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Dynamic Relationship among the Human Capital Distribution, Income Gap and Growth

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Abstract: This study investigates the dynamic relationship among the human capital distribution, income gap and growth momentum by incorporating the distributed lag model into a system of equations and using a panel data set that consists of 30 provinces in China from 1998-2010. The analysis shows that, both instantly and cumulatively, an improvement in the structure of human capital distribution tends to widen the income gap and weaken the growth momentum; narrowing income gap is likely to slightly deteriorate the structure of human capital distribution but strengthen the growth momentum; an enhancement in the growth momentum has a tendency to aggravate the structure of human capital distribution but narrow the income gap. Moreover, combination of the calculation results of the three index, an inverted U-shaped 'Kuznets curve' is detected. Finally, there also are some of other influence factors of the three.

Key words: Structure of human capital distribution, income gap, growth momentum, instant effect, cumulative effect

INTRODUCTION

Since the reform and opening up, China created the "economic growth miracle" that China's economy grew by 9% a year on average and China's GDP ranked second in the world in 2010. However, the contradictions of imbalanced, uncoordinated and unsustainable regional economic development were increasingly deepening at the same time, especially economic development gap between the eastern, central and western regions was widening. It can set regional economic development imbalance for example, in 1980 the ratio of per capita GDP in the eastern, central and western regions was 1.87:1.23:1, in 2010 this ratio rose to 2.52:1.13:1. In addition, the income gap between the urban and rural has been widening since 1990s which the ratio of urban and rural residents' per capita disposable income in China in 1978 was 2.57, in 2010 the ratio rose to 3.23. During this period, Chinese government and academic community launched extensive discussions so as to find a way to narrow the development gap in regions and the income gap between the urban and rural (Ming *et al.*, 2005; Shaoping and Zhigang, 2008; Binkai *et al.*, 2010). The majority of people believed that the key of solutions that solved the contradiction of regional economic development and narrowed income gap was human capital and education. They also found out many empirical relationships between the human capital, income gap and growth (Zhongchang and Hongqi, 2011) but they seldom researched on the dynamic relationship among the human capital distribution, income gap and growth. After a lot of research, the researchers almost agreed to these views

that education was helpful to promote growth and enhance the level of human capital. Therefore, in the background of unprecedented expansion of China's education, what was impact of education on the structure of human capital distribution in the area? What the dynamic relationship among the human capital distribution, income gap and growth momentum in the short term and the long term? The answers to these questions can not only enrich the theory about macroeconomics structure of human capital, the income gap relationship and economic growth but also enrich the inclusive growth theory. All the answers also have important practical meaning to fully complete the great goal of a well-off society in an all-round way, deepen economic reform especially the reform of the education system.

LITERATURE REVIEW

In the past two decades, the relationship between the structure of human capital, the income gap and economic growth in the world set off a boom once again but the literature which is concerning about the three intrinsic relationship and mechanism is rare. It should be pointed out that the structure of human capital includes the physical capital, intelligence capital and moral capital and the level of education is an important manifestation of the level of intelligence capital. In the process of the study of macroeconomic issues, the measurement methods of the structure of human capital is often used to years of education because of limiting data available; then education structure and the structure of human capital,

human capital and education often are synonyms. In order to promote growth and narrow the income gap, the researchers explored the influence mechanism of growth on the perspective of the causes of the income gap and the influence on the investment in human capital, i.e., income gap → growth, investment in human capital → growth (Galor and Tsiddon, 1997; Fishman and Simhon, 2002; De La Croix and Doepke, 2003). Galor and Moav (2004) found that the enlargement of income gap was helpful to the accumulation of material capital and promote growth because the accumulation of material capital was more significant to promote growth than the accumulation of human capital in the early period of economic development; human capital gradually played a leading role in growth in the middle and later period of economic development, the enlargement of inequality would hinder growth because of restricting the level of investment in human capital of low-income. Learnt from Barro (2000) and Lundberg and Squire (2003) research results and ideas, Ming *et al.* (2005) incorporated distribution-lag model into a system of equations to study the dynamic change of the nexus of inequality, investment, education and growth in China and they found that the cumulative effect of inequality on growth was always negative. As we can see from the research literatures, there are few research literatures on the nexus of the structure of human capital distribution, income gap and growth, i.e., growth → the structure of human capital distribution → income gap, the structure of human capital distribution → growth → income gap, so it is necessity to investigates the dynamic relationship among the human capital distribution, income gap and growth momentum.

