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Effect of equity in education on the quality of economic growth: evidence from China

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Abstract

In China, there is a general view that the equity in education has a negative effect on the quality of economic growth. Acting upon this viewpoint, China's education policy has gradually abandoned its low-gravity development strategies and would rather significantly invest more money into higher education than basic education. In this paper, an empirical study on the relationship between China's equity in education and the quality of economic growth is implemented to try to answer the following question, i.e., which is the more important one for the equality of China's economic growth, basic education, or higher education. By adopting China's recent 27-year macro-economic data from 1978 to 2004, the paper carries out the Granger causality test between the equity in education and the quality of economic growth and then establishes a regression model. Results of the empirical study show that the equity in education is significantly and positively related to the quality of economic growth, and the equity in education is the Granger reason of China's quality of economic growth. That is to say, besides promoting the social harmony, equity in education also has a positive role in promoting the quality of economic growth in China, which is a very different conclusion from the current point of view. Based on the results and the analysis of the mechanism of the relationship between equity in education and the quality of economic growth, this paper proposes that China's present education policies need many adjustments.

Key words: Equity in education, Quality of economic growth, Gini coefficient, TFP

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1 Introduction

As we all know, educational economic literature has paid much attention to the return of education investment for a long time. In fact, it is widely accepted that, for an individual, education investment can not only improve his or her ability of earning money, but improve his or her overall welfare. And for the whole society, investment in education can improve the human capital accumulation and technology level which can lead to higher quality of economic growth. But the relationship between equity in education and the quality of economic growth is not very clear, especially in China.

With the social development, equity in education, as a critical part of social justice, has gradually been viewed as a kind of moral standard of evaluating the advancement and value of the social system (Liu, 2006). People have widely accepted the point of view that enjoying equality in education is one of the basic human rights, thus equity in education is receiving more and more attention. Moreover, in some western countries, equity in education is even seen as the critical source of both social and economic development. According to a survey carried out by Barro(1998), countries with a good quality of economic growth usually have the fairer education systems. For example, Sweden, a country in north Europe which has received many great achievements in technology improvement and economic development, is one of the most developed countries in the world, though it is very small in country size and rather poor in natural resources. Both scholars and common people have taken it for granted that its economic growth mainly derives from its advanced education, i.e. an education with higher equity (Wei, Zhang, & Meng, 2008). Furthermore, a few empirical studies in western counties have confirmed that the inequity of education distribution will enlarge the income gap among each social class (O' Neill, 1995), and inversely affect economic growth (Ramon, Vinod, & Yan, 1998).

There has been no empirical study that can definitely tell us whether the equity in education can cause a higher quality of economic growth, especially in China (Wang, 2002). Specifically, we do not know which is more important for the quality of economic growth in China, to popularize basic education or to train higher-level talents. In China, we can see that the present popular view is that the equity in education has an obvious negative impact on the quality of economic growth. Therefore, things like cultivating higher-level people and promoting technology improvement are considered to be more important for the quality of Chinese economic growth. Having been instructed by this point of view, the education policy

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of the Chinese government, who should shoulder the responsibility of assuring equity in education of China (Le & Wu, 2007), has been gradually established to be giving up the "low-gravity" strategy for the development of education, and the structure of education investment has significantly been shifted to higher education.

Here is the question. Will the equity in education lead to a decline in the quality of Chinese economic growth, in other words, for Chinese economic growth quality, which is more important, basic education or higher education? Using China's macro-economic data from 1978 to 2004, this paper carries out an empirical research in an effort to reveal the relationship between equity in education and the quality of economic growth in China. Of course, as we all know, equity in education not only includes the equity in education in year distribution, but includes the equity in education in regional distribution, the equity in education in gender distribution, the equity in education in race distribution and the equity in education in rural-urban distribution, etc. In this paper, we mainly refer to equity in education in year distribution.

2 Equity in Education in China: estimation for Education Gini Coefficient during 1978-2004

2.1 Education Gini Coefficient and its calculation

From an ethical point of view, equity in education mainly includes enrollment opportunity equity, education conditions equity and education achievement equity. From an economic point of view, equity in education mainly refers to the equal distribution of educational resources among all people(Green, Preston, & Sabates, 2003). At present, the most commonly used measurement indicator of equity in education by scholars abroad is the Education Gini Coefficient (EGC).

EGC has been used as a new useful indicator of equity in education in cross-national analysis by some scholars (Vinod, Yan, & Fan, 2000; John, Jerry, & Lloyd, 2002; Zhang & Li, 2002). In China, several scholars examined the relationship between equity in education in regional distribution and regional economic growth with EGC (Liu, 2004). So far, EGCs have only been used for a few years in China by Chinese scholars, and there is no comprehensive examination on equity in education for each year since the open-door policy in 1978. Therefore, we not only can not explore the development history of Chinese equity in education, but can not appraise the success and failure of Chinese education development. Of

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course, we can not use the existing EGCs in China to test the relationship between equity in education and the quality of economic growth, instead, we have to calculate the EGCs in China from 1978 to 2004 in order to do the test.

As shown in Figure 1, we can choose X_i (APP) expressing the percentage of the population of group *i* in the whole population, and choose Y_i (APEA) expressing the percentage of the total educational tenure of group *i* in total tenure of the whole population. As we see, Y_i is similar with the income percentage of each group in Lorenz Curve (Zhai, 2007).

