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Capital Accumulation and Economic Growth in China

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Abstract[1]

China has experienced high economic growth for more than 30 years. However from 2008 onwards, the economic growth rate has been declining. The main factor that affects China's economic growth is investment, which has dual roles- investment spending in demand side and increasing production capacity in supply side.

The purpose of this paper is to examine the dynamic role of investment in China's economic growth. Based on revised Harrod model, we analyse the investment decision in a dynamic process. Estimating the "required" marginal capital-output ratio for entrepreneurial equilibrium (the warranted growth), we estimate the investment function and examine the relation between excess capacity and investment growth in China.

China's (actual) marginal capital–output ratio has exceeded the required marginal capital-output ratio since 2008. In this situation, investment growth rate and the economic growth rate decrease, which lead to increasing of the marginal capital-output ratio that causes the cumulative process.

Key Words: Economic Growth, Investment Function, Harrod

[1] This paper is a revised version of a paper presented to BACS Annual Conference 2014 at Newcastle University UK on 5th September 2014.

1. Introduction

China has experienced high economic growth for more than 30 years. However from 2008 onwards, the economic growth rate has been declining and excess production capacity has become a large concern in China. The main factor that affects China's economic growth is investment, which has dual roles, that is, investment spending in demand side and increasing production capacity in supply side.

The purpose of this paper is to examine the dynamic role of investment in China's economic growth. Based on revised Harrod model, we analyse the investment decision in a dynamic process. Defining the "required" marginal capital-output ratio for the warranted growth, we estimate the investment function and examine the relation between excess capacity and investment growth in China.

China's (actual) marginal capital–output ratio has exceeded the required marginal capital-output ratio since 2008. In this situation, investment growth rate and the economic growth rate decrease, which leads to increasing of the marginal capital-output ratio that causes the cumulative process.

The rest of this paper is structured as follows. Section 2 presents investment's contribution to economic growth in China. Section 3 provides the theoretical framework of our analysis. Section 4 presents the estimation of investment function of China. Section 5 presents the conclusion.

2. Economic Growth and Demand in China

In this section, to understand the composition of GDP growth, we decompose demand and examine the contributions of each component to economic growth. Contributions of each demand component to economic growth can be shown as equation (1.1).

$$\frac{\Delta Y}{Y}=\frac{\Delta C}{C}\frac{C}{Y}+\frac{\Delta I}{I}\frac{I}{Y}+\frac{\Delta J}{J}\frac{J}{Y}+\frac{\Delta\left(E-M\right)}{\left(E-M\right)}\frac{\left(E-M\right)}{Y} \tag{1.1}$$

Where Y is GDP, C is consumption, I is investment, J is inventory, E is export and M is import. Right hand side shows the contributions of each component to economic growth.

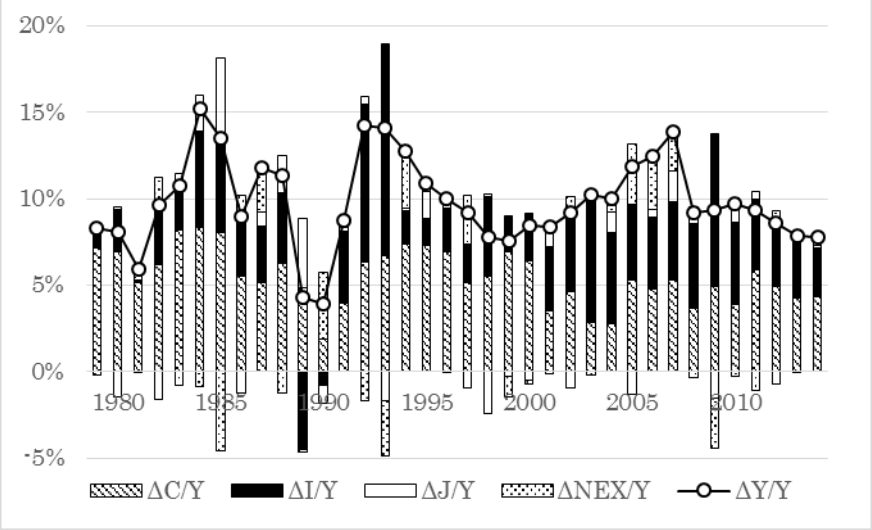
Using China's official data for the period 1978-2014 we have applied equation (1.1) to China. Fig. 1 shows demand side contributions to economic growth in China. In this paper, GDP is calculated by expenditure approach. Consumption(C) includes both private and government consumptions. Investment (I) is gross investment and includes private, government and residential investment.

