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COLLEGE RANKINGS AND RETURN TO TERTIARY EDUCATION IN CHINA

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ABSTRACT

This paper studied the relationship between school rankings and tertiary education returns in China. By using Chinese Household Income Project (CHIP) data, the study was able to include new CHIP 2007 data, and add tertiary school rankings into 2002 regression. The characteristics of Chinese higher education system and Gaokao were explained in detail. According to unique features of Gaokao, a three period discrete choice education demand model was introduced. The paper then set out to test the model, paying special attention to omitted-variable bias by forming parental education as a proxy variable to estimate unobservable individual abilities. Attending high ranking schools showed 5.97 estimated increase of personal earnings compared to attending middle ranking schools. Running age specific and ability specific regressions showed attending high ranking schools yield significantly higher earnings for younger individuals and lower ability individuals.

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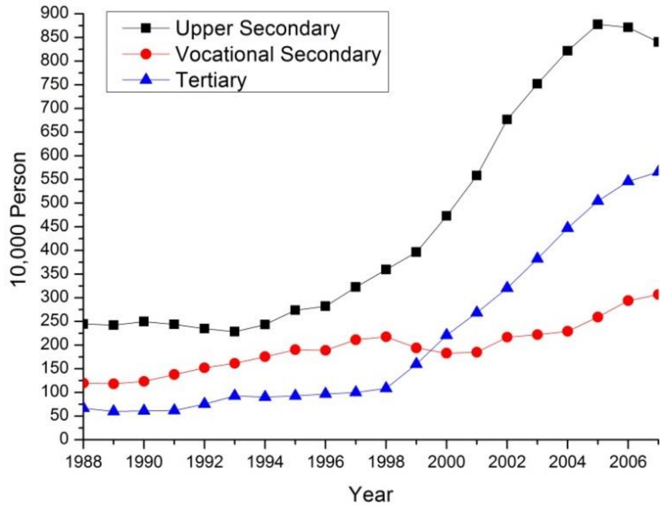
Chapter 1

Introduction

Tertiary enrollment has increased significantly in China during the past two decades. In this same time period, China's economy experienced rapid growth. While tertiary educational attainment rates in China are still significantly lower than developed countries in 2011 (OECD), as a result of the large size of the total population, China represents 12 percent, or 310 million of total world's tertiary graduates (China statistical yearbook, 2011). The rapid increase of people with tertiary education has occurred particularly in urban areas that are highly developed. Due to this rapid growth of education supply, there are concerns that the job market has become too competitive. Employers start to place more emphasis on education quality of job applicants, in addition to their educational attainment. Return to tertiary education by college ranking is becoming more relevant for urban China.

Both schooling reformations and economic growth contributed to a rapid increase in school enrollment, especially in upper secondary and tertiary education. New student enrollment in Chinese tertiary education increased tenfold in 20 years, from 5 million to more than 50 million (China Statistical Yearbook, 2011). There has been a relatively fast increase of tertiary enrollment percentage-wise, compared to developed countries, as well as developing countries in this same time period.

Figure 1, Number of New Student Enrollment (1988-2007)



Source: China Statistical Yearbook, 2011

This paper focuses on finding the effect college rankings have on personal earnings for people with tertiary education in China. In early 1990s, wage differences by level of education in China remained very narrow (Fleisher et al, 2004). In the past 15 years, return to education in China started to increase, although still lagging behind most developed countries (Zhang and Zhao, 2002; Li, 2003; Yang, 2004). The increase in return to education is associated with market reformations that happened in the same time period. There are multiple studies on this topic, such as focusing on the effect of different educational attainment level have on personal earnings (Lin and Gunderson, 2013; Faigen, 2012), and the difference in access to higher education promotes income inequality (Fleisher et al, 2004; Sato and Li, 2007). However, minimal work has been done on the relationship between college rankings and return to education. This topic is becoming increasingly relevant as the rapid increase of enrollment potentially leads to a differentiated schooling quality by institutions. The difference of schooling quality between higher-ranking colleges and lower-ranking colleges widened, as well as average earnings in different demographic areas.

Unlike in the U.S., College rankings are ordered by combinations of factors, the rankings of tertiary education institutes in China are mainly defined by college admission scores, or grade cut-off scores of Gaokao. The grade cut-off scores of each institution are released to the general public annually, and the only factor that determines an applicant's admittance is the individual's Gaokao score.

1.1 Schooling Reforms and GaoKao

In order to better understand the change of return to college rankings, several facts need to be addressed. Gaokao, or National Higher Education Entrance Examination is a college entrance examination held annually by the Chinese government. This examination is a prerequisite for entrance into higher education institutions at the undergraduate level, and it serves as a test to show participants' ability to gain admittance into tertiary education. Participants of this test are usually high school seniors, although there has been no age restrictions since 2001. Before 2001, Gaokao was restricted to individuals who were both under 25 and single. Students receive a total mark as a weighted sum of all their subject marks; the maximum score and the difficulty of the exam varies in a yearly basis.

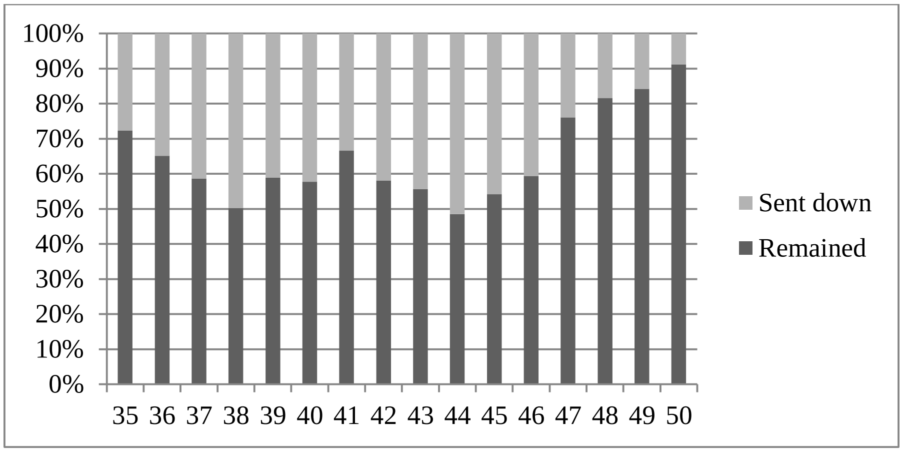
In supervision of Ministry of Education, tertiary education institutes set a quota on how many students they admit from each province every year. Students list their university preferences[1] and submit the list to Gaokao administrator. Depending on policies from different provinces, submission of the list can either be prior to the exam, after the exam, or after the scores are revealed. After Gaokao, a university will admit individuals who have the highest marks that

[1] Depending on the policy from the province, Gaokao participants list several universities and several majors of interest in a descending order, starting with their first choice and ending with their last choice. There may be a grade penalty for those applicants who were admitted into less preferred schools.

applied to a specific university. This form of admission leads to regional discrimination as universities usually admit a higher number of students from its home province. In some cases, regional discrimination can be extreme. In 2011, according to the admission plan of Peking University, the quota of admission in Beijing was 248, or 19.5 percent of the total admission, and the total number of Gaokao participants in Beijing was 76 thousand. In comparison, the quota of admission in Henan province was 60, or 4.7 percent of the total admission, and the total number of Gaokao participants in Henan was 855 thousand. As the number and quality of universities are distributed unevenly across China, the difficulty of getting into schools of the same ranking varies among different provinces.

