Higher Education and Economic Growth in China

by

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ABSTRACT

This thesis paper investigates the impact of higher education on the economic growth of China's subnational divisions leveraging on panel data collected from 31 Chinese subnational divisions over the 1996 – 2015 period. To build the econometrics model, several other factors are selected as explanatory variables, including investment ratio, government consumption, consumer price index and initial GDP per capita, etc. The results reveal that higher education provides a positive and significant impact on the economic growth of China's subnational divisions with a significant diminishing effect among all four Chinese economic regions. The study also finds that female and male higher education have different impacts on economic growth. These conclusions support previous results of western literature and contain important policy implications for China and other developing countries.

I. INTRODUCTION

Modern growth theory shows that an increase in human capital has a positive effect on economic growth. As the World Bank's Commission on Growth and Development stressed in *The Growth Report: Strategies for Sustained Growth and Inclusive Development* (2008), investment in health, education and other aspects of human capital has been viewed as important as investment in the more visible and physical capital of a country.

The present study has been mainly focusing on education among the human capital components. Hanushek and Woessmann (2010) explicitly outlined three mechanisms through which education may positively affect economic growth. First, education increases labor productivity and subsequent transitional growth toward a higher equilibrium level of output through increasing human capital inherent in the labor force. Second, education can increase innovative capacity, resulting in new knowledge on new technologies, products, and processes that promote growth. Third, education can facilitate the diffusion and transmission of knowledge to successfully implement new technologies devised by others, which again promotes growth.

Although all forms of education benefit public well-beings, this paper is focused on higher education. The Task Force argued in *Higher Education in Developing Countries* (2000) that economies with higher education attainment appear to be more dynamic and competitive in international markets and more successful in terms of income per capita. It also claimed that the equality of knowledge generated within higher education institutions and its availability to the wider economy, is becoming increasingly critical to national competitiveness. Take South Korea as an example. While high investments were essential to its huge growth during the second half of 20th century,

education especially higher education also played a vital role in pushing its economy to surge. Its higher education enrolment ratio jumped from around 5% in 1960 to more than 50% in the 1990s, as compared to that of average developing countries slightly rising from 2% to 10%.[1] Leveraging on adequate highly skilled labor generated from higher education institutions, South Korea was able to upgrade its economy from labor-intensive industries to an advanced entity with a specialization in information technology and other high value-added manufacturing.

China's modern higher education system has been undergoing constant changes since the foundation of the New China. All schools were suspended and the National Higher Education Entrance Exam (Gaokao) was canceled for ten years during the Cultural Revolution until Deng Xiaoping made the decision to resume it in 1977. Subsequent higher education reforms and projects conducted by the Ministry of Education of the P.R.C. have brought the gradual growth of development of China's higher education, with the most famous being Project 985 and Project 211. In the meanwhile, China has been enjoying a rapid economic boom since its economic reform and opening up in 1978. According to the World Bank, China falls in the upper-middle-income economies category for the current 2017 fiscal year, with a GNI per capita between $4036 and $12,475. In the meanwhile, its GDP growth has declined for two consecutive years since 2015, barely maintaining 6.7% in 2016. Struggling to maintain its growth momentum as China is narrowing the gap with high-income nations, China's policymakers have shown great determination to upgrade higher education, in response to the growing service sector of its economy.

There is a large volume of literature studying higher education and economic

[1] Data is collected from the World Bank.

growth among developed nations to explain cross-country differences. Very few empirical analysis has been conducted within China, in spite of the huge regional disparity in education and economic growth among Chinese provinces. This study attempts to contribute to the literature, and more importantly, provide implications for policy makers of less developed Chinese provinces to boost their regional economies as well as for leadership of more economically advanced regions to maintain their existing growth momentum.

The paper proceeds as follows: Section II outlines the methods, data, and model used to study the impact of higher education upon economic growth among the studied Chinese provinces; Section III presents and analyzes the results; Section IV draws broad conclusions and Section V provides implications for policy makers.

