The Impact of College Quality on Early Labor Market Outcomes in China

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ABSTRACT

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This study aims to explore the impact of college quality on early labor market outcomes in China, including the fresh college graduates' initial employment status and starting wages for students who graduated in 2011. The main data source is the College Student Labor Market (CSLM) survey conducted by Tsinghua University.

Distinguished from previous Chinese studies that merely utilized the broad and abstract college quality categories to measure college quality in China, input-based school resource indicators, including faculty-student ratio, proportion of faculty members holding doctoral degrees, average freshman National College Entrance Examination (NCEE) score, and teaching expenditure per student are collected to measure college quality in China for the first time.

To identify the causal effect of college quality, the instrumental variable approach and the propensity score matching method are employed to account for the endogeneity of elite college attendance in addition to the traditional ordinary least squares (OLS) regression. To explore the heterogeneous effect of college quality varying by student and family background characteristics, a series of interaction terms are generated in the OLS regressions. The quantile regressions are employed to explore the effect of college quality varying by earning distribution. Moreover, the Heckman correction approach is used to test for potential sample selection bias.

This study finds solid evidence that elite college attendance generally has a positive and

statistically significant effect on the initial employment status and starting salaries for fresh college graduates who intend to work after college graduation. I find weak support for the existence of heterogeneous effect of college quality. Less-capable students tend to benefit more from attending elite colleges. However, the impact of college quality does not seem to vary by graduates' earning distribution. When using the input-based college quality measures, the results suggest that the quality gap does exist between elite and non-elite colleges in China and the major finding that there is a positive impact of college quality on the starting salary still holds. Some input indicators have stronger correlations with college graduates' starting wages than others.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

2SLS	Two-Stage Least Squares
ATC	Average Treatment Effect on the Control
ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
B&B	Baccalaureate and Beyond Longitudinal Survey
C&B	College and Beyond
CCSS	Chinese College Student Survey
CET	College English Test
CHIP	Chinese Household Income Project
CI	Confidence Interval
CIA	Conditional Independent Assumption
CPC	Community Party of China
CPI	Consumer Price Index
CSES	College Student Engagement Survey
CSLM	College Student Labor Market survey
FE	Fixed Effects
GDP	Gross Domestic Product
GPA	Grade Point Average
HEIs	Higher Education Institutions
HLM	Hierarchical Linear Model
HS&B	High School and Beyond
IMR	Inverse Mills Ratio

IV	Instrumental Variable
KMO	Kaiser-Meyer-Olin
LATE	Local Average Treatment Effect
MAR	Missing At Random
MCAR	Missing Completely At Random
MOE	Ministry of Education
MYCOS	My China Occupational Skills Company
NCEE	National College Entrance Examination
NGO	Non-governmental Organization
NLS	National Longitudinal Surveys
NMAR	Not Missing At Random
NSSE	National Survey of Student Engagement
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
Ph.D.	Doctor of Philosophy
PSM	Propensity Score Matching
RCG	Recent College Graduates
R&D	Research and Development
RD	Regression Discontinuity
RMB	Renminbi (Chinese yuan)
SAT	Scholastic Aptitude Test
SD	Standard Deviation
SES	Socioeconomic Status

STD	Standardized Mean Differences
STEM	Science, Technology, Engineering and Mathematics
VIF	Variance Inflation Factor

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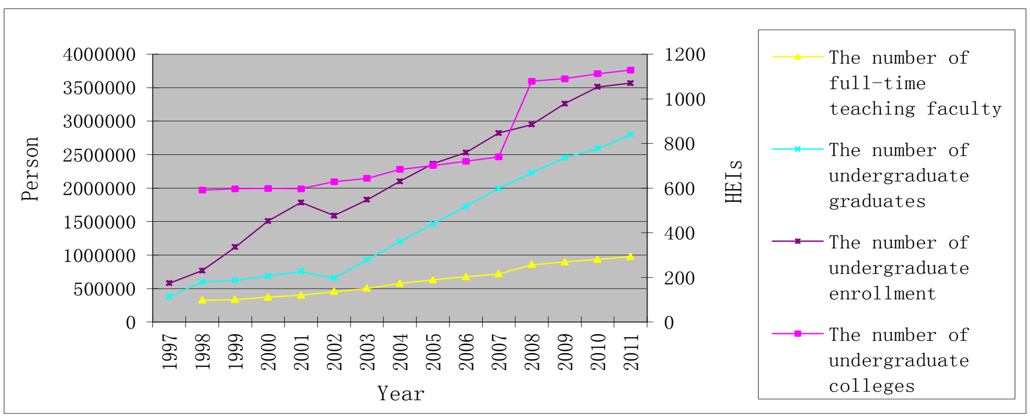
Chapter 1 Introduction

1.1 Context and Motivation

In 2011, the number of newly admitted undergraduates and the number of undergraduate graduates reached new highs of about 3.57 and 2.8 million, respectively, in China.[1] According to the Ministry of Education (MOE), the enrollment rate for students taking the National College Entrance Examination (NCEE) was 75% in 2012. As the majority of today's senior high school graduates manage to enter colleges[2] in China, parents and students are more interested in where to attend a college rather than whether to go to a college.

Figure 1-1 Chinese Undergraduate Education Expansion, 1997-2011



Note: Data are collected from the official website of the Ministry of Education in China. The scale on the left of the y-axis corresponds to the unit in person, while the scale on the right of the y-axis corresponds to the number of higher educational institutions.

Massive pursuit of higher education has been achieved by the unprecedented higher education expansion in China since 1999. Although the expansion began in an attempt to alleviate the economic crisis domestically after the Asian financial crisis, it became the fastest

[1] Data is collected from the Ministry of Education in China website at http://www.moe.edu.cn/publicfiles/business/htmlfiles/moe/s7255/list.html.

[2] In this dissertation, college refers to a degree-awarding tertiary educational institution. I use "college" and "university" interchangeably.

expansion in human history (Levin, 2010). Figure 1-1 shows the scale and speed of higher education expansion from 1997 to 2011 for higher educational institutions (HEIs) that confer bachelor's degrees. The number of HEIs that provide bachelor's degree programs in China almost doubled, from 591 in 1998 to 1129 in 2011. Meanwhile, the government ordered continuous dramatic jumps in the number of undergraduate college admissions and new graduates year by year, with a temporary slowdown in 2002. The annual undergraduate enrollments and graduates both leaped by five times from 1998 to 2011. For example, in 2011, about 2.8 million fresh college graduates with bachelor's degree were seeking jobs, which is an astonishing figure. During the same period, the number of full-time teaching faculty members also increased year by year, but the speed of the faculty increase could not keep up with the speed of student increase. We can see the gap between these two lines representing the number of students and the number of teachers grew wider over time.

In the context of Chinese higher education expansion, it is important to study the effect of college quality for students, colleges, and the government.

For students and parents, the expansion policy makes post-secondary education generally more accessible, whereas the number of students admitted into selective colleges and universities has increased much less due to their limited capacity. Expansion also creates a larger supply of new college graduates each year and exacerbates the severe unemployment problem that has been the major and persistent challenge right after the expansion since 1999 (Whalley & Xing, 2012). The number of fresh college graduates has reached its peak in recent years. For example, 2013 is the so-called "hardest job-hunting season in history" since the establishment of the People's Republic of China, with 6.99 million seniors who have graduated from institutions of higher education, according to the Ministry of Education (Yu, 2014). The labor market could not accommodate such a huge sudden supply of fresh graduates year after year, and many graduates may go unemployed or underpaid. The severity and prevalence of college graduates' unemployment dilemma and low initial pay have drawn much attention from society, especially when the number of recent college graduates has risen and jobs have failed to keep up in the economic downturn recently. Making the right school choice in terms of college quality by weighing both the benefits and costs is essential to students and parents to secure and enhance the returns of college investment.

For HEIs, the high unemployment rate and low average starting salary level raise concerns about institutional ineffectiveness and inefficiency. Challenges also arise to balance the quality and quantity in higher education development within a further diversified Chinese higher education sector. On the one hand, a large number of newly built and merged universities have emerged. They compete with the long-established colleges for personnel and capital inputs. On the other hand, the allocation of scarce resources to accommodate the extraordinarily large number of students who would be otherwise unable to accept higher education in the short term is made at the sacrifice of college quality. In other words, as the quality divergence between colleges becomes wider, many researchers are concerned that the expansion at such a rapid rate dilutes the education quality both within and among the colleges.

With the realization of these opportunities and challenges, the Chinese government launched a series of projects such as Project 985 and Project 211 aiming to enhance college quality and even to catch up with world-class universities more than a decade ago. HEIs in both Project 985 and Project 211 are well acknowledged as the top-quality colleges or elite colleges not only because, due to the extra investments they enjoy, these colleges tend to have many resources: they are advantageous institutions that possess capable and motivated students and more qualified and talented academic faculty, enjoy renovated and better equipped laboratories and facilities, and offer other aspects that are associated with quality upgrade. For example, according to a *People's Daily* news report, Chinese government has appropriated 71.725 billion RMB (approximately 10 billion U.S. dollars) to implement Project 985 and Project 211 until 2011.[3] Given the huge governmental and collegiate investments in college quality enhancement projects, there is an urgent need to understand whether and how college quality affects student labor market outcomes and how to allocate resources more efficiently to improve the cost-effectiveness of government policies in financing higher education.

1.2 Statement of Problem

While many studies attempt to evaluate the effect of college quality on future earnings in the United States (U.S.), the magnitude of the effect varies from moderately positive, slightly positive to null or even negative. No consensus has been reached on the sign and magnitude of the effect. Previous U.S. literature did not figure out what is functioning inside the black box of college quality and its possible channels and mechanisms to affect future earnings (Pascarella & Terenzini, 2005).

Although the influence of college quality has been well documented in developed countries such as the United States, we have limited knowledge about the return to college quality in developing countries such as China, not to mention the return to college quality in some unusual circumstances, such as under the continuous large expansion period. Anecdotal observations and economic theories suggest that the payoff is higher for elite college students than for non-elite college students. Still, there have been surprisingly few empirical studies with rigorous econometric analyses on the payoff of attending an elite college in China.

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[3] Data obtained from *People's Daily,* retrieved from
http://english.people.com.cn/90001/90776/90785/7323347.html

Furthermore, previous Chinese research also has not determined whether the wage premium for high-quality colleges is due to institutional characteristics or to students' unobservable characteristics as a result of the deficiencies in methodology, data, and measurements employed. Therefore, no causality can be drawn about the relationship between college quality and student labor market outcomes.

Distinct from other Chinese studies, this study proposes to employ multiple measures of college quality, multiple quasi-experimental methods, and the most recent Chinese data to ascertain the relationship between college quality and early labor market outcomes such as college graduates' starting salary as well as the initial employment status. The study will further explore the potential heterogeneous effects rather than making inferences merely on the average effect alone.

1.3 Key Research Questions

Given the context of the problem, the key research question for this dissertation is "**Does college quality affect the starting salary of fresh college graduates in China?**" This major research question can be split into five sub-questions:

1. Does college quality affect the initial employment status of fresh college graduates in China?
2. Does college quality affect the starting salary of fresh college graduates in China?
3. Does the effect of college quality vary by student individual characteristics, such as gender, ethnicity, family background and student ability?
4. Does the effect of college quality vary by fresh college graduates' earning distribution?
5. Does the effect of college quality vary by measures of college quality in China?

1.4 Overview of Higher Education in China

Historically and until the late Qing Dynasty (1644-1911) in China, advanced education was the privilege of the elite few with the sole purpose of screening and selecting the government officials. After the foundation of the People's Republic of China in 1949, the Soviet model was strictly followed to restructure higher education, which meant the HEIs were owned and administered by the government and open to a small, elite group. The system of a unified National College Entrance Examination (NCEE) was established in 1952, but it was halted from 1966 when the Cultural Revolution began. Before the NCEE was resumed in 1977 after the fall of the "Gang of Four", the student selection was based on political virtues. After 1977, the arts and sciences were taught at general and comprehensive universities, whereas specialized disciplines (agriculture, engineering, political science, etc.) and vocational training (teaching training) were taught in specialized institutions. It was highly competitive to gain access to higher education, and the colleges and universities were primarily responsible for finding job assignments for their graduates until the mid-1990s. The bachelor's degree is granted by universities, specialized institutions, and some vocational universities upon the completion of four-year studies. Graduates with bachelor's degrees can pursue master's and doctorate degrees in graduate schools through entrance examinations.[4] The large scale of higher education expansion began in 1999, which marks the transition of elite higher education to mass higher education in China. Jobs are no longer assigned, and graduates make great efforts to find jobs (Altbach & Umakoshi, 2004; Huang, 2005).

Now, admission to all formal higher education (bachelor's degree programs) requires graduation from a senior high school and a passing grade on the annual NCEE. The NCEE is administered by provincial authorities throughout the country in June every year and covers three

[4] http://www.oph.fi/download/127394_kiinanetti.pdf

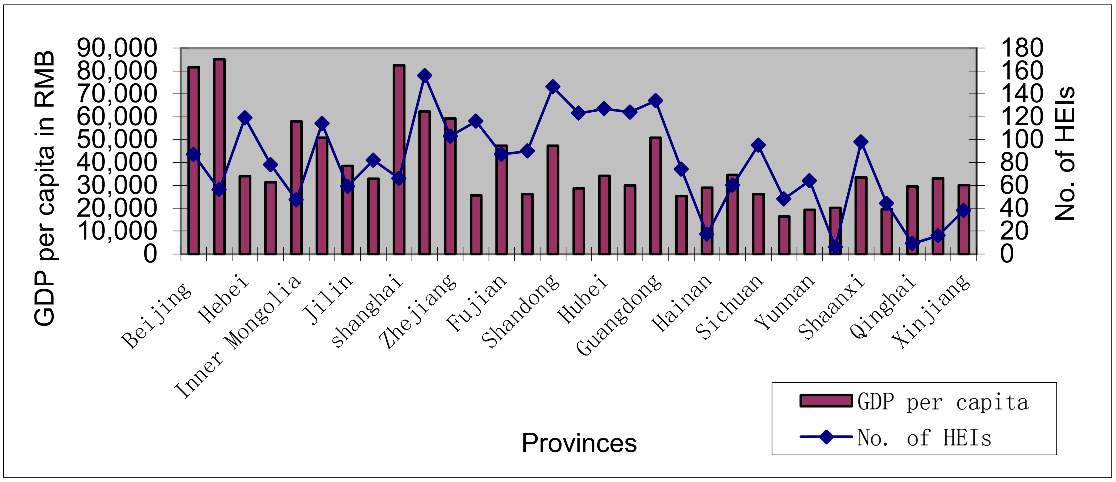
compulsory subjects (Chinese, mathematics and one foreign language) and several optional subjects (chosen from among physics, chemistry, biology, politics, history, and geography). The selection of subjects in the NCEE depends on the academic track taken in senior high school. For example, science track students in senior high schools take physics, chemistry, and biology as their specialties in the NCEE. The admission is to match students with both colleges and majors. Taking the NCEE is the first stage and the second stage is to match students with colleges based on the students' reported preferred college and major fields of study listed on the preference form(Davey, De Lian, & Higgins, 2007). A typical preference form categorizes colleges that confer bachelor's degrees into four tiers (early enrollment colleges, first-tier colleges, second-tier colleges and third-tier colleges). The higher-tiered colleges are given higher priority during admission. Students first fill in the name of the college in each tier and list majors in order of preference prior to or after the NCEE score is released. Their preferences are honored in the admission procedure if they meet the college admission threshold score and the admission quota has not been filled. Given the limited seats available in high-quality institutions, students may fail to be admitted to their preferred elite colleges even if their scores are higher than the minimum admission requirement score when there are more competitors than the quota allows. Since the second-tier colleges also give priorities to students who list their colleges as top choices, it may occur that if students were not admitted by their first-choice universities, they will end up in the second or lower-tier of colleges. Each student is granted at most one college offer. Not accepting means not going to any college in that year (Hongbin Li, Meng, Shi, & Wu, 2012a).

The higher education sector in China is highly diversified and there are many ways to categorize the colleges. As of May 2013, there were totally 2484 HEIs in China; 879 out of them were regular colleges and universities and 287 out of them are independent colleges.[5] Independent colleges are developed by private education providers and affiliated with degree-awarding HEIs. They also confer bachelor's degrees. According to their specialist subject in the China Statistical Yearbook 2004, HEIs can be classified into 13 categories: comprehensive institutions, science and engineering institutions, agriculture institutions, forestry institutions, medicine institutions, teacher training institutions, linguistics and literacy institutions, economics and finance institutions, politics and law institutions, physical education institutions, arts institutions, ethnic nationality institutions and short-cycle vocational colleges that confer associate's degrees.

China's higher education can also be classified by region. Figure 1-2 graphs the number of HEIs and GDP per capita in each province. Chinese higher education institutions are not equally distributed in different areas. Four municipalities even have a comparable number of institutions to some provinces. Western provinces tend to have a smaller number of universities. We can also notice that the numbers of institutions are close between the eastern and central provinces. However, the western and northeastern regions tend to have lower numbers. Regional economic development can be an important influential factor for explaining institutions' numbers, although it is not the only factor. China's economic development is highly unbalanced. Regions with higher Gross Domestic Product (GDP) per capita generally have a greater number of institutions since GDP is an indicator of economic development level, but the number of institutions does not increase proportionally with the increase in GDP.

[5] http://www.moe.edu.cn/publicfiles/business/htmlfiles/moe/moe_2812/200906/48836.html

Figure 1-2 The Number of HEIs and GDP Per Capita in Provinces



Data Source: China Statistical Yearbook 2011.

Notes: 1. Beijing, Tianjin, Shanghai, and Chongqing are four municipalities in China reporting directly to the central government the same way that provinces do in China's administrative structure.

2. Inner Mongolia, Guangxi, Tibet, Ningxia, and Xinjiang are five autonomous regions in China. They enjoy more autonomous power than the provinces.

3. The rest are 22 provinces. Hong Kong, Macao, and Taiwan are not included.

At present, colleges and universities in China are administered through an education provision system at two levels: the central government and provincial/local governments. The former is responsible for the overall planning and management and still directly administers 111 national-level universities that are under the jurisdiction of central-line ministries such as the Ministry of Education and the Ministry of Agriculture. Many of them were the so-called "key universities" that referred to universities recognized as prestigious and received a high level of support from the central government in the 1960s.[6] The provincial governments are mainly responsible for the provincial universities and colleges. Greater autonomy is granted to the HEIs, with various forms of joint establishment and cooperation with the government and the society.

With regard to the higher education financing system, the old funding system that was entirely dependent on the governments has gradually shifted to a new system that is capable of pooling resources and raising funds from diverse channels in addition to financial provision from

[6] http://baike.baidu.com/subview/4851439/4851651.htm and http://en.wikipedia.org/wiki/Key_university

the government (Zhu & Lou, 2011). Although there is still substantial bureaucratic control and involvement, China welcomes private and foreign investment and has opened up its private sector. Table 1-1 reflects this change in financing regular HEIs in selected years. In 1996, the majority of the funds came from the governments with most of them in public expenditure on education. From 1996 to 2011, this amount of government funds increased rapidly while the percentage of government funds decreased steadily, from 81% to nearly half of the total funds, though it is still the major funding source. The share of total funding that grows most is the tuition and miscellaneous fee, which means applicants should pay for their seats in universities and the burden of funding higher education was shifted to students and their parents partially. In addition, schools raise funds from soliciting contributions and from the society, but the percentage is quite low.

Table 1-1 Educational Funds in Regular Institutions of Higher Education in China for Years 1996, 2002, 2007, 2011 (10,000 RMB)

Year	Total	Government Appropriation for Education	Public Expenditure on Education	Funds from Investors of Private Schools	Donations and Fund-raising for Running Schools	Income from Teaching Research and Other Auxiliary Activity	Tuition and Miscel-laneous Fees	Other Educational Funds
1996	3267929	2625524	2299718	5667	36961	N/A	446237	153539
%	1	0.80	0.70	0.0017	0.01	N/A	0.14	0.05
2002	14878590	7521463	7243459	331363	278253	N/A	3906526	2840985
%	1	0.51	0.49	0.02	0.02	N/A	0.26	0.19
2007	36341851	15983187	15543042	318788	271809	16987027	12231914	2781040
%	1	0.44	0.43	0.01	0.01	0.47	0.34	0.08
2011	68802316	40234989	37632641	332915	431870	24007176	18121026	3795366
%	1	0.58	0.55	0.005	0.01	0.35	0.26	0.06

Data Source: China Statistical Yearbook 1997-2013.
Notes: % represents percentage.

1.5 Structure of Dissertation

The remaining part of this dissertation is organized as follows: In chapter two, the theory, literature on the empirical evidence concerning the effect of college quality on student labor market outcomes and methodologies used in previous studies will be reviewed and synthesized. In chapter three, the key research questions, conceptual framework, methodological designs and data processing procedure are presented. In chapter four, the descriptive statistics and the correlation matrix for covariates are reported. The summary statistics for college quality and early labor market outcomes are displayed, and the student profiles in elite and non-elite colleges are compared using t-tests. In chapter five, empirical results and findings are shown for each research question in the order of the identification strategy used to reach the findings and conclusions. Chapter six ends with a discussion of conclusions and political implications of this dissertation. It also points out the drawbacks of this study and directs the potential way for improvement and extension in the future. References and appendices are provided at the end of this dissertation.

1.6 Definition of Key Terms

The end part of this chapter introduces the definition of some key terms and concepts in this dissertation.

(1) College Quality

College quality measures are not consistent in previous studies. Generally, three common approaches are taken to measure quality in undergraduate education in existing empirical studies: (1) Reputational approach: The reputational approach defines quality solely based on a college's rank or prestige in the order relative to other institutions. Such ranking is largely based on subjective opinions and inconsistent standards held by evaluators. Examples include the

Gourman ratings and the Coleman prestige ranking used in early U.S. studies. This approach is abandoned in later literature due to numerous criticisms of its reliability (Brooks, 2005). (2) Categorical approach: The categorical approach is meant to define quality in terms of relative quality categories or rankings based on objective college resource measures (e.g., U.S. Barron's ratings, Astin's selectivity index, Carnegie category). (3) Resource approach: The resource approach specifies and assesses quality in terms of absolute and objective college resources usually measured by college inputs. Input resource measures can be further divided into several categories such as monetary resources (e.g., expenditure per student) and personnel resources (e.g., average student college entrance test score, teacher-student ratio, the average faculty salary, etc). The latter two approaches are commonly used in current literature. Recent studies have shown that college quality is associated with student earnings to some extent, depending on which measure of college quality is chosen.

In my dissertation, I use more than one approach to measure college quality. First, I divide Chinese undergraduate colleges into four quality categories (Project 985 colleges, Project 211 colleges, non-key colleges, and independent colleges) according to whether they enjoy the extra investment by the central government for quality upgrade. The colleges in projects 985 and 211 are further defined as elite universities whereas non-key colleges and independent colleges belong to the non-elite college group. Second, four college input-based resource indicators are used as college equality measures—namely, faculty-student ratio, proportion of faculty members with a doctoral degree, student selectivity, and expenditure per student for a subsample of institutions with needed data. Third, college quality composite indexes are constructed using the above input indicators to form a more comprehensive measure of overall quality and to reduce measurement error. Such input-based quality measures and indexes have not been used in research on college quality in China before.

(2) Project 985

Project 985 is a governmental constructive project to found world-class universities. It was announced on May 4, 1998, by former President Jiang Zemin, who declared that "China must have a number of first-class universities of international advanced level to realize modernizations" (thus, named after the date of the announcement date). In the initial phase, nine universities were chosen, referred to as the Chinese equivalent of the US Ivy League. In the second phase, from 2004 until now, Project 985 was expanded to 39 universities.[7] It was announced in 2011 that the project has closed its door to additional universities.[8]

(3) Project 211

Project 211 is the Chinese government's endeavor to strengthen about 100 HEIs and key disciplinary areas as a national priority for the twenty-first century, which was initiated in 1995 by the Ministry of Education. The figures of 21 and 1 in the name are from the abbreviation of the twenty-first century and approximately 100 universities, respectively.[9] There is an overlap between the 985 and 211 projects. All institutions in Project 985 are also in Project 211(with a total number of 112)[10], but the reverse is not true. All Project 985 colleges also receive Project 211 funding, but funding from Project 985 is much higher than that of Project 211. Compared to local universities and colleges, which are mainly funded and sponsored by local governments,

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[7] Based on the introduction by the MOE retrieved from http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s6183/201112/128828.html

[8] Based on the News report by China Youth Daily retrieved from http://zqb.cyol.com/html/2011-03/08/nw.D110000zgqnb_20110308_3-09.htm

[9] Based on the introduction by the MOE retrieved from http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/moe_846/200804/33122.html

[10] Based on the list of Project 211 colleges from the MOE website retrieved from http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/moe_94/201002/82762.html

the colleges within projects 985 and 211 draw a large portion of their funding from the central government.

(4) NCEE Score

NCEE is the abbreviation for the national college entrance examination, an academic examination held annually in China as the prerequisite for college entrance and sorting. The term "NCEE score" in this dissertation refers to the total score of three main subjects in the national college entrance examination in China, including Chinese, mathematics and a foreign language (e.g., English). It is used as a proxy for student cognitive ability. Extra credits for eligible students are not taken into account in this study. Because the scales of total NCEE score vary across the provinces, the NCEE score is rescaled to a range of 0 to 100.

(5) Initial Employment Status

Initial employment status relates to the employment status of a student at the time when he or she took the survey in May or June of the year of graduation. If the senior student with the intention to work after graduation successfully obtains at least one job offer in the college-to-work transition, the student is said to be employed; otherwise, the student is said to be unemployed.

(6) Starting Wage

Starting wage refers to the monthly wage that is paid to the college graduate new to a position in his or her initial accepted job offer, either contracted or non-contracted. Starting wage is generally lower than the mid-career salary level and is paid to the college graduates with virtually no previous formal work experiences. They are in the "starting" versus the "mid-career" or "late-career" working period.

Chapter 2 Literature Review

The literature review chapter is organized in five sections. The first section reviews the human capital theory that explains the economic returns to college quality. The second and third sections review and synthesize the empirical evidence on effect of college quality on labor market outcomes from both the United States and China. The fourth section summarizes and critiques the methods used to reach the conclusions and findings in existing research. The last section concludes main findings and knowledge gaps identified in previous review sections.

2.1 Theory

Defined by Goode (1959), "human capital" refers to knowledge, skills, attitudes, aptitudes, and other acquired traits that enhance the productive capacity of individuals. The human capital theory was pioneered and reinforced by the works of Theodore Schultz and Gary Becker. Before the human capital theory appeared, assets of money and physical equipment were the only two acknowledged factors of production. Schultz (1961) added the third factor of production, workforce or human capital, into the production process, and it helps explain a nation's economic growth. It was also pointed out that the expenditures on human capital should be classified as investment rather than consumption. Becker (1964) extended the concept of individual human capital investment into the area of microeconomics and attempted to explain the differences in individual earnings of workers. According to Becker, human capital accumulation takes the major forms of either formal schooling (i.e., when the individual devotes his or her whole time to education) or on-the-job training (i.e., post-school training in the workplace). Education is an important investment of time, expenditure and forgone earnings for a higher rate of return in later periods. Through education, the workforce's productivity is raised by obtaining higher human capital stocks shown as knowledge, skills, attitudes and traits contributing to production in schools. Workers with higher productivity due to human capital accumulation will be rewarded in a competitive labor with higher wages. Based on the previous theoretical framework and empirical arguments, Mincer (1974) modeled the natural logarithm of earnings associated with S years of schooling ($\ln \mathrm{Y}_s$) as a function of the earning with 0 years of education ($\ln Y_0$), years of schooling (S), labor market experience (E) and an error term (U) as follows:

$$\ln Y_s = \ln Y_0 + rS + \beta_1 E + \beta_2 E^2 + \mathrm{U} \qquad (2.1)$$

In the above classic Mincerian equation, the focus is on estimating the rate of return to investment in education (r), which is the most common human capital investment. Education is usually measured by the education quantity as in years of schooling in the equation and does not take education quality into account.[11]

Many studies have estimated the internal rate of return to education quantity. They suggest that people with additional years of formal schooling earn more, and people with college degree gain higher returns than their high school counterparts (Angrist & Krueger, 1999; Psacharopoulos, 1994). In fact, current literature relies heavily on human capital theory to explain the impact of college quality on future earnings. The reason is that the human capital accumulation process is different at HEIs. Students in higher-quality institutions tend to have a higher acquisition rate of academic knowledge, skills, and work-related experiences as well as traits through many channels such as the peer effect, curricular design, student-teacher interaction, administrative staff support, school climate and culture (both academic and social), and so on. Thus, students at elite colleges possess more human capital stock, which will later be rewarded in the labor market reflected by wage premium and lower probability of unemployment right after graduation.

[11] Section 3.4 in Chapter 3 will provide the analytical framework that incorporates the school quality into the Mincerian model.

2.2 Empirical Evidence of the Effect of College Quality in the United States

College quality may have profound effects on a number of outcomes, monetary and non-monetary. In addition to the immediate initial labor market success, previous U.S. studies also explored other intermediate or long-term pecuniary returns to college quality, such as the wage growth (Thomas & Zhang, 2005), and many types of non-pecuniary outcomes, of which we have limited prior knowledge, such as college graduates' graduate school enrollment behavior (Eide, Brewer, & Ehrenberg, 1998; L. Zhang, 2005a), overeducation (Robst, 1995), job satisfaction (X. Liu, Thomas, & Zhang, 2010) and even external returns such as health outcomes (Fletcher & Frisvold, 2011). Nevertheless, labor economists and education researchers are particularly interested in economic effects, and I will only focus within the scope of literature reporting economic effects of college quality.

Numerous early research studies on the economic effect of college quality have documented the association between college quality and future incomes since the later 1960s, (Brewer & Ehrenberg, 1996; Fox, 1993; Griffin & Alexander, 1978; Karabel & Astin, 1975; Kingston & Smart, 1990; Loury & Garman, 1995; Monks, 2000; Morgan & Duncan, 1979; Reed & Miller, 1970; Solomon, 1973, 1975; Solomon & Wachtel, 1975; Trusheim & Crouse, 1981; Wachtel, 1976; Wales, 1973; Weisbrod & Karpoff, 1968; Wise, 1975), and they were summarized and commented on by Pascarella and Terenzini (1991) and Zhang (2005). Overall, most early studies in the United States suggested that college quality had a small positive and statistically significant effect on earnings. This conclusion was usually achieved by employing the conventional ordinary least squares regression (OLS) (e.g., Weisbrod & Karpoff, 1968; Wales, 1973; Solmon & Wachtel, 1973), and this finding was confirmed by studies that used the recursive structural equation model to decompose the direct and indirect effect of college quality on earnings and the weighted least squares estimation method (James, Alsalam, Conaty, & To, 1989; Loury & Garman, 1995; Mueller, 1988; Smart, 1988).

However, the existence of correlation does not guarantee causality, because the college quality variable is potentially endogenous and the OLS estimate is biased and inconsistent in this case. A renaissance began with a new round of works that tried to correct for the endogeneity problem with econometric advances (Black & Smith, 2004; Brand & Halaby, 2006; Brewer, Eide, & Ehrenberg, 1999; Dale & Krueger, 2002, 2011; Hoekstra, 2009; Long, 2008; Monks, 2000). These recent studies that address the endogeneity problem are listed in Table 2-1 below, and the identification strategies employed to circumvent the endogeneity will be discussed in the methodology review in Section 2.4.

Table 2-1 Summary of Recent Studies on the Impact of College Quality on Earnings in the United States

Study	Data	College Quality Measure	Controls	Model	Findings
Rumberger & Thomas (1993)	8,021 Bachelor's degree completers from Recent College Graduates (RCG) 1987 Survey	Astin's selectivity score	Sex, race, father's education, mother's education, 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 two-level 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, Doctor of Philosophy (Ph.D.) granting, college size, average full professor salary, expenditure per student ,total students per faculty	School years, working experience	Log annual earnings estimated by the FE model	Higher faculty salary, granting of Ph.D., smaller college size, and private controls have significant positive effect on earnings.
Brewer & Ehrenberg (1996)	2,549 college attendees from High School and Beyond (HS&B) 1980 senior cohort, with 1986 earnings	Six-fold classification based on Barron's rating	Gender, 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	Attending an elite private college does not necessarily pay off in terms of early earnings, but it increases the probability of graduate school enrollment.
Brewer et al. (1999)	3,062 college attendees from National Longitudinal Surveys-72 (NLS-72) and 2,165 from HS&B	Six-fold classification based on Barron's rating	Gender, 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 Heckman correction for selection bias	Large premium to attending an elite private institution, smaller premium to attending a middle-rated private institution. Return to

	sophomore cohort				elite private college increases for 1980 cohort as compared to 1972 cohort.
Thomas (2000)	3,832 bachelor's degree completers from Baccalaureate and Beyond (B&B) first follow-up in 1994	Average SATs of the entering freshman	Gender, race, first generation bachelor's degree completers, parental occupation, GPA, number of other colleges attended, attended community colleges, 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 close to zero.
Dale & Krueger (2002)	College and Beyond (C&B)1976 cohort, with 1995 earnings	Average SAT scores divided by 100, net tuition, Barron's index	Race, SAT/100, high school 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, matching technique	Quality does not affect earnings, but tuition is significantly related to earnings.
Thomas (2003)	4,604 bachelor's degree 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 (2000)	Log annual earnings estimated by HLM	Quality confers larger earnings advantages compared with Thomas (2000), both for public and private institutions. Academic performance and major also affect earnings significantly.
Black & Smith (2004)	3,199 students in the full sample of National Longitudinal Survey of Youth 1979 cohort	Average faculty salary, average SAT score, average freshman retention rate	Basic demographic characteristics, family background, and high school experiences	Log annual wage estimated by PSM	Point estimates from the OLS regression and matching are similar for men but not women. PSM estimates tend to be smaller with higher standard errors.
Long (2008)	Panel data from the National	Median freshman SAT test score,	Replicate the model specification and controls in	Earnings a bachelor's degree, log hourly earnings	Alternative methods make no big difference.

	Education Longitudinal Study	net tuition, average full professor's salary, faculty-student ratio, quality index computed from above	Dale & Krueger (2002) and Black & Smith (2004)	and log family annual earnings regressed by the OLS, IV and PSM methods	Positive selection bias in the OLS regression.
Brand & Halaby (2006)	1733 men graduating in 1957 from Wisconsin Longitudinal Study	Two fold (elite vs. non-elite) classification supplied by Barron's index	Student ability, high school achievement, high school type, family background	Earning educational attainment, early, mid-, and late-career occupational status and annual income estimated by PSM	Insignificant effects are wage outcome, but elite college attendance promotes higher educational achievement and occupational status.
Hoekstra(2009)	12,189 applicants of a large flagship state university from 1986 to 1989	Adjusted SAT score relative to the admission cutoff SAT score in the flagship state university	Years of experience after high school graduation, year dummies, cohort dummies, actual SAT score, high school GPA	Average residual earnings derived from the earning equation in the fuzzy RD design	Attending the most selective state university causes earnings to be approximately 20% higher for white men.
Dale & Krueger (2011)	12,075 in 1976 cohort and 6,479 in 1989 cohort from the College and Beyond (C&B) survey linked to administrative earning records over a long time horizon for the 1976 cohort	Average SAT score, net tuition, Barron's index	Demographic characteristics, high school GPA, high school SAT score, predicted parental income, whether an athlete, the average SAT score of the colleges that student applied to, the number of applications	Log median of annual earnings in 2007 dollars over 5-year intervals estimated by the self-revelation model in matching techniques	Estimate of the return to college selectivity indistinguishable from zero when controlling for the unobserved student ability. Heterogeneous returns are found for minorities.

Far from getting closer to the convergence on how large the college quality impact is, the recent empirical evidence with new identification strategies have yielded mixed findings. The sign and magnitude of the estimates differ depending on the data, model specification, and methodology employed in recent studies. While some studies report solid large wage premiums for elite college attendees (Brewer et al., 1999; Hoekstra, 2009; Long, 2008), others find small positive and statistically significant estimates (Thomas, 2000; Black & Smith, 2004). The open debate continues with the null evidence presented consistently by Dale and Kruger (2002, 2011). They questioned the return to college selectivity in their 2002 paper, which obtained weak or insignificant payoff to attending more selective colleges by matching and self-revelation models. Their 2011 study found that after adjusting for unobserved student characteristics, the return to college selectivity dropped to values indistinguishable from zero, suggesting virtually no effect for most students. However, they did find a large positive effect for black and Hispanic students with less educated parents, which suggested the existence of heterogeneity of effect.

In fact, the heterogeneity of returns to institutional attributes across certain groups has been addressed by a number of previous studies in addition to Dale and Krueger (2011). For example, L. Zhang (2005c) tested a series of potential variabilities of effects by individual demographics and family backgrounds such as gender, race, family income, parental education, intellectual ability, and field of study by running separate regressions by subgroups. The effect of college quality turned out to be non-uniform. Non-White students tend to benefit more from attending high-quality colleges than did White students. College quality mattered more for students from low- and middle- income families than it did for those from wealthier families. Students in lucrative majors enjoy larger effects of college quality. Another example was Monks (2000), which allowed for possible variation of returns to individual and college characteristics by performing regressions for subgroups such as female vs. male students and, White vs. non-Whites, and statistical tests were implemented to see if the differences were significant or not. The results did suggest that the effects vary across gender and race. The author gave explanations from the human capital accumulation perspective and implied that peer effects or the classroom dynamics of race and gender may vary within an institution. Due to increasing evidence of variations in economic returns, many studies present the estimation results for the whole sample and sub-samples in their publications.

Another much less documented direction of heterogeneity is the variations in the effect of college quality across earning distribution pioneered by L. Zhang (2005c). The results generated from the quantile regressions at seven points of the earning distribution suggested a stronger effect of college quality for college graduates at the high end even many years after college graduation.

Common key covariates in model specifications included the variables from these categories: individual demographics, family background, labor market conditions, and student ability control.