On the other hand, the traditional quantitative index to a great extent does not meet the needs of the research (Hsieh and Klenow, 2009). Selecting and using structured index is gradually becoming a trend in the process of empirical research, for example, the Gini coefficient, Theil index are widely used in the structure of human capital distribution, income gap, the structure of industry and other fields (Barro and Lee, 2001; Gregorio and Lee, 2002; Shi and Chuliang, 2011). This study tries to choose growth momentum to stand for growth in China that is a extremely unbalanced development in regional economic and big nation because it can better reflect the difference of growth in regions and grasp the development trend of regional economic than other index such as GDP, the per capita GDP, GDP growth rate and so on.

VARIABLE AND MODEL

Variable and data description: China's according to the literature review and the need of this paper, the study mainly choose the following structured index.

EINEQ stands for the structure of human capital distribution which use the education Gini coefficient to reflect the structure of region education and inequality of education distribution, the computation formula is as follows:

$$EINEQ = \frac{\sum_{i=2}^{n} \sum_{j=1}^{i-1} p_i |y_i - y_j| p_j}{\left| \sum_{i=1}^{n} p_i y_i \right|}$$

where, p_i, p_j is a proportion of the population by certain education, y_i, y_j represents years of different education level, n is group number by education. In the study n is five which divided into illiteracy (0 years), primary school (6 years), middle school (9 years), high school and secondary school (12 years), junior college and above (16 years) by the level of education and the actual situation of statistics in China.

AYS stands for the average length of education which in a sense also reflects the level of human capital in the region; the computation formula is as follows:

$$AYS = \sum_{i=1}^{n} p_i y_i$$

Referring to the meaning of the letters is the same as EINEQ.

INEQ stands for income gap which use the Taylor index to reflect the structure of income in urban and rural and income inequality; the computation formula is as follows:

$$INEQ = \sum_{i=1}^{n} w_i Ln \frac{w_i}{p_i}$$

where, w_i is the proportion of the i group of residents' income in gross income of residents, is the proportion of the population of the i group of residents which use nonagricultural population, agricultural population instead of town population, rural population.

AGGR stands for growth momentum which is the growth rate of per capita GDP.

EINEQL, INEQL and AGGRL respectively stand for the cumulative effect of the structure of human capital distribution, income gap and growth momentum which mainly use to find that they have cumulative effect on the structure of human capital distribution, income gap and growth momentum in the long run.

GEDIN stands for the intensity of government investment in education which is education expenditure accounted for the proportion of the GDP.

PEDIN stands for investment intensity of human capital in urban and rural that uses to measure differences of investment in human capital between citizens and rural residents.

PGR stands for population growth rate that is a rate of annual natural population growth.

INGR is that the ratio of income growth in urban is to the ratio of income growth in rural which can effectively measure differences of income growth between citizens and rural residents.

UR stands for the rate of urbanization that is the proportion of nonagricultural population. GR stands for the rate of GDP growth. INVT stands for the intensity of material capital investment that is the total amount of annual material capital investment accounted for the proportion of the GDP. WEST stands for western region in China including Inner Mongolia, Shanxi, Gansu, Ningxia, Qinghai, Xinjiang, Sichuan, Chongqing, Guangxi, Yunnan and Guizhou.

CENTR stands for central region in China including Hei Longjiang, Jilin, Henan, Shanxi, Anhui, Jiangxi, Hubei and Hunan; and WEST and CENTR are dummy variables. In order to avoid the influence of the system reform during the period of transformation in China and overcome the possible defects of multinational data, this study uses a panel data set that consists of 30 provinces in China from 1998 to 2010 and the basic data comes from China statistical yearbook and the population of China statistical yearbook in 1999 to 2011.

