EDUCATION INVESTMENT AND ECONOMIC RETURNS IN 2010-2012 CHINA

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ABSTRACT

Along with the rapid economic growth, China revoked a nation-wide education revolution and the emphasis on education has been regarded as a contribution factor to the economic growth. This paper takes the attention on the relationship between education and economic growth in China. We collect 2012 Gross Domestic Product (GDP) data as a measure of economic growth and three education associated variables, which are education expenditure, higher education institutions and student-teacher ratio, to start the analysis. Descriptive statistics and simple graphics analysis are conducted to gives an overview of the education investment situation in 2010-2012 China. Pearson product-moment correlation is calculated to show how the education investment situation was related with the economic growth.

KEYWORDS

Economic Growth, Investment in Education, Descriptive Statistics and Statistical Correlation.

1. INTRODUCTION

In past decades, hundreds of papers were published estimating the economic returns to education. Part of the reasons why individuals are willing to take more years of schooling is that they expect to earn more and get better jobs, on average, with higher education level. Also research has shown that human capital is generated from education, through which labors can be equipped with adequate knowledge, social attributes and creativity in order to produce economic values (Simkovic, 2011). Others assert that more education in the labor force increases output in two ways: education adds skills to labor, increasing the capacity of labor to produce more output; and it increases the worker's capacity to innovate (learn new ways of using existing technology and creating new technology) in ways that increase his or her own productivity and the productivity of other workers (Psacharopoulos&Patrinos, 2002). Driven by the dynamic relationship between education and economic return, both economists and educationists are studying how education system was constructed and how it affected individuals and societies, especially in relation to the various economic aspects.

Estimates of economic returns to education vary significantly, depending on the data sets used, the assumptions made and the estimation techniques (Harmon, 2011).Barro was the first to show that, for a given level of wealth, the economic growth rate was positively related to the initial level of human capital of a country, whereas for a given level of human capital, the growth rate was negatively related to the initial level of GDP per capita (Barro, 1988). However, in "Where has all the education gone?" Pritchett (Pritchett, 2001) tested the impact of investment in human capital on a panel of 86 countries, and his results showed that there is no significant effect of education on economic growth.

China has experienced a rapid and dramatic GDP1 increase since 1990s (Figure 1), which is mainly attributed to Deng Xiaoping's economic reform started in December 1978. Along with the economic transformation, China also began a nation-wide education revolution, which includes the strategy of invigorating the country through science and education and the policy of nine-year compulsory education. The emphasis on education has been regarded as a contributing factor to the economic growth. However, this relationship between education and economic growth in China has not been tested. Questions such as "in which way does education contribute to economic growth?", "How much can education influence economic growth?", and "Would it be more beneficial to the economy if the resources invested in education were used elsewhere" remain to be answered. The objective of this article is to determine the relationship between education and "China's Economic Miracle"

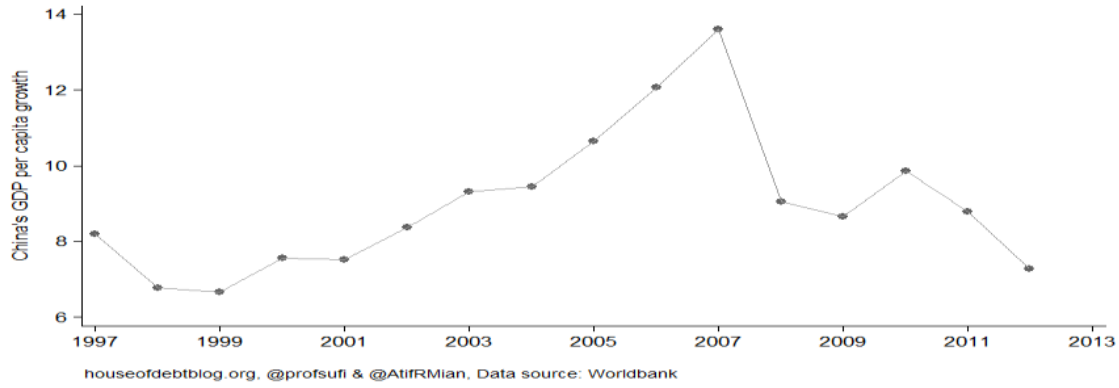

Figure 1. Historical Gross Domestic Product Data

2. DATA

Even though there has been lots of researches studying the education-growth relationship, similar research is rarely seen in China, and we consider the limited number of public data

sources to be the main problem. So we use two main websites for collecting our data: Ministry of Education of the People's Republic of China3 and National Bureau of Statistics of the People's Republic of China4.

