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**How the Changes in Exchange Rate  
Affect the Chinese Economic Growth?**

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# Abstract

This paper examines how the exchange rate affects Chinese economic growth. First, we go through the literature about exchange rate and how it affects the economic growth. We respectively analyze the transmission mechanism of RMB real effective exchange rate on the impact of Chinese import, export and foreign direct investment. We use the quarterly data from 1994 to 2016 and the method of cointegration test, Granger Causality test. From the test we found that the appreciation of RMB has a negative effect on Chinese economic growth. Further more, the correlation between total export and real effective exchange rate is negative. Meanwhile, the correlation between total import and real effective exchange rate is negative. For FDI, we found that the appreciation of RMB will decrease FDI.

Key words: real effective exchange rate, economic growth, import, export, foreign direct investment.

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# 1. Introduction

China as the second largest economy in the world is getting more and more attention. Before 1994 China applied the fixed exchange rate system and dual pricing system. In 1994 China changed to managed floating rate. Since then the Chinese currency pegged to U.S dollar. Before 1997, RMB remained stable but appreciated. In 1998, because of the Asian financial crisis, Chinese government narrowed the interval of RMB's floating to defend the crisis. After the Asian financial crisis, Chinese economic entered a fast growing era. Right before 2005, the current account and capital account both had a surplus which leads to the imbalanced international payments. At the end of 2005, the foreign exchange reserve of China was 11 billion U.S dollars. On July 22, 2005, the People's Bank of China (central bank of China) announced that China would no longer peg to U.S dollar but changed into a managed floating exchange rate regime based on market supply and demand with reference to a basket of currencies. Before the reform of RMB exchange rate, the exchange rate between RMB and USD was approximately 8.2765. From that, RMB is on a track of appreciating. At the end of 2013, the exchange rate between RMB and USD reached 6.0408. But after that point, it started to depreciate again especially since the last half of 2015. From 2012, the growth of Chinese economic has been slowed down compared to previous years. The growth of GDP was around 7%, and the sudden change of exchange rate draw a lot of attention. At the end of 2015, the IMF announced that RMB is part of the SDR (Special Drawing Right). The SDR is an international reserve asset. As of March 2016, 204.1 billion SDRs (equivalent to about \$285 billion) had been created and allocated to members. SDRs can be exchanged for freely usable currencies. The value of the SDR is based on a basket of

five major currencies—the U.S. dollar, euro, the Chinese RMB.

In this paper, we go through literature related to exchange rate, economic growth and the effect of exchange rate regime on economic growth. We define the concept of economic growth, exchange rate and how to calculate it. From the literature we think it is appropriate to study how the changes in exchange rate affect the economic growth through two channels: one is export and import, another one is foreign direct investment. We analyze theoretically how exchange rate will affect the economic growth through these two channels. After this, we introduce how Chinese exchange rate regime transformed which is unique all over the world. It's also quite important to figure out the current situation of Chinese macro economy, including gross domestic product (GDP), import and export trade and foreign direct investment (FDI). Next, we study the changes of RMB real effective exchange's impact on Chinese gross domestic product, import, export and foreign direct investment from the intuitive model. We used the first quarter of 1994 to last quarter of 2016 data respectively study the relationships between the RMB real effective exchange rate and gross product, import, export trading and foreign direct investment in China. And get some conclusion from the study may help the authority.

## 2. Literature review

Early studies about how changes in the exchange rate affect economic growth focused on developed countries in Europe and North America. The main effects of the changes in exchange rate on economic growth are exchange rate's relative wealth effect, price effect, and interest rate effect. Kenneth A. Froot & Jernemy C. Stein brought up the relative wealth effect in 1991. Their study finds that because of the difference of the individual's wealth position when the real exchange rate changes the wealth position also changes. When the real exchange rate depreciates domestic individuals' wealth will relatively decrease. When the real exchange rate appreciates, domestic individuals' wealth will increase. Changes in exchange rate also affect the foreign individuals' wealth; the appreciation of the real exchange rate will make those foreign individuals who hold possession of the currency's wealth decrease. Exchange rates affect the domestic and foreign individuals' wealth positions, which leads to different demands on consumption and investment that eventually affect the economic growth.

The real exchange rate's price effect is when the changes in the real exchange rate affect two kinds of products' (tradable and untradeable products) relative price. The shifts in the relative price of these two products will change the demand for these two products in one country, which will reallocate the resources in the process of manufacturing them.

Studies from Obstfeld & Rogoff (1996) brought up the interest rate effect. The interest rate is the domestic price of the currency and exchange rate is the foreign price of the currency. They think that a country's real interest rate is affected by one's exchange rate and the changes in one's interest rate will affect economic

growth. When a country's real exchange rate appreciates, the difference between domestic interest rate and the foreign country becomes bigger and cannot be changed in a short time. The domestic real interest rate will increase which is not good for foreign and domestic investment, which blocks the economic growth.