Gaokao has gone through major changes and reforms since the founding of the People's Republic of China. Between 1949 and 1952, when the People's Republic of China was just founded, students were privately admitted into tertiary institutions, due to lack of the government education system. Starting in 1952, Gaokao was introduced, which enabled students across the country to take a standardized and centralized test for college admission. During the Culture Revolution in China, higher education and examination was viewed as a remnant of the reactionary and patriarchal social structure, and should be aborted. From 1966 to 1976, Gaokao was aborted, leaving the higher education system in China in a state of despair. During this time period, many students and scholars were sent down to the countryside to be 'reeducated' by peasants, mainly participating in agricultural plantings. Education institutions were closed down, and those that were still functioning saw a significant slip in academic standard. In 1973, a new mechanism of education admission was adopted. Local government would recommend politically correct students to enter higher education, without considering their academic performance. People who went to school in this time period were expected to achieve less academically and earn a lower degree. The Culture Revolution had an impact on the labor market outcome today. According to CHIP1995, more than 40 percent of people were 'sent down' in the peak years, and the movement affected more than a 15-year age spread of people. According to CHIP 1995 data, only 5.98 percent of people in 1995 between age of 35-50 had college education or above, comparing to 9.83 percent of tertiary educational attainment for people above 50 years old. Around 50 percent of people were 'sent down' in the peak years (1937 to 1945), and those people were far less likely to obtain college education.

Figure 2, Sent down rate between age 35-50 in 1995



After the Culture Revolution, centralized Gaokao was in effect again in 1977. Gaokao was divided into two divisions, Arts and Sciences. Students aiming for different majors could choose one out of the two. For the first several years of the return of Gaokao, age restriction was lifted, and many 'Sent down youth' took it to pursue higher education. According to CHIP 2002 Data, 47.5 percent of the people that took Gaokao in 1977, were older than 20 years old, and 11.25 percent of the people were older than 25 years old.

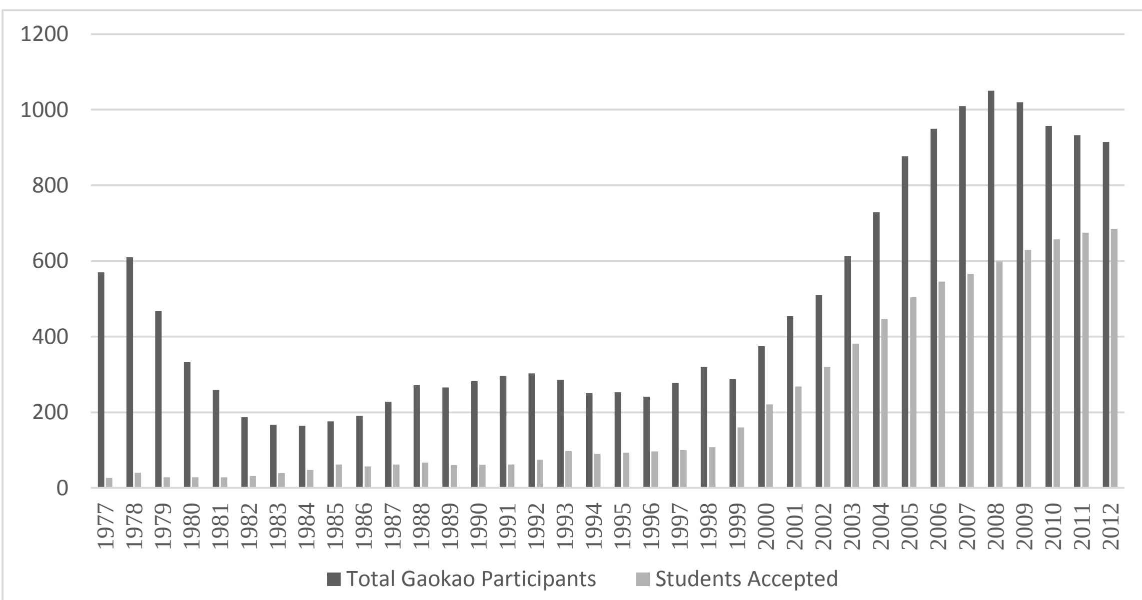
Table 1, Age of Gaokao participants, 1977-1979

Gaokao Year	Age	<20	20-25	>25
1977		52.50%	36.25%	11.25%
1978		66.67%	25.23%	8.11%
1979		79.57%	17.20%	3.23%

Between 1977 and 1999, the percentage increase of students admitted into tertiary education yearly were around 8.5 percent. In 1999, new schooling reforms were implemented. Increasing college admission was set as the main priority for the Chinese Government. 1999 yearly admission to higher education increased by 38.16 percent. According to the China Statistical Yearbook, the college admissions statistic nearly three folded between 1999 and 2003, admitting more than 3 million people in 2003. During this time period, some of the provinces started to run their own Gaokao by designing their own exams. In 1985, the College Enrollment Office of Shanghai was allowed to employ an independent exam, and that was the beginning of provincial proposition. Till 2010, there have been 16 provinces and municipalities adopting customized exams.

The rapid increase of college admittance made getting tertiary education easier. People started to place a higher value on higher ranking schools, compared to lower ranking schools. Instead of looking into individual's educational attainment, employers started to take more of job applicants' education quality into consideration.