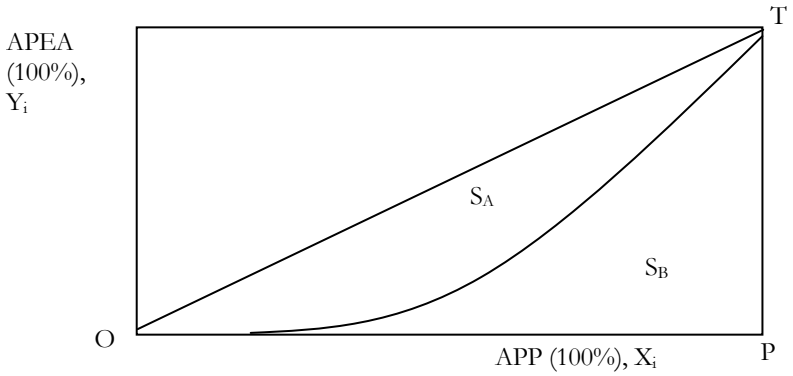

Figure 1 Lorentz curve of education

Based on equation 1, which is quoted from Bai & Zhao (1994), we can easily calculate EGC which describes the degree of distributional justice of education among each group. In equation 1, ACX_i and ACY_i represent the cumulated percentage of X_i and Y_i respectively. Of course, it is easy to understand that the lower the EGC is, the higher equity in education is.

$$EGC = 2 \times \left| \sum_{i=1}^{n} (Y_i \times \sum_{i=1}^{n} X_i) \right| - \sum_{i=1}^{n} Y_i \times X_i - 1$$
$$= 2 \times \left| \sum_{i=1}^{n} (Y_i \times ACX_i) \right| - \sum_{i=1}^{n} Y_i \times X_i - 1 \qquad (1)$$

2.2 Estimation of population with different educational background: 1978-2004[3]

Because China's Cultural Revolution largely dismantled the preceding educational systems (Cheng & Manning, 2003), it is very difficult for us to obtain the data of population with different educational background before 1978. That is why we only choose the data

[3] The content of this part is expanded from the Research Article: Zhang, C-Z., Huan, Z-J., & Li, H-Z. (2007). An empirical study on education equity in China, 1978-2004. *Frontiers of Education in China*, 2 (4), 536-544.

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after 1978. To calculate the EGC of 1978-2004, we must get the exact information about the population with different educational background in each year. But there is no complete statistical data for educational backgrounds of the population in China now, so the paper has to estimate them first. Based on the existing statistical data of the recent three censuses on Population respectively in "*China Population Statistics Yearbook 1983*", "*China Population Statistics Yearbook 1991*" and "*China Population Statistics Yearbook 2001*", we know the educational background of the population aged six and above for the years, 1982, 1990 and 2000, allowing us to estimate the other educational backgrounds of population for the last 24 years.

According to the analysis above, the paper defines PNE, IES, GES, JHS, SHS, POU, and POG as variables which respectively represents the population with no education, the population in elementary schools, the population graduated from elementary schools, the population graduated from junior high schools, the population graduated from senior high schools, the population of undergraduates, and the population of graduates. The calculation expressions of population with different educational background can be shown as follows.

$$PNE_i = PNE_{i-1} * (1-\delta_i) + SIXN_i - IESNN_i \quad (2)$$

$$IES_i = FIES_i + CIES_i \quad (3)$$

$$GES_i = GES_{i-1} * (1-\delta_i^*) + GESN_i - JHSN_i \quad (4)$$

$$JHS_i = JHS_{i-1} * (1-\delta_i^*) + JHSN_i - SHSN_i \quad (5)$$

$$SHS_i = SHS_{i-1} * (1-\delta_i^*) + SHSN_i - POUN_i \quad (6)$$

$$POU_i = POU_{i-1} * (1-\delta_i^*) + POUN_i - POGN_i \quad (7)$$

$$POG_i = POG_{i-1} * (1-\delta_i^*) + POGN_i \quad (8)$$

In equation 2, PNE_i represents population with no education. δ_i represents the natural mortality in rural area where there are more than 80% PNEs[4]. $SIXN_i$ represents the population of new six-aged children[5]. $IESN_i$ represents the population of enrollment in

[4] If there is no special explanation, all the related data in the paper are indexed from: National Bureau of Statistics of China. (2004). China Population Statistics Yearbook 2004. *Beijing: China Statistics Press.*

[5] There is no accurate information in each Yearbook. Though there is the data of the population with the appropriate age for enrollment into elementary school in China Education Yearbook, it is far away from being satisfactory. Therefore, the paper has to estimate it.

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elementary schools. In equation 3, IES_i represents the population in elementary schools. $FIES_i$ represents the population in full-time elementary schools, while $CIES_i$ represents both the population in adult elementary schools and illiteracy-eliminating schools[6]. In equation 4, GES_i represents the population graduated from elementary schools. δ_i^* represents the natural mortality in China. $GESN_i$ represents the population newly graduated from elementary schools, while $JHSN_i$ represents the population of enrollment in junior high schools. In equation 5, JHS_i represents the population graduated from junior high schools, while $SHSN_i$ represents the population of enrollment in senior high schools. In equation 6, SHS_i represents the population graduated from senior high schools, while $POUN_i$ represents the population of enrollment in college. In equation 7, POU_i represents the population graduated from college, while $POGN_i$ represents the graduates' population of enrollment. In equation 8, POG_i represents the population of graduates.

$$SIXN_i = POP_{i-6} * \sigma_{i-6} * (1-\delta_i^{**})^6 \qquad (9)$$

There is no accurate data about $SIXN_i$, the paper constructs equation 9 to estimate it. In equation 9, POP_{i-6} represents the whole population aged six and above, and σ_{i-6} represents the birth rate of people six years old, while δ_i^{**} represents the average mortality of children less than five years old in China.

$$IES_i = EE_i - PNE_i \qquad i = 1983, 1990, 2000 \qquad (10)$$

Because the data of the three censuses on population does not demonstrate the population in elementary schools directly, so the paper shall separate the population in elementary schools from the population with elementary education. In equation 10, EE_i represents the population with elementary education.