Measures using the categorical approach and the input resource approach are the most popular quality measures in the current literature. College quality categories are usually classified based on a computed overall quality index from various outside rating sources such as Astin's selectivity index, Carnegie ratings, and Barron's index (Brewer et al., 1999; Griffin & Alexander, 1978; Rumberger, 1993; Thomas, 2003). The following input resource measures appeared in literature with high frequency: average freshman SAT scores (Dale & Krueger, 2002, 2011; Griffin & Alexander, 1978; Morgan & Duncan, 1979; Mueller, 1988; Solomon, 1973, 1975; Solomon & Wachtel, 1975; Thomas, 2000, 2003), net tuition (Dale & Krueger, 2002, 2011; Long, 2008), expenditure per student (Behrman, Rosenzweig, & Taubman, 1996; Morgan & Duncan, 1979; Wachtel, 1976) and faculty-related indicators such as the average faculty salary (Black & Smith, 2004; Long, 2008) and the faculty-student ratio (Behrman et al., 1996; Long, 2008). L. Zhang (2005b) reviewed and explored the varying effects of college quality due to different measures of college quality, including Barron's ratings, mean SAT scores of entering freshman class, tuition and fees, and Carnegie Classification by the OLS regressions. The empirical results suggested that the effect of college equality on wage is sensitive to the measure of college quality. Thus, the implicit term of *college quality* is not enough in future studies. We should be explicit about what measure of college quality is under use. The author also explained that previous findings differed because they provided partial explanation of the entire entity of economic return to college quality. However, the wage premium to attending high-quality colleges is robust to different measures. Likewise, Long (2008) used a variety of different college equality measures and found significant positive effects in many cases by the OLS estimates, but these positive effects might not be consistent if alternative college quality measures were adopted.

Most studies used the natural log form of the self-reported monthly or hourly salary for fresh college graduates or experienced workers in their mid-career stage as measures for the outcome variable. One exception was Dale and Kruger (2011) which argues that administrative earning data is more precise and can reduce possible measurement errors.

One thing to note is that previous reviews are primarily based on the literature examining the effect of college quality on college graduates' wages after many years of graduation. As Brand and Halaby (2006) suggested, the effect may change depending on whether the surveyed college graduates are in their early-, middle-, or later-career. If we want a comprehensive picture of the effect of college quality over time, longitudinal data may be better than the cross-sectional data on this research topic.

To sum up, lessons learned from the U.S. literature are as follows: First, college quality's role in determining future earnings is still uncertain, probably small and positive. Second, it is necessary to control for both the observables and unobservables. It is well recognized that failure to correct for the endogeneity of high-quality college attendance biases the estimation, but the results can be method dependent. We should keep in mind that each causal method has its advantages and limitations when judging plausibility of the results. Third, the conclusion based on a single measure of college quality could be misleading. It is advisable to use more than one quality measure given the multi-faceted nature of college education. Fourth, the average effect of college equality is not universal. It is necessary to explore the heterogeneous effect of college quality for students with certain characteristics and to examine the point estimate with students at different earning distributions. Fifth, the mechanism of how college quality affects graduates' labor market outcomes is still largely unrevealed and requires future research.

2.3 Empirical Evidence on Labor Market Returns to College Quality in China

There is an increasing amount of literature on the rate of return to quantity of education in China (Fleisher, 2005; Haizheng Li, 2003; T. Li, 1998; D. T. Yang, 2005; J. Zhang, Zhao, Park, & Song, 2005) but only a few studies on return to quality of schooling partly due to the difficulty in measuring education quality. With an unprecedented increase in the number of college education recipients after the implementation of higher education expansion policy in 1999, the severe unemployment problem and resource constraints call for examination of the impact of college quality on newly graduated cohorts. For example, people are curious to know whether college education is still worth the investment. If so, are there disproportional returns to elite colleges given the limited expansion capacity in elite colleges? Are HEIs with extra investments from the government necessarily of better quality? If so, how do elite colleges differ from non-elite colleges in terms of quality and how to improve it?

However, college quality was often treated as a control factor and added as a dummy variable indicating that the student belongs to some broad college quality category in the OLS regression equation by empirical studies trying to find the determinants of college graduates' employment status and initial salary (Chen & Tan, 2004; Du & Yue, 2010; Min, Ding, Wen, & Yue, 2006; Yue, Wen, & Ding, 2004; Yue & Yang, 2012) with multivariate regression analysis.

For example, Chen and Tan (2004) randomly selected 1200 college graduates in 14 colleges in the central area in 2003 and 400 college graduates in 4 colleges in 2004 to conduct the survey and focus on two dependent variables: initial employment status and starting salary. When analyzing the employment status measured as discrete choices and the starting salary as a continuous variable, the logistic model and multivariate linear model were used. The researchers concluded that college prestige had no significant impact on either the employment status or the starting wage. The authors proposed a possible explanation that college prestige has a weaker correlation with early than with later career status.

Yue et al. (2004) conducted the college graduate survey in 7 provinces and 45 colleges with a sample of 18722 students. The descriptive statistics showed that the initial employment rate in Project 211 colleges is 49.7%, 53.7% in regular colleges and 20.2% in 3-year short-cycle colleges. Grouping by college control types, the initial employment rate was the highest, 43.2%, in public colleges followed by 10.7% in private independent colleges and 10.5% in private colleges. However, the OLS regression results showed that the students with bachelor's degrees earned less than their counterparts who are students with associate degrees and there was no clear distinction between earnings of Project 211 college students and students with associate degrees.

Based on a survey of 34 universities in 16 provinces conducted in 2005, Min et al. (2006) compared the empirical results of 2003 and 2005 and found that student performance in college is the key factor on both the employment status and starting salary. College prestige measured with dummy variables indicating if it is a Project 211 university, other undergraduate HEIs or 3-year short-cycle college. The authors found a significant impact of college prestige on both the initial employment status and starting salary. More specifically, the probability of finding a job right after college graduation was higher for graduates from Project 211 universities than from other types of universities. The same pattern also held true for starting salary.

Likewise, Du and Yue (2010) examined the determinants of initial employment status and starting salary with a college graduate survey in 2009. The estimation of college quality dummy indicator was statistically significant for both the employment status equation and the wage equation when the measurement of college quality is whether the student is from a Project 211 college. They also confirmed positive role of student demographics and family backgrounds in determining the labor market outcomes and concluded that the human capital accumulation in college is more influential than other factors in determining employment status.

With a new round of data collection, Yue and Yang (2012) applied the logit model for employment status and the OLS regression model for the wage outcome to 2011 graduation class. They found the probability of finding a job is higher for Project 211 college graduates and vocational college graduates when the reference group is the non-key college students. The school prestige also pays in the labor market. The coefficient on the 211 dummy is 0.13 and statistically significant at the 1% level. In addition, the highly influential role of job characteristics in starting wage determination was found.

However, several caveats undermined the reliability of these results for understanding the impact of college quality. First, these articles miss important determinants such as students' innate ability and job market conditions so that the results may suffer from the omitted variable bias. Second, many authors mix the students from undergraduate colleges and 3-year short-cycle colleges and define college quality using short-cycle colleges as the reference group while the students with bachelor's degrees and those with associate degrees are hardly comparable. It is difficult to interpret the effect as being purely the result of college quality difference or degree level. Third, none of these studies addresses the endogeneity problem of college quality. Most studies adopted the OLS regression corresponding to the wage outcome and the logit model corresponding to the employment status merely to establish the correlations. No causal relationship is warranted. Fourth, these surveys were mostly regional, and random sampling strategy was not employed. So the conclusion cannot be generalized to larger populations. Last but not least, none of them mentioned the potential sample selection bias when they restricted the regressions to observations with observable wage values, and no attempt was made to treat the missing data.

Some studies that explore the causes of salary inequality in the early labor market bring in a new angle to understand the impact of college quality. From their perspective, elite college attendance could be deemed a source of disparity in terms of college factors. A few studies also paid special attention to wage inequality from other aspects. For example, disparities arise due to demographic characteristics such as gender disparity in science and engineering majors (C. Guo, Tsang, & Ding, 2010), family background such as parents with different social economic status or social capital (Hongbin Li, Meng, Shi, & Wu, 2012b; Wen, 2005), and labor market conditions such as segmentation between urban and rural areas (Lai, 2001).

Four recent studies highlighted the economic returns of college quality (Hongbin Li et al., 2012a; Z. Liu & Qiu, 2011; S. Yang & Yang, 2011; Zhong, 2011). They are based on more representative national datasets and have a larger sample size.

Zhong (2011) found that returns to higher education vary significantly depending on college quality. However, the measurement of college quality in this article was a subjective and self-evaluated ranking of a college or university an individual attended, which is too crude and imprecise. Again, the omitted ability factor may bias the OLS estimates.

Hongbin Li et al. (2012a) argued that the premium of attending elite colleges (colleges in projects 985 and 211) drops but does not disappear with controlling for ability. They tackled the endogeneity by assuming that student unobservable characteristics are partly determined by observable individual and family backgrounds because it is common practice for students and parents to choose colleges together. Therefore, the "selection on observable" assumption is reasonable enough and the OLS regression with comprehensive controls is sufficient to draw causal inferences. They tried to generate squared term and cubic term of NCEE score and included them all in the wage determination equation to ensure sufficient controls, but it turned out none of these nonlinearities seemed to be reasonable. Admittedly, the college admission process in China may be largely dependent on student observed ability such as the NCEE score rather than other application materials, such as the reference letters and application essays in the United States. It is arbitrary to expect comprehensive controls of the NCEE to absorb all the effect of unobservable characteristics. This is why the authors call their estimate an upper bound of the true wage premium for elite colleges. One contribution of this paper is the attempt to explore the heterogeneous effects of college quality across student groups. The sub-group analysis revealed that the wage premium is larger for female students and students whose fathers are better educated.

Z. Liu and Qiu (2011) employed the propensity score matching method to overcome the selection bias. However, this method was poorly performed with the 2005 urban household survey dataset. Due to lack of proper measurements, many variables had to be replaced by proxy measures that contained large measurement errors, and even the author themselves suspected that their estimated point estimate on college quality was greatly overestimated because the dataset lacks key determinants that predict the treatment entry. Lack of such controls will drive the outcome differences across groups much higher than valid estimates.

S. Yang and Yang (2011) established the intercept and slopes as outcome models with the hierarchical linear modeling (HLM) technique. They found the starting salary higher for Project 985 and Project 211 colleges than others, and about 11% of total difference in starting salary can be attributed to institutional factors. It is the only article that distinguished individual level and college level factors and established multilevel models.

To summarize, most Chinese literature that examines the link between college quality and labor market outcomes focuses on the sample of fresh college graduates rather than workers in their mid- or late- career. It is encouraging that the Chinese research has improved over time in survey implementation, research design, and rigorous econometric analysis. Nevertheless, knowledge gaps remain in several aspects. First, no causal inference can be drawn with confidence from previous Chinese studies so far because they mostly apply the single OLS technique based on strong assumptions that may not hold in reality and they fail to adequately and sufficiently address the potential endogeneity of elite college attendance behavior. Second, the college quality measures as categorical dummies are too broad and crude to use. They mask potential distinctions within broad categories and are not informative enough to offer practical suggestions or interpret the findings. No previous Chinese study uses concrete college quality measures such as school inputs. Third, the results on the average effect of college quality may cover up the extraordinary benefits for a particular group of students concerning the dramatic diversity of the college student body. Most previous Chinese studies neglected potential heterogeneity of college quality. Fourth, previous Chinese literature does not address the potential sample selection problem properly and make endeavors to solve it. Fifth, previous studies rarely use national representative datasets with the most recent data to analyze this research topic. The following table provides a summary of the Chinese literature.

Table 2-2 Summary of Chinese Studies on Economic Returns to College Quality

Study	Model	Data	College Quality Measure	Findings on College Quality and Determinants of Employment Status (1) and Initial Salary (2)
Chen & Tan (2004)	Logit OLS	916/355 students in 2003/4 cohorts	College prestige dummy	(1)prestige(- insignificant), major(-), working experience(+), appearance (+), working ability(+) (2)prestige(- insignificant), academic performance(-), working ability(+), working experience(+)
Yue et al. (2004)	Logit OLS	1167 students in Peking University Survey 2003	Project 211 /non-key/other public dummy	(1)211(+ 0.794), non-key (+0.916), public college (+), bachelor's degree(+), graduate (+), education major(-), agriculture major (-), male(+), working experience (+), job search information(+) (2)211 (insignificant), regular (-), public college (+), graduate (+), law (-), CET-4 (+), job search cost (+), working in municipal cities (+), working in the non-Western regions (+), working in government (-), working in R&D sector (-), working in joint venture (+)
Min et al. (2006)	Logit OLS	Peking University Survey 2005	Project 211 /non-key/other according to prestige	(1)211(+0.478), associate's degree(-), male(+), top 25% in academic performance(+), scholarship(+), other certificate (+), job search cost(-), job search information (+), average family income (+), attend college in the west(-) (2)211 (+0.244), associate's degree(-), graduate degree(+), male(+), top 25% in academic performance(+), working experience(+), job search information(+), average family income(+), family social network(+), attend college in Beijing(+), attend college in the west(-)
Du & Yue (2010)	Logit OLS	Peking University Survey 2009	Project 211/other	(1) 211(+0.95), bachelor's degree(-), male(+), home in the East(+), annual family income(+), dual degree(+), student leader(+), party member(+) (2) 211(+779 RMB),bachelor's degree(+), master's degree(+), annual family income(+), mother's education(+), father's occupation(+),male(+), merit aid(+), English proficiency(+), dual degree(+),student leader(+), party member(+)
Zhong (2011)	OLS	8270 urban residents in CHIP 2002	Four-fold self-evaluated college ranking	(2) Earning gap between recipients of high and low quality higher education is (+28%) and the gap for annual return is 1.4% after controlling for ability. The quality effect is larger for newer working cohorts as the date of entering the labor force changes from 1981 to 1986 to 1993.
Hongbin Li et al. (2012a)	OLS	Tsinghua University Survey	Elite college are those covered by projects 985 and 211	(2) elite (+0.107) The return to elite college attendance varies by gender and father's education. The human capital and experience variables can explain a large proportion of the wage premium of elite colleges.

		2010		
Z. Liu & Qiu (2011)	PSM	753 workers in 2005 Urban Household survey	Project 211 vs. non-211	(2) average treatment on the treated (+0.375)
S. Yang & Yang (2011)	2-level HLM	54158 students in MYCOS Survey 2009	Six-fold College categories, average NCEE score, college location/composition	(2)985(+) , 211(+), private (-), independent College (-), average NCEE score (+), college located in urban cities (+), college with more disadvantaged students (-), recruit from the same province(insignificant), male(+), age (+), standardized NCEE score (+), work in urban cities(+), company size (+), high-income working sector (+), parent's education (+), parent's cadre (+)
Yue & Yang (2012)	Logit OLS	Peking University survey 2011	Project 211/other Public dummy	(1)211(+0.69),independent college(-0.78),male(+), student leader(+), associate's degree(-), academic ranking(+), certificate(+),family annual income(+), Part-time work(+), job search cost(+) (2)211(+0.13), male(+),student leader(+), master degree or higher(+), associate degree(-), annual family income(+), mother's education(+), job search cost(+),job characteristics(location, industry, position, ownership)

2.4 Methodology Review

As mention in section 2.2, milestone advancements began to emerge in the late 1990s to empirically estimate the unbiased economic return to college quality with a series of innovative new econometric approaches after the need to correct for the endogeneity problem was widely recognized. At least five methodologies and identification strategies are employed to determine the causal effect of economic return to college quality, including the instrumental variables (IV) approach (Long, 2008), matching conditioning on observables and unobservables (matching) (Dale & Krueger, 2002, 2011), propensity score matching (PSM) (Black & Smith, 2004; Brand & Halaby, 2006), regression discontinuity design (RD) (Hoekstra, 2009), and the fixed effects (FE) model (Behrman et al., 1996). The advantages and limitations for each of above identification strategies are summarized in Table 2-3 below:

Table 2-3 Recent Econometric Causal Methods and Identification Strategies to Solve the Endogeneity Problem of Elite College Attendance

Identification Strategy	Data structure	Advantages	Limitations	Studies
OLS	Cross-sectional	- control for confounding variables by directly controlling for observables	- strong assumption that controlling for observable confounding variables is adequate to eliminate the selection bias - adding further controls that correlated with observables has little effect	(Fox, 1993; Griffin & Alexander, 1978; Morgan & Duncan, 1979; Solomon, 1973, 1975; Solomon & Wachtel, 1975; Trusheim & Crouse, 1981; Wachtel, 1976; Wales, 1973; Weisbrod & Karpoff, 1968)
FE	Cross-sectional	- difference out the omitted variable problem by eliminating the fixed, unobservables associated with selection	- relevant omitted variable may not be fixed over time - may severely reduce the sample size - generally biased toward zero in the presence of random measurement error	(Behrman et al., 1996)
Matching	Cross-sectional	- complementary with regression adjustment - highlight areas of covariate distribution with insufficient overlap between the treatment and control groups	- harder to find the match as the number of strata or bins increase	(Dale & Krueger, 2002, 2011)
PSM	Cross-sectional	- relax the linearity assumption - only match on propensity scores instead of multidimensional match	- based on the assumption of selection on observables - assumptions of common support and balance may not hold	(Black & Smith, 2004; Brand & Halaby, 2006; Long, 2008)
IV	Cross-sectional	- purge the bias that results from the omitted variable problem - prevent selection bias	- hard to find valid instruments - not usable if it is weak - hard to justify interval validity directly	(Long, 2008)
RD	Cross-sectional	-most close to randomized experiments	- a large sample size is required within the bandwidth - assumptions that no manipulation the side of the cutoff and that people at two sides near the cutoff should be similar may not hold	(Hoekstra, 2009)

However, the results from the studies that applied these identification strategies did not yield a consensus on how big the impact of college quality is, mainly due to their discrepant underlying assumptions and contexts to use. As a result, too much reliance on estimates from a particular method based on pretty strong assumptions will not convince the reviewers. It is worth noticing that each method has its own pros and cons and we need to be cautious to draw definite conclusions about the estimated results.

The OLS regression method responds to the endogeneity problem by directly controlling for all the observable variables. This strategy is based on the assumption that adequate controls for confounding variables would eliminate the selection bias and potential omitted variable bias if observed and unobserved variables are correlated. Obviously, we never know what are the possible unobservable confounders. Therefore, it is arbitrary to make any assertion about the adequacy of controls.

Similar to the conventional OLS regression, the matching and PSM rest on the critical assumption of unconfoundedness, which regards treatment assignment as exogenous once we control for an explicit set of observed covariates (Murnane & Willett, 2010). PSM has some advantages that make it more favorable than the conventional OLS. First, PSM relaxes the linearity assumption in the OLS. Second, instead of specifying the multi-dimensional relationship between explanatory variables and outcomes, PSM as a special kind of matching technique reduces the dimensionality problem in matching. However, the major limitation of PSM is that we should be cautious to interpret any matching estimator as causal effect if the selection is likely to be based on unobservable variables that we fail to control. In this case, even after we apply the PSM, this selection bias remains.

The IV approach offers a powerful way to deal with the selection problem if we are able to find the valid instruments that are correlated with the suspected endogenous variable but uncorrelated with the error term. It also overcomes the omitted variable bias given that the instrument is uncorrelated with the omitted variable. The basic challenge is to find the valid instruments, ideally referred to as “natural experiments”. Moreover, the validity of the instruments cannot be tested directly and more work is required to justify the exogeneity of the instruments, not to mention in the cases of “weak” instruments, which may lead to biased estimates.

Taking advantage of the within family FE model, the FE strategy differences out any fixed, unobservable differences between twins or siblings. Any differences left in the outcome can be attributed to the remaining differences in variable of interest after we control for covariates. FE estimates are subject to a number of potential problems: First, and most obviously, the relevant omitted variable may not be fixed over time. Second, the fixed effects strategy often ends up with a severely reduced sample size. For example, the effect of college quality is identified from the twins enrolled in colleges of varying qualities. Twins who enter the same college quality category do not contribute to the identification. Third, the estimates are generally biased toward zero in the presence of random measurement error (Currie, 2005).

RD is the research design most close to the randomized experiment when only observational data are available. But it requires a large sample size to have sufficient observations within the bandwidths around a certain cutoff point to work, which might be troublesome to collect. Moreover, the fulfillments of some strict assumptions cannot be directly tested, and internal invalidity is often questionable (Imbens & Lemieux, 2008).

When realizing the ubiquitous problem of self-selection and omitted variable bias, it is advisable that we utilize multiple methodologies to deal with this issue and check result robustness.

2.5 Summary and Discussion

In theory, higher education pays not only in terms of quantity but also in quality due to the superior human capital accumulation in high-quality HEIs. Based on this explanation from the human capital theory perspective, quality, which is often neglected, should be incorporated into the classic wage determination model.

Abundant studies in the United States have documented the average effect of college quality. Although the conclusion concerning the magnitude of the effect is not unanimous, there is far more evidence suggesting the positively existing effects of college quality than indicating null or negative effects. The effect could also be heterogeneous and vary by student characteristics and distribution of labor market outcome. The result variation calls for consistency checks across multiple methods and with multiple college quality measures. The potential endogeneity and selection bias of college choice in terms of quality should be addressed with careful designed identification strategies to enhance causal inference regarding the findings.

Examining the determinants of fresh college graduates' labor market success is a hot research topic in China because the higher education expansion policy has generated the biggest number of college graduates in Chinese history in recent years. College graduates' labor market success is crucial to individuals, to their motherhood institutions, and to the society as it plays an important role in realizing personal education investment, enhancing institutional efficiency and promoting social equality and stability. However, current Chinese studies suffer from potential problems such as selection bias and omitted variable bias. The effect of college quality is often treated as homogeneous for all. In addition, no research collects concrete college quality measures. Therefore, the knowledge gap remains on this topic in Chinese studies.

When comparing the results, we should keep in mind that they are contingent on the method employed in the application. Each method has its own assumptions and conditions to work and has its own advantages and disadvantages.

In summary, there are significant large knowledge gaps in the study of the economic returns to labor market outcomes in China. Research with a carefully designed and collected dataset, innovated identification strategies, well-defined research questions, and proper measurements is much needed.

Chapter 3 Research Questions and Methodology

3.1 Introduction

In this chapter, the key research question and sub-questions are proposed to deal with some of the knowledge gaps identified in Chapter 2. A multilevel conceptual framework is established and displayed in Figure 3-1 and the analytical approach presented. The identification strategies and alternative models are set up to address the suspected endogeneity of elite college attendance. Other issues including the sample selection bias and heterogeneous effects of college quality by earning distribution are handled with the Heckman correction method and quantile regression, respectively. These methodologies and identification strategies are applied to the dataset collected by Tsinghua University. The rest of the chapter describes the data collection and processing procedures in detail, including the explanations of the sampling strategy, collaborative design of the questionnaire instruments, calculation of the sampling weight, treatment of missing data, and construction of the indexes.

3.2 Key Research Questions

To fuel the economy with technology and knowledge advances, raising college quality is a key concern of Chinese higher education policy formulation. It is important to study the labor market effects of college quality in China for several reasons. First, graduates from high-quality HEIs are expected to become highly productive future workers who serve the industries and communities in national economic development. Second, it is imperative to assess and supervise the quality assurance of HEIs, especially for the heavily endowed elite colleges and rapidly growing independent colleges. Third, because the priority and concentrated financial support were given to certain national leading universities and colleges in projects 985 and 211, the positive findings could justify the government's endeavor to upgrade and improve higher education quality in these selected HEIs with limited resources with the hope that Project 985 and 211 colleges might help raise the quality of the whole Chinese higher education system.

As identified in the literature review part, the primary knowledge gaps in existing Chinese studies include the following: (1) There are very limited empirical studies with special attention to college quality in China. (2) The causal inference methods are seldom applied to study the effect of college quality in China, particularly in treating the endogeneity problem. (3) The limited measure of college quality fails to provide informative findings and hinders the deeper understandings of the effect of college quality. (4) The potential heterogeneity of college quality is not examined. My study will try to reduce these gaps and address these deficiencies.

Based on the identified knowledge gaps in the literature review, the key research question for this dissertation is "**Does college quality affect the starting salary of fresh college graduates in China?**" This major research question can be split into five sub-questions:

1. Does college quality affect the initial employment status of fresh college graduates in China?
2. Does college quality affect the starting salary of fresh college graduates in China?
3. Does the effect of college quality vary by student individual characteristics, such as gender, ethnicity, family background, and student ability?
4. Does the effect of college quality vary by fresh college graduates' earning distribution?
5. Does the effect of college quality vary by measures of college quality in China?

The first two sub-research questions concern the average effect of college quality on two major early labor market outcomes: initial employment status and starting wage. The next two sub-questions address the heterogeneous effect for particular student groups and for college graduates obtaining starting salaries at certain positions in the earning distribution. The last sub-question involves the use of different measures of college quality, including input-based measures not previously used in studies in China.

3.3 Conceptual Framework

Figure 3-1[12] gives a visual illustration of the structure of the relationship between student early labor market outcomes and institutional factors at two levels: college level and student level. The influences from external contexts such as the government, the student's family, and the labor market, that affect student labor market outcomes are connected to the higher education sector. The complex process of student initial employment status and starting wage determination is connected with arrows, which indicate the direction of influence from one factor to another.

As depicted in Figure 3-1, the square box in the center shows the student level and college level factors in a two-level structure, which is the focus of this study. Students with different backgrounds are sorted into colleges based on their demographic characteristics, cognitive ability, pre-college experiences, and other unobserved characteristics. Meanwhile, family background factors such as parental SES, family size, and parental expectations interplay with student background to jointly influence the college choice decision. Students enter into colleges and become one key component of college personnel inputs.

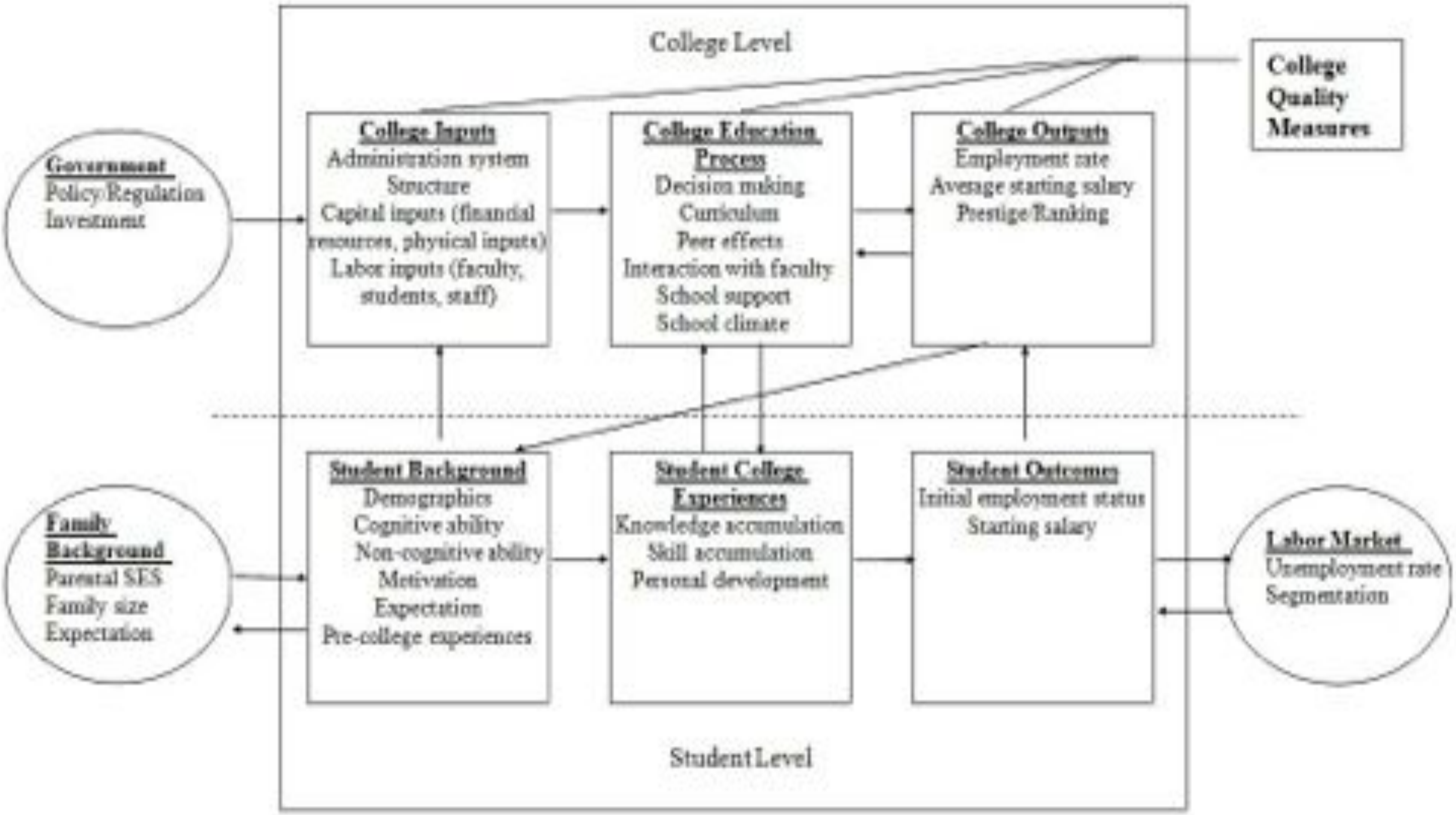
During college, students have a series of college experiences of all kinds, academic and social. Student personal experiences stimulate their knowledge, skill gains, and personal development, which lead to a higher productive capacity. Individual human capital accumulation rates differ both in the way students' behaviors are influenced by their own backgrounds and in the way they are influenced by colleges with varying qualities. These student college experiences will be rewarded in the early labor market differentially, partially due to the labor market

[12] The source of this conceptual framework is the literature review of the human capital theory and empirical evidence of the effect of college quality in China conducted by the author.

conditions such as the unemployment rate and many forms of job market segmentation. The student labor market outcomes affected by student college experiences include the initial employment status and the starting salary level. College output is obtained by aggregating the students' labor market outcomes to the college level. As we can see, college quality plays an essential role in this whole process. Conceptually, college quality can be measured either by college input resources, college education process or college outputs. It is believed that higher-quality colleges not only comprised of a highly selective student body, but they also possess advantageous resources in other college inputs such as capital inputs, faculty and staff inputs, administration support, and structure. In China, these resources are largely allocated and regulated by the government. When inputs are transformed in the education process, colleges with higher quality are those with better decision making, better curriculum designs, stronger positive peer effects and student-faculty interactions, more supportive school environments, and favorable school climates, all of which promote student engagement. Ultimately, people's perception of college quality can stem from college outputs such as the employment rate, average starting salary level, and general college prestige or ranking. These outputs serve as guidance for prospective students and parents who make the college choice decision in terms of quality.

Figure 3-1 provides conceptual guidance for the empirical study of the impact of college quality on early labor market outcomes of fresh college graduates.

Figure 3-1 A Two-level Conceptual Framework for Analyzing the Economic Returns of College Quality



3.4 Analytical Approach

Most empirical studies of school quality and earning relationship are derived from the cornerstone work of Jacob Mincer's model of earnings (Mincer, 1974) as reviewed in Section 2.1. The basic Mincerian function reveals how the two productive attributes of schooling and working experiences are rewarded in the labor market, but it neglects some other major determinants of actual returns. One of these determinants is schooling quality. Focusing on the return to general education level by treating schooling as homogeneous tends to overestimate the rate of return to education.

Behrman and Birdsall (1983) suggested two ways of introducing school quality into the Mincerian model. The school quality component enters the model either through an interaction with education or through another variable representing the school quality independent from education quantity. The former specification implies that school quality influences earnings indirectly through rate of return to education quantity. The latter specification allows school quality to have a direct effect on earnings. In this approach, the effective years of schooling is a linear function of years of schooling (S) and school quality (Q):

$$S^* = S^*(S,Q) = w_0 + w_1 S + w_2 Q \tag{3.1}$$

Most previous literature on the determinants of fresh college graduates' earnings took the second approach in which college quality is a separate factor. A general linear reduced form is as follows:

$$\ln Y_s = \ln Y_o + rw_0 + rw_1 S + \mathrm{r} w_2 \mathrm{Q} + \beta_1 E + \beta_2 E^2 + U \tag{3.2}$$

where Y_s represents an individual's earnings with S years of schooling, S indicates individual years of education, Q represents school quality, E represents working experience and U is the error term. The parameter on school quality equals to the product of the rate of return to years of education r when school quality is not incorporated and w_2. Most existing studies estimate some version of these specifications (Behrman et al., 1996; Card & Krueger, 1992; Heckman, Layne-Farrar, & Todd, 1995; Johnson & Stafford, 1973). To generate comparable results, this form will be used to incorporate the impact of college quality on the earnings function into this dissertation. Because we are concerned about the schooling quality at the undergraduate college level, all observations in the sample are senior college students who have the same number of years of schooling. Therefore, the years of schooling as education quantity measure could be omitted from our estimation equations. Extensions of the baseline Mincerian model can be made by including other factors that are related to fresh college graduates' earning determination as covariates.

3.5 Measuring College Quality

It is well known that HEIs have three major functions: teaching, research, and public service. Because the outcome of interest in my study is undergraduate students' early labor market performance, which is largely determined by college teaching quality, finding teaching quality measures that are closely related to undergraduate students' economic returns will be the focus. In other words, the basis of the whole study is to determine which are the high-quality and low-quality universities. The higher-quality colleges should be ones that facilitate the greater human capital accumulation during college intuitively.

In concept, many people vote for the so-called "gold-standard" value-added outcome approach to identify the colleges that are most/least capable of promoting the value-added student achievement in learning. Then, the college quality will be identified according to universities' relative locations in the distribution of their students' value-added achievement. However, a large-scale collegiate assessment system has not been established in China (or the

United States) and critics often doubt its validity in measuring individual knowledge and skills. In practice, most researchers turn to other proxies of college teaching quality, such as school input resource measures (as in school accountability reports), employer's perception of teaching quality (as in employer satisfaction survey instruments) and student's perception of teaching quality (as in students' college experience surveys) (Shin, Toutkoushian, & Teichler, 2011).

Existing empirical studies usually take advantage of college characteristics in terms of input amount and quality to identify college quality. The advocates of school input resource measures suggest that a number of college input measures (admission selectivity, faculty credentials, physical facilities, the size of the endowment, price of college education) are potential candidates for predicting college productivity. This study will be the first article to employ input-based college quality measures to examine the effect of college quality on labor-market outcomes in China.

Nevertheless, even the input resource approach is not without critics. Critics argue that college inputs tell us little about true quality. Colleges with more input resources are resource-advantaged schools rather than higher-quality ones (Pascarella, 2001). Actual process and outcomes for students matter more. Several initiatives are attempting to shift the conversation about the quality offered by institutions away from resources and reputation toward more relevant indicators, such as student learning process and outcomes surveyed by the National Survey of Student Engagement (NSSE) in the United States (Sarraf, Hayek, Kandiko, Padgett, & Harris, 2005). Based on students' individual perceptions of college quality, the missing links between college inputs and outcomes are filled out by the process measures in the NSSE, such as student-faculty contact, peer effects, and supportive campus environment. The NSSE also directly evaluates to what extent institutions contribute to students' knowledge, skills, and personal development. These students' practices and experiences can be at least as important to college quality as enrolled student ability because a substantial body of evidence has shown that the selectivity of the institution contributes minimally to learning and cognitive growth during college(Pascarella & Terenzini, 2005). Hu and Wolniak (2010) found that at the individual level, student engagement in college activities has a significant role in college graduates' earning power in the labor market. But, surprisingly few empirical studies took this approach to measure college quality. In an earlier version of my dissertation proposal, I had proposed to aggregate student learning process indicators at the institutional level and identify college quality according to colleges' relative positions in the distribution of their students' overall value-added learning and engagement. However, I could not gain access to the required data in China due to copyright issues. There are two potential problems even if data were available. First, when individual level process indicators are aggregated to the school level, the quality gap between high-quality and low-quality colleges could be reduced because it is calculated based on students' individual self-evaluations and perceptions without a reference college in mind. Then the correlation could be weakened. Second, the NSSE aims to assess learning gain, but some of the engagements are not so closely related to human capital accumulation. Measurement error could occur.

This dissertation study will use two approaches for measuring college quality. The first is the conventional categorical approach in which colleges are grouped into "elite" and "non-elite" ones. Elite colleges are those belong to "985" and "211" education quality enhancement projects that absorb special government funding. Elite colleges are presumably of higher quality than non-elite colleges in China. This approach enables a comparison of the findings of this study with previous Chinese studies. This study is also methodologically superior to previous studies because it deals with the endogenous elite college attendance with the IV approach and PSM method. Findings from these advanced econometric methods will provide new findings and insights on the effect of college quality when contrasting economic returns of elite college attendance (treatment) with non-elite college attendance (control).

The second approach consists of the use of input-based measures of college quality. This study will be the first one to do so in China. Some commonly used input measures in the United States cannot be applied to China's case. For example, the net tuition used by Dale and Krueger (2002) and Long (2008) is believed to reflect the quality of HEIs in the United States, where private, highly-renowned colleges charge much more than public less-famed colleges. However, because a large proportion of colleges are public in nature, tuitions in Chinese HEIs are regulated and manipulated by the Chinese government. Likewise, a professor's salary level as used in Black and Smith (2004) and Long (2008) is not appropriate in this study for three reasons: First, the salary level for professors is not market driven. Second, there is difficulty in adjusting for the local cost of living because the consumer price index (CPI) data do not allow provincial or regional comparison in China. Third, senior faculties with higher ranks tend to have more earnings, but they are not necessarily more helpful in promoting undergraduate learning. Instead, five input-based resource measures are chosen because they are more closely related to undergraduate learning and could well capture the essence of college quality in China's circumstances. The five input-based measures of college quality are:

(1) Faculty-student ratio. This measure is similar to class size and is a measure of faculty availability. Normally, we would expect faculty members who have higher intensity to interact with students if the faculty-student ratio is bigger.

