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The Impact of Industrial Structure Adjustment on Economic Growth in Japan

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Abstract

Industrial structure adjustment reflects the dynamic association between industries. The speed of industrial structure adjustment and the proportion changes in the three industrial structures are important factors that affect economic growth. In order to make quantitative analysis on the impact of Japanese industrial structure adjustment to economic growth, the paper reviews the evolution process of Japanese three industrial structures, measures the speed of Japanese industrial structure adjustment by the *K* value of industrial structure changes. And then this paper analyzes the impact of speed of industrial structure adjustment on economy growth by impulse response function, and assesses the contribution of the proportion changes in the three industrial structures on economy growth by econometric regression model. The empirical results show that the speed of industrial structure adjustment has a positive stimulating role on economic growth. Since 1985, the output elasticity of Japanese primary industry drops to negative, secondary industry and tertiary industry increase. However, the magnitude of secondary industry rise is greater than tertiary industry. Japanese industrial structure exist the problem of excessive servicing. Finally, this paper puts forward policy recommendations for China to speed up industrial structure adjustment.

Key words: Japanese economic; Industrial structure; Economic growth; The three industries

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INTRODUCTION

Industrial structure adjustment usually refers to the proportion changes of the three industries. It is a dynamic reflection of correlation between a country's industries, also is one of the determinants of economic growth. Industrial structure adjustment includes two aspects: one refers to the speed of industrial structure adjustment, namely the speed of economic resources transfers between the industries; the other one refers to the proportion changes of the three industries. The economic resources transfer to secondary and tertiary industry from the primary industry, namely industrial structure advancing. The speed of industrial structure adjustment and the proportion changes of the three industries will impact inevitably economic growth. High speed of industrial structure adjustment and reasonable proportion of the three industries will promote the sustained and healthy economic growth. Researching the influence of industrial structure adjustment on economic growth, the key is to analyze how better to adjust the industrial structure, promote the optimization and upgrading of industrial structure, and accelerate economic development. After World War II, Japanese industrial structure adjustment and economic growth occur simultaneously. Economic growth effect of industrial structure adjustment has been played effectively. Industrial structure adjustment is transferred from the primary industry to more productive secondary and tertiary industry, and stimulates the economy growth quickly. However, entering the late 1980s, along with the deepening of industrial structure advancing, the speed of Japanese industrial structure adjustment declined gradually, and the proportion of tertiary industry in economy was too high. These affected the speed of economic growth.

Comparison the industrial structure can reflect the situation of a country's economic growth to some extent. At present, Chinese economy is in a critical period of industrial structure upgrading. The rate of Chinese economic growth is transferred from the high

speed to medium speed, and the downward pressure of economic growth increases. From the perspective of Chinese three industrial structures, the proportion of the primary, secondary and tertiary industry were 10%, 43.9% and 46.1% respectively in 2013, which is similar with Japanese industrial structure around the 1960s. However, after 1960, Japanese economy entered into the accelerated period in industrial structure adjustment and the rapid economic growth lasted 10 years. Therefore, the potential of Chinese industrial structure adjustment is huge. With the deepening of Chinese industrial structure adjustment, the rapid growth of Chinese economy will still continue for some years. The trajectory of industrial structure adjustment and the changes of economic growth rate between China and Japan are higher similarity. Comparing the process of industrial structure adjustment between China and Japan, analyzing the evolution process of Japanese industrial structure and the impact of the industrial structure adjustment's speed and the proportion changes of the three industries to economic growth will provide important learning experiences for Chinese industrial structure upgrading and economic "steady growth strategy".