There are three main opinions about how exchange rate affects the economic growth from empirical studies.

First, the depreciation of one currency has a deflationary effect on economic growth meaning that the depreciation is bad for economic growth. Rogers and Wang(1995) used Mexican data from 1977-1990. They identified five shocks: fiscal, real, money growth, exchange rate, and asset shocks. They use these five shocks as variables conducted a VAR model. It shows that output is influenced primarily by real shocks. When the exchange rate depreciates, the economic growth slows in a small range. Kamin & Rogers (2000) used American data from 1981-1995 and conducted a VAR model. It contains three endogenous variables: real exchange rate, inflation rate, and real GDP. The exogenous variable is the interest rate. In their study, they found that if the country's currency is depreciating for an extended period, it has a negative influence on the economic growth.

Second, the study from Paulo Gala (2008) presented new econometric evidence for the exchange rate levels and growth relation based on Purchase Power Parity (PPP) deviations. It shows that a negative relationship between growth and overvaluation for a panel of 58 developing countries from 1960-1999 using PPP measures. The study also takes changes in average income into account.

Third, impacts of the changes in the exchange rate to the economic growth are uncertain.

Edwards (1989) selected a few developing countries' data as samples. He found that the changes in the exchange rate have opposite effects in different periods of time. In a long period, if one's currency is depreciating, it has a positive impact on

economic growth. In short time, it has negative consequences. Huang & Malhotra (2005) studied 12 developing countries in Asia and 18 developed countries in Europe from 1976 to 2001 try to figure out the connection between exchange rate regimes and economic growth. Their study shows that for developing countries in Asia the choice of exchange rate regimes impacts the economic growth more than those European developed countries.

A lot of researchers in China conducted empirical studies on the base on those studies I mentioned before. Most of the focus on what would the appreciation of the Chinese RMB do to the economic.

Li & Yu (2003) studied the effect on the significant Chinese RMB's appreciation during Asian financial crisis and world economic recession. They found out that the significant increase in the effective exchange rate of Chinese RMB in a short period has a negative effect on Chinese and world's economic growth. Weiwu Li (2005) used VAR model found that the depreciation of the real exchange rate of Chinese RMB boosts the economic growth. It also studied the different response to Chinese RMB's depreciation from different developing countries. Lu & Chen (2007), they take GDP into consideration, conducted a model between exchange rate and economic growth. Their empirical study shows that if the appreciation is not a lot, the impact will be limited. From 1995-2005 the real effective exchange rate of Chinese RMB increased 1%, the economic growth rate decreased 0.12%. At the same time, export and import rate fell by 2.370% and 2.192%. In 2008 Xiliang Zhao found that the appreciation of the currency has an entirely different impact on developed countries and developing countries. In developed countries, if the exchange rate appreciates it will boost the economic growth but in developing countries, it will slow down the growth. Kai Wang (2010) thinks that it is uncertain how the exchange rate affects the economic growth. In the long run, the depreciation of Chinese RMB is good for the economic growth, but in a short time, depreciation has a negative impact on economic growth. Li, Su & Zhong (2014) based on Ramsey- Cass-Koopmans model studied the changes in the exchange rate



and its impact on economic growth. They think that the REER of Chinese RMB has a relevantly stable relationship with economic growth. But the increased capital intensity, technology improvement, and money supply will increase a country's economic growth rate.

Some researchers also from pass-through effect, export and import and foreign direct investment perspectives studied how the changes in the exchange rate will affect economic growth. Zhang & Lu (2005) use VAR model studied the relations between the real exchange rate of Chinese RMB and foreign trade from 1994 to 2003. It shows that changes in the real exchange rate of Chinese RMB have a significant impact on foreign trades. Longchui Cao (2006) brought up that the exchange rate is not the main factor that can affect Chinese balance of trades. Weixian Wei (2006) thinks that the appreciation of Chinese RMB has a bad effect on export but boots import. The faster Chinese RMB appreciates the bigger impact it has on the labor-intensive industries. An & Huang (2009) established China-US and China-Japan models to study how changes in the exchange rate can affect the foreign trading. Changes in the exchange rate had a negative impact on international trading especially during 2008 when the financial crisis took place. The appreciation of Chinese RMB and the transition of exchange regime cannot offset that negative impact. Wangqing Lu (2010) thinks that if Chinese RMB appreciates, Chinese labor-intensive industries will lose competitive advantages and it will lead to the deterioration of Chinese balance of trades. Fang Ye (2014) analyzed the data from 1994 found that changes in exchange rate affect the foreign trading through the structure of trading products, ways of trading, and the disruptions of foreign trading. Yu and Zhao (2007) studied how changes in exchange rate affect foreign direct investment. The appreciation of Chinese RMB will harm the foreign direct investment in China. Pan & Guo (2012) used Pesaran bound testing method to analyze the dynamic relations between the exchange rate of Chinese RMB, foreign direct investment (FDI) and economic growth. The appreciation of Chinese RMB is beneficial for foreign direct investment.