Model: Learn from Barro (2000) and Gregorio and Lee (2002) on education, income gap and economic growth theory analytical framework, this study gives the distribution-lag model into a system of equations which focused on the impact of change of the structure of human capital distribution, income gap and growth momentum in instant and long-term. In fact, in the study there are six groups of relations will be investigated which mainly includes the structure of human capital distribution on income gap, the structure of human capital distribution on growth momentum, income gap on the structure of human capital distribution, income gap on growth momentum, growth momentum on the structure of human capital distribution, growth momentum on income gap. The model is following:

$$EINEQ = f_1(AGGR, AGGRL, INEQ, INEQL, AYS, GEDIN, \quad PEDIN, INGR, UR, WEST, CENTR \quad (1)$$

$$INEQ = f_2(EINEQ, EINEQL, AGGR, AGGRL, AYS, EDIN, \quad PEDIN, INGR, UR, GR, WEST, CENTR) \quad (2)$$

$$AGGR = f_3(EINEQ, EINEQL, INEQ, INEQL, INVT, AYS, \quad GEDIN, PEDIN, INGR, UR, WEST, CENTR) \quad (3)$$

In the above formula, the distribution-lag model is as follow:

$$Y_t = a + \sum_{i=0}^{\infty} \beta_i X_{t-i} + et \quad (4)$$

where, β_i is that X has effect on Y lag phase i, in other words, X has instant effect on Y in the ith year. If β_i is following:

$$\beta i = \sum_{j=2}^{n} \frac{b_j}{(i+1)}, i = 0, \wedge, \infty \quad (5)$$

where, b_j is parameter needing to estimate, then Y_t is below equation:

$$Y_t = a + b_2 \left| X_t + \frac{1}{4}x_{t-1} + \frac{1}{9}X_{t-2} + \wedge + \frac{1}{t^2}X_1 \right|$$
$$+ b_3 \left| X_t + \frac{1}{2^3}X_{t-1} + \frac{1}{3^3}X_{t-2} + \wedge + \frac{1}{t^3}X_1 \right| \quad (6)$$
$$+ \wedge b_n \left| X_t + \frac{1}{2^n}X_{t-1} + \frac{1}{3^n}X_{t-2} + \wedge \frac{1}{t^3}X_1 \right|$$

As can be seen from the equation, if it makes sure any n value of a polynomial order number, it can estimate a series of $b_j (i = 1, \Lambda, n)$. And if it makes sure the model set, it can calculate instant effect of X on Y in the ith year by equation β_i Finally, it can obtain the cumulative effect of X on Y by the year of β_i in turn accumulation. The cumulative effect of X on Y is as follow:

$$SUM \beta_i = \sum_{i=0}^{\infty} \sum_{j=2}^{n} \frac{b_j}{(i+1)^i} \quad (7)$$

ESTIMATION RESULTS AND EMPIRICAL ANALYSIS

Estimation results: The three-stage least squares estimation results for equations (1-3) are presented in Table 1 by the software of Stata 12.0. While determining the optimal polynomial order, it is noticed that there exists some linear relationship among the lags of different order. For example, the fifth lag goes away from the regression when it increases n to 6. It then sets n = 5 as our benchmark and discard those lags which are not statistically significant until the highest order is significant at 10% level. Based on this criterion, the study ends up with n = 5 for the growth momentum in equation (1), n = 3 for the structure of human capital distribution in Eq. 2, n = 5 for the structure of human capital distribution and n = 2 for income gap in Eq. 3.

The nexus of human capital distribution structure, inequality and growth momentum: The study first