The paper reversely estimates Census data in 1978-1981 based on data in 1982 according to equations from 2 to 7, and directly estimates the data in 1983-1989 based on Census data in 1982 according to from equation 2 to equation 7, and directly estimates Census data in 1991-1999 based on data in 1990 according to from equation 2 to equation 7, and directly estimates the data in 2001-2004 based on Census data in 2000 according to from equation 2 to equation 7.

[6] The data of the population in illiteracy-eliminating schools is not complete in many years, and it is summarized from the separated data of enrollment in each province. Therefore, this data may be not very accurate.

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Because there is no data on population of graduates till 2000, for the application of equation 8, the paper only can reversely estimate the population of graduates in 1978-1999 based on the data in 2000, while directly estimate the population of graduates in 2001-2004.

The estimation results of population of undergraduates in 1978-1999 include the population of graduates, so it is needed for us to exclude the population of graduates estimated above.

During the estimation process, the main data resource shows as follows. δ_i, δ_i^*, σ_{i-6} and δ_i^{**} come from " *China Health Statistics Yearbook2004*". $FIES_i$, $CIES_i$ and $GESN_i$ come from "*People's Republic of China yearbook 2004*". $JHSN_i$, $SHSN_i$, $POUN_i$ and POG_i come from "China Education Statistics Yearbook2004". $POGN_i$ comes from "*China Statistics Yearbook2004*", while POP_{i-6} comes from "*China Population Statistics Yearbook2004*". The data in 2004 is calculated as the average of the latest three years except for $POUN_i$ and $POGN_i$ which come from "China Statistics Abstract 2005". [7]The results are provided as in Table 1.

Table 1 Population with different educational background (Ten thousand)[8]

	PNE	IES	GES	JHS	SHS	POU	POG
1978	33212.7	22001.0	10424.1	12894.2	4733.4	454.9	15.9058
1979	31629.3	19509.1	13705.1	14253.4	5397.6	491.2	16.5748
1980	30357.3	17494.2	16532.5	15411.3	5997.9	515.5	16.8811
1981	29183.8	15487.2	19394.8	16658.8	6362.8	539.9	17.1414
1982	28388.4	14312.7	21203.3	17827.7	6647.8	584.2	17.4883
1983	26162.8	14104.7	23791.4	18647.9	6883.1	688.1	17.6589
1984	24777.1	13641.2	24648.5	19524.3	7137.6	806.1	19.2534
1985	23292.8	14192.4	24849.3	20748.5	7427.2	926.4	20.8329
1986	22099.3	13684.5	25790.2	21547.2	7710.0	1046.3	25.3949
1987	20984.5	13337.9	26717.3	22803.9	7978.9	1171.1	29.3736
1988	19847.8	13047.8	27678.4	23999.5	8267.6	1296.1	33.0991
1989	19088.5	12785.2	28558.9	25157.1	8577.7	1420.4	36.4649
1990	18003.0	12603.4	29417.1	26338.5	8988.8	1536.6	39.1031
1991	17324.3	12526.2	30626.8	26964.3	9169.0	1863.0	41.8334
1992	16758.1	12713.3	31635.8	27599.6	9352.5	2045.8	44.5502
1993	16405.6	12938.6	32573.5	28257.9	9599.8	2042.7	47.6269
1994	16032.5	13340.2	32172.1	28953.6	9822.8	2241.5	51.5556
1995	15124.6	13209.1	32116.4	33776.0	10221.1	2449.9	56.3327
1996	14111.4	13743.6	32081.5	35878.0	10734.4	2481.1	61.0999
1997	12890.4	14404.4	32104.8	36673.3	11874.5	3063.3	66.7098
1998	11659.1	14445.6	31909.2	37246.5	12028.6	3074.4	72.7178
1999	10340.8	13991.2	31685.6	39393.6	12288.0	3466.1	79.5687

[7] If the needed data is not complete in the above mentioned Yearbooks, the paper will choose the Yearbooks in other years as the supplement. Therefore, because too many all kinds of Yearbooks in each year are indexed, the paper will not list them completely in references. Thanks to China Statistics Press.

[8] In order to test reliability of the estimated data, we use the data of population change based on the selective survey at the ratio of one in a thousand during 1996-2003 (The data of the other years can not be reached, and the data of 2000 is also missing) to estimate the responding distribution of population with different education background. The results show that the estimation method in this paper is reliable.

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2000	8962.9	15127.8	31110.2	42238.7	13828.4	4225.2	88.3933
2001	8812.7	15698.7	29083.4	42783.2	14364.9	4986.1	104.471
2002	8669.7	16166.2	28675.1	44383.6	14683.7	5430.0	124.2202
2003	8527.6	15816.1	27516.2	45887.0	16128.6	6469.3	150.5537
2004	8409.9	14469.4	27497.3	48004.8	16365.5	6862.3	183.0924

Note: Because of the large number of students at elementary schools and their years of education, the stock of the overall education level will be obviously over-estimated if we do not single out the population in elementary schools.

2.3 Estimation of EGC and its empirical analysis: 1978-2004

Based on the analysis above, the whole population is divided into seven groups with different educational backgrounds. The educational tenure of each group is shown as C_i, which is equal to 0 year for PNE, 3 years for IES, 6 years for GES, 9 years for JHS, 12 years for SHS, 15 years for POU and 19 years for POG respectively.

According to equation 1, the paper calculates EGC during 1978-2004 in China based on the data in Table 1. The result is shown in Table 2.

According to Table 2 and Figure 2, we find that EGC in China has always decreased with the development of education since 1978, but the improving speed of EGC has actually become slower and slower, and there was even a reversed move of EGC that happened in 2001. On the one hand, it is determined inherently by the development rule of equity in education per se, which confirms us that the improvement probability becomes lower with the continuous improvement of equity in education, and so the changing rate begins to decrease. On the other hand, the most important reason is that Chinese government has gradually abandoned the “Low - gravity” strategy of education development originally established since 1950s. Especially we can see that the government has gradually slowed the growth rate of investment in elementary and secondary education, and relatively increases the investment in higher education. As a result, improving higher education has become the focus of Chinese education strategy.