Also, a lot of researchers studied the relationships between the exchange rate regime and economic growth. First of all, economic theory does not noticeably explain how the exchange-rate regime affects economic growth. But there are a lot of arguments on the exchange rate regime and its impact on investment and import and export trades. Ghosh A R, Gulde A M & Ostry J.D(1997) think that a peg has a positive effect on investments and a float can produce a faster productivity growth. Gylfason, T. (2000) discussed the pros and cons of fixed versus flexible exchange rate regimes under perfect capital mobility from a European perspectives. He thinks that fixed exchange rate may lead to faster output growth in the medium and long run because it supports the openness to international trade better. Levy-Yeyati, E. & Sturzenegger, F. (2002) argue that the relation between exchange rate regime and economic growth does exist, but the sign of it is unclear. Bailliu (2003) mentioned that the exchange rate regime's influence on economic growth could be direct or indirect. Flexible exchange rate regime can react faster and easier to accommodate and absorb economic shocks.

Empirical research has given different opinions to how the exchange rate regime affects the economic growth. Mundell(1995) use the data from US, JAPAN, Canada, EC and other European countries since 1947 to 1993. He found out that there is higher growth under generalized pegging. Edwards and Levy-Yeyati (2003) conduct an empirical study on 183 countries from 1947 to 2000. They think that under the fixed exchange rate regime the growth is lower compared to a flexible regime. De Grauwe and Schnabl (2004) think that pegged exchange rate does not slow the economic growth down. There is also a lot of studies show that the relationships between exchange rate regime and economic growth are inconclusive. Husain (2004) says that pegs do not harm growth. Meanwhile, the flexible regime does not boost the growth rate.

In the process of going through literature, we find that there are only a few English papers are focused in China since the exchange rate regime is relatively more complicated than others. Meanwhile, most of the Chinese studies only covered the partial relationships between the appreciation of Chinese RMB and the economic

growth. There are only a few papers that examined the channels of the changes in exchange rate's effect on economic growth in China. In this article, we will study the changes in exchange rate's effect on economic growth from two main channels: export and import, foreign direct investment. A lot of paper also selected annual data from 1985 to early 2000's. But there are some major changes after the beginning of 2000's. We choose the quarterly data from 1994 to 2016, which can increase the observations and the accuracy of the empirical study. But the transfer mechanism between exchange rate and economic growth is complicated. In this paper, we only break it down into two channels, which is a lot simpler than the real mechanism. We also failed to find a way to determine the role that exchange rate regime is playing, since there are a lot of different studies holding an entirely different point of views and the particularity of Chinese exchange rate regime. Our paper used more ordinary method and model instead of the general equilibrium theory.

## 3. Theoretical analysis

### 3.1 Definition and the calculation of exchange rate

The definition of the exchange rate is the price of one currency regarding another currency. Exchange rates can be either fixed or floating. Fixed exchange rates are decided by central banks of a country whereas floating exchange rates are decided by the mechanism of market demand and supply.

NEER is the nominal effective exchange rate. NEER is a measure of the value of a currency against a weighted average of several foreign currencies. The way to calculate is:

$$NEER = \sum_{i=1}^N \frac{Trade_i}{Trade} \times \frac{E_i}{E_{hi}} \times 100$$

$N$  is the number of countries who are trading with the home country.  $Trade_i/Trade$  means home country and another country's trade/ home country's total trade.  $E_i$  means the selected country's exchange rate against the home country's currency.  $E_{hi}$  is the selected country's exchange rate against the home country's currency on base period. Since the exchange rate in the calculation is using an indirect quotation, therefore an increase in NEER indicates an appreciation of the local currency against the weighted basket of currencies of its trading partners.

REER is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. An increase in REER implies that exports become more expensive and imports become cheaper; therefore, an increase indicates a loss in trade competitiveness. The way to calculate REER is:

$$REER = \sum_{i=1}^N \frac{Trade_i}{Trade} \times \frac{E_i}{E_{hi}} \times \frac{DCPI_t}{(FCPI_i)_t} \times 100$$

$DCPI_t$  means the home country's domestic CPI on base period.  $FCPI_i$  means the home country's trading partner  $i$ 's CPI on the same base period.

The difference between NEER and REER is the REER is the weighted average of NEER adjusted by the ratio of domestic price to foreign prices. REER captures inflation differentials between China and its major trading partners and reflects the degree of external competitiveness of one country's products. It captures movements in cross-currency exchange rates.

## 3.2 Theoretical background

The economic growth we mentioned in this paper means the real product growth. In this paper, we use GDP to measure the economic growth. From the method of calculating GDP, we know that

$$Y = C + G + I + X - M$$

Here  $Y$  means actual output,  $C$  represents consumption,  $G$  means government purchases.  $I$  means investment,  $X$  means export and  $M$  represents import. From this equation, we can see that the exchange rate is only a major effect for international trades and finance. This is the reason why we choose to break the economic growth into two parts: one is the import and export; another one is foreign direct investment. However, it is possible that exchange rate can affect the economic growth from other channels like consumption and government purchases. Because of the limitation of acquiring data and other reasons, in this paper, we just selected these two channels to conduct the research.