(2) Proportion of faculty members with doctoral degrees. This measure is intended to capture the overall faculty quality in an institution. Intuitively, faculty members with higher

education attainment may have more teaching skills and productivity.

(3) Average freshman NCEE score. This measure is similar to the median freshman SAT test score used in the U.S. literature. It is intended to capture the effects of both student selectivity and peer quality (Long, 2008).

(4) Teaching expenditure per student. This is the per student amount of institutional teaching-related operational cost and special funding. This variable measures the capital resources devoted to student cultivation and development in college.

(5) Index of college quality. Each of the above four input quality indicators captures some aspect of college quality in China. When we talk about college quality, we often refer to the overall quality. Therefore, an index is computed based on the above measures with the principal component analysis (PCA) method. PCA is useful for converting multiple measures into a single variable that explains the largest variance of all components. The index construction process with PCA will be presented in detail in Section 3.7.5. This measure of college quality is similar to the approach taken by Black and Smith (2004) and Long (2008). The majority of input quality indicators are all positively correlated with the overall quality index, with the exception of faculty-student ratio. A detailed description of data collection sources and data calculation formula for input-based college quality measures is provided in Appendix 1.

3.6 Research Methodology

3.6.1 The Baseline OLS/Probit Model

The typical economic model and methodology used to estimate the differentials in earnings across institutional characteristics conditional upon individual characteristics and labor market experiences is the OLS estimation. A reduced-form equation of the OLS estimation takes the following form:

$$\ln \mathrm{Y}_i = \beta_0 + \beta_1 Q_{ij} + \beta_2 D_i + \beta_3 A_i + \beta_4 F_i + \beta_5 C_i + \beta_6 \mathrm{I}_{ij} + \beta_7 J_i + \mu_i \quad (3.3)$$

This equation relates the logarithm of individual i's monthly wage (Y_i) as a function of quality variables of the college j the student attended (Q_{ij}) and a set of individual demographic characteristics (D_i), student ability (A_i), family background characteristics(F_i), college experiences (C_i), institutional characteristics of the college j for student i (I_{ij}), job market conditions and behaviors (J_i) and an individual disturbance term (μ_i). The estimated coefficient (β_1) of college quality (Q_{ij}) represents the impact of college quality on fresh college graduates' starting salary. The key independent variable, college quality, will be measured by two approaches—namely, the categorical approach and the input-based resource approach.

For another early labor market outcome of interest—the initial employment status—a probit regression equation will be performed when the dependent variable is binary initial employment status (whether the student obtained a job by the time of the survey just before the college graduation or not). The probit regression equation is specified as follows:

$$\Pr(Y = 1 / X) = \Pr(Y^* > 0) = \Pr(\alpha_0 + \alpha_1 Q_{ij} + \alpha_2 X_i + \theta_i > 0) \quad (3.4)$$

where Pr denotes the probability of finding a job. Y denotes the two possible outcomes: employed (Y = 1) or not (Y = 0). Y* is a latent variable. Y can be viewed as an indicator of whether this latent variable is positive. Q_{ij} is a measure of college quality. X_i is a set of covariates and θ_i is the error term. College quality will be measured in the same way as in Equation (3.3). The marginal effect on elite college attendance for an individual represents the advantage of probability that a student earns to find a job as an elite college student.

Variables from both the individual and the institutional surveys will be used in the models.

Table 3-1 below is a list of definitions and measures of key variables.

Table 3-1 Definition and Measure Descriptions for Key Variables

Variable Name	Definition	Measures
Dependent Variable		
Starting salary	Natural log monthly salary of the first accepted job offer	Continuous
Employment status	Initial employment status: whether graduate has at least one job offer at the time of the survey	Dummy, 1 = employed; 0 = unemployed
Key Independent Variable: College Quality		
Elite	College quality categories: Project 985 and Project 211 colleges are elite colleges; other regular HEIs are non-elite colleges	Dummy:1 = elite college, 0 = non-elite college
Project 985 colleges	College in Project 985	Dummy:1 = Project 985 college, 0 = otherwise
Project 211 colleges	College in Project 211	Dummy:1 = Project 211 college, 0 = otherwise
Non-key colleges	Public college not in the 985 or 211 projects	Dummy:1 = non-key colleges, 0 = otherwise
Independent colleges	Private college affiliated to public HEIs	Dummy:1 = independent colleges, 0 = otherwise
Faculty-student ratio	Number of faculty members divided by the number of undergraduate students	Continuous
Proportion of teaching faculty with doctoral degrees	Number of teaching faculty members with doctoral degrees/Sum of teaching faculty members with doctoral and master's degrees	Continuous
Teaching expenditure per student	The per capita measure of teaching expenditure measure	Continuous
Student selectivity	Average freshman NCEE score	Continuous
Quality composite index from input indicators	First principal component extracted from the above input-based resource indicators	Continuous
Key Covariates		
<u>Student demographics</u>		
Female	Student's gender	Dummy variable: 1 = female, 0 = male
Age	Age at college graduation	Continuous, calculated from birth year and month
Minority	Whether the student is an ethnic minority	Dummy variable: 1 = minority, 0 = Han
<u>Student ability</u>		
Intellectual /academic ability	Student cognitive ability measured by NCEE score rescaled to 0-100	Continuous
Academic track	Academic track in senior high school	Categorical: Science, liberal arts, arts and athletics

Non-cognitive leadership skills	Whether the student has leadership experiences in senior high school	Dummy:1 = class/school leader, 0 = otherwise
Family background		
Rural residency	The household's registered residence location is in urban or rural area	Dummy variable: 1 = rural, 0 = urban
Only child	Whether an only child in the family	Dummy: 1 = Only child, 0 = has siblings
SES index	An index of family Socioeconomic status constructed from the family background variables	Continuous
College experiences		
Major	Major field of study in college	Categorical: STEM is the reference group
Party membership	Whether the student joins the Communist Party of China (CPC)	Dummy: 1 = CPC member, 0 = otherwise
Student leader	Whether has leadership experiences in student organizations	Dummy: 1 = student organization leader, 0 = otherwise
Have certificate	Whether has technical certificate	Dummy:1 = has certificate, 0 = otherwise
English proficiency	Whether passes the College English Test (CET) level 4 and level 6	Categorical: does not pass CET4 is the reference group
Part-time work	Whether has part-time work experiences during college	Dummy:1 = works in college,0 = otherwise
Have merit aid	Whether has merit aid scholarships in college	Dummy:1 = has merit aid, 0 = otherwise
Have need-based aid	Whether has need-based financial aid in college	Dummy:1 = has need-based aid, 0 = otherwise
Have loan	Whether has student loan in college	Dummy:1 = has loan, 0 = otherwise
Have minor	Whether has a minor in college	Dummy: 1 = has minor, 0 = otherwise
Like major	Whether likes his/her major field of study	Continuous: 1-4
Number of resumes submitted	The Number of resumes submitted for job seeking	Continuous: 0-100
Institutional characteristics		
Institution region	The institutional location region[13]	Categorical: municipalities (reference group) , northeast, east, central and west
Institution specialization	The institutional specialization type	Categorical: comprehensive (reference group), engineering, etc.
Job market conditions and behaviors		
Job industry	The student's job industry sector	Categorical: agricultural industry is the reference group

[13] We divide the whole nation into several economic regions according to the seventh 5-year plan in 1986. The institution region division is according to the regional belonging of the province or the municipal city where the college campus locates. The municipalities include Beijing, Tianjin, and Shanghai. The eastern region includes Hebei, Jiangsu, Zhejiang, Fujian Shandong, Guangdong, Guangxi and Hainan. The northeastern region includes Liaoning, Jilin and Heilongjiang. The central region includes Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan. The western region includes Inner Mongolia, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Ningxia and Xinjiang.

Workplace province	The province of workplace	Categorical: Beijing is the reference group
Work migration	Whether has interprovincial migration behavior	Dummy:1 = migrate, 0 = otherwise
Employer sector	The ownership sector of the employer	Categorical: public sector is the reference group

The typical methodological challenge to draw causal inference from observational data is that we do not observe the earnings if the student had attended a college that differs in quality from the one she actually did attend. In this study, the treatment of interest college quality is potentially endogenous because it may be correlated with the residual. There are two main sources of endogeneity that we are particularly concerned about: the omitted variables bias and the omitted selection. Both of them will generate biased results. Specifically, although we attempt to control for the observable student background characteristics that are correlated with college quality and earnings in the OLS regression as best as we can (for example, we try to eliminate the ability bias by using NCEE score as the proxy for student ability and the NCEE is the key determinant in college admission), the application and admission decisions may be based in part on some unobservable student characteristics that are not held constant. Suppose those who attend elite colleges tend to have higher non-cognitive skills, motivation, ambition, and drive for achievement, just to name a few. Neglecting these unobservable characteristics that are positively correlated with future earnings would lead to overestimated results in the OLS regression.

Moreover, the college participants are not randomly assigned to different colleges. In fact, they have been able to self-select their own college quality types according to the expected cost and return of attending each school quality category. Because of the selection, students in elite colleges and students in non-elite colleges will differ in some ways. This is problematic because differences between both the treatment and control groups may be correlated with labor market outcomes and missing controls for the selection causes the bias. To avoid the potential endogeneity that may not be handled by the OLS strategy, we resort to other identification strategies with additional information incorporated into the model.

This study will address the endogeneity problem with two quasi-experimental methods: IV and PSM. Other identification strategies are not appropriate to apply considering the data structure and research context. For example, the dataset does not satisfy the demanding sample size requirement of a regression discontinuity design or the particular requirement to include twin pairs for within-family fixed effect analysis. Even if the sample size is big enough, the admission procedure in China is not the same as in the U.S. where the SAT score works well as the treatment assignment variable and the people accepted and rejected by a comparable set of colleges could be matched. Instead, this study will use PSM strategy, which constructs a comparable control group (students in non-elite colleges) identical to students in the treatment group (students in elite colleges) in all observed characteristics except the treatment status (elite college attendance). The IV strategy offers the particular advantage of addressing the estimation problems associated with the omitted variable bias and selection bias. Estimates from these two strategies will be compared with the results from conventional OLS regression. Each proposed identification strategy and possible model specification forms will be discussed in the rest of the section. PSM and IV are causal-inference methods that are still seldom used in previous studies in China on my research topic.

3.6.2 Instrumental Variables Estimation

IV estimation is typically used to estimate causal effects in the contexts in which randomized experiment are not feasible, such as, in our case, students' elite college attendance.

The standard estimation method that can be used to calculate IV estimates is the two-stage least squares estimation (2SLS). In the first stage, the endogenous treatment variable is regressed on exogenous covariates to obtain the predicted treatment value as in equation (3.5). In the second stage, the endogenous treatment variable is replaced by the predicted value from the first stage in the outcome function (3.6). More specifically, the first-stage model takes the form:

$$Q_i = \alpha_0 + \alpha_1 IV_i + \alpha_2 X_i + \alpha_3 P_i + \varepsilon_i \tag{3.5}$$

where IV_i denotes the instrumental variable; X_i is a vector of control covariates including individual, family, institutional and job market controls and P_i stands for additional covariates for students' home provinces. In equation (3.5), the categorical measure of college quality (elite versus non-elite college) will be used for research questions 1 and 2, and the continuous measures of college quality will be used to answer research question 5.

In the second stage, we regress the wage outcome on the predicted elite college attendance from the first stage and all the exogenous covariates to determine the impact of elite college attendance on students' starting salary as follows:

$$\ln Y_i = \beta_0 + \beta_1 Q_i + \beta_2 X_i + \beta_3 P_i + \nu_i \tag{3.6}$$

In the face of the potential threats to validity as discussed above, the appropriateness of proposed instrumental variables could be tested by several statistical tests such as the F-test to identify weak instruments (Stock & Yogo, 2002) and the Durbin-Wu-Hausman test to verify exogeneity (Hausman, 1978).

3.6.3 Propensity Score Matching

PSM is a statistical matching technique that attempts to reduce the selection bias due to confounding variables by matching the treated units with comparable comparison units that differ in treatment status but are similar across a high-dimensional set of pretreatment characteristics with a single dimension of calculated propensity score. This strategy works when two underlying assumptions are fulfilled: the conditional independence assumption (CIA) and the common support assumption. The CIA implies that after controlling for covariates, the assignment of units to treatment is "as good as random" (equivalent to unconfoundedness or selection on observables) (Angrist & Pischke, 2008) and the common support assumption states that the probability of receiving treatment is strictly within the unit interval between 0 and 1 so that there is sufficient overlap for adequate matching. Basically, there are six implementation steps when using PSM according to Caliendo and Kopeinig (2008), as follows:

The first step is the estimation of propensity score. This study estimates the propensity score of elite college attendance with a probit model. Based on the college choice and human capital theory as well as previous empirical findings, the college attendance choice in terms of quality is influenced by observed covariates including student ability, high school characteristics, pre-college experiences, home environment and family background. The propensity score estimation model is specified as follows:

$$\mathrm{p}_i = \Pr(Q_i = 1 \mid X_i) = \delta_0 + \delta_1 X_i + \varphi_i \tag{3.7}$$

where p_i is the propensity score to get the treatment; Q_i is the treatment status which equals to 1 if the student attends an elite college and 0 when untreated; and X_i is a set of covariates that determine the treatment status.

The second step is to match up students who are in elite colleges with those in non-elite ones based on their propensity scores. We have to make decisions in terms of which matching algorithm to employ. This study considers four alternative matching algorithms: One-to-one Nearest Neighbor matching, Epanechnikov kernel matching, Gaussian kernel matching and Caliper matching. One-to-one Nearest Neighbor matching means that one case in the control group is matched to a treated case based on the closest propensity score. Kernel matching uses weighted average of all cases in the control group to estimate counterfactual outcomes. The weight is calculated by the propensity score distance between a treatment case and all control cases. The closet control cases are given the greatest weight (Heckman, Ichimura, & Todd, 1998). Caliper matching uses all cases in the control group within a specified caliper to avoid the risk of bad matches. Units with extreme propensity scores that lack common support will be dropped out of the comparison group.

The third step is to check the overlap or common support assumption. To identify the region of common support in which we can estimate the treatment effects, visual analysis of the propensity score distribution in the treatment and control groups is very helpful. We need to find counterfactual observations in the control groups for observations in the treatment group.

The fourth step is to check the balances. The balance is tested by comparing the covariates in the treatment and control group to make sure these groups are truly comparable. If the matching quality is not satisfactory, we should go back to step one and change the specification forms by including higher-order or interaction terms of the existing covariates or adding different covariates in an iteration process until we find acceptable matching with a good tradeoff between overlap and balances.

The fifth step is to estimate the treatment effects by performing the multivariate regression. For the regression adjusted treatment effect, the sample is restricted to the common support area.

Finally, a last step is to test the sensitivity of results with respect to "hidden bias", which determines how strongly an unmeasured variable contributes to the selection process with the Rosenbaum bound (Rosenbaum, 2002). If the result is highly sensitive, the CIA assumption will be doubted.

3.6.4 The Quantile Regression

The OLS regression by design is to evaluate the effect of college quality at the mean of the earnings distribution while the quantile regression examines the effect of college quality at different quantiles in the earnings distribution. Therefore, the quantile regression estimates are more robust against outliers than the OLS. Moreover, if we are interested in obtaining a more comprehensive picture of the relationship between variables rather than only the relationship between the means of such variables, quantile regression is more desirable in this case.

Tracing back to Koenker and Bassett (1978), the conditional quantile function of dependent variable $\ln Y_i$ at quantile q given a vector of regressors can be defined as:

$$Q_Y(q) = \inf\{\ln Y_i : F_Y(Q_i, D_i, F_i, A_i, C_i, I_i, J_i, \mu_i) \geq q\} \quad \text{where} \quad q \in [0,1] \tag{3.8}$$

Quantile regression solves the minimization problem that minimizes the weighted sum of the absolute value of errors, where the weights assigned to positive and negative errors determine the quantile:

$$\beta_q = \min[\sum_{\{i|\ln Y_i \geq X_i\beta\}} q\,|\ln Y_i - X_i\beta| + \sum_{\{i|\ln Y_i < X_i\beta\}} (1-q)\,|\ln Y_i - X_i\beta|] \tag{3.9}$$

3.6.5 The Heckman Selection Correction

The methods above are all based on the sample with students who have non-missing wage values. There is a sample selection concern that missing wage values are not missing at random, which would bias the results.

The sample selection bias can be corrected by the Heckman selection correction procedure (Heckman, 1979). The Heckman correction is a two-step approach to correct for non-randomly selected samples. It is typical to be applied to research on determinants of wage while we observe wage values only for those who work. Thus, it is suitable for our study.

In the first stage, we formulate a probit model to predict employment status (E_i). This selection mechanism is modeled as

$$E_i^* = w'_i \gamma + u_i \tag{3.10}$$

When $E_i^* > 0$, $\Pr(E_i = 1 | w_i) = \Phi(w'_i \gamma)$ (3.11)

When $E_i^* \leq 0$, $\Pr(E_i = 0 | w_i) = 1 - \Phi(w'_i \gamma)$ (3.12)

We compute the inverse mills ratio (IMR): $\hat{\lambda}_{\text{i}} = \phi(w'_i \hat{\gamma}) / \Phi(w'_i \hat{\gamma})$ (3.13)

In the second stage, we correct for sample selection by incorporating a transformation of the predicted individual probabilities as an additional explanatory variable in the wage equation. This additional variable is the so-called inverse mills ratio (IMR). If the coefficient on IMR is statistically significantly different from zero, it is a signal to assert that the results are subject to the sample selectivity.

$\ln Y_i = X'_i \beta + \lambda_1 + \varepsilon_i$, observed only if $E_i = 1$ (3.14)

Table 3-2 below summarizes the research designs discussed so far.

Table 3-2 Summary of Research Design

Research Question	**Data**	**Research Design and Identification Strategies**
Q1: The impact of college quality on initial employment status	College student labor market survey	Probit, IV-probit
Q2: The impact of college quality on starting salary	College student labor market survey	OLS, IV, PSM Heckman correction is used to test for the sample selection bias.
Q3: The effect of college quality varying by student individual characteristics	College student labor market survey	OLS with interaction terms
Q4: The effect of college quality varying by graduates' earning distribution	College student labor market survey	Quantile regressions
Q5: The result sensitivity to college quality measures	1) College student labor market survey by Tsinghua University 2) Institutional survey by Tsinghua University 3) Annual Undergraduate	OLS, IV Probit, IV-probit PCA is used to construct overall college quality indexes

	Teaching Quality Reports 4) The Sunshine NCEE information platform supported by the MOE	

To sum up, I will start with the conventional categorical college quality measure to estimate the average effect of college quality by performing the baseline OLS/probit models, IV and PSM methods. Then the heterogeneous effects are tested with the interaction terms in OLS regressions and quantile regressions. Lastly, alternative quality measures of input-based resource measures will be employed to conduct the additional sensitivity tests with institutional level information from various data sources.

3.7 Data Collection and Data Processing

3.7.1 Data Collection and Questionnaire Design

The survey data used in this dissertation are mainly collected through the Chinese College Student Survey (CCSS) project conducted by the Institute of Education, Tsinghua University in China. This dataset is accessible due to a research cooperation project between the Institute of Education, Tsinghua University, and the Center on Chinese Education in Teachers College, Columbia University.

The CCSS project was initiated in 2009 with the primary purpose to evaluate and improve undergraduate teaching quality in China. It is comprised of three major surveys: the College Student Labor Market (CSLM) survey, which tracks the post-college placement for fresh college graduates; the Chinese Student Engagement Survey (CSES) which is a Chinese version of the NSSE in the U.S.; the brief institutional survey, which contains information about college characteristics. The dataset used in this dissertation study is a merged dataset constructed from the CSLM survey, which includes the student individual level data, and the institutional survey, which encompasses the concrete college quality measures.

The final institutional level data in use is compiled from several sources due to the extreme difficulty of collecting concrete college quality measures in China. The institutional data are mostly derived from 2011 official Annual Undergraduate Teaching Quality Reports available for HEIs in the sample and the 2011 Tsinghua institutional survey. Where there is a conflict between these two sources, the official published data from the institutional annual teaching quality report posted on the website of the Office of Academic Affairs will be used. To ensure credibility, student selectivity as measured by freshman NCEE scores for the 2007 entering class is obtained from the Sunshine NCEE information platform online database supported by the MOE. Ideally, we measure school quality for the 2007 entering class by taking the average values of a 4-year span of input indicators from when this cohort was in college. For example, for typical students in our sample who started college in September 2007 and graduated in July 2011, the average college level data from 2007 to 2011 are desirable. Nevertheless, even the preferred official annual quality report was only initiated in 2010 for a limited range of best universities. It is impossible to collect reliable data that span four years. But given the stability of college ratings, it's not a big problem.

Experts in the disciplines of education, sociology, and economics design the questionnaires collaboratively in Tsinghua University. The surveys contain not only the basic information such as student characteristics and family backgrounds, but also information about students' pre-college experiences, during-college activities, and post-college placement after graduation.

3.7.2 Sampling Strategy

The CCSS employed a multi-stage stratified random sample strategy to select the sample. First, institutions were selected using a stratified sampling strategy by region (municipal cities, northeastern, eastern, central and western) and by quality categories (elite, non-elite). For example, 2011 survey randomly chose 50 institutions, 13 of which are from three municipal cities (Beijing, Shanghai and Tianjin), 14 from the eastern region, 11 from the central region and 12 from the west. With regard to college academic specialization, there are 15 comprehensive universities, 21 science and engineering concentrated institutions, and 12 other institutions concentrated in other academic disciplines such as agriculture, finance and economics, political science and law, teacher training and ethnic nationality studies. This sample is therefore a good national representative sample of HEIs in China in terms of geographic locations and specialized academic disciplines. With regard to college quality, for the 2011 CSLM survey, the total sample size for use is 6977, which is significantly larger than in previous rounds. About half of them (24 out of 49) are Project 211 or Project 985 colleges. Eight colleges are involved in Project 985 and sixteen are Project 211 universities. Thus, the elite colleges are oversampled in the final sample. Among a total of 6977 students, 3275 are from elite colleges. More specifically, 937 students are from Project 985 colleges, 2338 students are from Project 211 colleges, 3490 students are from non-key colleges, and 212 students are from two independent colleges.

The survey process is strictly managed and monitored to guarantee anonymity in each participating institution. In a lottery at each college, 200 to 300 randomly selected senior students in the graduating class are drawn by picking their student ID numbers. T-tests are further conducted to make sure the selected students are representative in terms of gender and major selected. Students whose IDs are picked by the lottery are asked to take back and complete the CSLM questionnaire sealed in the coded envelopes. The rate of submission of the questionnaire and the attrition rate vary by institution. Overall, the response rate is about 74%.

3.7.3 Sampling Weight

In order to make inferences about the national population of college graduates in 2011, sampling weight should be used to adjust for the non-representativeness of surveyed students. The sampling weight is readily available from the dataset. It is calculated according to the stratified sampling arrangement alone. Response rates of students are not taken into account. Simply put, the sampling weight for each observation can be expressed as the multiplication of two parts: the inverse of the first stage selection probability assigned to the sampled college and the inverse of the second stage selection probability assigned to the sampled student.

3.7.4 Sample Selection and Missing Data

The original sample size for submitted student questionnaires is 8176. In order to study the Cohort 2007 students, who entered college in 2007 and graduated in 2011, we restrict our sample to Cohort 2007 students and delete observations in other cohorts. This action makes the sample size to decrease to 6985. In addition, students from 3-year vocational colleges are excluded from our sample because our focus is to estimate the returns to college quality for 4-year academic college students. Pooling the students from both 3-year and 4-year colleges would mix the effects of quantity of higher education with quality of higher education, which is undesirable. After this action, the sample size of 2011 fresh college graduates in four-year academic colleges is 6983. Then one student who reports his residence region before college as being Hong Kong is discarded from our sample to restrict the college graduates to Mainland China. One student who reports his work place in Macau after graduation is excluded from the sample. Furthermore, four contract students who are assigned to take college education by their current working units and will return after graduation are also discarded because their labor market outcomes are not determined by the market force. Therefore, the remaining 6977 observations constitute the final whole sample.

According to criteria that related to college graduates' plan right after the graduation, the whole sample can be split into three subgroups—namely the "Intention-to-work" sample, "No-intention-to-work" sample and the "Missing-intention" group. In accordance with labor economics definitions, the unemployed status is conditional on one's intention to find a job. Thus, the analysis on employment status will be conducted based on the "Intention-to-work" sample. According to Table 3-3 below, the valid sample size accounts for 61% of the original sample.

Table 3-3 Sample Selection Criteria

Sample Selection Criteria	Action	Frequency	Percent	Cumulative Percent
Have the intention to work in 2011 four-year college graduates	Keep	4984	61	61
No intention to work after graduation in 2011 four-year college graduates	Keep, for robustness check	1867	22.8	83.8
Missing intention in 2011 four-year college graduates	Keep, for robustness check	126	1.5	85.3
2011 four-year college graduates (Mainland area)	Keep	6977	85.3	85.3
Four 2011 4-year college graduates who will return to their previous work units by contract	Delete	4	0.05	85.35
One 2011 4-year college graduate work in Macau	Delete	1	0.01	85.36
One 2011 4-year college graduate from Hong Kong	Delete	1	0.01	85.37
2011 college graduates from 3-year vocational colleges	Delete	2	0.03	85.4
Other cohorts	Delete	1191	14.6	100.00
Total		8176	100.00	

Table 3-4 reports the proportion of missing values of all variables derived from both the student questionnaire and the institution questionnaire in the "Intention-to-work" sample and Table 3-5 below calculates the proportion of missing values for the "Have-job-offer" sample.

Two separate tables are generated respectively because each table corresponds to one labor market outcome that we are interested in. More specifically, the regression on initial employment status is based on the "Intention-to-work" sample, and the regression on starting salary will be run on the "Have-job-offer" sample. It is also worth noting that the model specifications and set of variables used in these two samples differ as well. Thus, it is necessary to present missing rate calculation tables for both samples separately. For both samples, the missing rate is quite small (less than 5%) for the majority of the variables.

For the "Intention-to-work" sample, some variables have moderate missing rates of more than 10% or even 20% for student questionnaire instruments. They are concentrated in family background related variables, especially the SES index, which is built on a set of parental information and family background information. It is not surprising given that students may have difficulty recalling or providing the accurate figures. The missing rates for students' academic performance during high school and college are relatively high. For example, the missing rate for average score in college exceeds 20% and the missing rate for NCEE score exceeds 10%, which reflect either the students' inability to know their precise academic performance or their reluctance to reveal it. Students who fail to report the number of resumes that they submitted for job hunting is over 25%.

For the "Have-job-offer" sample, additional job related variables are associated with moderate missing rates. For example, 9.58% of the sample participants fail to provide the starting monthly salary figure. It seems that for this retrospective dataset, variables with the most missing values at student level are the job-related and family background related variables.

For the institution questionnaires, we have no missing values when the categorical college quality measures are used due to the sampling strategy. However, it is difficult to collect concrete college quality measures for sampled institutions, especially for non-elite colleges. Even if data from multiple sources are used, the missing rate is still very high for some concrete input-based resource measures such as the proportion of faculty members with doctorates and the teaching expenditure per student. The high missing rate of around 68% occurs when collecting the teaching expenditure per student measure due to the extreme difficulty of finding institutional level operational and expenditure data, particularly for non-elite colleges in China. Although elite colleges have been required to increase transparency and accountability since 2010, many non-elite colleges are still not obliged to publish annual teaching quality reports and they are conservative in disclosing school finance facts that are considered to be sensitive.

Table 3-4 Proportion of Missing Values of Variables in the "Intention-to-work" Sample

Measures	Percent of Missing Values
Student Level (4984 in total)	
Age	1.89
Female	0.34
Minority	0.84
Rural household registration	0.30
Students' national college entrance examination (NCEE) total score	11.32
Academic track in senior high school	1.08
Student leader in senior high school	0
Has private room in senior high school	0
Has private desk in senior high school	0
Has private computer in senior high school	0
Has a high volume of books in senior high school	1.85
Home environment index in senior high school	1.85
Key senior high school	1.16
Only child	1.26
Father's employment status	10.09
Father's highest education level	8.86
Father's industry	17.81
Father's occupation	9.33
Mother's employment status	10.39
Mother's highest education level	9.21
Mother's industry	16.21
Mother's occupation	9.63
Type of dwelling	1.36
Area of the dwelling	4.96
Annual household income	17.84
Socioeconomic status (SES) index	21.99
Enrollment rate of ministry-administered universities in home province	2.55
Average GDP per capita in home province, 1993-2007	2.55

Residential region before college	2.53
College major	0.12
Average academic score in college	22.57
Whether student has leadership experience in college	0
Whether student is a Chinese Communist Party member	0.98
Whether student has technical certificates	0
Whether student has passed College English Test level-4 and level-6	2.73
Whether student has Part-time work experiences at college	1.34
Whether student has merit aid in college	0
Whether student has need-based aid in college	0
Whether student has loan in college	2.01
Whether student has a minor in college	2.09
Whether student likes the major	1.97
Number of resumes submitted	26.46
Whether student has obtained at least one job offer	0
Institution Level (4984 in total)	
Institution quality categories	0
Institution specialization	0
Institution region	0
Faculty-student ratio in 2011	7.20
Proportion of faculty members with doctoral degrees in 2011	24.68
Average NCEE score for newly admitted 2011 college freshman	0
Teaching expenditure per undergraduate student in 2011	67.54
College quality index for four input indicators	72.35
College quality index for three input indicators (expenditure per student excluded)	24.68

Table 3-5 Proportion of Missing Values of Variables in the "Have-job-offer" Sample

Measures	Percent of Missing Values
Student Level (3547 in total)	
Age	1.58
Female	0.28
Minority	0.82
Rural household registration	0.28
Students' national college entrance examination (NCEE) total score	9.78
Academic track in senior high school	0.82
Student leader in senior high school	0
Has private room in senior high school	0
Has private desk in senior high school	0
Has private computer in senior high school	0
Has a high volume of books in senior high school	1.86
Home environment index in senior high school	1.86
Key senior high school	1.21
Only child	1.26
Father's employment status	8.57
Father's highest education level	7.22
Father's industry	16.49
Father's occupation	7.72
Mother's employment status	8.88
Mother's highest education level	7.56
Mother's industry	14.66

Mother's occupation	8.03
Type of dwelling	1.24
Area of the dwelling	4.23
Annual household income	16.69
Socioeconomic status (SES) index	19.79
Enrollment rate of ministry-administered universities in home province	2.26
Average GDP per capita in home province,1993-2007	2.26
Residential region before college	2.23
College major	0.11
Average academic score in college	20.44
Whether student has leadership experience in college	0
Whether student is a Chinese Communist Party member	0.87
Whether student has technical certificates	0
Whether student has passed College English Test level-4 and level-6	2.09
Whether student has Part-time work experiences at college	1.21
Whether student has merit aid in college	0
Whether student has need-based aid in college	0
Whether student has loan in college	2.11
Whether student has a minor	2.23
Whether student likes the major	1.58
Monthly starting salary from the highest initial job offer	10.54
Industry of the initial job	3.89
Whether student has inter-provincial migration behavior	10.4
Province of workplace	10.37
Ownership sector of the employer	5.22
Institution Questionnaire (3547 in total)	
Institution quality categories	0
Institution specialization	0
Institution region	0
Faculty-student ratio in 2011	7.08
Proportion of faculty members with doctoral degree in 2011	25.85
Average NCEE score for newly admitted 2011 college freshman	0
Teaching expenditure per undergraduate student	68.71
College quality index for four input indicators	74.23
College quality index for three input indicators (expenditure per student excluded)	25.85

Overall, the missing data problem is not severe. However, given the moderate missing data percentages for some variables for the above two samples, it is better to treat the missing data problem carefully instead of simply ignoring it. In this dissertation, the dummy variable adjustment approach is employed to deal with the missing data in student questionnaire instruments. The results reported in the main body of this dissertation are based on the imputed data with the single imputation procedure and the dummy variable adjustment method.

In pursuit of the complete case analysis, STATA will automatically drop any observation in case of missing value in one or more variables by default. Thus, the valid sample size for the full model of the wage determination equation shrinks considerably. Complete case analysis is often criticized for loss of statistical power and efficiency. Although, in the case that missing data mechanism is missing completely at random (MCAR), the result is generally unbiased. But the conclusion will not hold if the data missing mechanism for the dataset is indeed missing at random (MAR) and not missing at random (NMAR). Moreover, the inconsistent sample sizes from model to model make the direct comparison of results infeasible.

When the dummy variable adjustment treatment is executed, we generate a set of missing dummy indicators D (1 for missing, and 0 for not missing) and include them in regressions. The missing values in original variables with incomplete cases X are imputed by Z (0 for dummies and group mean for continuous variables). Then, X is replaced by both Z and D in regressions. The coefficients on Z are our focuses, which captures the effects of the non-missing X while the coefficients on D are the average impact of missing data. For the dataset in use, the results are quite robust when the dummy variable adjustment treatment is employed.

The outliers are identified before any missing data treatment measures are executed. There is no outlier for dichotomous variables or categorical variables. For continuous variables, an outlier influences both the mean and standard deviation of a variable's distribution and twists the true relationship between this variable and another. A few monthly wage numbers that are near the top or bottom distribution of wage values are deemed outliers and recoded to missing. No outliers are identified for the NCEE score since all of them lie in a reasonable range. In fact, no test score can be seen as the outlier as long as it does not exceed the full score. Thus, only a few very low average academic scores in college are treated as outliers. Furthermore, our research subjects are college students, and it is unusual to have college graduates younger than 20 due to the Chinese education system. But there is no upper bound for students' age. Thus, several observations in the bottom of the age distribution are regarded as outliers. The cleaned age variable ranges from 20 to 31.

3.7.5 Index Construction

In multiple regressions, retaining all available covariates may lead to a severe multicollinearity problem and cause over fitting of the model. It may also reduce the estimation accuracy by inducing a larger standard error when we have a large number of measurements from different dimensions to gauge certain variables. In order to avoid possible measurement error and collinearity, some variables derived from the student and institutional instruments are combined into fewer indexes with the method of principal component analysis (PCA). Invented by Pearson (1901) and Hotelling (1933), PCA is a statistical procedure to transform a set of interrelated variables into a new set of uncorrelated variables, the principal components, while maintaining the variation as much as possible in order to reduce the dimensionality of a data set (Jolliffe, 2002). Because the first principal component keeps the largest possible variance, the indexes using the first principal component will replace the original set of pre-transformation variables. The tables below report the loading matrixes for constructed indexes in this dissertation.

With extensive measures for family background and household wealth, it is an increasingly common routine to create a Socioeconomic status (SES) index to avoid the potential multicollinearity problem when a collection of family or household variables are jointly used (Houweling, 2003; Krishnan, 2010; Vyas & Kumaranayake, 2006). The SES index in this dissertation is constructed from many family background variables including annual household income, type and area of residential dwelling as measures of household wealth, parents' education levels and parents' occupations. Most of these raw family background variables are categorical variables except annual household income and household wealth variables. For instance, parents' education attainment is categorized into 12 categories. Likewise, we have 20 categories for parents' occupation and 18 categories for parents' industry. These categorical variables are recoded as binary variables because the quantitative scale does not have any meaning and is not suitable for PCA analysis, as suggested by Vyas and Kumaranayake (2006). Even with these recoded binary variables, including all of them would lead to a Kaiser-Meyer-Olkin (KMO) value below the acceptance threshold of 0.5.

Therefore, the categorical variables are recoded in the following way: For parents' education levels, they are recoded into continuous years of education measures based on the rule specified in a previously Chinese study (Du & Yue, 2010). Specifically, people with "no schooling" are recoded as having 0 years of education, "primary school graduates" as having 9 years of schooling, "high school or secondary vocational school graduates" as having 12 years of schooling, "post-secondary vocational college" as having 14.5 years of schooling and "college graduates" as having 16 years of school. Unlike Du & Yue (2010), we further differentiate people with master's degrees and doctoral degrees. "Master's degree holders" are coded as having 19 years of schooling and "doctoral degree holders" are coded as having 22 years of education. This coding rule is in accordance with the typical length of schooling completion at each educational level in China. For parents' occupational information, three sets of binary variables are created. These new variables are created at the household level, so a value of 1 indicates that at least one parent in the household belongs to that category. The first set of variables describes the position or nature of one's occupation. The categories include whether a parent in the household was a manager or leader, a professional staff (i.e., highly-skilled workers), an ordinary staff (e.g., office clerks, sales), self-employed (e.g., small business owners, peddlers), a manual worker or farmer, or unemployed/not in the labor force. The second set of variables describes the parents' working industry. The categories represent whether a parent in the household worked in the manufacturing industry, retail or service industry, high-income industry including IT and finance industries, or public service industries including education and medical service. The third set describes the nature of the employer. The categories are whether a parent in the household worked for the government, for public services, for enterprises, or for a self-owned business. The type of dwelling is recoded into six categories: a dwelling in a rural area, a dwelling in an affordable housing community, a dwelling in town, a dwelling in the residency community of one's employer, an ordinary commercial dwelling and a commercial dwelling in high-income community.

The continuous variables, annual household income and area of dwelling are transformed with the natural logarithm form to avoid distribution skewness and kurtosis. Outliers are identified and deleted during the PCA because of its sensitivity to outliers. Any missing observations are also dropped in the PCA process. A final sample of 5231 observations is left in the analysis.

Additional criteria are met before the PCA proceeds. The correlation matrix examination ensures that no variables with too weak correlation (none of the correlation parameters is greater than 0.2) or too strong correlation (any correlation parameter is greater than 0.9) with other variables are dropped. In addition, variables with individual KMO value less than 0.5 is also not allowed. We pay special attention to keep at least two variables from each of the three sets of variables that describe parents' occupational information.

Finally, a list of 14 variables that are included in the analysis comprises annual household income in its natural logarithm form, father's years of education, mother's years of education, area of dwelling in its natural logarithm form, two variables describing type of dwelling (rural/urban, ordinary commercial dwelling or not), four variables describing parents' occupation position (whether a manager, a professional, an ordinary staff, or a manual worker or farmer), two variables describing the nature of employers (government, public institutions) and two variables describing the parents' working industry (public service, service and retail industry).