Table 1: Human capital distribution, income gap and growth momentum

Independent variable	Dependent variable					
	(1)		(2)		(3)	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
EINEQ (n = 2)			0.7296	0.515	-17.7775	0.002
EINEQ (n = 3)			-2.5404	0.067	155.3696	0.004
EINEQ (n = 4)					-356.4875	0.007
EINEQ (n = 5)					220.0585	0.008
INEQ (n = 2)					-0.1686	0.006
AGGR (n = 2)	4.4477	0.008				
AGGR (n = 3)	-29.0727	0.023				
AGGR (n = 4)	56.0524	0.040				
AGGR (n = 5)	-31.2922	0.052				
AYS	-0.0550	0.000	-0.1711	0.000	0.0454	0.004
GEDIN	0.4257	0.055	3.0021	0.003	-0.0055	0.995
PEDIN	-0.0014	0.413	0.0131	0.060	0.0082	0.110
INGR	-0.0034	0.428	-0.0042	0.811	-0.0037	0.764
UR	0.2173	0.000			-0.5145	0.000
GR			0.0060	0.987		
INVT					0.0727	0.090
PGR					-2.6408	0.344
WEST	0.0031	0.661	0.0761	0.008	0.0311	0.140
CENT	0.0010	0.861	0.5359	0.013	0.0138	0.408
_cons	0.5533	0.000	2.0562	0.000	-0.1846	0.254

Note: Coef: Correlation coefficient. p>OzOstands for significant level

calculates the direct pairwise correlation of the structure of human capital distribution, income gap and growth momentum according to the coefficient estimates in Table 1 and then obtains the indirect correlation by using the coefficients in the equation system. The total correlation is the sum of the direct and the indirect one.

Figure 1 describes the impact of the structure of human capital distribution on income gap. The structure of human capital distribution has a strong negative effect on income gap instantly; this effect is weakened gradually and becomes weakly positive. In the long run, the cumulative effect of human capital distribution structure on income gap is negative, in other words, an improvement in the structure of human capital distribution tends to widen the income gap.

Figure 2 describes the impact of the structure of human capital distribution on growth momentum. The structure of human capital distribution has a strong positive effect on income gap instantly; this effect turns to be negative and then turns to be positive, finally falls down gradually until weakly negative. In the long run, the cumulative effect of human capital distribution structure on growth momentum is positive, in other words, an improvement in the structure of human capital distribution tends to weaken the growth momentum. In fact, the nexus of the structure of human capital distribution on growth momentum that the study finds is similar with Barro and Lee (2001).

Figure 3 describes the impact of income gap on the structure of human capital distribution. The income gap has a strong negative effect on the structure of human
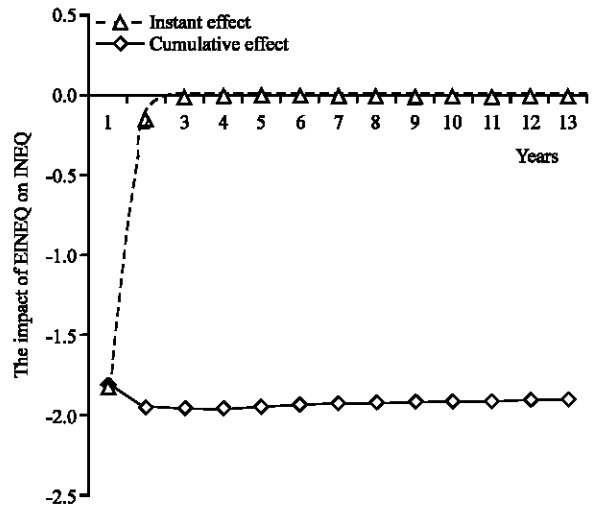

Fig. 1: Total nexus of EINEQ on INEQ

capital distribution instantly; this effect is weakened gradually and becomes weakly positive. In the long run, the cumulative effect of income gap on the structure of human capital distribution is negative, in other words, narrowing income gap is likely to slightly deteriorate the structure of human capital distribution.