### 3.2.1 The transmission mechanism of changes in real effective rate's effect on trades

There are a few main theories about the relationship between exchange rate and

import and export. The elasticity approach, the multiplier theory, the absorption approach and the monetary approach. In all these theories, the elasticity approach is the most representative theory. The elasticity approach to the balance of payments demonstrates how the change in the value of the currency affects a country's balance of payments.

### **The mechanism of the elasticity approach**

The elasticity approach to the balance of payment is associated with the Marshall-Lerner condition, which was worked out independently by these two economists. It studies the conditions under which exchange rate changes restore equilibrium in the balance of payment by depreciating a country's currency. This approach is related to the price effect of depreciation.

### **Marshall-Lerner Condition**

The analysis is based on following assumptions:

- a. Supplies of exports are perfectly elastic
- b. Product prices are fixed in domestic currency
- c. The price elasticities of demand for export and imports are arc elasticities
- d. Price elastic refer to absolute values
- e. The country's current account balance equals to its trade balance

Under these assumptions, if one country's currency is depreciating, the domestic prices of the imports are raised and the foreign prices of its exports are decreased. The depreciation helps to improve the balance of payment of a country by increasing its exports and decreasing its imports. We assume that  $D_x$  is the demand elasticity of export and  $D_m$  is the supply elasticity for imports.  $S_x$  is the supply elasticity of export and  $S_m$  is the supply elasticity of import. When:

$$|D_x| + |D_m| > 1$$

The sum of price elasticities of demand for exports and imports in absolute terms is greater than one; depreciation will improve the country's balance of payments. On the contrary, if the sum of price elasticities of demand for exports and imports in absolute terms, is less one, will worsen (increase the deficit) the balance of payment. If the sum of these elasticities in absolute terms is equal to unity,  $|D_x| + |D_m| = 1$ ,

depreciation has no effect on the balance of payment situation which will remain the same.

The most important assumption of Marshall-Lerner Condition is the supplies of exports and imports are perfectly elastic. But in real world, this assumption is invalid since one country may be unable to increase the supply of its exports when the products become cheap with depreciation of its currency.

### **Bickerdike-Robinson-Metzler Condition**

We assume  $EM$  is the total net export;  $P_x$  is the domestic price of export product;  $P_x^*$  is the foreign price of exports.  $P_m$  is the domestic price of imports;  $P_m^*$  is the foreign price of imports.  $X$  is the total export and  $M$  is the total import.  $e$  is the nominal exchange rate. Where:

$$EM = P_x^*X - P_m^*M$$

If there is no trade restriction:

$$P_x = P_x^*e; P_m = P_m^*e$$

$$\frac{dEM}{de} = P_m^*M \left[ \frac{-D_x(1 - S_x)}{S_x - D_x} - \frac{S_x(1 + D_x)}{S_m - D_m} - 1 \right]$$

Where  $D_x$  is the demand elasticity of export and  $D_m$  is the supply elasticity for imports.  $S_x$  is the supply elasticity of export and  $S_m$  is the supply elasticity of import.

From the equation above we can see that if one country's currency depreciates can improve the balance of payment of that country then:

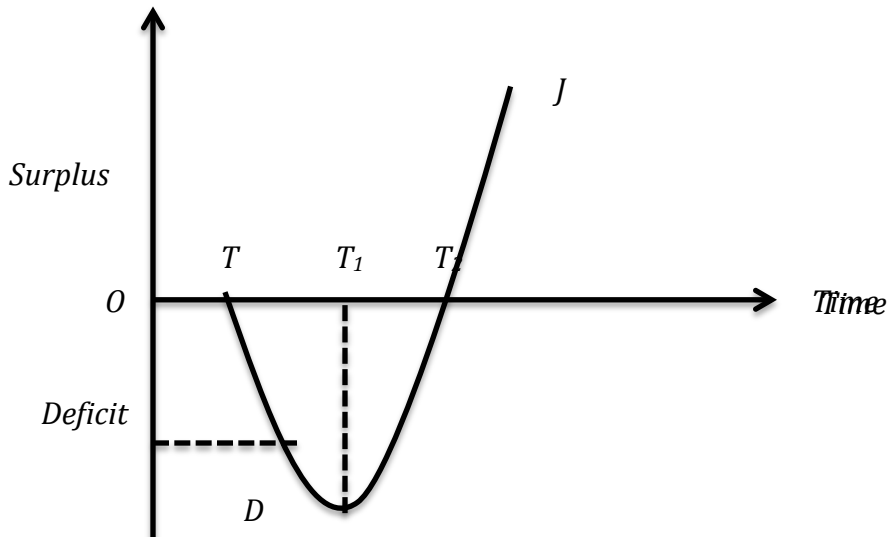
$$\frac{-D_x(1 - S_x)}{S_x - D_x} - \frac{S_x(1 + D_x)}{S_m - D_m} - 1 > 0$$

The equation above is the condition when the supplies of exports and imports are not perfectly elastic the depreciation can improve balance of payment.

