The relationship between transport infrastructure and regional economic growth------A case study of China

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1. Introduction

A lot of theory studies and practices have proved the importance of economic growth. The shortage of infrastructure brings about "bottle neck" of the economic development. Looking from macro level, the quality of the supply of infrastructure decides the marginal productivity of private investment; in micro level, high quality infrastructure can reduce the product cost, and it can affect the supply-demand structure in economy. High quality infrastructure can led to the long-term economic growth.

According to the definition of "*World Development Report 1994*", infrastructure include (1) public utility: electricity, gas, telecommunications, water and sanitation and safe disposal of wastes-are central to the activities of households and to economic production, (2) public project: dam, irrigation and road, (3) other transportation facilities.

The empirical studies on the relationship of infrastructure and economic growth start from Aschauer[1], he considered the relationship between the government expense and economic growth. After Aschauer's paper, many researchers[2-7] start to focus on infrastructure, they use various methods evaluate the infrastructure in US.

This paper mainly focuses on the relationship between infrastructure and economic growth, China is taken as an example to consider the function of infrastructure in economic growth. Cobb-Douglas Production Function is estimated by Chinese data from the year 1985 to 2006.The value of marginal productivity of infrastructure investment is calculated.

2. Estimation of Infrastructure Stock in China from 1985 to 2008

Within all of the China statistical data, data of infrastructure stock could not be found. Hence, a proper method should be used to estimate the infrastructure stock of China.This study adopts perpetual inventory method to estimate the infrastructure of China. It origin from Goldsmith in 1951, it is now widely used in OECD countries. The function is as follow

$$G_t = I_{Gt} + (1 - \alpha_t) G_{t-1} \tag{A}$$

Once the base year of the infrastructure stock is set, the investment on infrastructure of every year depreciation rate of every year, and infrastructure stock can be obtained. G_t: infrastructure stock in the year t; I_{Gt}: investment in the year t;α_t: depreciation rate in the year t; G_{t-1}: infrastructure stock in year $t-1$.

The Chinese yearbook is used as data source. The investment of "Transport, Storage, Post & Telecommunication Services" and the investment of "Production and Supply of Electricity Gas and Water" is taken as the investment of infrastructure. According to the Chinese yearbook, the investment of infrastructure can be divided into 2 parts:

(1) The Investment in Capital Construction and Newly Increased of Infrastructure Department;
(2) The Investment in Innovation by Type of Construction of Infrastructure Department;

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The year 1985 is set as the base year, "Net Value of Fixed Assets of nation-owned" in the year 1985 is taken as the basic stock of the infrastructure. From Chinese yearbook , the stock of infrastructure of China in 1985 is 1613 ten million CNY.

Assume that the depreciation rate of capital is 5%($\alpha_t = 0.05$), The value of Capital Stock is from ZhangJun[8-9], his data (from 1985 to 2002) is used for the study and his method is also used to estimate the data from 2003 to 2007. Result is show as the following 2 figures:
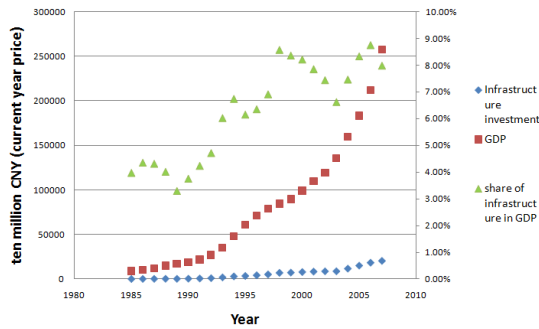

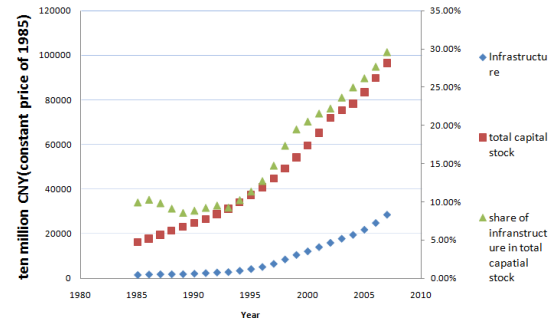
Figure 1: Infrastructure Investment and GDP

Figure 2: Infrastructure and total capital stock

The investment of infrastructure in China was increasing year by year, and the share of infrastructure stock in total capital stock was also increasing, from 9.97% in 1985 to 29.55 in 2007; and share of the investment of infrastructure in GDP is also increasing, from 3.98% in 1985 to 7.99% in 2007. This increase is the result of China government active fiscal policy. Both the amount and the share of infrastructure were increasing greatly.

