

## Does Regional Education Inequality Affect China's Economic Growth

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**Abstract**—The research results of this paper show that: educational inequality would have negative impact to the economic growth. If the education inequality rises by 1%, the China's economic growth rate would decline by 0.066%. And education inequality also really has important influence to economic divergence and convergence. Education inequality enlarged the regional economic disparities on during 1997-2002, however education inequality decreased the regional economic disparities at the period of 2003-2008 because China's educational investment system has been the reconstructed, education equality has been improved greatly and the convergence rate of economic disparities has also been prompted. Therefore, improving education equality is the important measure which would be conducive to develop economy in cooperativeness and promote economic convergence.

**Keywords**- Education inequality; Economic growth; Dynamic panel data model;  $\beta$ -convergence model

### I. INTRODUCTION

In modern society economic function of education is the most important power promoting social and economic development. Lewis (1954) directly attributed the "knowledge growth caused by the education" as one of three reasons of economic growth. Schultz (1961) thought that "as a source of economic development, education's effect is much stronger than the other physical capital resources such as buildings, facilities, inventory and so on." For a long time, researches on the relationship between education and economic development have been hot issues of national economy. In addition, education is also a kind of consuming activity which means education investment could spur the related industries' development, and then promote economic growth. Therefore, Human Capital Theory, Catch-up Model, Learning by Doing Model and many other theories all take education as investment activity in economy. Although the researches on the contribution of education to economic growth are abundant, they all affirmed and emphasized the important and irreplaceable role of education development to economic growth.

In general, the measurements of education development are not only these indicators, for instance, the educational financial investment, education expenditure, education enrollment rate, education resources and teachers; difference

of education development is also a very important aspect. Educational equality which is generally measured by Education Gini Index(EGINI) is such an important indicator to describe the reasonability of education development. The relationship between educational inequality and economic development is rather closely. Does the education inequality promote or hinder economic growth? Although the articles on the relationship between education and economy are very abundant, there are few articles directly on China's educational inequality and economic growth no matter at home or abroad. Most of the scholars focused on the impact of the education investment and expenditure to economic growth, income inequality and education development. Vinod Thomas (2000) estimated 85 countries' average education years and education Gini coefficients from 1960 to 1990 and his research result showed that education Gini coefficient had negative correlation with average education years and economic growth under the hypothesis of the Lorenz Curve. In China, Guo Danbo (2005) pointed out that the education Gini coefficient had a negative impact on economic growth and equitable distribution of education could promote economic development. Yang Jun and Li Xuesong (2007) also said that education inequality would hamper economic growth and education inequality had become the important factor which caused the regional differences of economic development.

According to these articles mentioned above, scholars have common that educational inequality would hamper economic growth. However, all of the time series data and panel data used in these studies had not been examined the unit root or co-integration, therefore the stability of the data and their research results are questionable. In addition, these articles no matter holding supporting or opposing view only analyzed the impact of educational inequality to economic growth. So their results are not comprehensive. Education inequality, which reflects differences of education development, also has the great impact to the reasonability of economic growth. In other words, is educational inequality conducive to the disparities convergence or divergence of economic growth? The inter-regional coordination of education development is also the necessary mean to promote regional economic coordinated development. However, these documents had not clear analysis on this impact.

This paper argues that education inequality has the great impact not only on the economic growth, but also on the disparities convergence or divergence of economic growth among regions. Does the education inequality promote or hinder the economic growth? Is it conducive to the disparities convergence or divergence of economic growth? Therefore, the study on the impact of educational inequality to economic growth and economic convergence has important academic value and practical significance. After estimating China's average education years, education Gini coefficients and economic growth of China's 31 provinces beside Hong Kong, Macao and Taiwan from 1997 to 2008, this article analyzes the impact of educational inequality to China's economic growth by Arellano-Bond dynamic panel data model, in addition applies the method of "Economic Convergence" to compare convergence rates of economic growth disparities affected by educational inequality.

## II. PANEL DATA DESCRIPTION OF THE EDUCATION INEQUALITY AND ECONOMIC GROWTH

### A. Measuring the Education Inequality and Economic Growth

In general, measurement methods of education development are not only financial investment, education expenditure and admissions rates which indicate educational development, education equality is also a very important aspect. Recently, the Education Gini coefficient has been widely applied to measure the educational fairness. Maas and Criel (1982) estimated the education Gini coefficient of 16 countries in East Africa. Thomas et al. (2001, 2003) measured by many countries' education inequality by the education Gini coefficient. China's scholars, for example, Wang Shanmai (1998), Wu Degang (1999), Du Peng (2005), Sun Baicai (2005), Zhang Changzheng (2006), Nie Jiang (2006), Zhu Meijuan (2006), Yang Jun and Li Xuesong (2007), Zhai Bo (2008), Sun Baicai (2009) and so on also applied education Gini coefficient to measure China's education equality at different periods. Currently, although the indicator of education Gini coefficient still has defects, it is widely accepted as a quite effective indicator to measure education equality. Therefore, this paper also applies the education Gini coefficient to measure the rationality of the educational development; and the Gross Domestic Product (GDP) growth rate (GR) per people to measure China's economic growth.