Table 2 EGC in 1978-2004

year	EGC	year	EGC	year	EGC
1978	0.567900758	1987	0.395016863	1996	0.307787842
1979	0.541442966	1988	0.381058475	1997	0.300652955
1980	0.518033114	1989	0.370193132	1998	0.291967316
1981	0.494702926	1990	0.35746346	1999	0.279275453
1982	0.477956738	1991	0.349314966	2000	0.269474295
1983	0.451736989	1992	0.342596335	2001	0.271526958
1984	0.436838214	1993	0.337133025	2002	0.269821745
1985	0.422789445	1994	0.334867347	2003	0.267037566
1986	0.409246390	1995	0.317886458	2004	0.259985440

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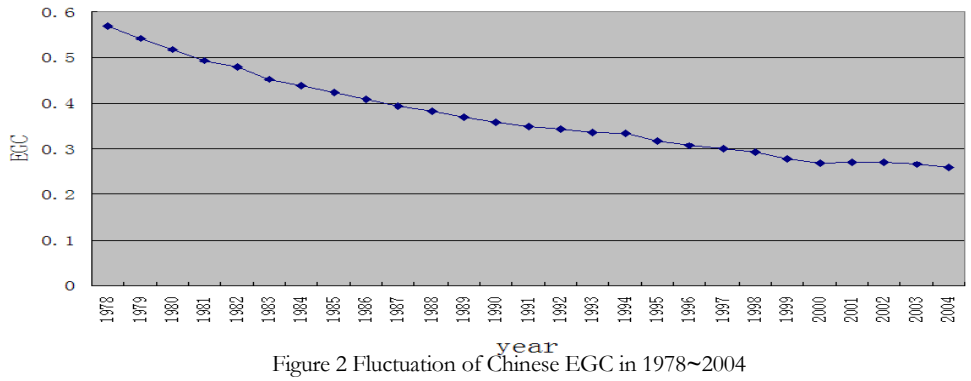

Figure 2 Fluctuation of Chinese EGC in 1978~2004

To judge impersonally, the equity in education is continually improving, and the improvement is rather obvious compared with the equity in education in 1978. But such a fact conceals two critical inequity, namely, regional inequity and rural-urban inequity.

First, because of many objective facts such as government policy difference, resource storage diversity and many other history conditions among different regions, especially between eastern regions and western regions, there exits great disparity in economic development which finally leads to great disparity in equity in education among different regions. According to the study of Liu (2004), we can divide all regions in China into 4 groups based on equity in education level. Beijing, Shanghai, Tianjin belong to the regions of the highest level, and can obviously overmatch the other regions in equity in education. Shanxi province, Liaoning province, Jilin province, Heilongjiang province and Guangdong province belong to the regions of the second level. Jiangsu province, Zhejiang province, Henan province, Hebei province, Neimenggu province, Hubei province, Hunan province and Shannxi province belong to the regions of the third level. The other regions have the lowest level of equity in education. Especially, we find several western regions have the obviously lower equity in education than the average level in China. For Example, EGC of Tibet is less than 50% of the average. The disparity of education investment among regions is rapidly increasing which leads to inequity in education in regional distribution worse and worse (Zhu, 2003). Second, the inequity in education for children in rural area is getting more and more severe. There is a large gap between rural area and urban area. The money of elementary and secondary education in rural area is severely in short. There are many disadvantages in teaching environment, teaching establishment and teacher adequacy which lead to the opportunity of receiving education is severely unfair. The inequity in elementary education naturally continues in secondary and higher education. Before 1960, the

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population ratio between rural and urban area was 8:2 and the ratio of undergraduates is 7:3. While the present population ratio between rural and urban is 7:3, but the ratio of undergraduates is 3:7. The inequity in education opportunity and education degree results in the inequity of obtaining employment opportunity, and finally leads to excessive income inequity.

Compared with the severely increased inequity education in regional distribution and inequity in education in rural-urban distribution, the obvious improvement of the whole equity in education in China does not mean much. Because of the structural inequity, the improvement of equity in education has very limited positive effect on economic growth and social equity. The inequity in education in regional distribution results in that the disparity of economic growth among regions gets more and more severe, which finally leads to both oversupply in high-developed regions and supply shortage in undeveloped regions. Such a fact does not benefit the upgrade of industry structure in China. The inequity in education in rural-urban distribution results in that children in rural area are always receiving poorer education and therefore have lower capability. If the fact can not be changed, it is impossible for them to avoid the vicious circle of “poverty - no education – more severe poverty”. Children in rural area belong to the ones in the lower social class. If they can not change their fates through education, it is not possible for the up-movement of social class in China, and so it will do harm to the construction of harmonious society.

3. Quality of economic growth in China: estimation for total factor productivity (TFP) during 1978-2004

The total factor productivity (TFP) is the most world-widely-used indicator to measure the quality of economic growth. TFP is much more superior to single factor productivity when reflecting the quality of economic growth.

3.1 TFP: A measurement for the quality of economic growth

TFP is the portion of output not explained by the amount of inputs used in production, and it is determined by how efficiently and intensely the inputs are utilized in production (Diewert, 1981). TFP growth is usually measured by the Solow residual (Solow, 1956). Let g_Y denote the growth rate of aggregate output, g_K denote the growth rate of aggregate capital, g_L denote the growth rate of aggregate labor and α denote the capital share. The Solow residual is then defined as $g_Y - \alpha * g_K - (1 - \alpha) * g_L$. The Solow residual accurately measures

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TFP growth if the production function is neoclassical, there is a perfect competition in the factor markets, and the growth rates of the inputs are measured accurately.