China's average real economic growth rates are 10.05% during 1978-2007 and 8.84% during 2008-2014. From 2008 onwards, the economic growth rate has been declining. In China, consumption(C) and investment (I) are two major components contributing to the economic growth. In 1992-1993, 2002-2004 and 2008-2010, investment makes largest contributions to the real economic growth. However, compared to relatively stable positive contributions of consumption, contributions of investment show unstable movements and cause fluctuations of GDP growth rate.

External demand (net export) plays a smaller and unstable role before 2005. During the period 2005-2007, net export (NEX in Fig.1) for the first time makes three consecutive years' large positive contributions to the growth.

From this decomposition analysis, we can see China's economic growth has been mainly driven by internal demand and fluctuation of GDP growth rate is affected especially by Investment.

Fig.1 Real Economic Growth and Demand Contribution



Source: Calculated by author using the data from National Bureau of Statistics of China.

Note: GDP(Y) is calculated by expenditure approach.

3. Theoretical Framework

In this section we present the theoretical framework of our analysis. Using the Harrod type model, we analyse the dynamic process in which the production capacity is changed by investment.

New investment (I) generates the increase in the capital stock K.[2]

$$I=\Delta K \qquad (2.0)$$

From the product market equilibrium, the change of capital stock equals the saving.

$$I= sY \qquad (2.1)$$

Where s represents a saving rate and Y represents the quantity of output (GDP).

Let's denote **C** marginal capital coefficient. C is the accretion of capital divided by the increment of output.

$$C = \Delta K/ \Delta Y \qquad (2.2)$$

From (2.1) and (2.2), **actual growth rate of GDP (G)** can be written as follows:

$$G = s/C \qquad (2.3)$$

Actual growth rate G does not mean a desirable rate for the company. And actual marginal capital coefficient C does not mean a desirable value for the company. There could be an excess or deficiency of capital.

When the increment of product induced by the increment of capital is fully sold, the investment is warranted. **The warranted growth rate Gw** is determined by

$$Gw = s/Cr \qquad (2.4)$$

Cr is required marginal capital coefficient for the company.

When C equals Cr, the company decides to keep ongoing growth rate Gw. In that meaning Gw is an equilibrium growth path. But this equilibrium is unstable.

From (2.3) and (2.4), Harrod tries to prove the instability of the equilibrium. When C is different from Cr, G also deviates from Gw. The change of G can be written as a function of the difference between C and Cr.

$$\Delta G = f(Cr-C), \quad f(0) = 0, f'>0 \qquad (2.5)$$

[2] In this theoretical framework, we ignore capital depreciation. So new investment generates an increase of capital stock.

Equation (2.5) shows that if Cr=C, the company decides to keep ongoing growth rate (Gw). And if Cr>C, actual growth rate G increases and if Cr<C, G decreases.

Substituting (2.3) to (2.5), we have

$$\Delta G = f(Cr - s/G) \qquad (2.5)'$$

Equation (2.5)' shows ΔG is negatively related to G, which proves the instability of the warranted growth path.

From (2.0) and (2.1), (2.5) can be written as follows:

$$\Delta Ig = g(Cr-C), \quad g(0) = 0, \ g'>0 \qquad (2.6)$$

(2.6) shows that the change of **Investment growth (Ig)** is positively affected by Cr-C.[3] From (2.6) we can interpret the investment decision of the company and instability of equilibrium growth path Gw. Using the discrete time, equation (2.6) can be written as follows.

$$Ig(t)-Ig(t-1) = a + b(Cr(t-1)-C(t-1)) \qquad (2.7)$$

Here *t* presents time.

If in the previous year C is smaller than appropriate marginal capital coefficient Cr, the company thinks there is **deficiency of capital**. So in this year the company increases the investment growth rate **Ig** to solve the deficiency of capital in the previous year. Then the Ig increase causes the increase of aggregate demand growth and increase of G in the current year. When production growth rate G increases, marginal capital coefficient **C decreases** in this year**.**

Using the discrete time, marginal capital coefficient can be presented as,

$$C(t) = \Delta K(t-1) / \Delta Y(t) \qquad (2.2a)$$

Capital stock $K(t)$ represents the amount of capital at the end of the period (t).

$$\Delta K(t) = K(t) - K(t-1)$$

As shown in (2.2a), while the investment growth of this year increases the aggregate demand in current year $\Delta Y(t)$, increase of production capacity is determined by the investment growth of the last year. So when investment growth rate increases, marginal capital coefficient decreases.