1. LITERATURE REVIEW

1.1 Researches on the Industrial Structure Adjustment and Economic Growth

Industrial structure adjustment and economic growth are hot spot research in the field economics, which attracting more and more researchers. Chenery, Robinson and Syrquin have studied the relationship between the economic structure transformation and economic growth, and found that the changes in economic structure and economic growth are closely related. The changes in the economic structure, especially under non-equilibrium conditions, can accelerate economic growth. Structural changes can be divided into different stages. In each stage, the contributions of the different sectors on economic growth are different (Chenery, Robinson & Syrquin, 1986). Ester and Aurora have studied the influence of industrial structure adjustment on economic growth by the panel data model. They argue that the changes of industrial structure and the growth of high technology sector promote economic growth (Ester & Aurora, 2011). Zhang and Wang have considered that the changes of industrial structure are the important reason of economic growth. Correcting the adverse of industrial structure evolution by the industrial policies can accelerate the transformation of industrial structure and promote economic growth (Zhang & Wang, 2009). Chen has studied the impact of industrial structure changes on economic growth in China, and fond that the rationalization and advancing of industrial structure promote economic growth in China (Chen, 2010). Tian, Wang and Liu have studied the impact of proportion changes in the three industrial structures on economic growth, and fond that government should promote economic growth by the method of industrial structure adjustment (Tian, Wang & Liu, 2010).

1.2 Researches on the Changes in Japanese Industrial Structure

Japanese Industrial structure adjustment has been a hot research field of economy. Xue et al. have analyzed the relationship between industrial structure and Japanese economic growth, and fond that the lag of Japanese industrial structure advancing is the main reason for the slow economic growth (Xue, Bai, Pang, Bao, & Zhou, 2002). Bai has studied the changes of Japanese industrial structure after 1980s, and considered that the falling speed of Japanese industrial structure adjustment affect the economic growth and employment. The fundamental method to solve Japanese slump is eliminating the barriers that hindered industrial structure adjustment and accelerating industrial restructuring (Bai, 2003). Guan and Ding have combed the changes process of Japanese industrial structure during 1955-2009 in the two angles of output and employment, and also analyzed the relationship between industrial structure and economic growth by the panel data model. They argue that Japanese industrial structure has been in the passageway of advancing and rationalization. This process promotes economic growth of Japan (Guan & Ding, 2012).

In summary, most of the existing researches are shown that the speed of industrial structure adjustment and the proportion changes in the three industries have an important impact on economic growth. In the existing researches, there are many theory researches focusing on the impact of the proportion changes of the three industries on economic growth. But the empirical researches on the impact of Japanese industrial structure adjustment's speed and the proportion changes of industrial structure to economic growth are very little. So, this paper will make efforts in the following two aspects to make up the shortage of the existing literature. First, this article will measure the speed of Japanese industrial structure adjustment by the K value of industrial structure changes, and analyze quantitatively the impact of the K value on economic growth by the impulse response function. Second, this paper will comb the changes process of Japanese three industrial structures' proportion, and analyze quantitatively the impact of the proportion changes on economic growth by econometric regression model.

2. THE SPEED OF INDUSTRIAL STRUCTURE ADUSTMENT AND ECONOMIC GROWTH

2.1 The Process of Japanese Industrial Structure Adjustment Postwar

The standard of three industries division in Japan is as following: The primary industry includes agriculture, forestry and fisheries. The secondary industry includes mining and quarrying of stone and gravel, construction and manufacturing. The rest of the industries belong to the tertiary industry. From postwar to the present, Japanese industrial structure has undergone more substantial adjustment. The direction of industrial structure adjustment is from the primary industry to the secondary industry, and eventually transfers to the tertiary industry. Overall, Japanese three industrial structure changes have experienced four stages. The first stage is the heavy industrialization stage (1955-1973). In this stage, the secondary industry developed rapidly and the proportion in the national economy continued to grow. The proportion rose from 34.9% in 1955 to 44.7% in 1973. The increasing of the secondary industry's proportion derived the development of the tertiary industry. The proportion of the tertiary industry rose from 45.2% in 1955 to 49.4% in 1973. The proportion of the primary industry dropped rapidly, dropped from 19.9% in 1955 to 5.9% in 1973. The second stage is the industrial energy saving stage (1973-1985). The oil crisis that broke out in the early 1970's ended Japanese heavy industrialization. In order to reduce dependence on imported energy and get out of the energy crisis, Japanese industry began to implement energy conservation and industrial lighting. In this stage, the proportion of the secondary industry began to decline, down from 44.7% in 1973 to 36% in 1985. The proportion of the tertiary industry was rising rapidly, reached 60.8% by 1985. The proportion of the primary industry continued to decline, fell to 3.1% by 1985. The third stage is the industrial structure knowledge and intelligence stage (1985-2000). In the mid-1980s, the Yen exchange rate rose, Japanese exports costs continued to increase and the cost advantage were lost. The government began to promote vigorously the intelligent and mechanization. The rapid rise of the Yen also contributed to the development of tertiary industry, such as financial industry. By 2000, the proportions of Japanese primary and secondary industry dropped to 1.8% and 29.7% respectively, the tertiary industry rose to 68.6%. The fourth stage is the industrial structure serving stage (after 2000). Entering the new century, with the rapid development of service industry, secondary industry serving continuous developed and the industry proportion fell further. The proportion of the tertiary industry was rising fast, accounted for more than 70%.