### **J-Curve Effect**

Empirical evidence shows that Marshall-Lerner condition can be applied in the majority of advanced counties. Still researchers in general agree that both demand

and supply elasticities will be greater in long time period than in the short time period.



*The J-curve effect graph*

Therefore, the depreciation makes the balance of payment worse in the short time period then improves in the long run. In the beginning, imports and exports do not change as fast as the exchange rate. Products are still trading with the agreed price as before until  $T$ . From  $T$  to  $T_1$ , the price of import and export products changed with the exchange rate's change. But the volume of trading in short time period is slow. From  $T_1$  to  $T_2$ , the type and the volume of the trading products begin to change. This is when the exchange rate start to affect the import and export. The trading situation will change in this country.

However, if the country has flexible exchange rate regime, balance of payment will get worse when there is depreciation on its currency. Due to depreciation, there is an excess supply of currency in the exchange market, which may depreciate the currency. As a result, the foreign exchange market will be unstable and the exchange rate of the currency may overshoot.

### **3.2.2 The transmission mechanism of changes in real effective rate's effect on foreign direct investment**



There are also quite many different theories on how the exchange rate affect foreign direct investment.

Aliber in 1970 brought up that the differences in the strength of the currencies in host and source country. He thinks that weaker currencies compared with stronger investing country currencies had a higher capacity to attract foreign direct investment to take advantage of differences in the market capitalization rate.

Kojima brought up that the better local firms were pushing the worse firm out of the domestic market to overseas. And then the weaker companies move to other developing countries. He conducted the study based on Japanese foreign direct investment outflow from Japan. But this theory didn't explain the expansion overseas of domestically successful firms.

In this paper, we based on the research of Sun & Liu and divided into two parts: the cost-oriented foreign direct investment and market-oriented foreign direct investment.

### **Cost-oriented foreign direct investment**

We assume foreign direct investment  $I^*$  are mainly used to purchase productive input like labor  $L$  and capital  $K$ . The quantity of products is  $Q$ , assume that product price is  $P^*$ ,  $w$  is the unit price of labor,  $r$  as the unit price of capital.  $e$  is the indirect quotation of the exchange rate.  $A$  means the capability of the firm.

If the foreign direct investment wants to have maximum profits:

$$\text{Max } P^*Q - I^*$$

$$s.t \quad \begin{cases} Q = \max(AL^\alpha K^\beta) \\ \frac{I^*}{e} = wL + rK \end{cases} \quad \alpha + \beta < 1 \quad (a)$$

We assume that the foreign direct investment follow Cobb-Douglas production function and  $\alpha + \beta < 1$ .

We use the method of Lagrange multipliers to get the new object function:

$$I = AL^\alpha K^\beta + \lambda \left( \frac{I^*}{e} - wL - rK \right)$$

We take partial derivatives of L and K:

$$L = \frac{\alpha}{\alpha + \beta} \times \frac{I^*}{e} \times \frac{1}{w} \quad (b)$$

$$K = \frac{\beta}{\alpha + \beta} \times \frac{I^*}{e} \times \frac{1}{r} \quad (c)$$

And we use (b) and (c) in (a) and we got:

$$QI^* = A \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta \left( \frac{1}{w} \right)^\alpha \left( \frac{1}{r} \right)^\beta \left( \frac{I^*}{e} \right)^{\alpha + \beta}$$

The condition of maximize profit is

$$\max_{I^*} P^*Q(I^*) - I^* = P^* A \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta \left( \frac{1}{w} \right)^\alpha \left( \frac{1}{r} \right)^\beta \left( \frac{I^*}{e} \right)^{\alpha + \beta} - I^* \quad (d)$$

And then we take first derivatives of (d): we can get the optimal investment amount is:

$$I^* = [P^* \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta (\alpha + \beta)]^c A^c w^{-c\alpha} r^{-c\beta} e^{-(\alpha + \beta)c}$$

Where  $c = \frac{1}{1 - \alpha - \beta}$

The relationship between optimal investment and exchange rate is:

$$\frac{\partial I^*}{\partial e} = \frac{-\alpha - \beta}{1 - \alpha - \beta} e^{-c} \Phi < 0$$

Where  $\Phi = [P^* \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta (\alpha + \beta)]^c A^c w^{-c\alpha} r^{-c\beta} e^{-(\alpha + \beta)c} > 0$ . (e)

From equation (e) we can now that the appreciation of one currency will decrease foreign direct investment. We can see that if the cost- oriented firms start manufacturing bases in China and export products to overseas. And the sales will be restrained by the appreciation of Chinese currency. The appreciation of Chinese RMB will raise the manufacturing cost of these firms so that the firms will reduce their direct investment in China.