Ministry of Education of the People's Republic of China provides education related data, such as student-teacher ratio, number of female students, and number of students enrolled. However, this information is not provided on the website in a format that is directly downloadable, so we use statistical software R5to extract the data table and merged data files based on the report topic
.
National Bureau of Statistics of the People's Republic of China offers a wide range of economic data, and we collected two key variables: GDP and education expenditure from this website.

Our final sample consists of 31 provinces or cities in Mainland China (Table 1) and the data predominantly across four years: 2009, 2010, 2011 and 2012.

Table 1. 31 Provinces/Cities

1.	BEIJING	9.	SHANGHAI	17.	HUBEI	25.	YUNNAN
2.	TIANJIN	10.	JIANGSU	18.	HUNAN	26.	TIBET
3.	HEBEI	11.	ZHEJIANG	19.	GUANGDONG	27.	SHAANXI
4.	SHANXI	12.	ANHUI	20.	GUANGXI	28.	GANSU
5.	INNER MONGOLIA	13.	FUJIAN	21.	HAINAN	29.	QINGHAI
6.	LIAONING	14.	JIANGXI	22.	CHONGQING	30.	NINGXIA
7.	JILIN	15.	SHANDONG	23.	SICHUAN	31.	XINJIANG
8.	HEILONGJIANG	16.	HENAN	24.	GUIZHOU		

3. METHODOLOGY

In this article, we use descriptive statistics to start our journey, exploring the relationship between education and economic growth. Descriptive statistics are used to describe the basic features of the data in this study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, descriptive statistics help us to understand large sets of data in a visual and simple way.

Correlation is one of the most common and the most useful descriptive statistics methods. In this paper we apply the Pearson product-moment correlation to measure the linear relationship between two variables. It can tell us two aspects about thelinear relationship between two variables: a). Whether thelinear relationship is positive or negative (Table2); b.)The strength of linear relationship (Table3).Statistical correlation is measured by what is called coefficient of correlation (r). Its numerical value ranges from +1.0 to -1.0. (“Correlation,” n.d.)

In general, $r > 0$ indicates positive linear relationship, $r < 0$ indicates negative linear relationship while $r = 0$ indicates no linear relationship (or that the variables are independent and not related). Here $r = +1.0$ describes a perfect positive linear correlation and $r = -1.0$ describes a perfect negative linear correlation.Closer the coefficients are to +1.0 and -1.0, greater is the strength of the linear relationship between the variables. What should be noticed is the correlation coefficient only measures the linear relationship between two variables, we can neither measure other relationship nor study causation by using the statistical correlations.

Table 2. The Value of Correlation Coefficient (1)

Value of r	Relationship
r> 0	Positive Relationship
r = 0	No Relationship
r< 0	Negative Relationship

Table 3. The Value of Correlation Coefficient (2)

Value of r		Strength of Relationship
-1.0<r< -0.5	1.0>r> 0.5	Strong
-0.5<r< -0.3	0.5>r> 0.3	Moderate
-0.3<r< -0.1	0.3>r> 0.1	Weak
-0.1<r< -0.1		None or Very weak

4. GROSS DOMESTIC PRODUCT AND EDUCATION FACTORS IN CHINA

4.1 Gross Domestic Product

In prior researches, many factors were used to measure the economic growth and the returns realized from education, such as human capital earnings. Due to the limited availability of data, our measure of the economic growth is derived from the Gross Domestic Product (GDP). In our data, we collected GDP for three years, measured in units of One Hundred Million RMB, for Thirty One Provinces. With larger population, Jiangsu, Shandong and Guangdong are the top 3 in the GDP ranking, these three provinces also had the fastest growing economies between 2010 and 2012 (Figure 2). Even though GDP increased in each of provinces during these three years, it is obvious to see that there is an issue of severe imbalance issue in China's economic development (Figure 3).The combined Gross Domestics Products of Tibet, Qinghai and Ningxia, the provinces with the lowest GDPs, don't even amount to one fourth of Jiangsu Province's GDP. Figure 4 clearly presents that most well-developed provinces or cities are located on the eastern coast of China, while the relatively undeveloped areas are predominantly in the west of China.

