Human Capital, Innovation Capacity and Quality of Economic Growth-Based on Chinese Provincial Panel Data from 2000 to 2013

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Abstract- This paper took 30 Chinese provinces, autonomous regions and municipalities directly under the central government as sample and used the provincial panel data from 2000 to 2013, constructed a static and dynamic panel data model, analyzed the relationship among human capital, innovation and the quality of economic growth and came to a conclusion that: ① the first-order lag item of quality of economic growth, the human capital of bachelor degree or above education, innovation, urbanization and industrial structure are positively correlated with the quality of economic growth ② however, the human capital of post-secondary education and marketization are not effective predictor of quality of economic growth in China. Therefore, to positively promote the quality of economic growth in China, duly attention should be paid to human capital investment, innovation promotion, urbanization advancement as well as adjustment of industrial structure.

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HUMANCAPITALINNOVATIONCAPACITYANDQUALITYOFECONOMICGROWTH−BASEDONCHINESEPROVINCIALPANELDATAFROM2000TO2013

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I. Introduction

Since the 21st century, with the rapid development of its economy, China has become the world's second biggest economy, measured by GDP: from 9921.46 billion RMB in 2000 to 56884.52 billion RMB in 2013, an average annual increase of 13.29%. Such rapid growth miracle has grabbed attention of domestic and international economic circles: why does China's economic growth constantly stay at a high level? What are the driving forces of China's economy growth rate? These questions are academic focus for scholars. Moreover, China showed a strong recovery power during the global financial crisis in 2008, and since then many scholars began to summarize the experiences of China's success, among which China Model, Three Carriages and so on came into being.

Meanwhile, many natural disasters, one after another, have gradually become common phenomenon in Chinese society, such as haze, debris flow and soon. The primary reason is that, for the sake of economic

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development, the original ecological balance is broken, which causes the wasting of resources and ecological environment deterioration. Meadows et all (1972) [1] discussed the consequences of seeking economic growth. They not only focused upon population-food-crisis but also paid close attention to resource depletion and environmental deterioration caused by exponent increase of the economy. This unsustainable development pattern has aroused the concern of the central government, and it has become a social consensus that we should promote industrial upgrading by transforming mode of development and adjusting industrial structure. How to make sustainable development come true and ensure both economic growth and ecological civilization construction? The answer is that great importance should be attached to the quality concept of economic growth instead of the quantity concept of economic growth. Chao Xiaojing and Ren Baoping (2008)[2] pointed out that economic growth involves both the quality and the quantity of economic growth, the latter being not an aim but a tool for the benefit of humanity and the former being the root of development. In the historical development of theory of economic growth, how to realize economic quantity expansion has always been the central issue and improving the quality of economic growth has always been ignored. Kama Aliyev (1983) [3] maintains that it is insufficient to evaluate economic growth from the perspective of quantity, the cost of economic growth should be taken into consideration, and efficiency of resource usage directly influences the improvement of the quality of economic growth. Therefore, at the present stage, since the quantity of economic growth, such as GDP, national income and so on, should not be our sole focus, our focus should be shifted from quantity to quality, and only in doing so can a resource conservation and environment friendly society be built. This paper, in this context, tries to hold a discussion about the quality of China's economic growth and aims to discover connected factors that influence the quality of China's economy.

With the review of literature, there are mainly ways to define the quality of economic growth: a narrow sense and a broad sense. In a narrow sense, the quality of economic growth is the efficiency of economic growth

(Karamayev, 1983; Liu Yajian, 2002; Zhao Yingcai & Zhang Chunhong, 2004). Liu Yajian (2002) [4] holds that the economic growth rate can only reflect the changes in total of economic growth, and the quality can be understood as a synonym for efficiency. Efficiency means the amount of surplus products included in per unit economic growth. The less input of funds and materials in unit economic growth rate means the higher quality of economic growth. In a broad sense, the quality of economic growth is opposite to the quantity of economic growth, so the former falls into the normative value judgment and possess rich connotation. (Barro, 2002; Liu Shucheng, 2007).Barro (2005) [5] deems the quality of economic growth as factors, such as society that is closely related to economic growth, politics, religion and so on, which include degree of education, life expectancy, health condition, the degree of development of law and order, income inequality and so on. Liu Shucheng (2007) [6], in a broad sense, defines the quality of economic growth and holds that promoting the quality of economic growth means continuously improving the stability of economic growth, the sustainability of economic growth mode, the harmony of economic growth structure and the concordance of economic growth benefit. This paper, aiming to do researches, tends to define the quality of economic growth in a broad sense.

