Returns to Secondary Education: Evidence from China

A thesis submitted by

Bocheng Wu

In partial fulfillment of the requirements for the degree of

Master of Science

in

Economics

Tufts University

May 2015

Adviser: Professor Thomas Downes

Abstract

This study applies the conventional Mincer equation and pseudo-panel approach in estimating the secondary education returns in China. A pseudo-panel is constructed from the independently cross sectional database of China Household Income Project from 1988 to 2007, with about twenty years age range, , this paper tried to eliminate the heterogeneity among people, and decrease the upper-ward bias in education returns, and compare the different secondary education returns.

Introduction

The return to education has been widely studied for 60 years. The conventional way to estimate the rate of return is using the Mincer equation. Traditional human capital theory posits that labor income can be estimated as a function of schooling and working experience. And individuals who invest in education at an early age expect to gain a higher salary in later life. Given the above assumption, additional investment in education should lead to higher discounted lifetime income. Before 1980, there was small salary gap between different industries and people with different level of degrees in China due to the command economy. However, it is possible to use the market economy theory to quantify the education returns of this large economy after the Reform.

Recently, economists have begun to pay attention to education returns in China. Most work has focused on finding better instruments to get more accurate estimates of education returns. This paper adopts a different strategy, using pseudo-panel techniques to eliminate heterogeneous characteristics in the error term.

In China, after completing high school, students can take the National Matriculation Examination (called University Entrance Exam) in order to pursue higher education. Although junior colleges and regular universities are both Regular HEIs (Higher Education Institution), three years are required to complete a junior college degree compared to four years for regular university degree. Depending on the matriculation order, regular universities are classified as first tier, second tier and third tier universities, meaning first tier universities have first priority to choose students, and then the second tier and third tiers. Noteworthily, some third tier universities require twice or much more tuition than the other tiers. Tuition for first tier and second tier is usually 5,000 to 6,000 yuan per year excluding arts and medical majors, while it is often 5,000 to 25,000 yuan per year for third tier schools based on major and other geographic factors. Typically, universities in developed eastern part of China cost more. It seems to be obvious that in China, tuition takes the role of balancing the demands for high quality education instead of being an indicator of the quality of high education itself.

Hundreds of papers have studied human capital and education returns. Cultural difference plays a role in China when parents put substantial efforts in sending their children to higher education regardless of its potential income and tuition. Since students in community college (or junior college) had similar ability as those in third tier universities while facing a relatively low tuition, it is interesting to compare the difference of future benefits between those two secondary education institutions. Based on this, the initial idea of this paper was to estimate education returns in China with an emphasis on comparison between third tier universities and community college. It will provide in education investment choice if it is proved by statistic evidence that the education returns of these two institutions do not have vital discrepancies.

The paper first uses a conventional Mincer equation to get Ordinary Linear Square (OLS) estimates. Then it compares these potentially biased estimators to those from pseudo-panel (which is designed to eliminate biases created by unobserved ability). Since there is no panel data available, we use pseudo-panel approach as a substitute. It can be told from its name that pseudo-panel is not real panel data, it is a method to use independent, cross sectional data and apply panel data research approaches. In contrast to panel data, which tracks the same individuals over time, pseudo-panel uses cohorts as observations. In this paper, age and region are taken as trackers to group people into different cohorts. Assuming cohorts' characteristics do not change much over time, the paper uses cohorts' data to get valid estimates from the newly generated 'panel'.

In the rest of this paper, section one presents the methodologies for both Mincer model and pseudo-panel method. It then discusses the variables in both models, and how cohort means method solve heterogeneity problem.

Section two provides a brief description of the Chinese system of higher education.

Section three presents data description and discusses age range in building pseudo-panel, It also describes pseudo-panel model settings, presents data choosing methods, and indicates which specific income information is used in analysis.

Section four provides results and interpretations for the Mincer model and the pseudo-panel model with a discussion of difference between different education levels. And section five offers conclusion and suggests further research directions.