TFP can play a critical role in economic fluctuations, economic growth and cross-country differences of per capita income. At business cycle frequencies, TFP is strongly correlated with the output and working hours. Based on the observation, Kydland & Prescott (1982) initiated the real business cycle research. In the standard business cycle model, shocks to TFP are expressed by periodic labor supply and investment, thus bringing fluctuations into the output and labor productivity at business cycle frequencies. The subsequent research has brought periodic fluctuations into the measurement of TFP by incorporating unmeasured labor hoarding and capacity utilization in the standard structure (Diego, 2006; King & Rebelo, 1999).

All in all, just because of its effect on such things as economic fluctuations, economic growth and cross-country per capita income differences, TFP is usually seen as the index of the quality of economic growth.

3.2 TFP Estimation of China: 1978-2004

According to some western scholars, the East Asian miracles mostly came from input accumulation (Klenow & Rodriguez, 1997; Young, 1995), and their TFP growth rates were not extraordinarily high (Young, 1994). As for China specifically, though it has maintained a rapid speed of economic growth during the nearly 30 years of reform and openness, Krugman (1994), as a typical representative of the above Western scholars, still regarged that the TFP of China's economic growth was actually rather low which reflected the poor quality of economic growth, and China’s economic growth relied basically on the economic input, just as the other East Asian countries. The issue also has caused widespread concern of Chinese scholars. Many of the scholars estimate TFP of different periods in China (Zhao, 2005; Wang, 2000; Guo & Jia, 2005). As the accounting treatment and methods of data processing are different, different results have occurred. However, scholars both at home and abroad have come to an agreement that the quality of China’s economic growth is not high enough.

After comparing the calculation results of the growth rate of TFP (tfp) of many Chinese scholars, this paper adopts that of Guo & Jia’s method of calculating the potential output (Guo & Jia, 2004). Roughly speaking, there should be three reasons for the choice. First, the method of potential output has a comprehensive consideration for the impact of both

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technology and ability application on TFP, thus the result is comparatively more correct. Second, the research estimated the TFP during the period 1978-2004 which was consistent with this paper's. The last but not the least, the calculation results of TFP are more in line with the facts of China's economic growth.

$$TFP_t = TFP_{t-1} + tfp_t \qquad (11)$$

According to the tfp data *(*i.e. tfp_t*)* in Guo & Jia (2005) and equation (11) , the paper gives the TFP results from 1978 to 2004. When the index of TFP in 1978 is set as 100, the indexes of TFP in other years can be reached. The results are provided as in Table 3.

Table 3. Index of TFP from 1978 to 2004 in China

year	TFP	year	TFP	year	TFP
1978	100.000	1987	111.245	1996	116.623
1979	100.154	1988	113.699	1997	117.160
1980	100.098	1989	109.361	1998	117.290
1981	97.280	1990	103.418	1999	117.008
1982	97.643	1991	103.507	2000	117.625
1983	99.499	1992	107.965	2001	117.552
1984	104.774	1993	111.537	2002	118.521
1985	108.734	1994	114.565	2003	120.883
1986	108.717	1995	115. 844	2004	122.986

3.3 Empirical analysis on TFP of China during 1978-2004

According to Table 3, we can obtain Figure 3 showing the fluctuation of index of TFP during 1978-2004 in China.

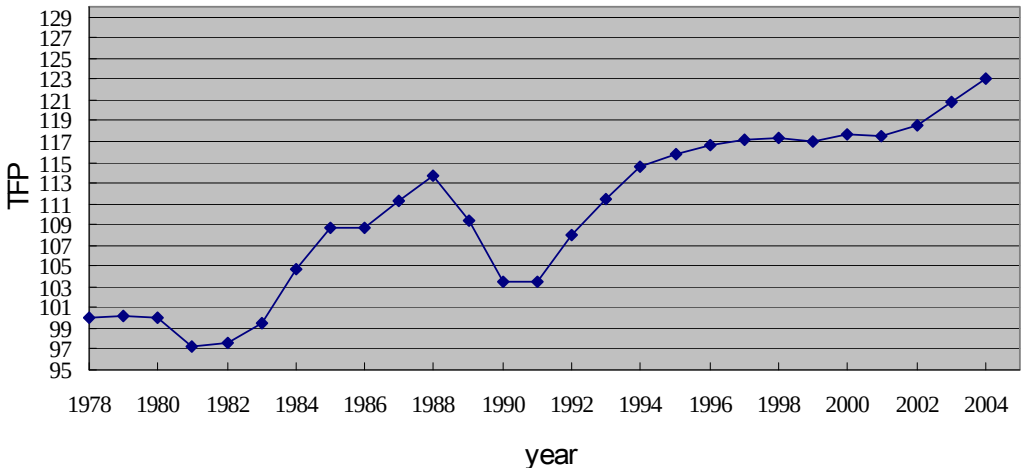

Figure 3. Fluctuation of index of TFP during 1978-2004 in China

In the light of Figure 3, we can see that the TFP fluctuation during 1978-2004 is rather significant, but the whole level of TFP has been improved obviously since the Reform and

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Openness. According to the data in Table 3, except for the data of 1989 and 1990, the growth rates of TFPs of China were all positive, and the growth rate of TFP in 1983, 1984, 1985, 1987, 1992, 1993 and 1994 respectively even exceededed 5%. Furthermore, according to our work, the average TFP growth rate in China during 1978-2004 is 3.25%, and the contribution of technology to economic growth is more than 30%. Such a great achievement mainly depends on the policy of Reform and Openness. The policy of Openness has brought advanced technology into China, and the policy of Reform has brought great motivation to domestic economy in China Mainland and improved the R&D activities greatly. Therefore, both of the two forces have promoted the quick improvement of labor productivity in China. Thus we can conclude that the policy of Reform and Openness of about 30 years has reached its goal for the development of productivity.

