

## Characteristics of the Transformation of China's Economic Growth Pattern and the Empirical Analysis of the Paths of the Transformation

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(Received 24 June 2011, accepted 30 July 2011)

**Abstract:** This thesis proposes the characteristics of economic growth and basis for judging the transformation of the growth pattern according to two dimensions of the total factor productivity (TFP) and factors of production-oriented type. On this basis, an empirical analysis of the influence on economic growth is done from the perspective of industrial structure, marketization, technical progress and a variety of factors of production and other variables. According to the model, an analysis of the characteristics of economic growth and transformation paths in China is done. It is self-evident in the results that from the perspective of factors of production-oriented type, the transformation path mode of China's economic growth is from "capital-human capital-oriented to capital-energy-oriented to capital-human capital-oriented"; from the perspective of the transformation type of technical progress, China's economic growth is in a period of transition from the medium extensive to low extensive type; from the perspective of the influence by factors of production, economic growth is primarily driven by capital input, and energy plays an increasingly prominent role, while the role of human capital needs to be further strengthened.

**Keywords:** the pattern of economic growth; growth pattern; characteristics of the transformation; extensive type; intensive type

### 1 Introduction

The transformation of economic growth pattern has long been an issue studied by experts and scholars. Hong Yinxing [1] believes that intensive economic growth should not be rashly excluded from the capital accumulation, and we should be more concerned about the efficiency of capital investment and improve the input quality of production factors in order to increase its contribution to economic growth. Chang Jin [2] maintains that it is a feasible way to improve the efficiency of human capital and the quality of labor to achieve the transformation of economic growth pattern by increasing investment in education. However, Ge Xinquan [3] states that industrial restructuring during 1952 to 1997 had a positive effect on China's economic growth. Liu Wei [4] considers that

China's economic growth is mainly driven by the tertiary industry and the expansion of the tertiary industrial structure will reduce the positive effects of the primary and secondary elements of industrial efficiency. Hu Jianyuan [5] thinks that the extensive economic growth is mainly due to the shortcomings of our system while structural imbalance of our system results from a series of negative effects caused by institutional change. Therefore, the adjustment of institutional structure is the premise of the transformation of China's economic growth pattern. Yang Qing [6] also agrees that we should form a pattern of China's economic growth through innovation and perfection of our system and improve it by transforming the market mechanism.

The research mentioned above studies economic growth pattern from the perspective of economic growth, industrial restructuring and institutional innovation. From the perspective of the production function, their study only involves the role of capital, labor, and technical progress, but doesn't explore the role of the energy factor for economic growth. In fact, the extensive type of economic growth in China is characterized by over-reliance on the expansion usage of energy and resource which further exacerbates environmental pollution, so the transformation of economic growth should take the impact of energy into account. This paper argues that we should clarify the characteristics of China's economic growth

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and the transformation pattern of economic growth. Only when we have a clear goal of the transformation pattern of economic growth and fully grasp the factors that impact the economic growth, can we select the appropriate pattern for economic growth. On this basis, this paper analyzes the characteristics of China's economic growth pattern from the perspective of the production function and analyzes the influence of industry structure, marketization, technical progress and other variables of production factors on economic growth; and then puts forward countermeasures and suggestions of economic growth pattern.

## 2 Characteristics of the transformation of economic growth Pattern and its direction

From the perspective of production functions, economic growth pattern actually refers to the combination patterns of various elements of economic growth and the way such patterns promote the economic growth. In each different combination of production factors, different production factors will play different roles in economic growth, which will make economic growth take on different characteristics and thus bring different patterns to achieve economic growth.

Currently, economic growth pattern is divided into the extensive economic growth and intensive economic growth by modern Western economists from the perspective of the efficiency of economic growth. If the division of economic growth pattern is different, the definition of economic growth pattern is different. If it is divided into extensive and intensive types, the transformation pattern of economic growth will be from extensive to intensive. This definition is accordant with the formulation of "Eleventh Five-Year Plan" which is put forward by the CPC Central Committee about transformation pattern of economic growth.

