Estimating the External Returns to Education: Evidence from China *

Wen Fan † Yuanyuan Ma ‡

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Abstract

We examine how individual wage changes associated with the share of college graduates in a given province using longitudinal data from China Health and Nutrition Survey (CHNS). The individual fixed effect model shows that the external returns to education in China appear to be zero. We estimate an instrumental variables fixed effects model where share of college graduates is instrumented by the number of universities with special status and find positive external returns to education of about 10% to 14%. We also find the returns are affected by individual heterogeneity. While negligible returns are found for urban, women and highly-educated workers respectively, the returns are positive and statistically significant for rural, men and low educated workers. This finding provides motivations for increasing education investment in rural China and targeting it more towards poorly educated workers.

Keywords: Education, Externalities, Spillover, Signaling, China

JEL classification: J0; J24; O15

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†School of Public Administration, Nanjing University of Economics and Finance, No.3 Wenyuan Road, Nanjing, Jiangsu, P.R. China. Postal code: 210046. Email address:wen.e.fan@gmail.com.

‡Corresponding Author.School of Economics and Geary Institute, University College Dublin, Belfield, Dublin 4, Ireland. Email address: yoyo.yuanyuanma@gmail.com.

1 Introduction

A good understanding of human capital externalities is important for both policy makers and social science researchers. While much attention has been devoted to the empirical investigation on the role of human capital in the process of economic growth and development at the aggregate level, the relevant work at the individual level seems to be inadequate. Education, one measure of human capital in empirical work, is usually used for such studies. There are at least two reasons why people care about the effect of human capital externality, i.e. external returns to education. Firstly, current education policies are often justified on the basis of at least modest human-capital externalities, better understanding of which would produce important implications or even guidelines for policy making. Secondly, the magnitude of the external returns to education is important for assessing the efficiency of public investment in education.

Economists have speculated for at least a century that the social returns to education may exceed the private returns (Moretti 2004). However, most of these studies on education externality focus on the developed countries. In this paper, we attempt to contribute to the existing literature with new evidence on the external returns to education in China, which is considered to be an important developing economy in the world, and hope to shed more light on the cross-country income differential via human capital externality perspective.

Since the Reform and Opening-up policy implemented in the year 1978, China has gradually altered the attitude towards education through learning the importance of education for the economic growth and social development. Figure 1 shows the nation's total investment in education and educational investment from government in China from the year 1980 to 2009. From 1980 onwards, the total investment on education and government's investment on education kept increasing drastically. Although the investment from other sources (charity, social donation, etc.) became more and more important, government's investment is still the dominant body for education investment.

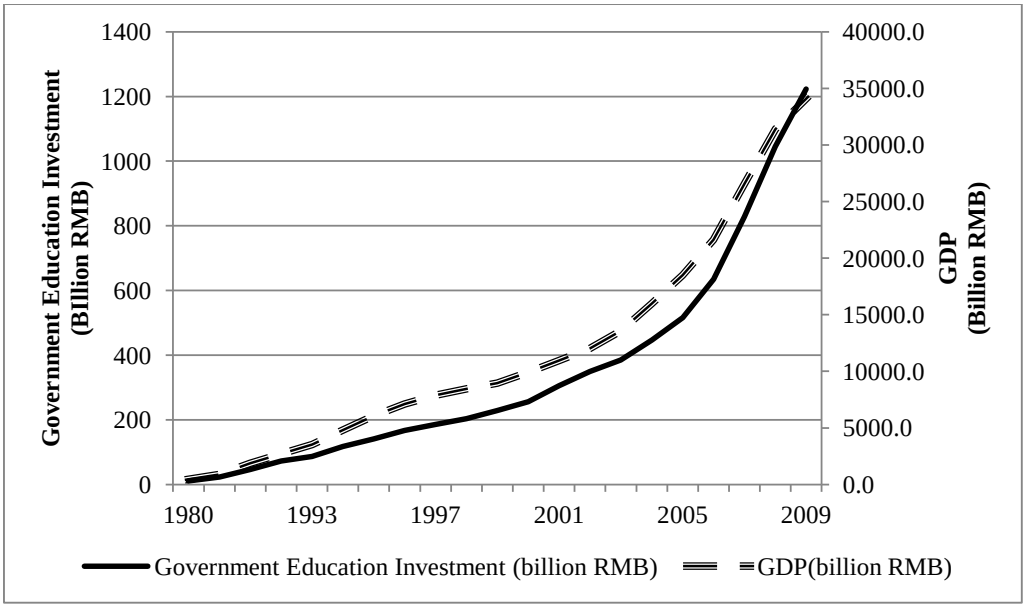

Figure 1: GDP and Total Education Investment in China (1980-2009)