The consensus has been achieved that the economic transformation is urgently needed and the pursuit of quality of economic growth should be the focus to keep the stable, rapid economic growth in China. The core of the problem lies in finding the factors influencing the quality of economic growth. Many scholars, from perspectives of their own researches, have made valuable conclusions. Barro (2002) [7] studied the determinant factors of the quality of economy growth using transnational data and concluded that there is a close relationship between factors, such as health conditions, productivity, income distribution, political system, criminal behavior, religious belief etc., and the quality of economic growth. Dai Wutang (2003) [8] pointed out that factors, which can influence the quality of economic growth, mainly include labor productivity, economic benefit, employment rate, quality and level of household consumption and reasonable degree of income inequality. From the angle of productivity, Liu Jianya (2002) [9] analyzed factors that influence the quality of economic growth in China and concluded that scientific and technological competitiveness is of vital importance, but the low education investment makes it very difficult to improve the quality of economic growth. Hong Yingfang (2002) [10] theoretically studied the influence of human resource on the quality of economic growth and believed that human resource development can activate people's creativity and vitality and is the basic impetus for the highly efficient and sustainable economic growth;

human resource development can maximize all the factors of objects in their effective form, thus greatly improving economic effectiveness; human resource development plays a fundamental role in improving quality of enterprise. Liu Haiying, Zhao Yingcai and Zhang Chunhong (2004) [11] analyzed the influence of Chinese human capital on the quality of economic growth and believed that economic growth dependent on technological progress is of high quality and, at the same time, sustainable. Shi Zili (2013) [12] chose Central Plains economic region as the research sample, took 1991-2010 as the time period, with the establishment of VAR model, conducted an empirical analysis of the mutual effect between the quality of economic growth represented by Central Plains economic region and multilayered innovation ability (including innovation investment intensity, innovation of human capital and the ability of institutional innovation). The research finding shows: in the short run, the ability of institutional innovation can significantly improve the quality of regional economic growth; in the long run, the increase of innovation investment intensity and innovation of human capital can significantly improve the quality of regional economic growth. Chao Xiaojing and Ren Baoping (2008) [13], on the basis of the data from 1979 to 2004 in China, conducted an empirical analysis of the relationship between economic transformation and the quality of economic growth and studied the influence of economic transformation on the quality of economic transformation. They concluded that there is a positive correlation between the marketization rate, industrialization rate, urbanization rate and the quality of economic growth. He Qiang (2014) [14], basing on Lucus' classical economic growth theory framework and random heterogeneous boundary panel data models, using the sample data of 31 provinces from 1997 to 2011 in China, conducted an empirical analysis of the factors that can influence the quality of economic growth in China and concluded that physical capital, labor force and human capital accumulation played an important role during the sample period in the improvement of economic growth in China, and furthermore, the growth elasticity of labor force and human resources is greater.

Given the studies of factors influencing the quality of economic growth made by scholars mentioned above, it can be found that there is still big research gap in this field. First, in current researches when scholars studied quality factors of economic growth there are two key variables: people and scientific innovation; however, at the same time, there are other two variables that are rarely analyzed with quality factors of economic growth, which needs to be strengthened. Second, scholars chose a comparatively longer period to study the quality of economic growth in China; however, specifically speaking, it was not until the 21st century that the attention was paid to the quality of

economic growth in China. As a result, it is advisable to choose data from the beginning of the 21st century.