However, because of the fact of the large fluctuation of Chinese TFP, it is easy for us to tell that the TFP growth rate in China is substantially influenced by government system. The seven years with higher TFP growth rate appeared respectively in the years before and after 1984 tightly and the years after 1992, and both the years, 1984 and 1992 were just the critical years when Chinese government began to liberate their brain, and the economic policy was rather loose. The negative growth rate in 1989 and 1990 respectively was influenced by the political storm when the economic policy became much stricter. All in all, the TFP growth rates since 1978 are mainly determined by technological improvement which is the critical variable that can determine the expected growth rate of the economy (Aghion & Howitt, 1992), while the influence of government policy cannot be overlooked.

4. Empirical analysis on the relationship between the equity in education and the quality of economic growth

As we all know, one of the most important issues in the areas of time series econometrics is the ability to statistically perform causality tests. By causality we mean causality in the Granger (1969) sense. Through the Granger approach to the question whether the variable y_1 causes the other variable y_2, we will see how much of the current value of the second variable can be explained by past values of the first variable. Y_2 is said to be Granger-caused by y_1 if y_1 helps in the prediction of y_2, or equivalently, if the coefficients of the lagged y_1 are statistically significant in a regression of y_2 on y_1. Sometimes econometrics scholars use the shorter terms “causes” as shorthand for “Granger causes".

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The definition of Granger causality does not indicate anything about possible instantaneous correlation between the two time series. If the innovation to one time series and the innovation to the other are correlated, we say there is instantaneous causality. We will often find instantaneous correlation between two time series, but since the causality can go either way, one usually does not test for instantaneous correlation. However, if you do find Granger causality in only one direction, you will feel that the case for "real" causality is stronger if there is no instantaneous causality, because thus the innovations to every series can be considered as actually being generated from this particular series rather than part of some vector innovations to the vector system. Of course, if the data is sampled with a long sampling period, for example annually, then we would have to explain why one variable would only cause the other after such a long lag.

Empirically, one way to test for causality in Granger sense is by means of vector autoregressive (VAR) model. The Granger causality tests are most useful in situations where one is willing to consider 2-dimensional systems. If the data are reasonably well described by a 2-dimensional system, Granger causality concept is the most straightforward to think about and also to test. By the way, be aware that there are special problems with testing for Granger causality in co-integrated relations (Toda & Phillips, 1991).

According to Part II, we have known the status of equity in education which is expressed as EGC and its fluctuation in China during 1978-2004, and according to part III, we have known the status of the quality of economic growth which is expressed as TFP and its fluctuation in China during 1978-2004. In this part, we will use the data of EGI and TFP to analyze the relationship between equity in education and the quality of economic growth by the method of Granger causality test.

As we all know, the Log transformation does not change the cause and effect relationship between the two variables, this paper will deal with the data of the education Gini coefficient (EGC) and total factor productivity index (TFP) with Log transformation. For simplicity, they are respectively expressed as LG and LTFP in the form of natural logarithm. LG means ln(1+EGC), and LTFP means ln(TFP). The transformation results are shown respectively in Table 4 and Table 5.

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Table 4 Transformational result of EGC during 1978-2004 in China (LG)

year	LG	year	LG	year	LG
1978	0.4497376	1987	0.3329065	1996	0.2683370
1979	0.4327190	1988	0.3228502	1997	0.2628664
1980	0.4174155	1989	0.3149517	1998	0.2561661
1981	0.4019275	1990	0.3056179	1999	0.2462939
1982	0.3906606	1991	0.2995970	2000	0.2386029
1983	0.3727608	1992	0.2946053	2001	0.2402185
1984	0.3624450	1993	0.2905278	2002	0.2388765
1985	0.3526193	1994	0.2888319	2003	0.2366816
1986	0.3430551	1995	0.2760293	2004	0.2311002

Table 5 Transformational result of index of TFP during 1978-2004 in China (LTFP)

year	LTFP	year	LTFP	year	LTFP
1978	4.6051702	1987	4.7117350	1996	4.7589465
1979	4.6067090	1988	4.7335546	1997	4.7635405
1980	4.6061497	1989	4.6946543	1998	4.7646495
1981	4.5775934	1990	4.6387790	1999	4.7622423
1982	4.5813180	1991	4.6396392	2000	4.7675016
1983	4.6001476	1992	4.6818071	2001	4.7668808
1984	4.6518056	1993	4.7143564	2002	4.7750902
1985	4.6889045	1994	4.7411423	2003	4.7948231
1986	4.6887482	1995	4.7522445	2004	4.8120705

Because the method of Granger causality test requires smooth data of the time series, we have to do a smooth test for LG and LTFP which are Time-series data. The results are shown in Table 6. As shown in Table 6, both LG and LTFP have become a smooth series after date transformation. Additionally, we also do the smooth tests for EGC and TFP which tell us that the two original time series are not suitable for Granger causality test. Obviously, the Log transformation is absolutely necessary. The results are omitted in the paper just for simplicity.

Second, we will do Granger causality test for LG and LTFP. The results are in Table 7. As shown in Table 7, the probability of the Type I error is 0.00195, which tells that LG is the Granger cause of LTFP at least 99% confidence level. With a greater probability (0.30656) for the assumption that LTFP is not the Granger cause of LG, it is concluded that LG is the cause and LTFP is the effect. As the transformation of data does not change the relationship between cause and effect, it is concluded that equity in education is the cause of TFP, that is, the good change of equity in education degree will lead to the good change in total factor productivity.

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Table 6 Test of ADF value

variable	ADF value	Test(C,T,L)	1% Critical value	5% Critical value	Mackinnon p
LG	-3.112	(C,T,2)	-3.738	-2.992	0.039**
LTFP	-4.450	(C,T,3)	-4.416	-3.622	0.0084***

Note: In the test(C,T,L), C means constant, T means time and L means lag order. The symbol of ** and *** means that the significant level is 5% and 1% respectively.