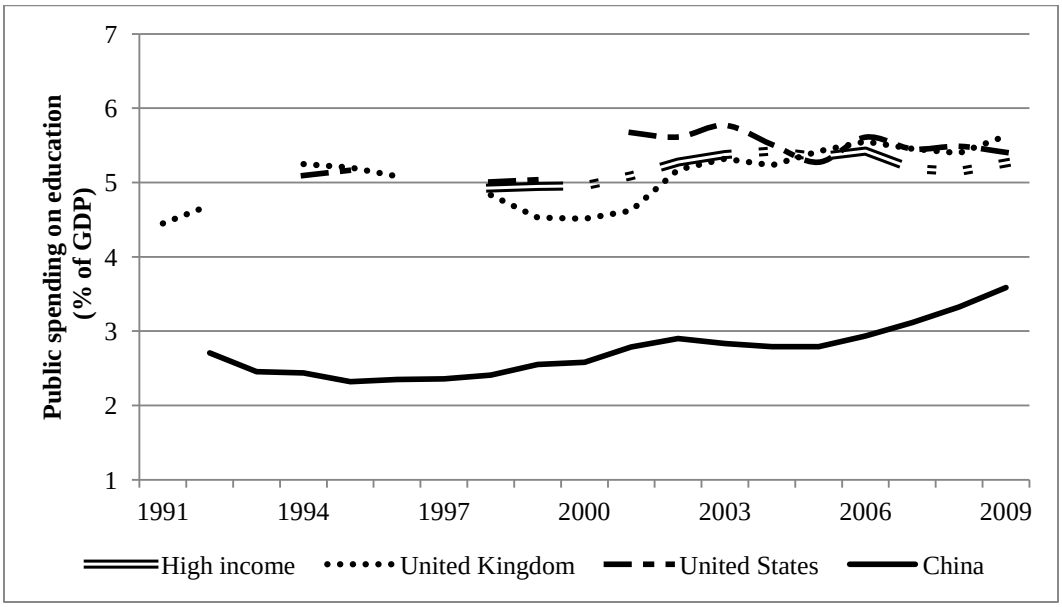

Figure 2: The Proportion of Government Education Investment in GDP(1980-2009)

However, when turning to the striking GDP growth, it is not surprising to see the criticisms that Chinese government's investment on education is far from satisfactory. Heckman (2003) argues that China has invested too little in human capital relative to its investment in physical capital. Figure 1 shows the GDP and the government's investment in education (in current billion RMB) in China from 1980 to 2009. Compared with the rapid growth of the absolute

value of investment, the proportion of government's education investment in GDP during the same period is relatively stable. And the magnitudes of the proportion in China are much smaller than they are in developed world during the same period. Figure 2 shows the international comparison. However, we argue that it may be quite hasty to judge whether the government's investment on education is enough or not before fully understanding the essence of education. Education is a semi-public good with both private and external returns. Although there is a large body of literature investigating the private returns to education in China, little has focused on the education externalities. In this paper, we are trying to answer a handful of questions related to the external returns to education such as "Whether China has a positive education externality like most developed countries?", "How large are the externalities?" and most importantly, "What would we learn from questioning so?".

In this paper, we examine how individual wage changes associated with the share of college graduates in a given province using longitudinal data from China Health and Nutrition Survey (CHNS). [1] In conventional fixed effects (FE) estimates, insignificant coefficients suggest that the external returns to education are almost zero. However, when we account for endogeneity problem and then implement instrumental variables fixed effects estimates, we find positive external returns to education for full sample of about 10% to 14%.

Taking individual heterogeneity into consideration, we split our sample by region, gender and education levels. Our results speak to different stories and shed more light on policy implications. While negligible returns are found for urban, women and highly-educated workers respectively, the returns are positive and statistically significant for rural, men and low educated workers. This finding provides motivations for increasing education investment in rural China and targeting it more towards poorly educated workers.

The layout of this paper is as follows. In next section, we review some relevant literature. Section 3 presents data and methodology. Section 4 shows main empirical results and section 5 provides further discussion. Section 6 concludes.

[1] We describe this dataset in details in section 3.1.

2 Literature Review

Marshall (1961) argues that increasing the geographic concentration of specialized inputs increases productivity because the matching between factor inputs and industries is improved. Therefore, firms find it profitable to invest in new technologies only when there is a sufficient supply of trained workers to replace employees who quit. Greater human capital encourages more investment by firms and raises other workers' wages via this channel.

On the other hand, if we believe the knowledge spillover story in which the sharing of knowledge and skills through formal and informal interaction may generate positive externality across workers, living with more educated people would make you earn more. In contrast, if the school could teach you nothing but identify your ability in labor market, signaling theory tells us that the external returns to education tend to be very low, even zero. (Acemoglu and Angrist (2000)).

Furthermore, people could find negative external returns to education if labor supply extremely exceeds demand and then crucial competition may induce a decrease in individual wages when workers have to face much stronger competitors. (Moretti (2004))

In empirical, Rauch (1993) is the first attempt to estimate human-capital externalities, finding that the externalities are on the order of 3% to 5% in United States. Moretti (2004) also finds significant external returns to education using the American National Longitudinal Survey of Youths and American Census data. Both studies above use college share as a parameter of interest. When using average schooling as an alternative, Acemoglu and Angrist (2000) find little evidence with the 1950-1990 American Census data.

Liu (2007) provides the first set of estimates on the external returns to education in Chinese cities. The 2SLS estimates indicate that a one-year increase in city average education could increase individual earnings by 11% to 13%, whereas one percentage increase in college share would increase wages by about 1%. Given that he finds over 10 times larger external returns

using average schooling than using college share, the huge difference interest us to revisit the issue and our study differs at least two strands.

Firstly, while Liu (2007) uses cross-sectional data in his analysis, our paper is hoped to be the first attempt using longitudinal data. By virtue of the panel element, we are able to get rid of many noises caused by individual unobservables and avoid potential bias with simpler cross-sectional specifications.

Secondly, while Liu (2007) only looks at cities, our study covers both urban and rural areas. Since more than 50% of the Chinese population live in the rural areas, [2] our study tends to be more informative thanks to the more representative samples. Exploring regional heterogeneity enables us to understand and explain different social phenomena in urban and rural areas and also helps contributing to pragmatic policy implications, especially on education investment.

In practice, we restrict sample to person who has never moved to motivate individual fixed effects (FE) estimates and examine how individual wage changes associated with the share of college graduates in a given province over time. Different from Liu (2007), we find that one percentage increase in the share of college graduates would increase individual earnings by about 10% to 14%.

We also find the returns are affected by individual heterogeneity. Perhaps most interestingly, we do find the external returns to education vary across education levels. Low educated people tend to earn more associated with an increase in college share, which is consistent with the existing prediction (Moretti (2004)). Null benefit for highly-educated workers implies that the spillover effect is not strong enough to exceed the supply effect.

[2]China Statistical Yearbook, 2011.

3 Data and Methodology

3.1 Data

The data used in this paper comes from the China Health and Nutrition Survey (CHNS), the largest micro-level survey for current China. Started in 1989, CHNS is an ongoing open cohort, international collaborative project between the Carolina Population Centre at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Centre for Disease Control and Prevention.