Background

Students in China choose their universities and majors after the National Matriculation Examination. They are accepted to a university with a specific major based on test scores. In other words, majors have already been decided before students enter university. A student can choose several ideal majors for a certain school with a ranked preference on majors. For example, if one chooses mathematics, physics and economics in sequence, a school would interactively decide his/her major based on a cut-off grade point. Therefore, score gaps can be large across majors within one school. Consequently, popular majors would require much higher scores even in the same school. Students and their parents often struggle choosing from a better-ranked school or a preferred major. This entrance policy of high education in China sometimes ends up with student choosing a reputable school in sacrifice of their favorite major. While changing majors after enrollment is possible, chances are slim due to high volume of demands and fierce competition.

Like in the States, schools have their own specialties, liberal arts, science, medicine or engineering, with top universities usually covering all areas. For instance, Renmin University of China has its voice in almost all the arts and humanity areas like finance, economics, laws, journalism, and politics. But it has not set up engineering branches until now. With similar top rankings, Peking University and Tsinghua University, in contract, both retain all-round research capabilities among all majors. School specially is another heterogeneous problem that may affect school choice and education variable setting in the model.

In China, different provinces may have different enrollment processes even for the same school. School matriculation policies vary, too. Some provinces ask students to submit school and major preference before announcement of results while some province do this after. In the first case, students often risk being rejected by their second choice if their scores are not high enough for the first choice, even if their score well exceed people in the same school. Since universities may enroll enough students who list them as first choice, they would not keep looking for better qualified candidates with higher test scores but put them as second choice. This is considered to be a 'double standard' rule that takes school preference into account even more than students' actual ability and causes many misallocations of students. So in some other provinces, students can put down five universities without order. They will be accepted by a matched school if they pass the borderline for any of these five choices.

The above background information shows another view of the geographic factor in this problem. Province has great latitude in setting its typical criteria to schools and students. Thus, province must be taken into account in this analysis. In the models estimated below, I account for province using dummy variables. This is a method to eliminate provincial fixed effect of education income return and distinguishing coefficient variance across provinces.

Total score is quite different among different provinces, thus I just take Beijing as an example to illustrate the score range for different tiers. There are two kinds of tests, Science exam and Arts exam, and both of them are 750 points in total. In 2012, the first tier university requirement was 477 for Science and 495 for Arts, and the second tier requirement was 433 for Science and 446 for Arts, and the third tier requirement was 402 for Science and 416 for Arts. The community college requirement was much lower, it was 150 for both science and arts. The difference between community college and third-tier university is quite large. While in other provinces the difference is not so large, the entrance score for a community college may still be about half of the third-tier university.

For the data available at the official website of ministry of the People's Republic of China, at the end of September of 2013, there were 2,242 regular HEIs institutions, of which 1,145 were HEIs offering degree programs, 303 were independent institutions, and the other 1,297 were all higher vocational colleges, in other words, the community college. In 2009, there were 6,247,338 undergraduates graduated from regular HEIs, with 3,038,473 graduating from the normal universities, and 3,208,865 graduating from community colleges. In the same year, 3,740,574 students enrolled into the normal universities, and 3,147,762 students enrolled into community colleges. The above data indicate that there were almost the same number of regular universities and community colleges, and almost the same number of students enrolled into these two kinds of institutions. Thus, there were many more students going to community colleges than going to third-tier universities.

Literature Review

The foundation for estimating the rate of return to education was developed by Mincer(Mincer 1974). And almost all the later research are based on the work of Mincer.

Recently, economists began to use China labor market data to estimate the returns to education using Mincer-style methods. Analyses include examinations of differences in the income distributions between urban and rural area, the effect of economic reform on returns, and education returns of migrants. And results vary according to the data and methodologies used.