Qiu Jiantao (1999) [7] determines the economic growth pattern according to the share of contribution of the total factor productivity (TFP) and total factor input (TFI) to economic growth. If the contribution of TFP is less than the contribution of TFI, the economic growth pattern is extensive; if the contribution of TFP is equal to TFI, the economic growth pattern is neutral. It is still debatable whether it is appropriate to determine the transformation pattern economic growth according to the share of the contribution of TFP, but if there is no other more appropriate indicator, this is a common one adopted by many economists.

Gao Zhiying (2003) [8] has also done a detailed division for extensive economic growth: If the relation is  $0.5 \leq S_{TFI} < 0.75$ , it is low-extensive; if  $0.75 \leq S_{TFI} \leq 1$ , it is moderately extensive; if  $S_{TFI} > 1$ , it is highly extensive. Similarly, this paper has done a further detailed division for intensive economic growth: if the relation is  $0.25 \leq S_{TFI} < 0.5$ , it is moderate intensive; if  $0 \leq S_{TFI} < 0.25$ , it is highly intensive. Economic growth pattern is divided as shown in Table 1.

Table 1: The extent of extensive and intensive economic growth.

contribution of TFI	economic growth pattern
$0 \leq S_{TFI} < 0.25$	highly intensive
$0.25 \leq S_{TFI} < 0.5$	moderately intensive
$S_{TFI} = 0.5$	neutral
$0.5 \leq S_{TFI} < 0.75$	low-extensive
$0.75 \leq S_{TFI} \leq 1$	moderate extensive
$S_{TFI} > 1$	highly intensive

Note:  $S_{TFI}$  is the contribution of production factors.

Suppose  $S_E$  is the contribution of energy,  $S_K$  is the contribution of capital,  $S_H$  is the contribution of human capital, so  $B_{KE} = S_K / S_E$ ,  $B_{HE} = S_H / S_E$ . In order to give an intuitive description of evolution path for the production-oriented economic growth pattern, this paper will make  $B_{HE}$  as the horizontal axis and  $B_{KE}$  as the vertical axis in order to give an intuitive map of the evolution path for the production-oriented economic growth pattern as shown in Figure 1.

From the experience of developed countries, the transformation of economic growth patterns will generally experience two basic paths:

- (1) Labor-dependent — capital-dependent — capital & technology-dependent — technology-dependent
- (2) Labor-dependent — energy-dependent — energy & technology-dependent — technology-dependent

If it is seen from the perspective of the combination of production factors and technical progress, economic growth pattern is a complex spiral process when transforming from labor-dependent to technology-dependent. Therefore, only when we have a clear goal of the transformation pattern of economic growth and fully grasp the factors that impact the economic growth, can we select the appropriate pattern for economic growth.

### 3 Empirical Analysis

While studying China's economic growth, Wang Xiaolu 2009[9] thinks that the Cobb-Douglas production function is suitable for describing the economic growth in China. This function is also adopted by this essay. It is

$$Y = AE^{\sigma_1} K^{\sigma_2} H^{\sigma_3} \sigma_1 + \sigma_2 + \sigma_3 = 1 \quad (1)$$

In this function,  $Y$  stands for the economic income;  $A$  is the technological progress expressed by total factor productivity;  $E$  and  $K$  respectively stand for the amount of energy consumption and the material capital stock; and the human capital  $H=BL$ , which means the product of capital efficiency and labor;  $\sigma_1, \sigma_2, \sigma_3$  respectively stand for the output elasticity coefficients of the corresponding factors of production.

The growth rate of total factor productivity is calculated with the classic Solow Complementary Method. In order to distinguish the influence coming from variables such as marketization and readjustment of industrial structures, the regression estimate of production function (1) is analyzed with time series analysis. Its logarithmic form is:

$$\ln Y_t = C_0 + C_1 t + C_2 \ln S_t + C_3 \ln J_t + C_4 \ln E_t + C_5 \ln K_t + C_6 \ln H_t + \mu_t \quad (2)$$

In this formula,  $S_t$  refers to the extent of marketization,  $J_t$  stands for the extent of the readjustment of industrial structure, and  $KJ_t$  represents the input for scientific research.