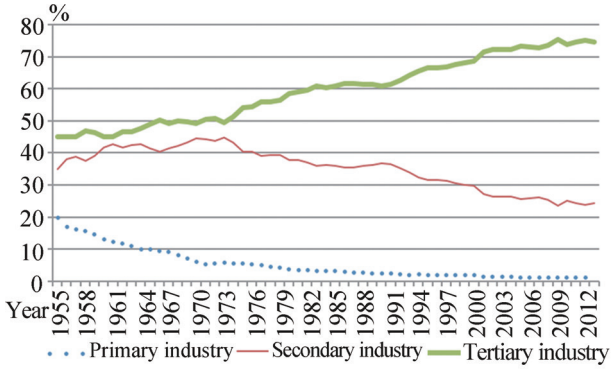

Figure 1
Changes in Industrial Structure of Japan
Note. Source: Japanese Statistics Bureau.

2.2 The Speed of Japanese Industrial Structure Adjustment

When measuring the speed of industrial structure adjustment, the *K* value of industrial structure changes is the more commonly used index. The index, which commonly used to analyze the speed of a country's three industrial structures changes in a certain period, is measured by the sum value of the difference in the three industries' proportion between the current and the base period. The formula of the K value as follow:

$$K = \sum_{i=1}^{n} \left| q_{it} - q_{i0} \right| \quad (1)$$

In equation (1), q_{it} represents the i industry's proportion in the current period. q_{i0} represents the i industry's proportion in the base period. When the K value is big, it indicates that the big magnitude of the industrial structure changes. When the K value is small, it indicates that the magnitude of industrial structure changes is small. According to equation 1, this paper will calculate the speed of Japanese industrial structure adjustment by annual data. The results are shown in Figure 2.

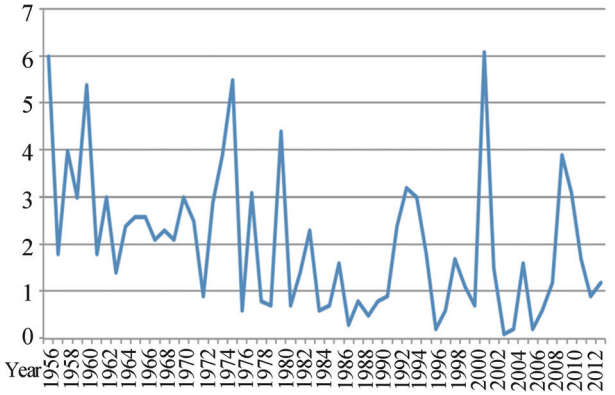

Figure 2
Changes in the *K* Value of Japan

It can be seen from Figure 2, the speed's fluctuations of Japanese industrial structure adjustment is big in different periods. Overall, there are three large fluctuations peaks. These fluctuation peaks consistent with the actual situation of Japanese industrial structure adjustment.

The first peak was in 1956. The *K* value reached 6, and then gradually decreased. At this point, it was the peak of Japanese industrial heavy industrialization. The second peak was in 1975 and the *K* value reached 5.5. At this point, it was the beginning that Japanese industrial structure transferred from the heavy industrialization to industrial energy saving and industrial lighting. The third peak was in 2001 and the *K* value reached 6.1. At this point, it was the peak of Japanese industrial serving.