3. Modeling Infrastructure Stock relationship between Economic Growth

Production function is a function that shows relation between the input and the output factors. In economic growth, only the abundance of labor is not enough, the accumulation of wealth and the improvement of technology is also very important. Hence, all of the factors that can affect the economic growth should be considered. Cobb-Douglas Production Function is a widely used function that can explain all of the factor above, and it is also proved to be useful and valid to China. In this study, a Cobb-Douglas Production Function is structured as follow:

$$Y_t = F(K_t, L_t, G_t, t) = A_t \cdot K_t^\alpha \cdot L_t^\beta \cdot G_t^\gamma \tag{B}$$

Where，$A_t = A_0 \cdot e^{rt}$

A_t means the technology is improved with time. In the function, Y_t stand for the GDP (constant price of some year)of the year t ; K_t stand for the stock (constant price of some year) of productive assets of the year t ; L_t stand for the number of labor in the year t ; G_t stand for the stock (constant price of some year) of infrastructure of the year t ; r stand for the speed of technology improvement ; α ,β ,γ stand for the output elasticity of productive assets, labor and infrastructure.

Because the function includes exponent item, it will be hard to deal with. Logarithm of both side of the Cobb-Douglas Production Function is alternated as follow:

$$y_t = a_t + e_K \cdot k_t + e_L \cdot l_t + e_G \cdot g_t \tag{C}$$

Where, $a_t = \ln A_t$, $e_K = \alpha$, $e_L = \beta$, $e_t = \gamma$, where e_i stand for the output elasticity of variable i ;$k_t = \ln K_t$, $l_t = \ln L_t$, $g_t = \ln G_t$.

According to the economic meaning of the equation, If ($\alpha + \beta + \gamma$) < 1, it means Decreasing returns to scale ; If ($\alpha + \beta + \gamma$) =1, it means Constant returns to scale; If ($\alpha + \beta + \gamma$) > 1, it means Increasing returns to scale.-

Production Function is assumed as constant returns to scale, then $e_K + e_L + e_G = 1$, the Cobb-Douglas Production Function can be alternated as follow:

$$y_t - l_t = a_t + e_K \cdot (k_t - l_t) + e_G \cdot (g_t - l_t) \tag{D}$$

Base on this equation (D), a sample data of Chinais used to estimate the parameters of the Cobb-Douglas Production Function.

The data is as follow: (1) GDP: can be obtained in the yearbook; (2) Labor force: can be obtained in the yearbook; (3) Stock of infrastructure: according to calculation of sector 2 ; (4) Stock of productive assets: Capital Stock - Stock of infrastructure .These data are shown in Figure3 and Figure 4.
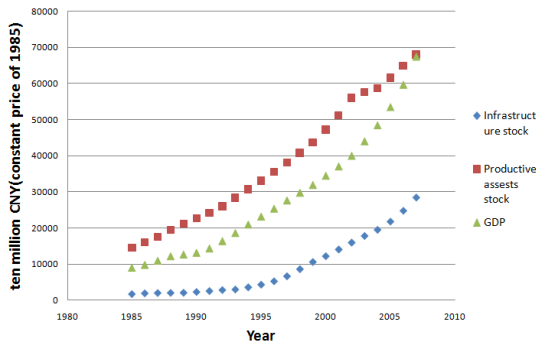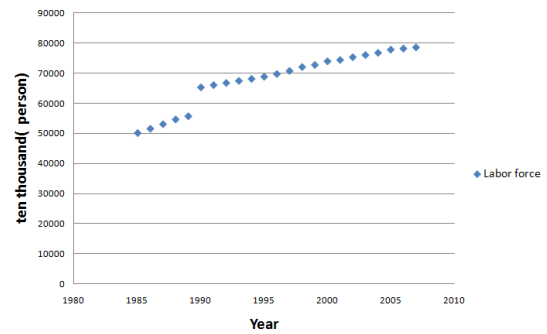

Figure 3: Stock and GDP

Figure 4: Labor Force

According to the estimation, Equation (E) and (F) can be identified:

$$y_t - l_t = -57.114 + 0.028t + 0.434 \cdot (k_t - l_t) + 0.159 \cdot (g_t - l_t) \tag{E}$$

$$Y_t = A_0 \cdot e^{0.028t} \cdot K_t^{0.434} \cdot L_t^{0.407} \cdot G_t^{0.159} \tag{F}$$

In this equation, all of the parameters are estimated. Assume that the other variables do not change, the increase of productive assets stock by 1% will lead GDP increase by 0.434%; the increase of infrastructure stock by 1% will lead GDP increase by 0.159%. It means that investment infrastructure is positive function to the economic growth.