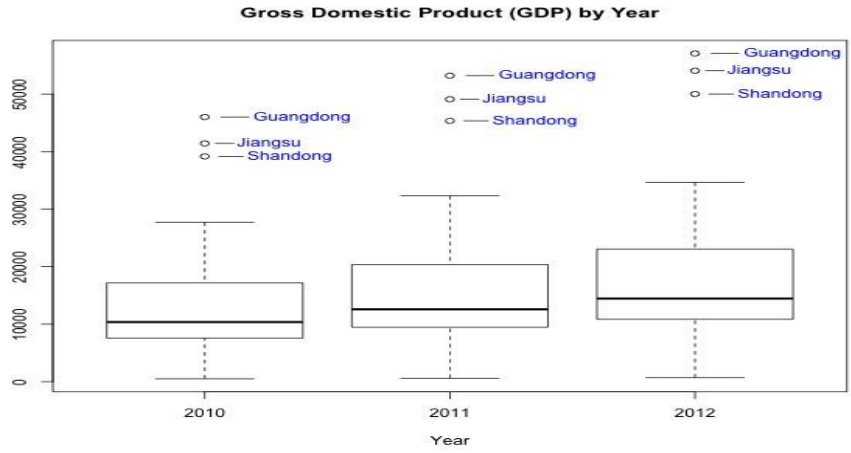

Figure 2. Gross Domestic Product by Year (Outliner)

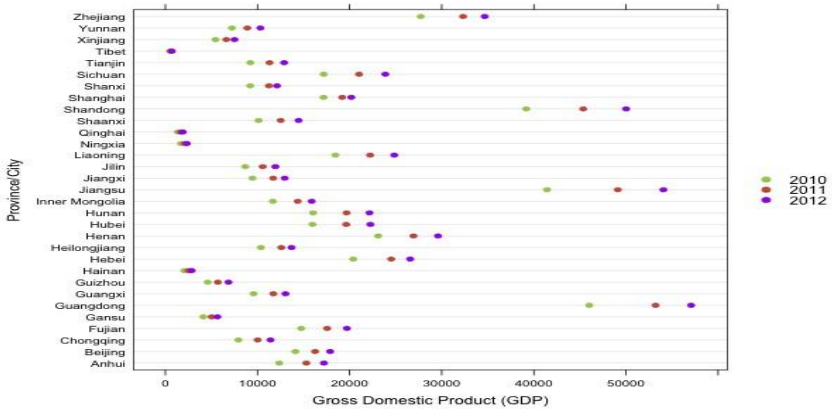

Figure 3 Gross Domestic Product (One Hundred Million RMB) by Province or City (2010-2012)

Figure 4. Map of China

4.2 Education Expenditure

Expenditure on education is an investment that can foster economic growth, enhance productivity, contribute to personal and social development and reduce social inequality (OECD, 2011). In China, the financial resource devoted to education is one of the key choices made by central and local governments.

Due to data limitation, we only collect 2009 to 2011 education expenditure data, measured in Ten Thousand RMB. Figure 5 indicates that in line with GDP growth, Guangdong, Jiangsu, and Shandong also rank the highest for education expenditure. Tibet, Qinghai, and Ningxia are the lowest in education expenditure. Again, this is the total expenditure, so we have to take population into consideration. Besides, the education expenditure is differentiated greatly among provinces. Table 4 shows that the average education expenditure increases two hundred billion RMB just in three years, from 4,739,386 (Ten Thousand RMB) in 2009 to 6,946,336 (Ten Thousand RMB) in 2011.

Table 4. Summary of Education Expenditure (In Ten Thousand RMB)

Variable	Observation	Mean
Education Expenditure in 2009	31	¥4,739,386.00
Education Expenditure in 2010	31	¥5,614,032.00
Education Expenditure in 2011	31	¥6,946,336.00