II. METHODOLOGY

There are multiple models studying the determinants of economic growth. The endogenous growth model stresses that endogenous forces such as investment in human capital and innovation are vital to the development of a country's economy. It is much developed in the 1980s and one major contributor is Romer (1990). The recent empirical framework, however, combines both the neoclassical model with extensions emphasizing government policies and institutions and the accumulation of human capital, e.g. Barro (2013). The standard method of estimating the effect of education on economic growth, however, is to run cross-region regressions where the GDP per capital is expressed as the function of a measure of education and other determinants (Hanushek and Woessmann, 2010). Therefore, this thesis will build on Barro's empirical framework to further test the impact of higher education on the economic growth of Chinese provinces, i.e. whether the relationship between education and economic growth still holds in the context of Chinese provinces during a more recent time period as compared to Barro's study.

There are 34 provincial-level administrative divisions in China. Hong Kong, Macau and Taiwan are excluded due to their different government policies and measurement methods of data from Mainland. Therefore, this study covers 31 provincial-level administrative divisions, including 22 provinces, 4 municipalities, and 5 autonomous regions. In 2011, the National Bureau of Statistics of China divides the whole country into four economic regions based on distinct social and economic development status of various regions, to provide insights for regional policy makers, i.e. East Coast, Central China, Northeast China and Western China.[2] The 31 provincial-level administrative divisions and their summary statistics are displayed in Table 1. From this

[2] For a detailed categorization of Chinese economic regions, see Appendix 1.

table, we can see that there are huge distinctions among Chinese subnational divisions in terms of different aspects including population, area, and economy. For example, the area of Xinjiang is 260 times as large as the size of Shanghai. The richest region, Tianjin municipality, is 4 times richer than the poorest province, Gansu.

Table 1: Basic Statistics of Chinese Provincial-Level Administrative Divisions (2015)[a]

	Population (in million)	Area (in km^2)	GDP (in CNY billion)	GDP Per Capita (in CNY)
Beijing municipality	21.71	16411	2297	106497
Tianjin municipality	15.47	11917	1654	107960
Hebei province	74.25	188800	2981	40255
Shanxi province	36.64	156700	1280	34919
Inner Mongolia autonomous region	25.11	1183000	1803	71101
Liaoning province	43.82	148400	2874	65352
Jilin province	27.53	187400	1427	51086
Heilongjiang province	38.12	454800	1508	39462
Shanghai municipality	24.15	6340.5	2496	103796
Jiangsu province	79.76	102600	7012	87995
Zhejiang province	55.39	101800	4289	77644
Anhui province	61.44	139400	2201	35997
Fujian province	38.39	123900	2598	67966
Jiangxi province	45.66	166900	1672	36724
Shandong province	98.47	157100	6300	64168
Henan province	94.8	167000	3701	39123
Hubei province	58.52	185900	2955	50654
Hunan province	67.83	211800	2905	42754
Guangdong province	108.49	179700	7281	67503
Guangxi autonomous region	47.96	237600	1680	35190
Hainan Province	9.11	35354	370	40818
Chongqing municipality	30.17	82400	1572	52321
Sichuan province	82.04	486100	3010	36775
Guizhou province	35.3	176200	1050	29857
Yunnan province	47.42	394100	1372	28806
Tibet autonomous region	3.24	1228400	103	31999
Shaanxi province	37.93	205,800	1817	47626
Gansu province	26	425800	679	26165
Qinghai province	5.88	722300	242	41252
Ningxia autonomous region	6.68	66400	291	43805

Xinjiang autonomous region	23.6	1664900	932	40036

[a] Data from China Statistical Yearbook 2015

When deciding which explanatory variables to include in our model, several cross-country regressions are considered, e.g. Bloom et al. (2014), Barro (1996) and Barro (2013). In general, these models include explanatory variables such as education attainment, economic openness, international trade, etc. The model used in this paper will be based on the model used by Barro (2013) and adjusted in the context of Chinese provinces.

The regressors in the original model in Barro (2013) include the starting level of real per capita GDP, some education indicator (male upper school), the ratio of investment to GDP, a measure of demographics (total fertility rate) and an array of government policy variables such as the ratio of government consumption to GDP, a measure of international openness and the inflation rate based on the consumption price. Since this thesis is focused on the impact of higher education on economic growth instead of other education levels, we use an indicator of the higher education level of each subnational division as the education indicator. The National Bureau of Statistics of China conducts the national population census in years ending with 0, national one percent population sample survey in years ending with 5 and about one per thousand population survey in the rest of the years. The higher education indicator of this thesis, i.e. the proportion of higher education institution graduates is calculated by dividing the number of higher education institution graduates by the number of surveyed population aged 6 and over, both of which are obtained from the National Bureau of Statistics of China surveys over 20 years between 1996 and 2015. The dependent variable per capita GDP represents the level of economy of each region. The international openness ratio is

measured by dividing exports plus imports by gross GDP. The investment ratio is the ratio of investment to GDP. The other two variables are government consumption and the inflation rate.