Other than fulfilling the standards above, the appropriateness of the PCA process is tested and proved. The null hypothesis of Bartlett's test of sphericity is rejected with a p-value of 0.000, which satisfies the requirement. The KMO value of all variables is 0.805, larger than the minimum requirement of 0.5. The determinant of the correlation matrix is 0.019, larger than the necessary value. Five components with eigenvalues greater than 1 are derived from the PCA extraction. The first component explains 30.35% of the total variance. We use the first component to present the SES as the common routine in applications of PCA in SES index construction (Houweling, 2003). The component loadings for SES variables are shown in Table 3-6. Additional results from the PCA analysis for SES index construction are included in Appendix 2.

Table 3-6 Component Loadings for Socioeconomic Status Variable

	Component
	1
Annual household income	0.625
Area of dwelling	-0.120
Mother's years of schooling	0.723
Father's years of schooling	0.729
Rural residency	-0.739
Ordinary commercial residency	0.514
At least one parent is a manager in the household	0.568
At least one parent is a professional in the household	0.541
At least one parent is an ordinary staff in the household	0.307
At least one parent is a farm worker	-0.602
At least one parent works in the government	0.414

At least one parent works in public institutions	0.606
At least one parent works in the public service sector	0.582
At least one parent works in the service and retail industry	0.168

Note: Extraction Method: Principal Component Analysis
Component 1: Socioeconomic Status (SES)

Table 3-7 lists pre-college home environment variables. The home environment variable describes the study environment at home and parental attention to kids' study. This first component explains 42% of the total variance. It is constructed from four indicator variables for whether the student has a private room, a private desk, a private computer, and a high volume of books during senior high school period. The loadings for all variables are positive. The overall KMO value is 0.65, which satisfies the validity requirement.

Table 3-7 Component Loadings for Pre-college Home Environment Variable

Variable	Component 1
Have private room in senior high school	0.4496
Have private desk in senior high school	0.4832
Have private computer in senior high school	0.5779
Have a high volume of book in senior high school	0.4800

Note: Extraction Method: Principal Component Analysis
Component 1: Pre-college Home Environment

Table 3-8 reports input-based resource college quality variables. Two college quality indexes are computed. One index is for four input-based college quality indicators, and the other index is for three input-based college quality indicators excluding the expenditure per student because of the extraordinarily high missing rate on this variable. These two indexes explain about 60% of the total variance in the data. They both have high positive loadings on the proportion of faculty members with doctoral degrees and the average freshman NCEE score, but negative loading on the faculty-student ratio.

Table 3-8 Component Loadings for College Quality Variable

Variable	Component 1 (four inputs)	Component 1 (three inputs)
Faculty-student ratio	-0.3343	-0.0933
Proportion of faculty members with doctoral degrees	0.5554	0.7032

Average freshman NCEE	0.5837	0.7048
Teaching expenditure per student	0.4890	Not included

Note: Extraction Method: Principal Component Analysis
Component 1: College Quality Index

Chapter 4 Descriptive Statistics

Chapter 4 begins with the descriptive statistics tables for both the "Intention-to-work" sample and the "Have-job-offer" sample and it is followed by the descriptive analysis on early labor market outcomes and college quality. Section 4.1 presents the descriptive statistics for all the variables used in the models. Then the partial correlation coefficients are listed for covariates used in the empirical models. Section 4.2 presents the distribution of early labor market outcomes by college quality type. Section 4.3 shows the aspects of college quality and student characteristics by college quality type.

4.1 Descriptive Statistics and Correlation

4.1.1 Descriptive Statistics

The descriptive statistics analysis aims to give us an understanding of how the data are distributed for each variable in our dataset. We could inspect distributions of all quantitative variables by providing the mean, standard deviation, the minimum values and the maximum values in Table 4-1 and Table 4-2. It is worth noting that means for dichotomous variables (the categorical variables are broken down into dummies) should be interpreted as proportions.

Table 4-1 and Table 4-2 below show the descriptive statistics of variables that are going to be used in the employment status determination model and the wage determination model separately. The former is based on the "Intention-to-work" sample, while the latter is based on the sample with students within the "Intention-to-work" sample who successfully obtained at least one job offer. Thus, the latter one is called the "Have-job-offer" sample. Both tables report the original data without missing data replacements, and the figures are weighted by the sampling weights. Indices are provided for the SES index, pre-college home environment index, and overall college quality indexes.

According to Table 4-1, the percentage of students that have at least one offer is 66.2%. Female students account for around 46% of all the students who have the intention to work after graduation. About 5.4% of all students are minority students, and 46.6% are rural registered-residence students. The sampling weighted average NCEE score is 69.8. Within this sample, 34.8% of students are only children in the family, and their average academic score in college is about 79. More than half are in the science, technology, engineering and math (STEM) majors compared with 13.1% in liberal arts majors, 8% in social sciences, 17.8% in economics and management, and 6.1% in others. The percentage of party members, student union leaders, and technical certificate holders is 27.1%, 20.5%, and 45.1%, respectively. 24.1% of students do not pass the College English Test (CET) level 4 even when they are about to graduate, in contrast to 46.3% of CET 4 passers and 29.6% of CET 6 passers. It is common for students to take part-time jobs in college. The percentage of students that have part-time working experiences is about 82.2%, and 30.8% of students have earned merit aid scholarships. 21% of students have need-based aid and almost 30% of students take out loans. 6.4% of students have a minor. Students make great efforts to find jobs. The average number of resumes submitted for job hunting is about 22 copies.

In terms of institutional characteristics, 16% of students are in elite colleges versus 84% in non-elite colleges. More specifically, 5.1% are in Project 985 colleges, 10.8% are in Project 211 colleges, 72.8% are in non-key colleges, and 11.2% are in independent colleges. Engineering is the most popular specialized subject category in our sample, which is followed by 29.7% of students attending normal universities [14] and 21.2% of students attending comprehensive colleges. The sample covers institutions from five regions with the largest proportion of students

[14] Normal universities are teacher training universities and colleges in China.

from institutions in the East. On average, one faculty member needs to accommodate about 17 students. There is a large discrepancy among HEIs in terms of the composition of faculty education attainments and the teaching expenditures on the undergraduate student body. It is astonishing that the best-equipped university has spent nearly 20 times the expense on stimulating student learning and teaching than the worst-equipped university in our sample.

Table 4-1 Descriptive Statistics of Variables in the "Intention-to-work" Sample-Weighted

Variable	N	Mean/ Proportion	S.D.	Minimum	Maximum
Student variables					
Have job offer (Yes = 1) (%)	4984	0.662	0.473	0	1
Age	4890	23.016	0.995	20	31
Female (Yes = 1) (%)	4967	0.459	0.498	0	1
Minority (Yes = 1) (%)	4942	0.054	0.227	0	1
Rural household registration (Yes = 1) (%)	4969	0.466	0.499	0	1
NCEE (rescaled to 1~100)	4420	69.824	7.721	24	100
Academic track in high school (%)					
Humanities	4930	0.245	0.430	0	1
Science and comprehensive	4930	0.693	0.461	0	1
Arts and athletics	4930	0.062	0.242	0	1
Non-cognitive leadership skills (%)	4984	0.398	0.490	0	1
Home environment in high school	4892	-0.155	1.167	-1.479	2.95
Only child (Yes = 1) (%)	4921	0.348	0.476	0	1
SES index	3888	-0.237	0.942	-2.191	2.799
Enrollment rate of ministry-administered colleges in home province	4857	4.806	2.733	1.890	13.770
Average GDP per capita in home province	4857	10835	6528	3360	32344
Residential region before college (%)					
Municipality	4858	0.093	0.291	0	1
East	4858	0.308	0.462	0	1
Northeast	4858	0.134	0.340	0	1
Central	4858	0.248	0.432	0	1
West	4858	0.216	0.412	0	1
College majors (%)					
Liberal arts	4978	0.131	0.338	0	1
Social sciences	4978	0.080	0.271	0	1
STEM	4978	0.551	0.497	0	1
Economics and management	4978	0.178	0.382	0	1
Others	4978	0.061	0.239	0	1
Average academic score in college	3859	78.617	6.553	25	100
Communist party member (Yes = 1)(%)	4935	0.271	0.444	0	1
Student leader (Yes = 1) (%)	4984	0.205	0.404	0	1
Have technical certificate (Yes = 1) (%)	4984	0.451	0.498	0	1
College English Test proficiency (%)					
does not pass CET4 & CET6	4848	0.241	0.428	0	1
pass CET4	4848	0.463	0.499	0	1

pass CET6	4848	0.296	0.456	0	1
Have Part-time work experience (Yes = 1) (%)	4917	0.822	0.382	0	1
Have merit aid (Yes = 1) (%)	4396	0.308	0.462	0	1
Have need-based aid	4984	0.210	0.408	0	1
Have loan	4884	0.293	0.445	0	1
Have minor (Yes = 1) (%)	4880	0.064	0.246	0	1
Like major	4886	2.633	0.802	1	4
Number of resumes submitted	3990	22.432	24.727	0	100
Institution variables					
Elite college (Yes = 1) (%)	4984	0.160	0.366	0	1
Institution quality categories (%)					
Project 985 colleges	4984	0.051	0.221	0	1
Project 211 colleges	4984	0.108	0.311	0	1
Non-key colleges	4984	0.728	0.445	0	1
Independent colleges	4984	0.112	0.316	0	1
Institution specialization (%)					
Comprehensive	4984	0.212	0.408	0	1
Engineering	4984	0.441	0.497	0	1
Normal	4984	0.297	0.457	0	1
Agriculture	4984	0.040	0.196	0	1
Finance	4984	0.001	0.035	0	1
Political science	4984	0.007	0.081	0	1
Ethnic	4984	0.003	0.053	0	1
Institution region (%)					
Municipality	4984	0.133	0.339	0	1
East	4984	0.272	0.445	0	1
Northeast	4984	0.150	0.357	0	1
Central	4984	0.242	0.428	0	1
West	4984	0.203	0.403	0	1
Faculty-student ratio	4625	0.057	0.007	0.042	0.077
Proportion of Ph.D. faculty members	3754	0.335	0.163	0.070	0.870
Average freshman NCEE score	4984	67.2	5.3	56.0	86.5
Teaching expenditure per student	1618	5056	4293	1177	20000
College quality index	1378	-0.249	1.437	-3.031	4.864
College quality index(expenditure excluded)	3754	-0.988	1.422	-3.727	3.991

A number of variables included in the equation of employment status also appear in the wag equation. Minor changes of descriptive statistics occur for these shared variables, as shown in Table 4-2. The mean starting monthly wage for the students who have at least one job offer is 2377 RMB. Students show a large distribution of wages, with a standard deviation of about 1208 RMB. This may be due to highly uneven job placements and job pay even when entering the labor market. For example, the maximum monthly wage reaches 20000 RMB even after the outliers are identified and removed. Some graduates' starting salaries barely surpass the local minimum-wage level and these graduates need to work the entire year to earn the equivalent amount. Wage determination models control for student job market behaviors that are not in the employment status determination model. College students are highly flexible and mobile in terms of work place destination choice. For example, 43.2% of students have inter-provincial migration behaviors that are conditional on successfully finding a job. Students lean to jobs in the knowledge-intensive industries and high value-added industries. The mining, manufacturing, and construction industry sector absorbs the biggest proportion of college graduates, about 26%. It is followed by telecom/computer service and the software industry and then finance and utilities/energy. The developed areas such as the coastal provinces and large municipal cities are the most attractive workplace destinations for fresh college graduates. 46.8% of students find jobs in the private sector and 40.9% are in the public sector. The foreign or co-owned enterprises absorb 12.2% of students.

Table 4-2 Descriptive Statistics of Variables in the "Have-job-offer" Sample-Weighted

Variable	N	Mean/ Proportion	S.D.	Minimum	Maximum
Student variables					
Starting monthly wage (in RMB)	3173	2376.94	1207.63	500	20000
Age	3491	23.031	0.997	20	30
Female (Yes = 1) (%)	3537	0.427	0.495	0	1
Minority (Yes = 1) (%)	3518	0.0500	0.219	0	1
Rural household registration (Yes = 1) (%)	3537	0.503	0.500	0	1
NCEE (rescaled to 1-100)	3200	70.55	7.335	24	100
Track in high school (%)					
Humanities	3518	0.213	0.410	0	1
Science and comprehensive	3518	0.736	0.441	0	1
Arts and athletics	3518	0.051	0.219	0	1
Student leader in high school	3547	0.419	0.494	0	1
Home environment in high school	3481	-0.245	1.148	-1.479	2.950
Residential region before college (%)					
Municipality	3468	0.088	0.283	0	1
East	3468	0.287	0.453	0	1
Northeast	3468	0.121	0.327	0	1
Central	3468	0.273	0.445	0	1
West	3468	0.231	0.421	0	1

Only child (Yes = 1) (%)	3510	0.305	0.461	0	1
SES index	2845	-0.310	0.931	-2.191	2.799
Enrollment rate of ministry-administered universities in home province	3467	4.730	2.708	1.890	13.770
Average GDP per capita in home province	3467	10551	6437	3360	32344
College major (%)					
Liberal arts	3543	0.116	0.320	0	1
Social sciences	3543	0.059	0.235	0	1
STEM	3543	0.605	0.489	0	1
Economics and management	3543	0.170	0.376	0	1
Others	3543	0.051	0.219	0	1
Average academic score in college	2822	78.209	6.173	25	100
Communist party member (Yes = 1) (%)	3516	0.285	0.451	0	1
Student union leader (Yes = 1) (%)	3547	0.204	0.403	0	1
Have technical certificate (Yes = 1) (%)	3547	0.461	0.499	0	1
College English Test proficiency (%)					
does not pass CET4 & CET6	3473	0.226	0.418	0	1
pass CET4	3473	0.472	0.499	0	1
pass CET6	3473	0.301	0.459	0	1
Have Part-time work experience (Yes = 1) (%)	3504	0.855	0.352	0	1
Have merit aid (Yes = 1) (%)	3128	0.372	0.483	0	1
Have need-based aid	3547	0.235	0.424	0	1
Have loan	3472	0.328	0.470	0	1
Have minor	3468	0.065	0.247	0	1
Like major	3491	2.651	0.785	1	4
Inter provincial work migration (Yes = 1) (%)	3178	0.432	0.495	0	1
Job industry (%)					
Agriculture/Fishing/Forestry	3409	0.023	0.150	0	1
Mining/Manufactory/Construction	3409	0.260	0.439	0	1
Utilities/Energy	3409	0.056	0.231	0	1
Transportation/Storage/Postal	3409	0.042	0.201	0	1
Telecom/Computer and software	3409	0.154	0.361	0	1
Wholesale/Retail	3409	0.039	0.193	0	1
Hospitality/Food service	3409	0.023	0.151	0	1
Finance	3409	0.072	0.258	0	1
Real estate	3409	0.041	0.197	0	1
Lease & Business service	3409	0.021	0.143	0	1
Education	3409	0.085	0.279	0	1
Medical care	3409	0.029	0.167	0	1
Culture/Sport/Social utility	3409	0.046	0.209	0	1
Science & Research/Technology service	3409	0.055	0.227	0	1
Water/Environment protection	3409	0.012	0.108	0	1
Community and other services	3409	0.015	0.121	0	1
Government/NGO/International organization	3409	0.012	0.111	0	1
Other	3409	0.016	0.124	0	1
Province of work place (%)					
Beijing	3179	0.109	0.311	0	1
Tianjin	3179	0.013	0.113	0	1

Hebei	3179	0.014	0.116	0	1
Shanxi	3179	0.005	0.072	0	1
Inner Mongolia	3179	0.005	0.074	0	1
Liaoning	3179	0.036	0.187	0	1
Jilin	3179	0.030	0.170	0	1
Heilongjiang	3179	0.015	0.120	0	1
Shanghai	3179	0.045	0.207	0	1
Jiangsu	3179	0.038	0.192	0	1
Zhejiang	3179	0.041	0.198	0	1
Anhui	3179	0.008	0.088	0	1
Fujian	3179	0.144	0.352	0	1
Jiangxi	3179	0.038	0.191	0	1
Shandong	3179	0.057	0.231	0	1
Henan	3179	0.045	0.207	0	1
Hubei	3179	0.019	0.136	0	1
Hunan	3179	0.036	0.187	0	1
Guangdong	3179	0.128	0.334	0	1
Guangxi	3179	0.012	0.107	0	1
Hainan	3179	0.005	0.070	0	1
Chongqing	3179	0.023	0.151	0	1
Sichuan	3179	0.022	0.148	0	1
Guizhou	3179	0.006	0.078	0	1
Yunnan	3179	0.010	0.100	0	1
Tibet	3179	0.001	0.034	0	1
Shannxi	3179	0.078	0.267	0	1
Gansu	3179	0.004	0.062	0	1
Qinghai	3179	0.001	0.036	0	1
Ningxia	3179	0.002	0.040	0	1
Xinjiang	3179	0.010	0.101	0	1
Ownership type of Employer (%)					
Public	3362	0.409	0.492	0	1
Foreign or co-owned	3362	0.122	0.328	0	1
Private	3362	0.468	0.499	0	1
Institution variables					
Elite college (%)	3547	0.175	0.380	0	1
College quality categories (%)					
Project 985 colleges	3547	0.059	0.236	0	1
Project 211 colleges	3547	0.116	0.320	0	1
Non-key colleges	3547	0.736	0.441	0	1
Independent colleges	3547	0.089	0.285	0	1
Institution specialization (%)					
Comprehensive	3547	0.206	0.405	0	1
Engineering	3547	0.503	0.500	0	1
Normal	3547	0.247	0.431	0	1
Agriculture	3547	0.035	0.183	0	1
Finance	3547	0.001	0.020	0	1
Political science	3547	0.006	0.076	0	1
Ethnic	3547	0.003	0.053	0	1
Institution region (%)					
Municipality	3547	0.126	0.332	0	1
East	3547	0.260	0.439	0	1

Northeast	3547	0.134	0.341	0	1
Central	3547	0.260	0.439	0	1
West	3547	0.220	0.414	0	1
Faculty-student ratio	3296	0.057	0.007	0.042	0.077
Proportion of Ph.D. faculty members	2630	0.346	0.157	0.070	0.870
Average freshman NCEE score	3547	67.7	5.1	56.0	85.5
Teaching expenditure per student	1110	5498	4691	1177	20000
College quality index	914	-0.151	1.517	-3.031	4.864
College quality index (expenditure excluded)	2630	-0.848	1.333	-3.727	3.991

4.1.2 Correlation

It is necessary to check the correlation coefficients of the covariates in multivariate regressions to detect potential multicollinearity problems and refine the models. In this section, I examine the pairwise correlation coefficients between the covariates by Pearson's correlation coefficient matrixes for the "Intention-to-work" sample and the "Have-job-offer" sample.

According to results from the Pearson's correlation coefficient matrixes in Table 4-3 and Table 4-4, all covariate pairs yield correlation coefficients lower than |0.7|, which is regarded as an appropriate indicator for finding possible collinearity that might severely distort model estimations.

Further diagnosis is conducted with the Variance Inflation Factor (VIF) method after each regression is run to guarantee that no explanatory variable in the correlation tables has VIF higher than the threshold value of 10. Therefore, we should not be concerned about the multicollinearity problems. More specifically, the VIF test results demonstrate that high VIF values appear when several pairs of covariates are included simultaneously in the regression models. For instance, students' region of residence before college and the region of the college location are highly correlated, and it tends to generate a high VIF value when both variables are included in analysis models, so the students' region of residence variable has been deleted from the model. Similarly, fresh college graduates' initial job positions are related to their initial job industries and the initial job position variable itself lacks variation because most of the fresh graduates end up in junior positions when their career begins. Therefore, graduates' job position indicators are not included in subsequent model specifications.

The SES index is constructed to reduce the multidimensional family background information, and it includes information from highly correlated family background such as the annual household income, parental years of education, parental job industry and parental occupation. We use the SES index to replace the set of family background variables. As expected, the overall college quality indexes are correlated with input-based college quality indicators.

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted

	Elite	Faculty-student ratio	Proportion of Ph.D. faculty	Student selectivity	Expenditure per student	Quality index for 4 inputs	Quality index for 3 inputs
Elite	1						
Faculty-student ratio	-0.0185	1					
Proportion of Ph.D. faculty	0.5802**	0.1316**	1				
Student selectivity	0.6245**	-0.0430**	0.6964**	1			
Expenditure per student	0.4388**	-0.2371**	0.6495**	0.5134**	1		
Quality index 4	0.6372**	-0.2115**	0.9428**	0.9230**	0.8473**	1	
Quality index 3	0.6337**	-0.0191	0.9008**	0.9366**	0.6584**	0.9669**	1
Age	-0.0694**	-0.0416**	-0.1712**	-0.0718**	-0.0225	-0.0927**	-0.1266**
Female	-0.0502**	0.0383**	-0.1129**	-0.0125	-0.0625*	-0.0310	-0.0470**
Minority	0.0575**	-0.0888**	-0.0558**	-0.0268	0.0341	0.00480	-0.0515**
Rural	-0.0216	-0.00850	-0.0115	0.00310	0.1229**	0.0639*	0.00790
NCEE	0.3851**	-0.1543**	0.4171**	0.5017**	0.1496**	0.2986**	0.5135**
Humanities track	-0.0496**	0.1693**	-0.0916**	-0.0544**	-0.1402**	-0.1053**	-0.0735**
Arts and Athletics track	-0.0310*	0.0816**	-0.1257**	-0.0263	-0.0215	-0.0440	-0.0894**
Non-cognitive leadership skills	0.0330*	-0.0285	-0.0171	0.0430**	0.0589*	0.0664*	0.0177
Only child	0.0360*	-0.0573**	0.0146	-0.0234	0.0297	0.1047**	-0.0180
SES	0.0612**	-0.0440**	-0.00420	-0.0261	-0.0339	0.0559	-0.0389*
Annual household income	0.0594**	0.0192	0.1425**	0.0486**	-0.0465	0.0324	0.0953**
Major in liberal arts	-0.0571**	0.0787**	-0.1952**	-0.1192**	-0.0469	-0.0383	-0.1777**
Major in social sciences	-0.0450**	0.0258	0.0132	0.0398**	-0.0717**	0.0137	0.0595**
Major in	0.0410**	0.0552**	0.0408*	-0.000700	-0.0119	-0.0578*	0.0134

economics and management							
Major in other disciplines	0.0181	0.0528**	-0.0637**	0.00190	0.0218	0.0576*	-0.0356*
Average Academic score	-0.0175	0.0912**	-0.0978**	-0.0449**	-0.0658*	-0.0118	-0.0793**
Party member	0.0713**	0.0738**	0.0358*	0.1164**	0.0149	0.00140	0.0927**
Student leader	0.0176	0.0342*	0.0286	0.0600**	-0.0641**	-0.0784**	0.0565**
Pass CET4	-0.0475**	-0.0491**	-0.0496**	-0.0867**	-0.0179	-0.0666*	-0.0845**
Pass CET6	0.1685**	-0.0168	0.2329**	0.2753**	0.0225	0.1238**	0.3100**
Have certificate	-0.0284*	-0.0290*	-0.0605**	-0.0405**	0.00900	-0.00340	-0.0583**
Part-time work	-0.0240	0.0559**	-0.0369*	0.0275	0.0390	0.0157	0.00410
Have merit aid	0.00110	0.0215	-0.0433**	0.00720	-0.0176	0.0478	-0.0117
Have minor	0.0197	-0.0765**	0.0364*	0.0597**	-0.0473	-0.0570*	0.0627**
Like major	0.0130	-0.00150	-0.0747**	-0.0399**	-0.00110	0.0171	-0.0720**
Engineering college	-0.0568**	-0.3324**	0.0402*	-0.0417**	-0.0874**	-0.0766**	-0.0184
Normal college	-0.2451**	0.2273**	-0.5007**	-0.2981**	-0.00570	0.1107**	-0.4438**
Agriculture college	0.0681**	0.1860**	0.2140**	0.0569**	-0.0328	-0.0200	0.1326**
Finance college	-0.0153	-0.00880	-0.00880	-0.00760			-0.00840
Political science college	-0.0357*	-0.0376*	0.0628**	0.1369**	-0.1212**	-0.0160	0.1181**
Ethnic college	0.1223**	-0.0384**		0.0730**			
College in the Northeast	-0.1307**	-0.5236**	-0.3390**	-0.2795**	-0.00540	0.0275	-0.3166**
College in the Central	-0.0404**	0.2891**	0.2102**	-0.1817**	-0.3507**	-0.4630**	-0.0363*
College in the West	0.0895**	0.0688**	-0.3020**	0.1512**	0.5949**	0.3568**	-0.0804**

** $p < 0.01$, * $p < 0.05$

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted (Continued)

	Age	Female	Minority	Rural	NCEE	Humanities track	Arts and athletics track
Age	1						
Female	-0.0413**	1					
Minority	0.0169	-0.000100	1				
Rural	0.1579**	-0.0754**	-0.0557**	1			
NCEE	-0.0650**	-0.0331*	-0.0968**	0.1180**	1		
Humanities track	-0.00750	0.3744**	-0.0225	-0.0394**	0.0778**	1	
Arts and athletics track	0.0578**	0.0387**	0.00630	-0.0748**	-0.5436**	-0.1470**	1
Non-cognitive leadership skills	0.0201	0.0207	0.0246	-0.0507**	0.0142	0.0264	0.00930
Only child	-0.1375**	-0.0110	0.0761**	-0.4582**	-0.1155**	-0.0399**	0.0828**
SES	-0.1979**	0.0880**	0.0741**	-0.6564**	-0.1124**	0.0304	0.0671**
Annual household income	-0.1473**	0.0817**	0.0205	-0.3377**	-0.0385*	0.0823**	0.0139
Major in liberal arts	0.00650	0.3005**	0.00330	-0.0342*	0.0194	0.5073**	-0.0700**
Major in social sciences	0.00710	0.1330**	-0.0410**	0.0214	-0.0189	0.2152**	0.0876**
Major in economics and management	-0.0376**	0.1197**	0.00790	-0.0559**	0.0519**	0.2442**	-0.1003**

Major in other disciplines	0.0339*	0.0583**	0.0571**	-0.0482**	-0.3669**	-0.1063**	0.5957**
Average academic score	0.0354*	0.2915**	-0.0298	0.0108	-0.00660	0.1760**	0.0940**
Party member	0.0374**	0.1355**	-0.0481**	0.0371**	0.0608**	0.0664**	0.0401**
Student leader	0.00140	0.0619**	0.000700	-0.0729**	0.0247	0.0717**	-0.0109
Pass CET4	0.0278	-0.0820**	-0.00120	0.0111	-0.00120	-0.0790**	-0.0403**
Pass CET6	-0.0984**	0.2402**	-0.0745**	-0.0452**	0.3243**	0.1878**	-0.1486**
Have certificate	0.00210	0.0368**	-0.00280	0.00860	-0.0100	0.0116	-0.00140
Part-time work	0.0702**	0.1329**	-0.0392**	0.1148**	-0.0281	0.0776**	-0.00380
Have merit aid	0.00630	0.1959**	-0.0203	0.0536**	0.0273	0.0226	-0.0140
Have minor	0.0143	0.0434**	-0.00180	-0.0751**	0.0381*	0.0325*	0.0293*
Like major	0.0469**	0.0391**	0.0243	0.0163	-0.0947**	0.0202	0.1155**
Engineering college	-0.0201	-0.2917**	0.0322*	0.0513**	0.0803**	-0.2863**	-0.0749**
Normal college	0.0890**	0.2745**	-0.0746**	0.0857**	-0.2003**	0.3152**	0.0882**
Agriculture college	-0.0260	0.0779**	0.0129	-0.0635**	-0.0693**	-0.0299*	-0.0164
Finance college	-0.00160	-0.00660	0.00120	0.00450	-0.00200	0.0330*	-0.00910
Political science college	-0.0426**	0.00920	-0.00560	-0.0622**	0.0948**	0.0460**	-0.0212
Ethnic college	-0.00300	0.0202	0.1164**	-0.0100	0.0300*	0.0216	0.00820
College in the Northeast	0.1100**	0.0118	0.1471**	-0.0907**	-0.1278**	-0.0633**	0.0125
College in the Central	-0.0665**	-0.2375**	-0.0636**	0.0881**	0.0466**	-0.1065**	-0.0792**
College in the West	0.1085**	0.00570	-0.0346*	0.0743**	-0.0755**	-0.0001	0.1508**

** $p < 0.01$, * $p < 0.05$

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted (Continued)

	Non-cognitive leadership skills	Only child	SES	Annual household income	Major in liberal arts	Major in social sciences	Major in economics and management
Non-cognitive leadership skills	1						
Only child	0.0840**	1					
SES	0.0240	0.5091**	1				
Annual household income	0.0162	0.2531**	0.5391**	1			
Major in liberal arts	0.0343*	-0.0333*	-0.0107	-0.0242	1		
Major in social sciences	0.00460	-0.0469**	-0.0296	0.0300	-0.1142**	1	
Major in economics and management	0.0296*	0.0601**	0.0862**	0.1272**	-0.1806**	-0.1367**	1
Major in other disciplines	0.00200	0.0775**	0.0517**	0.00960	-0.0988**	-0.0748**	-0.1182**
Average academic score	0.1322**	-0.0308	-0.0428*	-0.0186	0.1604**	0.0263	0.0448**
Party member	0.1383**	-0.0500**	-0.0195	-0.00660	0.0429**	0.0503**	0.0234
Student leader	0.1512**	0.0640**	0.0627**	0.0431**	0.0575**	0.0246	0.0339*
Pass CET4	0.0246	0.0162	0.000600	-0.0138	-0.1002**	0.0205	-0.0310*
Pass CET6	-0.00260	-0.00660	0.0392*	0.0594**	0.1536**	0.0196	0.0852**
Have certificate	0.00170	0.00240	-0.0371*	-0.0423**	0.0226	-0.0171	0.0323*
Part-time work	0.0643**	-0.1632**	-0.1136**	-0.0369*	0.0663**	0.0422**	0.0242
Have merit aid	0.1016**	-0.0870**	-0.0491**	-0.0105	0.00730	-0.0287*	0.0183
Have minor	0.0484**	0.0693**	0.1001**	0.0508**	-0.00360	0.0747**	0.00640
Like major	0.0767**	0.0634**	0.0545**	0.0258	0.0555**	0.00400	0.0213
Engineering college	-0.00100	-0.0170	0.00630	-0.0594**	-0.1974**	-0.2196**	-0.0247
Normal college	-0.00990	-0.1177**	-0.1453**	-0.0903**	0.2696**	0.2594**	-0.0805**
Agriculture college	-0.0315*	0.1178**	0.0710**	0.0540**	-0.0733**	0.00460	0.0451**
Finance college	-0.00120	-0.000300	-0.00590	-0.00120	-0.0106	0.00880	0.0350*
Political science college	0.0373**	0.0737**	0.0791**	0.1187**	-0.0318*	0.2756**	-0.0381**

Ethnic college	0.00360	0.000600	0.0180	-0.00190	0.0258	-0.00410	0.00800
College in the Northeast	0.0464**	0.1662**	0.0884**	-0.0590**	0.0493**	-0.0411**	-0.0561**
College in the Central	-0.0308*	-0.0940**	-0.0622**	-0.0514**	-0.1231**	-0.1209**	0.0505**
College in the West	0.00330	-0.0911**	-0.0617**	-0.1183**	0.0207	0.00600	-0.0413**

** $p < 0.01$, * $p < 0.05$

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted (Continued)

	Major in other disciplines	Average academic score	Party member	Student leader	Pass CET4	Pass CET6	Have certificate
Major in other disciplines	1						
Average academic score	0.0821**	1					
Party member	0.00320	0.2354**	1				
Student leader	-0.0301*	0.1472**	0.2258**	1			
Pass CET4	-0.0554**	-0.0306	-0.0270	0.00350	1		
Pass CET6	-0.1061**	0.1827**	0.1010**	0.0546**	-0.6020**	1	
Have certificate	-0.00720	0.0451**	0.0253	0.0406**	0.0274	0.0491**	1
Part-time work	0.00900	0.0323*	0.0458**	0.0522**	-0.0517**	0.0329*	0.0204
Have merit aid	-0.0200	0.3647**	0.3165**	0.1616**	-0.00970	0.1244**	0.0415**
Have minor	-0.00770	0.0799**	0.0721**	0.0789**	0.000500	0.0565**	0.0258
Like major	0.0577**	0.2495**	0.0926**	0.0615**	-0.0418**	0.00160	0.0217
Engineering college	-0.0799**	-0.1467**	-0.0307*	-0.0511**	0.0832**	-0.0962*	0.0207
Normal college	0.0433**	0.1010**	0.0404**	0.00960	-0.0362*	-0.00160	0.0711**
Agriculture college	0.1267**	0.0349*	-0.00450	-0.0106	-0.00260	-0.0505**	-0.0823**
Finance college	-0.00890	-0.0135	0.00890	0.00260	0.00680	-0.0139	0.00760
Political science college	-0.0208	0.0327*	0.0693**	0.0234	-0.0498**	0.0985**	0.0136
Ethnic college	0.00830	0.0162	-0.00430	-0.0115	-0.00680	0.0123	0.00630
College in the Northeast	0.0185	0.0778**	-0.1386**	-0.0168	0.0826**	-0.1170**	0.0696**
College in the Central	-0.0797**	-0.0809**	0.00320	-0.0113	0.0504**	-0.0761**	-0.00870
College in the West	0.1077**	0.0321*	0.1827**	-0.0255	-0.0503**	-0.00160	0.0219

** $p < 0.01$, * $p < 0.05$

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted (Continued)

	Part-time work	Have merit aid	Have minor	Like major	Engineer -ing college	Normal college	Agricul- ture college
Part-time work	1						
Have merit aid	0.1233**	1					
Have minor	0.00290	0.0164	1				
Like major	-0.00650	0.0938**	0.0196	1			
Engineering college	-0.1470**	-0.0261	0.0153	-0.0260	1		
Normal college	0.1348**	0.0468**	-0.0405**	-0.0267	-0.5769**	1	
Agriculture college	-0.00920	-0.0151	-0.0293*	0.0234	-0.1813**	-0.1326**	1
Finance college	0.00560	0.00340	-0.000500	-0.00980	-0.0312*	-0.0228	-0.00720
Political science college	-0.0184	0.00220	0.0764**	0.0289*	-0.0727**	-0.0532**	-0.0167
Ethnic college	0.0113	-0.00610	-0.00970	0.00750	-0.0474**	-0.0346*	-0.0109
College in the Northeast	-0.1088**	0.0265	0.0422**	0.0841**	0.1759**	0.00810	0.0128
College in the Central	-0.0975**	-0.0552**	0.0109	-0.00700	0.5138**	-0.3672**	-0.1154**
College in the West	0.0560**	0.0508**	-0.0131	0.00530	-0.0523**	0.1463**	-0.0479**

** p < 0.01, * p < 0.05

Table 4-3 Pearson's Correlation Coefficients for the "Intention-to-work" Sample-Weighted (Continued)

	Finance college	Political science college	Ethnic college	College in the Northeast	College in the Central	College in the West	
Finance college	1						
Political science college	-0.00290	1					
Ethnic college	-0.00190	-0.00440	1				
College in the Northeast	-0.0148	-0.0344*	-0.0224	1			
College in the Central	-0.0198	-0.0463**	-0.0301*	-0.2379**	1		
College in the West	0.0694**	-0.0414**	-0.0270	-0.2127**	-0.2857**	1	

** p < 0.01, * p < 0.05

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted

	Elite	Faculty-student ratio	Proportion of Ph.D. faculty	Student selectivity	Expenditure per student	Quality index 4 inputs	Quality index 3 inputs
Elite	1						
Faculty-student ratio	0.00740	1					
Proportion of Ph.D. faculty	0.6055**	0.2104**	1				
Student selectivity	0.6508**	0.00240	0.6515**	1			
Expenditure per student	0.4074**	-0.2608**	0.6346**	0.5066**	1		
Quality index 4 inputs	0.6521**	-0.2109**	0.9447**	0.9343**	0.8421**	1	
Quality index 3 inputs	0.6666**	0.0495*	0.8868**	0.9256**	0.6471**	0.9686**	1
Age	-0.0748**	-0.0603**	-0.1458**	-0.0581**	-0.0367	-0.0911**	-0.1033**
Female	-0.0333*	0.0555**	-0.0927**	0.00480	-0.0549	-0.0161	-0.0249
Minority	0.0549**	-0.1092**	-0.0123	0.0194	0.0373	0.0143	0.00260
Rural	-0.0158	-0.0140	-0.0265	-0.0208	0.0976**	0.0331	-0.0175
NCEE	0.3982**	-0.1158**	0.4125**	0.5181**	0.0901**	0.2490**	0.5300**
Humanities track	-0.0345*	0.1751**	-0.0431*	-0.0406*	-0.1222**	-0.0801*	-0.0326
Arts and athletics track	-0.0229	0.0646**	-0.1101**	0.00680	0.0223	0.0259	-0.0666**
Non-cognitive leadership skills	0.0226	-0.0242	-0.0225	0.0426*	0.0371	0.0632	0.0189
Only child	0.0441**	-0.0714**	0.0351	0.0430*	0.0252	0.1030**	0.0337
SES	0.0524**	-0.0465*	0.000400	0.00130	-0.0294	0.0584	-0.0216
Annual household income	0.0590**	0.0357	0.1232**	0.0271	-0.0329	0.0645	0.0662**
Major in liberal arts	-0.0480**	0.0620**	-0.1278**	-0.0947**	-0.0233	0.00760	-0.1199**
Major in social sciences	-0.0450**	0.0457**	-0.0233	0.0246	-0.0552	0.0322	0.0264
Major in economics and management	0.0697**	0.0741**	0.0167	0.0188	-0.0347	-0.0672*	0.0095
Major in other disciplines	0.0199	0.0287	-0.0263	0.0343*	0.0231	0.0471	0.0021
Average academic score	0.0160	0.0830**	0.0202	0.0517**	-0.0667*	-0.00840	0.0465*
Party member	0.0579**	0.0968**	0.0216	0.0797**	-0.0109	-0.0450	0.0600**
Student leader	0.0311	0.0555**	0.0365	0.0800**	-0.0449	-0.0348	0.0762**
Pass CET4	-0.0499**	-0.0910**	-0.0433*	-0.0755**	-0.0104	-0.0735*	-0.0681**
Pass CET6	0.1814**	0.0419*	0.2304**	0.2777**	0.0115	0.1362**	0.3093**
Have certificate	-0.0263	-0.0461**	-0.0540**	-0.0174	-0.0088	-0.0007	-0.0345
Part-time work	-0.0301	0.0690**	-0.0268	0.0153	0.0484	0.0458	0.0049