## Market-oriented foreign direct investment

The difference between cost-oriented and market-oriented foreign direct investment is: the market-oriented firms sell their product in host country instead of exporting. The firms' products  $Q$  are selling in the host country with price  $P$ . The profits they get will be changed into the source country's currency through current exchange rate  $e$ .

If the foreign direct investment wants to have maximum profits:

$$\begin{aligned} & \max PQe - I^* \\ \text{s.t.} \quad & \left\{ \begin{array}{l} Q = \max(AL^\alpha K^\beta) \\ \frac{I^*}{e} = wL + rK \end{array} \right. \quad \alpha + \beta < 1 \end{aligned}$$

We use the same method as the cost-oriented foreign direct investment and we can get the optimal investment is

$$I^* = [P^* \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta (\alpha + \beta)] A^c w^{-c\alpha} r^{-c\beta} e$$

And the relationship between optimal investment and exchange rate is:

$$\frac{\partial I^*}{\partial e} = [P^* \left( \frac{\alpha}{\alpha + \beta} \right)^\alpha \left( \frac{\beta}{\alpha + \beta} \right)^\beta (\alpha + \beta)] A^c w^{-c\alpha} r^{-c\beta} e \quad (\text{g})$$

From equation (g) we can see that the appreciation of the host country, on the contrary, will not restrict the market-oriented foreign direct investment but promote it.

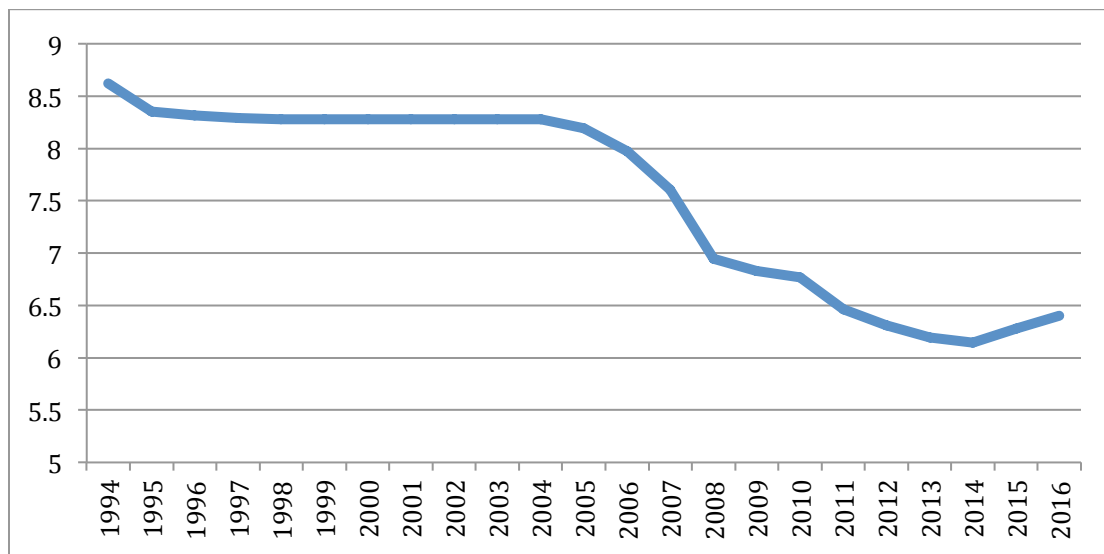
## **4. Current situation of Chinese macro economy and exchange rate regime**

The choice of exchange rate regime has an enormous impact on one country's economy even though there is no conclusion how the exchange rate regime affects the economic growth. After the reform and opening-up policy, the exchange rate regime in China went through three stages: First is from August 1979 to December 1993, it's called "double track exchange rate regime." From January 1994 to June 2005, it's fixed regime. It was pegged to the U.S dollar at approximately 8.2 yuan to a dollar. In July 2005, Beijing announced it would revalue the yuan and peg it to a basket of currencies, which among others includes the dollar, the Euro, the Japanese yen, and the Korean won. Currently, the exchange regime is a hybrid of fixed and floating called "managed float."

From 1979, China was transforming from planned economy to Chinese-style market economy. At that time the exchange rate of Chinese RMB was lower than export currency cost which leads to the loss in the export sector. To change this, in August 1979 China decided to reform the exchange rate regime. From 1981, the Chinese government announced that China would keep the official exchange rate regime at the same time apply the internal settlement exchange rate towards U.S dollar. At that time China had two different exchange regimes. The existence of "double track" exchange rate regime is considered an unfair method to withdraw cash from international trades. International Monetary Fund pressured China to give up the "double track" exchange regime. In 1985, the People's Bank of China (central bank of China) canceled the internal settlement exchange rate and pegged RMB 8.2 yuan to a dollar.