Therefore, the basic model is constructed as:

$$loggdp_{ij} = \alpha + \beta_1 hgredu_{ij} + \beta_2 intlopn_{ij} + \beta_3 ivmtratio_{ij} + \beta_4 gvmtcon_{ij}$$

$$+\beta_5 cpi_{ij} + \beta_6 inigdp_{ij} + \varepsilon \quad (1)$$

where α denotes the intercept term, $loggdp_{ij}$, $hgredu_{ij}$, $intlopn_{ij}$, $ivmtratio_{ij}$, $gvmtcon_{ij}$, cpi_{ij} and $inigdp_{ij}$ denote natural log value of GDP per capita, proportion of population aged 6 and over holding higher education degrees, investment ratio, government consumption, consumer price index and initial GDP per capita for subnational division i at year j respectively. β_n, n = 1, 2, 3, 4, 5, 6 are the coefficients representing the effect of each explanatory variable on the log value of GDP per capita and ε denotes an estimator error.

III. RESULTS

Table 2 presents the results of regressions for per capita GDP growth using selected explanatory variables. Each coefficient in this table represents the impact that a specific factor had on the per capita GDP growth. From this table, we can observe that when the dependent variable is regressed by higher education and one other factor, the impact of initial per capita GDP, international openness and investment ratio are significantly positive as shown in Regressions (1) to (3). Government consumption and inflation rate, however, have an insignificant impact as presented by Regressions (4) and (5). The R^2 of these regressions are all above 60%, meaning regional growth from 1996 to 2015 can be mostly explained by the differences of higher education level of the population and the other chosen factor and the two factors together are strong predictors of economic growth. The coefficients of higher education indicate that an increase in the proportion of population holding higher education institution diplomas of 10% predicts 0.8% to 1% increase of per capita GDP when holding the other factor unchanged.

Table 2: Regressions for Per Capita GDP Growth[a]

Regression[b]	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(per capita GDP)	0.9343*** (0.0125)					.0000853*** (9.18e-06)	.0000757*** (7.72e-06)
International Openness		0.2861*** (0.0546)				.1683* (.0776)	-0.0077 (.0660)
Investment Ratio			0.0088*** (0.0011)			.0155*** (0.0009)	.0092*** (0.0008)
Government Consumption				0.0069 (0.0025)		.0151*** (0.0025)	.0172*** (0.0021)
Inflation Rate					0.0082 (0.0070)	.0043 (.0036)	0.0041 (.0030)
Higher Education Squared							20.6485*** (1.3700)

Higher Education	7.9665*** (0.3519)	8.1335*** (0.3532)	9.3264*** (0.2946)	9.5892*** (0.3128)	9.7627*** (0.3061)	4.3524*** (0.5232)	11.2938*** (.6358)
R-Squared	0.6714	0.6425	0.661	0.6329	0.6267	0.8609	0.9025

[a] Standard Errors are in parentheses. Significantly different than zero at 99 (***), 95 (**), and 90 (*) percent confidence.
[b] Regression (1) - (5) are cross-sectional regressions. Regression (6) and (7) are panel regressions.

The R^2 surged to almost 90% when we use a panel regression to study the impact of each factor on economic growth as shown in Regression 6. This suggests that regional growth of each studied subnational division can be almost completely explained by the differences of chosen explanatory variables. In the meanwhile, the coefficient of higher education level decreases to 4.3524. This is because the impact of the higher education level of previous regressions is partly due to other factors that are not included in the regressions. But still, the significant coefficient indicates that with an increase in the proportion of population holding higher education institution diplomas of 10%, per capita GDP increases by 0.44%.

When adding the variable of higher education squared in our model, the R^2 slightly increased from 0. 8609 in Regression 6 to 0. 9025 in Regression 7. It turned out that the higher education squared factor is also statistically significant. The negative sign of its coefficient indicates that before the level of higher education reached the turnaround value 0.3167, the impact of the level of higher education decreases. This finding supports the previous literature explaining the diminishing effect of the return to education (e.g. Trostel 2005).