To better understand the influencing factors of quality of economic growth, this paper, making use of 30 provinces, autonomous regions and municipalities directly under the central government and provincial panel data from 2000 to 2013 to construct a panel data model which combines the static state and dynamic state, put both human capital and innovation ability into the model, analyzed the relationship between them and the quality of economic growth, and finally proposed some policy suggestions according to the conclusion.

II. Methodology

a) Model for empirical study

To intuitively reflect the relationship between the quality of economic growth and human capital, innovation ability, this paper constructed a basic model:

$$G_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 P_{it} + \beta_3 B_{it} + u_i + \varepsilon_{it} \quad (1)$$

In this equation, i stands for region, t for year, G for the quality of economic growth, P and B respectively for human capital with post-secondary education and bachelor degree or above education, I for innovation ability, u_i for unobservable individual fixed effect and ε_{it} for the random error.

Moreover, to discuss factors influencing the quality of economic growth from higher level with references to previous research findings, we think the social context of the current stage in China should be considered in order to study the quality of economic growth in China. China is vigorously promoting the construction of new model urbanization, which influences the economic trends of China. Zhou Minliang (2013) [15] pointed out that only sticking to new model urbanization can contribute to healthy Chinese economic development. Second, China's economic development should be considered. At this stage China's economic growth has two most distinctive features: the adjustment of industrial structure and the deepening marketization. The industrial structure is transforming and tends to be more rational and advanced. Meanwhile, marketization makes production elements flow from the low productivity sectors to the higher productivity sectors, thus improving the social productivity, which is beneficial to improving the quality of economic growth. Therefore, this paper added some control variables to the model: urbanization level (U), marketization (M) and industrial structure (Is). Finally, the equation becomes:

$$G_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 P_{it} + \beta_3 B_{it} + \beta_4 U_{it} + \beta_5 M_{it} + \beta_6 Is_{it} + u_i + \varepsilon_{it} \quad (2)$$

b) Data Sources

We selected six variables in this study: the quality of economic growth, human capital, innovation ability, urbanization, marketization and industrial structure. Here the quality of economic growth is represented by the index of the quality of economic growth and the data come from 2014 quality report of China's economic growth; there are comparatively more categories of human capital variables, for example, Ding Donghong (1999) et al., according to forms of human capital productivity, divided human capital into two types: the same quality type human capital and the heterogeneous medium type human capital; Liu Zhiyong et al. (2008) [16] used average span of elementary education, secondary education and higher education to stand for different human capitals. This paper, having compared previous researches and availability of data, at last decided to choose post-secondary education and bachelor degree or above education to stand for different human capitals, and the data come from Statistical Yearbook of each province and China's Population and Employment Statistics Yearbook over the years; innovation ability is manifested in two ways: first, fees invested in innovation activities are used to show innovation ability, such as educational expense, the proportion of scientific and technological investment in local finance; second, innovation putout is used to show innovation ability. We chose the number of patents per research personnel to stand for innovation ability in

this paper, and the data come from Statistical Yearbook of each province and China statistical yearbook on science and technology over the years; as for the urbanization variable, this paper used the proportion of urban population in total population, and the data come from Statistical Yearbook of each province and China Compendium of Statistics over the years; this paper referred to Fan Gang (2011) [17] et al. and used marketization index to show the marketization variables, and the data come from China's marketization index: 2013 report of regional marketization processes; The proportion of the third industry output value in GDP is used to measure industry structure variable, and the data come from Statistical Yearbook of each province and China Compendium of Statistics over the years. The information of 6 variables is shown in table 1.

Table 1 : Definitions of variables and data sources

Variable	Name	Operational Definition/ Proxy Variable	Data Sources	Dimension
Explained variables	Quality of economy growth	Index of the quality of economic growth	2014 quality report of China's economic growth	null
Classical Explanatory variables	Human Capital	Education	Statistical Yearbook of each province; China's Population and Employment Statistics Yearbook	post-secondary education; bachelor degree or above education
	Innovation ability	Patents per research personnel	Statistical Yearbook of each province; China statistical yearbook on science and technology	null
Explanatory variables to be tested	Urbanization	Proportion of urban population in total population	Statistical Yearbook of each province; China Compendium of Statistics	null
	Marketization	Marketization index	China's marketization index: 2013 report of regional marketization processes	null
	Industrial structure	proportion of the third industry output value in GDP		null