Early work using basic Mincer models and conventional OLS estimations found very low education returns. For instance, an analysis using 1986 data on 800 adults in Nanjing(Jiangsu Province) found only around a 4% income increase for each additional year of schooling, and significant declines for females with the same qualifications(Byron and Manaloto 1990). And Meng and Kidd found a much lower rate of 2.5% per additional year for 1981 (Meng and Kidd 1997). Johnson and Chow used data from 1988 CHIP and found the rate of return to education was 4.2 percent in the rural areas and 3.29 percent in the urban areas (Johnson and Chow 1997). Retrospective data collected in 1994 covering more than 4000 individuals confirm that schooling returns began to increase almost 15 years after the market reform (Fleisher and Wang 2005). However, these rates of returns still lag other transition economies. And economists believe it was a result of the type of economic regime prior to reform. Before reform people could not change their jobs and companies could not fire workers easily, which restricted efficiency and working incentives. After many years of reform, the regime is so different from the past. Thus, I will focus more on the years after 1990.

While conventional OLS results provide us some evidence about the positive relationship between education and income, selection bias and other problems made the causality questionable. Since people with great ability may seek higher education, the greater income may come from the difference in ability or family background but not the schooling. The most common way to solve the selection bias and heterogeneity problem is trying to find a suitable instrument variable.

Li and Luo used parental education and whether the child is boy or girl as instrumental variables to deal with the selection bias problem and found the education returns is about 15%, which is much higher than from OLS estimates (Li and Luo 2004). Chen and Hamori used spouses' education as an instrument and estimated schooling returns of 12.5% and 14.5% for men and women, respectively (Chen and Hamori 2008). All the above results are much higher than the OLS estimates, which not only come from solving selection bias, but also because the data they used are those after the transition from command economy to market economy.

Researchers also discussed possible causes of the presence of large selection bias. For example, Li and et. al. proposed the idea that the examination-oriented education system in China has created a system in which those who go to high-ranked universities are the most talented (Li, Liu, and Zhang 2012).

Other than using IV, using panel data included fixed effect term in the equation can solve the selection problem. Since panel data are unavailable for many developing countries, economists tried to use independent, cross sectional data to construct pseudo-panels. Robert and Sasiwimon employed pseudo-panel approach to estimate education returns in Thailand and found the results were similar to the IV regression results (used the location of teacher training college as the IV), showing pseudo-panel approach is a tenable method to get credible estimation (Warunsiri and McNown 2010).

Heckman and Li used semi-parametric methods to solve self-selection and sorting problem. They focused the difference in rates of return between senior high school graduates and college graduates, finding college attendance led to a 43% increase in lifetime earnings in 2000 (Heckman and Li 2004).

Recently, some research has looked at the rate of returns to different secondary education paths. Agan estimated the life-cycle private and public returns to different post-secondary education paths, documenting the low cost for attending community college and the high returns from it (Agan 2014). In the United States, students may transfer to college education after or during community college study, but these transfer students earn less than do students who begin their college education in a four-year institution. Analyzing secondary education paths and their future returns show the difference clearly, and give students information to make good choices.

Model

A. Mincer Model

This part begins with the basic human capital returns function. The forms of the regression are based on the conventional Mincer model:

$$\ln Y = \beta_0 + \beta_1 S + \beta_3 E + \beta_4 E^2 + u \quad (1)$$

where Y is annual income, S is years of schooling. E is experience, and E^2 is experience squared. Including experience squared intends to capture the inverted U-curve character of the whole life income trend, since earnings will increase in the first several decades with working experience, while returns to experience may go down at a point when people are near retiring. To generate the experience variable, most assume people begin their schooling at six years old and ignore work experience gained in school. The experience variable is defined as follows.

$$Exp = age - school - 6$$

Education returns may not display a linear growth trend; one year of undergraduate study may not generate equal returns to one year in high school. To account for this nonlinearity, S can be replaced by school level dummies. In addition, other possible influential factors could be included.

Equation (2) is the revised Mincer equation used in the paper:

$$\ln Y_i = \beta_0 + \beta S_i + \gamma X_i + u_i \quad (2)$$

Where Y is still annual income, S is a vector variable of dummies for school levels, and X is a vector variable containing years of experience, experience squared, dummies for provinces, gender, marriage, communist party member, urban or rural area residence and minority factors that could influence income returns other than education.