Figure 3, Gaokao admission record (in ten thousands of people), 1977-2012



Source: Ministry of Education of the People's Republic of China

Table 2 showed Gaokao admission record in ten thousands of people since the resume of Gaokao in 1977. From 1977 to 1980, significantly more people took Gaokao, as many sent down youths participated in the exam, and the acceptance rate was lower than 10 percent. From 1981 to 1998, Gaokao participants stayed relatively constant, as acceptance rates steadily increased to around 35 percent. Since 1999 till 2008, both Gaokao participants and Gaokao admission increased rapidly, and acceptance rates raised to around 60 percent. 2008 was the peak year of Gaokao participants, with 10.5 million of people taking gaokao that year. As of 2012, the acceptance of participants of Gaokao rose to a record high of 74.86 percent. For high school graduates especially from urban areas, entrance into tertiary education by taking Gaokao has become much easier, comparing to what it was like two decades ago. With much easier access to tertiary education, individuals need to get into better schools with better rankings in order to stand out from competitors in the job market.

Chapter 2

Data description

Chinese Household Income Project, or CHIP, is a series of micro-level data sets that recorded personal income, educational attainment, as well as many other variables that contribute to personal earnings. (Griffin & Zhao, 1993; Riskin, Zhao & Li, 1995; Li, 2006; Gustafsson, Sicular & Li, 2009). The surveys were designed by international researchers and scholars at the Chinese Academy of Social Sciences (CASS). The data contains four time periods: 1988, 1995, 2002, and 2007. 1988, 1995 and 2002 data are obtained from Inter-University Consortium for Political and Social Research (ISCPR)[1], whereas new 2007 data was obtained from China Institute for Income Distribution. In the data, annual earnings include regular wages, floating wage, bonuses, subsidies, and other income from the work unit. This paper will focus on the urban component of 2002 data, as information on college rankings was reported as a subjective question asking individual's college tier upon graduation[2].

The urban component of the CHIP data mainly focused on urban cities, and individuals with urban living permit (Hukou). It is not representative of the whole population in China as tertiary educational attainment rate is much lower in rural areas. Average annual income reported in the CHIP data was around 10 percent higher than urban average earnings that census reported,

[1] ICPSR is a unit within the Institute for Social Research at the University of Michigan

[2] See Appendix E for survey question

indicating possible selection bias as CHIPs mainly focused on populated provinces[1]. Another concern of using the CHIP data is that the key question of university rankings in the survey is self-reported, and subjective to personal judgment. In the 2002 data, 20,632 observations were included in the urban sample. The proportion of people with upper secondary, tertiary vocational, or college degree showed a significant increase over time.

Table 2 Key variable means in CHIP data

Variables	CHIP88	CHIP95	CHIP02	CHIP07
Annual income (in 2007 Yuan)[2]	1890.23 (1747)	6153.34 (5500)	13846.34 (12422)	27827.81 (24932)
Lower secondary (%)[3]	45.44	40.77	37.32	34.90
Upper secondary (%)	21.98	19.52	24.14	24.24
Tertiary vocational (%)	5.72	10.03	14.68	17.80
4 Yrs. University (%)	5.45	5.96	7.18	11.45
Graduate school (%)	-	-	0.43	1.79
Female (%)	50.44	50.40	50.65	50.50
Minority (%)	2.50	4.46	4.41	1.3
Party member (%)	15.01	18.38	23.10	-
No. of observations	**31827**	**21698**	**20632**	**14700**

Source: CHIP data 1988, 1995, 2002, and 2007; China Statistical Yearbook, 2011

[1] 9 Provinces included in Chip1988: Beijing, Liaoning, Jiangsu, Anhui, Henan, Hubei, Guangdong, Yunnan, and Gansu. The 1995 sample added Sichuan province. 2002 sample added Chongqing municipality. Chongqing, a city in Sichuan province, became a municipality in 1997.

[2] Annual income includes basic wage, floating wage, bonuses, and subsidies. Macro data extracted from China Statistical Yearbook reported in parentheses

[3] Lower secondary includes normal middle schools and technical middle schools

Chapter 3

Literature review

Before this paper looked into the return of college rankings, the return of educational attainments need to be included into the discussion. The positive correlation between educational attainment and personal earnings is one of the most established facts in Economics (Checchi, 2008). However, education directly causes a change of earnings remains debated. Major doubts rise from the correlation between educational attainment and the error term: unobservable personal ability or productivity is linked to educational attainment as well as personal earnings. Personal ability can be highly correlated to educational attainment in China. Students pass rigid Gaokao to get into tertiary education. It is only hosted once a year on a provincial level and the score is strictly associated with different rankings of schools that examinees are admitted into. Study showed that when parental education is used as proxies for ability, one-year increase in father's education increases the probability of attending college by 1.72 percent (Fleisher et al, 2004). In order to estimate the return of college rankings, this potential bias needs to be taken into consideration.

3.1 CHIP2007

Many studies were done on the return to education with CHIP data involved performing OLS regression without a proxy for personal ability or a discussion of potential underlying bias (Faigen, 2012; Lin and Gunderson, 2013). The results of those regressions show an increase in regression coefficients of educational attainment between 1988 and 2002. Table 5 shows a regression with CHIP data without dealing with endogeneity, adding the new 2007 data.

Individuals aged between 18 and 65 entered the regression, focused on people that are not retired, not currently in school, and not temporary workers. For CHIP 1988, working experiences were not reported, it was estimated by the current age subtracting the age when the individual left school. CHIP 2007 does not include party membership information, thus omitted. Annual earnings include regular wage, floating wage, bonuses and subsidies. Note that for people working in the state sector, welfare benefits such as free or cheaper housing distribution are not included in the earnings. The sample sizes were 16,849, 11,412, 9,598, and 6830 in 1988, 1995, 2002, and 2007 respectively.

According to Table 5, replicated OLS regressions showed similar results. Regression coefficients for tertiary education increased throughout, with sharp increases between 1995 and 2002. An independent variable accounting for the income level of the province that the individual resided in, were added to the original regression. This is to adjust for different price level in different geographic locations. By adding this variable, the coefficient of determination showed roughly 0.15 increase in every time period, suggesting that the difference of earning levels play a significant part in determining individual earnings. These regressions in Table 5 did not account for individual abilities. Adding a proxy for ability decreases the regression coefficients of educational attainments. Performing OLS regressions with parental education as a proxy for ability, showed the return to education was biased upward, but the bias was diminishing over time (Fleisher et al, 2004).

3.2 Estimating unobservable individual ability

Researchers try to use many different proxies for ability analyzing return to education. Parental education, parental income, standardized test score, and academic performance are some examples. It is always in question if the proxy for ability really captures unobservable ability of the individual. Table 6 showed regressions with parental education as an ability proxy on CHIP 2002 data. By including parental education in the regression, the regression coefficient of dummy variable tertiary educational attainment decreased by 4.3 percent. Regression coefficients of tertiary vocational, upper secondary, and lower secondary also decreased. The study included another model using parental income as a proxy for ability, but how well parental earnings represent ability remains questionable. CHIP is not a long-term follow up study, and every wave of CHIP focuses on different individuals. Parental earnings at the time CHIPs were conducted would not accurately reflect parental earnings when individuals were in school. Parents of individuals could be retired, promoted, or switched to another job. On the other hand, parental educational attainments tend to be constant throughout time.