III. Result

To better observe the influence of above-mentioned factors on the quality of economic growth, static panel regression analysis was taken. And then we also took a regression analysis with generalized method of moments (GMM) to improve the effectiveness of the parameters.

a) Results of static panel regression analysis

We conducted static panel regression analysis with fixed effect model and the resultis listed in table 2 as below. From table 2, we can see that: in the regression analysis with three predictive variables (human capital, innovation ability), one dimension of human capital (bachelor degree or above education) and innovation ability are positively correlated with the quality of economic growth, but not the other dimension of human capital (post-secondary education). In the regression analysis with six variables, four variables (bachelor degree or above education, innovation ability, urbanization and industrial structure) are positively correlated with the quality of economic growth, while the two variables (human capital of post-secondary education and marketization) are not significantly correlated.

Table 2 : Result of static panel regression analysis

Predictive variable	Model 1	Model 2
Constant term	-0.85	-7.27
Human capital of Post-secondary education	0.14	0.05
Human capital of Bachelor degree or above education	0.23**	0.11**
Innovation ability	0.61***	0.19**
Urbanization		0.14*
Marketization		0.21
Industrial Structure		0.002**
Sample Size	330	330
R²	0.61	0.68

Note: the result is from the processed by software Stata16.0. *, **, *** respectively stand for the significant level of 0.0 1, 0.05 and 0.1, the same below

b) Results of regression analysis withgeneralized method of moments

Economic growth is a dynamic process. The quality of economic growth of the current period will be influenced and succeeded by that of the former period. So, this paper chose the first-order lag item as the control variable and put it into the model to conduct a dynamic study. But it is possible that by doing so would lead to a correlation between the lagged variable and the random disturbance term. Besides, the model may have the cross section dependency, i.e., the endogenous problem. To solve this problem, this paper

employed generalized method of moments (GMM) to improve the fixed effect model, thus improving the effectiveness and consistency of the result. The result can be seen from table 3.

Table 3 : Result of regression analysis with GMM

Predictive variable	Model 1	Model 2
Constant term	1.01	-1.64
The first-order lag item of the quality of economic growth	0.62***	0.45***
Human capital of Post-secondary education	-0.24	-0.15
Human capital of Bachelor degree or above education	0.22*	0.28**
Innovation ability	0.24*	0.07*
Urbanization		0.05*
Marketization		0.25
Industrial Structure		0.07*
Sample Size	300	300
Sargan	81.67	134.2

From table 3, we found that in the regression analysis with four predictive variables (first-order lag item of the quality of economic growth, human capital and innovation ability), the first-order lag item of the quality of economic growth, human capital and innovation ability are positively correlated with the quality of economic growth, but not the human capital of post-secondary education. In the regression analysis with seven variables, four variables (the first-order lag item of the quality of economic growth, human capital of bachelor degree or above education, innovation ability, urbanization and industrial structure) are positively correlated with the quality of economic growth, but not the human capital of post-secondary education and marketization.

The model is robust because the significance of main variables does not change in the regression results with static fixed effect model and the dynamic GMM.

IV. Discussion

The human capital of bachelor degree or above education is positively correlated with the quality of economic growth both in static and dynamic analysis, but the human capital of post-secondary education is not significant, which means that the human capital of bachelor degree or above education can improve the quality of economic growth in China while post-secondary education barely contributes. Traditional economic theories have agreed that human capital can greatly contribute to economic growth, and the researched done by Lucas and Roemer showed that the high quality economic growth mainly derive from the effective accumulation of human capital stock. Therefore, it is impossible for China to improve the quality of economic growth without investment in human capital. Compared with the quantity of economic growth, the quality of economic growth emphasizes quality, efficiency and sustainable development. Human capital with bachelor degree or above education received more than 16 years' of education on average, so they have improved their skills and knowledge by investing in themselves. The driving effect promotes the skills and knowledge of others around them, which advances the economic development level and really improves the quality of economic growth in China. But the human capital of post-secondary education is not significant in the model because it may not satisfy the requirement of quality. This conclusion of this paper is similar to that of Lou Haiying (2004) and Hong Yingfang (2002).