Based on a pooled sample of individuals from 1988, 1995, 2002 to 2007, the Mincer model is modified as the following equation by including year dummies allowing different intercepts across periods:

$$\ln Y_i = \beta_0 + \beta S_i + \gamma X_i + \eta Year + u_i \quad (3)$$

where $Year$ is a vector variable of dummies for years, it is set to be (1, 0, 0, 0) for observations of 1988, (0, 1, 0, 0) for those in 1995 and so on.

B. Pseudo-panel Model

In the conventional Mincer model, the major problem is the omitted ability in the error term, which is correlated with the highest education people pursue. Thus, $\text{cov}(S_i, u_i) \neq 0$. It is technically impossible to include the ability variable into the equation to control for the heterogeneity among people. Thus, the OLS (ordinary least square) estimation for education returns β is biased and inconsistent. There are three traditional methods to solve this selection: 1) Instrumental variables (IV) 2) A fixed-effect method: using a paired comparison such as a genetic twin or sibling with similar or identical ability 3) Use proxy variables for ability, including them as regressors in X_i. This study uses a pseudo-panel approach, attempting to eliminate the selection bias in the error term. Based on individuals' birth years, Deaton (Deaton 1985) found by defining a set of $c(c = 1, \ldots, C)$ cohorts, and averaging over those cohorts members, it is tenable to suppose that there is no or little individual heterogeneity among these cohorts. Thus we should use cohorts' means to replace the original individual data, and use cohorts as the new observations to get pseudo-panel estimations. This idea is made clear by drawing out the ability term from the error term:

$$\ln Y_{it} = \beta_0 + \beta S_{it} + \gamma X_{it} + a_{it} + u_{it} \qquad (4)$$

where a_{it} is the heterogeneous ability or motivation term for different people. Averaging equation (4) we have:

$$\overline{\ln Y_{ct}} = \beta_0 + \beta \overline{S_{ct}} + \gamma \overline{X_{ct}} + \overline{a_{ct}} + \overline{u_{ct}} \qquad (5)$$

where $\overline{a_{ct}}$ is the mean of a_{it} over sample observations in cohort c at period t. We can treat a_{it} as a random term, and its mean is much more likely to be uncorrelated with other explaining variables. People found when the observation numbers in each cohort exceed 100, $\overline{a_{ct}}$ can be treated as the true cohort fixed effect, and this approach can eliminate the bias.

Data Description

The data used in this analysis are taken from 1988 to 2007 Chinese Household Income Project (CHIP). Including 1988, 1995, 2002 and 2007, these are four data sets. The sample is collected from all the provinces excluding Tibet and Taiwan. CHIP is a project to measure the distribution of people's income in both rural and urban areas of the People's Republic of China. The questionnaire includes different kinds of income sources, such as basic salary, bonus, property earnings, items received from work, food subsidy, rental subsidy, and transportation subsidy. All subsidies are measured in market value.

In my analysis, those people who failed to report information on annual income, age, and highest education level were dropped, as were those who were not full time workers and those with total income equal to zero.

This paper focuses on the income difference on primary job, although ability contributes to second job earnings. Different reasons exist for people not using part-time work to earn more, such as primary job earnings is high enough or they want to consume more leisure. Thus, it is more reasonable to compare the primary job income.

Total income includes basic wages, income bonuses, all kinds of subsidy and items from companies at market value. It does not include earnings from properties, including stock earnings, house rental and other investment income, because that income mainly comes from what people already own, even though stock earning may relate to financial knowledge or ability.

Rural income information is only available for people who work in established businesses. In other words non-agriculture income is the only kind of income information available. Since agriculture work income may come from work of the whole family, it is difficult to divide it into several parts for each person by how much contribution they made. However, without agricultural income, it may be biased to estimate the rural residence effect on annual income.