Definitions of some relevant figures and their sources:

Energy consumption volume- Source: China Energy Statistical Yearbook; Unit: 10,000 Tons of standard coal

Labor force- the total employed people in the society; Source: China Statistical Yearbook, Unit: 10,000 people

Capital stock-Referring to the total material capital stock; Unit: 100,000,000 Yuan. Figure between 1985-2004 was from Zhang Jung 2004[10] (Price based on 1952); figure between 2004-2005 was from the database of China Center for Economic Studies, Fudan University, and figure between 2006-2007 was calculated with the extrapolation method

Economic output-referring to the GNP (based on the price of 1952 so as to keep it in line with the capital stock); Source: China Statistical Yearbook, Unit: 100,000,000 Yuan

Efficiency of human capital- Referring to the average education level of the labors; unit: year(s). There are many ways to calculate the human capital  $H=BL$ . Generally, it can be the school life expectancy, or it may refer to the cost of education, etc. Normally we use the school life expectancy to represent the efficiency of human capital. This method is not only simple, but also reliable and accurate. The formula which shows the average schooling life expectancy of labors is:

$$B = \sum (p_i/p) B_i$$

In this formula,  $B_i$  refers to the school life expectancy of level  $i$ ,  $p_i/p$  refers to the percentage of educated people among all people in level  $i$ , and  $B$  stands for the average school life expectancy.

In order to work out the percentage of educated people among all people in level  $i$ , in this essay, we suppose that the proportion of people with different levels of education among all the working people is exactly the same as the proportion among the people who are above 6 years old. Meanwhile, we divide the labors into 5 levels: illiterate, semi-illiterate, primary school, secondary school, high school, and college and above. According to the education system in China, the schooling time for illiterate and semi-illiterate people is 2 years, primary school 6 years, secondary school 9 years, high school 12 years, and college and above 16 years. Source: China Statistical Yearbook.

Extent of marketization-Because no indexes on marketization are disclosed by any authorities in China, the extent of marketization is expressed by the percentage of non-state economy in the total industrial output. The figure is from Wang Xiaolu 2009.

Extent of the readjustment of industrial structure-it is expressed by the percentage of GDP from the secondary industry in the overall GDP volume. Source: China Statistical Yearbook.

In order to eliminate the possible heteroscedasticity in the estimation model of regression equation, by means of WLS, we take  $1/|v_t|$  as the weight to do the estimation of production function, and the estimator of the model is:

$$\begin{aligned} \text{LOGY} &= -1.555043 + 0.033663 * T + 0.310239 * \text{LOGS} + 0.143181 * \text{LOGJ} + 0.133927 * \text{LOGE} \\ &\quad (0.0160)(0.0001)(0.0465)(0.0170)(0.0001) \\ &\quad + 0.446591 * \text{LOGK} + 0.41948 * \text{LOGH} \\ &\quad (0.0000)(0.0000) \end{aligned} \quad (3)$$

$$DW = 1.919694 F = 43045.15 R^2 = 0.999871 AIC = -6.165069, Sqr = 0.001680$$

From the perspective of the influence given to the economic growth by each variable, we can make the following conclusion: each factor of production has a different influence to economic growth. The capital output has the highest elasticity,

then follows the output of human capital, and energy output has the minimum elasticity; from the interchangeability point of view, the elasticity of interchangeability between capital and energy is 3.3346, and the value between human capital and energy is 3.1322. It is relatively easy for capital and human capital to replace each other. It is feasible to reduce the dependence on energy for economic growth by substituting energy input with the other production factors; if we look at the influence from the extent of marketization whose elasticity coefficient is 0.310239, it is possible to promote the economic growth by accelerating the process of marketization; and finally, if we look at the influence to economic growth from the transformation of the patterns of economic growth, whose elasticity coefficient is 0.143181, it has a positive impact to economic growth.

Table 2 shows the contributions to economic income by each variable. From this table we can see:

(1) In terms of the contributions from factors of production, it is very obvious that the capital input still has a big role in the economic growth. Its accounts for over 50% of the economic growth; energy and human capital almost have the same contribution towards the growth. It will be difficult to reduce the dependence on energy consumption if the growth of human capital lacks momentum.

(2) When we look at the contribution by human capital, it is relatively low and is largely relying on the increased intensity of human capital. The contribution from a more efficient human capital is quite little, compared with the increase in its intensity.

(3) In terms of the contribution from technical progress, if we also put total factor productivity and the efficiency of human capital into this category, then its contribution is elevated high, but is still below 40%.