CHNS covers nine provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shangdong), which vary considerably in the geographic characteristics and economic development levels. A multistage, random cluster process was used to draw the sample surveyed in each of the provinces.

Some macro level information (e.g. the provincial share of college graduates, GDP per capita, lag average adjacent provincial wage, [3] provincial education expenditure, number of universities and colleges per province, number of high school graduates per province, and 4-year-ago university/college enrolments), is obtained from China Statistical Year Books.

Started in 1989, the survey takes place every 2-4 years. Based on the original longitudinal dataset, we extract an unbalanced panel covering the years 1991, 1997, 2000, 2004, 2006, and 2009. [4]

Figure 3 and 4 are two graphs which depict the correlation between individual's wage (Log monthly wage) and the share of college graduates by province in 1991 and 2009, respectively.

[3] It is one-year lag of the average wages in adjacent provinces within that region. The 9 provinces surveyed covers the four region — north eastern (LIAONING and HEILONGJIANG), south eastern (SHANDONG and JIANGSU), middle areas (HENAN, HUBEI and HUNAN) and western areas (GUANGXI and GUIZHOU). Similar economic and cultural backgrounds and close distance make labor migrations more likely to happen across provinces within region. As a result, skilled workers are likely to move to the adjacent provinces when there are better job offers. To control for this migration effect, we add the lag average adjacent provincial wage.

[4] Year 1989 and 1994 are excluded, because no information on the provincial share of college graduates can be matched for these two years.

It is clear to see that while the correlation curve appears to be very flat-sloping for the year 1991, it turns out to be evidently positive almost 20 years later. Although this visual comparison suggests that the wage are higher in areas where the labor force is better educated, it is far from inferring whether this documented association is causal. To further probe the sign and size of external returns to education in empirical, we first need to address the underlying mechanisms.

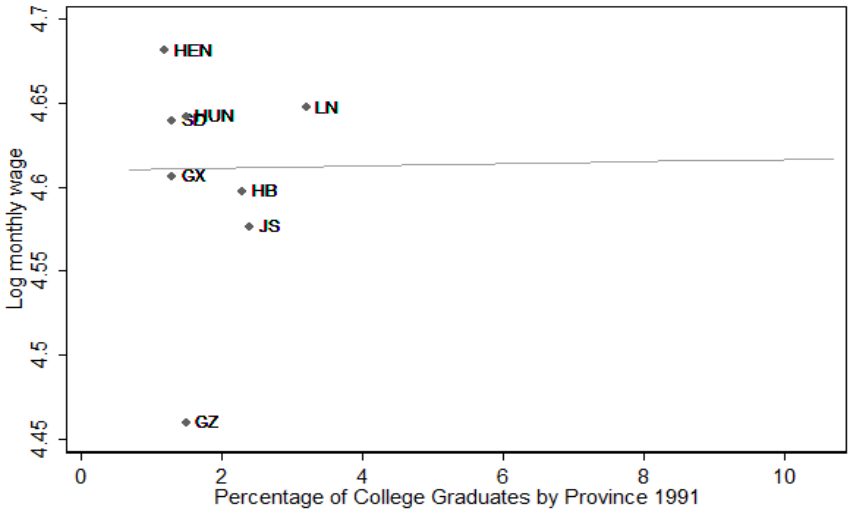

Figure 3: Correlation between log monthly wage and share of college graduates (1991)

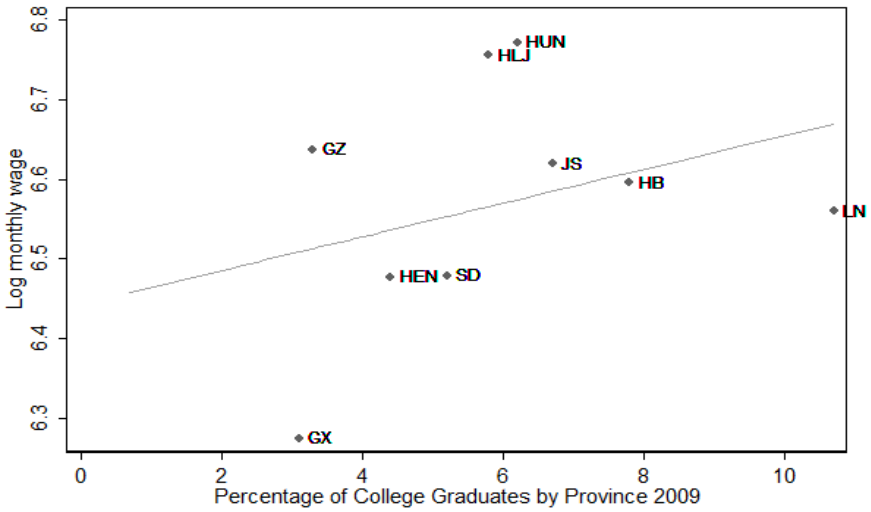

Figure 4: Correlation between log monthly wage and share of college graduates (2009)

3.2 Empirical Strategy

The baseline individual FE estimation equation is as follows:

$$LnW_{ijt} = \delta_{ij} + \lambda_t + \sigma * X_{ijt} + \gamma * P_{jt} + \rho * Z_{jt} + \mu_{jt} + \epsilon_{ijt} \quad (1)$$

where LnW_{ijt} is the log monthly wage of individual i in province j in year t, μ_{jt} is a province-year error component, and ϵ_{ijt} is an individual error term. The controls δ_{ij} and λ_t are individual and year effects. The coefficient σ is the parameter for individual characteristics, while the coefficient γ is meant to capture the effect of the share of college graduated workers (P_{jt} in province j and year t). Z_{jt} is a vector of province characteristics that we control for. In practice, we also allow for the private return to schooling to vary over time by including the interaction of individual years of schooling and year dummies.