2.3 Empirical Analysis on the Speed of Industrial Structure Adjustment and Economic Growth

The speed of industrial structure adjustment will affect the rate of economic growth to some extent. In order to analyze quantitatively of the influence of the Japanese industrial structure adjustment's speed on the rate of economic growth, this paper selects the GDP growth rate and the *K* value of industrial structure changes for variables to construct variable autoregressive (VAR) model. First, this paper will determine the lag order and make AR test and Johansen cointegration test. If through the test, this paper will analyze the dynamic relationship between variables by impulse response function. The data are Japanese annual data in the period 1955-2013. The GDP growth rate is the nominal year-on-year GDP growth data. The *K* value is calculated according to the annual current price data. All original data are from the Japanese Statistics Bureau (http://www.stat.go.jp/english/data/index.htm).

2.3.1 Johansen Cointegration Testing

First of all, according to the FPE, AIC and SC information criterion, we can determine the lag order number is 1. Then based on the VAR (1) model, we will make AR test and Johansen cointegration test. AR test results show that all the reciprocal roots are within the unit circle. Johansen cointegration test results show that trace statistic and Max-Eigen statistic reject the null hypothesis and accept the hypothesis that at most 1 cointegration vector at the 0.05 level. This results show that there is long-term equilibrium relationship among GDP growth and the K value.

Table 1
VAR Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-267.8358	NA	90.62569	10.18248	10.25683	10.21107
1	-222.598	85.35440*	19.12175*	8.626338*	8.849390*	8.712113*
2	-221.4405	2.096493	21.30573	8.733605	9.105358	8.876563
3	-217.0336	7.649841	21.02259	8.718247	9.238702	8.918389
4	-214.5774	4.078158	22.36272	8.776505	9.445661	9.033830
5	-213.319	1.994472	24.93931	8.879961	9.697818	9.194470

Note. * Indicates lag order selected by the criterion.

Table 2
Results of Johansen Cointegration Rest

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic (Prob.)	Max-Eigen Statistic (Prob.)
None*	0.322721	38.79252 (0.0007)	21.82162 (0.0217)
At most 1*	0.261439	16.97089 (0.0084)	16.97089 (0.0084)

Note. * Denotes rejection of the null hypothesis at the 0.05 level.

2.3.2 The Impulse Response Function Estimating

In the VAR model, impulse response function can measure the impact of the changes in an endogenous variable on other endogenous variables. Based on the Johansen cointegration test, we use the impulse response function to analyze the impact of the *K* value on GDP growth. The results show in Figure 3. In Figure 3, the horizontal axis represents lag phase of variable impact effect (unit: Year). The vertical axis represents the degree of response, and dashed line represents the deviation band of plus or minus two standard deviations. As can be seen from the figure, when giving a positive impact to the *K* value, there is no effect on GDP growth in the current period. From second period, the effect on GDP growth begins to have a positive influence, reaches to the maximum (about 0.4) in the second period, and then begins to weaken gradually. This indicates that the speed of Industrial structure adjustment has a positive pushing effect on economic growth, and there is one period lag. That is to say, when the industrial structure adjustment fast, there will have large pushing effect on economic growth. When the speed of adjustment of industrial structure is small, the pushing function on the economic growth is also small.

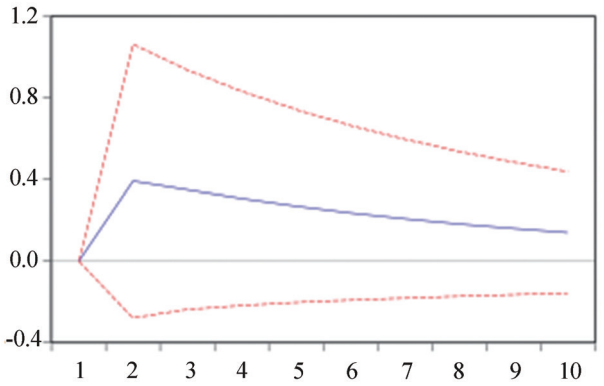

Figure 3
Response of GDP to *K* Value's Changes

3. THE PROPORTION OF INDUSTRIAL STRUCTURE AND ECONOMIC GROWTH

The economy is composed by the three industries. Changes in the proportion of the three industries structure will have an impact on the economic growth. In order to analyze quantitatively the impact of changes in the proportion of industrial structure to economic growth, this article will make the regression analysis by the data of Japanese three industries and economic growth during the period of 1955-2013.