Figure 4 describes the impact of the income gap on growth momentum. The income gap has a strong negative effect on growth momentum instantly; this effect is weakened gradually. In the long run, the cumulative effect of the income gap on growth momentum is negative, in other words, narrowing income gap is likely to strengthen
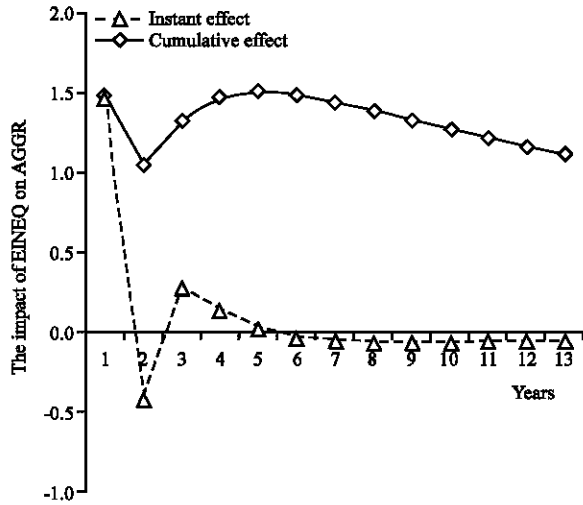
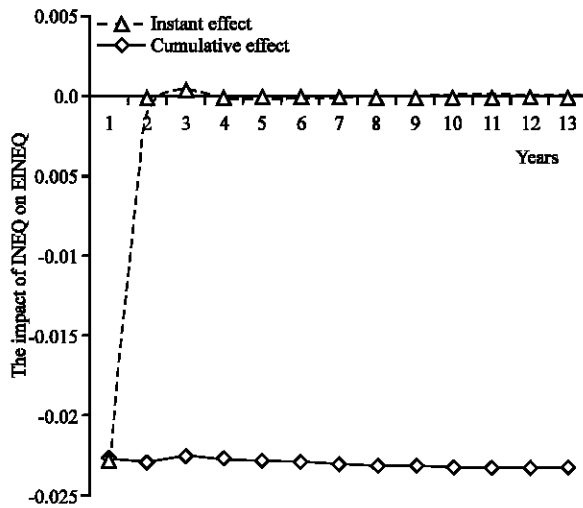Fig. 2: Total nexus of EINEQ on AGGR

Fig. 4: Total nexus of INEQ on AGGR

Fig. 3: Total nexus of INEQ on EINEQ

Fig. 5: Total nexus of AGGR on EINEQ

the growth momentum. In fact, the nexus of the income gap on growth momentum that the study finds is similar with Galor and Moav (2004).

Figure 5 describes the impact of growth momentum on the structure of human capital distribution. The growth momentum has a strong positive effect on the structure of human capital distribution instantly; this effect turns to be negative and then turns to be positive, finally falls down gradually until weakly positive. In the long run, the cumulative effect of growth momentum on the structure of human capital distribution is positive, in other words, an enhancement in the growth momentum has a tendency to aggravate the structure of human capital distribution.

Figure 6 describes the impact of the growth momentum on income gap. The growth momentum has a
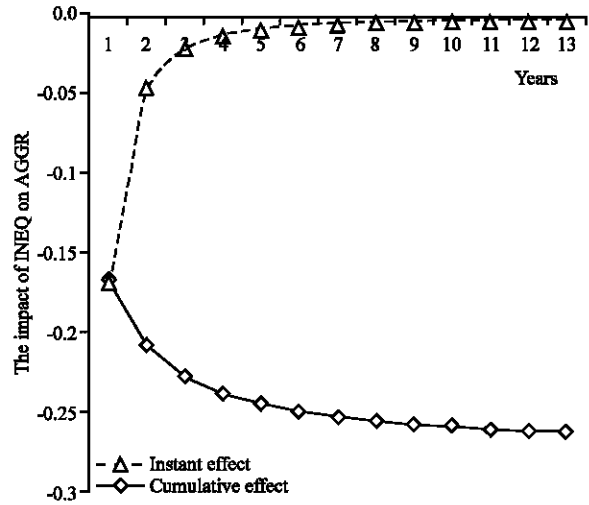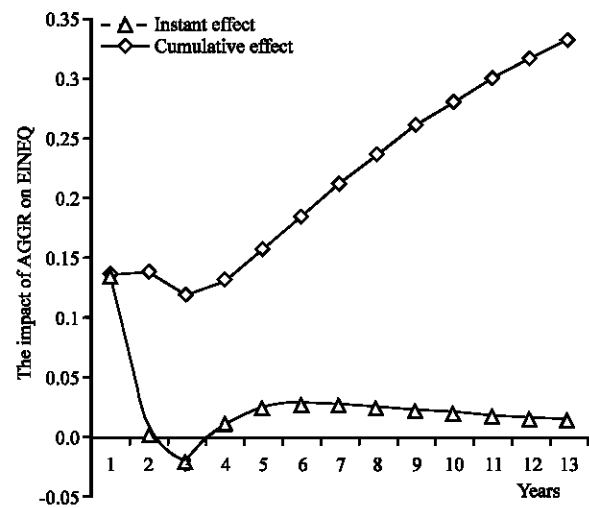
strong negative effect on income gap instantly; this effect is weakened gradually. In the long run, the cumulative effect of the growth momentum on income gap is negative, in other words, an enhancement in the growth momentum has a tendency to narrow the income gap.