Table 7 Results of Granger causality test

Null hypothesis	Obs	F statistics	Asymp . Sig	Result
LG is not Granger cause of LTFP	25	8.66464	0.00195	Reject the Null hypothesis
LTFP is not Granger cause of LG	-	1.25509	0.30656	Receive the null hypothesis

Then this paper does the regression estimate. The result is shown here.

$$LTFP = 5.009646 - 0.98959LG \quad (12)$$
$$(165.128) \qquad (-10.4422)$$
$$R^2 = 0.81349 \qquad R^2_{adj} = 0.806 \qquad DW = 0.6139 \qquad F = 109.0402$$

In equation (12), the data in brackets is *t* test value. Setting u_t as the model residual, we do ADF test for the data of u_t. The result is shown in Table 8.

Table 8 The result of ADF test for the residual (u_t)

variable	ADF value	Test(C,T,L)	1% Critical value	5% Critical value	Mackinnon p
u_t	-3.699	(C,0,5)	-3.808	-3.0207	0.0126

As shown in Table 8, the assumption that the residual is smooth is acceptable at the 5% significance level which tells that model (12) has no problem of spurious regression. It is concluded that there is a long-term co-integration relationship between equity in education degree (LG) and the quality of economic growth (LTFP).

First of all, we do the test of statistical inference of the regression model. The determination coefficient, R^2 is 0.81349, which tells that the model has a better ability to explain the relationship between the variables. The T test data of constant and LG coefficients are 165.128 and -10.442 respectively which are both significant at 1% level. And F statistic of the model is 109.0402, also significant at 1% level. Therefore, we can conclude that the statistical regression model is appropriate.

Second, we have to do the econometric autocorrelation test of the model. As shown above, DW is 0.6193. At the significance level of 0.05, the critical values are 1.316 and 1.469. Therefore, there is a problem of the significant existence of autocorrelation.

Because there is the existence of autocorrelation in the regression results, the regression model has been adjusted by the way of CORC by adopting Eviews5.0. The result is shown as in below.

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$$LTFP = 5.071707 - 1.209495\,LG + 0.654852\,AR(1) \quad (13)$$
$$(63.4793) \quad (-4.4274) \quad (4.4933)$$
$$R^2 = 0.90187 \quad R^2_{adj} = 0.89334 \quad DW = 1.847039 \quad F = 109.652$$

In the revised model, DW is 1.847039 which tells that autocorrelation does not exist in the model. R^2 is also amended significantly. Therefore, the model (13) will well express the relationship between the degree of equity in education (LG) and the quality of economic growth (LTFP). As shown in model (4), the elasticity of education Gini coefficient to the quality of economic growth is -1.21, that is, when education Gini coefficient decreases by 1% (the degree of equity in education increases by 1%), the TFP (the quality of our economic growth) will increase by 1.21%.

5. Discussion on the link between equity in education and quality of economic growth

In this paper, empirical results show that the equity in education is significantly positive related to the quality of economic growth, and the former is the Granger reason of the latter. Therefore, equity in education is not only able to promote a harmonious social development, but also promote harmonious economic growth. At present, China's investment in education has shifted its focus to higher education. It is not conducive to the improvement of the quality of economic growth.

The mechanism that equity in education promotes the quality of economic growth is that equity in education improves human capital accumulation, optimizes the structure of human capital, increases the return of education investment, and improves social cohesion. The above effects ultimately reflect on the performance of total factor productivity (Futoshi, 2005). The mechanism is shown in Figure 4.

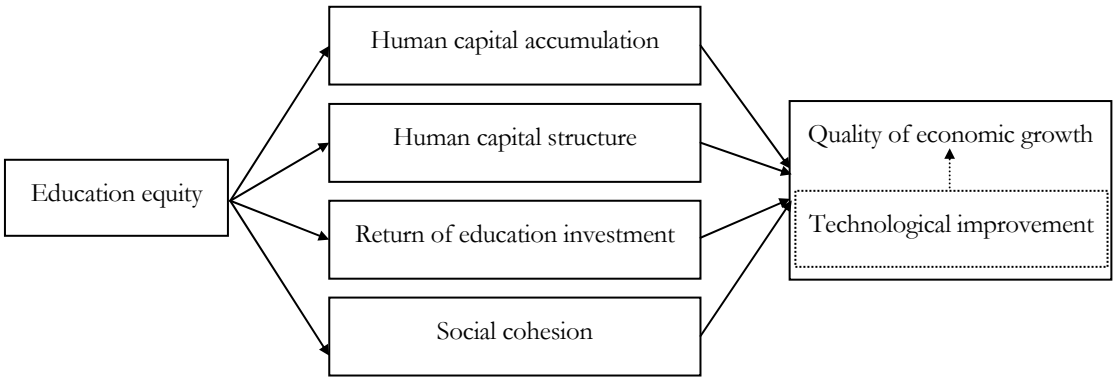

Figure 4. Effect of Equity in education on the Quality of Economic Growth

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First, equity in education can promote human capital accumulation, which is the key contributor to both the quality of economic growth and the rate of economic growth (Romer, 1990). As we all know, fundamental education for one person needs less resources, while higher education needs more. For China, more investment in lower education than that in higher education, will improve equity in education. Therefore, due to the features of different education levels, if the same amount of education investment from the government is given to different education levels, the better equity in education will bring out a greater human capital accumulation which can be expressed by the average years of education for one person. In fact, from the aspect of the level of human capital accumulation, it has been proved that a fairer degree of education in our country will raise the level of human capital accumulation. For example, Liu (2004) carried out research by adopting a Chinese cross-section of data in 2000, and finally proved the idea. It is concluded that because of the better equity in education, accumulation of human capital will be accelerated to raise total factor productivity, in other words, the quality of economic growth will improve.

