

Empirical Research on Regional TFP Contribution Rate in China Based on Generalized Regression Model with Convex Constraint

Hengqing Tong, Xujie Zhao, Chao Yu
Department of Mathematics, Wuhan University of Technology
Wuhan, Hubei, 430070, P.R.China
Email: hzxj83@163.com

Extended Abstract

1 Introduction

China has undergone a continuous and spectacular economic growth since the beginning of the reforming and opening-up policy. However, the growth shows a great difference among different regions. From the studies on influencing factors of the growth, researchers have recognized that innovation is a major driving force in economic growth. Therefore, it's important to analyze the regional difference of economic growth from the innovation perspective. It is well known that total factor productivity (TFP) contribution rate can reflect the contribution of innovation to the economic growth effectively. So we focus on analyzing the difference of TFP contribution rate in different regions.

This paper first deduces the generalized regression model with convex constraints from the Cobb-Douglas production function to satisfy the modeling requirements of regional TFP measurement. With this model, we can obtain a final TFP of each region based on the every province's data involved, thus to calculate TFP contribution rate. From these final values, we can compare the innovation ability of different regions more easily. Then we carry on the empirical research using the practical provincial statistical data in China.

2 TFP contribution rate estimate based on evaluation model

In 1930s, the American famous mathematician G.W. Cobb and economist P.H. Douglas studied the relation of output and input together, and described it by function which is known as Cobb-Douglas production function

$$Y = AL^\alpha K^\beta (\alpha > 0; \beta > 0). \quad (1)$$

where, Y is output, K is capital input and L is labor input; α and β are capital elasticity and labor elasticity; A is parameter of technology advancement. Today Cobb-Douglas production function still impresses economic measure and analysis.

According to Cobb-Douglas production function equation (1), TFP is the total output getting rid of the part influenced by factor input (capital and labor). After total differential and neatening to the upper equation, we can get

$$\frac{dA}{A} = \frac{dY}{Y} - \alpha \frac{dK}{K} - \beta \frac{dL}{L}. \quad (2)$$

That is

$$a = y - \alpha k - \beta l, \quad (3)$$

where a is TFP growth rate, y is growth rate of Y , k is growth rate of K and l is

growth rate of L . Using output growth rate to divide into both sides of equation (3), we can get TFP contribution rate, which is growth rate of technology advancement.

$$\frac{a}{y} = 1 - \alpha \frac{k}{y} - \beta \frac{l}{y}. \quad (4)$$

If we can work out α, β by equation (3), we can get the TFP contribution rate $\frac{a}{y}$ from

equation (4). Usually we simulate the economy under the condition of $\alpha + \beta = 1$.

Now we consider how to measure the regional TFP including several provinces. Suppose there are m regions to be considered, each region has n_m provinces. n_m can be different according to the region. For every province, labor input, capital input and output is known. Our problem is to give a final value of regional TFP. Based on above assumption and formula (3), we can deduce the generalized regression model with convex constraints as follows

$$\begin{cases} \| Da - (y - \alpha k - \beta l) \|^2 \rightarrow \min \\ \alpha + \beta = 1 \\ \alpha > 0, \beta > 0 \end{cases}, \quad (5)$$

where $\mathbf{1}_m = (1, \dots, 1)'$, $Da = a \otimes \mathbf{1}_m$, $a = (a_1, \dots, a_m)'$ denoting vector of TFP of all regions,

\otimes is the Kronecker product, and y, α, β denote the vector of output, capital input and labor input of all involving provinces respectively. The data structure of model is shown as follows

Table 1 Data structure

a	y	k	l
		α	β
a_1	y_{11}	k_{11}	l_{11}
\vdots	\vdots	\vdots	\vdots
a_1	y_{1n_1}	k_{1n_1}	l_{1n_1}
a_2	y_{21}	k_{21}	l_{21}
\vdots	\vdots	\vdots	\vdots
a_2	y_{2n_2}	k_{2n_2}	l_{2n_2}
\vdots	\vdots	\vdots	\vdots

a_m	y_{m1}	k_{m1}	l_{m1}
\vdots	\vdots	\vdots	\vdots
a_m	$y_{m m_m}$	$k_{m m_m}$	$l_{m m_m}$

We have proved that model (5) exist unique solution. Furthermore, we can obtain the least square solution of this model using alternating projection algorithm between two convex sets. The detailed information can refer to author’s paper [1].

3 Empirical Research

In this extended abstract, we only calculate TFP of three regions in 2005 (we can only get the data before 2005 from National Bureau of Statistics of China until Jan. 2008). They are West China, Central China and East China. Each region includes 10 provinces or municipalities. The data is omitted in this abstract. With our software DASC, we get the TFP contribution rates are 10.65%, 26.87% and 37.52%. The soft ware can be downloaded from our website <http://public.whut.edu.cn/slx/English/index.HTM>.

The black line denotes the initial data, the red line denotes the fitting data.

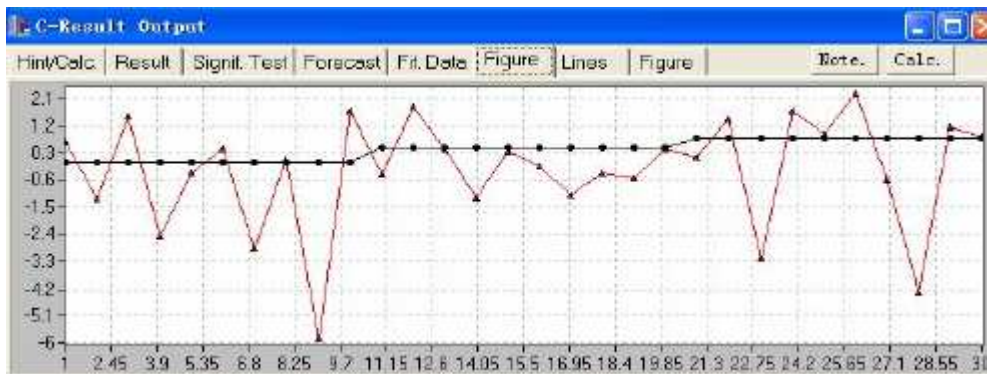


Figure 1 TFP measurement with evaluation model

4 Conclusion

The result shows that the average regional TFP contribution rate of China is not high and TFP contribution rate to output increases from West China to East China. This means that East China has the strongest innovation ability among these three regions. Its value in 2005 exceeds the average level 33.225% (from the world bank) of four Asian tigers during their rapid economic growth period from 1960 to 1989 and the average level 33.4% (from ministry of education, culture, sports, science and technology-Japan) of Japan from 1971 to 1995. However, it is much less than American TFP 52.5% from 1948 to 1973.

Obviously, the regional disparity of innovation ability leads to the low value of the whole country’s TFP contribution rate. In view of this problem, policy makers should intensify efforts to improve the innovation ability of Central and West China by some preferential policies while strive to enhance the East China. Only in this way can our country have a rapid and steady economic growth.

References

- [1] Hengqing Tong. Evaluation model and its iterative algorithm by alternating projection. Mathematical and Computer Modelling. vol. 18, no. 8, pp. 55-60, 1993.