(4) In terms of the contributions from the readjustment of industrial structures and marketization, the contribution from the readjustment of industrial structures is not quite distinctive, but that from marketization is comparatively high. However, the contribution from marketization is gradually declining with the continuous perfection of market mechanism.

(5) If we compare the contributions from factors of production and technical progress, the patterns of economic growth is gradually transforming from a medium extensive style to low extensive style. From 1985 to 1990, the contribution from factors of production was 93.705%, which means it was a medium extensive pattern of economic growth, while as in other time, the figure was always below 75%, which means the pattern of economic growth was lowly extensive.

Table 2: Contributions to economic growth by different variables(100%).

	1985-1990	1991-1995	1996-2000	2001-2005	2006-2007
Energy consumption	8.7464	8.4541	9.8922	14.487	8.6255
Capital Stock	70.715	51.383	55.952	50.981	50.519
Labor	14.244	6.8549	6.6563	6.398	7.45
Efficiency of human capital	9.6138	4.4186	5.6387	3.3906	3.2499
Human capital	23.858	11.274	12.295	9.7886	10.7
Total factor productivity	-3.3192	28.889	21.861	24.743	30.156
Readjustment of industrial structures	-0.7573	3.084	-0.853	1.4111	-0.4107
Marketization	21.264	11.066	-2.7008	8.7117	3.2617
Technical progress	6.2946	33.308	27.5	28.134	33.406

Note: Contribution from technical progress refers to the contributions from human capital efficiency and total factor productivity combined.

Figure 2 shows the changes of driving forces in the economic development pattern. We can find that from 1985 to 1990 the pattern of economic development was capital-human capital oriented, from 2001 to 2005 it became capital-energy consumption oriented, and then from 2006 to 2007 it bumped back to capital-human capital oriented. It is obvious that nowadays China's economic growth is driven by capital input, and the role of energy consumption in economic growth is getting stronger and stronger. If energy is not used in an effective way, the growth of our economy will not be sustainable because of energy depletion.

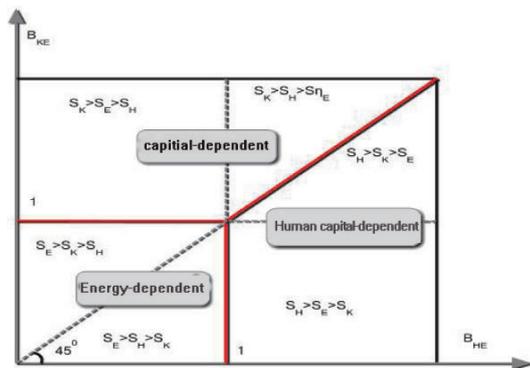


Figure 1: Illustrative diagram about changes.

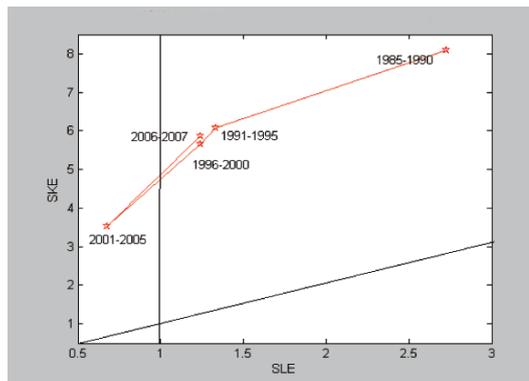


Figure 2: Changes of driving forces in of driving forces in the economic development pattern the economic development pattern.

### 4 Measures and suggestions

To sum up, in order to realize a good transformation of the pattern of economic development, we should take the following steps:

- (1)To expedite technical progress-this is the key to the transformation of the pattern of economic development.
- (2)Further improve the quality of our laborers and expand capital input. It is an important approach for the transformation of the pattern of economic development to improve the quality of our laborers. In order to achieve this target, we must expand human capital input to increase its efficiency.
- (3)Improve the market system of effective competition. The micro foundation for intensive economic growth is the effective competition. Thus, to improve the market structure is one of the most important approaches to transform the pattern of economic development.
- (4)Introduce new industrial policies and timely readjust industrial structure. Industrial policy is a critical element which influences the transformation of economic development pattern. Although its effect range is limited, experiences from other countries have proven that it is still a crucial measure for improving the macro management and promoting the transformation of economic development pattern.

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