Have merit aid	-0.0156	0.0410*	-0.0200	0.0001	-0.0428	0.0267	0.0006
Have minor	0.0284	-0.0705**	0.0258	0.0820**	-0.0738*	-0.0954**	0.0723**
Like major	0.00600	-0.0141	-0.0500*	-0.0325	0.0259	0.0341	-0.0570**
Engineering college	-0.1020**	-0.3396**	-0.0714**	-0.1096**	-0.1658**	-0.1824**	-0.1241**
Normal college	-0.2259**	0.2531**	-0.3953**	-0.2348**	-0.0234	0.0918**	-0.3318**
Agriculture college	0.0678**	0.1750**	0.1890**	0.0427*	-0.0558	-0.0412	0.1117**
Finance college	-0.00900	-0.00320	-0.00680	-0.00630			-0.0074
Political science college	-0.0350*	-0.0279	0.0537**	0.1258**	-0.1209**	-0.0273	0.1076**
Ethnic college	0.1162**	-0.0332		0.0715**			
Work migration	0.0959**	-0.1218**	0.0301	0.0364*	0.2001**	0.1298**	0.0267
Foreign sector	-0.00760	-0.0268	0.0292	0.00150	0.0229	-0.00190	0.0156
Private sector	-0.0806**	0.0580**	-0.0352	-0.0809**	-0.0794**	-0.0818*	-0.0548**

** $p < 0.01$, * $p < 0.05$

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted (Continued)

	Age	Female	Minority	Rural	NCEE	Humanities track	Arts and athletics track
Age	1						
female	-0.0557**	1					
Minority	0.00490	-0.0206	1				
Rural	0.1847**	-0.1164**	-0.0385*	1			
NCEE	-0.0556**	-0.0127	-0.0697**	0.1038**	1		
Humanities track	0.0102	0.4165**	-0.0445**	-0.0826**	0.0906**	1	
Arts and athletics track	0.0529**	0.0366*	-0.0125	-0.0740**	-0.5341**	-0.1204**	1
Non-cognitive leadership skills	0.00300	0.0178	0.0163	-0.0684**	0.0182	0.0251	0.0164
Only child	-0.1509**	0.0159	0.0420*	-0.4426**	-0.1002**	-0.0169	0.0733**
SES	-0.2089**	0.1024**	0.0560**	-0.6680**	-0.0965**	0.0548**	0.0923**
Annual household income	-0.1561**	0.1036**	-0.00830	-0.4103**	-0.0557**	0.0881**	0.0566**
Major in liberal arts	0.0390*	0.3267**	-0.0320	-0.0113	0.0352*	0.5370**	-0.0542**
Major in social sciences	-0.00600	0.1200**	-0.0320	-0.0266	-0.0642**	0.1985**	0.1412**
Major in economics and management	-0.0355*	0.1629**	-0.0122	-0.0748**	0.0730**	0.3040**	-0.0943**
Major in other disciplines	0.0229	0.0549**	0.0817**	-0.0425*	-0.3483**	-0.0971**	0.5689**
Average academic score	0.00180	0.2676**	-0.0667**	0.0380*	0.0558**	0.1319**	0.0521**
Party member	0.0536**	0.1465**	-0.0434*	0.0297	0.0333	0.0860**	0.0364*
Student leader	0.0264	0.0499**	0.00360	-0.0620**	0.0511**	0.0619**	-0.0170
Pass CET4	0.0298	-0.1022**	0.0217	0.0220	0.00770	-0.0580**	-0.0764**
Pass CET6	-0.1117**	0.2574**	-0.0779**	-0.0629**	0.3094**	0.1999**	-0.1253**
Have certificate	0.0221	0.0169	0.0178	0.0252	0.00980	0.0257	-0.0285
Part-time work	0.0581**	0.1511**	-0.0525**	0.1166**	-0.0462**	0.0953**	0.0378*
Have merit aid	-0.0130	0.1940**	-0.0311	0.0549**	0.0161	0.0374*	0.00190
Have minor	0.0105	0.0379*	-0.00750	-0.0821**	0.0362*	0.0464**	0.0486**
Like major	0.0316	0.00360	0.0126	0.0182	-0.0633**	-0.00990	0.1111**
Engineering college	0.00100	-0.3043**	0.0583**	0.0453**	0.0228	-0.2806**	-0.0639**
Normal college	0.0608**	0.2875**	-0.0863**	0.0550**	-0.1908**	0.3144**	0.0814**

Engineering college	-0.0211	0.1003**	0.0262	-0.0708**	-0.0782**	-0.0409*	0.00410
Finance college	0.00860	0.0001	0.00960	0.00830	-0.00600	0.0240	-0.00450
Political science college	-0.0403*	0.0333*	0.000100	-0.0715*	0.0836**	0.0456**	-0.0177
Ethnic college	-0.000100	0.0238	0.1015**	-0.00980	0.0191	0.0144	0.0236
Work migration	0.0446*	-0.2255**	0.0179	0.0733**	0.0709**	-0.1720**	-0.0477**
Foreign sector	0.0493**	0.0244	0.00960	0.0192	0.0342	-0.0118	-0.0423*
Private sector	0.0164	0.1020**	-0.0180	0.0796**	-0.0585**	0.0874**	0.0177

** p < 0.01, * p < 0.05

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted (Continued)

	Non-cognitive leadership skills	Only child	SES	Annual household income	Major in liberal arts	Major in social sciences	Major in economics and management
Non-cognitive leadership skills	1						
Only child	0.1059**	1					
SES	0.0555**	0.5167**	1				
Annual household income	0.0229	0.2895**	0.5603**	1			
Major in liberal arts	0.0112	-0.0309	-0.0157	-0.00390	1		
Major in social sciences	0.00610	-0.0282	0.00710	0.0660**	-0.0902**	1	
Major in economics and management	0.0408*	0.0398*	0.0946**	0.1285**	-0.1639**	-0.1130**	1
Major in other disciplines	0.00340	0.0576**	0.0690**	0.0465*	-0.0835**	-0.0576**	-0.1046**
Average academic score	0.1165**	-0.0977**	-0.0749**	-0.0192	0.0593**	0.0627**	0.0762**
Party member	0.1427**	-0.0498**	-0.0454*	-0.0277	0.0767**	0.0591**	0.0477**
Student leader	0.1417**	0.0827**	0.0525**	0.0419*	0.0298	0.0179	0.0584**
Pass CET4	-0.00390	0.0102	-0.00840	0.00530	-0.0933**	-0.0190	-0.00450
Pass CET6	0.0133	0.00850	0.0543**	0.0500**	0.1512**	0.0526**	0.0942**
Have certificate	-0.00980	0.00220	-0.0720**	-0.0615**	0.0611**	-0.0368*	0.0139
Part-time work	0.0716**	-0.1436**	-0.1508**	-0.0484**	0.0648**	0.0633**	0.0342*
Have merit aid	0.0643**	-0.0968**	-0.0841**	-0.0104	-0.0398*	-0.00600	0.0504**
Have minor	0.0410*	0.0850**	0.1047**	0.0913**	0.00210	0.0844**	0.0154
Like major	0.0695**	0.0371*	0.0405*	-0.00600	0.0191	0.0217	0.0390*
Engineering college	-0.0229	0.00240	0.0268	-0.0716**	-0.1781**	-0.2009**	-0.0788**
Normal college	0.0151	-0.1288**	-0.1311**	-0.0414*	0.2661**	0.2702**	-0.0348*
Agriculture college	-0.0368*	0.1076**	0.0725**	0.0411*	-0.0642**	-0.0253	0.0389*
Finance college	0.000400	-0.000800	-0.00140	-0.00480	-0.00710	0.00700	0.0134
Political science college	0.0294	0.0806**	0.0869**	0.1193**	-0.0275	0.2998**	-0.0345*
Ethnic college	0.0119	0.00210	0.0229	0.00390	0.0102	0.000100	0.00920
Work migration	0.0391*	-0.0498**	-0.0429*	-0.0746**	-0.0652**	-0.1316**	-0.0931**
Foreign sector	0.000800	0.00250	-0.0177	0.0224	0.00270	-0.0684**	0.00830
Private sector	-0.0536**	-0.0890**	-0.1109**	-0.0511**	0.0911**	0.00740	0.0451**

** p < 0.01, * p < 0.05

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted

(Continued)

	Major in other disciplines	Average academic score	Party member	Student leader	Pass CET4	Pass CET6	Have certificate
Major in other disciplines	1						
Average academic score	0.0700**	1					
Party member	-0.00660	0.2309**	1				
Student leader	-0.0198	0.1291**	0.2142**	1			
Pass CET4	-0.0880**	-0.0634**	-0.0542**	-0.0259	1		
Pass CET6	-0.1011**	0.2340**	0.1213**	0.0565**	-0.6217**	1	
Have certificate	-0.0579**	0.0278	0.0579**	0.0167	0.00220	0.0467**	1
Part-time work	0.0588**	0.0782**	0.0404*	0.0343*	-0.0299	0.0283	0.0100
Have merit aid	0.000600	0.3876**	0.2851**	0.1377**	-0.0509**	0.1575**	0.0486**
Have minor	0.0191	0.0813**	0.0644**	0.0774**	0.00220	0.0576**	0.00400
Like major	0.0390*	0.1942**	0.0858**	0.0708**	-0.0411*	0.00450	0.0129
Engineering college	-0.0719**	-0.1019**	-0.0423*	-0.0503**	0.0963**	-0.1198**	0.0203
Normal college	0.0125	0.00200	0.0621**	0.0106	-0.0504**	0.0103	0.0644**
Agriculture college	0.1810**	0.0569**	0.0194	0.000700	-0.0207	-0.0449**	-0.0834**
Finance college	-0.00450	-0.00990	0.0001	-0.00290	-0.00170	-0.0130	-0.00690
Political science college	-0.0176	0.0321	0.0535**	0.0192	-0.0521**	0.0947**	0.0124
Ethnic college	0.0235	0.0206	-0.00940	-0.00750	-0.000200	0.00260	0.00420
Work migration	-0.0680**	0.00360	0.0400*	0.00280	0.0549**	-0.00450	0.0546**
Foreign sector	0.0243	0.0122	-0.0180	-0.0164	-0.0108	0.0113	0.00540
Private sector	0.0256	-0.0307	-0.0302	-0.0812**	-0.0679**	0.0258	-0.0031

** p < 0.01, * p < 0.05

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted (Continued)

	Part-time work	Have merit aid	Have minor	Like major	Engineering college	Normal college	Agriculture college
Part-time work	1						
Have merit aid	0.1117**	1					
Have minor	0.0129	0.0213	1				
Like major	-0.0396*	0.0902**	0.0320	1			
Engineering college	-0.1650**	-0.0342*	-0.0134	0.00720	1		
Normal college	0.1679**	0.0474**	-0.0246	-0.0597**	-0.5760**	1	
Agriculture college	-0.00340	0.00670	-0.0295	0.0254	-0.1911**	-0.1088**	1
Finance college	0.000200	0.00420	-0.00520	0.00160	-0.0197	-0.0112	-0.00370
Political science college	-0.0161	-0.00650	0.0799**	0.0177	-0.0765**	-0.0436**	-0.0145
Ethnic college	0.00440	-0.00720	-0.00760	0.00380	-0.0538**	-0.0306	-0.0102
Work migration	-0.1069**	0.0214	-0.0285	0.00180	0.3951**	-0.2595**	-0.0870**
Foreign sector	0.0219	-0.00460	-0.00640	-0.00100	0.0227	-0.0197	0.0318
Private sector	0.0774**	-0.0220	-0.0965**	-0.0579**	-0.0985**	0.1452**	-0.0200

** p < 0.01, * p < 0.05

Table 4-4 Pearson's Correlation Coefficients for the "Have-job-offer" Sample-Weighted

(Continued)

	Finance college	Political science college	Ethnic college	Work migration	Foreign sector	Private sector	
Finance college	1						
Political science college	-0.00150	1					
Ethnic college	-0.00100	-0.00410	1				
Work migration	-0.0104	-0.0339	-0.0265	1			
Foreign sector	-0.00700	0.00530	0.000700	0.0113	1		
Private sector	0.00540	-0.0147	-0.00250	-0.1214**	-0.3139**	1	

** $p < 0.01$, * $p < 0.05$

4.2 Employment Status and Starting Salary

Focusing on fresh college graduates who want to find jobs after graduation, the employment rates vary by college quality categories. More specifically, the employment rate for students enrolled in elite colleges is about 72%, and it is around 65% for non-elite college students. These numbers are relatively lower for surveyed students who took the survey right before college graduation compared with the official reported employment rates of over 90%, which were typically reported 6 months later after students' graduation. When split into four detailed college quality categories, the data reveal an unsurprising employment rate that has decreased as college quality becomes lower. It is worth noting that nearly half of graduates of independent colleges have not successfully obtained any job offer. The Project 211 college students only have minor advantages in terms of finding jobs than students from non-key colleges.

Table 4-5 Employment Rates of Students by College Quality Categories in the "Intention-to-work" Sample

Have job offer	College Quality Categories			
	Elite college (0.72)		Non-elite college (0.65)	
	Project 985 colleges	Project 211 colleges	Non-key colleges	Independent college
Yes	0.76	0.71	0.67	0.53
No	0.24	0.29	0.33	0.47
Total	1	1	1	1

Figure 4-1 and Figure 4-2 below present the histogram and distribution density plots of the starting monthly salary by college elite/non-elite groups with the blocks as the normal density and the lines as the kernel density estimates. To distinguish the earning ability by elite college groups, the red color is used for earnings of non-elite college students, whereas the wages for elite college students appear in blue. In both graphs, we can see a clear trend that the earning density with high frequency for non-elite college students is to the left of the highly concentrated earning area of elite college students. In other words, we have an impression that in general, elite college students outperform non-elite college students in terms of starting wages. From the kernel density plot, we find two earning peaks for students in both college quality categories. This pattern suggests that many fresh college graduates are offered with threshold starting wage levels corresponding to 2000, 2500 and 3000 RMB per month before the natural log transformation. Elite college students are more likely to be offered the higher threshold level of 3000 RMB as their starting wage level than are non-elite college students. Even after outliers are removed, the wage variable is highly skewed. Thus, the wage variable has been transformed by taking the natural logarithm form to make its distribution normalized and the interpretation easier in the following regression analyses.

Figure 4-1 Histogram Plot of Starting Monthly Salary for Students in Elite and Non-elite Colleges

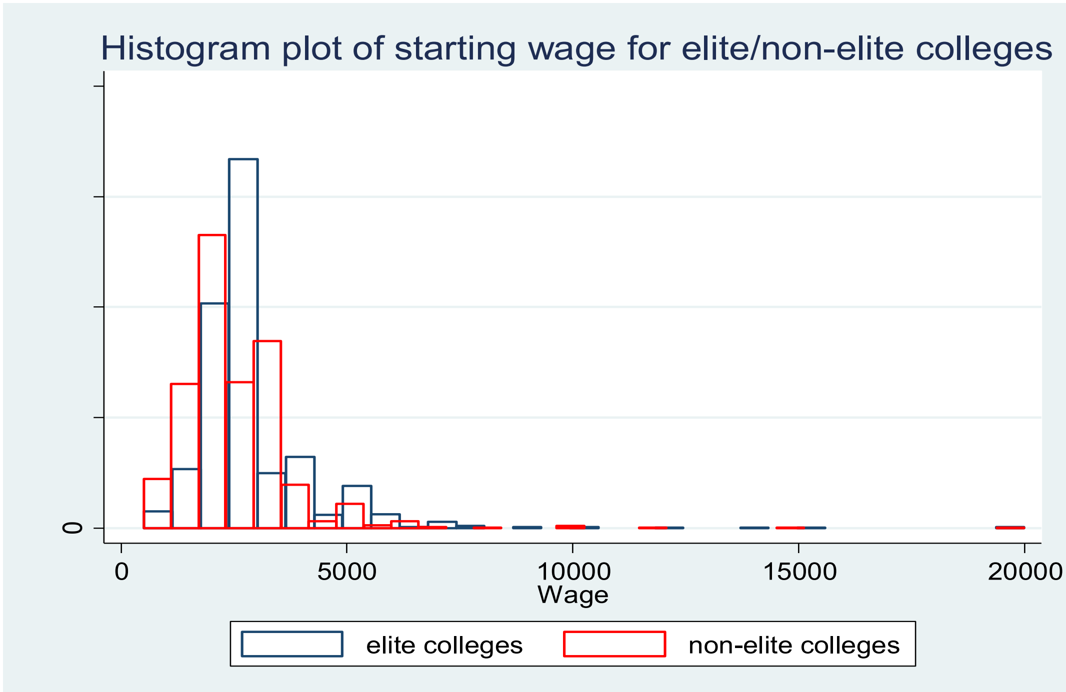
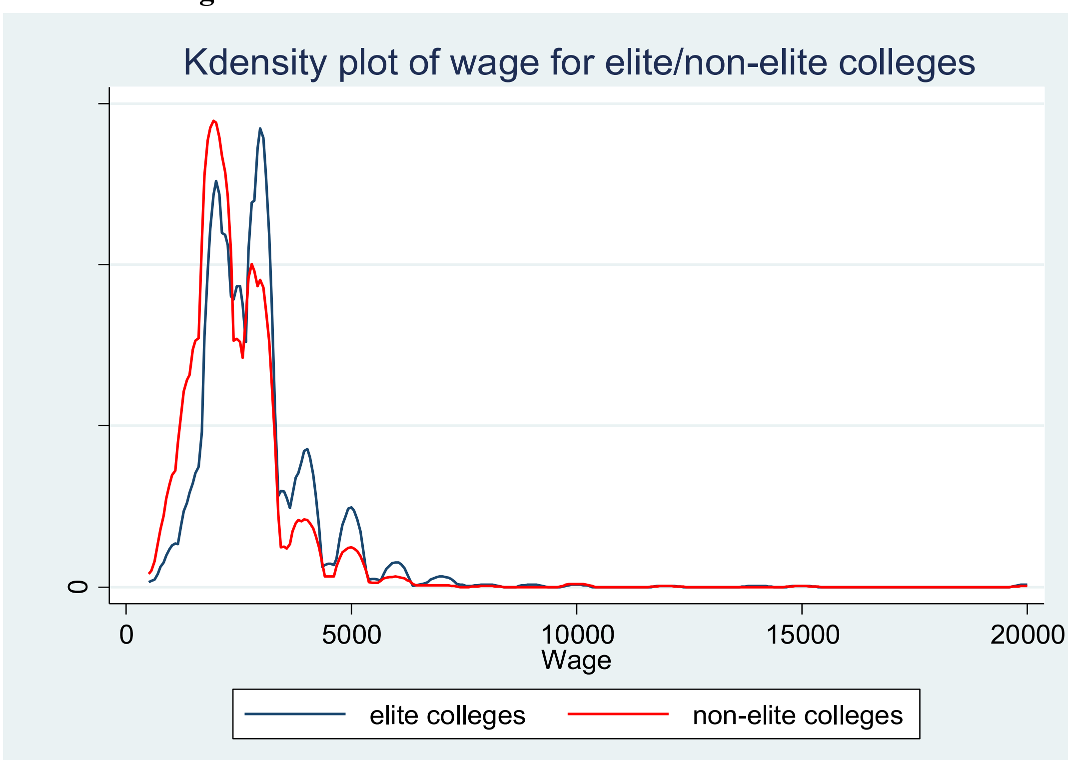


Figure 4-2 Kernel Density Plot of Starting Monthly Salary for Students in Elite and Non-elite Colleges



4.3 College Quality

Table 4-6 presents average levels of four input-based resource indicators for each college quality category. With the exception of the faculty-student ratio, there is a clear declining trend for input indicators from top quality to bottom quality categories. Higher quality colleges are equipped with teaching faculties with higher qualifications, more capable students and can afford more teaching expenses for students. Unexpectedly, faculty availability does not follow this trend. The faculty members seem to be more abundant in independent colleges. It may be due to the small scale of many newly established independent colleges and their nature as teaching colleges.

Table 4-6 College Inputs for Each Quality Category

Input-based college quality indicators	College quality categories			
	Elite colleges		Non-elite colleges	
	Project 985 colleges	Project 211 colleges	Non-key colleges	Independent colleges
Faculty-student ratio	0.059	0.055	0.057	0.061
Proportion of doctorate faculty members	0.615	0.510	0.334	0.230
Average freshman NCEE score	76.821	73.665	68.583	57.906
Teaching expenditure per student	9773.74	4623.10	2374.52	N/A

Table 4-7 displays group means and differences in means from t-test results conditional on elite college attendance for the “Have-job-offer” sample. After weighted by the sampling weight, the group means and group differences are compared for the representative sample of the population. The simple t-test reveals that the average wages offered to students in elite colleges is 32% higher than students in non-elite colleges (2960.16 versus 2250.42). The difference is significant at the 1% significance level.

It is essential to examine whether the student profiles differ by elite college attendance.

Simple T-test results from Table 4-7 demonstrate that students' individual characteristics and family backgrounds in elite colleges differ from those of students in non-elite colleges. For example, female students encounter difficulties in gaining access to elite colleges, whereas minority students may have minor advantages in terms of elite college entrance. Being the only child in the family might allow for easier access to into elite colleges. Student selectivity as measured by the overall national college entrance examination score is significantly higher for elite college students, reflecting the higher admission score line set by elite colleges in China.

In terms of college experiences, elite college students are less likely to choose liberal arts majors and less likely to gain part-time working experience. However, they have accumulated more leadership experience in student organizations and are more likely to have become members in the Chinese Communist Party (CPC) while in college. They also perform better on College English Test (CET) in terms of the CET-4 passing rate and in achieving higher a higher English proficiency level as demonstrated in CET-6. After graduation, elite college students appear to be more likely to migrate across provinces.

Elite colleges have more favorable school environments and conditions as shown in T-test comparisons on concrete college input indicators. Elite college students have more interactions and greater attention from faculty members. They are surrounded by higher quality peers, faculty members with higher educational attainments, and supported by substantially higher investments as reflected by the per-capita expenditure measure.

Table 4-7 Group Means and Mean Differences in Elite and Non-elite College Groups for the "Have-job-offer" Sample-Weighted

Variables	Non-elite Mean	Elite Mean	Mean Differences
Wage	2250.42	2960.16	709.74***
Age	23.066	22.869	-0.197***
Female	0.438	0.391	-0.047***
Minority	0.046	0.076	0.031***
Rural	0.507	0.486	-0.021
NCEE	69.208	76.906	7.698***
Science track	0.727	0.777	0.050***
Humanities track	0.220	0.183	-0.037**
Arts and athletics track	0.053	0.040	-0.013
Only child	0.297	0.350	0.053***
SES	-0.333	-0.208	0.126***
Major in liberal arts	0.123	0.082	-0.041***
Major in social sciences	0.063	0.036	-0.027***
Major in STEM	0.606	0.595	-0.012
Major in economics & management	0.158	0.227	0.069***
Major in other disciplines	0.049	0.060	0.011
Average academic score in college	78.161	78.413	0.251
CPC party member	0.273	0.342	0.069***
Student organization leader	0.198	0.231	0.033*
Have certificate	0.467	0.433	-0.034
Does not pass CET4&6	0.253	0.100	-0.153***
Pass CET4	0.484	0.419	-0.065***
Pass CET6	0.263	0.481	0.218***
Part-time work	0.871	0.844	-0.027*
Have merit aid	0.332	0.313	-0.019
Have need-based aid	0.224	0.283	0.059***
Have loan	0.338	0.280	-0.059***
Have minor	0.062	0.081	0.018*
Like major	2.648	2.660	0.012
Inter-provincial work migration	0.412	0.534	0.123***
Public sector	0.385	0.520	0.135***
Foreign sector	0.124	0.114	-0.010
Private sector	0.491	0.366	-0.125***
Faculty-student ratio	0.0565	0.0566	0.0001***
Proportion of Ph.D. faculty members	0.300	0.541	0.241***
Average freshman NCEE score	66.147	74.843	8.696***
Teaching expenditure per student	2337.719	6652.876	4315.158***

*** $p < 0.01$, ** $p < 0.05$, *$p < 0.10$

Chapter 5 Empirical Results

In this chapter, empirical findings for the effect of college quality will be discussed in the order that the research questions are proposed. In each section, the empirical results are organized and presented by the methodology and identification strategies to achieve these results. In Section 5.1, the first research question concerning the effect of attending high-quality colleges on initial employment status will be examined with the baseline probit model and the IV estimation. In section 5.2, the principal research question on the average effect of college quality on starting salary will be answered by three identification strategies, namely, the OLS regression, the IV estimation, and the PSM approach. The heterogeneous effect of college quality across different individuals is explored in section 5.3, and the effect variability by earning distribution is examined in section 5.4. Section 5.5 seeks to overcome the shortcomings of previous Chinese studies by using input-based college quality measures. Statistical significance is assessed at the 5% level and 1% level unless stated otherwise, and robust standard errors are reported in parentheses. For categorical variables, comparisons are always made by contrasting with the reference group. At the student level, students who take NCEE exams in the science track are in the reference group. For major field of study in college, the science, technology, engineering and mathematics (STEM) major group is set as the reference group. For English proficiency levels, students who do not pass College English Test level-4 (CET 4) form the reference group. For college characteristics, comprehensive universities are compared with colleges of other concentrated disciplines. Colleges in municipal cities constitute the reference group for regional location of colleges. In the labor market, the employer in the public sector is the reference group for employers in both the foreign and private sectors. For brevity, the coefficients of categorical variables that have more than 10 categories are not shown in the results table, such as job industry (18 categories) and workplace province (31 categories).

5.1 The Effect of College Quality on Initial Employment Status

In this section, we examine the effect of college quality with weighted probit models, as the outcome of interest here is the binary employment status. Focus will be concentrated on the coefficients of quality categorical dummies. Other determinants of the probability of successfully obtaining at least one job offer before graduation are also reported and discussed. Section 5.1.1 and 5.1.2 will present the estimation results from the sample weighted probit model and the IV-probit model, respectively.

5.1.1 The Baseline Probit Model

In Table 5-1, the results from estimating the baseline probit model are reported. The dichotomous categorical measure of college quality (elite/non-elite) is used in the estimation equation. Student demographic characteristics, family background, student ability, college experiences, institutional characteristics and labor market behaviors are the covariates. The sampling weight is used to address the oversampling of elite colleges in the stratified randomized sampling process.

In column 1 of the result table 5-1, we report a regression that does not control for student ability and college experiences. Model 2 in column 2 adds student cognitive ability and non-cognitive leadership skill controls. Model 3 additionally controls for a set of college experience variables, and model 3 is our full model or preferred model, which also contains rich sets of covariates including student demographics, student ability, family background, college experiences, institutional characteristics and student labor market behaviors. Model specification in model 4 is the same as model 3, but we extend the sample restriction from those who have the intention to work (Number of observations = 4984) to the whole sample (Number of observations = 6977) for robustness check purposes.

The coefficient for elite college participation dummy is positive but not statistically significant for the preferred model in column 3 in the "Intention-to-work" sample. As such, no definite conclusion can be drawn when splitting colleges into two broad quality categories. This dichotomous grouping might be too general and obscures the effect differentials across different types of colleges. For a more informative analysis, the regression models are rerun after the measures of college quality are changed to four categories (Project 985 colleges, Project 211 colleges, non-key colleges and independent colleges).

Results from our preferred model in column 3 are reported as the marginal effect calculated at the mean values of all regressors. Table 5-1 shows that family background matters when job seeking. Being an only child in a family would lower the probability to be employed by 5.9% compared with students who have siblings. Students with higher ability, both cognitive and non-cognitive, are more likely to be employed. Some college experiences affect job placements. Students who major in social sciences are at a disadvantage compared with STEM students. Student academic performance is not positively associated with a higher probability of employment, but having part-time work experience during college enhances the probability of finding a job after graduation by 10.9%, which is a huge contrast compared with these students' inexperienced counterparts. Students who report liking their major fields of study are more likely to be employed. One additional copy of a resume submitted is associated with 0.1% probability increase of employment. This means that students who spend higher amounts of job search cost and make more endeavors in job seeking are paid off in the early labor market. Institutional subject specialization and regions are also significant determinants of initial employment status.

The regression results are sensitive to the inclusion of covariates and sample selection.

Omitting covariates that influence job-seeking success would induce large biases and worsen the goodness of fit of the model as suggested in the results in Table 5-1. To separate the effect of student ability and that of college quality, model 2 incorporates the student ability controls and the significant coefficient on the elite college dummy becomes insignificant and of lesser magnitude. The Pseudo R^2 improves remarkably from model 2 to model 3. A comparison of model 3 and model 4 suggests that we should impose the sample restriction to students who intend to work. Otherwise, the effect of elite college attendance on obtaining job offers becomes negative, which might merely reflect that a larger proportion of students in elite colleges would go on to attend graduate school after obtaining bachelor's degrees.

Table 5-1 The Effect of College Quality on Initial Employment Status Elite vs. Non-elite Colleges

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Elite	0.048**	0.006	0.016	-0.017
	(0.020)	(0.023)	(0.024)	(0.023)
Age	0.006	0.006	-0.001	-0.007
	(0.012)	(0.012)	(0.012)	(0.013)
Female	-0.026	-0.019	-0.048*	-0.018
	(0.023)	(0.024)	(0.027)	(0.027)
Minority	-0.045	-0.034	-0.033	-0.031
	(0.042)	(0.041)	(0.045)	(0.045)
Rural	0.027	0.023	0.010	0.030
	(0.030)	(0.031)	(0.032)	(0.033)
Only child	-0.087***	-0.089***	-0.059**	-0.023
	(0.028)	(0.028)	(0.029)	(0.027)
SES	-0.025	-0.019	-0.017	-0.042***
	(0.017)	(0.017)	(0.017)	(0.016)
NCEE		0.005***	0.005***	0.003
		(0.002)	(0.002)	(0.002)
Humanities track		-0.059*	0.001	0.013
		(0.032)	(0.041)	(0.041)
Arts and athletics track		-0.034	0.047	0.087
		(0.049)	(0.054)	(0.061)
Non-cognitive leadership skills		0.069***	0.058**	0.045*
		(0.022)	(0.023)	(0.024)
Major in liberal arts			-0.035	0.013
			(0.054)	(0.052)

Major in social sciences			-0.179***	-0.160***
			(0.067)	(0.062)
Major in economics and management			-0.073*	-0.011
			(0.039)	(0.037)
Major in other disciplines			-0.097*	-0.105**
			(0.053)	(0.049)
Average academic score			-0.005**	-0.010***
			(0.002)	(0.002)
Party member			0.038	-0.019
			(0.027)	(0.028)
Student leader			-0.003	0.005
			(0.030)	(0.030)
Have certificate			0.032	0.011
			(0.023)	(0.024)
Pass CET4			0.057*	0.018
			(0.030)	(0.033)
Pass CET6			0.053	-0.044
			(0.035)	(0.038)
Part-time work			0.109***	0.104***
			(0.032)	(0.028)
Have merit aid			0.019	-0.010
			(0.028)	(0.028)
Have need-based aid			0.050	0.027
			(0.031)	(0.035)
Have loan			0.055*	0.030
			(0.028)	(0.031)
Have minor			0.049	0.091**
			(0.042)	(0.038)
Like major			0.039***	0.032**
			(0.015)	(0.015)
Number of resumes submitted			0.001***	0.002***
			(0.001)	(0.001)
Engineering college	0.179***	0.158***	0.161***	0.184***
	(0.027)	(0.027)	(0.029)	(0.033)
Normal college	-0.108***	-0.088**	-0.045	-0.087**
	(0.037)	(0.036)	(0.038)	(0.041)
Agriculture college	-0.022	-0.015	0.080*	0.118**
	(0.045)	(0.045)	(0.042)	(0.046)
Finance college	-0.485***	-0.477***	-0.393***	-0.358***
	(0.071)	(0.074)	(0.095)	(0.068)
Political science college	0.004	-0.063	0.044	0.187**
	(0.058)	(0.066)	(0.079)	(0.075)
Ethnic college	0.009	0.016	-0.042	0.004
	(0.076)	(0.075)	(0.088)	(0.070)
College in the East	0.022	0.004	0.002	0.087**

	(0.038)	(0.039)	(0.041)	(0.041)
College in the Northeast	-0.111***	-0.117***	-0.117***	-0.063*
	(0.037)	(0.037)	(0.042)	(0.038)
College in the Central	-0.121***	-0.107***	-0.106***	-0.105***
	(0.037)	(0.037)	(0.040)	(0.040)
College in the West	0.034	0.035	-0.016	0.038
	(0.033)	(0.033)	(0.037)	(0.036)
N	4984	4984	4984	6977
Pseudo R^2	0.059	0.072	0.196	0.261

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5-2 presents the results for four categories of college quality, with non-key colleges as the reference group. It shows that on average, students graduating from project 985 colleges have a significant marginal probability of 9.2% higher than non-key college students of finding employment. However, no distinguishable differences are found for students in other college quality categories. Although the magnitudes of coefficients on covariates change when we alter the measurement of college quality from two categories to four categories, the effect sign and general inferences remain unchanged for covariates. If we use the independent college as the reference group, we find similar results that students in Project 985 colleges have significant higher employment probability than students in independent colleges but no assertions can be made for differences among students in Project 211 colleges, non-key colleges and independent colleges.

Contrary to previous Chinese literature that identified the determinants of initial employment status mostly with logit regressions, this study employs the probit model with notably higher pseudo R^2 of about 0.2 in the preferred specification. This study contains a rich set of covariates including student ability and labor market behavior controls that had been mostly overlooked in previous works. Without these covariates, previous studies tended to find a statistically significant effect of elite college attendance (Du & Yue, 2010; Yue & Yang, 2012), whereas it is not evident in this study when the elite dummy is used to measure college quality. However, previous studies did not use the four-fold college quality measure. When the four-fold college quality measure is used in this study, the source of differential employment probability due to college quality is pinned down to the difference between students in Project 985 colleges and students in non-key colleges. This study has not been able to achieve full consensus with previous findings on key determinants of initial employment status. For example, this study is unable to confirm some significant determinants of initial employment status such as family socio-economic factors and the possession of technical certificate or being a student union leader, but this study finds some previously non-significant or neglected factors to be significant determinants such as being an only child and student's attitude about his or her major. This study has used a much richer set of covariates than previous studies, which may partly explain the difference in some findings.

Table 5-2 The Effect of College Quality on Initial Employment Status for Four College Quality Categories

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Project 985 college	0.099***	0.057	0.092**	-0.008
	(0.033)	(0.039)	(0.037)	(0.037)
Project 211 college	0.014	-0.006	-0.006	-0.019
	(0.020)	(0.023)	(0.024)	(0.023)
Independent college	-0.154***	-0.120**	-0.081	-0.014
	(0.048)	(0.049)	(0.052)	(0.055)
Age	0.006	0.006	-0.001	-0.007
	(0.012)	(0.012)	(0.012)	(0.013)
Female	-0.034	-0.025	-0.052*	-0.018
	(0.024)	(0.024)	(0.027)	(0.028)
Minority	-0.042	-0.039	-0.036	-0.031
	(0.042)	(0.042)	(0.044)	(0.044)
Rural	0.020	0.019	0.006	0.030
	(0.030)	(0.031)	(0.032)	(0.033)
Only child	-0.083***	-0.087***	-0.059**	-0.023
	(0.028)	(0.028)	(0.029)	(0.027)
SES	-0.025	-0.019	-0.017	-0.042***
	(0.017)	(0.017)	(0.017)	(0.016)
NCEE		0.003	0.004*	0.003
		(0.002)	(0.002)	(0.002)

Humanities track		-0.055*	0.003	0.013
		(0.032)	(0.041)	(0.041)
Arts and athletics track		-0.056	0.036	0.085
		(0.050)	(0.055)	(0.061)
Non-cognitive leadership skills		0.067***	0.056**	0.045*
		(0.022)	(0.023)	(0.023)
Major in liberal arts			-0.031	0.014
			(0.054)	(0.051)
Major in social sciences			-0.184***	-0.160***
			(0.067)	(0.062)
Major in economics and management			-0.072*	-0.011
			(0.038)	(0.037)
Major in other disciplines			-0.099*	-0.106**
			(0.054)	(0.049)
Average academic score			-0.005**	-0.010***
			(0.002)	(0.002)
Party member			0.036	-0.020
			(0.027)	(0.028)
Student leader			-0.004	0.004
			(0.030)	(0.030)
Have certificate			0.035	0.012
			(0.023)	(0.024)
Pass CET4			0.058*	0.018
			(0.030)	(0.033)
Pass CET6			0.052	-0.045
			(0.036)	(0.038)
Part-time work			0.107***	0.103***
			(0.032)	(0.028)
Have merit aid			0.020	-0.010
			(0.028)	(0.028)
Have need-based aid			0.049	0.027
			(0.031)	(0.035)
Have loan			0.054*	0.030
			(0.028)	(0.031)
Have minor			0.048	0.091**
			(0.042)	(0.038)
Like major			0.040***	0.032**
			(0.015)	(0.015)
Number of resumes submitted			0.001***	0.002***
			(0.001)	(0.001)
Engineering college	0.185***	0.166***	0.172***	0.186***
	(0.027)	(0.028)	(0.029)	(0.033)
Normal college	-0.079**	-0.069*	-0.025	-0.085*
	(0.038)	(0.037)	(0.038)	(0.043)
Agriculture college	-0.021	-0.017	0.081*	0.118**

	(0.045)	(0.045)	(0.043)	(0.046)
Finance college	-0.469***	-0.465***	-0.371***	-0.356***
	(0.075)	(0.077)	(0.099)	(0.069)
Political science college	0.003	-0.041	0.064	0.191**
	(0.058)	(0.065)	(0.076)	(0.074)
Ethnic college	-0.048	-0.020	-0.119	-0.003
	(0.086)	(0.084)	(0.098)	(0.074)
College in the East	0.010	0.002	-0.003	0.087**
	(0.038)	(0.039)	(0.040)	(0.041)
College in the Northeast	-0.090**	-0.100***	-0.111***	-0.062
	(0.037)	(0.038)	(0.042)	(0.038)
College in the Central	-0.065*	-0.064*	-0.079**	-0.101**
	(0.035)	(0.035)	(0.038)	(0.041)
College in the West	0.018	0.025	-0.033	0.036
	(0.035)	(0.034)	(0.039)	(0.037)
N	4984	4984	4984	6977
Psuedo R^2	0.065	0.075	0.198	0.261

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

5.1.2 Instrumental Variable Estimation

The outcome of interest in this section is an indicator of employment status that equals 1 if the student has obtained at least one job offer when he or she took the survey and equals to 0 if the student is unemployed, but still looking for a job. Because the endogeneity of elite college attendance is suspected, the employment status equation is estimated again by the IV-probit model. The instrument in the IV-probit regression is an opportunity index of entering high-quality colleges in a student's home province before college. This is measured by dividing the admission quota in ministry-administered or affiliated colleges by the number of NCEE takers in one's home province before college. It is the same instrument used in the IV estimation models of the wage equations in the subsequent section. The validity of the instrument will be discussed in details later in section 5.2.2. The stata module "*ivprobit*", which combines a first-stage linear probability model with a probit model in the second stage, is used to estimate the model because using a linear regression for the first-stage rather than probit or logit regression generates consistent second-stage estimates even with a dummy endogenous variable (Angrist & Krueger, 2001).