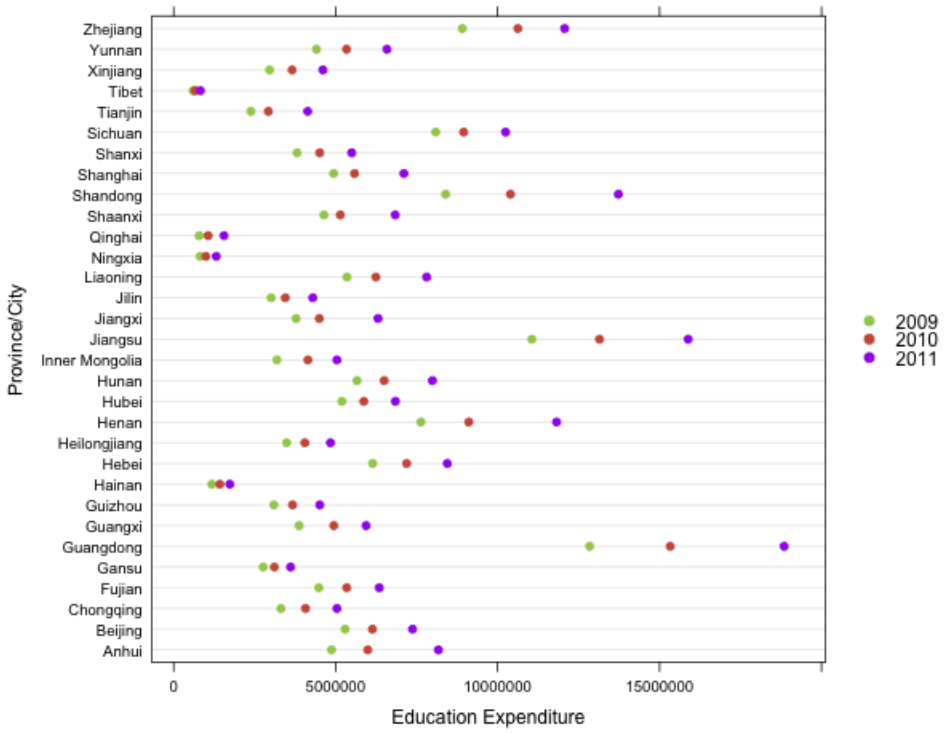

Figure 5. Education Expenditure by Province or City (2009-2011)

4.3 Higher Education Institutions

The varying amounts of resources committed to the establishment and support of higher education institutions is representative of the Chinese government's interest in meeting the education needs of the local populace. Based on our data chart (Figure 6), we can tell that the top three places in terms of numbers of higher education institutions are Jiangsu, Shandong and Guangdong for the years from 2010 to 2012. Jiangsu held the leading position in the past three years. Interestingly Shandong had more higher education institutions than Guangdong in 2011, but a year later, Guangdong beat the record of Shandong in 2012. In terms of the least number of higher education institutions, we have limited data showing that Tibet, Qinghai, Ningxia and Hainan are the provinces with the fewest institutions of higher education. Tibet, Qinghai and Ningxia are all located in the northwest part of China, where access to education resources is limited. The local economies in these provinces are both weak and slow in comparison to other provinces in China. On the chart, we can see from the limited data available that Ningxia has experienced a slight increase in the number of institutions of higher education. Meanwhile, Hainan, a province in the southeast of China, also has relatively fewer institutions of higher education

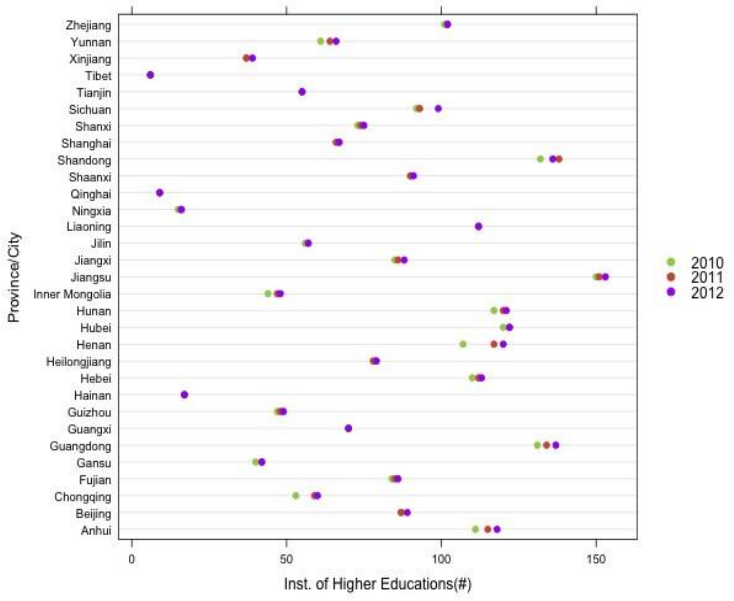

Figure 6. The Number of Inst. of Higher Educations by Province or City

4.4 Student-Teacher Ratio

Student–teacher ratio is the number of students who attend a school divided by the number of teachers in the institution. Take Beijing Regular Primary Schools as example, a student–teacher ratio of 13.4:1 indicates that there are around 13 students for every one teacher. The larger student-teacher ratio also indicates a large class size. In a recent study, class size is considered as an important determinant of student outcome, and one that can be directly determined by policy. Most importantly, this research points out that increasing class size will harm not only children's test scores in the short run, but also their long-run human capital formation. Money saved today by increasing class sizes will result in more substantial social and educational costs in the future.(Schanzenbach, 2014)

According to the three-year average of student-teacher ratio, it can be summarized that the student-teacher ratio ranges from 9 to 39 across seven different levels of education, and Table 5 shows that among seven types of schools, on average, Regular Senior Secondary Schools and Secondary Vocational Schools provided the smallest and biggest class size between 2010-2012.