Construction of the pseudo-panel is done by tracking the birth year of each individual across the four data sets. Replacing individual data with cohort means significantly decreases the observations. Further, to insure enough people are in each cohort, the age range needs to be long enough. Since the year range from 1988 to 2007 is twenty years in total, and in China the legal retirement age is 60 years old for male, and legal working age is 18 years old, I select those people who are born between 1948 with 1969. Then the youngest in 1988 is 19 years old, and the oldest in 2007 is 60 years old, which is the largest range we can have to use age as a cohort determinant.

Results

(a) Conventional Mincer equation estimates

In this section I present the results for the Mincer equation. The estimates from the OLS regression with repeated cross sectional data are presented in Table 1.

Table 1. Estimated Conventional Mincer Model

	1988		*1995*		*2002*		*2007*	
Variable	*Coefficient*	*Robust Std error*	*Coefficient*	*Robust Std error*	*Coefficient*	*Robust Std error*	*Coefficient*	*Robust Std error*
JuniorSeniorHigh	0.2094	0.0198	0.3954	0.0327	0.2950	0.0286	0.1680	0.0138
Profession	0.2931	0.0208	0.6290	0.0339	0.5727	0.0339	0.2312	0.0254
Community	0.3657	0.0204	0.6827	0.0344	0.6960	0.0324	0.3141	0.0458
College	0.4336	0.0212	0.7871	0.0350	0.9133	0.0360	0.4401	0.0465
exp	0.0470	0.0021	0.0347	0.0026	0.0248	0.0025	0.0137	0.0016
expsq	-0.0007	0.0000	-0.0006	0.0001	-0.0006	0.0001	-0.0005	0.0000
minority	0.0331	0.0212	-0.1261	0.0394	-0.1165	0.0331	-0.1313	0.0504
Female	-0.1011	0.0087	-0.0865	0.0133	-0.1328	0.0138	-0.2796	0.0101
Urban	0.8730	0.0341	1.1020	0.0227	1.3684	0.0170	0.4851	0.0102
provMN	-0.0263	0.0150	-0.0154	0.0173	0.0528	0.0167	0.0128	0.0142
provE	0.2168	0.0192	0.6956	0.0191	0.6932	0.0184	0.2652	0.0132
Intercept	5.6969	0.0476	6.4943	0.0404	6.9810	0.0369	9.3592	0.0238
Observations	19,979		16,791		19,626		16,112	
R-squared	0.2391		0.3690		0.4617		0.2125	

The base individual is a male with highest degree of elementary school or lower, working in the western part of China in an rural area, and all coefficients are statistically significant except the variable provMN (the dummy for people who work in Middle or Northeastern part of China, and provE is the dummy for people who work in Eastern part of China). Table 1 shows that the coefficient on college dummy is higher than the coefficient for community college dummy, and the range is from 6 to almost 22 percentage points higher compared to the returns for those with element school degree or lower, and the gap is smallest in year 1988 and largest in year 2002. The education returns gap between different school levels shows the same trend among those years, the gap grows from year 1988 to year 2002, and drops in year 2007. As expected, the coefficients are positive for experience and negative for experience squared, which indicates the inverted U curve for a typical life-long earning pattern. The gender effect drops a bit from year 1988 to year 1995, while it increases a lot from then on.

The returns gap between male and female ranges from 8 to 28 percentage points among those years. The residential location effect is both statistically and economically significant. The total income for those who live in an urban area is almost double that for those who live in rural areas, which indicate the residential condition contributes great to the annual income. Family background may accounts for part of this effect, and Hukou (the residential condition: urban or rural residence) should explain most of the gap. However, the result may overstate the difference, as we only have non-agricultural income information. In spite of the missing information, we expect the difference should be even larger than we get from the estimate. Those rural area people who work in urban areas would do agriculture work if they could earn more. The reason they leave their hometown is the high income work in urban areas.

The model indicates that minority annual income with a given level of education and experience is a bit lower than Han Chinese. As expected, people work in eastern part of China earn 22 to 70 percentage points higher than those who work in the western part of China, while almost the same as those who work in middle and northeastern part of China, because the eastern part of China is the most developed part, including Beijing, Shanghai, Tianjin, Zhejiang, Jiangsu, Hebei, Shandong, Fujian and Guangdong provinces. But from the estimation it seems there is no difference between western part and northeastern part of China, which is counter to expectation.