Studying research methods on different educational attainment helps to understand how to construct a model evaluating the return to education within tertiary education. According to the theory of signaling (Spence, 1973), employers evaluate job applicants based on their educational attainments. Employers want to know job applicants' personal abilities, or productivities, but it is generally hard to observe directly. Having higher educational attainment is one of the signals of the individual's high ability. The same goes for the quality of the degree. A job applicant with bachelor's degree from a higher ranking institution tend to signal a higher ability. The theory of signaling suggests the return to education by different university rankings can be analyzed in a similar manner.

One of the best ways to estimate the bias in the regression is to use twins to study education return, as twins have similar abilities and family background. Several studies were done to use twins' data to estimate the bias of education return regression with data gathered in many countries (Taubman, 1976a; Ashenfelter and Krueger, 1994; Behrman et al., 1994; Miller et al., 1995; Behrman et al., 1996; Ashenfelter and Rouse, 1998; Behrman and Rosenzweig, 1999; Rouse, 1999; Isacsson ,1999; Bonjour et al., 2003; Li et al., 2005).

Table 3, Estimated return to years of education using different twins samples.

Study	Sample and country	OLS (A)	FE (B)	Omitted variable bias (C = A - B)
Taubman (1976a)	NAS-NRC Twin Registry sample of white male army veterans, USA	0.079	0.027	0.052
Ashenfelter and Krueger (1994)	Twinsburg sample, USA	0.084	0.092	0.008
Behrman et al. (1994)	NAS-NRC Twin Registry, Minnesota Twin Registry, USA	0.035	0.05	
Miller et al. (1995)	Australia Twin Registry	0.064	0.025	0.039
Behrman et al. (1996)	Female twins born in Minnesota, USA	0.075		
Ashenfelter and Rouse (1998)	Twinsburg sample, USA	0.11	0.07	0.04
Behrman and Rosenzweig (1999)	Minnesota Twin Registry, USA	0.104		
Bonjour et al. (2003)	Twins Research Unit, St., Thomas' Hospital (female only), London, UK	0.077	0.039	0.038
Li et al. (2005)	Chinese Twins Survey, China	0.084	0.027	0.057

Source: Table A1, Estimating returns to education using twins in urban China, Li et al. (2005)

According to Table 3, most of the Twins studied showed that regressions without controlling for ability have high positive bias. In particular, a study done on education return of Chinese twins (Li et al., 2005) showed a significant decrease of education return. With accounting for ability and family background, the point estimate of return by one extra year of education was only 3.8 percent, comparing to 8.4 percent in uncontrolled regressions. The study of Chinese twins showed that there was a 55 percent drop on the return to education by eliminating ability and family background bias. Comparing this result to the result from Table 6, parental education attainments only account for a small portion of the bias. However, objection raised against twin studies is the small sample sizes of those studies and potentially data selection bias. As a result of having small sample sizes, the confidence interval of education return is often wide. It would be fair to assume that the ability and family background bias should be smaller than what twin studies showed, while the bias is not fully captured by parental education proxy.

3.3 College rankings and earning

There are not many recent studies done on the relationship of college rankings and personal earnings. A study was done on graduate school education quality and earnings with male electrical engineers (Link, 1975). It showed that the quality of graduate schools was a statistically significant determinant of earnings. However, the quality influence diminished for engineers age 40 and older. This study used proxy ability variables by including average student ability at different institutions. The gross returns to education were reduced by approximately 25-33 percent by including proxy ability variables. Another study done on quality of education by average admitted SAT score supported this conclusion. By using academic rating of undergraduate colleges, the study showed 'drastically altered return' based on different quality of education (Wales, 1973). College dropout earns either 14 or 37 percent more than the average high school student, depending on whether or not the individual attends a high ranking school. The corresponding estimation percentages for the undergraduate degree holder were 29 and 39.

There are other studies showed that rankings of school does not significantly affect individual's lifetime earnings. According to the paper "Ignore the rankings: A study of the relationship between commercial college rankings and lifetime economic value" (Baldeschwieler, 2010), the *U.S. News & World Report*, a widely consulted college ranking, is considered an imperfect means of gauging college quality. It should be noted that the ranking of schools are not equivalent to quality of schools, but ranking can be a reasonable indication of education quality. In China, the score ranking of schools are largely based on the number of applicants to that school and the quotas schools set for admissions. There can be the same problem for Chinese school rankings as the score cutoff does not fully reflect the quality of education.

Study by David Card and Alan B. Krueger (1992) estimates the effects of school quality in the U.S. by measuring pupil/teacher ratio, average term length, and relative teacher pay. Their models control for differences across state of birth, state of current residency, and family background. The study showed that the school quality has a significant effect on labor market performance. In this current study, however, it is uncertain how well school rankings are correlated with school quality. School rankings in China are mainly determined by Gaokao grade cut-offs of each school, and different provinces have different grade cut-offs. The ranking of schools can only be perceived as an imperfect indication of school popularity and school education quality.

Chapter 4

Education demand model

Unlike SAT, the Scholastic Assessment Test, held multiple times a year, Gaokao is only held once a year with few exceptions[1]. The long exam cycle raises problems where the scores some examinees receive does not reflect their true ability. Retaking the exam in the following year often lead to some form of penalty, usually point reductions. In 2013, universities would accept first time exam takers first if they have the same mark, considering the large amount of people taking Gaokao, this would be a considerable disadvantage for retakers. Although there are certain restrictions and penalties for retaking Gaokao, more and more individuals that did not reach their expectation choose to retake the exam. According to an online survey by Sina[2] and MyCOS Data[3] Research (Mycos Research, 2011), 90% of individuals accepted into first tier universities enrolled, 77% of individuals accepted into the second tier and third tier enrolled, and only 69% of individuals accepted into two-year technical colleges enrolled. According to figure 4, 51% of those who did not enroll responded that they are aiming to retake Gaokao in the following year. This suggests examinees are placing more emphasis on rankings of schools they got admitted into. Looking into CHIP 2002 data, 15.7 percent of people with Bachelor's degree