What's more, one interesting phenomenon is that there has been a continuous growth between 2009-2011 in education expenditure (Figure 5). However, it is hard to see a strong reduction of class size, especially in three basic education institutions: Regular Primary Schools, Regular Higher Education Institutions and HEIs offering degree programs (Figure 7).

Table 3. The Three-Year Average of Student - Teacher Ratio (2010-2012)

	Regular Primary Schools	Junior Secondary Schools	Regular Senior Secondary Schools	Secondary Vocational Schools	Regular Higher Educations Institutions	HEIs Offering Degree Programs	Higher Vocational Colleges
BEIJING	13.4	10.0	9.7	22.7	16.3	16.5	14.3
TIANJIN	13.8	10.2	12.2	14.3	17.0	16.9	17.3
HEBEI	17.0	12.6	14.8	21.1	17.8	17.9	17.5
SHANXI	14.7	13.6	15.1	21.4	17.2	17.0	17.5
INNER MONGOLIA	12.4	12.5	15.7	18.6	17.5	18.1	16.6
LIAONING	14.8	11.9	15.4	17.6	17.0	17.3	15.7
JILIN	11.8	11.3	17.2	13.0	17.4	17.6	16.6
HEILONGJIANG	12.7	12.3	14.8	18.6	16.4	16.7	15.4
SHANGHAI	15.7	12.4	9.8	19.4	17.0	17.0	16.9
JIANGSU	16.4	11.6	13.2	22.1	15.7	16.3	14.7
ZHEJIANG	19.5	13.1	14.0	20.4	17.1	16.9	17.6
ANHUI	17.9	15.3	18.5	29.7	18.7	18.6	18.7
FUJIAN	15.8	12.1	13.5	32.6	17.3	17.4	17.0
JIANGXI	21.1	16.3	16.5	27.3	17.1	17.3	16.7
SHANDONG	16.4	13.0	13.9	20.7	17.0	16.9	17.3
HENAN	21.9	16.5	18.2	26.4	17.7	18.2	16.9
HUBEI	18.4	12.8	16.3	25.9	17.7	17.7	17.7
HUNAN	19.3	12.4	15.1	25.7	18.4	18.4	18.4
GUANGDONG	19.1	17.6	16.2	35.4	18.8	19.0	18.6
GUANGXI	19.6	16.8	17.9	38.9	17.6	17.5	17.6
HAINAN	14.8	15.7	16.7	33.6	18.9	19.1	18.4
CHONGQING	17.1	15.5	18.8	27.1	17.5	17.9	16.6
SICHUAN	18.9	15.9	18.0	31.1	18.2	18.3	18.1
GUIZHOU	20.6	19.0	18.8	30.4	17.6	17.3	18.4
YUNNAN	17.9	16.9	15.5	27.6	18.3	17.9	19.0
TIBET	15.6	15.0	13.0	33.5	15.2	14.3	17.6
SHAANXI	14.6	12.9	17.3	25.3	17.8	17.6	18.6
GANSU	15.7	15.3	16.9	22.7	18.8	19.1	18.2
QINGHAI	19.5	14.9	14.0	25.0	14.2	13.7	15.7
NINGXIA	19.0	15.8	16.0	31.3	17.7	16.9	19.5
XINJIANG	14.2	11.5	13.8	16.9	16.7	16.1	17.8