It should be pointed out that the relationship among the structure of human capital distribution, income gap and growth momentum in the instant and the long run is consistent with the statistic results of the three. As can be seen from the statistic results of the structure of human capital distribution, income gap and growth momentum, growth momentum in developed regions such as Shanghai and Beijing, is obviously lower than growth momentum in backward regions such as Inner Mongolia and Guangxi. It may be helpful to alleviate or even
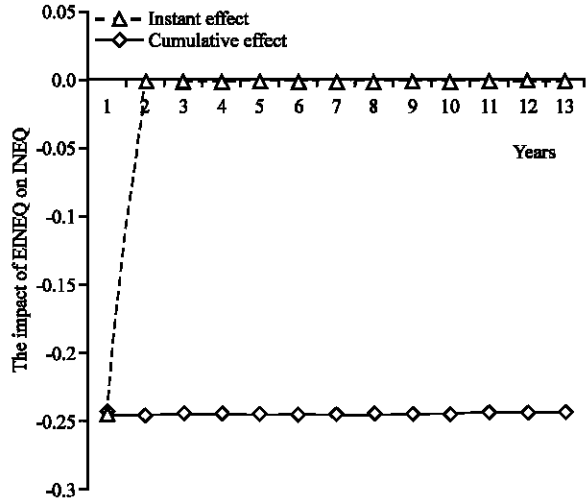
Fig. 6: Total nexus of AGGR on INEQ

Table 2: The significant test of human capital distribution, income gap and growth momentum

Equation	Obs	Parms	RMSE	"R-sq"	χ^2	P
1	150	12	0.0231	0.5893	301.94	0.0000
2	150	12	0.0957	0.7426	509.94	0.0000
3	150	14	0.0627	0.2910	80.73	0.0000

Obs: No. of observation in the model. Due to cutting eight years of data in the process of the actual estimation; the number of observation is 150. Parms: No. of params. RMSE: Square root of the variance as the standard error

Table 3: The significant test of f human capital distribution, income gap and GDP growth rate

Equation	Obs	Parms	RMSE	"R-sq"	χ^2	P
1	150	12	0.0179	0.4193	215.35	0.0000
2	150	12	0.0846	0.6617	428.51	0.0000
3	150	14	0.0036	0.1954	26.69	0.0000

Obs: No. of observation in the model. Due to cutting eight years of data in the process of the actual estimation; the number of observation is 150. Parms: No. of params. RMSE: Square root of the variance as the standard error

eliminate an imbalance of regional development; the structure of human capital distribution and income gap in economic developed regions shows decline trend year by year. This phenomenon reflects that economic development in the process of transition from lower stage to higher stage in regions, the structure of human capital distribution gradually become irrational and income gap gradually become widening; when in middle and even higher stage of economic development in regions, the structure of human capital distribution will tend to rationalization and income gap will be narrowed. Furthermore, there exists inverted U-shaped "Kuznets curve" between the level of economic development and the structure of human capital distribution and income gap, it can not make sure whether there exists U-shaped "Kuznets curve" between the level of economic development and growth momentum.