4. Estimation of Marginal Productivity

How to evaluate the efficiency of investment? The question can be answered in the following analysis.According to the Cobb-Douglas Production Function (F), marginal productivity of the investment of infrastructure can be calculated as follow:

$$F_G = \frac{\partial}{(\frac{\partial G_t}{\partial t})} F(K_t, L_t, G_t, t) = e_G \frac{F(K_t, L_t, G_t, t)}{\frac{\partial G_t}{\partial t}} = e_G \frac{GDP_t}{\frac{\partial G_t}{\partial t}} \tag{G}$$

Where, F_G stand for marginal productivity of the investment of infrastructure, it means if 1 CNY is invested in infrastructure, GDP will increase F_G CNY; GDP_t stand for the GDP on time t.

According to the data. Then the marginal productivity of the infrastructure investment is obtained, meanly the Efficiency on infrastructure investment as follow:
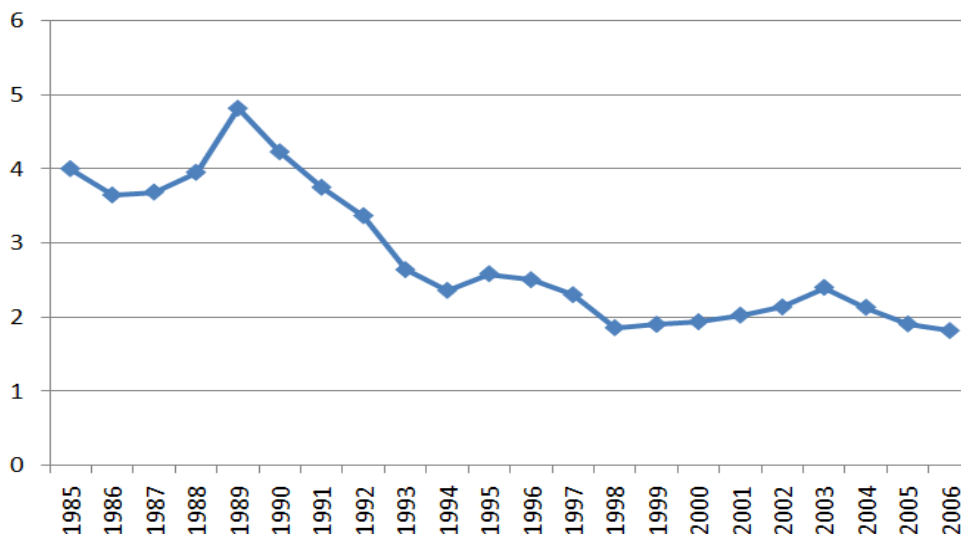

Figure 5: Efficiency of infrastructure investment (1985-2006)

The vertical axis of Figure 5 is the efficiency of the investment of infrastructure, if it is above 1, it means that the investment is efficient, because the investment in 1CNY will bring the more than 1CNY's increase in GDP.

Totally, the line is above 1, it means the infrastructure investment is meaningful and efficient for the economic growth. At the first, the efficiency is high, then it comes down to a value around 2, the value fluctuates at the value around 2.

(1)From 1985 to 1994: the efficiency increases first and then go down, it was because, at that time, China is short of infrastructure, the increase in investment would lead the change in GDP greatly, hence, the efficiency of infrastructure investment is getting higher from 1985 to 1989. From 1989 to 1994, the infrastructure stock is becoming bigger, the change in infrastructure investment did not change the infrastructure stock greatly. Hence, the efficiency comes down at that period.

(2)After 1994: the infrastructure stock is big, the infrastructure stock is not affected much by the investment, hence the efficiency of infrastructure investment comes down to around 2.

5. Conclusion

In this study, perpetual inventory method is used to estimate the infrastructure stock and total capital stock with the statistical data in Chinese yearbook. With these data, a Cobb-Douglas Production Function is structured to simulate the economic growth of China. The Production Function shows that the investment infrastructure in China had a relatively high rate of return.

Also, there are some improvement can be done in the research. The Cobb-Douglas Production Function can be amended more to fit for the actual situation, such as the item A_0 can be improved to fit for the reality, the capital stock can be divided much in detailed.

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