Table 5-3 reports the marginal probabilities in the second-stage that is associated with the probit coefficients. The coefficient of college quality in this IV-probit model is positive and statistically significant. The magnitude of this coefficient implies that one unit increase in the probability of being in an elite college is associated with 62.3% higher probability of employment. In both the probit and IV-probit models, the sign for the elite college dummy is positive, although it is not statistically significant in the baseline probit model. The magnitude is substantially higher in the IV-probit model than in the probit estimation. With regard to other covariates, the magnitude and significance level change for some covariates, but the general inferences for most covariates are consistent. It is reasonable because the effect is revealed for the subpopulation that is affected by the observed changes in the instruments. The p-value from the Wald test of exogeneity is close to zero, which suggests that the appropriate estimation strategy is the IV-probit model. No previous study used the IV-probit model to examine the effect of college quality in China. The magnitude of the coefficient is smaller than the previous findings that were close to 1 and obtained from the logit regressions in Yue et al. (2004) and Du and Yue (2010).

Table 5-3 Second Stage of Estimates of IV-probit−Initial Employment Status

	IV-probit
Elite	0.623***
	(0.162)
Age	0.008
	(0.010)
Female	-0.018
	(0.021)
Minority	-0.087**
	(0.036)
NCEE	-0.011***
	(0.004)

Humanities track	0.023
	(0.030)
Arts and athletics track	-0.144**
	(0.064)
Non-cognitive leadership skills	0.030
	(0.019)
Rural	0.009
	(0.023)
Only child	-0.056***
	(0.021)
SES	-0.018
	(0.013)
Major in liberal arts	-0.108**
	(0.048)
Major in social sciences	0.029
	(0.038)
Major in economics and management	-0.026
	(0.035)
Major in other disciplines	-0.075
	(0.052)
Average academic score	-0.002
	(0.002)
Party member	0.003
	(0.022)
Have certificate	0.024
	(0.017)
Student leader	0.001
	(0.022)
Pass CET4	0.024
	(0.023)
Pass CET6	0.001
	(0.031)
Part-time work	0.078***
	(0.023)
Have merit aid	0.024
	(0.021)
Have need-based aid	0.000
	(0.027)
Have loan	0.047**
	(0.021)
Have minor	0.039
	(0.033)
Like major	0.024**
	(0.012)
Number of resumes submitted	0.001**

	(0.0004)
Engineering college	0.265***
	(0.032)
Normal college	0.127***
	(0.049)
Agriculture college	0.064
	(0.039)
Finance college	0.045
	(0.134)
Political science college	0.383***
	(0.090)
Ethnic college	-0.204***
	(0.052)
College in the East	0.113**
	(0.044)
College in the Northeast	0.017
	(0.048)
College in the Central	0.038
	(0.053)
College in the West	0.055
	(0.040)
Ln(average GDP per capita) 1993-2007 in home province	0.109***
	(0.034)
N	4857
Wald test of exogeneity p-value	0.002

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

5.2 The Effect of College Quality on Starting Wage

In this section, the average effect of college quality on graduates' starting salaries will be examined empirically. In section 5.2.1, baseline OLS regression models will be established to investigate the average effect of elite college attendance. To address the potential endogeneity problem of the treatment variable, the IV estimation and the propensity score matching approach will be applied, respectively, in section 5.2.2 and section 5.2.3.

5.2.1 The Baseline OLS Model

The following analyses are based on students in the "Have-job-offer" sample. The dependent variable is the natural logarithm form of starting monthly wage for the first accepted job offer. The robust standard errors are reported, and the sampling weight is used to adjust the oversampling of elite colleges. In parallel to the baseline probit regression result table, we show a regression that does not control for student ability and student college experience covariates in column 1 of Table 5-4. Model 2 in column 2 adds student cognitive and non-cognitive ability controls. Model 3 additionally controls for a set of college experience variables, and it is our preferred model because it contains a full set of covariates including student demographics, student ability, family background, college experiences, institutional characteristics, and labor market behaviors. Model specification in model 4 is the same as that in model 3, but we extend the sample restriction from those who intend to work and obtain at least one job offer to those who do not report their intentions as job seekers but do have jobs (Number of observations = 3384 students) for robustness checks.

Table 5-4 presents the OLS estimates for elite college attendance status and covariates. When all covariates are held constant, graduates from elite colleges enjoy a 12.4% wage premium over those from non-elite colleges in China as shown in the preferred model. There is solid empirical evidence that there exists an earning advantage for elite college graduates because this earning advantage is always present across various model specifications and samples. The sensitivity tests suggest that omitting key covariates such as student ability and college experience controls in the OLS regression tends to generate overestimated results (The coefficients on the elite dummy are larger in models 1 than in model 2 and model 3.) Even after controlling for various types of college experiences, the magnitude of the elite dummy slightly drops from 0.129 to 0.124. It implies that these college experiences can only explain a small portion of human capital accumulation differentials between elite and non-elite colleges. A minor decrease in coefficient magnitude is detected when we change the sample to include observations that pursue further studies in graduate schools and report wage values. Generally, the estimates are quite robust across specifications and across samples.

The following detailed result interpretations are based on the preferred estimates in model 3. We can see that a number of other factors are significant determinants of the starting salary besides college quality. The only significant factor in student demographic variables is gender. Female graduates on average earn 7.3% less than male graduates. This gender gap in pay has been consistently documented in previous Chinese studies.

This study does not find that students with favorable family backgrounds perform better in the labor market in terms of earnings as was reported in previous literature. For example, some U.S. literature asserted that the effect of family background functions indirectly through family propensity to invest in education(L. Zhang, 2005c). A recent Chinese study also found that the wage premium is associated with having a cadre parent[15] (Hongbin Li et al., 2012b), and this premium is not attributed to indirect human capital gain. Further work needs to be done to confirm the existence of strong family background effects.

It is worth noting that student cognitive ability measured by the total NCEE score seems to positively affect graduates' earnings, though the effect size is small. One additional point in the NCEE score is associated with a 0.7% increase in starting salaries. Although we do not observe and measure all non-cognitive skills, leadership skills is found to be a significant determinant of starting salary, suggesting that leadership skills are highly rewarded by employers when one's career begins.

A rich set of college experience variables is included as control variables. The substantial

[15] Cadre parents are parents who work in government and government-controlled public organizations in China.

earning differentials among graduates from different study majors are found. For example, students who major in economics and management earn 9.8% less than STEM students. English skill requirements are stressed and valued by many employers and we use passage of the College English Test (CET) to measure the English proficiency of college graduates. It turns out that students who have passed CET level-6 earn 13.6% more than students who neither pass CET level-4 nor CET level-6. It is suggested that CET level-4 passage is also beneficial, but not as much as is CET level-6 passage. As expected, winning merit aid and liking one's major are positively associated with starting wage, whereas having need-based aid is detrimental, although these effects are significant at the 10% level.

Realizing that starting salary may also be in part dependent on the characteristics of institutions that students chose to participate in, we include two sets of covariates: dummies for institution subject specializations and the institution's region. Even after controlling for individual majors, students in normal universities and agriculture colleges show difficulty competing with their counterparts in comprehensive colleges in terms of earning ability.

To explain earning differentials, it is necessary to control for students' labor market behavior and job characteristics. On the job market, the students who have inter-provincial migration behaviors tend to enjoy higher earnings. Thus, a series of industry dummies are included. As expected, students in technology and skill-intensive industries show earning advantages over those in the labor-intensive agriculture industry. A series of province dummies of their workplaces are also included to mitigate the concerns that economic development levels, consumption expenses and labor market conditions vary across provinces and they should be adjusted accordingly. For example, the surveyed wage values are nominal wages. It is the real wage that reflects one's human capital and work capacity.

The economic return of attending elite colleges with 2011 college graduates data in this study is as high as 12.4%, which is similar to 10.7% for the 2010 graduation class as found by Hongbin Li et al. (2012a) and echoes the premium of 13% for the same cohort in the study by Yue and Yang (2012). However, once the authors control for human capital and college experiences, the effect of college quality diminishes to a small and insignificant figure, which leads the authors to assert that college quality functions through these college experiences (Hongbin Li et al., 2012a). But, this study shows the persistent presence of the effect of college quality even after controlling for all types of college experiences. It implies that college quality might raise individual human capital accumulation in college through other ways or it is also possible that students in elite colleges earn more simply because their university prestige or rankings provide employers with a signal of higher productivity.

Table 5-4 The Baseline OLS Estimates for the Starting Wage Equation

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Elite	0.186***	0.129***	0.124***	0.116***
	(0.024)	(0.025)	(0.025)	(0.024)
Age	-0.001	0.004	0.008	0.009
	(0.010)	(0.010)	(0.009)	(0.009)
Female	-0.050**	-0.046**	-0.073***	-0.070***
	(0.021)	(0.020)	(0.021)	(0.020)
Minority	-0.029	-0.012	-0.003	0.001
	(0.044)	(0.044)	(0.045)	(0.042)
Rural	-0.038	-0.037	-0.036	-0.041*
	(0.027)	(0.027)	(0.025)	(0.025)
Only child	0.018	0.023	0.013	0.023
	(0.024)	(0.025)	(0.024)	(0.023)
SES	0.013	0.020	0.014	0.010
	(0.016)	(0.015)	(0.015)	(0.014)
NCEE		0.009***	0.007***	0.006***
		(0.002)	(0.002)	(0.002)
Humanities track		-0.062**	-0.047	-0.063*
		(0.028)	(0.036)	(0.035)
Arts and athletics track		0.007	-0.028	-0.029
		(0.054)	(0.060)	(0.059)
Non-cognitive leadership skills		0.043**	0.042**	0.037**

		(0.019)	(0.018)	(0.018)
Major in liberal arts			0.079	0.056
			(0.057)	(0.054)
Major in social sciences			0.013	-0.015
			(0.045)	(0.043)
Major in economics and management			-0.098**	-0.109***
			(0.043)	(0.042)
Major in other disciplines			0.046	-0.016
			(0.055)	(0.055)
Average academic score			-0.000	0.000
			(0.002)	(0.002)
Party member			0.030	0.026
			(0.022)	(0.021)
Student leader			0.026	0.024
			(0.022)	(0.021)
Have certificate			-0.014	-0.015
			(0.018)	(0.017)
Pass CET4			0.055**	0.060**
			(0.026)	(0.026)
Pass CET6			0.136***	0.134***
			(0.031)	(0.030)
Part-time work			-0.031	-0.027
			(0.027)	(0.026)
Have merit aid			0.040*	0.031
			(0.021)	(0.020)
Have need-based aid			-0.038*	-0.034*
			(0.021)	(0.020)
Have loan			-0.019	-0.023
			(0.021)	(0.020)
Have minor			0.004	0.012
			(0.032)	(0.031)
Like major			0.021*	0.018*
			(0.011)	(0.011)
Engineering college	-0.008	-0.021	-0.029	-0.028
	(0.032)	(0.032)	(0.032)	(0.031)
Normal college	-0.132***	-0.107**	-0.114**	-0.109**
	(0.049)	(0.049)	(0.048)	(0.045)
Agriculture college	-0.127**	-0.115**	-0.119**	-0.115**
	(0.055)	(0.054)	(0.053)	(0.051)
Finance college	-0.100	-0.093	-0.108	-0.089
	(0.154)	(0.159)	(0.159)	(0.157)
Political science college	0.283***	0.204**	0.048	0.042
	(0.087)	(0.091)	(0.099)	(0.095)
Ethnic college	0.125*	0.116*	0.103	0.085
	(0.065)	(0.066)	(0.066)	(0.072)

College in the East	0.053	0.035	0.016	0.026
	(0.052)	(0.052)	(0.051)	(0.049)
College in the Northeast	-0.118**	-0.104*	-0.095*	-0.081
	(0.054)	(0.053)	(0.054)	(0.053)
College in the Central	-0.074*	-0.053	-0.054	-0.049
	(0.040)	(0.040)	(0.040)	(0.039)
College in the West	0.016	0.030	0.017	0.030
	(0.041)	(0.041)	(0.041)	(0.041)
Work migration	0.130***	0.119***	0.114***	0.121***
	(0.031)	(0.031)	(0.031)	(0.030)
Foreign-sector employer	0.038	0.043	0.054*	0.045
	(0.031)	(0.030)	(0.029)	(0.029)
Private-sector employer	-0.065***	-0.054**	-0.038*	-0.048**
	(0.022)	(0.022)	(0.020)	(0.020)
Work industry	Yes	Yes	Yes	Yes
Workplace province	Yes	Yes	Yes	Yes
Constant	7.696***	6.978***	6.965***	6.987***
	(0.229)	(0.271)	(0.295)	(0.283)
N	3173	3173	3173	3384
R^2	0.280	0.300	0.335	0.323

Note: Standard errors in parentheses *p < 0.1, ** p < 0.05, *** p < 0.01

When the four-fold college quality measure is used as shown in Table 5-5, we find that students in project 985 and project 211 colleges earn significantly higher than non-key college students. There is no statistically significant difference between non-key college students and students in independent colleges. There are minor changes in coefficients on covariates.

Table 5-5 The Effect of College Quality on Starting Wage for Four College Quality Categories

	OLS
Project 985 college	0.121***
	(0.043)
Project 211 college	0.127***
	(0.023)
Independent college	-0.064
	(0.046)
Age	0.008
	(0.009)
Female	-0.076***
	(0.021)
Minority	-0.004
	(0.045)

Rural	-0.036
	(0.025)
NCEE	0.006***
	(0.002)
Humanities track	-0.045
	(0.036)
Arts and athletics track	-0.043
	(0.062)
Non-cognitive leadership skills	0.040**
	(0.018)
Only child	0.012
	(0.024)
SES	0.014
	(0.014)
Major in liberal arts	0.079
	(0.057)
Major in social sciences	0.014
	(0.045)
Major in economics and management	-0.098**
	(0.044)
Major in other disciplines	0.045
	(0.055)
Average academic score	-0.0001
	(0.002)
Party member	0.031
	(0.022)
Student leader	0.024
	(0.022)
Have certificate	-0.014
	(0.018)
Pass CET4	0.055**
	(0.025)
Pass CET6	0.134***
	(0.031)
Part-time work	-0.031
	(0.026)
Have merit aid	0.040*
	(0.021)
Have need-based aid	-0.035*
	(0.021)
Have loan	-0.021
	(0.021)
Have minor	0.002
	(0.032)
Like major	0.022**

	(0.011)
Engineering college	-0.026
	(0.036)
Normal college	-0.115**
	(0.050)
Agriculture college	-0.116**
	(0.053)
Finance college	-0.111
	(0.160)
Political science college	0.058
	(0.100)
Ethnic college	0.111
	(0.071)
College in the East	0.021
	(0.050)
College in the Northeast	-0.097*
	(0.053)
College in the Central	-0.038
	(0.039)
College in the West	0.018
	(0.041)
Work migration	0.117***
	(0.032)
Foreign-sector employer	0.055*
	(0.029)
Private-sector employer	-0.037*
	(0.020)
Job industry	Yes
Workplace province	Yes
Constant	7.025***
	(0.290)
N	3173
R^2	0.336

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

5.2.2 Instrumental Variable Estimation

In this section, the IV method is used to estimate the starting wage equation to address the potential endogeneity of college quality.

Table 5-6 presents the second stage estimates from the 2SLS regression for the wage equation. The measurement of elite college participation status is employed to gauge the college quality and the overall explanatory power of the IV model is less than the baseline OLS regression. According to Table 5-6, the predicted probability of elite college attendance has a significantly positive effect on fresh college graduates' starting salaries at the 5% level. A one unit increase in the probability of attending an elite college is associated with an 81% increase in starting salary. The IV estimator recovers the local average treatment effects (LATE) rather than the average treatment effect (ATE). The effect is revealed for the subpopulation that enrolled in elite colleges induced by the provincial enrollment opportunity into higher quality HEIs in their home provinces but that would not have participated otherwise.

In student demographic variables, the gender gap is notable, with female students earning 5.4% less than male students earn if other things are equal. Again, family background does not seem to matter. In college experience covariates, students major in economics and management earn 10.3% less than STEM students. Students who pass the CET-6 possess a competitive edge when they enter the early labor market. Having merit aid scholarships is also helpful to seize well-paid jobs, whereas having need-based aid is harmful to earning. Students from political science colleges and those employed in the foreign sector are rewarded with higher starting wages.

Table 5-6 IV Estimation for Starting Salary: Elite Colleges versus Non-elite Colleges

	IV
Elite	0.810**
	(0.336)
Age	0.018
	(0.011)
Female	-0.054**
	(0.023)
Minority	-0.035
	(0.055)
Rural	-0.044
	(0.029)
NCEE	-0.010
	(0.008)

Humanities track	-0.026
	(0.041)
Arts and athletics track	-0.270**
	(0.124)
Non-cognitive leadership skills	0.037*
	(0.020)
Only child	-0.009
	(0.030)
SES	0.005
	(0.016)
Major in liberal arts	0.051
	(0.062)
Major in social sciences	0.035
	(0.047)
Major in economics and management	-0.103**
	(0.045)
Major in other disciplines	0.022
	(0.062)
Average academic score	0.001
	(0.002)
Party member	0.001
	(0.028)
Have certificate	-0.011
	(0.020)
Student leader	0.022
	(0.024)
Pass CET4	0.049*
	(0.027)
Pass CET6	0.109***
	(0.035)
Part-time work	-0.029
	(0.029)
Have merit aid	0.063**
	(0.026)
Have need-based aid	-0.072**
	(0.029)
Have loan	-0.006
	(0.025)
Have minor	0.006
	(0.036)
Like major	0.022*
	(0.012)
Engineering college	0.216*
	(0.127)
Normal college	0.210

	(0.168)
Agriculture college	-0.090
	(0.060)
Finance college	0.224
	(0.267)
Political science college	0.711**
	(0.345)
Ethnic college	-0.117
	(0.127)
College in the East	0.191*
	(0.107)
College in the Northeast	0.089
	(0.110)
College in the Central	0.130
	(0.104)
College in the West	0.129*
	(0.075)
Work migration	0.065
	(0.043)
Foreign-sector employer	0.074**
	(0.033)
Private-sector employer	-0.020
	(0.023)
Ln(average GDP per capita) in home province	0.118*
	(0.069)
Job industry	Yes
Workplace province	Yes
Constant	6.340***
	(0.580)
N	3120
R^2	0.109
F-statistic	16.340
Durbin-Wu-Hausman test of endogeneity	0.018

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A large body of literature has cautioned about the risks of having weak instruments. In essence, the results of the IV estimation would be biased if the instruments are weak. A discussion on the validity of instrumental variables is crucial and necessary to assess the reliability of results derived from the IV estimation models for the starting wage equations. Instruments are valid if the following three requirements are satisfied within the IV estimation framework: relevance, ignorability, and exclusion restriction.

Several instrument candidates are tested to verify instrument validity. The list of instrument candidates include parental years of education, distance from student's hometown to the nearest capital city in student's home province, and the number of elite colleges in student's home province. They all turned out to be too weak as none of them pass the relevance tests (F-statistic test and significant correlation coefficient in the first stage with the right sign and size). Geographical distance is a commonly used instrument to predict access to selective colleges in the United States. (Griffith & Rothstein, 2009; Long, 2008). As demonstrated in (Do, 2004), living near a high-quality public university increases the quality of college the student actually attended because of its positive role-model effect and encouragement effect. This evidence indicates that changing the incentives and costs associated with elite college attendance would affect college selection. However, distance fails to apply to China because the number of students at the margin who are constrained by the distance in attend elite colleges may not be large. Furthermore, the benefits may outweigh the costs of attending prestigious colleges in China, especially for those from rural and remote areas. In addition, the absolute number of elite colleges fails to account for college accommodation capacity.

Instead, the instrumental variable used in this study is the provincial level enrollment rate of high-quality HEIs in students' home provinces before college. A good measure would be the ratio of the quota of elite college slots divided by the total undergraduate enrollment in the student's home province in 2007. However, this measure is not available publicly, and this study resorts to a proxy variable. This proxy variable is calculated as the enrollment slots in ministry-administered or affiliated colleges in 2006 divided by the number of NCEE takers in students' home province in 2007. Given that elite colleges had reached their expansion limit after the expansion policy started in 1999, only about 10000 more students were admitted in ministry-administered colleges in 2007. The increased enrollment slots from 1996 to 1997 only accounted for less than 2% of the total enrollment slots for ministry-administered colleges according to the MOE regulations. In addition, the correlation between the provincial enrollment slots in the last year and the current year is as high as 98.4% (Pan, Xu, Chen, Kang, & Lan, 2010). Therefore, the enrollment slots in 2006 could be used to replace the 2007 figure when the 2007 data are not available. The proportion distribution among provinces remained unchanged until 2008 when regional equality was stressed in setting the enrollment quota across provinces.[16] In sum, this proxy is reasonable to capture the provincial inequality in elite college enrollment opportunities. But this proxy may induce a component of measurement error in the estimation, and the coefficients in the first stage of the 2SLS will probably be biased toward zero. Because most of the ministry-affiliated universities are traditional national key colleges and most of them are current 985 and 211 project colleges, it is not a large problem. The 2006 enrollment slots in ministry-administered universities is readily available from Qiao (2007), and the number of NCEE takers in 2007 is from the Sunshine NCEE information platform supported by the MOE. This paper calculates the enrollment rate for ministry-administered national key universities in each province throughout China. Theoretically, this instrumental variable accounts for the school capacity and takes advantages of the provincial variation of enrollment opportunities into high-quality HEIs across provinces in China. There is a large variation in this opportunity index across provinces. A detailed analysis of the validity of the instrument in use will be discussed in the following paragraphs to check whether it meets three requirements.

First, valid instrumental variables should be highly correlated with endogenous regressors

[16] According to the Number 2008[4] public announcement of the Ministry of Education http://govinfo.nlc.gov.cn/gtfz/zfgb/jyb/20084/201010/t20101012_456770.html?classid=423

even after controlling for the exogenous covariates (Relevance). This requirement can be empirically tested in the first stage of the IV regressions. In this study, the correlation coefficient between provincial elite college enrollment rate and elite college attendance status is 0.019 and statistically significant at the 1% level in the first-stage. It implies that one percentage point increase in the elite college enrollment rate would increase the probability of entering an elite college by 1.9 %, holding other things constant. The sign of the coefficient is in the right direction as we expected, because the underlying rationale is that the students take the NCEE and enroll in the province with more elite college slot quota to have better chances to access elite colleges. Because college admission is highly segmented provincially in China, colleges often allocate a high proportion of freshman slots for enrollees living in the same province. It is reasonable to expect a greater opportunity to enroll in an elite college if the student is from elite college concentration areas such as in large municipal cities. Students who live in a province or municipality with higher chances to enter elite colleges tend to be more encouraged and have less fierce competition, so they have a higher probability of ultimately attending one. Moreover, the instrument used in this paper meets the standard of Staiger and Stock (1997) because the F statistic is 16.05, which passes the threshold of 10 (an accepted value of F-statistic to reject the hypothesis that the coefficients on the instruments in the first-stage regression of 2SLS are jointly equal to zero). Overall, the weak instrument is not a problem in this study.

Second, the instrumental variable should be randomized or conditionally randomized (Ignorability of the instrument). Although the exogeneity of the instrument cannot be tested in theory, there are reasons it is regarded as exogenous. The elite colleges in China are usually built for a long time and their establishment is more correlated with historical and cumulative factors rather than driven by the immediate market demand or directly related to students' individual starting salary levels. Moreover, one feature of Chinese college admission procedure is that the number of slots in elite colleges in China is determined by the government quota before or after the NCEE. It functions as a government decision or policy regulation at the provincial level, and it is independent of market demand. Government policies and college openings were commonly used instruments in previous literature related to education access and attainment (Angrist & Krueger, 1991; Currie & Moretti, 2003; Oreopoulos, 2006). In summary, though the instrument variable might be endogenous at the provincial level, it is highly exogenous for individual level outcomes.

Third, the instrument only affects the outcome through the treatment and there is no third path (Exclusion restriction). This assumption is not directly testable. In this study, the provincial level elite college enrollment rate is unlikely to be directly related to individual level personal wages, but there might be indirect links that we need to control for. The additional covariate is hoped to account for possible channel through which provincial features might affect wages. There is a possibility that provinces with higher elite college enrollment quotas are relatively richer provinces with a higher number of elite colleges. Students earn more not because they gain higher human capital accumulation from high-quality colleges, but because they benefit from where they come from if they are from richer provinces and stay there to attend colleges and find jobs. To rule out this possibility, the natural logarithm form of the average GDP per capita from 1993 to 2007 for students' home provinces is also included in the regression with the hope that it helps account for this possible unobservable channel through which student wages are affected. Moreover, provinces with higher enrollment quota of ministry-administered colleges are not always the richer area in China. According to Qiao (2007), students in some western provinces enjoy favorable education policies and higher enrollment rate of high-quality HEIs.

In theory, we need at least one instrument for each endogenous variable. When the number of instruments exceeds the number of endogenous regressors, the IV estimator is over-identified. We do not have the over-identification problem in this study because we have one instrument (provincial enrollment opportunity to elite colleges) for one potentially endogenous variable (elite college attendance status), and other instrument candidates fail to work out. Thus, the IV estimator is regarded as just-identified, and no further tests are needed.

One might be concerned about inter-provincial mobility that students might move to provinces with more elite college openings or slots in order to attend an elite college. The *hukou* (household registration) system is a feature of China that greatly restricts such endogenous mobility when students were taking NCEE exams in 2007. Students are only allowed to take NCEE and admitted from the provinces where they have local *hukou*. Therefore, it should not be a big concern.

Finally, we test whether the potential endogenous variable (elite college attendance status) is indeed endogenous by using the Durbin-Wu-Hausman test. The p-value for the Durbin-Wu-Hausman test is 0.018, so we tend to reject the null hypothesis of exogeneity. This suggests that elite college attendance is endogenous and that we should rely more on the IV estimations to draw inferences.

5.2.3 Heckman Sample Selection Correction

The prevalence of sample selection bias research in labor economics has been widely recognized over the past decades. We are concerned about the potential sample selection bias that could arise in this study because we only observe the starting salaries for fresh college graduates who obtained at least one job offer immediately after graduation. If we limit the regression to the non-random sub-sample of fresh college graduates with observable wage values, selection effects may lead to biased results. In other words, the coefficients we obtained may not apply to all college graduates (those who have job offers and those who do not).

To assess whether this selection distorts our estimations, the common approach called "Heckman sample selection correction" method is adopted. The "Heckman correction" fits into the context of this study by involving both the estimation of a selection equation with a probit model, determining the selection process and a second-step outcome equation with an OLS model with the correction factor—the Inverse Mills Ratio (IMR) plugged in (Heckman, 1979). This strategy requires strong model identification that includes the exclusion restrictions. Exclusion restrictions are variables that only affect the outcomes through the selection process but do not have an independent effect on the outcomes. Implementation without exclusion restrictions might exacerbate the standard error inflation due to collinearity between the IMR and the included regressors (Bushway, 2007). In this case, the number of resumes submitted is used as an additional identifying variable because job search costs and endeavors are tested to predict the probability of finding a job, but not to influence wages for job offers once a person is working.

The results from the selection equation suggest that one additional submitted resume increases the probability of working by 0.14 percentage points. The identifying variable is significant at the 1% level, which is a good signal to be qualified for the exclusion restriction. The bottom of the Table 5-7 lists the coefficient and the standard error associated with the IMR, which represents a test for the presence of selection bias. The coefficient on the IMR is not statistically significant at any significance level, indicating that selection bias might not be present in this study. For the sake of comparison, results both corrected and uncorrected for the selection are presented for the starting wage equation in this study. There are minor changes in the magnitudes of coefficients, and the inferences do not change before and after the IMR term is included in the OLS regression equation. For the above reasons, we conclude that the sample selection does not bias our estimates and that the students who find jobs are likely representative of the "Intention-to-work" sample and we should not be concerned about the sample selection bias. For the sake of brevity, the remaining part of the dissertation will show the results from the regression without the IMR.

Table 5-7 The Effect of College Quality on Starting Wage with and without the Heckman Selection Correction

	(1) With IMR	(2) Without IMR
Elite	0.124***	0.124***
	(0.025)	(0.025)
Age	0.008	0.008
	(0.009)	(0.009)
Female	-0.076***	-0.073***
	(0.022)	(0.021)
Minority	-0.005	-0.003
	(0.045)	(0.045)
Rural	-0.035	-0.035
	(0.025)	(0.025)
NCEE	0.007***	0.007***
	(0.002)	(0.002)
Humanities track	-0.047	-0.046
	(0.036)	(0.036)
Arts and athletics track	-0.025	-0.028
	(0.061)	(0.060)
Non-cognitive leadership skills	0.045**	0.041**
	(0.019)	(0.018)
Only child	0.010	0.013
	(0.024)	(0.024)
SES	0.013	0.014
	(0.015)	(0.014)
Party member	0.032	0.031
	(0.022)	(0.022)
Student leader	0.025	0.026
	(0.022)	(0.022)
Have certificate	-0.013	-0.014
	(0.018)	(0.018)
Pass CET4	0.058**	0.056**
	(0.026)	(0.026)

Pass CET6	0.139***	0.136***
	(0.031)	(0.031)
Part-time work	-0.025	-0.031
	(0.026)	(0.026)
Have merit aid	0.041**	0.039*
	(0.021)	(0.021)
Have need-based aid	-0.036*	-0.038*
	(0.021)	(0.021)
Have loan	-0.016	-0.019
	(0.021)	(0.021)
Have minor	0.007	0.005
	(0.032)	(0.032)
Like major	0.024**	0.022**
	(0.011)	(0.011)
Work migration	0.114***	0.113***
	(0.031)	(0.031)
Foreign-sector employer	0.055*	0.054*
	(0.029)	(0.029)
Private-sector employer	-0.038*	-0.038*
	(0.020)	(0.020)
The Inverse Mills Ratio	0.048	
	(0.056)	
Major dummies	Yes	Yes
Institution specialization dummies	Yes	Yes
Institution region dummies	Yes	Yes
Job industry dummies	Yes	Yes
Workplace province dummies	Yes	Yes
Constant	6.928***	6.961***
	(0.296)	(0.293)
N	3173	3173
R^2	0.335	0.335

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The potential sample selection concern was never addressed in previous Chinese studies by the Heckman sample selection method. Hongbin Li et al. (2012a) tried to identify the possible direction of the sample selection bias by separately estimating the probability of having non-missing wage values for elite and non-elite samples with OLS regressions, but their attempts failed because the selection may go in either direction, and they were unable to determine which direction had the leading effect.

5.2.4 Propensity Score Matching

Propensity score methods have seen a tremendous increase in use during the last decade to estimate the labor market effects of college quality in American studies (Black & Smith, 2004; Brand & Halaby, 2006; Long, 2008). As discussed in section 2.4, PSM has advantages over the standard regression approach primarily because it is sufficient to match the propensity core instead of specifying the multi-dimensional relationship between the dependent variable and independent variables. Moreover, PSM relaxes the linearity assumption as a semi-parametric or non-parametric alternative and fulfills the restriction of regression in the common support area. A common PSM practice usually involves several steps. This dissertation will illustrate the implementation steps in detail as follows:

(1) Estimation of Propensity Score

The first step is to estimate the propensity score. In this study, the treatment is defined as whether the student has attended an elite college in China. It is coded to 1 for elite college attendants and 0 for non-elite college attendants in our sample. Because the treatment is binary, a probit model is used as the choice of model in our treatment equation. Appropriate confounders should be the pre-treatment variables that predict both the treatment and the outcome. Therefore, I prioritize the confounding covariates into three categories in Table 5-8 in the order based on their importance with respect to the treatment and outcome variables according to the economic theory and previous empirical evidence. Student cognitive ability as measured by the NCEE score is the primary determinant for college admission. Previous Chinese studies have documented unequal access to high quality education due to family background, household registration system, and the region of residence (Xie & Wang, 2006; Yue, 2009). The ignorability assumption also requires exhaustive inclusion of potential pre-college confounders, such as the high school characteristics and home environment due to the concern that the selection bias could be largely induced by omitting these observable pre-college confounders (Brand & Halaby, 2006). Some student demographic characteristics belong to the variables that are the least important to balance category.

Table 5-8 A List of Confounders in Categories in Order of Importance to Balance

Rank of confounders	Variables
Most important to balance	NCEE score, Residential region before college, Academic track in senior high school, Minority
Somewhat important to balance	Whether from a key senior high school, Rural household registration, SES index, Home environment
Least important to balance	Age, Female, Only child, Non-cognitive leadership skills

Table 5-9 gives the results of a probit regression of elite college attendance on the pre-college covariates. We can see that the most important determinants of elite college attendance in this sample are student cognitive ability, student ethnicity, student age, student's high school quality, academic track in senior high school and region of residence. Although the coefficients for variables SES, home environment, only child and non-cognitive leadership skills are not significant, the signs are in the expected direction. All the variables in this probit model are included in the propensity score estimation model.

Table 5-9 Probit Regression of Elite College Attendance on Pre-college Covariates

Pre-college covariates	Coefficient	Standard Error
Age	-0.019***	0.005
Female	-0.007	0.011
Minority	0.139***	0.039
Rural	0.006	0.013
Residential region in the East	0.003	0.022
Residential region in the Northeast	0.006	0.025
Residential region in the Central	-0.018	0.021
Residential region in the West	0.149***	0.031
NCEE	0.024***	0.001
Humanities track	-0.027**	0.012
Arts and athletics track	0.600***	0.085
Non-cognitive leadership skills	0.0003	0.010

Only child	0.018	0.013
SES	0.008	0.008
Key senior high school	0.030***	0.011
Home environment	0.009*	0.005
N	3537	
Pseudo R^2	0.29	

Note: Municipality is the reference group for residence region and science track is the reference group for academic tracks.
* p < 0.1, ** p < 0.05, *** p < 0.01

(2) Choice Among Alternative Matching Algorithms

There are a variety of matching algorithms to choose during the implementation of PSM. Researchers need to make choices in terms of how to assign the comparison observations to each treated observation. Some of the previous researches considered more than one matching algorithm and compared the results from various matching algorithms because the estimates would differ in finite samples. For example, Black and Smith (2004) considered three alternative matching estimators: the nearest neighbor estimator, the Gaussian kernel estimator, and the Epanechnikov kernel estimator. The leave-one-out validation mechanism results suggested that the latter two perform better, and the nearest neighbor estimator and the Epanechnikov kernel estimator performed modestly better than the Gaussian kernel matching. In addition, all estimators were insensitive to the bandwidth selection unless it was very small. In another example of PSM application in China, Z. Liu and Qiu (2011) compared the treatment effect from four matching algorithms: the nearest neighbor estimator, the Gaussian kernel estimator, the Epanechnikov kernel estimator and the Caliper estimator. They confirmed the superiority of the Epanechnikov estimator and the insensitivity of choice of bandwidth. Given this evidence, I present treatment effect estimates from these four commonly used matching algorithms to test the robustness of the results. Given the limited space, I have merely presented the checks of overlap and balance assumptions for the Epanechnikov kernel matching, as it was tested to be the most reliable matching algorithm for this research topic. The bandwidth choices cross-validated in Z. Liu and Qiu (2011) (bandwidth = 0.03 for Gaussian kernel matching, bandwidth = 0.12 for Epanechnikov matching, and bandwidth = 0.08 for Caliper matching) are used so that the results are more comparable across studies. Matching with replacement option is taken for the one-to-one nearest neighbor matching.

(3) Checking the Overlap or Common Support Assumptions

Visual analysis of the propensity score distribution is a straightforward way to examine the overlap between treatment and control groups. The overlap assumption is met when there are individuals in the control group that have propensity scores similar to those in the treatment group. The overlapping range is commonly referred to as the region of common support.