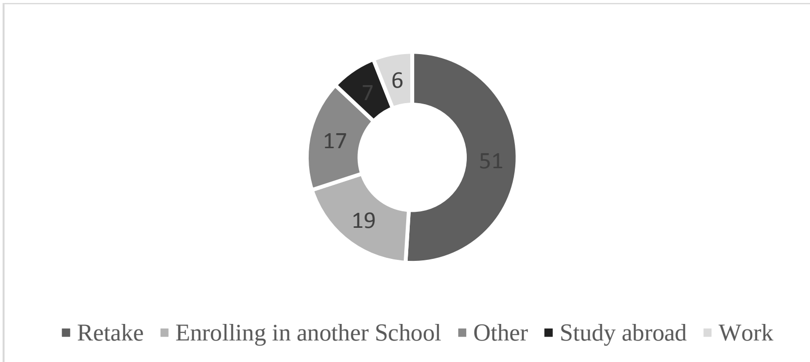
[1] In 2000, Beijing, Shanghai, Anhui, Inner Mongolia started Spring Gaokao in addition to regular Gaokao. In 2013, Shandong started Spring Gaokao. However, Spring Gaokao is mainly experimental in very small scale, only 6177 people took Shanghai Spring Gaokao in 2008, and only 1568 people were admitted into 8 institutions.

[2] Sina is a well-known Chinese online media company.

[3] MyCOS Data is a Consulting firm specializes in higher education consulting and outcome evaluation in China.

reported having more than 16 years of schooling. Although it's unusual for Chinese students to spend more years to finish tertiary programs, it's unclear if the extra years of schooling is associated with retaking gaokao.

Figure 4, Reasons of individuals not enrolling in admitted schools



Source: Gaokao admission survey, Sina-MyCOS data.

With more people retaking Gaokao, the education demand model needs to take this drop of enrollment rate into consideration. Simple two-period discrete education choice model need to be altered so it can reflect rankings of schools. A three-period education demand model is introduced: Suppose an individual with the ability or productivity θ. Education is a discrete choice that one decides to get tertiary education or not, $e \in \{0, \bar{e}\}$. When $e = 0$, the individual gets no tertiary education at all. When $e = \bar{e}$, the individual gets tertiary education and works $(1 - \bar{e}) > 0$ before graduation. Suppose that there are three time periods.

In period one, all individuals take an entrance exam to gain acceptance into education institutes in the beginning of the period. There are two education institutes: high ranking education institute and low ranking education institute. Individual with θ_i has probability $P_H(\theta_i)$ to get into high ranking institute, probability $P_L(\theta_i)$ to get into low ranking institute, and probability $1 - P_H(\theta_i) - P_L(\theta_i)$ to get rejected from both institutes. $P_H(\theta_i)$ and $P_L(\theta_i)$ are mutually exclusive. Further assuming:

$$\frac{\partial P_H(\theta_i)}{\partial \theta_i} > 0, \frac{\partial P_L(\theta_i)}{\partial \theta_i} > 0, \text{ and } P_H(\theta_i) + P_L(\theta_i) < 0 \quad (1)$$

Equations in (1) are based on the rationale there people with higher ability have higher probability to get higher score in the entrance exam. If an individual was accepted into one type of institute, then the individual decide to get tertiary education or not by choosing $e \in \{0, \bar{e}\}$. If an individual was not accepted into any institute, the individual can only choose $e = 0$. So in period one:

$$Y_1(e) = \omega_1 (1 - e), e \in \{0, \bar{e}\} \quad (2)$$

where Y_1 is total income of the period 1, and ω_1 is wage in period 1.

In period two, those individuals who chose $e = 0$ in period one take the entrance exam again, and choose $e \in \{0, \bar{e}\}$ in period two. Those who finished their education in period one continue to work with a wage premium $h_x(e, \theta), x = L \, or \, H$. Assuming:

$$\frac{\partial h_L(e,\theta)}{\partial \theta} > 0, \frac{\partial h_H(e,\theta)}{\partial \theta} > 0, \text{and } 1 < h_L(\bar{e}, \theta_i) < h_H(\bar{e}, \theta_i) \quad (3)$$

According to (3), people with higher ability get higher return from education, and higher ranking schools always indicate higher return holding ability constant. Moreover, assuming that if $e = 0$, there are no wage premium for any individuals:

$$h_L(0, \theta) = h_H(0, \theta) = 1 \quad (4)$$

In period two:

$$Y_2(e) = \begin{cases} \omega_2 h_x(e, \theta) & \text{for individuals not taking education in period 2} \\ \omega_2 (1 - \bar{e}) & \text{for individuals taking education in period2} \end{cases} \quad (5)$$

Y_2 is total income of the period 2, and ω_2 is wage in period 2.

In period three, all individuals work with their education achieved:

$$Y_3(e) = \omega_3 h_x(e, \theta) \quad (6)$$

Y_3 is total income of the period 3, and ω_3 is wage in period 3.

According to this model, individuals would get two chances to obtain education. Since higher ranking schools always indicate higher return when holding ability constant, individuals accepted into high ranking institute in period one would attend if the wage premium is greater than the cost of education:

$$Wage\ premium = \omega_2(h_H(\bar{e},\theta) - 1) + \omega_3(h_H(\bar{e},\theta) - 1) \geq \omega_1\bar{e} = education\ cost \quad (7)$$

Since $\frac{\partial h_H(e,\theta)}{\partial \theta} > 0$, there exists a $\theta = \theta^*_{H1}$ where $h_H(\bar{e},\theta) = \frac{\omega_1}{\omega_2+\omega_3}\bar{e} + 1$, that is, wage premium is equal to education cost. If $\theta < \theta^*_{H1}$, individuals would not attain any education.

Similarly, individuals accepted into high ranking institute in period two would attend if:

$$Wage\ premium = \omega_3(h_H(\bar{e},\theta) - 1) \geq \omega_2\bar{e} = education\ cost \quad (8)$$

and there exists a $\theta = \theta^*_{H2}$ where $h_H(\bar{e},\theta) = \frac{\omega_2}{\omega_3}\bar{e} + 1$.

If individuals accepted into low ranking institute in period two would attend if:

$$Wage\ premium = \omega_3(h_L(\bar{e},\theta) - 1) \geq \omega_2\bar{e} = education\ cost \quad (9)$$

and there exists a $\theta = \theta^*_{L2}$ where $h_L(\bar{e},\theta) = \frac{\omega_2}{\omega_3}\bar{e} + 1$.