3.1 Model Building

On the basis of Romer economic growth function, Chen has deduced the contribution of the proportion changes in the three industries structure to economic growth, and revised economic growth function (Chen, 2010). The equation is as follows:

$$Y = F(X_1, X_2, \ldots, X_k, A) \tag{2}$$

In equation (2), Y represents the total output, X_i represents the i industry's output（i=1,2,3⋯,k）, and A represents institutional and technical factors. Making the total differential to equation (2), we can get the following equation:

$$dy = \frac{dy}{dx_1}dx_1 + \frac{dy}{dx_2}dx_2 + \ldots + \frac{dy}{dx_k}dx_k + \frac{dy}{dA}dA \tag{3}$$

The both sides of equation (3) divided by Y, we can get equation as follow:

$$\frac{dy}{y} = \frac{x_1}{y}\frac{\partial y}{\partial x_1}\frac{dx_1}{x_1} + \frac{x_2}{y}\frac{\partial y}{\partial x_2}\frac{dx_2}{x_2} + \ldots + \frac{x_k}{y}\frac{\partial y}{\partial x_k}\frac{dx_k}{x_k} + \frac{A}{y}\frac{\partial x}{\partial A}\frac{dA}{A} \tag{4}$$

Order $\frac{x_i}{y}\frac{\partial y}{\partial x_i} = \beta_i$ represents the output elasticity of i industry, $\frac{A}{y}\frac{\partial x}{\partial A}\frac{dA}{A} = \beta_0$ represents the contribution of institutional and technical of economy, the equation (4) can be rewritten as follow:

$$\frac{dy}{y} = \beta_0 + \beta_1\frac{dx_1}{x_1} + \beta_2\frac{dx_2}{x_2} + \ldots + \beta_k\frac{dx_k}{x_k} \tag{5}$$

Take logarithm on both sides of equation (5), after processing, we can get equation as follow:

$$\ln y = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \ldots + \beta_k \ln x_k \tag{6}$$

This article will analyze quantitatively the impact of the proportion changes in Japanese three industries structure to economic growth by the model. The equation is as follows:

$$\ln GDP = \beta_0 + \beta_1 \ln PI + \beta_2 \ln SI + \beta_3 \ln TI + \varepsilon \tag{7}$$

In equation (7), GDP represents Japanese economic output. PI, SI and TI represent respectively the primary, secondary and tertiary industry's output.

3.2 Data Descripting and Testing

This paper selects the data of Japanese nominal GDP and nominal output of the primary, secondary and tertiary industry in the period 1955-2013 to form time series sample data set, and then use EViews6.2 metering software to test data. All the original data are from the Japanese Statistics Bureau. Because all data are time series data, we need to examine data's stationary, and then review the cointegration relationship between variables by EG two-step method.

Using the EViews, this paper make ADF unit root test to the sample data. The results are shown in Table 3. The results show that lnGDP, lnSI reject the null hypothesis at the 0.01 level, and lnPI, lnTI reject the null hypothesis at the 0.05 level. These indicate that the sequences of lnGDP, lnSI, lnPI, lnTI are the same order stationary series, and don't exist the unit root. So, this article can make variable regression analysis firstly, and then test the stability of regression residuals.