As the time past by, the official price of RMB had less and less effect on the actual exchange rate. With the change of RMB exchange rate formation mechanism, in 1994, the People's Bank of China canceled the official exchange rate and foreign exchange swap price. So the "double track" became one. From 1994, Chinese government regulates the floating range to control and modify the foreign exchange market to keep the exchange rate of RMB stable.

With the rapid development of China's economy, the rising international status, China's economic development is objectively pushing the appreciation of the RMB. From 2004, with the USD continued to depreciation, the United States, Japan, and some other developed countries have accused China of restraining the exchange rate of RMB to expand exports. The pressure caused by the appreciation of RMB has increased significantly. The issue has become a global hot topic. Since July 21, 2005, based on market supply and demand, People's Bank of China has deployed the floating exchange rate mechanism with reference to a basket of currencies, to deal with the status quo of the continuing appreciation. Before the announcement, the exchange rate of Chinese RMB is stable around 8.2 yuan to 1 U.S dollar. Until December 31st, the exchange rate of Chinese RMB was 6.937.



*Official exchange rate (LCU per US\$, period average)*

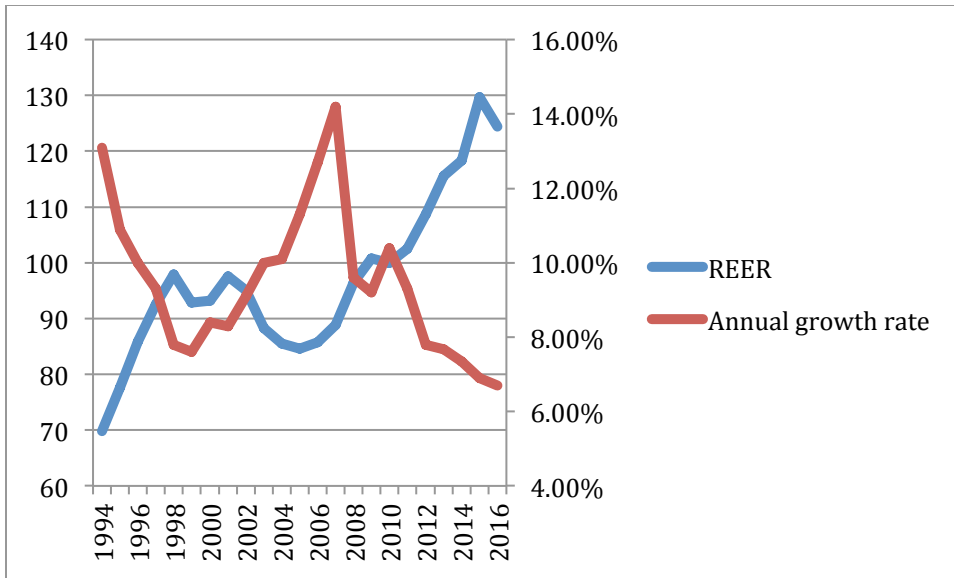
## 4.1 Current situation of Chinese macro economy

### 4.1.1 Economy growth and real effective exchange rate

From the table, we can see that Chinese GDP and GDP per capita are growing rapidly. In 2010, Chinese GDP exceeded Japan became the second largest economy in the world. According to world bank low-income economies are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of \$1,025 or less in 2015; lower middle-income economies are those with a GNI per capita between \$1,026 and \$4,035; upper middle-income economies are those with a GNI per capita between \$4,036 and \$12,475; high-income economies are those with a GNI per capita of \$12,476 or more. Now China has become the upper-middle-income economy. If we calculate by constant price in twenty years from 1994 the average growth rate of Chinese GDP is 9.1%. The GDP of 2014 is 5.74 times of 1994's.

Time	GDP (100million yuan)	GDP per capita (yuan)	Time	GDP (100million yuan)	GDP per capita (yuan)
1994	48637.5	4081	2005	187318.9	14368
1995	61339.9	5091	2006	219438.5	16738
1996	71813.6	5898	2007	270232.3	20505
1997	79715	6481	2008	319515.5	24121
1998	85195.5	6860	2009	349081.4	26222
1999	90564.4	7229	2010	413030.3	30876
2000	100280.1	7942	2011	489300.6	36403
2001	110863.1	8717	2012	540367.4	40007
2002	121717.4	9506	2013	595244.4	43852
2003	137422	10666	2014	643974	47203
2004	161840.2	12487	2015	689052.1	50251
			2016	744127	53817