Figure 5-1 plots histograms of the estimated scores for elite college attendants in the top histogram and non-elite college attendants in the bottom histogram. The horizontal axis defines the propensity score and the length of each bar on the vertical axis indicates the fraction of sample fall into a corresponding interval of propensity score. We can see that observations in the control group span the full range of propensity scores, which means for nearly all elite college students, more than one student in the non-elite college has a similar propensity score and vice versa. There are a few exceptions in the very high and low spectrums, which form the narrow off-support regions. Moreover, the distribution is highly uneven. Most of the cases in the control group are concentrated below the propensity score of 0.7, whereas the majority of cases in the treatment group have propensity scores of higher than 0.5. The frequencies at the top end for observations in the control groups are very low. Therefore, the thick support area is between approximately 0.2 and 0.7.

Figure 5-2 includes histograms and kernel density plots that indicate the propensity score distributions before and after the Epanechnikov matching. Before and after matching graphs are the same for the Epanechnikov matching because this matching algorithm uses weighted averages of all the cases in the control group to estimate counterfactual outcomes. We can see that the overlap of the propensity scores is substantial and that the common support region is quite wide. As such, the two figures demonstrate that the primary assumption of overlap is met in this study.

Figure 5-1 The Distribution of Propensity Scores

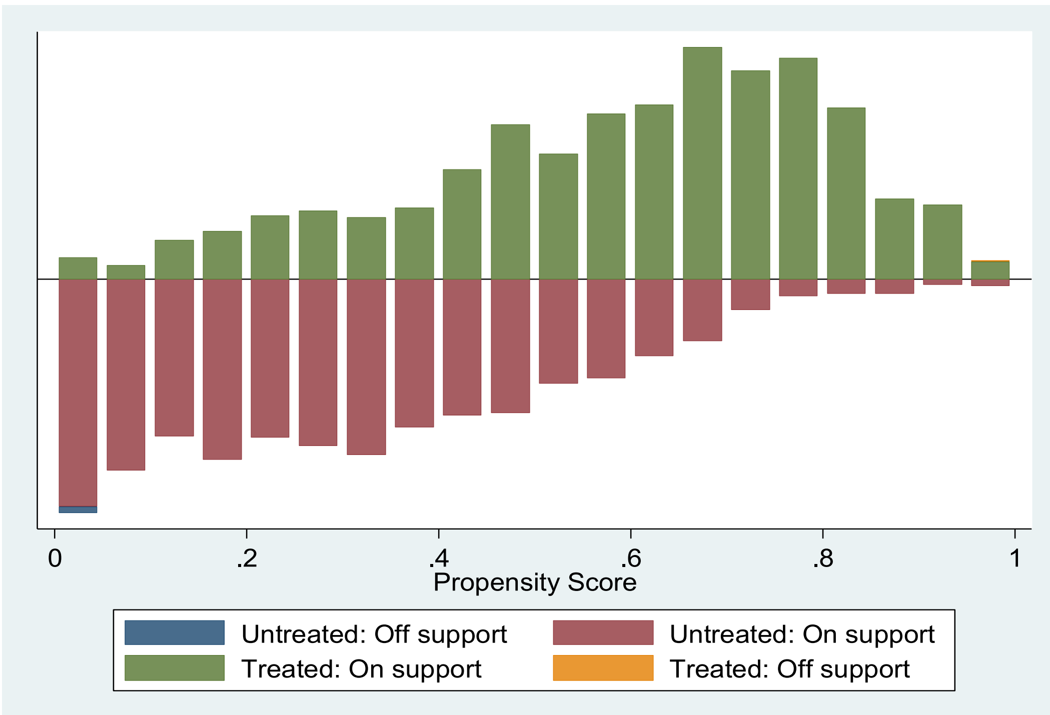
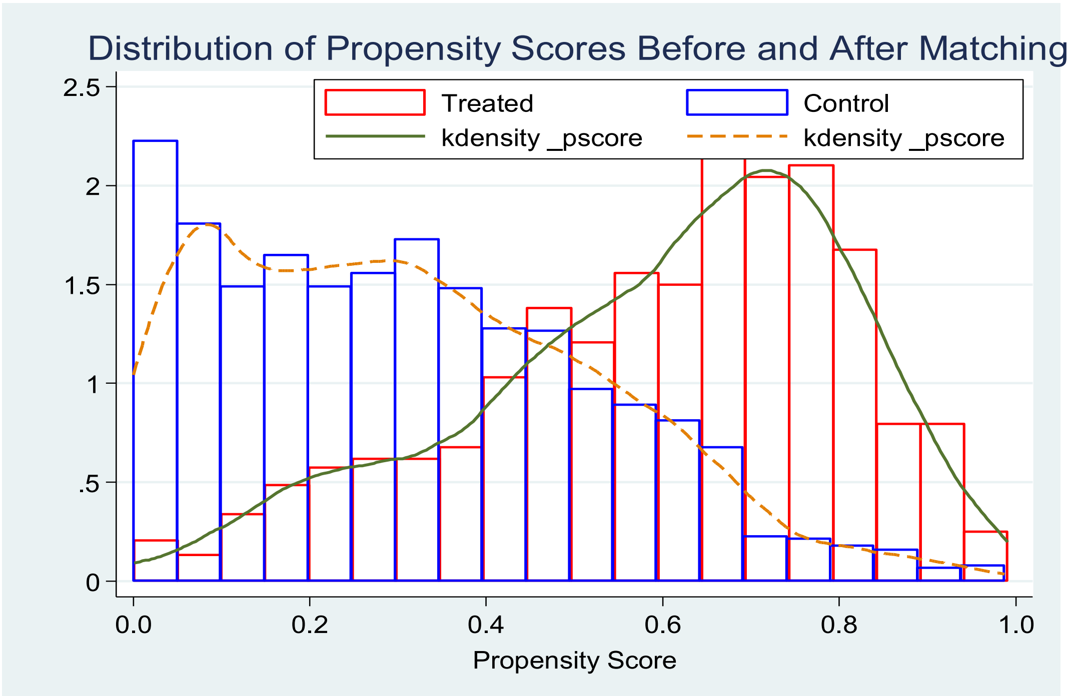


Figure 5-2 Checking for the Overlap Before and After the Epanechnikov Matching



(4) Assessing the Matching Quality and the Balance

The goal of the matching procedure is to balance the distribution of relevant cofounders so that the group differences between the treatment group and control group on the measured confounders can be minimized after adjusting for the propensity scores. Balance evaluation based on statistical tests such as the T-test and the Chi-square test are not reliable because even small differences may be statistically significant if the sample size is large. Therefore, the standardized mean differences (STD) are used to diagnose the balance as recommended by Rosenbaum and Rubin (1985).

Standardized mean differences are calculated as the difference in means/proportions across the treatment groups divided by the standard deviation within the treatment group (Stuart, 2010). It is difficult to tell how close is close enough and what balance is good enough. Here, the commonly used rule of thumb of 0.2 is adopted because it is considered a small effect size

(Cohen, 1988; Lanza, Moore, & Nicole, 2013). Thus, if standardized mean differences are less than an absolute value of 0.2 after matching, the treatment groups are regarded as balanced on measured confounders. When the differences are less than 0.2 for all the confounders, the balance has been fully achieved. If some of the differences are larger than 0.2, the model specification can be adjusted by adding square terms and interaction terms or by dropping variables. The above four steps of PSM implementation can be repeated iteratively until balance is achieved. In this study, adding square terms for age or NCEE score seems unreasonable because there is no evidence of a nonlinear relationship between these variables and elite college attendance. Finally, the balance is fully achieved no matter what matching algorithm is chosen. For brevity, Table 5-10 below represents the balance diagnostics for the Epanechikov kernel matching. The standardized mean differences between students in elite and non-elite colleges on each of the confounders pre- and post- match are calculated and compared. Any difference greater than 0.2 is denoted with an asterisk. After matching, the standardized mean differences are much lower than in the unmatched data for most confounders and all below 0.2. The standard deviation ratios for most covariates are close to 1. Therefore, the balancing of covariates is properly achieved.

Table 5-10 Balance Diagnostics of Standardized Mean Differences for Epanechikov Kernel Matching

		Mean		SD		STD	Ratio
Variable	Sample	Treated	Control	Treated	Control	Diff	of SDs
NCEE score	Unmatched	75.98	70.55	6.540	6.870	0.830*	0.950
	Matched	75.97	75.30	6.530	6.790	0.117	0.960
Humanities track	Unmatched	0.162	0.173	0.370	0.380	-0.030	0.970
	Matched	0.162	0.183	0.370	0.390	-0.058	0.950
Arts and athletics track	Unmatched	0.034	0.051	0.180	0.220	-0.096	0.820
	Matched	0.034	0.058	0.180	0.230	-0.136	0.770
Science track	Unmatched	0.800	0.770	0.400	0.420	0.075	0.950
	Matched	0.800	0.746	0.400	0.440	0.133	0.920
Residential region in	Unmatched	0.036	0.176	0.190	0.380	-0.757*	0.490
Municipalities	Matched	0.036	0.045	0.190	0.210	-0.050	0.900

Residence region in the East	Unmatched	0.267	0.167	0.440	0.370	0.227*	1.190
	Matched	0.267	0.440	0.440	0.014	0.014	1.010
Residential region in the	Unmatched	0.071	0.103	0.260	0.300	-0.127	0.840
Northeast	Matched	0.071	0.069	0.260	0.250	0.008	1.010
Residential region in the	Unmatched	0.188	0.317	0.390	0.470	-0.331*	0.840
Central	Matched	0.188	0.176	0.390	0.380	0.031	2.030
Residential region in the	Unmatched	0.438	0.236	0.500	0.430	0.407*	1.170
West	Matched	0.438	0.449	0.500	0.500	-0.022	1
Minority	Unmatched	0.090	0.046	0.290	0.210	0.154	1.360
	Matched	0.090	0.097	0.290	0.300	-0.024	0.970
Key senior high school	Unmatched	0.845	0.757	0.360	0.430	0.243*	0.840
	Matched	0.845	0.820	0.360	0.380	0.067	0.940
SES index	Unmatched	-0.284	-0.244	0.940	0.900	-0.043	1.040
	Matched	-0.285	-0.182	0.940	0.920	-0.110	1.020
Rural	Unmatched	0.527	0.470	0.500	0.500	0.114	1
	Matched	0.528	0.474	0.500	0.500	0.108	1
Home Environment	Unmatched	0.308	0.351	0.460	0.480	-0.094	0.970
	Matched	0.308	0.321	0.460	0.470	-0.027	0.990
Age	Unmatched	22.97	23.02	1.020	0.970	-0.052	1.050
	Matched	22.97	22.93	1.020	0.970	0.044	1.050
Female	Unmatched	0.361	0.421	0.480	0.490	-0.125	0.970
	Matched	0.362	0.409	0.480	0.490	-0.100	0.980
Only child	Unmatched	0.308	0.351	0.460	0.480	-0.094	0.970
	Matched	0.308	0.329	0.460	0.470	-0.045	0.980
Non-cognitive	Unmatched	0.436	0.426	0.500	0.490	0.022	1
leadership skills	Matched	0.436	0.434	0.500	0.500	0.003	1

* Standardized effect sizes greater than 0.2

(5) Treatment Effect Estimates

Once the key overlap and balance assumptions have been satisfied, the treatment effect can be estimated with difference in mean outcomes or a regression-adjusted matched estimate. This study proceeds with the regression-adjusted matched estimate with the hope that the additional covariate adjustment in the outcome equation will help with both bias and precision. The same set of covariates used in the baseline OLS model including student demographics, family background, college experiences, institution characteristics, and labor market conditions will be used as controls.

Three related estimands should be distinguished, namely, the average treatment effect (ATE), the average treatment effect on the treated (ATT) and the average treatment effect on the control

(ATC). The focus of this study is to examine the effect of attending elite colleges for those who actually attended one in our sample, not the economic gain for non-elite college students if they had attended an elite college otherwise or the average economic gain for all. Therefore, ATT is the estimand of interest in this dissertation.

Table 5-11 presents the estimated treatment effect for elite college attendance for four matching algorithms of choice. For each method, the first column corresponds to the ATT. The second and third columns correspond to the standard error and p-value. The PSM results demonstrate that students who receive elite college education outperform students who attend non-elite colleges in terms of monthly starting salary. The PSM estimates are all statistically significant and positive, regardless of the propensity score technique used. The matching estimates range from 0.133 to 0.165, suggesting smaller impacts with Epanechikov kernel matching and Caliper matching techniques. In sum, the effect of college quality on starting salary is about 0.133 produced by the PSM Epanechikov kernel estimator, which means that students in elite colleges earn 13.3% higher than non-elite fresh college graduates. The PSM estimation is similar, but slightly larger than the estimation coefficient from the OLS regression (0.124).

Table 5-11 Treatment Effect of Elite College Attendance versus Non-elite College Education

Method	ATT		
	Estimate	Std. Error	p-value
Epanechikov kernel matching (Bandwidth = 0.12)	0.133***	0.026	0.000
Gaussian kernel matching (Bandwidth = 0.03)	0.165***	0.036	0.000
Caliper matching (Bandwidth = 0.08)	0.135***	0.026	0.000
One-to-one Nearest neighbor matching	0.165***	0.036	0.000

Note: The PSM is based on the unweighted sample because the module "*psmatch2*" does not have a procedure to properly account for sample weights.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(6) Sensitivity Analysis

PSM is built on the same assumption of ignorability or selection on observables as the OLS regression. To test the sensitivity of estimated treatment effects with respect to unobserved covariates, the Rosenbaum bounds for ATT proposed by Rosenbaum (2002) are calculated in Table 5-12. The sensitivity analysis shows that the study becomes sensitive to hidden bias at 1.9. Since 1.9 is a value that is neither too low or too high and it is between the highly sensitive and highly robust gamma values suggested by S. Guo and Fraser (2010), the conclusion is that college quality appears to have a positive treatment effect on fresh college graduates' starting salary, and the PSM results are not very sensitive to hidden bias. The treatment effect would be altered only if the hidden bias is large in this study. But, we still need to be cautious and sufficiently control for potential confounders.

Table 5-12 The Rosenbaum Bound Sensitivity Test for the PSM

Gamma	Sig+	Sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	0.112226	0.112226	0.096362	0.132453
1.1	0	0	0.101985	0.128194	0.078168	0.144712
1.2	0	0	0.084272	0.139677	0.063388	0.163019
1.3	3.4e-14	0	0.07114	0.152809	0.054284	0.173016
1.4	1.0e-10	0	0.059311	0.167505	0.042055	0.188000
1.5	5.6e-08	0	0.051506	0.176295	0.030074	0.198079
1.6	7.6e-06	0	0.04075	0.189748	0.021794	0.202579
1.7	0.000321	0	0.030287	0.19799	0.014031	0.211084
1.8	0.005328	0	0.022749	0.201892	0.005054	0.221813
1.9	0.040652	0	0.016418	0.208182	-0.001156	0.229821
2	0.164701	0	0.008616	0.217318	-0.004368	0.239630

Note: Gamma is the odds ratio that individuals will receive treatment due to unobserved factors.
Sig+ is the upper bound of the p value using the Wilcoxon's signed-rank test.
Sig- is the lower bound of the p value using the Wilcoxon's signed-rank test.
t-hat+ is the maximum value of the Hodges-Lehmann point estimate.
t-hat- is the minimum value of the Hodges-Lehmann point estimate.
CI+ is the upper bound of the 95% confidence interval of the Hodges-Lehmann interval estimate.
CI- is the lower bound of the 95% confidence interval of the Hodges-Lehmann interval estimate.
The sensitivity tests are based on 1372 matched pairs.

5.2.4 Summary of Findings

The analysis in section 5.2 answers the key question by estimating the effect of college quality on starting salaries. According to estimation results from various methodologies, a positive and statistically significant effect has been confirmed for elite college attendance in China. This effect is very robust to changes in model specifications and sample restrictions and its existence has been firmly demonstrated. Overall, the economic return to elite college attendance is around 0.124 as suggested by the OLS regression, and it is statistically significant at the 1% level. The estimation results are robust, no matter what methodology is employed. The PSM estimator (0.133) is close and slightly larger than the OLS estimator. The magnitude of the point estimate from the IV estimation (0.81) is substantially larger than from either the OLS or PSM. The results also suggest that the potential endogenous elite college attendance stemmed from either omitted variables or omitted selection on unobservable student characteristics is a concern and should be dealt with in Chinese studies as suggested by the Durbin-Wu-Hausman exogeneity test.

In terms of covariates, previous studies usually miss the cognitive ability control due to lack of proper measurements and fail to sufficiently control for covariates that should be taken into account such as college experience activities, institution characteristics and individual labor market behaviors. This dissertation also includes an exhaustive set of student individual and family background covariates to address the potential selection bias. For example, in the PSM applications, some individual pre-college experiences that were never used in previous Chinese studies are also used to match the observations in treatment and control groups with the hope that any unobserved variables that correlated with both elite college entrance and labor market performance are included in the model. The majority of coefficients of the covariates are in the expected direction and the inferences for covariates do not change across estimations from three different identification strategies. At student level, determinants of starting wage include student's gender, innate ability, major, English proficiency, merit aid awards, job industry, workplace province, and inter-provincial work migration pattern. At college level, the institutional subject specialization affects students' early labor market outcomes.

Compared with previous Chinese studies, this dissertation ascertains the positive and highly statistically significant effect of college quality at the 1% level for undergraduate cohort graduating in 2011. The magnitude of the effect generated by the OLS in this dissertation is identical to findings that used the same method in Yue and Yang (2012) for the same cohort, whereas it is about 0.02 larger than in Hongbin Li et al. (2012a), which focused on the 2010 cohort and less significant. It may imply the gaining of a competitive edge for students in high-quality colleges in the harsh hunting season in recent years.

5.3 The Heterogeneous Effect of College Quality Varying by Student Characteristics

This section complements the above section by exploring the potential heterogeneous effect of college quality for different groups of college graduates. It might be the case that attending elite colleges is more beneficial for some students with some traits than for others. The empirical analysis in section 5.3 aims to detect the potential differential effect of college quality among individuals varying by student characteristics such as gender, ethnicity, rural household registration status, SES and innate ability.

Accordingly, several research questions are posed. For example, do female students enjoy a higher wage premium than male students through elite college attendance? Do ethnic minority students have an earning advantage over the majority (Han) students that are provided by elite college educations? Do elite colleges benefit rural students more than urban students? Do elite colleges affect the starting salary of poor students who fall below the average of SES level more than wealthy students that who fall above the mean SES index? Does elite college attendance offer higher earning potential for less-capable students who have below-average NCEE scores than for those who are more capable? These potential disparities are tested by generating a series of interaction terms in the OLS models.

The interpretation would be obvious when two dummy variables are used to generate interaction terms. In this section, the college quality is coded as a dummy variable. Many student demographics of interest are also coded in dummies such as gender, ethnicity and rural residence. However, interpretations are not very straightforward for some continuous variables such as SES index and student cognitive ability score rescaled to a range of 0 to 100. Therefore, I divide the students into two comparable groups in two halves: the group of students with the SES index lower than the average SES index and the group of students with the SES index higher than the average level. Similarly, the student ability variable is recoded to separate students into two comparable groups: the group of students with high intellectual ability and the less-capable student group.

Table 5-13 lists the estimation results for each of above characteristics one by one. Column 1 to 5 considers adding one interaction term at a time and column 6 adds all the interaction terms in the wage equation. Several observations emerge from Table 5-13. First, none of the newly added interactions is statistically significant at the 5% or 1% significance level except the interaction between student ability and elite college participation. Second, the only heterogeneous effect appears when less-capable students are sorted into elite colleges. The coefficient on the interaction of elite college and less capable student dummy suggests that the effect of college quality is not uniform for all students. Graduating from an elite college boosts the less-capable students in obtaining higher entry-level earnings by 6.4%. This finding helps explain the phenomenon that many parents and students are eager to attend elite colleges even when their children are less-capable. Third, this effect does not diminish even if we control for other sources of heterogeneity by including all the interaction terms. Fourth, general inferences for covariates still hold compared with results from the baseline OLS wage equation. The results are consistent with previous findings in the sense that often the higher benefits of education are found for disadvantaged groups. The students with lower capabilities may earn additional human capital when they interact with higher-quality peers and in better school environments.

Hongbin Li et al. (2012a) suggested that the wage premium is not uniform and that the economic returns lean toward female students and students with favorable family background; however, these previous findings are not supported by this study. The new finding that the returns are higher for students with lower cognitive abilities and the existence of potential heterogeneity should be verified through future research.

Table 5-13 Heterogeneous Effect of Attending Elite Colleges Varying by Student Characteristics

	(1) Female	(2) Minority	(3) Rural	(4) NCEE	(5) SES	(6) All
Elite	0.114***	0.124***	0.127***	0.110***	0.140***	0.114***
	(0.029)	(0.025)	(0.029)	(0.027)	(0.032)	(0.038)
Elite*Female	0.024					0.020
	(0.034)					(0.034)
Elite*Minority		0.002				-0.014
		(0.072)				(0.072)
Elite*Rural			-0.007			0.021
			(0.032)			(0.038)
Elite*Low NCEE				0.064**		0.064**
				(0.032)		(0.032)
Elite* Low SES					-0.026	-0.035
					(0.035)	(0.041)
Age	0.008	0.008	0.008	0.008	0.008	0.008
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Female	-0.079***	-0.073***	-0.074***	-0.074***	-0.074***	-0.079***
	(0.025)	(0.021)	(0.021)	(0.021)	(0.021)	(0.025)
Minority	-0.002	-0.003	-0.003	-0.005	-0.003	-0.002
	(0.045)	(0.058)	(0.045)	(0.045)	(0.045)	(0.059)
Rural	-0.035	-0.035	-0.034	-0.035	-0.035	-0.038
	(0.025)	(0.025)	(0.027)	(0.025)	(0.025)	(0.029)
NCEE	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Humanities track	-0.045	-0.046	-0.046	-0.048	-0.046	-0.047
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Arts and athletics track	-0.027	-0.028	-0.028	-0.024	-0.029	-0.025
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Non-cognitive leadership skills	0.041**	0.041**	0.041**	0.041**	0.041**	0.041**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)

Only child	0.013	0.013	0.013	0.014	0.013	0.013
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
SES	0.014	0.014	0.014	0.014	0.012	0.011
	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)	(0.016)
Major in liberal arts	0.079	0.081	0.081	0.081	0.081	0.079
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Major in social sciences	0.013	0.014	0.014	0.013	0.013	0.012
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Major in economics and management	-0.098**	-0.097**	-0.097**	-0.099**	-0.098**	-0.100**
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
Major in other disciplines	0.046	0.046	0.046	0.044	0.047	0.044
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Average academic score	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Party member	0.031	0.031	0.031	0.031	0.031	0.031
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Student leader	0.026	0.026	0.026	0.026	0.026	0.026
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Have certificate	-0.014	-0.014	-0.014	-0.013	-0.014	-0.014
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Pass CET4	0.056**	0.056**	0.056**	0.055**	0.056**	0.056**
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Pass CET6	0.136***	0.136***	0.136***	0.136***	0.136***	0.135***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Part-time work	-0.031	-0.031	-0.031	-0.031	-0.031	-0.032
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.027)
Have merit aid	0.039*	0.039*	0.039*	0.039*	0.039*	0.039*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Have need-based aid	-0.038*	-0.038*	-0.038*	-0.037*	-0.037*	-0.037*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Have loan	-0.019	-0.019	-0.019	-0.019	-0.019	-0.019
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Have minor	0.004	0.005	0.005	0.005	0.005	0.005
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Like major	0.022**	0.022**	0.022**	0.022*	0.022**	0.022*
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Engineering college	-0.029	-0.029	-0.029	-0.030	-0.031	-0.031
	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)	(0.033)
Normal college	-0.113**	-0.114**	-0.114**	-0.113**	-0.116**	-0.114**
	(0.048)	(0.048)	(0.048)	(0.048)	(0.049)	(0.049)
Agriculture college	-0.118**	-0.118**	-0.118**	-0.124**	-0.120**	-0.125**
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
Finance college	-0.108	-0.108	-0.109	-0.106	-0.109	-0.106
	(0.159)	(0.159)	(0.159)	(0.158)	(0.159)	(0.158)

Political science college	0.049	0.048	0.048	0.043	0.050	0.045
	(0.099)	(0.099)	(0.099)	(0.100)	(0.099)	(0.100)
Ethnic college	0.091	0.099	0.099	0.093	0.098	0.089
	(0.067)	(0.065)	(0.066)	(0.065)	(0.066)	(0.064)
College in the East	0.013	0.016	0.016	0.013	0.014	0.009
	(0.051)	(0.050)	(0.051)	(0.050)	(0.051)	(0.051)
College in the Northeast	-0.096*	-0.094*	-0.094*	-0.096*	-0.095*	-0.100*
	(0.055)	(0.054)	(0.054)	(0.054)	(0.054)	(0.055)
College in the Central	-0.056	-0.053	-0.054	-0.054	-0.055	-0.058
	(0.041)	(0.040)	(0.040)	(0.040)	(0.040)	(0.041)
College in the West	0.015	0.018	0.017	0.016	0.016	0.013
	(0.042)	(0.041)	(0.041)	(0.041)	(0.041)	(0.042)
Work migration	0.114***	0.113***	0.113***	0.114***	0.114***	0.115***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Foreign-sector employer	0.053*	0.054*	0.054*	0.054*	0.053*	0.053*
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Private-sector employer	-0.038*	-0.038*	-0.038*	-0.038*	-0.038*	-0.038*
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Job industry	Yes	Yes	Yes	Yes	Yes	Yes
Workplace province	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.960***	6.962***	6.962***	6.930***	6.968***	6.936***
	(0.292)	(0.293)	(0.293)	(0.294)	(0.294)	(0.295)
N	3173	3173	3173	3173	3173	3173
R^2	0.335	0.335	0.335	0.335	0.335	0.336

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.4 The Varying Effect of College Quality by Earning Distribution

The analyses in previous sections in this chapter are based on the design of econometric models that evaluate the effects at the mean of the earning distribution. Given the large divergence in staring salary level, people may wonder how the effect of college quality might change over the earning distribution. This section extends the examination of the economic returns to college quality to another dimension with data from China. For example, the hypothesis that the predictive power of college quality may be higher at the top of the earnings distribution than for the graduates at the bottom was confirmed in the U.S.(L. Zhang, 2005c). People may be curious to know whether this pattern holds for China as well.

To convey a sense of trend on the impact of college quality across the entire wage distribution, results are reported for the 10th, 25th, 50th, 75th and 90th percentile points in wage distribution. These points in earning distribution are commonly used as representative points that spread evenly across the distribution. The specifications in this section are exactly the same as in the preferred baseline OLS model (Model 3) in section 5.2.1, and the quantile regressions are estimated. The OLS estimates in column 1 provide a benchmark for comparison with quantile regression results estimates in column 2 through column 6. Because the dependent variable is in its natural log form, the estimates are in log points and the following inferences will be discussed in unit of log points.

A couple of observations can be drawn from Table 5-14: First, overall, elite college attendance leads to an increase in starting wages, no matter what position is examined in the wage distribution. This effect is positive and statistically significant at the 1% level. Second, college quality has the most pronounced impact on wages at the two tails of the earning distribution, and it has smaller effects in the middle area of the distribution in terms of point estimates. The general pattern is mixed, and the effects fluctuate across earning distribution positions. For example, having attended elite college is associated with a 13.4 percentage point increase at the 10th percentile. In contrast, the starting wage is increased by 12 percentage points at the median of the wage distribution and 12.8 percentage points at the 90th percentile for elite college graduates. However, the magnitudes of these effects across earning distribution are quite close, roughly within the range of 0.11 to 0.14. Third, the OLS results are similar to that of median regression (i.e., regression at the 50th percentile). It makes sense intuitively because median quantile regression by construction is largely based on observations at average levels and resembles the OLS regression that examines the average effect methodologically. Fourth, the magnitude and the level of significance vary for covariates across the earning distributions, but the directions generally do not change.

To my knowledge, this study is the first attempt to explore the potential heterogeneous effect of college quality by earning distribution for fresh college graduates in China. Compared with previous U.S. studies that examine the effect of college quality for college graduates with many years of work experience, the results in this section reveal that the pattern of differential college quality effects for earning distribution does not hold in China. In the United States, a diploma from a high-quality college will not help much if the student ends up in a low-paid job placement while the brand of college matters much more for college graduates with well-paid jobs. In other words, it implies that college quality is a stronger determinant of starting wage at the top of the earning distribution than at the bottom of it (L. Zhang, 2005c). There may be several possible reasons why a similar finding does not occur in China. First, quality differentiation and divergence would be bigger in sampled American colleges that cover all types of universities nationwide. Second, the elite social class in the U.S. labor market tends to value individuals with elite education backgrounds more than in China's case. Third, the effect of college quality tends to be more evident at the mid- or later-career stages than at the starting point. The elite college premium may rise as graduates gain longer periods of work experience.

Table 5-14 The Effect of Attending Elite Colleges Varying by Earning Distribution

	(1) OLS	(2) 10th Percentile	(3) 25th Percentile	(4) 50th Percentile	(5) 75th Percentile	(6) 90th Percentile
Elite	0.124***	0.134***	0.103***	0.120***	0.109***	0.128***
	(0.025)	(0.031)	(0.026)	(0.012)	(0.020)	(0.029)
Age	0.008	0.028**	0.008	0.007	0.006	0.006
	(0.009)	(0.012)	(0.010)	(0.005)	(0.007)	(0.010)
Female	-0.073***	-0.064**	-0.059**	-0.069***	-0.091***	-0.113***
	(0.021)	(0.029)	(0.023)	(0.011)	(0.017)	(0.024)
Minority	-0.003	-0.014	0.034	0.023	0.008	0.005
	(0.045)	(0.048)	(0.040)	(0.018)	(0.028)	(0.038)
Rural	-0.035	-0.001	-0.002	-0.008	-0.015	-0.045*
	(0.025)	(0.034)	(0.026)	(0.012)	(0.018)	(0.025)

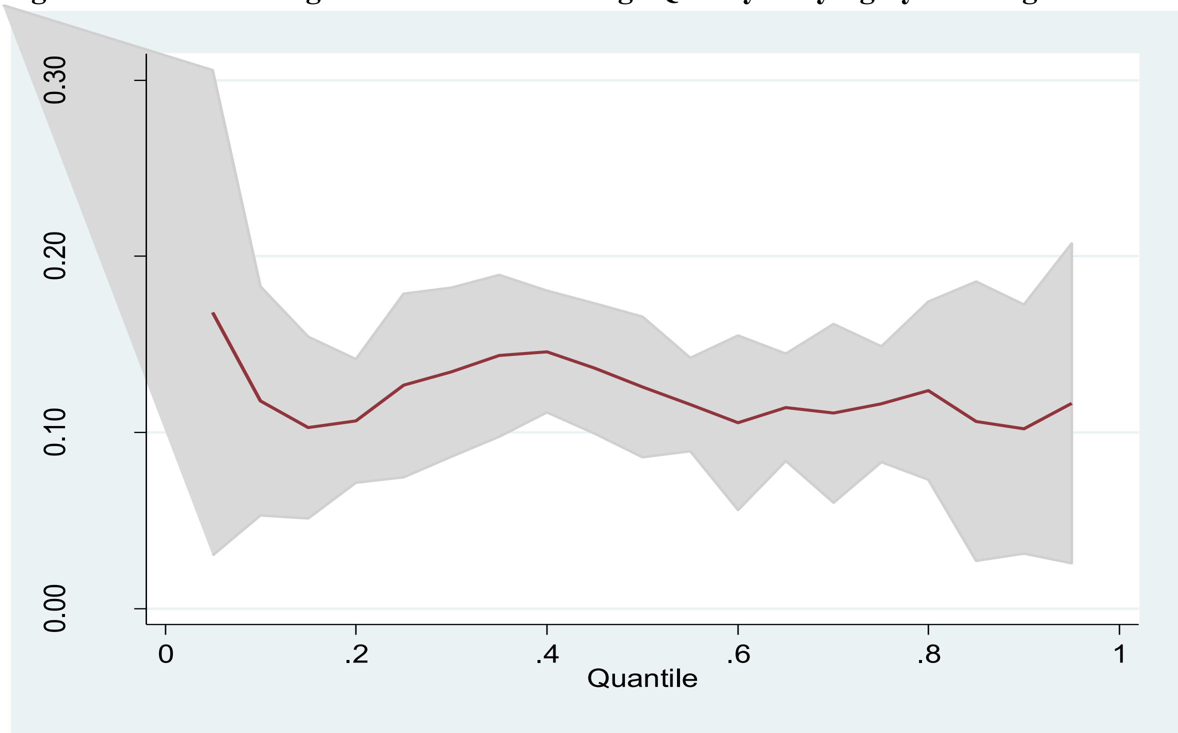
NCEE	0.007***	0.003	0.004*	0.005***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Humanities track	-0.046	-0.017	0.021	-0.055***	-0.079***	-0.040
	(0.036)	(0.041)	(0.035)	(0.016)	(0.026)	(0.035)
Arts and athletics track	-0.028	-0.092	-0.023	0.018	0.071	0.033
	(0.060)	(0.076)	(0.067)	(0.031)	(0.050)	(0.070)
Non-cognitive leadership skills	0.041**	0.015	0.016	0.020**	0.027*	0.003
	(0.018)	(0.023)	(0.019)	(0.009)	(0.014)	(0.020)
Only child	0.013	0.027	0.012	0.005	-0.010	0.023
	(0.024)	(0.031)	(0.025)	(0.011)	(0.018)	(0.024)
SES	0.014	0.007	0.025	0.035***	0.041***	0.032**
	(0.014)	(0.019)	(0.015)	(0.007)	(0.010)	(0.014)
Major in liberal arts	-0.014	-0.078	-0.122***	-0.050**	-0.004	-0.007
	(0.045)	(0.056)	(0.046)	(0.022)	(0.033)	(0.044)
Major in social sciences	0.067	0.037	-0.026	0.040	0.016	0.012
	(0.054)	(0.076)	(0.061)	(0.028)	(0.041)	(0.051)
Major in economics and management	-0.111***	-0.128***	-0.099***	-0.049***	-0.009	-0.011
	(0.031)	(0.038)	(0.031)	(0.014)	(0.022)	(0.029)
Major in other disciplines	0.033	-0.026	0.004	0.012	0.029	0.034
	(0.044)	(0.065)	(0.056)	(0.025)	(0.039)	(0.054)
Average academic score	-0.000	-0.001	0.000	0.000	0.004***	0.005***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Party member	0.031	0.069**	0.041*	0.041***	0.043***	0.042*
	(0.022)	(0.027)	(0.022)	(0.010)	(0.016)	(0.023)
Student leader	0.026	0.009	0.023	0.029***	0.057***	0.074***
	(0.022)	(0.030)	(0.024)	(0.011)	(0.018)	(0.025)
Have certificate	-0.014	0.012	0.020	0.003	-0.003	-0.019
	(0.018)	(0.023)	(0.019)	(0.009)	(0.014)	(0.019)
Pass CET4	0.056**	0.057*	0.067**	0.049***	0.066***	0.070**
	(0.026)	(0.033)	(0.027)	(0.013)	(0.020)	(0.028)
Pass CET6	0.136***	0.148***	0.123***	0.095***	0.095***	0.133***
	(0.031)	(0.039)	(0.032)	(0.015)	(0.023)	(0.034)
Part-time work	-0.031	-0.081**	-0.058**	-0.044***	-0.040**	0.031
	(0.026)	(0.034)	(0.028)	(0.013)	(0.020)	(0.029)
Have merit aid	0.039*	0.048*	0.029	0.024**	0.026	-0.001
	(0.021)	(0.027)	(0.023)	(0.010)	(0.017)	(0.024)
Have need-based aid	-0.038*	-0.006	0.010	-0.000	-0.017	-0.045*
	(0.021)	(0.029)	(0.024)	(0.011)	(0.017)	(0.024)
Have loan	-0.019	-0.043	-0.033	-0.023**	-0.028*	0.001
	(0.021)	(0.028)	(0.022)	(0.010)	(0.016)	(0.022)
Have minor	0.005	-0.012	0.029	-0.002	0.012	0.008
	(0.032)	(0.046)	(0.038)	(0.017)	(0.027)	(0.036)
Like major	0.022**	0.020	0.012	0.015***	0.028***	0.032**

	(0.011)	(0.015)	(0.012)	(0.006)	(0.009)	(0.013)
Work migration	0.113***	0.115***	0.085***	0.078***	0.077***	0.100***
	(0.031)	(0.033)	(0.027)	(0.013)	(0.021)	(0.030)
Foreign-sector employer	0.054*	0.098**	0.078**	0.085***	0.120***	0.118***
	(0.029)	(0.039)	(0.032)	(0.015)	(0.024)	(0.034)
Private-sector employer	-0.038*	-0.011	-0.007	-0.002	0.009	0.011
	(0.020)	(0.027)	(0.022)	(0.010)	(0.017)	(0.023)
Institution specialization	Yes	Yes	Yes	Yes	Yes	Yes
Institution region	Yes	Yes	Yes	Yes	Yes	Yes
Job industry	Yes	Yes	Yes	Yes	Yes	Yes
Workplace province	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.975***	5.851***	6.871***	7.226***	6.785***	6.783***
	(0.287)	(0.420)	(0.396)	(0.195)	(0.294)	(0.365)
N	3173	3173	3173	3173	3173	3173
R^2/Pseudo R^2	0.335	0.192	0.153	0.191	0.160	0.221

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 5-3 plots the heterogeneous effect of college quality by measure of elite college attendance status across the whole earning distribution. Basically, a positive effect between 0.1 to 0.17 is consistently present across different quantile positions. The effect seems to fluctuate across the distribution and there is no clear trend. The positive effect in the middle of the distribution is slightly lower than in the two ends, and the lowest effect appears to be around the 20th and 90th percentile. The standard errors at the two extremes are larger than at other positions. This suggests that we should be more cautious about drawing inferences at two tails of the earning distribution.