### B. Calculations on Education Gini Coefficient

The education level is divided into five different qualifications: illiterate or semi-illiterate, primary, junior high school, senior middle school, college or above, and the education years are as follow: illiterate or semi-illiterate for 0 year, primary school for 6 years, junior high school for 9 years, senior middle school for 12 years, college or above for 16 years. And mathematical formula which estimates the average education years is defined as follows:

$$AEY = \sum_{i=1}^5 EY_i \times P_i$$

In this formula, "AEY" represents Average Education Years, "i" represents the number of different educational

qualifications, "EY<sub>i</sub>" represents the education years of each education level, and "P<sub>i</sub>" represents the population percentage of each education level in total population.

Mathematical formula which estimates Education Gini Coefficient is defined as follows:

$$Egini = \left| \sum_{i=1}^4 (TEA_i \times P_{i+1} - TEA_{i+1} \times P_i) \right|$$

In which, "EA<sub>i</sub>" represents the educational achievement percentage of each group, "TEA<sub>i</sub>" represents the percentage of total educational achievements and its formula is:

$$TEA = \sum_{i=1}^5 EA_i = \sum_{i=1}^5 \left( \frac{EY_i \times P_i}{\sum_{i=1}^5 EY_i \times P_i} \right)$$

### C. Data Sources

Data comes from "China Statistical Yearbook" and "China Population Statistics Yearbook" from 1998 to 2009, statistics caliber is "6 years old population and above", and according to the calculation formula, we get Panel Data of the Education Gini Coefficient and economic growth rates from 1998 to 2008.

## III. UNIT ROOT TEST

In order to avoid "False Regression", before the analysis, it is necessary to do the unit root test and co-integration test to check panel data's stability.

As is shown in Table 1, this paper applies LLC, IPS, ADF-Fisher, PP-Fisher, and Hadri respectively to check panel unit roots of EGINI and GR and found that all of these two are zero-order variables. Additionally, these results show that education Gini coefficient and economic growth exist co-integration relations. Therefore, panel data of EGINI and GR is stable.

TABLE I. PANEL DATA'S UNIT ROOT TEST

Category	LLC	IPS	ADF-Fisher	PP-Fisher	Hadri
EGINI	-14.094*** (0.000)	-6.571*** (0.000)	143.305*** (0.000)	265.450*** (0.000)	7.411*** (0.000)
GR	-4.839*** (0.000)	-2.502*** (0.006)	90.968*** (0.010)	113.903*** (0.000)	4.803*** (0.000)

Note: \*\*\*, \*\* and \* indicates 1%, 5% and 10% significance level respectively.

## IV. IMPACT OF EDUCATION INEQUALITY TO ECONOMIC GROWTH

### A. Dynamic Panel Data Model

In economic activities, many economic variables are not only influenced by a number of current factors but also influenced by the previous variables. On the other hand, many time series data models are dynamic. Because the panel data model is a kind of cross-sectional time-series data, dynamic panel data model also exists. Therefore, the advantage of dynamic panel model is that it could study dynamic features of economic relations. The basic form of the dynamic panel model is as follows:

$$y_{it} = \gamma y_{i,t-1} + \sum_{k=1}^K \beta_k x_{kit} + \xi_i + u_{it}, \quad |\gamma| < 1$$

Where,  $\xi_i \sim i.i.d(0, \sigma_\xi^2)$ ,  $u_{it} \sim i.i.d(0, \sigma_u^2)$  and  $E(\xi_i, u_{it}) = 0$ ;  $i=1, 2, \dots, N$ ;  $t=1, 2, \dots, T$ ;  $\gamma$  is constant,  $\beta$  is  $k \times 1$  vector,  $x_{it}$  and  $y_{it}$  are explanatory variables and dependent variables.  $x_{kit}$  is strictly exogenous. And when  $i=1, 2, \dots, N$ ;  $t=1, 2, \dots, T$ ;  $s=1, 2, \dots, T$ ;  $E(x_{kis}, \Delta u_{it})=0$ . the first-order difference model is:

$$\Delta y_{it} = \gamma \Delta y_{i,t-1} + \sum_{k=1}^K \beta_k \Delta x_{kit} + \Delta u_{it}$$

Where,  $\Delta y_{it} = (y_{it} - y_{i,t-1})$  is Instrumental variable of  $y_{it}$ ,  $\Delta x_{kit}$  is Instrumental variable of  $x_{kit}$ . When  $i=1, 2, \dots, N$ ;  $t=1, 2, \dots, T$ ;  $E(\Delta x_{kis}, \Delta u_{it})=0$ . Therefore, compared with the static model, the effect and impact of the dynamic panel model are much greater.