This means the deficiency of capital gets worse this year. So the company decides to increase the investment growth rate **Ig** in the next year. This investment decision generates the cumulative upward growth process.

On the contrary, when C is larger than Cr, the company thinks there is **excess of capital**. So it decreases the investment growth rate **Ig** to solve the excess of capital. **Ig** decrease causes aggregate demand decrease and decrease

[3] It is based on Okishio (1977). Harrod didn't show the investment function explicitly.

of G. Then the decrease of G makes **C increase**. This means the excess of capital gets worse, which make the company decide to decrease the investment growth rate **Ig** in the next year.

In our model, the company has a required marginal capital coefficient **Cr** with which it judges whether the current C shows the excess or deficiency of capacity. In next section, we will define **Cr**.

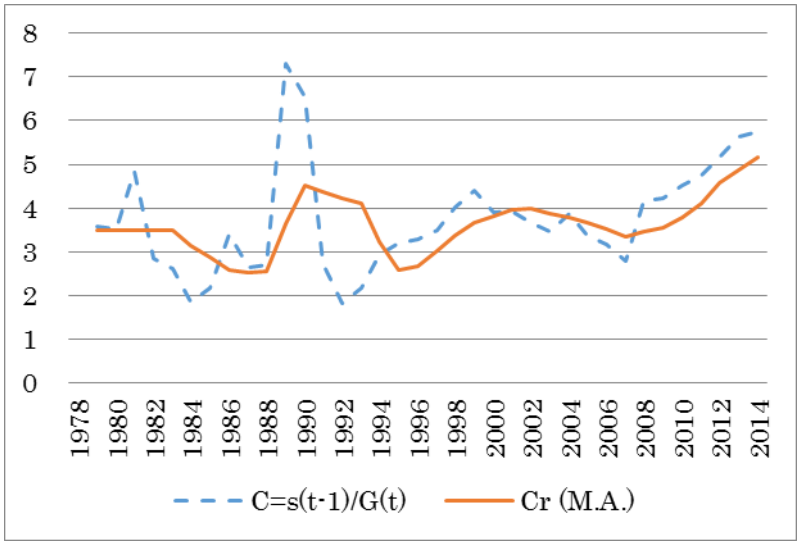
4. Estimation of Investment Function

In this section, we use Chinese official data from National Bureau of Statistics of China for the period 1978-2014 to estimate equation (2.6) by OLS (Ordinary Least Square).

4.1 Estimation of Cr

To estimate the investment function, we have to define the required marginal capital coefficient **Cr. Cr** could change depending on the economic situation. So we define Cr as a moving average of C. We estimate a 5-year moving average of C.

Fig.2 Transition of C and Cr in China



Source: Calculated by author using the data from National Bureau of Statistics of China.

Note: Cr is calculated as a 5-year moving average of C.

Fig.2 shows the transition of C and Cr (5-year moving average) in China. Excluding the idiosyncratic values in 1989 and 1990, C is smaller than Cr during the period 1982-1994 and 2001-2007. During the period 1995-2000 and from 2008 onwards C increases and is larger than Cr.

Comparing Fig.2 with Fig.1, we can see that GDP growth rate (G) decreases during the period of C>Cr.

4.2 Estimation of Investment Function

Having got the values of Cr, we now turn to the estimation of the investment function of China. We estimate equation (2.6) by OLS (Ordinary Least Square) for the period 1978-2014.

Model 1

Using the discrete time, equation (2.6) can be written as follows.

$$Ig(t)-Ig(t-1)= a + b(Cr(t-1)-C(t-1)) \qquad (2.7)$$

As described in section 3, in this model a dependent variable is the change of investment growth rate Ig. An independent variable is Cr-C in the previous year.

Estimation result of equation (2.7) is

$$Ig(t)-Ig(t-1) = -0.0039547 -0.0261244[Cr(t-1)-C(t-1)] \qquad (2.7a)$$
$$(0.21)^{4} \qquad (1.54)$$
$$\text{Adj-R-square= 0.0435,} \qquad N=31$$

In investment function (2.7a), the coefficient of Cr-C is statistically insignificant.