Figure 5-3 The Heterogeneous Effect of College Quality Varying by Earning Distribution



5.5 Input-based Measures of College Quality

This section extends the previous sections by examining the effect of college quality with measures of input-based college quality indicators: faculty-student ratio, proportion of faculty members with doctoral degrees, average freshman NCEE score, teaching expenditure per student, and an index composed of these measures. These measures provide additional information on the operation and productivity of the HEIs in the sample and are constructed as continuous variables. The OLS regression and IV estimation models are employed to replicate the analysis procedure with these new college quality measures to answer the key research question. The outcome under investigation in this section is the starting salary level.

People often wonder whether non-elite colleges really differ from elite colleges in quality and how big the quality gap is. In this section, we first explore whether the high-quality college category and the low-quality college category differs on four school input resource indicators by the simple OLS regression with institution level data and controls. Then, we present the estimation results with the new college quality index measures. Finally, our target is to determine which aspect of college quality or which input indicator is more important in determining starting salary.

Table 5-15 presents simple comparisons for elite and non-elite colleges with institution level clustered data from the OLS regressions. Other institution characteristics are controlled for such as the institution subject specializations and institution location regions. Columns 1 through 4 show the differences in concrete input-based resource indicators between elite and non-elite colleges. Columns 5 and 6 examine the differences among college quality categories with regard to overall quality indexes. According to Table 5-15, the proportion of faculty members holding doctoral degrees in elite colleges is 0.211 higher than in non-elite colleges, and the average freshman NCEE score is 7.075 points higher in elite colleges than in non-elite colleges. Both of these differences are statistically significant at the 1% level. On average, the teaching-related expenditure per undergraduate student is 2215.8 RMB higher in elite colleges, but the faculty members are less available in elite colleges. However, these effects are not statistically significant at the college level when other college characteristics are held constant. Therefore, the results suggest that elite colleges and non-elite colleges differ primarily in personnel inputs. Elite colleges in China are HEIs with higher quality faculty members and students. It is worth noting that although we are able to collect school average NCEE score for all institutions, the number of complete cases is 20, 37, 45, respectively for teaching expenditure, faculty quality and faculty availability measures at the institution level. Thus, we calculate two overall college quality indexes. Quality index in column 5 is compiled from all four input indicators for 17 HEIs in the sample, and the quality index in column 6 is constructed from all input measured except expenditure, which has a high missing data rate of over 60%. We find consistent and statistically significant differences in overall institutional quality between elite and non-elite colleges when the two quality indices are in use, suggesting the existence of difference in overall quality between elite and non-elite colleges.

Table 5-15 Differences in Input-based Quality Indicators: Elite Colleges versus Non-Elite Colleges

	(1) Teaching expenditure per student	(2) Proportion of Ph.D. faculty members	(3) Faculty-student ratio	(4) Student selectivity	(5) Quality index for 4 inputs	(6) Quality index for 3 inputs
Elite	2215.810	0.211***	-0.001	7.075***	2.048*	1.965***
	(2208.186)	(0.043)	(0.002)	(1.403)	(1.002)	(0.379)
Engineering college	672.761	0.087	-0.003	1.534	0.282	0.816
	(2468.763)	(0.061)	(0.002)	(1.736)	(0.835)	(0.500)
Normal college	-967.640	-0.037	0.0003	-1.621	-0.097	-0.435
	(2081.270)	(0.073)	(0.003)	(2.046)	(1.226)	(0.655)
Agriculture college	-5476.558	0.089	0.002	-0.210	-1.455	0.477
	(4098.451)	(0.076)	(0.003)	(1.791)	(0.869)	(0.577)
Finance college		0.083	-0.002	-1.087		0.385
		(0.073)	(0.002)	(1.954)		(0.573)
Political science college	-958.378	0.090	-0.006***	8.466***	-0.791	1.753**
	(4487.013)	(0.083)	(0.003)	(2.819)	(2.872)	(0.782)
Ethnic college			-0.006***	-0.221		
			(0.007)	(2.245)		
College in the East	264.561	0.055	-0.001	2.102	-1.867	0.793
	(4002.542)	(0.089)	(0.003)	(2.546)	(2.958)	(0.811)
College in the Northeast	4786.039	-0.167**	-0.007*	-3.738	-1.093	-1.314*
	(2807.521)	(0.076)	(0.004)	(2.357)	(2.368)	(0.689)
College in the Central	-3120.669	-0.110	0.001	-2.479	-3.555	-0.931
	(2689.031)	(0.067)	(0.003)	(1.932)	(2.485)	(0.610)
College in the West	3698.689	-0.133*	-0.003	-0.480	-1.829	-0.657
	(2807.521)	(0.069)	(0.003)	(1.970)	(2.368)	(0.604)
Constant	3418.748	0.350***	0.060***	67.595***	0.433	-1.005**
	(4487.013)	(0.083)	(0.002)	(2.819)	(2.872)	(0.782)
N	20	37	45	49	17	37
R^2	0.428	0.602	0.219	0.648	0.662	0.656

Note: Standard errors in the parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

Table 5-16 contains the OLS and IV estimation results for college quality indexes extracted from four input indicators (including the expenditure measure) in column 1 and 2. Columns 3 and 4 present the parallel results for the overall college quality index extracted from three input indicators (excluding the expenditure measure) for sensitivity checks given the severity of the missing rate in the teaching expenditure measure. In this dissertation, single imputation is only implemented at student level but not at the institution level because we lack proper ways to impute institution level missing values. Moreover, to make plausible inferences, the results should be based on the real treatment status, not imputed ones. Thus, the number of complete cases shrinks dramatically from around 2300 to fewer than 800 if the expenditure measure is taken into account. To make the regression results more comparable across regressions, specifications are the same as the baseline OLS model in section 5.2.1 and the IV estimation model in section 5.2.2. Nevertheless, the elite dummy is replaced by overall college quality indexes to answer the key research question—estimating the economic return to college quality.

Table 5-16 shows that the effect of overall quality on earning is positive and statistically significant at the 1% level if we use the quality index compiled either from all four input indicators or from three input indicators. The coefficients are smaller than those obtained from regressions with elite dummies. The interpretation is that one unit increase in the overall college quality index raises the starting salary by 7.9 percentage points, according to the OLS regression with the college quality index from four inputs. The IV estimations are substantially larger than the OLS results, which resembles the pattern when the elite dummy is plugged in. When we use the quality index extracted from three inputs, the sample size expands almost three-fold. However, the IV estimator is less precisely estimated with the weak instrument that does not pass the F-statistic threshold and a larger standard error in column 4. Generally speaking, the results from the OLS regressions in column 1 and column 3 are consistent; albeit, they are much smaller than point estimates in IV estimations. The IV estimations in column 2 and column 4 are not consistent, and the instrument turns out to be weak in the column 4 model. The Durbin-Wu-Hausman test in column 2 infers that the IV model is more appropriate than the OLS regression when there is an endogenous treatment regressor. To sum up, the basic conclusion that higher college quality fosters a higher starting wage will not change if the college quality is measured by indexes but the effect wanes.

Table 5-16 The Impact of College Quality Indexes on Starting Salary

	(1) OLS	(2) IV	(3) OLS	(4) IV
Quality index for 4 inputs	0.079***	0.543***		
	(0.022)	(0.196)		
Quality index for 3 inputs			0.071***	0.750*
			(0.012)	(0.417)
Age	0.024	0.047**	0.003	0.036
	(0.018)	(0.024)	(0.010)	(0.026)
Female	-0.126***	-0.111	-0.066***	-0.017
	(0.039)	(0.051)	(0.023)	(0.047)
Minority	-0.0004	-0.034	0.038	-0.059
	(0.048)	(0.069)	(0.047)	(0.127)
Rural	-0.075	-0.090	-0.042	-0.038
	(0.048)	(0.056)	(0.029)	(0.049)
NCEE	-0.001	-0.011*	0.003*	-0.053
	(0.003)	(0.006)	(0.002)	(0.034)
Humanities track	-0.006	0.092	-0.064	-0.052
	(0.046)	(0.071)	(0.038)	(0.075)
Arts and athletics track	-0.078	-0.288*	-0.035	-0.899*
	(0.090)	(0.158)	(0.062)	(0.542)
Non-cognitive leadership skills	0.052	-0.013	0.025	0.022
	(0.034)	(0.048)	(0.021)	(0.036)
Only child	-0.065	-0.095*	0.008	-0.097
	(0.041)	(0.057)	(0.026)	(0.086)
SES	0.014	0.037	0.008	0.042
	(0.020)	(0.030)	(0.017)	(0.036)
Major in liberal arts	0.037	-0.074	-0.022	0.074
	(0.101)	(0.112)	(0.046)	(0.105)

Major in social science	0.043	-0.045	-0.006	-0.147
	(0.086)	(0.111)	(0.053)	(0.127)
Major in economics and management	-0.033	-0.066	-0.077***	-0.014
	(0.048)	(0.061)	(0.034)	(0.068)
Major in other disciplines	0.025	-0.047	0.001	-0.089
	(0.055)	(0.096)	(0.046)	(0.115)
Average academic score	0.004	0.009*	-0.001	0.003
	(0.003)	(0.005)	(0.002)	(0.004)
Party member	0.059	0.100*	0.026	-0.071
	(0.042)	(0.048)	(0.023)	(0.070)
Student leader	0.061*	0.088*	0.006	0.020
	(0.033)	(0.046)	(0.025)	(0.041)
Have certificate	0.047	0.089**	-0.004	-0.0001
	(0.032)	(0.044)	(0.020)	(0.034)
Pass CET 4	0.056	0.035	0.062**	0.032
	(0.052)	(0.070)	(0.029)	(0.055)
Pass CET 6	0.120**	-0.011	0.165***	-0.013
	(0.055)	(0.090)	(0.034)	(0.130)
Part-time work	-0.056	-0.066	-0.019	-0.065
	(0.042)	(0.060)	(0.031)	(0.061)
Have merit aid	-0.067*	-0.090*	0.032	0.081
	(0.038)	(0.047)	(0.023)	(0.051)
Have need-based aid	0.002	0.010	-0.069***	-0.110**
	(0.038)	(0.048)	(0.023)	(0.046)
Have loan	-0.022	0.040	0.002	0.038
	(0.032)	(0.050)	(0.023)	(0.048)
Have minor	0.041	0.095	-0.034	-0.069
	(0.052)	(0.066)	(0.035)	(0.061)
Like major	0.048**	0.064**	0.016	0.022
	(0.020)	(0.026)	(0.013)	(0.024)
Engineering college	0.026	0.648**	-0.046	0.149
	(0.056)	(0.269)	(0.032)	(0.151)
Normal college	0.226**	-0.018	0.004	0.901
	(0.102)	(0.153)	(0.051)	(0.565)
Agriculture college	-0.057	1.008**	-0.133**	-0.752***
	(0.084)	(0.456)	(0.052)	(0.367)
Finance college			-0.074	0.606
			(0.170)	(0.568)
Political science college	0.020	1.264**	0.072	0.526

	(0.133)	(0.564)	(0.095)	(0.325)
College in the East	-0.182*	0.999*	-0.045	-0.423*
	(0.103)	(0.557)	(0.051)	(0.220)
College in the Northeast	-0.065	0.317	-0.105*	0.294
	(0.125)	(0.293)	(0.063)	(0.306)
College in the Central	0.034	1.975**	-0.043	0.256
	(0.106)	(0.881)	(0.045)	(0.262)
College in the West	-0.072	0.572	-0.029	-0.042
	(0.092)	(0.361)	(0.045)	(0.117)
Work migration	0.078	-0.284*	0.146***	0.141**
	(0.048)	(0.169)	(0.039)	(0.067)
Foreign-sector employer	0.017	0.045	0.082***	0.173**
	(0.052)	(0.061)	(0.031)	(0.081)
Private-sector employer	-0.0003	0.032	-0.021	0.060
	(0.038)	(0.051)	(0.141)	(0.061)
Ln(average GDP per capita) in home province		0.056		-0.088
		(0.078)		(0.064)
Job industry	Yes	Yes	Yes	Yes
Workplace province	Yes	Yes	Yes	Yes
Constant	6.912***	5.335***	8.035***	11.977***
	(0.623)	(1.274)	(0.369)	(2.475)
N	789	773	2331	2294
R^2	0.360		0.367	
First-stage relevance		0.053***		0.029*
		(0.018)		(0.015)
F-statistic		11.953		3.502
Durbin-Wu-Hausman test of exogeneity		0.002		0.001

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

A further step is taken to determine what aspect of college quality is the most important determinant in overall college quality with the baseline OLS model when we plug in all four concrete input indicators. Again, results from another parallel baseline OLS model with three input indicators are also presented for robustness check purposes. The OLS regression is adequate on this issue because it was shown to be rather efficient and robust in previous sections, and it is more complicated to use the IV method when we have three or four treatment variables. Both the outcome variable and predictors are standardized with a mean of zero and a standard deviation of one so that the coefficients on the input indicators are comparable with the assumption that one standard deviation in one variable is equivalent to the same metric in another variable.

When all four input indicators are plugged into the same wage equation, the single factor that has the biggest contribution to the variation in starting wage is the proportion of faculty members holding doctoral degrees. It is significant at the 10% level and based on a sample of about 830 observations in Table 5-17 column 1. The result is reversed when the teaching expenditure per student measure is omitted from the OLS regression in Table 5-17 column 2. It seems that the effect of faculty quality is overtaken by the positive effect of student selectivity and the negative effect of faculty availability. The results align with the previous studies that the conclusion could be sensitive and contingent on the explicit measures of college quality. Thus, this highlights the importance of examining college quality comprehensively and interpreting the results with caution. It seems that hiring additional faculty members with doctoral degrees and enhancing teacher quality would be the most effective way to raise college quality in China. In other words, the knowledge and ability gains in college that are passed on by teachers are the essence of college quality that is rewarded in the early labor market. However, we should be cautious to this conclusion because the coefficient is statically at the 10% level and this conclusion is based on the smaller sample of 830. Also, there are too few measures of college quality; and there is no consideration of costs and cost-effectiveness. Due to the data limitations, we need future studies with complete institution level data to confirm these findings.

Table 5-17 The Effect of College Quality Input Indicators on Starting Salary

	(1) Four input indicators	(2) Three input indicators
Faculty-student ratio	-0.054	-0.167***
	(0.069)	(0.036)
Proportion of Ph.D. faculty members	0.339*	0.052
	(0.178)	(0.041)

Average freshman NCEE score	0.012	0.230***
	(0.245)	(0.047)
Teaching expenditure per student	0.187	
	(0.127)	
Age	0.053	0.007
	(0.041)	(0.025)
Female	-0.148***	-0.089***
	(0.046)	(0.028)
Minority	0.0004	0.026
	(0.030)	(0.030)
Rural	-0.088	-0.052
	(0.056)	(0.035)
NCEE	-0.025	0.004
	(0.059)	(0.040)
Humanities track	0.008	-0.044
	(0.045)	(0.037)
Arts and athletics track	-0.046	-0.040
	(0.052)	(0.038)
Non-cognitive leadership skills	0.061	0.027
	(0.039)	(0.025)
Only child	-0.073	0.004
	(0.048)	(0.032)
SES	0.039	0.002
	(0.048)	(0.040)
Major in liberal arts	0.021	-0.024
	(0.065)	(0.034)
Major in social science	-0.002	-0.017
	(0.055)	(0.034)
Major in economics and management	-0.038	-0.076***
	(0.042)	(0.032)
Major in other disciplines	0.017	-0.012
	(0.035)	(0.030)
Average academic score	0.070	0.001
	(0.035)	(0.029)
Party member	0.062	0.025
	(0.045)	(0.027)
Student leader	0.072**	0.006
	(0.032)	(0.025)
Have certificate	0.074**	-0.004

	(0.038)	(0.024)
Pass CET4	0.067	0.071**
	(0.061)	(0.035)
Pass CET6	0.127*	0.192***
	(0.063)	(0.041)
Part-time work	-0.064	-0.017
	(0.041)	(0.031)
Have merit aid	-0.080*	0.046*
	(0.042)	(0.027)
Have need-based aid	-0.002	-0.070***
	(0.037)	(0.023)
Have loan	-0.030	-0.003
	(0.034)	(0.024)
Have minor	0.025	-0.034
	(0.033)	(0.024)
Like major	0.120***	0.028
	(0.043)	(0.028)
Engineering college	0.097	-0.081**
	(0.068)	(0.040)
Normal college	0.143*	0.063*
	(0.082)	(0.037)
Agriculture college	-0.015	-0.028
	(0.048)	(0.033)
Finance college		-0.012
		(0.032)
Political science college	0.070	0.025
	(0.056)	(0.035)
College in the East	-0.079	-0.014
	(0.104)	(0.045)
College in the Northeast	-0.049	-0.133***
	(0.097)	(0.047)
College in the Central	0.121	0.069
	(0.094)	(0.045)
College in the West	-0.025	-0.065
	(0.110)	(0.050)
Work migration	0.076	0.175***
	(0.054)	(0.044)
Foreign-sector employer	-0.004	-0.027
	(0.039)	(0.026)

Private-sector employer	-0.004	-0.027
	(0.042)	(0.026)
Job industry	Yes	Yes
Workplace province	Yes	Yes
Constant	0.156	0.004
	(0.154)	(0.117)
N	830	2331
R^2	0.364	0.381

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

Chapter 6 Conclusions and Policy Implications

College quality may play a crucial role in determining the early labor market outcomes for fresh college graduates in China. Understanding such a role is meaningful for students, colleges, and the government. However, the college quality measures were too broad and abstract in previous Chinese studies. They provided very little information on how to improve college performance and how college quality functions and influences student outcomes, not to mention they were insufficient to address the differential effects for various groups of students. This dissertation aims to determine the effect of college quality on early labor market outcomes of college students by answering the five research questions stated in Chapter 3.

The student survey and institutional survey conducted by Tsinghua University facilitate this study by providing valuable second-hand data. With my effort to collect explicit institutional quality measures from multiple data sources, this dissertation makes new advances in several aspects: First, the new round of data collected by the CSLM survey enables comprehensive analyses on determinants of early labor market outcomes in China, from aspects of student characteristics, family background, student college experiences, institutional characteristics, and labor market behaviors. Second, input-based concrete college quality measures primarily collected from the Tsinghua institutional survey and official reports relax the data constraints on college operations in China. These data constraints had hindered previous studies from addressing the issues of college quality assessment and enhancement in China. More thorough and informative insights are gained in this study with better defined college quality categories and concrete input-based college quality measures. This study is the first empirical study to use the new and specific input-based college quality measures to examine the impact of college quality on early labor market outcomes in China. Third, advanced econometric models are built to examine the controversial role of college quality systematically and rigorously. To establish the causality between college quality and labor market outcomes, the IV and PSM strategies are applied in additional to the conventional OLS model. The potential sample selection is also tested by the Heckman sample correction method. This study is more rigorous and thorough than previous Chinese studies in terms of identification strategies and causality analysis. Last but not least, this study extends research scopes by focusing on potential heterogeneity of the effect of college quality. The heterogeneous effects are examined for students of different individual characteristics and family backgrounds, and for students in different positions of the earning distribution.

This chapter first summarizes the key findings and conclusions in this study, and then discusses the policy implications and limitations and suggestions for future research.

6.1 Summary of Findings and Conclusions

In this section, the main findings of this dissertation are inventoried in the sequence of proposed research questions.

First, the assertion about the effect of college quality on initial employment status is inconclusive when the dichotomous categorical measure of college quality is employed in the baseline probit model. However, when splitting the sampled HEIs into four quality categories, earning a degree from a Project 985 college appears to provide advantages in job seeking relative to graduating from a non-key college. The IV-probit model suggests that fresh college graduates in elite colleges have significantly higher employment opportunities than do their non-elite college counterparts. Thus, the effect size and significance level change depending on how colleges of various qualities are defined and categorized and what methodology is adopted. In sum, evidence suggests the existence of inequality in initial job attainment due to college quality.

Second, the average effect of college quality on starting wages is positive and highly significant even after controlling for a rich set of covariates. The magnitudes of the economic return to college equality vary by alternative measures of college quality and by identification strategies employed. The point estimate from the OLS regression for elite college attendance dummy is 0.124. It is substantially smaller than the IV estimate of 0.810, which has a larger standard error. But it is quite similar to the PSM estimate of about 0.133. Therefore, the impact of college quality is consistently present across different model specifications and identification strategies. Generally speaking, we find unambiguous evidence that college quality has a positive and significant impact on fresh college graduates' starting salary in China. The sample selection issue does not bias our results.

Third, we only find weak evidence that the effect of college quality operates in a heterogeneous manner. Less-capable students tend to benefit more from having more-capable schoolmates. Moreover, we do not find the effect of college quality vary by other individual student characteristics or family background such as gender, ethnicity, household registration status, and SES. Our findings are unable to confirm the previous Chinese studies that discovered greater benefits of attending elite colleges for female students and students with favorable family backgrounds.

Fourth, the quantile regression results suggest that the effect of college quality fluctuates across the earning distribution and that the variation is too subtle to distinguish. We do not observe the similar pattern as is found in the U.S. that if students end up in the low earning distribution, they will not enjoy as much of the premium of college quality as their counterparts in high-paying jobs. On the contrary, it suggests a relatively uniform effect of college quality at the starting career phase of one's life span in China. It may be due to the fact that the earning trajectories over college graduates' careers differ for students in colleges of various quality categories, but the differences may not be evident at the initial stages of graduates' careers.

Fifth, when alternative overall college quality index measures are utilized, we consistently find positive effects for starting salaries, and we do observe a substantial overall quality distinction between elite and non-elite colleges. When explicit input-based resource indicators are used to replace the abstract elite dummy, we find certain college quality measures have effects on the starting salary while others do not. Thus, we should rely on the measures that are strongly correlated with actual college teaching performance and view overall college quality as the assembly of various quality components. Among all four input measures, the proportion of doctoral faculty appears as the strongest determinant of starting salary. This suggests that students are more successful in obtaining well-paid jobs from HEIs with more faculty members with higher qualifications and advanced educational attainments. When the teaching expenditure measure is excluded, the results suggest otherwise. Thus, it is crucial to view college quality from the multidimensional perspective and to avoid misleading findings.

6.2 Policy Implications

The following policy implications are proposed based on the key findings of this dissertation. Because some research questions in this dissertation are new and it is the first Chinese study to apply some identification strategies on this research topic, further research is needed to confirm these preliminary findings. Tentative suggestions are offered to students, college administrators, and education policy makers in the higher education sector. The primary goal is to stimulate college graduates' early labor market success and to raise college quality in China.

Colleges of varying qualities tend to funnel students into different types of job placements in the early labor market. The elite college graduates have an easier time finding jobs and enjoy higher starting wages. This inequity might be passed on and widen over time. The findings provide justifications for daily observations that students and their parents make every effort to enter higher-quality universities. It is rational to expect continual fierce competition for elite college entrance because it is an important way to secure college investments that yield higher economic returns. Therefore, college quality may serve as a top priority in order to make rational college choice decisions. Given the highly unbalanced supply and demand of seats in elite colleges in China, preparation for the NCEE may continue to consume great social and financial costs unless the college admission system is reformed.

For HEIs, to overcome the financial restraints, non-elite colleges might take the initiative to welcome investments from society and enterprises that could build cooperative relationships with colleges. To better use the financial support, non-elite colleges might consider recruiting better-quality faculty members with doctoral degrees. It is possible that the performance gap between elite and non-elite colleges in the early labor market can be attributed to the differential speed of human capital accumulation, non-elite institutions may consider stress the cultivation of skills and abilities that are needed and rewarded in the labor market. Non-elite colleges might also implement various types of job recruitment encouragement programs that help students successfully search and locate jobs immediately after graduation.

For the government, the findings of higher returns for elite college attendance justify the huge governmental investments in national quality enhancement projects in China. Government agencies at all levels, central, provincial, and local, have paid great attention to the challenges of severe unemployment for fresh college graduates in China and are trying to end the discrimination and barriers that have occurred in the early labor market for fresh college graduates. For example, the MOE announced a new regulation in April, 2013 that emphasizes the elimination of discrimination of all forms when campus recruitment activities are held by employers and HEIs. New regulations forbid discriminations against female students, students with rural household registrations and students with lower levels of education attainment, and this is the first time that the discrimination against the students in certain college quality types is officially regulated: “The job recruitment advertisements that include the keywords such as “985” and “211” are strictly forbidden.” In other words, the government calls for the equal treatment of college students from institutions of various qualities. It reflects the government’s concern that non-elite college students are at a disadvantaged position when job hunting. Graduates from non-elite college are less likely to find jobs simply due to the less prestigous college names of HEIs students attended, not because of graduates’ lower working productivity. Based on the key findings of this study, evidence is found to support the disadvantageous initial job recruitment situation for non-elite college students. The findings also suggest that the influence of college quality discrimination may go beyond initial employment status. It is more evident for the equalities in starting salaries as supported by solid evidence in this study. The government may consider avoiding forming a hierarchy in any visible or invisible way in the early labor market in which elite-college students take the superior job placements while non-elite students take the inferior job placements. Policy makers may face tradeoffs when making policies that exploit the existence of the heterogeneous effect of college quality. The perfect sorting of students with high abilities into colleges with favorable backgrounds would exacerbate the future earning inequalities in the labor market, while inefficient sorting could result in lower student quality and poor college performance. The imperfect sorting may stem from the regional disparity in elite college enrollment opportunities and abuses of institutional autonomy, which should be strictly regulated and eliminated.

6.3 Limitations and Future Research Suggestions

Despite the effort to undertake a sound study, this dissertation still suffers from a number of limitations. Further research should be conducted to adjust for these deficiencies and to gain in-depth understandings in this field of study.

The first and the most obvious caveat is the data quality. The data is self-reported. Although tremendous efforts have been devoted to collect concrete input-based college quality indicators, the missing rates for some key input indicators such as the teaching expenditure per student and the faculty-student ratio are still high, and no missing data treatment procedure has been approved to be the proper cure thus far. Therefore, the results are mitigated by the data deficiency at college level. Furthermore, because part of the raw data is not accessible, the input indicators are calculated and reported by self-calculations in different HEIs from different sources, which raises the suspicion of inconsistent metrics used in these sources to some extent. Not satisfied with the limited input-based quality measures used in this study, I believe that additional investigation should be continued to find better and comprehensive measures of college quality that well capture the essence of quality. It is a pity that the process-related college quality measures were denied access for this study. Otherwise, it is interesting to look at how students gain knowledge and human capital stock in colleges through various engagement activities and how these activities are related to the labor market outcomes. Qualitative research can also be designed to shed light on the college dynamics and mechanisms for college quality to have impacts.

Second, given the timeline to conduct the survey, there would be a higher proportion of fresh graduates who have not received any job offers compared with U.S. studies that typically collect job placement data several months after graduation. It might cause the downward bias in this study when we draw inferences for these time-variant labor market outcomes. This study focuses on the early labor market outcomes. The estimation results from the early labor market may not be generalized to other contexts in a person's lifetime. Further research is needed to track the sampled students and to check the reliability of the results due to the fact that the returns to college quality might be fully exhibited in one's mid- or late-career. The heterogeneity of the impact of college quality may also present with survey data that include college graduates with many years of work experience.

Third, the internal and external validity of the identification strategies is subject to potential threats. We need to satisfy the assumptions for the PSM and IV strategies to work. If we have more detailed information about how the government policies are implemented and how colleges operate, we can run falsification tests to verify the validity of the IV such as the exogeneity and exclusion restriction conditions or to better control for the selection bias. Moreover, this study fails to incorporate the sampling weight in the PSM procedure. The PSM results are unweighted. The estimations should be interpreted with caution. Future research should be done to address these issues and to produce more convincing results. With recent reforms and developments of HEIs, it seems promising that China's higher education system will improve its transparency and accountability soon so that future studies on this research topic will produce results with greater precision and reliability.

Fourth, this study only addresses the potential sample selection problem within the "Intention-to-work" sample. There might exist other kinds of sample selections so that the sample under examination in this study is unable to represent all four-year college students in China. For example, by design, college dropouts are not present in the sample. Further research may want to examine the dropout rates in Chinese colleges and check whether these rates affect the findings. Future work might also want to explore the determinants of students' post-graduation plans and intentions to better understand why students choose to work or pursue further studies.

Fifth, this study cannot explain why there is a college quality effect. It may due to the human capital accumulation, the signaling effect, social networking, or through other ways. Thus, the policy suggestions in this study are tentative, not prescriptive. Further studies are warranted.

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APPENDICES

Appendix 1: Data Collection and Calculation for Input-based College Quality Indicators

Input-based College Quality Indicators	Data Collection Sources	Data Calculation
Faculty-student ratio	If the student-faculty ratio is reported in the 2011 Annual Undergraduate Teaching Quality Report, take the inverse of it. If it is not reported in the annual report, use the value reported from 2011 institutional survey by Tsinghua University. When there is a conflict, priority is given to the data reported by the official annual teaching quality report.	The student-faculty ratio equals the total number of full-time equivalent teaching faculties divided by all the full-time equivalent students. (Note: the calculation may vary across HEIs although the Ministry of Education has the calculation guidance on this indicator. For example, 1 undergraduate student = 1.5 master's student = 2 doctoral student.)
Proportion of faculty members with doctoral degrees	If the proportion is reported in the 2011 Annual Undergraduate Teaching Quality Report, use it. If it is not reported in the annual report, use the proportion calculated with data reported in 2011 institutional survey by Tsinghua University. When there is a conflict, priority is given to the data reported by the official annual teaching quality report.	The proportion of faculty members with doctoral degrees equals the number of teaching faculties with doctoral degrees divided by the number of teaching faculties with at least a master's degree. (Note: Most faculty members in Chinese HEIs have a master's or higher educational degree. The majority of HEIs have only recruited new teachers with Ph.D. degrees in recent years.)
Average freshman NCEE score	The 2007 freshman NCEE score on the Sunshine NCEE Information Platform back-office supported by the Ministry of Education	The raw student score is the 2007 freshman NCEE score rescaled to 0-100 by province and by academic track (science and liberal arts) in all provinces except Jiangsu province due to unavailability. Then, the average freshman NCEE score is calculated by taking the average of the raw data.
Teaching expenditure per student	2011 Annual Undergraduate Teaching Quality Report	The sum of teaching-related operational cost per undergraduate student and special funding per undergraduate student in 2011. (Note: Special funding includes the funding that is appropriated by the government for Project 985 and Project 211.)

Appendix 2: Results From the SES Index Construction Process

Table 1. Descriptive Statistics[a]

	Mean	Std. Deviation	Analysis N
lnfaminc	10.5186	.83543	5231
lnresarea	4.6866	.39662	5231
Mother's years of schooling	9.7541	3.89198	5231
Father's years of schooling	10.9011	3.39531	5231
resrural	.46	.499	5231
resordinary	.25	.434	5231
hous_manager	.14	.351	5231
hous_professional	.17	.374	5231
hous_ordstaff	.16	.364	5231
hous_farmworker	.48	.500	5231
hous_gov	.10	.297	5231
hous_inst	.19	.389	5231
hous_pub	.15	.360	5231
hous_servsale	.25	.431	5231

Note: a. Only cases for which etr_sescase = 0 are used in the analysis phase.

Table 2. Correlation Matrix[a,b]

		lnfaminc	lnresarea	Mother's years of schooling	Father's years of schooling	resrural	resordinary
Correlation	lnfaminc	1.000	.057	.396	.383	-.461	.365
	lnresarea	.057	1.000	-.089	-.040	.227	-.127
	Mother's years of schooling	.396	-.089	1.000	.620	-.487	.319

	Father's years of schooling	.383	-.040	.620	1.000	-.454	.271
	resrural	-.461	.227	-.487	-.454	1.000	-.535
	resordinary	.365	-.127	.319	.271	-.535	1.000
	hous_manager	.309	.008	.348	.407	-.348	.200
	hous_professional	.248	-.040	.320	.335	-.266	.140
	hous_ordstaff	.145	-.105	.166	.168	-.257	.140
	hous_farmworker	-.325	.025	-.333	-.313	.415	-.259
	hous_gov	.194	.019	.240	.281	-.227	.105
	hous_inst	.248	-.025	.320	.354	-.292	.130
	hous_pub	.237	-.026	.323	.365	-.257	.109
	hous_servsale	.158	-.078	.067	.041	-.226	.163
Sig. (1-tailed)	lnfaminc		.000	.000	.000	.000	.000
	lnresarea	.000		.000	.002	.000	.000
	Mother's years of schooling	.000	.000		.000	.000	.000
	Father's years of schooling	.000	.002	.000		.000	.000
	resrural	.000	.000	.000	.000		.000
	resordinary	.000	.000	.000	.000	.000	
	hous_manager	.000	.279	.000	.000	.000	.000
	hous_professional	.000	.002	.000	.000	.000	.000
	hous_ordstaff	.000	.000	.000	.000	.000	.000
	hous_farmworker	.000	.036	.000	.000	.000	.000
	hous_gov	.000	.080	.000	.000	.000	.000
	hous_inst	.000	.033	.000	.000	.000	.000

	hous_pub	.000	.030	.000	.000	.000	.000
	hous_servsale	.000	.000	.000	.002	.000	.000

Correlation Matrix[a,b]

		hous_manager	hous_professional	hous_ordstaff	hous_farmworker	hous_gov
Correlation	lnfaminc	.309	.248	.145	-.325	.194
	lnresarea	.008	-.040	-.105	.025	.019
	Mother's years of schooling	.348	.320	.166	-.333	.240
	Father's years of schooling	.407	.335	.168	-.313	.281
	resrural	-.348	-.266	-.257	.415	-.227
	resordinary	.200	.140	.140	-.259	.105
	hous_manager	1.000	.087	.013	-.330	.472
	hous_professional	.087	1.000	-.030	-.272	.093
	hous_ordstaff	.013	-.030	1.000	-.233	.164
	hous_farmworker	-.330	-.272	-.233	1.000	-.219
	hous_gov	.472	.093	.164	-.219	1.000
	hous_inst	.295	.487	.167	-.272	.096
	hous_pub	.213	.550	.085	-.251	.129
	hous_servsale	-.018	-.034	.239	-.198	-.046
Sig. (1-tailed)	lnfaminc	.000	.000	.000	.000	.000
	lnresarea	.279	.002	.000	.036	.080
	Mother's years of schooling	.000	.000	.000	.000	.000
	Father's years of schooling	.000	.000	.000	.000	.000
	resrural	.000	.000	.000	.000	.000
	resordinary	.000	.000	.000	.000	.000
	hous_manager		.000	.175	.000	.000

	hous_professional	.000		.014	.000	.000
	hous_ordstaff	.175	.014		.000	.000
	hous_farmworker	.000	.000	.000		.000
	hous_gov	.000	.000	.000	.000	
	hous_inst	.000	.000	.000	.000	.000
	hous_pub	.000	.000	.000	.000	.000
	hous_servsale	.102	.006	.000	.000	.000

Correlation Matrix[a,b]

		hous_inst	hous_pub	hous_servsale
Correlation	lnfaminc	.248	.237	.158
	lnresarea	-.025	-.026	-.078
	Mother's years of schooling	.320	.323	.067
	Father's years of schooling	.354	.365	.041
	resrural	-.292	-.257	-.226
	resordinary	.130	.109	.163
	hous_manager	.295	.213	-.018
	hous_professional	.487	.550	-.034
	hous_ordstaff	.167	.085	.239
	hous_farmworker	-.272	-.251	-.198
	hous_gov	.096	.129	-.046
	hous_inst	1.000	.600	.033
	hous_pub	.600	1.000	-.099
	hous_servsale	.033	-.099	1.000
Sig. (1-tailed)	lnfaminc	.000	.000	.000
	lnresarea	.033	.030	.000
	Mother's years of schooling	.000	.000	.000

	Father's years of schooling	.000	.000	.002
	resrural	.000	.000	.000
	resordinary	.000	.000	.000
	hous_manager	.000	.000	.102
	hous_professional	.000	.000	.006
	hous_ordstaff	.000	.000	.000
	hous_farmworker	.000	.000	.000
	hous_gov	.000	.000	.000
	hous_inst		.000	.009
	hous_pub	.000		.000
	hous_servsale	.009	.000	

Note: a. Only cases for which etr_sescase = 0 are used in the analysis phase.

b. Determinant = .019

Table 3. KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.805
Bartlett's Test of Sphericity	Approx. Chi-Square	20618.685
	df	91
	Sig.	.000

Note: a. Only cases for which etr_sescase = 0 are used in the analysis phase.

Table 4. Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.249	30.351	30.351	4.249	30.351	30.351
2	1.647	11.763	42.114	1.647	11.763	42.114
3	1.326	9.475	51.588	1.326	9.475	51.588

4	1.033	7.380	58.968	1.033	7.380	58.968
5	1.004	7.169	66.137	1.004	7.169	66.137
6	.780	5.574	71.711			
7	.716	5.116	76.827			
8	.643	4.593	81.420			
9	.603	4.307	85.727			
10	.558	3.984	89.711			
11	.382	2.725	92.436			
12	.375	2.679	95.115			
13	.371	2.652	97.767			
14	.313	2.233	100.000			

Note: Extraction Method: Principal Component Analysis.[a]

a. Only cases for which etr_sescase = 0 are used in the analysis phase.

Table 5. Component Matrix[a,b]

	Component				
	1	2	3	4	5
lnfaminc	.625	-.159	.067	.067	.415
lnresarea	-.120	.244	.377	.597	.562
Mother's years of schooling	.723	-.019	.064	-.170	.049
Father's years of schooling	.729	.065	.139	-.099	.004
resrural	-.739	.333	.107	.202	-.053
resordinary	.514	-.397	-.109	-.319	.317
hous_manager	.568	-.001	.577	-.040	-.110
hous_professional	.541	.517	-.324	-.026	.088
hous_ordstaff	.307	-.396	-.210	.464	-.466
hous_farmworker	-.602	.153	.010	-.275	-.001
hous_gov	.414	-.059	.633	.093	-.365

hous_inst	.606	.439	-.261	.200	-.131
hous_pub	.582	.571	-.234	.077	-.109
hous_servsale	.168	-.565	-.357	.378	.105

Note: Extraction Method: Principal Component Analysis.[a,b]

a. 5 components extracted.

. Only cases for which etr_sescase = 0 are used in the analysis phase.