Table 3 shows the impact of each factor on the economic growth in different economic regions of China with Regressions (9), (10), (11) and (12) studying East Coast, Northeast China, Central China and Western China respectively. Again, high R^2 values of

these regressions indicate good predictions of economic growth by the chosen explanatory variables. Interestingly, the turnaround values for each region are very different. The Each Coast's turnaround value, 0.3176, is very close to value when we study the whole sample, while the values for Northeast China, Central China and Western China are much smaller, being 0.1824, 0.1314 and 0.1515 respectively. The reason might be due to the fact that the East Coast has a wide range of education level from 1996 to 2015, with the lowest being 0.0125479 and the highest 0.4233505. Thus, this region's result can better represent the true relationship between higher educational level and economic growth of Chinese provinces.

Table 3: Regressions for Per Capita GDP Growth[a]

Regression	(8)	(9)	(10)	(11)	(12)
Log (per capita GDP)	0.000076 *** (7.72e-06)	0.000062*** (0.0000111)	0.000114*** (0.0000178)	0.000132*** (0.0000201)	0.000141*** (0.0000134)
International Openness	-0.0077 (0.0660)	0.0359 (0.0704)	-0.8112 (0.4182)	1.6496** (0.6371)	0.1235 (0.2739)
Investment Ratio	0.0092*** (0.0008)	0.0088*** (0.0020)	0.0074*** (0.0019)	0.01023*** (0.0023)	0.0055 (0.0011)
Government Consumption	0.0172*** (0.0021)	0.0140*** (0.0043)	0.0209*** (0.0044)	0.0182*** (0.0055)	0.0111 (0.0029)
Inflation Rate	0.0041 (0.0030)	0.0002 (0.0048)	-0.0036 (0.0067)	-0.0037 (0.0045)	0.006 (0.0052)
Higher Education	11.2938*** (0.6358)	9.0106*** (1.0215)	9.5269*** (2.7438)	16.8505*** (2.4041)	14.7343*** (1.6931)
Higher Education Squared	-20.6485*** (1.3700)	-14.1817*** (1.7654)	-26.1086** (11.5317)	-64.1082*** (13.8826)	-48.6003*** (9.5977)
R-Squared	0.9025	0.9064	0.9686	0.9633	0.9157

[a]Standard Errors are in parentheses. Significantly different than zero at 99 (***), 95 (**), and 90 (*) percent confidence.

Previous cross-countries studies have shown the impact of gender equality on the economic growth. Societies preferring not investing in girls pay a price for it with reduced income and slow growth (Dollar and Gatti, 1999). Table 4 presents the impact of both male and female higher education level on the economic growth in different social-

economic regions of China.

Table 4: Regressions for Per Capita GDP Growth[a]

Regression	(13)	(14)	(15)	(16)	(17)
Log(per capita GDP)	0.0000885*** (9.62e-06)	0.0000966*** (0.0000131)	0.0001139*** (0.0000184)	0.0001183*** (0.0000211)	0.0001152*** (0.0000141)
International Openness	0.1142449 (0.0791)	0.2166*** (0.0768)	-0.6443 (0.4187)	2.2043*** (1.5437)	0.3458 (0.2801)
Investment Ratio	0.01582*** (0.0008)	0.0175*** (0.0020)	0.0089*** (0.0018)	0.01373*** (0.0023)	0.0064*** (0.0011)
Government Consumption	0.0143*** (0.0025)	0.0045*** (0.0050)	0.0251*** (0.0042)	0.0271*** (0.0057)	0.0146*** (0.0029)
Inflation Rate	-0.0011 (0.0037)	-0.0088 (0.0056)	-0.0085 (0.0068)	-0.0076 (0.0050)	0.0030 (0.0058)
Higher Education Male	4.4257*** (.9037)	3.3853*** (1.1923)	3.5412** (1.6805)	2.2043 (1.5437)	4.8322*** (1.4290)
Higher Education Female	4.3326*** (1.1094)	1.3282 (1.4518)	4.0597** (2.0107)	12.4859*** (2.3028)	11.9807*** (1.6628)
R-Squared	0.8600	0.8705	0.9663	0.9560	0.9099

[a]Standard Errors are in parentheses. Significantly different than zero at 99 (***), 95 (**), and 90 (*) percent confidence.