There are two major methodological concerns. Firstly, there may be unobservable factors that are correlated with both wages and education. We use longitudinal data and individual FE model to deal with this problem. A benefit of using longitudinal individual level data is that we can deal with some of the most relevant endogeneity and selectivity issues that might bias a simpler cross-sectional specification. In our case, when the non-mover sample is used (and we also control for the migration effect), individual FE estimates enable us to control for permanent unobserved characteristics of individuals as well as provinces where individuals reside. Taking ability for instance, we can eliminate any unobservables that may correlate with individual education and wage by assuming the unobserved ability is equally valued over time.

Secondly, time-varying factors that are correlated with overall level of human capital and wage in an area could also bias our estimates. [5] We use IV FE estimates to circumvent the potential endogeneity problem of provincial share of college graduates.

[5] In theory, people might think to absorb such shocks by adding province*year effect. However, it would not work in empirical as model would be perfectly saturated then.

Ideally, we need an instrument variable that is highly correlated with college share in a province but uncorrelated with unobserved time-varying factors that affect wage directly. In our case, we instrument the share of college graduates with the number of "211" universities in each province in each year. [6] Given only universities with long historical reputation [7] were considered to be listed in Project 211, one might expect that the number of "211" universities in each province is more likely to be correlated with historical and accumulative factors than contemporary market condition. [8] With regard to individual characteristics, we avoid including any variables which could be endogenous to the share of college graduates, say, occupations, marital status, and so on.

Our paper may call into questions by the following caveats. Firstly, a lot of wage information is missing. To show that there is no sample bias issue raised, we split the whole sample into wage-earners and non-wage-earners and find that individual variables are not significantly different between those two groups (shown in Table A.1).

Secondly, although IV methods are used to deal with endogeneity problem, we are not able to completely rule out the possibility that unobserved time-varying variables would also bias our estimates.

For this concern, we consider two types of time-varying factors. One is referred as migration effects, meaning that educated people move in and out due to unobservables. Say if low wage in a given province, more natives (e.g. educated people) will migrate out. This labor flow would affect the college share of the destination province and in turn affect the estimated return to the college share. To control for this, we add a new variable, which is the one-year

[6] "211" denotes Project 211. Project 211 is a project of National Key Universities and Colleges initiated in 1995 by the ministry of Education of the People's Republic of China, aiming to raise the research standards of high-level universities and cultivate strategies for socio-economic development. The fact that universities were conferred "211" title in different years depending on their quality offers us natural variation on region*year level. We will introduce it more in section 4.2.1.

[7] The establishment year is 50 years ago at least. Many universities are over 100 years old. Among 100 universities, only two youngest universities were established in 1960s.

[8] The other concern might be the underlying correlation between the education feature and the economy development in a given province. The estimates would be biased upwards if provinces with more 211 universities are also rich areas, and tend to have higher wages. As addressed before, individual FE help to deal with this problem. We will discuss it more in section 4.2.1.

lag of the average wage in adjacent provinces, under the assumption that people are more likely to move to provinces with similar economic and cultural backgrounds to where they used to live. [9]

The other one is known as "catch-up" effect, referring that the new-developing regions would attract more skilled people. According to regional and urban economics, this concern involves a number of attributes, including economic factors, changes in demographics which might affect education and employment environments, and etc. We introduce two provincial level variables—"GDP per capita" and "total education expenditure" to account for economic factors. In addition, we use "provincial number of universities/colleges" and "provincial high school graduates" to proxy higher education supply and demand. People would expect that our key variable—share of college graduates should be impacted by these kinds of factors. To calibrate more precisely to which extent college graduates flow into labor market and allow for a lag effect of college graduation (i.e. it is reasonable to assume that since people realize and understand the appearance of "211" universities, it will at least take 4 years to get graduated and enter the labor market), we employ the number of college enrolments in years which are 4 years before the wage is measured. These education variables would also help to strengthen our instruments. [10]

Table 1 presents the summary statistics. Note that the share of college graduates is reported and used in percentage in our paper provided its considerably low figure in China case for presenting purpose.

[9] Solo province and year dummies are not able to capture the effect of time-varying variation, such as migration, etc.

[10] Our instrument is the number of special status universities in each province; people might think this variable would affect people's wages through other channels apart from the share of college graduates. For example, graduates in the province with more 211 universities will have higher human capital and wages. If high school skills (human capital) are complementary to university human capital, the high school students will also have higher productivity even if there are no externalities. These variables are expected to capture possible effects of education feature on income level.

Table 1: Summary Statistics

Variable	N	Mean	Std. Dev.
Individual level			
Log(monthly wages)	12772	6.09	1.06
Individual years of schooling	38931	8.78	3.54
Age	40488	38.63	10.54
Female	40491	0.52	0.5
Survey year	40560	2000.88	6.05
Province level			
Share of college graduates (%)	40560	3.8	2.17
Number of 211 Universities	40560	2.54	2.93
GDP per capita (in thousand Yuan)	40560	9.67	8.48
Lag log(annual average wage) of adjacent provinces	40560	8.87	0.82
Provincial education expenditure (in billion Yuan)	40560	20.06	17.52
Number of universities and colleges	40560	62.96	27.88
Number of high school graduates (in thousands)	40560	232.28	177.04
University and college enrolments (in thousands)	40560	83.02	78.85

4 Empirical Results

4.1 Fixed Effects

Table 2 presents individual FE estimates. Column 1 reports the results without any provincial economic and education controls, and we find a significant negative effect of provincial college graduates share—one percentage point increase in the share of college graduates will reduce individual wages by 2.5%.

In column 2, when we add controls for other relevant factors, the coefficients turn out to be insignificant, suggesting that the previous negative returns might be crowded out by some time-varying factors. For instance, the migration effect, the catch-up effect, and the time lag between getting enrolled in a university/college and actually entering the labor market, and etc.