Model 2

As equation (2.7) can't be adopted, we will estimate the more general version of (2.7) as shown below.

$$Ig\ (t) = a + b\ (Cr\ (t-1)-C\ (t-1)) +c\ Ig\ (t-1) \qquad (2.8)$$

[4] Figures in parentheses are t-values of estimates.

In equation (2.8), a dependent variable is investment growth rate **Ig** in the current period. And (2.8) has a lagged variable Ig (t-1) as an independent variable. (2.8) is a modified version of (2.7). If the coefficient c of previous investment growth is unity, equation (2.8) is exactly same as equation (2.7).

Estimation Result of equation (2.8) is

$$Ig\ (t) = 0.1462221 + 0.0565822[Cr\ (t-1)-C\ (t-1)] - 0.1682067 Ig\ (t-1) \quad (2.8a)$$

(3.63) (2.29) (0.57)

Adj-R^2=0.2289 N=31

In investment function (2.8a), the coefficient of Ig (t-1) is negative and statistically insignificant.

Model 3

As equation (2.8) can't be adopted, we will estimate another equation as follows.

$$Ig\ (t) = a + b\ (Cr\ (t-1)-C\ (t-1)) \quad (2.9)$$

In equation (2.9), a dependent variable is investment growth rate **Ig** in the current period and an independent variable is (Cr-C) in the previous year only. (2.9) is quite different from (2.7) and (2.8), as in (2.9) investment growth of the current year is not affected by the investment growth in the previous year.

Estimation Result of equation (2.9) is

$$Ig\ (t) = 0.1245986 + 0.0446735\ [Cr\ (t-1)-C\ (t-1)] \quad (2.9a)$$

(8.16) (3.29)

Adj-R^2=0.2465 N=31

In investment function (2.9a), the coefficient of (Cr-C) is significantly positive. From the estimation result of (2.9), we found that Investment growth rate Ig in the current period is positively affected by (Cr-C) in the previous year.

Having the investment function (2.9a), the cumulative process of economic growth can be explained in China. The investment growth in the current year

negatively affects the marginal capital coefficient in the same year, which negatively affects (Cr-C) in the current year. Then (Cr-C) in the current year positively affects the investment growth rate in the next year as (2.9a) shows.

Based on the investment function (2.9a), we can explain the slowdown of the economic growth in China since 2008. In China, from 2008 to 2014, actual marginal capital coefficient C has been exceeding the required marginal capital coefficient Cr. And (Cr-C) has been decreasing. Being affected by this, investment growth rate has been declining from 2010 onwards, which has made the (Cr-C) decrease in the same year. Thus in China cumulative downward process has occurred.

5. Conclusion

In this paper, we examined the dynamic role of investment in China's economic growth. Based on Harrod model, we constructed a dynamic model including investment function and try to explain China's economic growth.

The contribution of this paper is defining and estimating the required marginal capital coefficient Cr and estimating the investment function using calculated Cr.

Based on a revised Harrod model, we estimated the investment function (2.7) in which the change of investment growth is a dependent variable. But from the estimation result we found that it can't be adopted. So we estimated the modified investment function (2.8) which has a lagged investment growth Ig as an independent variable. However from the estimation result we found that it can't be adopted.

So we estimated another investment function (2.9) in which the investment growth of the current year is not affected by the investment growth in the previous year. From the estimation result of (2.9), we found that Investment growth rate Ig in the current period is positively affected by (Cr-C) in the previous year. Based on the investment function (2.9a), we can explain the slowdown of the economic growth in China since 2008.

Reference

Harrod Roy F., *Economic Dynamics,* Macmillan Press, 1973.

Harry X. Wu, "Accounting for China's Growth in 1952-2008 : China's growth performance debate revised with a newly constructed data set", *RIETI Discussion Paper Series 11-E-003*, 2011.

Harry X. Wu, "Constructing China's Net Capital and Measuring Capital Services in China, 1980-2010", *RIETI Discussion Paper Series 15-E-006, 2015.*

Hiroko Hagiwara, "Effects of Declining Population Growth on Economic Growth", *Shodai Ronsyu,Vol.55, No.3/4, 2004.*

Hiroko Hagiwara, "Economic Growth and Capital Accumulation in China", *Shodai Ronsyu, Vol.65, No.3*, 2014.

Nobuo Okishio, *Gendai Keizaigaku (Modern Economics),* Chikuma Shobo, 1977.

National Bureau of Statistics of China, *China Statistical Yearbook,* various years.