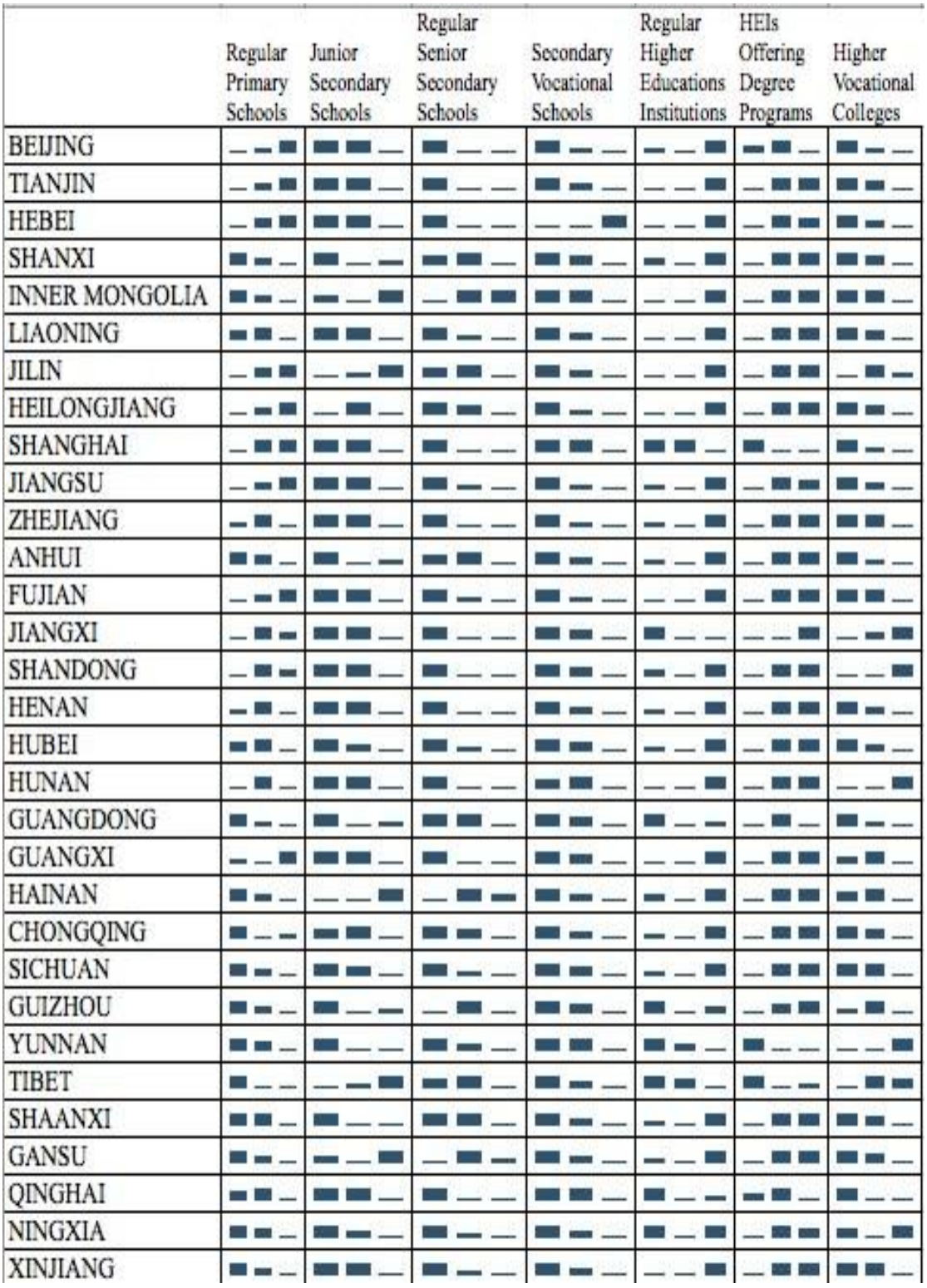

Figure 7. Bar plots of 2010-2012 Student-Teacher Ratio

5. STATISTICAL CORRELATION RESULTS

5.1 GDP and Education Expenditure

In order to see the relationship between education investment and economic returns, we correlate GDP with all other variables. As aforementioned, GDP is employed as the measurement of economic return, thus we employ education expenditure as our main outcome of interest.

Previous researches have found positive relationship between economic growth and education expenditure. Michael Ash and Shantel Palacio's study has found that investment in public higher education can benefit the society in multiple ways such as increasing job openings and tax revenue, and the benefit is both short-term and long-term (Ash & Palacio, 2012).

As is expected, there is a strong and positive relationship between 2012 GDP and education expenditure in the years 2009, 2010, and 2011, which are also significant at the 0.01 probability level (Table 6). The scatterplot graph (Figure 8) also shows that GDP has a linear correlation with education expenditure in all three years.