The situation where individual accepted into low ranking institute in period one is more complicated. An individual would not attend if wage premium is lower than the education cost:

$$Wage\ premium = \omega_2(h_L(\bar{e},\theta) - 1) + \omega_3(h_L(\bar{e},\theta) - 1) \geq \omega_1\bar{e} = education\ cost \quad (10)$$

However, individual attending lower ranking school in period one gives up the chance to attend high ranking school in period two. Assuming individuals in this model only seek to maximize life time earnings, the expected payoff of retaking the exam needs to be taken into consideration:

$$Expected\ payoff\ of\ not\ attending\ period\ one = \omega_1 + \omega_2(1 - \bar{e}) + \omega_3 h_H(\bar{e},\theta)PH(\theta) + \omega_3 h_L(\bar{e},\theta)PL(\theta) + \omega_3\,(1 - PH(\theta) - PL(\theta)) \quad (11)$$

$$Payoff\ of\ attending\ period\ one = \omega_1(1 - \bar{e}) + \omega_2 h_L(\bar{e},\theta) + \omega_3 h_L(\bar{e},\theta) \quad (12)$$

One of the factors influencing (12) – (11) is the differential between wage premium of high ranking education and wage premium of low ranking education, $d(\bar{e},\theta) = h_H(\bar{e},\theta) - h_L(\bar{e},\theta)$.

The major question is that how $d(\bar{e}, \theta)$ is correlated with θ. If $d(\bar{e}, \theta)$ decreases as θ increases:

$$\frac{\partial d(\bar{e},\theta)}{\partial \theta} = \frac{\partial (h_H(\bar{e},\theta) - h_L(\bar{e},\theta))}{\partial \theta} < 0$$

(12) – (11) for people with higher ability would decrease, implying that people with higher ability are less likely to retake Gaokao..

If $d(\bar{e}, \theta)$ increases as θ increases:

$$\frac{\partial d(\bar{e},\theta)}{\partial \theta} = \frac{\partial (h_H(\bar{e},\theta) - h_L(\bar{e},\theta))}{\partial \theta} > 0$$

Then (12) – (11) for people with higher ability would increase, implying that people with higher ability are more likely to retake Gaokao.

Chapter 5

Estimating the return of different rankings of tertiary education

5.1 Methodology

To examine the Education demand model, college rankings and personal abilities need to be addressed. In order to take tertiary education rankings into account, dummy variables indicating the quality of tertiary education is introduced. Upper tier stands for "Very high" and "High" University rankings, middle tier stands for "middle" University rankings, and lower tier stands for "Lower in the middle" and "Lower" University rankings. Table 4 showed numbers of people in each categories:

Table 4, Rankings and Tier comparison, CHIP 2002

Rank of College/ University	University Tier	Frequency	Percentage (%)
Very high	Upper Tier	150	2.09
High		473	6.59
Middle	Middle Tier	747	10.41
Lower in the middle	Lower Tier	206	2.88
Lower		118	1.64
No Tertiary Degree		5481	76.39
Total		7175	100

Source: CHIP 2002

Based on the earning's function, an ordinary least squares (OLS) regression with the natural logarithm of annual earnings as dependent variable is being served as the baseline model for estimating the return of different rankings of tertiary education. To reduce bias due to unobservable ability, parental education is being used as a proxy variable:

$$Ability_{\,i} = \beta(Father\ education + Mother\ education) + V_t \qquad (1)$$

V_t is the measurement error where Ability is not captured by parental education.

For individual i, our estimation model is expressed as:

$$\text{Ln } Y_i = \beta_0 + \lambda A + \beta_1 \text{Tertiary education} + \beta_2 \text{ Upper tier} + \beta_3 \text{ Lower tier} + \varepsilon \qquad (2)$$

where Ln Y is the natural logarithm of annual earnings, Tertiary education is a dummy variable indicating if the individual has tertiary educational attainment. Tertiary education includes tertiary vocational degrees, bachelor's degrees, and beyond. Upper tier and lower tier are two dummy variables indicating the quality of tertiary education. A is a set of control variables including educational attainment other than tertiary education (upper secondary and lower secondary), gender (female = 1), Communists party membership (party member = 1), Ethnicity groups (Han = 1), experience, experience squared, sector of employment (State sector = 1), provincial income level, and parental education (father education and mother education). λ is a matrix of Beta values of A, and ε is the error term.

One major weakness about this estimation model is that parental education is an imperfect proxy variable to estimate ability, and parental education would not account for all of the bias. As discussed in 4.3, parental education reflects only part of personal ability and family background. However, due to the limitation of CHIPs data, the true ability of individuals cannot be fully observed. Discussion on twins data in 4.3 would give a rough picture of underlying bias in this model.

Tertiary educational attainment in this model includes different types of degrees. Including 2-year vocational trainings are potentially problematic. The return of two year tertiary vocational degrees is different from the return of four year bachelor's degrees. The model would not be able to differentiate between individuals with tertiary vocational degrees from a higher ranking school and individuals with bachelor's degrees from a lower ranking school. This is again a result of limitation on CHIPs data.

The regression is then divided into three age groups, 18 to 35 as group 1, 36 to 45 as group 2, and 45 to 65 as group 3. There are two reasons of running age group specific regressions: first reason is that getting tertiary education in 1970s can be perceived differently by employers comparing to getting tertiary education in 1990s. This is especially the case in China due to the rapid increase of tertiary education enrollment and possible slips of academic standard. The second reason is that employers tend to observe personal ability on the job as individual's working experience increases. The underlying assumption is that the effect of education on personal earnings tend to wear off across time and the true ability or productivity of the individual would become the key factor.

In order to better understand earnings differential by ability, or $\frac{\partial \mathrm{d}(\bar{\mathrm{e}},\theta)}{\partial\theta} = \frac{\partial(\mathrm{h}_H(\bar{\mathrm{e}},\theta) - \mathrm{h}_L(\bar{\mathrm{e}},\theta))}{\partial\theta}$, ability specific regressions are introduced. Grouping data with father's educational attainment, forming one group of high ability individuals and one group of low ability individuals. Individuals with father's educational attainment less than middle school are in low ability group, and individuals with father's educational attainment more than (or equal to) middle school are in high ability group.

5.2 Empirical results

The estimates of the return to educational attainment obtained in Table 7 are generally consistent with previous studies as well as result from Table 6. For all age groups, the return of graduating from the upper tier is significantly higher. It is especially true for the younger age group, as the expected return of graduating from higher ranking schools is estimated to be 5.97% higher than graduating from middle tier schools. However, individuals who graduated from lower tier schools did not earn significantly less. It could be a result of a relatively small sample size, or this result could indicate employers do not value middle tier schools and lower tier schools significantly different.