(b) OLS with cohorts and Pseudo-panel regression

The estimates from the regressions with individual data and cohort means are presented in Table 2. Column (i) shows the results from a cross-sectional regression OLS on individual data, and column (ii) shows the results on individual data with cohorts' dummies included. The estimate using cohort-means are presented in column (iii).

Table 2. *Returns to education for individual data, cohort means*

	Individual data (cross-sectional regression) OLS	Individual data (cross-sectional regression) OLS	Pseudo-panel (cohort-means) GLS
	(i)	(ii)	(iii)
exp	0.0515***	0.0330***	0.0372
	(0.00189)	(0.00297)	(0.0511)
expsq	-0.000933***	-0.000955***	-0.000476***
	(0.0000438)	(0.0000452)	(0.000140)
JuniorSeniorHigh	0.332***	0.262***	0.434
	(0.0164)	(0.0181)	(0.271)
Profession	0.611***	0.498***	0.738
	(0.0188)	(0.0226)	(0.697)
Community	0.742***	0.595***	1.224*
	(0.0187)	(0.0250)	(0.531)
College	0.881***	0.712***	0.845
	(0.0212)	(0.0287)	(0.886)
Female	-0.119***	-0.112***	0.733**
	(0.00751)	(0.00747)	(0.264)
minority	-0.144***	-0.141***	-1.506***
	(0.0242)	(0.0241)	(0.427)
Urban	1.085***	1.052***	0.459*
	(0.0128)	(0.0138)	(0.194)
provMN	0.00476	-1.696***	-0.256
	(0.0107)	(0.231)	(1.128)
provE	0.499***	-0.750**	0.209
	(0.0116)	(0.231)	(1.140)
year1995	1.141***	1.262***	1.324***
	(0.0108)	(0.0163)	(0.313)

year2002	1.523***	1.781***	1.412*
	(0.0126)	(0.0300)	(0.637)
year2007	2.810***	3.138***	2.721**
	(0.0146)	(0.0380)	(0.877)
Intercept	5.251***	7.096***	5.621***
	(0.0279)	(0.234)	(1.589)
Observations	42782	42782	264

Standard errors in parentheses
="* p<0.05 ** p<0.01 *** p<0.001"

The basic finding of Table 2 is that the estimated returns to education drops after including cohort dummies. The cohort dummies in some sense control for the unobservable individual characteristics in the error term, and the column (ii) shows the failure of controlling selection bias leads to an upper ward bias of the education returns.

Personal ability in the error term is positively correlated with the school-level variables. Thus excluding the ability term from the equation would remove the upper ward bias for the coefficient vector β. Apparently, even including only cohort dummies corrects some of the bias arising from heterogeneity.

Given the same age, experience, gender and residence, the college graduate earnings is 11.7 percentage points higher than a community college graduate based on the average earning for a person with degree of elementary school or lower. From column (i), the area fixed effect is significant; the eastern part of China owns a much higher average income level, which is almost 50 percent more than those who live in western part of China, and income level is quite similar among eastern part and middle and northeastern part. But column (ii) shows that those working in middle, northeastern and eastern parts of China earn much less than those working in western part of China, and the coefficients are significant. I think the problem here is I also use these three regions as cohorts' trackers, because the regions' effects already show in the cohorts' coefficients. Thus, the coefficients here are misleading. The year dummies show an increasing trend of people's annual earnings over years.

In the pseudo-panel random effect regression, by applying the largest age range and using three region dummies as extra trackers, we get 66 observations each year, and 264 observations in total. As a result, we get higher education returns than the individual data estimations. Although the estimates for college is statistically insignificant, a magnitude comparison between college and community college coefficients shows us the education returns between those two choices is quite similar. The problem here is why the education returns to community college graduates are higher than college graduates? The magnitude changes when we include 66 cohorts' dummies as variables.