The variable of innovation ability had in both the static and dynamic analysis a positive correlation, which means that innovation ability is beneficial to the quality of economic growth in China. Innovation means new economic growth point and economic evolution and brings new knowledge and concept, so it is sure that in 21st century the core competence of China's national economic growth lies in innovation ability. Innovation ability not only can help us overcome the shortage of natural resources, material capital, but also it can bring important revolution of production method and increase production capacity several times over, which means the same input can bring more output and eliminate the bad influence of diminishing marginal returns of factors, such as material capital etc., on long-term economic growth. In this way, it can guarantee the sustainable economic growth. The economic growth in China is transforming and in pursuit of the quality of economic growth, so innovation ability is a must. This conclusion is in line with that of Hu Shulin (2002), Zhu Yong, Zhang Zongyi (2005).

The variable of first-order lag item of the quality of economic growth had a positive correlation, which showed this predictive variable can improve the quality of economic growth, confirmed the consistency of economic growth and the quality of economic growth has some accumulation effect. Economic theories hold a basic fact that economic growth is continuous, namely, the former and latter period mutually influence each other and the former period of economic growth can indicate the latter period.

The variable of urbanization had a positive correlation both in static and dynamic analysis, which means that urbanization is beneficial to the quality of economic growth. According to the policy of the new

urbanization of China, instead of sacrificing agriculture, food, ecology and environment for urbanization as before, urban and rural areas, being a whole, should be combined for a better cooperation by using resources more economically and intensively to make an ecological and livable environment, to achieve harmonious development and to realize common prosperity. This implication agrees with the quality of economic growth, so it is sure that the promotion of new urbanization can greatly improve the quality of economic growth. Zhou Minliang (2013) [18] holds that Chinese government should regard the increase of the quality of urbanization as an important breakthrough in improving the quality of economic growth.

The variable of marketization is not significant in either static or dynamic analysis. Hence, empirically speaking, it is not an effective predictive variable for quality of economic growth. While in theory, the contrary should be predicted. Chao Xiaojing and Ren Baoping (2008)[19] proved that marketization is positively correlated with the quality of economic growth; however, it is not so significant in this paper. The possible reason may be that the advancement of Chinese marketization in the research period of this paper is not dramatic enough to see its influence on the quality of economic growth statistically.

The variable of industrial structure had a positive correlation both in static and dynamic analysis, which means that industrial structure is beneficial to the quality of economic growth. Industrial economics holds that there is a natural relationship between economic growth and industrial structure. Ling Wenchang and Deng Weigen (2004)[20], through calculating the index of industrial transformation and economic growth, conducted an analysis and concluded: production factors will transfer from industries with lower marginal contribution ratio to higher ones, therefore, the industrial transformation can greatly promote the quality of economic growth in China. Liu Haiying (2005)[21] through his analysis concluded that there is a causal relationship between the industrial structure and the quality of economic growth and the former actually greatly promotes the latter in China. Chao Xiaojing and Ren Baoping (2008)[22] used the contribution degree of total factor productivity to quantify the quality of economic growth since the reform of 1978 and they believed that over the 30 years China had improved the quality of economic growth when the quantity of economic growth had been greatly increased.

V. Conclusion

This paper took 30 Chinese provinces, autonomous regions and municipalities directly under the central government as sample and used the provincial panel data from 2000 to 2013, constructed a static and dynamic panel data model, analyzed the relationship among human capital, innovation and the quality of economic growth and came to a conclusion that the four variables (the first-order lag item of quality of economic growth, the human capital of bachelor degree or above education, innovation, urbanization and industrial structure) are positively correlated with the quality of economic growth; however, the two variables (the human capital of post-secondary education and marketization) are not. Therefore, to positively promote the quality of economic growth in China, duly attention should be paid to human capital investment, innovation promotion, urbanization advancementas well as adjustment of industrial structure.

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