Table 6. Correlation Table Between 2012 GDP and 2009-2011Education Expenditure

		2012 GDP
Education Expenditure	YEAR 2009	0.95 ***
	YEAR 2010	0.96 ***
	YEAR 2011	0.97 ***
P< 0.05 *		
P< 0.01 **		
P<0.001***		

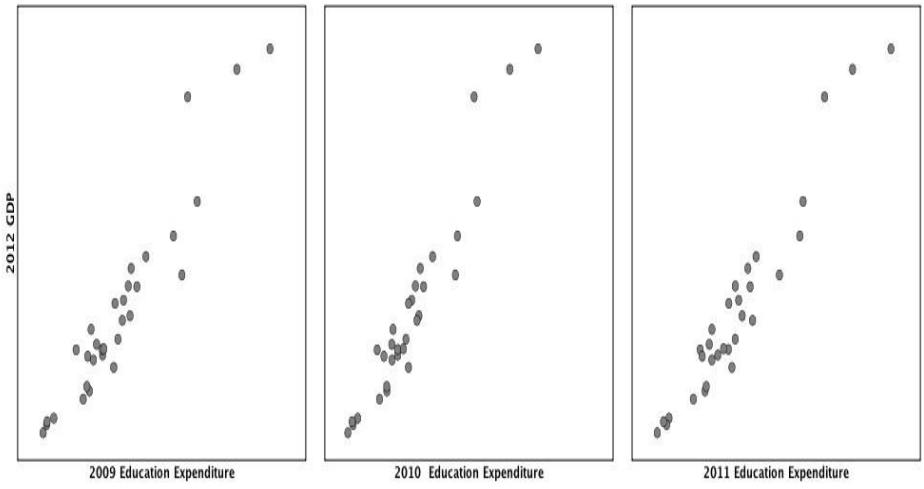

Figure 8. Scatterplots Between 2012 GDP and 2009-2011Education Expenditure

5.2 GDP and Number of Institutions of Higher Education

Many researchers assert that higher education can enhance the labor force to produce additional economic value that will lead to the overall growth of GDP. Higher education institutions have more capacity and resources to add more skills to labor, and increase the workers' capacity to innovate by utilizing existing technology and creating new technology (Galal, 2008).

In our data, the number of institutions of higher education is both positively and strongly related to 2012 GDP at .001 significant level, and the correlation coefficient (r = .86) is consistent across all three years, which can be attributed to the static number of institution of higher education (Figure 6). And it can be clearly seen in the scatterplot (Figure 9).

Table 7. Correlation Table Between 2012 GDP and 20010-2012 Number of Inst. of Higher Education

		2012 GDP
Number of Inst. of Higher Education	YEAR 2010	0.86 ***
	YEAR 2011	0.86 ***
	YEAR 2012	0.86 ***
P< 0.05 *		
P< 0.01 **		
P<0.001***		

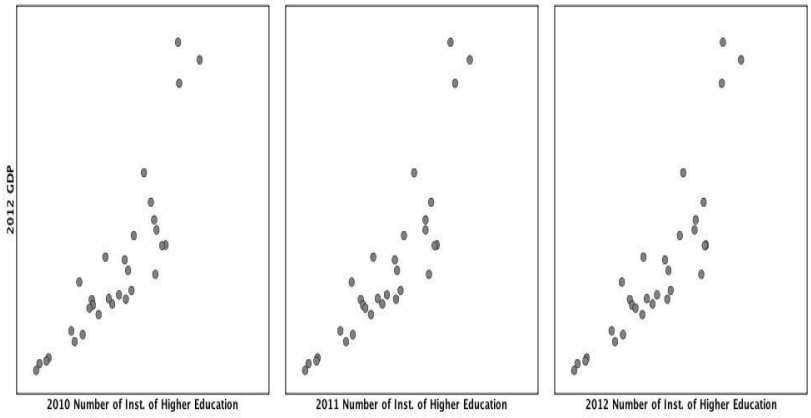

Figure 9. Scatterplots Between 2012 GDP and 2010-2012 Number of Inst. of Higher Education

5.3 GDP and Student-Teacher Ratio

Class size is a rising topic in education field, and many researches show that, as one of the most-studied education policies, reduction of class size positively influences student

achievement. As an important education indicator, student-teacher ratio reflects local investment in education and education awareness. Therefore we expected a strong and negative relationship between GDP and the student-teacher ratio. However, surprisingly, there seems to be no any significant relationships between 2012 GDP and student-teacher ratios across all seven education

levels (Table 8). Even more interestingly, there are positive relationships between 2012 GDP and student-teacher ratios in Regular Primary Schools and HEIs offering Degree Program.