Based on all the other estimations, I believe college graduates earn more than community college graduates. The problem may come from several factors. And the main reason may be the small variance for college dummy variable. After dividing all the individuals into 66 cohorts, there is too small a share of them earned whom a bachelor degree, and there are some cohorts even do not have any people who graduated from colleges. And the close portion among different cohorts may lead to the lack of precision in my estimates.

(c) Period of time required to cover the education tuition cost between different secondary education graduates

Those community college graduates take one year less than those college graduates to get their degrees, and when we compare returns it should be taken into consideration. In this part, we use the 2002 average annual earning as the time cost. Here, we take the DCF (discounted cash flow) model, and use 0%, 2%, 4% and 6% four different interest rate to compute how many years it takes to cover the one year less working returns.

Discounted cash flow model considers the concept of the time value of money, all future cash flows are discounted to present value, and the discount rate is the interest rate you can get if you put your money into investment. Here, we use 4 different discount rates: 0%, 2%, 4% and 6%. Because the one-year interest rate for a savings account was 3.5% in 2008, and treasury bond interest rate was a bit higher, and both of them are non-risky investments, we chose rates centered on 4 percent.

The present value of the future cash flow income is:

$$PV = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} \quad (6)$$

The natural log average income of an elementary school graduate living in urban area is 8.77, in other word his annual income is 6438.17 yuan. The difference between community college graduate and college graduate is 11.7 percentage points, thus there is 753.27 yuan gap for each year. We suppose the tuition fee for college is 5,000 per year (which is the tuition fee for the first-tier, and it will be much higher for the third-tier universities). Thus, it takes 6.64 years with 0% interest rate, 7.19 years with 2% interest rate, 7.87 years with 4% interest rate, and 8.72 years with 6% interest rate to cover the cost of tuition.

	0%	2%	4%	6%
Years to cover tuition cost	6.64	7.19	7.87	8.72

There are two factors to which I need to pay attention: First, the income gap I use is the difference between college graduates and community college graduates, but the first-tier graduates will earn much more than the average, which indicates that the third-tier college graduates will earn less than the average. Second, the tuition fee for first-tier universities is 5,000, but it becomes 5,000 to 25,000 for different third-tier universities. Thus it will take more years than I estimate above to cover the tuition cost.

In conclusion, using my estimates, it takes at least 8 years to cover the one more year of education cost for the college graduates.

(d) Advantages and disadvantages of different methods

The most obvious advantage of using the conventional Mincer model is that it is the easiest way to get reasonable estimates, while its disadvantage is the heterogeneity among people in the error term which leads to biased estimates.

By tracking the birth year and working region of each person, dividing individuals into 66 different cohorts, we assume those same age people have the same characteristics. It is a weak assumption, but when the cell size becomes large, it is tenable. As Table 2 shows, including cohort dummies may decrease the upper ward bias created by unobserved ability. Although using cohort average to replace the individual data smoothes the difference between people, the small size of the sample and the small variance among education variables make it problematic in this context. Only the order of magnitude of the coefficients provides some information.

The pseudo-panel approach provides us a method to get rate of education returns when panel data are unavailable, with more surveys conducted, the estimations will be more accurate. The method provides us another way to check if the IV results are tenable by comparing different methods' results.

Conclusion

This study applies a revised Mincer model and pseudo-panel approach to estimate the rate of return to education in China from 1988 to 2007.

Based on the OLS including cohorts' dummies estimations, the overall rate of return compared to those with elementary or lower degree people, college graduates earn 71 percentage points more and community college students earn 60 percentage points more. Additionally, females earn 11 percentage points less than males, and minorities earn 14 percentage points less than Han Chinese people. The living area effect is substantial, it is not surprising that people living in urban areas earn about double the income of those living in rural area, and people working in the eastern part of China gain about 50 percentage points more than those working in other parts of China.

The pseudo-panel approach eliminates part of the unobserved ability in the error term by using the cohort means to estimate the parameters. The results are not accurate because of the small sample size, but the order of the magnitude of the education returns shows there is no big difference between college graduates and community college graduates.