However, the estimates in column 2 are still questionable, largely due to the endogeneity problem concerned with the key variable "share of college graduates". If some unobserved supply factors that we did not control for would also affect the labor demand side, the

estimated will be biased. A reasonable guess could be the Chinese higher education expansion that took place in later 1990s. [11]

Both the higher education expansion and the instrument variable that we will use in later section (Project 211) can be considered as supply shock. And supply shock itself will not bias the FE results. It is only problematic when the supply shocks also affect the labor demand. Unlike the Project 211, the higher education expansion does affect the labor market somehow. Or at least, it is not that neat. For example, to counter against the drastic labor supply increase caused by huge college degree labor entrants, governments (both central and local) came up with various related policy bundles to help the newly graduated find a job, including creating new jobs, providing preferable incentives to firms that hire newly graduates, and etc. This is the direct impact on the labor demand side. We will argue in the following section that the instrument we employed does not suffer from this problem, especially with further help of the controls.

As mentioned before, we also allow for the private returns to schooling to vary over time by including the interaction of individual years of schooling and year dummies. In both columns, the private returns to schooling increased year by year from 1997 to 2009, which is in accordance with previous literature. And the magnitudes of the returns also fall in the range of various research works in the existing literature.

4.2 Instrumental Variables Fixed Effects

4.2.1 Project 211

Project 211 is a project of National Key Universities and Colleges initiated in 1995 by the Ministry of Education of the People's Republic of China, aiming to raise the research standards of high-level universities and cultivate strategies for socio-economic development.

[11] Albeit supply shocks caused by policy reform is less likely to directly bias fixed effects estimates here, people might think some other supply factors would be resulted from such education reform and then affect FE results.

Table 2: Fixed Effects Estimates of External Returns to Education (1991-2009)

Y=LOG(MONTHLY WAGE)	**[1]**	**[2]**
Share of College Graduates	-.025***	-0.014
	(.009)	(.010)
Age	.355***	.288***
	(.088)	(.092)
Age sq./100	-0.013	-0.014
	(.009)	(.009)
Years of edu*1997	0.007	0.007
	(.006)	(.006)
Years of edu*2000	.034***	.034***
	(.006)	(.006)
Years of edu*2004	.067***	.063***
	(.007)	(.007)
Years of edu*2006	.083***	.079***
	(.007)	(.007)
Years of edu*2009	.095***	.091***
	(.007)	(.007)
Provincial Characteristics		
GDP per capita		yes
Lag log(annual wage) of adjacent province		yes
Provincial education expenditure		yes
Number of universities and colleges		yes
Number of high school graduates		yes
University and college 4-years ago enrolments		yes
Observations	11,893	11,893

Note: (1) All specifications also include year-dummies. (2) Robustness standard errors in parentheses allow for clustering by individual. (3)* denotes the significance level, with *** P<0.01, ** p<0.05, * P<0.1.

It is envisaged that after several years of efforts in the 21st century, about 100 universities and institutions of higher education would have greatly improved their quality of education, scientific research, management and institutional efficiency. In addition, these universities and institutions will also have made remarkable progress in reforming the management system and consequently become the bases for training high-level professional manpower and solving major problems for the country's economic construction and social development. The name for the project comes from an abbreviation of the 21st century and approximately 100 universities.

There are over 2,000 standard universities and higher education institutions in China, among which, 112 are 211 universities. Those 211 universities could receive extensive financial and policy support from central government. The preparation work started from around 1990, and the project has been ceased in 2009 so there is no new university entitled since then.

Our instrument is hoped to be valid due to the following features. Firstly, the instrument is strongly correlated with the endogenous variable. As the province with more 211 universities is always a more attractive place to study and work, it is quite natural that more college graduates would enter the labor market over there than otherwise. The assumption making here is that the provincial number of 211 universities would impact the individual wages through its effect on the share of college graduates in that province while others are equal. Some people might argue that even 211 universities indeed attract people, it might take a while rather than immediately to get into effect—college graduates are supposed to enter the labor market about 4 years later than the time 211 status is conferred. Is there a lag effect of Project 211 in this sense? The answer is no, at least, we could say there is no obvious time discontinuity here. This is because, although 211 status has been conferred to universities very recently since 1995, it stands for a long-term education standard and quality for a given university, even for the province where the university locates.

Two features of Project 211 are helpful to understand why it is a good instrument. 1) 211 status could not increase a university's fame and enrolment suddenly. 2) Even if there were no

Project 211, qualified university and corresponding province could still attract more students, because of their long-standing advantages and reputation in the quantity and quality of higher education provided. Given it reflects a stable trait of education development, number of 211 universities is capable to instrument college share in our case.

The other point here is to compare the Project 211 with the education expansion policy. They are essentially different in terms of the impact on labor supply: the education expansion policy means enrolment expansion to higher education institution in general sense. Existing universities/college will recruit more students, and there will be newly established higher education institutions to absorb more higher education entrants. It will certainly increase the total amount of college graduates labor supplied. Fundamentally different, as we mentioned above, the project 211 is basically recognition of the accumulated and existing good reputation and high quality of certain universities, and further indicates the education levels in local regions. No universities with less than 50 years of history is nominated, and most "211" universities have a history over 100 years. Therefore, without other factors, the Project 211 itself won't cause drastic labor supply increase like the education expansion policy, and the government won't need to come up with policies to influence the demand side to deal with the huge influx of new entrants into the labor market.

Secondly, the instrument is exogenous to the outcome variable. One advantage of using Project 211 compared to the "share of college graduates" is that although the former is also an indicator of the education level, it is a government policy, which is much more exogenous to the local system than the latter variable. Much previous education literature used government policy as exogenous shock, like the compulsory schooling law, and the education expansion policy (Oreopoulos (2006), Devereux and Fan (2011)). But certainly, we also need to control for certain issues here. Like the education expansion policy, it is reasonable to consider the governments' Project 211 as an exogenous variable. Given only universities with long historical reputation have been considered, one might expect the number of "211" universities is more likely to be correlated with historical and accumulative factors rather than contemporary conditions. As mentioned before, we also include several

education covariates that help to account for possible channel through which education features might affect wages.