We suspect that the insignificant relationship is mainly due to unique education system in China. In China, the student-teacher ratio may not be as strongly related to education quality as in the US, because, in China, student-teacher ratio is not a direct indicator of education quality. Most schools in China, from elementary level to tertiary level, are public schools, and many popular public schools have a large number of students (this is especially true at the elementary to high school level, but may not necessarily true in the higher education level

6. SUMMARY&FURTHER STEPS

China is on the stage of rapid economic development, which increases the demand of well-educated and skilled laborers to continue the fast-paced economic growth. Investment in education doesn't mean randomly throwing money towards the education sectors in an illogical manner, it means to invest in education in such a manner as to realize maximum returns on investment.

In this article, we try to understand how the investment in education looked like between 2010-2012 and how it was related to the economic growth by using a simple descriptive statistics instead of inferential statistics. Through quantified results, we have found some shortcomings in Chinese education system.

Table 8. Correlation Table Between 2012 GDP and 20010-2012 Student-Teacher Ratio

School Type	Year	2012 GDP
Regular Primary Schools	2010	0.11
	2011	0.17
	2012	0.23
Junior Secondary Schools	2010	-0.12
	2011	-0.13
	2012	-0.14
Regular Senior Secondary Schools	2010	-0.1
	2011	-0.14
	2012	-0.15
Secondary Vocational Schools	2010	-0.12
	2011	-0.06
	2012	-0.02
Regular Higher Educations Institutions	2010	0.19
	2011	0.09
	2012	-0.04
HEIs Offering Degree Programs	2010	0.27
	2011	0.22
	2012	0.12
Higher Vocational Colleges	2010	-0.03
	2011	-0.17
	2012	-0.29

P< 0.05 * P< 0.01 ** P<0.001***

The increasing education expenditure in 2010-2012 didn't cause a sizable change in the number of higher education institutions, and it also didn't have any influences in reducing the student-teacher ratios. Particularly of note, as mentioned above, is that the student-teacher ratio was trending to upwards in Regular Primary Schools, Regular Higher Education Institutions and HEIs offering degree programs (Figure 7).

The 2010-2012 education expenditure is strongly and positively related with 2012

GDP (Figure8), however it is hard to say whether there is a causal relationship between education expenditure and GDP growth. Or in other words, we are curious that what are the key elements in terms of education expenditure contributing the most to GDP growth. Does education expenditure in technology have a huge impact to cause the growth? More research is needed to figure this question out.

Why is the relationship between the student-teacher ratio and GDP so weak? And why there is a positive relationship between these two variables calls for further research.

Gender equity in education could also be a critical factor in the casual relationship between education expenditure and GDP growth. We cannot ignore the female leaders and female working professionals in the labor force, which is in a large degree contributing to economic growth in terms of GDP and personal incomes per capita. With more related data information, we can try to analyze the correlation and causality relationship between education investment in female and GDP growth.

The next step is to focus more on collecting better data on both economic growth and education investment, such as GDP per capita, education quality, study hours etc. And advanced statistical methodology will be applied for studying the casual effects of education investment on economic.

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FNU completed her M.A in Education and Social Policy at New York University, and received her B.A in International Politics from Peking University in 2010. She believes education has a lifelong effect that extends beyond academic achievement. She is a dedicated researcher and advocate for the provision of quality education for all. As founder of Ed Analyzer, FNU is working together with her talented team members to build a Chinese education database as well as provide valuable insight and advise to policy makers in the field of education.

Xinyi Qi

Xinyi Qi graduated with a M.S. Degree in Economics from Texas A&M University and earned her B.S Degree in Statistics at Southwestern University of Finance and Economics. She keeps making progress in statistical analysis and economics models. She shows great interest in education research and is dedicated to apply the quantitative methodologies in education study. She believes that the effort made by Ed Analyzer to build Chinese education database is very insightful and it will provide valuable advice to both researchers and policy makers in the field of education.

Yiqing Fang

Yiqing earned her MA degree in Education and Social Policy at New York University. She is dedicated to pursing education and social equality and is interested in applying quantitative methods in the study of education. She believes the work that has done by Ed Analyzer is unprecedented and meaningful by establishing an educational dataset and providing unique insight for both researchers and policy makers.

Mo Wang

Mo Wang has been working in research and consulting business for the last three years. She is currently having her Master degree in Education and Social Policy at New York University. Mo has a strong interest in terms of educational research and school management. She is also willing to conduct interdisciplinary research and experimental studies. Mo is one of the core team members of Ed Analyzer, which is an online educational data platform regarding Chinese education trend, funding status, educational institutions and so on. Ed Analyzer hopes to provide insight and useful data information for researchers.