Comparing between age groups, return to education tends to wear off over time. Parental educations become less important for higher age groups, which can be explained as parental education becomes less related to individual's ability for higher age groups. The R squared value decreases as age increase, indicating that personal earnings become harder to predict. This is consistent with the hypothesis that the real ability on the job determines personal earnings as individuals spend more time in the workforce.

When performing regressions by ability groups, the results were altered significantly. The regressions suggest for low ability group, the return of graduating from high ranking schools is significantly higher than graduating from middle and low ranking schools. However, the regressions suggest low ability group gets less return from education in general. High ability group showed insignificant change of earnings by school rankings. Parental education is much more correlated with earnings for high ability group. This may indicate parental education as a proxy of ability actually includes more information. This is not surprising as parental education is also expected to correlate with family connection and family wealth. Extra information in parental education may play a big part in these regression results, but due to the limitation of data, it's not possible to separate out the extra information.

Chapter 6

Conclusions

This paper sets out to estimate the return of education based on different College rankings. An update of the return of education in China by adding in new CHIP 2007 data estimated an 86.77 percent increase of earnings for people with College education in 2007. The paper discussed possible omit variable bias regarding unobservable ability, then introduced parental education as a proxy variable. By including parental education, the return of education dropped. According to table 6, point estimate of the return for College education with CHIP 2002 data dropped from 0.8464 to 0.8063. Chinese higher education system and history of Gaokao were introduced and explained. The paper then added individual's college rankings as well as returns to education into the model. Individuals who attended upper tier colleges are estimated to earn 5.97 percent more than individuals who attended middle tier colleges. Individuals attended lower tier colleges showed insignificant change of earnings compared to middle tier colleges.

When running age specific regressions, the return of tertiary education is smaller for higher age groups, suggesting that the return to education tends to wear off over time. Experience in the workforce becomes more reliable in predicting personal earnings for higher age groups. When running ability specific regressions, the return of tertiary education is estimated 18.6 percent higher for high ability group, but college ranking is a more significant variable for low ability group. For individuals in low ability group, attending high ranking schools is estimated to increase earnings by 7.48 percent. The regression results, together with the education demand model introduced, suggest that earnings differential by ability, or $\frac{\partial \mathrm{d}(\bar{\mathrm{e}},\theta)}{\partial\theta} = \frac{\partial(\mathrm{h}_H(\bar{\mathrm{e}},\theta) - \mathrm{h}_L(\bar{\mathrm{e}},\theta))}{\partial\theta}$, is negative.

Due to the limitation of this study, the proxy used estimating unobservable ability is imperfect and problematic. A better proxy for ability may be constructed by including standardized test scores, IQ test scores, or family wealth. It requires further data collection and research to reach further conclusion. At a minimum, the findings in this paper showed a positive link between school rankings and economic returns to education in China.

Appendix A

Table 5, Regression results CHIP88-07, model without an ability proxy1

Variable	CHIP88	CHIP95	CHIP02	CHIP07
University	0.3007 (0.0138) ***	0.4836 (0.0266) ***	0.8533 (0.0370) ***	0.8677 (0.0454) ***
Tertiary vocational	0.2101 (0.0136) ***	0.4017 (0.0239) ***	0.6081 (0.0345) ***	0.5994 (0.0444) ***
Upper secondary	0.1532 (0.0096) ***	0.2845 (0.0217) ***	0.3785 (0.0334) ***	0.2897 (0.0434) ***
Lower secondary	0.0662 (0.0092) ***	0.1600 (0.0220) ***	0.1767 (0.0340) ***	0.1105 (0.0446) **
Female	-0.0944 (0.0057) ***	-0.1068 (0.0098) ***	-0.1637 (0.0113) ***	-0.2387 (0.0147) ***
Party membership	0.0710 (0.0071) ***	0.0732 (0.0119) ***	0.0855 (0.0132) ***	--
Minority[2]	-0.0055 (0.0142)	-0.0406 (0.0232) *	-0.0455 (0.0275) *	0.1130 (0.0709)
Experience	0.0473 (0.0010) ***	0.0514 (0.0017) ***	0.0283 (0.0022) ***	0.0126 (0.0008) ***
Experience^2	-0.0007 (0.0000) ***	-0.0008 (0.0000) ***	-0.0003 (0.0001) ***	-0.0001 (0.0000) ***
State sector	0.0585 (0.0056) ***	0.1517 (0.0107) ***	-0.0265 (0.0119) **	-0.0201 (0.0157)
Income Level[3]	0.0004 (0.0000) ***	0.0002 (0.0000) ***	0.0001 (0.0000) ***	0.0001 (0.0000) ***
Constant	7.4640 (0.0205) ***	7.0417 (0.0336) ***	7.9515 (0.4900) ***	8.7383 (0.0895) ***
R-squared	0.3528	0.3433	0.3077	0.2966

[1] Robust standard errors are in parentheses. *, **, and *** represent statistical significance at the 10%, 5% and 1% level, respectively. All regressions estimated via ordinary least squares. The dependent variable is the log of real annual earnings adjusted as 2007 Yuan.

[2] Minority = 0 if the person is minority, =1 if the person is Han ethnicity.

[3] Income level adjusts different income levels across different provinces.

Appendix B

Table 6, Regression results CHIP02, with ability proxy1

	CHIP02	CHIP02
Variables	(1)	(2)
University	0.8464(0.0393)***	0.8063 (0.0395) ***
Tertiary vocational	0.6138 (0.0369) ***	0.5766 (0.0372) ***
Upper secondary	0.3814 (0.0362) ***	0.3572 (0.0362) ***
Lower secondary	0.1720 (0.0366) ***	0.1581 (0.0365) ***
Female	-0.1800 (0.0119) ***	-0.1837 (0.0119) ***
Party membership	0.0702 (0.0129) ***	0.0766 (0.0129) ***
Minority[2]	-0.0533(0.0286) *	-0.0509 (0.0286)*
Experience	0.0110 (0.0030) ***	0.0115 (0.0030) ***
Experience^2	-0.00002 (0.00007)	-0.00002 (0.00006)
State sector	-0.0285 (0.0124) **	-0.0291 (0.0124) ***
Income Level	0.00005 (0.0000) ***	0.00005 (0.0000) ***
Father Education[3]	--	0.0286 (0.0046) ***
Constant	8.0794(0.5415) ***	8.0527 (0.0520) ***
R-squared	0.3001	0. 3134

[1] Robust standard errors are in parentheses. *, **, and *** represent statistical significance at the 10%, 5% and 1% level, respectively. All regressions estimated via ordinary least squares. The dependent variable is the log of real annual earnings adjusted as 2007 Yuan.