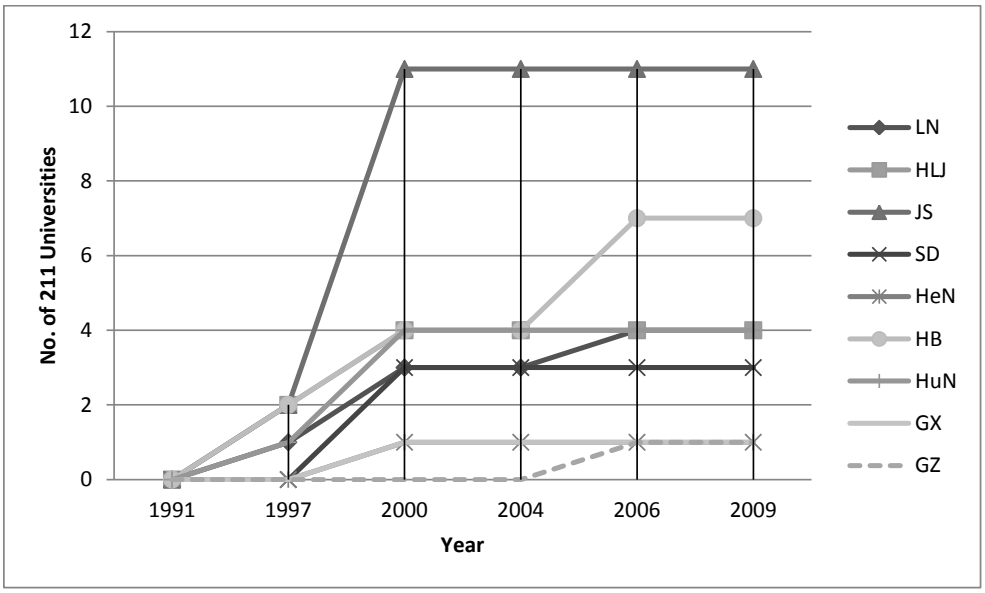

Figure 5: The Number of 211 Universities in Each Province (1991-2009)

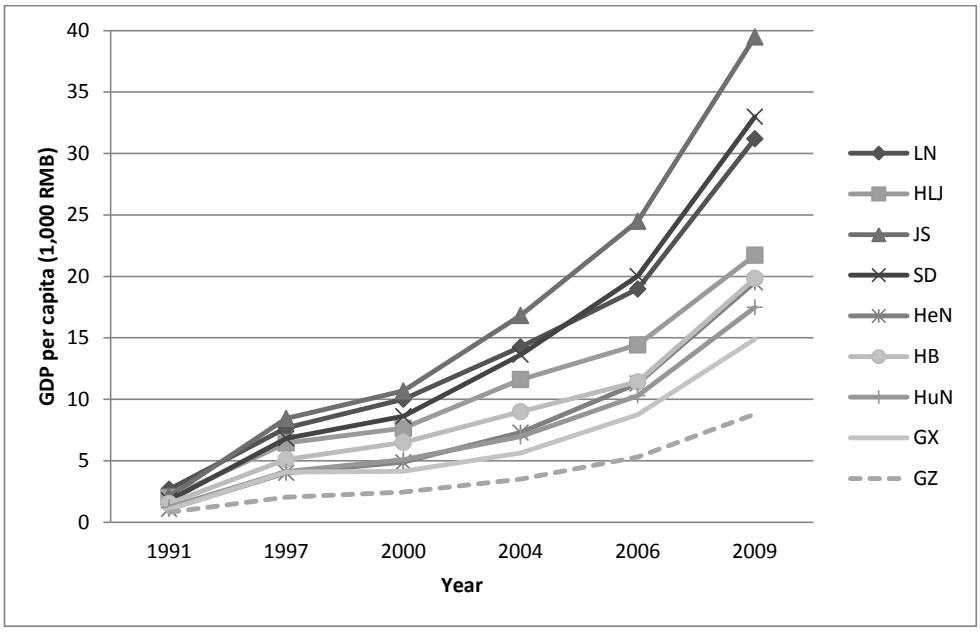

Figure 6: GDP per capita in Each Province (1991-2009)

Even so, one might still question about the possible underlying correlation between the education feature and the economic development in a given province. For example, provinces with more 211 universities are richer areas that have higher wages. If it is the case, failure

of including richness variable would bias our estimates. However, conditioning on non-mover sample, individual FE estimates help to deal with this problem by taking account of any time-invariant province-specific factors that may affect our results. That is, as long as such region feature does not vary over time, say richness, it would not induce bias to our FE estimates.

Moreover, we can show that provinces with more 211 universities are not always the richer areas in China. Figure 5 shows the number of 211 universities in each province from 1991 to 2009. Jiangsu has the most 211 universities, reaching eleven in 2000 and staying at eleven since then. Hubei has the second most, with seven universities entitled as 211 universities. Liaoning, Heilongjiang, and Hunan have four, while Henan, Guangxi and Guizhou only have one each. Figure 6 shows the GDP per capita, indicating the economic development level in those provinces. As we can see from the figure, Jiangsu has the highest GDP per capita almost throughout the whole period. But Hubei only ranked the fifth, after Shandong, Liaoning, and Heilongjiang, with huge decrease of GDP per capita. Although Hunan has the same number of 211 universities as Liaoning and Heilongjiang, its GDP per capita is much lower.

4.2.2 IV FE Estimates

Our specifications are:

$$P_{jt} = \delta_{ij} + \lambda_t + \sigma * X_{ijt} + \beta * N211_{jt} + \rho * Z_{jt} + \mu_{jt} + \epsilon_{ijt} \tag{2}$$

$$LnW_{ijt} = \delta_{ij} + \lambda_t + \sigma * X_{ijt} + \gamma * P_{jt} + \rho * Z_{jt} + \mu_{jt} + \epsilon_{ijt} \tag{3}$$

Equation (2) presents the first stage estimation, where "N211" denotes the number of 211 universities in province j at year t. Equation (3) presents the second stage estimation equation. All variables are as defined before.