Table 3
Results of ADF Test

Variable	ADF statistics	Prob.	Conclusion
lnGDP	-3.592748	0.0089	stationary
lnPI	-3.073166	0.0343	stationary
lnSI	-3.937347	0.0033	stationary
lnTI	-3.516609	0.0110	stationary

3.3 Model Estimating

Taking lnGDP as the explained variable, lnSI, lnPI and lnTI as the explanatory variables, this paper will use OLS regression method to estimate the impact of the proportion changes in industrial structure to economic growth. In order to reflect fully the characteristics of different stages of the industrial structure adjustment, combined with the requirements of regression analysis to the sample data volume, this paper will merge the four stages of Japanese industry structure adjustment into two, that is divided into 1955-1985 and 1985-2013 two stage regression analysis. Results of regression estimating are shown in Table 4.

Table 4
Results of Regression Estimating

Variable	(1) 1955-1985	(2) 1985-2013
	Coefficient (t-Statistic)	Coefficient (t-Statistic)
C	1.092707 (21.04060)***	1.207722 (19.49901)***
lnPI	0.052048 (3.259045)***	-0.013342 (-1.749184)*
lnSI	0.291136 (20.67407)***	0.323036 (29.55017)***
lnTI	0.632785 (47.09908)***	0.642705 (87.49798)***
R^2	0.999967	0.999676
Adjusted R^2	0.999963	0.999637
F-statistic	269715.6	25703.45

Note. ***, * indicate respectively significant at 0.01 and 0.1 level.

Comparing with the regression estimation results of 1955-1985 and 1985-2013 two stages, we can find that the secondary industry and tertiary industry are the main driving force of economic growth. It is corresponding with the proportion of the two industries account for Japanese economy. The difference is that the primary industrial output elasticity is 0.052048 (more than 0) in the stage of 1955-1985, while the output elasticity drops to a negative value in the stage of 1985-2013. This is because the proportion of the primary industry in the economy declines, industrial production costs rise and the efficiency declines. Accordingly, the output elasticity of the secondary and tertiary industry rises. But the secondary industry rises more than the tertiary industry. This suggests that Japanese secondary and tertiary industry's production efficiency have improved. However, the amplitude of the tertiary industry's production efficiency rising less than the proportion of industrial structure rising. The tertiary industry's output efficiency is diminishing marginal. Japanese industrial structure has the problems of excessive servicing, and the proportion of the tertiary industry in the economy is too high.

In order to test the reliability of the regression results, we need make unit root test on the residuals of regression estimating 1 (1955-1985) and regression estimating 2 (1985-2013). The results are shown in Table 5. The test results show that, the residuals of regression estimating 1 (1955-1985) and regression estimating 2 (1985-2013) are less than the corresponding critical value at the 0.1 level. This shows that the residual sequences are stationary series, and don't exist unit root. There are long-term cointegration relationship between explanatory variables and explained variables of regression estimating 1 (1955-1985) and regression estimating 2 (1985-2013). The regression results in Table 4 are credible.

Table 5
Results of Residual Series' ADF Test

Regression estimation	ADF statistics	Prob.	Conclusion
(1)1955-1985	-2.804447	0.0700	stationary
(2)1985-2013	-2.673627	0.0916	stationary

CONCLUSION AND RECOMMENDATIONS

According to the above research, this paper draws the following conclusion: First, excepting for a few year fluctuations, the speed of Japanese industrial structure adjustment is decreasing since 1955. Because the proportion of the tertiary industry has occupied more than 70% in Japanese economy and industrial structure upgrading has reached a high level, the space for further adjustment of industrial structure is limited. Second, the speed of industrial structure adjustment has a significant positive effect on economic growth. According to the empirical analysis on Japanese industrial structure adjustment, we can find that the speed of industrial structure adjustment has a positive pushing effect on economic growth. When the speed of industrial structure adjustment rapid, it will have large pulling effect on economic growth. When the speed of industrial structure adjustment is small, the pull function on the economic growth is also small. So, using the policy of industrial structure, a government can accelerate the industrial structure adjustment to promote economic growth. Third, comparison before 1985, Japanese industrial structure exist the problem of excessive service after 1985. Since 1985, the proportion of Japanese tertiary industry in the economy is increasing. However, the extent of industrial output elasticity growth is small. The too high proportion of tertiary industry in the economy may be the reason for the decline of the marginal output efficiency.