### B. Impact of Education Inequality to Economic Growth

Respectively, this paper takes GR as the dependent variable,  $GR_{it}$  and  $EGINI$  as independent variables and uses Arellano-Bond dynamic panel data model to analyze the impact. Model 1 is the impact of education Gini coefficient to economic growth. And measurement results are as follows.

TABLE II. Arellano-Bond Dynamic Panel-data Estimation

Category	Coef.	Std.Err.	z	P>z	[95%Conf.Interval]
C	0.075	0.002	44.790	0.000	0.072 0.079
$\Delta GR_{i,t-1}$	0.373	0.011	35.380	0.000	0.352 0.393
$\Delta GR_{i,t-2}$	0.072	0.011	6.830	0.000	0.051 0.092
$\Delta EGINI_{it}$	-0.066	0.026	-2.550	0.011	-0.117 -0.015

Note:  $\Delta$  indicates the first-order difference.

Because Wald  $\chi^2(3) = 1305.36 > \chi^2_{0.05}(3)$ , Wald  $\chi^2$  test results of model 1 reject (except intercept) the null hypothesis which is model's coefficients are zero. Under the significance of 5%, the lagged first-order and second-order difference items of GR, the lagged first-order difference item of EGINI and the intercept term all passed the z test. Because Prob.>chi2=0.000, Sargan test accepts the GMM estimation of the hypothesis "Over-constrained model". Therefore, in the statistical sense, the model 1 is a good dynamic panel data model. In addition, from the economic sense, the impacts of lagged terms of GR and EGINI to the economic growth have reasonable economic meanings. Thence the Arellano-Bond dynamic panel data model 1 is as follow:

$$\Delta GR_{it} = -0.075 + 0.373 \Delta GR_{i,t-1} + 0.072 \Delta GR_{i,t-2} - 0.066 \Delta EGINI_{it} + \Delta v_{it}$$

This model could also be written as follow:

$$GR_{it} = \alpha_i - 0.075t + 0.373GR_{i,t-1} + 0.072GR_{i,t-2} - 0.066EGINI_{it} + v_{it}$$

From the above model, educational inequality have negative effects to China's economic growth. If the education inequality increased by 1%, China's economic growth rate would decline by 0.066%. The marginal effects of lagged first-order and second-order difference items of GR were 0.373 and 0.072 respectively. According to the analysis above, China's economic growth existed ratchet effect which was that the provinces with better economic basis, compared with those provinces with poor economic condition, would develop their

economy much more rapidly and enlarge the economic development disparities.

Therefore, according to the above analysis, this paper gets inference 1 as follows:

Inference 1: Generally speaking, educational inequalities would have a negative effect on economic growth. If the education inequality increased by 1%, China's economic growth rate would decline by 0.066%. Moreover there is ratchet effect of China's economic growth.

## V. IMPACT OF EDUCATIONAL INEQUALITY TO ECONOMIC DISPARITIES' CONVERGENCE

Currently, convergence method is mainly used in regional economic analysis. On the analysis of economic convergence, Levine (1992), Carlino and Leonard (1993), Bernard and Durlauf (1995, 1996), Hoeffler (2002), Barro and Sala-i-Martin (2004) all have had theoretical and empirical researches. In China, scholars, such as Wei Houkai (1997), Zhu Baohua and Xu Litian (2000), Cai Fang and Du Yang (2000), Shen, Kunrong and Ma Jun (2002), Chen Anping and Li Guoping (2004), Xu Xianxiang and Shu (2005), jin Sangyu (2006), Zhang Huanming (2006), also have had empirical studies from different perspectives on the regional convergence of China's economic growth. Although the literatures on economic convergence are abundant, most of the scholars focused only on demonstrating the existence of regional economic disparities convergence. Moreover there are few articles analyzing China's economic convergence affected by educational inequality with the method of "economic convergence". Therefore, this paper focuses on the comparison on the changes and differences of economic convergence rate after adding the educational inequality as controlling variable.

### A. $\beta$ Convergence of Inter-provincial Education Disparities

During the  $\beta$  convergence analysis, this paper applies Barro, R. J. and Sala-I-Martin model, their  $\beta$  convergence model is as follow:

$$\frac{1}{T} \log\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = B - \frac{1 - e^{-\beta T}}{T} \log y_{i,t-T} + \mu_i$$

Where:  $B$  is constant,  $i$  represents an economy,  $t$  represents a certain time,  $T$  is the length of the observation period,  $y_{i,t}$  and  $y_{i,t-T}$  are the beginning figure and the end figure of the observed output indicators,  $\beta$  is convergence rate,  $\mu_i$  is random error. After regression calculation, if  $\beta > 0$ , the economy is convergence; if  $\beta < 0$ , the economy is divergence.