Second, equity in education can promote human capital structure which is also the key contributor to technological improvement. From the aspect of the structure of human capital, technological improvement includes technology innovation, technology diffusion, technology application, and so on. Only if each of the sessions has sufficient human capital, technological improvement may well improve the quality of economic growth. As a result, technological improvement requires an appropriate allocation of human capital. Because technology innovation needs high-level innovative human capital as the main innovator, and because technology diffusion needs professional human capital as the entity of communication, technology application also requires workers with a certain level of human capital. Due to the lower level of equity in education in China, the level of the latter two types of human capital accumulation is low, and far away from meeting the requests of technology diffusion and technology applications. For the economic growth, the technology diffusion and technology application are critical factors to increase total factor productivity. According to the World Bank, only 10% to 30% of existing scientific and technological achievements in China has been applied to production (Yu, 2007). This is mainly because of our structural imbalance in human capital. The poor structure of human capital in China has seriously hindered the effect of technological improvement to promote the quality of economic growth. And the increasing level of equity in education in China will lead to the

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training of a large number of people who are of much-needed human capital useful for technology diffusion and technology application, and lead to optimize the structure of human capital and eventually to promote the total factor productivity.

Third, equity in education can increase the return of education investment which is another direct measure for the quality of economic growth. Recently, the idea that students who do not pursue college have a low economic rate of return to education, has been challenged. As summarized by Card (1999, 2000), there is consistent evidence from several countries suggesting that the "causal" labor market return to education is at least the same, or quite possibly larger than that for those who received higher education. Even in China, we also usually find that a higher education degree does not bring higher earnings. Many rich people are the ones with lower education. For the whole society, the return of lower education investment is higher than that of higher education investment, especially in China.

The last but not the least, equity in education can improve social cohesion which is the necessary precondition for rapid technological improvement. It is well-accepted that equity in education will improve social cohesion. Furthermore, we want to indicate that social cohesion can accelerate technological improvement. As mentioned above, technological improvement mainly includes technology innovation, technology diffusion and technology application. For technology innovation, social cohesion mainly improves the innovation capability by providing better teamwork spirit; for technology diffusion, social cohesion mainly decreases the difficulty of diffusion by enhancing people's willingness to share their knowledge and wealth; while in technology application, social cohesion mainly increases the possibility of technology application by making the behavior with positive economic externalities more feasible. According to the concept of the quality of economic growth, technology improvement just means the improvement of the quality of economic growth. Therefore, equity in education can improve technological improvement and thus improve the quality of economic growth by improving social cohesion.

6. Conclusion

With more than twenty years' rapid economic growth, China has made great achievements in improving the living and social standards of its people, however, the rate of educational development has not caught up with the rate of economic growth. Both the structure and the regional distribution of education investment are unequal. Inequity in

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education severely restrains the positive effect of education on both social and economic development in China. This paper tries to reveal the natural relationship between equity in education and the quality of economic growth which is practically ignored all along by both the Chinese scholars and the Chinese government. In general this paper provides two great contributions to the research on this topic.

First, according to the research, this paper systematically provides the data of EGC, the key indicator of equity in education, in China from 1978 to 2004 for the first time. Referring to many official statistical sources, e.g. "*China Health Statistics Yearbook2004*", "*People's Republic of China yearbook 2004*", "*China Education Statistics Yearbook2004*", "*China Statistics Yearbook2004*", and "*China Population Statistics Yearbook2004"*, etc., the authors design the computation formula of each population with different educational background and give the final results. Based on the results, the paper further provides the data of EGC in China from 1978 to 2004 which can be referred to conveniently by the other scholars who have interest in such an topic all over the world without hardwork. According to the data of EGC in this paper, to judge impersonally, the equity in education is continually improving, and the improvement is rather obvious compared with the equity in education in 1978, however, the improving speed of equity in education has actually become slower and slower, and there was even a reversed move of equity in education that happened in 2001.

Second, according to the research findings, this paper empirically proves that there is an cause and effect relationship between equity in education and the quality of economic growth. By adopting China's recent 27-year macroeconomic data from 1978 to 2004, respectively the data of EGC which is achieved in this paper and the data of TFP which is mainly referred from the work of Guo & Jia (2004, 2005), the paper carries out the Granger causality test between the equity in education and the quality of economic growth and then establishes a regression model. Results of the empirical study show that the equity in education is significantly related to the quality of economic growth, and the equity in education is the Granger reason of China's economic growth quality. That is to say, besides promoting the social harmony, equity in education has also played a positive role in promoting the quality of economic growth in China, which is a very different conclusion from the current point of view, especially in China. The mechanism that equity in education promotes the quality of economic growth is that equity in education can improve human capital accumulation, optimize the structure of human capital, increase the return of

education investment, and improve social cohesion. All the above effects ultimately reflect on the improvement of TFP. Such a result is of great meaning for both the academic circle and the government, especially the Chinese government. According to such a conclusion, China's present education policies need many adjustments

When interpreting the results obtained in this study, some limitations of the study should be borne in mind. First, the data is a little limited in time duration. Because the official statistical sources before 1978 can not be reached due to the Great Cultural Rvolution in China, the paper only gets 27-year macroeconomic data in this research. To a certain degree, the validity of the cause and effect relationship between equity in education and the quality of economic growth is affected. Second, equity in education in this paper only refers to the year equity in education for the whole population, while the other dimensions of the equity in education, e.g. the equity in education in regional distribution, equity in education in rural-urban distribution, equity in education in race distribution and equity in education in gender distribution, are not considered. Beyond all doubt, such a neglect will affect the comprehensiveness of the research findings. Third, this paper only investigates such an issue in the background of China. More cross-national comparisons should be carried out to investigate whether the research findings still hold or not in many other countries. As a matter of fact, the three limitations does provide the further research questions in this field.

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