The other influence factors of the three: It can be deduced the following conclusions from Table 1. Firstly, the average length of education has obviously positive effect on the structure of human capital distribution, income gap and growth momentum. Secondly, the intensity of government education investment has obviously negative effect on human capital distribution structure, income gap and growth momentum. Thirdly, the intensity of material capital investment has obviously positive effect on growth momentum. The fourth, the ratio of income growth in urban has obviously positive effect on income gap. The fifth, urbanization rate has obviously negative effect on the structure of human capital distribution and growth momentum. The sixth, investment intensity of human capital in urban and rural has few

effects on the structure of human capital distribution, income gap and growth momentum. Besides, population growth rate has few positive effects on growth momentum, it shows that population structure has fundamentally changed, demographic dividend has declined and Lewis turning point has came (Cai, 2010). That the population growth rate appropriately increases will help to improve growth at the time. In Eq. 1-3, the coefficient of CENTR and WEST are positive but not significant in Eq. 1 and 3. It shows that the inequality in central and western region are more serious unfair than in the eastern region in China.

Significant test: The results of significant test of the equations are shown in Table 2. As can be seen from Table 2, Eq. 1-3 all pass the test of significance. In order to verify the validity of the growth rate of per capita GDP index, the study use the GDP growth rate instead of growth momentum for comparison study in the same way; and the results of significant test are shown in Table 3. It can see from Table 3, "R-sq" of Eq. 3 is only 0.1954 which do not obviously pass the test of significance. Moreover, "R-sq" of Eq. 2 and 3 in the table 3 is lower than Table 2. In the other words, the result of the study which selects the indexes in this study is more effective.

CONCLUSION AND SUGGESTIONS

From the study investigates the dynamic relationship among the human capital distribution, income gap and growth momentum by incorporating the distributed lag model into a system of equations and using a panel data set that consists of 30 provinces in China from 1998-2010. The study finds that there is a significant direct

correlation and indirect correlation among the human capital distribution, income gap and growth momentum. The total correlation is the sum of the direct and the indirect one. After that, The study finds there exist three group total correlations both instantly and cumulatively, an improvement in the structure of human capital distribution tends to widen the income gap and weaken the growth momentum; narrowing income gap is likely to slightly deteriorate the structure of human capital distribution but strengthen the growth momentum; an enhancement in the growth momentum has a tendency to aggravate the structure of human capital distribution but narrow the income gap. Combined with the calculation results of the three index, the study also finds that there exists inverted U-shaped "Kuznets curve" between the level of economic development and the structure of human capital distribution and income gap, it can not make sure whether there exists U-shaped "Kuznets curve" between the level of economic development and growth momentum.

As can be seen from the results of this study, the study thinks that there are at least three of the policy suggestions for the current development of China. Firstly, government should continue to increase investment in human capital investment and physical capital. At the same time, it also should pay attention to the match and balance both in quantity and structure so as to constantly improve the coupling efficiency of human capital and physical capital and enhance regional economic growth potential (HCRRG, 2012). Secondly, it should accelerate the process of equalization of basic public services reform in order to build a harmonious society and achieve inclusive growth. Meanwhile, it should also unswervingly consolidate basic education and vocational education and improve the quality of higher education to enhance the average years of schooling and per capita level of output, optimize the structure of human capital distribution, narrow the income gap between urban and rural areas and promote growth. In addition, it should strengthen the exchanges and cooperation among the eastern region, central region and western region.

There are three issues that need to explain in the process of the research. Firstly, the effects of each items reform on statistics data can not be ignored when the Chinese economic system reform did not stop during this period because this paper uses a panel data set that consists of 30 provinces in China from 1998-2010 which can effectively reduce the fluctuations due to system changes and overcome the defect that the transnational data may exist. Secondly, the requirement of the data sample is not only smooth but also a longer time span in

the process of in-depth study of the dynamic change of the nexus among the human capital distribution, income gap and growth momentum because the effect of human capital on growth in different stages of economic development is quite different and there is a time lag of human capital on growth. Thirdly, the measuring results of the selected structural index in the study will inevitably be a deviation because of the distortion of the original data caused by changing statistical methods, incompletely collecting data and other reasons, for example, the value of income gap in the paper is significantly lower than Shi and Chuliang (2011) estimated value. Thus, the conclusions drew from empirical analysis that is whether better to reveal the dynamic relationship among the human capital distribution, income gap and growth momentum still need further confirmation.

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