As Regression (13) shows, both female and male higher education levels have a significant impact on the economic growth of the entire studied subnational divisions. However, when it comes to East Coast as Regression (14) presents, male higher education level has a significant explanatory power for economic growth while female higher education level turns out to be less significant both in terms of coefficient and statistical significance. One possible reason for the weak role of female school in East Coast is that many eastern provinces follow discriminative practices towards females which prevent the efficient exploitation of female labor force. As a survey research done by National Academy of Development and Strategy points out, male college graduates are 42% more likely to receive an interview invitation than female graduates with all the

other things being equal and higher educated females are more discriminated against as compared less educated females (Ge *et al.*, 2015). With the existing gender inequality, it is not surprising that higher educated females do not show up as a significant factor of enhancing economic growth.

When it comes to Regressions (15), (16) and (17), however, higher education level of females become statistically significant and more practically significant than higher education level of males if we compare the coefficients of the higher education level of males and females. One possible reason is the massive brain drain from less developed inland regions to the developed coastal areas due to the attraction of more developed economy and technology, policy inclination and better education and career opportunities in the coastal areas. As is mentioned before, higher educated males have social advantages over females, thus higher educated males from inland provinces have more chance to work in coastal areas and contribute to the local economy. Therefore, the levels of higher education of females in Northeast China, Central China and Western China have more explanatory power than that of males.

IV. CONCLUSION

Higher education has long been viewed to have a substantial impact on individual earnings. A large volume of cross-country studies has proved that it also has a significant impact on productivity and economy growth as a measure of human capital of a region. When looking at the results of this China-focused study, results of previous economists studying cross-country higher education and economic growth still apply. On top of that, from the comparison of impacts of both higher education level of males and females, we find that higher education of males and female have different impacts on the economic growth and one possible reason is that social discrimination against higher educated females discourages female labor force from being efficiently exploited in the labor market.

In the meanwhile, this study also has some limitations. The primary limitation is that by using the proportion of the higher educated population as the indicator of human capital, we are assuming students from different regions receive the same quality of higher education. This might be an even bigger problem for cross-country studies as higher education quality in different countries substantially differs. Therefore, economists have proposed to use international test scores as an indicator of education quality (e.g. Hanushek and Wossermann, 2007). There are no national test score data, however, can be obtained to indicate the higher education quality of different Chinese provinces. Thus, the chosen higher education indicator fits best for our research purpose. The second limitation is that this study doesn't reveal how different academic disciplines of higher education affect economic growth, e.g. whether science and engineer education have a more powerful effect in driving economies to growth than humanities. Lin (2004)'s

study of Taiwan has shown engineering and the natural sciences majors played the most prominent role in how higher education impacting economic growth.

V. POLICY IMPLICATIONS AND FURTHER RESEARCH

Given the economically and statistically significant impact of the level of higher education on economic growth, policymakers in less developed regions should seek measures to improve the human capital of their population. Actually the Ministry of Education of P.R.C. has implemented constant strategies to improve the higher education situation in the less developed provinces. In 2001, it set forth a one-to-one support project which pairs 13 higher education institutions in Western China with 13 most prestigious Chinese universities, most of which located in East Coast. In the meanwhile, to fully exploit female labor force, the government might need to consider enforcing stricter anti-sexism laws to prohibit employers from discriminating against female employees. It is also desirable to provide incentives and policy inclination to empower females to be more engaged in daily productivity. Lastly, since brain drain of inland provinces has been existing for long, the government needs to take actions to encourage brain return from developed coastal regions. One great ongoing project is the One Belt, One Road which generated great demand for highly skilled labor specializing in languages, international business, transportation, information technology in the inland regions.

The diminishing marginal effect of higher education on economic growth suggests that as the higher education level increases, higher education shall be less focused as compared to it is when the higher education level is low so that resources can be allocated to other more vigorous factors that drive economy. In fact, since the model covers a variety factors including demographic, economic and political features of a region, it is critical to keep a balance of resource allocation to all the determinants of economic growth as higher education is only one of the important factors.

Appendix 1: Four Economic Regions of China

East Coast: Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan

Northeast China: Heilongjiang, Jilin, Liaoning

Central China: Shanxi, Henan, Anhui, Hubei, Hunan, Jiangxi

Western China: Xinjiang, Gansu, Qinghai, Ningxia, Inner Mongolia, Shaanxi, Sichuan, Chongqing, Tibet, Yunnan, Guizhou, Guangxi

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