In this paper  $y_{i,t}$  and  $y_{i,t-T}$  are the beginning figure and the end figure of the AEY or EGINI. From this equation,  $\beta$  depends on the initial variables and is independent of other factors. Therefore the coefficient  $\beta$  reflects an absolute convergence.

Furthermore, if adding a control variable, the convergence model is changed as follows:

$$\frac{1}{T} \log\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = B - \frac{1-e^{-\beta T}}{T} \log y_{i,t-T} + \psi X_{i,t-T} + \mu_i$$

Where:  $X_{i,t-T}$  represent steady controlling variables.

### B. Impact of Educational inequality to Economic Disparities' Convergence

This paper applies  $\beta$  convergence model to analyze economic disparities convergence after adding education inequality as controlling variable, and then compares the changes of convergence rates at three periods 1997-2002, 2003-2008 and 1997-2008. The reason why this article divides the period from 1997 to 2008 into two periods 1997-2002 and 2003-2008 is both these two periods are 6 years. However, the main reason is that China began the Compulsory Education System Reform in 2002. This division could also be helpful to study the changes of economic disparities' convergence rate after the reform. Here  $X_{i,t-T}$  represents educational

inequality. In the following analysis, ① represents the case without controlling variable; ② represents the situation with controlling variables.

According to table 3, at the period of 1997-2002, regional economic disparities tended to increase. The rate of divergence was 0.009. At the period of 2003-2008, China's economy trended to converge. And the convergence rate was 0.026. However, at the entire period of 1997-2008, the regional economic disparities still tended to converge. The convergence rate was 0.009. At the period of 1997-2002, after adding education Inequality as controlling variables, the divergence rate was 0.017. The educational inequality accelerated economic divergence rate, which was 1.82 times than that without the controlling variables. In addition, educational inequality also expanded the regional economic disparities. At the period of 2003-2008, the education Gini coefficient declined, educational equality has been greatly improved. The improvement of educational equality has accelerated the regional economic convergence rate which was 1.12 times than that without the controlling variables. It indicates that the decrease of educational inequality could promote economic development, accelerate the economy convergence and reduce regional economic disparities.

TABLE III. IMPACT OF EDUCATION INEQUALITY TO ECONOMIC CONVERGENCE

Model	1997-2002		2003-2008		1997-2008	
	①	②	①	②	①	②
$\beta$	-0.009**	-0.017***	0.026***	0.029***	0.009*	0.007*
$\psi$		0.063***		-0.031*		0.013*
$R^2$	0.12	0.47	0.31	0.34	0.10	0.11
$\bar{R}^2$	0.09	0.43	0.28	0.29	0.06	0.05
DW	1.95	1.82	1.78	1.82	1.75	1.71

Note: \*\*\*, \*\* and \* indicates 1%, 5% and 10% significance level respectively.

The impact of education inequality to economic convergence at the period of 1997-2002 and 2003-2008 were different; the reason was mainly because of China's Compulsory Education System Reform. After the reform of rural compulsory education, inter-provincial education disparities and educational equality have been significantly improved. In 1985, China began to implement the reform of education finance and the hierarchical management system. In this system, the burden of compulsory education structure is irrational. The central and provincial government share little burden, however the township government and farmers should afford the most of the compulsory education investment. As the township government and farmers did not have sufficient finance, rural education faced a serious shortage of funds. Since 2002, in order to address the input problem of rural compulsory education, the county government became main investor of the rural compulsory education. The convergence rates show that the reform effect of financial system for compulsory education is obvious.

Therefore, according to the above analysis, this paper gets inference 2 as follows:

**Inference 2:** Educational inequality has significant impact to the economic divergence and convergence. Therefore education development and the improvement of education equality would be to the important means promoting regional economic development coordinately.

## VI. CONCLUSION

In conclusion, there is ratchet effect of China's economic growth. Educational inequalities would have a negative effect on economic growth. If the education inequality increased by 1%, China's economic growth rate would decline 0.066%. In addition, Educational inequality has significant impact to the economic divergence and convergence. At the period of 1997-2002, education inequality accelerated the divergence rate of economic disparities, and it also expanded economic disparities. However, in the period of 2003-2008, the improvement of education equality accelerated economic convergence rate and it also promoted the economic development because the education equality has been greatly improved. The impact of education inequality to economic disparities at the period of 1997-2002 and 2003-2008 were different. The reason is mainly because of China's Compulsory Education System Reform. After the reform of rural compulsory education, inter-provincial education disparities and educational equality have been significantly improved. Therefore education development and the improvement of education equality would be to the important means promoting regional economic development coordinately.

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