Middle-quality, public institution	0.0015	0.10	0.0026	0.10	-0.0042	0.10
Middle-quality, private institution	-0.0175	1.39	-0.0329	1.28	0.0505	1.32
High-quality, public institution	-0.0066	0.70	-0.0117	0.69	0.0183	0.69
High-quality, private institution	0.0065	0.43	0.0108	0.44	-0.0172	0.43
Historically black coll. and inst.	0.0474	1.73	0.0641	2.26	-0.1115	2.00
Demographic Characteristics						
Female	0.0011	0.17	0.0018	0.17	-0.0029	0.17
Native American	-0.0135	0.37	-0.0251	0.34	0.0386	0.35
Asian	0.0135	0.77	0.0217	0.83	-0.0353	0.81
Black	0.0258	1.66	0.0393	1.89	-0.0651	1.80
Hispanic	-0.0143	1.12	-0.0265	1.05	0.0409	1.07
Family Background						
Family income (in $10,000)	-0.0001	0.20	-0.0002	0.20	0.0004	0.20
First generation college graduate	-0.0042	0.68	-0.0072	0.68	0.0115	0.68
Academic Background						
Merged SAT/ACT quartile	-0.0017	0.55	-0.0030	0.55	0.0048	0.55

Table E.10 – *Continued*

Satisfaction with Supervisor, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	0.0141	1.28	0.0234	1.31	-0.0375	1.32
Engineering major	-0.0133	0.98	-0.0244	0.92	0.0377	0.94
Health major	0.0528	2.64	0.0706	3.43	-0.1234	3.08
Public affairs major	0.0017	0.09	0.0028	0.09	-0.0045	0.09
Biological science major	0.0073	0.36	0.0122	0.37	-0.0195	0.37
Math science major	0.0041	0.26	0.0069	0.27	-0.0110	0.27
Social science major	0.0071	0.52	0.0118	0.53	-0.0189	0.53
History major	0.0287	1.00	0.0425	1.17	-0.0713	1.09
Humanity major	0.0303	1.81	0.0452	2.08	-0.0755	1.97
Psychology major	0.0359	1.52	0.0514	1.83	-0.0873	1.70
Other major	0.0113	0.91	0.0186	0.94	-0.0299	0.93
Labor Market						
Age	-0.0005	0.13	-0.0008	0.13	0.0013	0.13
Age squared / 100	0.0000	0.36	0.0000	0.36	0.0000	0.36
Tenure	0.0020	0.95	0.0034	0.95	-0.0053	0.95
Tenure squared /100	-0.0001	0.84	-0.0001	0.84	0.0002	0.84
Number of hours per week	0.0004	1.28	0.0007	1.28	-0.0011	1.28
N	3,870					
χ^2	62					

Table E.10 – *Continued*

Satisfaction with Co-worker, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Log earnings	0.0003	0.26	0.0035	0.26	-0.0038	0.26
Educational debt (in $1,000)	-0.0001	0.69	-0.0008	0.69	0.0008	0.69
Institutional Characteristics						
Low-quality, private institution	0.0041	1.19	0.0417	1.27	-0.0458	1.27
Middle-quality, public institution	-0.0003	0.17	-0.0030	0.17	0.0033	0.17
Middle-quality, private institution	0.0022	1.08	0.0235	1.11	-0.0258	1.11
High-quality, public institution	0.0075	1.80	0.0734	2.04	-0.0809	2.02
High-quality, private institution	0.0052	1.43	0.0523	1.55	-0.0575	1.54
Historically black coll. and inst.	0.0002	0.05	0.0019	0.05	-0.0021	0.05
Demographic Characteristics						
Female	-0.0008	0.68	-0.0085	0.68	0.0093	0.68
Native American	0.0043	0.45	0.0434	0.48	-0.0477	0.47
Asian	0.0085	1.96	0.0820	2.27	-0.0905	2.24
Black	0.0047	1.51	0.0474	1.63	-0.0520	1.62
Hispanic	-0.0033	1.41	-0.0366	1.37	0.0399	1.38
Family Background						
Family income (in $10,000)	-0.0001	0.81	-0.0012	0.81	0.0013	0.81
First generation college graduate	-0.0010	0.88	-0.0112	0.89	0.0122	0.89
Academic Background						
Merged SAT/ACT quartile	-0.0011	1.73	-0.0116	1.77	0.0127	1.77