[2] Minority = 0 if the person is minority, =1 if the person is Han ethnicity.

[3] Father education record father's educational attainment: 0 for below primary education, 1 for primary education, 2 for lower secondary education, 3 for upper secondary education, 4 for tertiary vocational education, 5 for 4 years tertiary education.

Appendix C

Table 7, Regression result on College rankings and return to tertiary education, by age groups[1]

Variables	All age groups	Age 18-35	Age 36-45	Age 46-65
Tertiary	0.6534 (0.0393)***	0.7036 (0.1086)***	0.7416 (0.0788)***	0.6063 (0.0567)***
Upper tier	0.0597 (0.0268)**	0.0667 (0.0316)**	0.0460 (0.0409)	0.0641 (0.0502)
Lower tier	-0.0142 (0.0302)	0.0658 (0.0638)	-0.0701 (0.0414)*	-0.0311 (0.0552)
Upper secondary	0.3405(0.0349) ***	0.4359 (0.1041)***	0.3927 (0.0744)***	0.3135 (0.0434)***
Lower secondary	0.1443 (0.0352) ***	0.1631 (0.1056)	0.2222 (0.0755)***	0.1243 (0.0428)***
Female	-0.2022 (0.0128) ***	-0.2380 (0.0298)***	-0.2186 (0.0190)***	-0.1550 (0.0216)***
Party membership	0.0846 (0.0142) ***	0.0803 (0.0365)**	0.0778 (0.0209) ***	0.0889 (0.0223)***
Minority[2]	-0.433 (0.0320)	-0.1204 (0.0578)**	-0.0610 (0.0467)	-0.0088 (0.0564)
Experience	0.0131 (0.0022) ***	0.0149 (0.0066)**	0.0096 (0.0050) **	0.0214 (0.0033)***
Experience^2	-0.00006 (0.00005)	-0.00007 (0.00022)	0.00001 (0.00012)	-0.00012 (0.00006)**
State sector	-0.0184 (0.0133)	0.0243 (0.0337)	0.0050 (0.0199)	-0.0575 (0.0212)***
Income Level	0.00005 (0.0000) ***	0.00007 (0.0000)***	0.00005 (0.0000)***	0.00004 (0.0000)***
Father Education	0.0259 (0.0066)***	0.0320 (0.0158)**	0.0263 (0.0096) ***	0.0174 (0.0110)
Mother Education[3]	0.0139 (0.0073)*	-0.0082 (0.0158)	0.0202 (0.0107)*	0.0135 (0.0135)
Constant	8.0770 (0.0443) ***	7.8840 (0.1248)***	8.0121 (0.0878)***	7.9920 (0.0700)***
R-squared	0.3043	0.3246	0.3114	0.2897

[1] Robust standard errors are in parentheses. *, **, and *** represent statistical significance at the 10%, 5% and 1% level, respectively. All regressions estimated via ordinary least squares. The dependent variable is the log of real annual earnings in 2002.

[2] Minority = 0 if the person is minority, =1 if the person is Han ethnicity.

[3] Father education and Mother education record parental educational attainment: 0 for below primary education, 1 for primary education, 2 for lower secondary education, 3 for upper secondary education, 4 for tertiary vocational education, 5 for 4 years tertiary education.

Appendix D

Table 8, Regression results on College rankings and return to tertiary education, by ability groups

Variables	All ability groups	Low ability group	High ability group
Tertiary	0.6534 (0.0393)***	0.6539 (0.0466)***	0.7754 (0.0781)***
Upper tier	0.0597 (0.0268)**	0.0748 (0.0386)**	0.0442 (0.0368)
Lower tier	-0.0142 (0.0302)	0.0111 (0.0421)	-0.0384 (0.0426)
Upper secondary	0.3405(0.0349) ***	0.3227 (0.0387)***	0.4848 (0.0737)***
Lower secondary	0.1443 (0.0352) ***	0.1196 (0.0388)***	0.2222 (0.0755)***
Female	-0.2022 (0.0128) ***	-0.1939 (0.0169)***	-0.2117 (0.0198)***
Party membership	0.0846 (0.0142) ***	0.0759 (0.0184)***	0.0972 (0.0224) ***
Minority[1]	-0.433 (0.0320)	-0.0525 (0.0578)	-0.0222 (0.0568)
Experience	0.0131 (0.0022) ***	0.0129 (0.0029)***	0.0141 (0.0034) ***
Experience^2	-0.00006 (0.00005)	-0.00004 (0.00006)	0.00001 (0.0008)
State sector	-0.0184 (0.0133)	-0.0038 (0.0170)	-0.0455 (0.0215)**
Income Level	0.00005 (0.0000) ***	0.00005 (0.0000)***	0.00005 (0.0000)***
Father Education	0.0259 (0.0066)***	0.0383 (0.0173)**	0.0362 (0.0141) ***
Mother Education[2]	0.0139 (0.0073)*	-0.0001 (0.0134)	0.0211 (0.0088)**
Constant	8.0770 (0.0443) ***	8.0963 (0.0639)***	7.8785 (0.1025)***
R-squared	0.3043	0.2955	0.3054

[1] Minority = 0 if the person is minority, =1 if the person is Han ethnicity.

[2] Father education and Mother education record parental educational attainment: 0 for below primary education, 1 for primary education, 2 for lower secondary education, 3 for upper secondary education, 4 for tertiary vocational education, 5 for 4 years tertiary education.

Appendix E

Survey question regaring College/University rank, CHIP 2002

117. If you ever studied in college/university, please evaluate the rank of your school in the countrywide:
1) Very good; 2) Good; 3) Just so-so; 4) Lower in the middle; 5) Lower

P117	**Rank of college/university**
Location:	51-51(width: 1; decimal: 0)
Variable Type:	numeric (ISO)
Range of Missing Values (M):	0 , .
Question:	If you ever studied in college/university, please evaluate the rank of your school in the countrywide:

Value	*Label*	*Unweighted Frequency*	*%*
1	Very good	287	1.4 %
2	Good	869	4.2 %
3	Just so-so	1242	6.0 %
4	Lower in the middle	343	1.7 %
5	Lower	172	0.8 %
0 (M)	-	17491	84.8 %
. (M)	-	228	1.1 %

- Mean: 2.74
- Median: 3.00
- Mode: 3.00
- Minimum: 1.00
- Maximum: 5.00
- Standard Deviation: 0.99

Based upon 2913 valid cases out of 20632 total cases.

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Olympic Youth Camp
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