I use the DCF model to estimate the years it takes to cover the extra year tuition cost of college study and get an estimate of 8 years at least. It takes longer for those third-tier universities since their tuition are much higher.

The education returns difference between college graduates and community graduates is not large enough to reflect the cost and ability difference, since those who go to college have an average higher University Entrance Exam score than those go to community college, and it takes one more year to complete the bachelor degree. In conclusion, when people cannot go to a college, choosing community college should also be a good choice when taking time cost and earnings in consideration.

REFERENCES

Agan, A. 2014. Disaggregating the returns to college: Forthcoming Working Paper.

Byron, R.P. and E.Q. Manaloto. 1990. Returns to Education in China. *Economic Development and Cultural Change* **38:783-796**.

Deaton, A. 1985. Panel data from time series of cross-sections. *Journal of econometrics* **30:109-126**.

Fleisher, B.M. and X. Wang. 2005. Returns to schooling in China under planning and reform. *Journal of Comparative Economics* **33:265-277**.

Heckman, J.J. and X. Li. 2004. Selection Bias, Comparative Advantage and Heterogeneous Returns to Education: Evidence from China in 2000. *Pacific Economic Review* **9:155-171**.

Johnson, E.N. and G.C. Chow. 1997. Rates of Return to Schooling in China. *Pacific Economic Review* **2:101-113**.

Li, H.; P.W. Liu; and J. Zhang. 2012. Estimating Returns to Education Using Twins in Urban China. *Journal of Development Economics* **97:494-504**.

Li, H. and Y. Luo. 2004. Reporting Errors, Ability Heterogeneity, and Returns to Schooling in China. *Pacific Economic Review* **9:191-207**.

Meng, X. and M.P. Kidd. 1997. Labor Market Reform and the Changing Structure of Wage Determination in China's State Sector during the 1980s. *Journal of Comparative Economics* **25:403-421**.

Mincer, J. 1974. Schooling, Experience, and Earnings. Human Behavior & Social Institutions No. 2.

Warunsiri, S. and R. McNown. 2010. The Returns to Education in Thailand: A Pseudo-panel Approach. *World Development* **38:1616-1625**.

APPENDIX

Cell sizes for each cohort:

cohort	1988	1995	2002	2007
1	121	214	60	69
2	359	338	121	84
3	192	280	104	128
4	94	219	83	87
5	333	374	126	101
6	203	357	147	148
7	118	281	92	98
8	418	392	144	111
9	244	360	149	168
10	99	234	93	97
11	379	432	148	128
12	217	371	167	170
13	106	278	137	140
14	396	486	200	134
15	234	358	154	192
16	144	305	156	139
17	399	493	186	160
18	231	377	193	236
19	126	293	183	147
20	350	458	261	196
21	215	347	234	260
22	90	347	192	144
23	345	507	239	186
24	225	388	208	270
25	88	267	168	131
26	318	429	268	196
27	260	331	205	244
28	90	262	196	116
29	297	471	282	210
30	205	305	222	285
31	84	223	162	129
32	333	384	190	171
33	198	247	162	300
34	75	195	124	82
35	181	386	219	157
36	157	224	188	245
37	65	190	142	67
38	183	330	221	151
39	123	205	163	233
40	49	174	153	68
41	191	319	226	169

42	169	192	171	220
43	59	232	198	124
44	228	411	405	299
45	184	240	260	367
46	73	309	241	226
47	295	513	348	355
48	183	223	210	437
49	77	230	230	137
50	232	418	282	305
51	175	208	189	338
52	69	263	186	157
53	187	408	259	302
54	155	218	143	327
55	71	174	179	157
56	221	330	258	254
57	144	179	128	303
58	44	224	148	108
59	204	357	255	236
60	199	183	135	270
61	53	197	179	181
62	220	299	255	308
63	183	219	173	359
64	47	201	141	164
65	185	305	223	263
66	157	220	117	306