Based on the study of Japanese industrial structure adjustment and economic growth, comparison with Chinese industrial structure adjustment, this paper puts forward policy recommendations as follow:

(1) China should adopt the industrial structure policy to speed up the speed of industrial structure adjustment. In the changes of the K value of industrial structure, the speed of Chinese industrial structure adjustment has a trend of decline since 2000. This weakens the economic growth rate to some extent. Since 2010, Chinese year-on-year GDP growth has declined for 5 consecutive years. The growth rate fell from 10.4% in 2010 to 7.4% in 2014, and likely fall to 7% in 2015. Downward pressure on the economy continues to grow. The important measure of Chinese economic "steady growth strategy" at present is taking the industrial structural policies to speed up industrial structure adjustment and promote the optimization and upgrading of industrial structure.

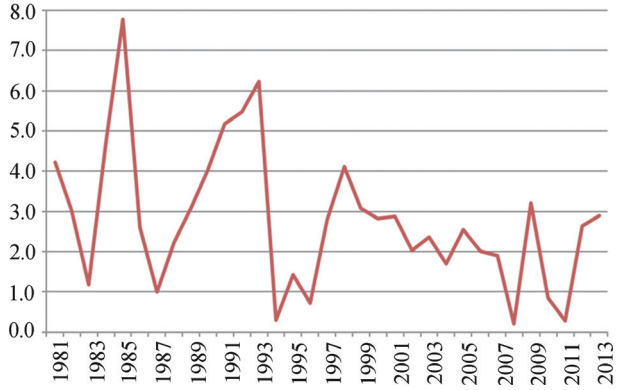

Figure 4
Changes in the *K* Value of China
Note. Source: Chinese National Bureau of Statistics

(2) China should accelerate the development of tertiary industry and promote industrial structure servicing. Comparing with the proportion of the three industries in developed countries, Chinese tertiary industry is low, less than 50%. The proportion of secondary industry is too high, high than 40%. Among developed countries, the driving force of economic growth comes from the tertiary industry. But in China, the secondary industry is largest source of economic growth. Therefore, Chinese should further intensify the development of the tertiary industry, and promote the servicing and information for manufacturing industry. Through tax cuts, financial support for service industry, government should increase the proportion of the tertiary industry in the economy.

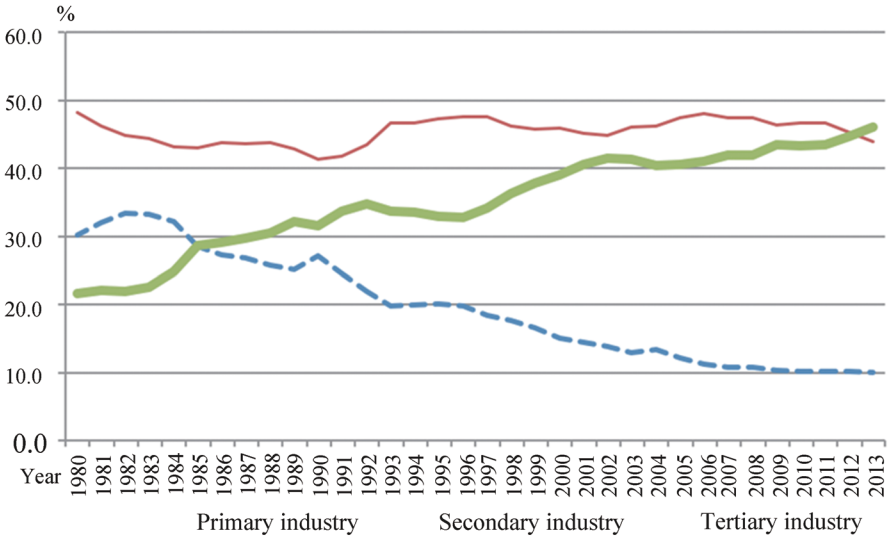

Figure 5
Changes in Industrial Structure of China
Note. Source: Chinese National Bureau of Statistics

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