Table 3 reports the IV FE estimates. The first stage estimates are significantly positive with or without additional provincial controls. As one might expect, the more 211 universities

one province has, the higher college graduates share will be in that province. Although after controlling for other economic and educational factors, the magnitudes decreased a little bit, the results remains quite similar by large. One additional 211 universities would induce about 0.1% increase in college share in a given province. [12]

The coefficient of college graduates share turns out to be positively significant with and without provincial controls, suggesting that the conventional FE estimate is biased downwards. One percentage point increase in the share of college graduates will increase individual wages by about 10% in the base model, and 14% with further controls. This is remarkably different from the FE estimates, indicating that the variation in the college graduates share across provinces captured before is probably driven by unobserved supply factors. As we discussed in section 4.1, it could be related to the higher education expansion that took place in China in late 1990s.

Comparing our results to the former research in related areas, we find larger educational externalities in general. Firstly, with regard to Rauch (1993), Moretti (2004), Acemoglu and Angrist (2000) who based on US data, our Chinese data gives a higher estimation. One possibility is, strong competition effect driven by longer average schooling and higher education quality in developed countries would offset spillovers. In this sense, people could not benefit from working with more skilled people, the resulting education externality tends to be very low even zero. Secondly, when comparing to Liu (2007) who finds about 1% external returns, our estimates are still much larger. On one hand, we look at the whole nation rather than only cities. As we will see in section 5.1, education externalities are much higher in rural than in urban China. On the other hand, we employ different data structure and methodology.

[12]The dependent variable (share of college graduates) is measure in percentage.

Table 3: IV FE Estimates of the External Returns to Education (1991-2009)

	First Stage		**IV**	
	Y= college share		Y= Log (monthly wage)	
Instrument : No. of 211 Universities	.117***	.085***		
	(.002)	(.002)		
Share of College Graduates			.098*	.138***
			(.051)	(.049)
Observations	38,867	38,867	8,456	8,456
Provincial Characteristics				
GDP per capita		yes		yes
Lag log(annual wage) of adjacent province		yes		yes
Provincial education expenditure		yes		yes
Number of universities and colleges		yes		yes
Number of high school graduates		yes		yes
University and college 4-years ago enrolments		yes		yes

Note: (1) All specifications also include age, age-squared, year-dummies, interactions between individual education and year dummies and provincial characteristics mentioned in text. (2) Robustness standard errors in parentheses allow for clustering by individual. (3) Individual fixed effects are included in the first stage regression. (4) * denotes the significance level, with *** P<0.01, ** p<0.05, * P<0.1.

5 Discussion

The above analysis estimated the external returns to education using representative samples for the whole nation. In the following context, we try to split the full sample into different groups by region, gender and education levels to see whether the external returns to education vary across individual heterogeneity.

5.1 Education Externalities in Urban and Rural China

Are the external returns to education different in urban and rural China? Table 4 reports the results. Liu (2007) finds that a one-year increase in city average education could increase individual earnings by between 11% and 13% in China. Li, Chen and Zhang (2010) find that from 1989 to 2000, the external returns to education in urban China is about 0.64%, while after 2004, it increased to about 1%, meaning that if the share of higher education graduated increase by one percentage point, the individual wages would increase by 1%. Unlike them, we find no significant evidence on education externalities in urban China, suggesting that the

signaling story, rather than pure positive spillover nor pure negative competition effect, suits here. College degree may simply help you stand out in the screening process in the labor market. Even if there is positive spillover among urban workers, the fierce competition effects may still cancel it out. Huge higher education expansion seems leading to the over-education problem in urban China, which means that urban people have to face severe competition in labor market and also tend to suffer from signaling effect.

To date and to our knowledge, work on the external returns to education for rural China is quite limited, due to data limitation. Thereby, our estimates are hoped to provide some new evidence. In rural China, one percentage point increase in the share of college graduates in a given province would increase the individual wage by about 22%. Given education level is extraordinarily low in those areas, people might expect the increase in proportion of educated people would bring a larger spillover relative to what would happen for urban areas.

Additionally, while signaling theory explains the zero external returns for urban areas, significant positive spillovers found in rural areas are supportive evidence for standard human capital theory, implying that it is necessary to further improve the education investment and education quality in rural areas in China.

5.2 Education Externalities for Male and Female

The discrimination literature has an emphasis on investigating the gender difference in labor market. In education context, most researchers focus on comparing the private returns to education for males and females. For China case, Li (2003), Chen (2004), Yuan (2005), Zhang (2005) and Yao (2007) find that females' private return to education is higher than that of males. Except Li (2003), all the others use data collected from urban areas.

As far as we are concerned, there is no paper comparing the education externalities between men and women in China. So here, we split the sample into males and female and try to compare the education externalities in these two groups. Table 5 shows the results. While

there are strong positive externalities among men, there are nearly zero externalities among women.

As nowadays, the workplace has become more and more competitive. Maybe we can explain this by men and women's different attitudes and behaviors towards competition/networking. Niederle and Vesterlund (2007) find evidence to show that while men embrace the competition, women tend to shy away from it. Gneezy, Niederle and Rustichini (2003) find that women may be less effective than men in competitive environments, even if they are able to perform similarly in non-competitive environments. Compared to men, the negative competition effect for women might be so huge that it cancelled out the positive spolliover effect. Or, the shyness and fear may further prevent women from interacting and networking with colleagues.

5.3 Education Externalities for Different Education Groups

Existing research usually finds that the marginal returns to private education decrease along with the improvement of education level. It is naturally to question how the external returns to education may vary across educational levels. Table 6 gives the estimates. We split the sample into individuals with college education or higher, who tend to be high-skilled workers, and individuals with only junior high school education or even lower, who are otherwise seen as low-skilled workers in labor market.