Table E.10 – *Continued*

Satisfaction with Co-worker, Direct Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0038	2.14	-0.0421	2.17	0.0460	2.18
Engineering major	-0.0042	1.94	-0.0478	1.90	0.0521	1.90
Health major	-0.0014	0.54	-0.0148	0.53	0.0162	0.53
Public affairs major	-0.0038	1.50	-0.0427	1.45	0.0464	1.45
Biological science major	0.0031	0.76	0.0319	0.80	-0.0350	0.80
Math science major	0.0026	0.84	0.0274	0.87	-0.0300	0.87
Social science major	0.0028	1.02	0.0286	1.06	-0.0314	1.06
History major	0.0019	0.41	0.0204	0.43	-0.0223	0.43
Humanity major	-0.0008	0.34	-0.0088	0.33	0.0096	0.33
Psychology major	-0.0047	1.80	-0.0546	1.73	0.0594	1.74
Other major	-0.0010	0.48	-0.0106	0.48	0.0116	0.48
Labor Market						
Age	0.0013	1.79	0.0143	1.84	-0.0156	1.84
Age squared / 100	0.0000	1.60	-0.0002	1.63	0.0002	1.63
Tenure	0.0000	0.06	-0.0003	0.06	0.0003	0.06
Tenure squared /100	0.0000	0.96	-0.0002	0.97	0.0003	0.97
Number of hours per week	-0.0001	1.04	-0.0007	1.05	0.0008	1.05
N	3,870					
χ^2	75					

Table E.10 – *Continued*

Satisfaction with Co-worker, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Financial Variables						
Educational debt (in $1,000)	-0.0001	0.70	-0.0008	0.70	0.0008	0.70
Institutional Characteristics						
Low-quality, private institution	-0.0002	0.15	-0.0027	0.15	0.0029	0.15
Middle-quality, public institution	0.0076	1.82	0.0741	2.06	-0.0817	2.04
Middle-quality, private institution	0.0041	1.20	0.0419	1.28	-0.0460	1.27
High-quality, public institution	0.0023	1.09	0.0239	1.13	-0.0262	1.13
High-quality, private institution	0.0053	1.45	0.0531	1.58	-0.0584	1.57
Historically black coll. and inst.	0.0001	0.03	0.0014	0.03	-0.0015	0.03
Demographic Characteristics						
Female	-0.0008	0.71	-0.0088	0.71	0.0097	0.71
Native American	0.0043	0.45	0.0437	0.48	-0.0480	0.48
Asian	0.0086	1.98	0.0825	2.28	-0.0911	2.26
Black	0.0047	1.51	0.0475	1.64	-0.0521	1.63
Hispanic	-0.0032	1.40	-0.0365	1.37	0.0397	1.37
Family Background						
Family income (in $10,000)	-0.0001	0.80	-0.0011	0.80	0.0012	0.80
First generation college graduate	-0.0010	0.88	-0.0113	0.89	0.0123	0.89
Academic Background						
Merged SAT/ACT quartile	-0.0011	1.73	-0.0116	1.77	0.0126	1.77

Table E.10 – *Continued*

Satisfaction with Co-worker, Total Effects

	Marginal Effect					
	Dissatisfied		Somehow satisfied		Satisfied	
	Coeff.	t	Coeff.	t	Coeff.	t
Business major	-0.0038	2.12	-0.0412	2.16	0.0450	2.16
Engineering major	-0.0041	1.91	-0.0466	1.87	0.0507	1.88
Health major	-0.0012	0.49	-0.0133	0.48	0.0145	0.48
Public affairs major	-0.0037	1.48	-0.0422	1.43	0.0460	1.44
Biological science major	0.0032	0.78	0.0326	0.81	-0.0357	0.81
Math science major	0.0028	0.89	0.0288	0.93	-0.0316	0.92
Social science major	0.0028	1.05	0.0294	1.09	-0.0322	1.09
History major	0.0019	0.41	0.0200	0.42	-0.0220	0.42
Humanity major	-0.0008	0.32	-0.0084	0.32	0.0092	0.32
Psychology major	-0.0047	1.78	-0.0543	1.71	0.0590	1.72
Other major	-0.0009	0.46	-0.0101	0.46	0.0110	0.46
Labor Market						
Age	0.0013	1.81	0.0144	1.86	-0.0158	1.86
Age squared / 100	0.0000	1.61	-0.0002	1.65	0.0002	1.65
Tenure	0.0000	0.04	-0.0002	0.04	0.0002	0.04
Tenure squared /100	0.0000	0.97	-0.0002	0.98	0.0003	0.98
Number of hours per week	-0.0001	1.01	-0.0007	1.02	0.0007	1.02
N	3,870					
χ^2	75					

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