We may argue that the change in share of college graduates in certain areas may affect workers with different skill levels differently. Moretti (2004) summarizes these with two effects: the standard imperfect substitution effect associated with a shift in college share and the spillover effect. The spillover effect is a positive effect that has been addressed extensively. The standard imperfect substitution effect related to the labor supply change has different impact on skilled and non-skilled workers.

Theoretically speaking, irrespective of the magnitude of spillover, the increase in the share of college graduates would help to increase low-skilled workers' wages. For the high-skilled

workers, the final effect depends on the comparison of those two effects. If the spillover effect is stronger than the imperfect substitution effect related to labor supply, the externality coefficient would be positive. Otherwise, if the supply effect is stronger than the spillover effect, the coefficient would be negative.

As we can see from Table 6, there are strong positive externalities among low-skilled workers, whereas there is no significant externality among high-skilled workers. The possible explanation could be that the substitution effect associated with labor supply and the spillover effect cancel out each other for high-skilled workers. This finding is opposite to some urbanization research under developed countries, where human capital spillovers are felt more strongly by college-educated workers than by those without college degree (Wheeler (2001); Rosenthal and Strange (2008)), [13] and could lead to some different inference. In our case, given that the increase in college graduates share is largely due to the higher education expansion policy, our results suggest that such policy could in some sense help to decrease the wage differentials between high-skilled workers and low-skilled workers.

Table 4: FE and IV FE Estimates of External Returns to Education by Region (1991-2009)

	Urban		**Rural**	
	FE	**IV FE**	**FE**	**IV FE**
First Stage				
Number of 211 Universities		.065***		.093***
		(.003)		(.002)
Observations		12,460		26,407
Share of College Graduates	-0.018	0.043	-0.007	.223***
	(.016)	(.083)	(.016)	(.062)
Observations	5,799	4,301	6,094	4,155

Note: (1) All specifications also include age, age-squared, year-dummies, interactions between individual education and year dummies and provincial characteristics mentioned in text. (2) Robustness standard errors in parentheses allow for clustering by individual. (3) Individual fixed effects are included in the first stage regression. (4) * denotes the significance level, with *** P<0.01, ** p<0.05, * P<0.1.

[13] Restricting samples to urban areas still generate spillover effects for more educated workers.

Table 5: FE and IV FE Estimates of External Returns to Education by Gender (1991-2009)

	Men		Women	
	FE	**IV FE**	**FE**	**IV FE**
First Stage				
Number of 211 Universities		.091***		.080***
		(.002)		(.002)
Observations		18,849		20,018
Share of College Graduates	0.008	.177***	-.046***	0.06
	(.014)	(.063)	(.015)	(.076)
Observations	6,941	5,127	4,952	3,329

Note: (1) All specifications also include age, age-squared, year-dummies, interactions between individual education and year dummies and provincial characteristics mentioned in text. (2) Robustness standard errors in parentheses allow for clustering by individual. (3) Individual fixed effects are included in the first stage regression. (4) * denotes the significance level, with *** P<0.01, ** p<0.05, * P<0.1.

Table 6: FE and IV FE Estimates of External Returns to Education by Education Levels (1991-2009)

	Compulsory schooling or below		Some college and College +	
	FE	**IV FE**	**FE**	**IV FE**
First Stage				
Number of 211 Universities		.841***		.086***
		(.002)		(.006)
Observations		27,192		3,995
Share of College Graduates	.010	.131**	-.047***	-.021
	(.017)	(.061)	(.016)	(.128)
Observations	5,642	3,449	3,020	2,562

Note: (1) All specifications also include age, age-squared, year-dummies, interactions between individual education and year dummies and provincial characteristics mentioned in text. (2) Robustness standard errors in parentheses allow for clustering by individual. (3) Individual fixed effects are included in the first stage regression. (4) * denotes the significance level, with *** P<0.01, ** p<0.05, * P<0.1.

6 Conclusion

This paper provides the first set of estimates on the external returns to education in China with longitudinal data. Using CHNS, we examine how individual wage changes associated with the share of college graduates in a given province in China from 1991 to 2009. The individual FE estimates of external returns to education in China appear to be zero.

Taking account of endogeneity problem, we use the "number of 211 universities and colleges" to instrument the "share of college graduates" in a given province, and obtain sizeable positive external returns to education for the whole population. One percentage point increase in the share of college graduates would increase individual wage by about 10% to 14%. Thanks to the nation-wide representative sample, this finding provides justification for governments' (central and local) policy and financial investment in higher education in China. Increasing the overall education level would also help to increase individuals' earnings in China.

Besides the main findings, we also have three further important insights into the role of education by looking at individual heterogeneity. Firstly, we find nearly zero education externalities in urban area, but large positive externalities in rural area, providing evidence for further improving the education investment and education quality in rural China. This evidence also implies some over-educated problem in urban area, which means that urban people have to face severe competition in labor market and also tend to suffer from signaling effect. The signaling effect states that college would teach you nothing but just helps to identify yourself with a college degree from those without.

Secondly, there are also gender differences in the external returns to education in China as well. Men workers gain from networking with other educated ones whereas women do not.

Last but perhaps most interestingly, there are strong positive externalities among low-skilled workers, while no significant externalities among high-skilled workers. This intriguing comparison indicates that education spillover in some sense can help to decrease the wage

differentials between high-skilled and low-skilled workers.

It is also noted that our sample only covers those who have never moved during survey periods. Our estimates could suffer from this limitation. We would like to see feasible solution to such sample selection problem for panel data.

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Appendix

Table A.1: Summary Statistics for Wage and Non-wage Sample

	Wage Sample		**Non-wage Sample**	
	Mean	**(SD)**	**Mean**	**(SD)**
Individual Years of Schooling	10.73	3.22	7.92	3.32
Age	37.39	9.47	39.2	10.95
Female	0.42	0.49	0.56	0.5
Sample Size	12,717		27,788	