*1994-2016 Chinese GDP and GDP per capita*



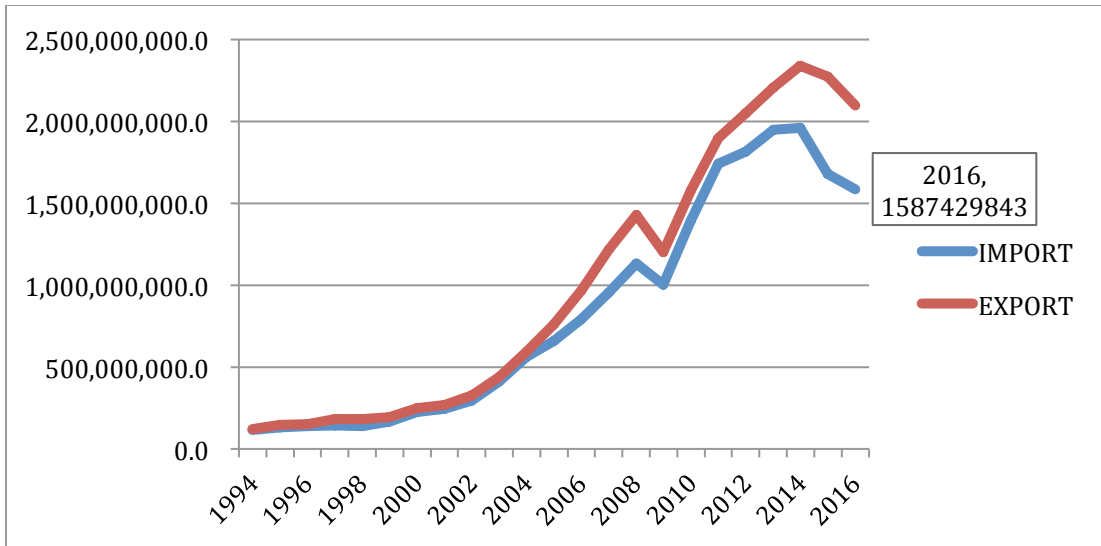
1994-2016 GDP annual growth rate and real effective exchange rate

From the graph we can see the trend of annual growth rate is on the contrary of the real effective exchange rate.

#### 4.1.2 Export, import and real effective exchange rate

Since 2001, China joined WTO; it expands its communication with other countries. In 1978, China ranked 32nd in export and import. After joining WTO, the total volume of exports and import ranked 6th in the world.

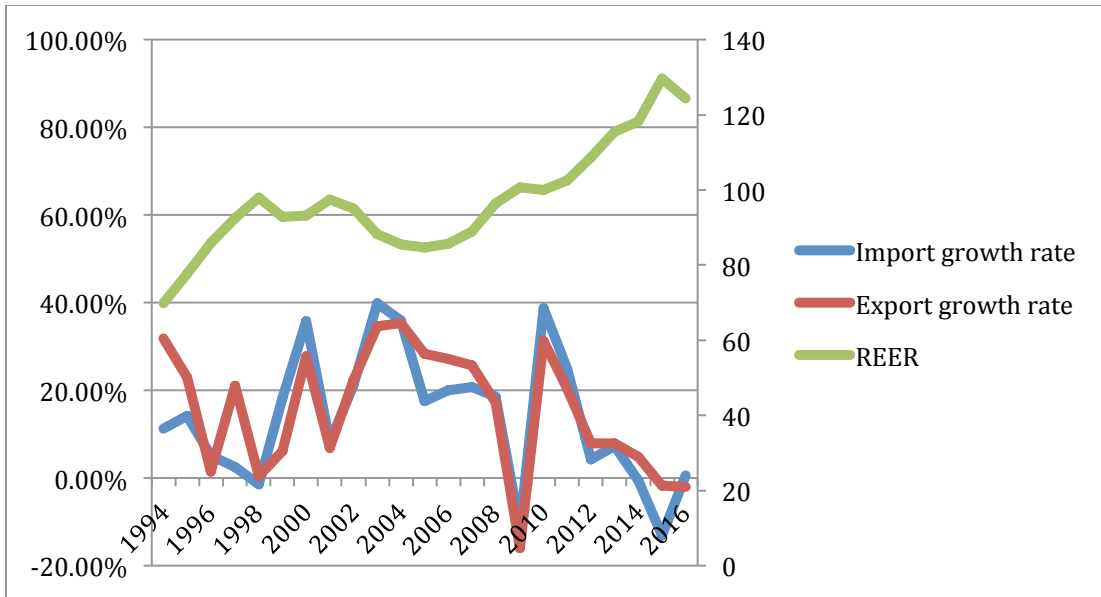
In 2013 the total export and import volume of the U.S were 391.041 billion dollars. Chinese is 416.033 billion dollars. China has become the largest exporting and importing country in the world. From the graph below we can see that from 1994 to 2001 the growth of export and import are slow. Export is slightly higher than import. From 2001, since China joined WTO, the total number of trades increased rapidly. Until financial crisis in 2008, in 7 years, the total number of trades increased 207.59%; annual average growth is 11.00%. Export grew 240.51% meanwhile import grew 171.86%. 2008, because of the financial crisis, demand from Chinese main trading partners dropped rapidly, export and import decreased significantly.



1994-2016 Chinese import and export

From the graph below we can see that the real effective exchange rate of RMB is increasing, but the growth rate of import and export have a greater volatility. After 1997, the trend of export growth rate and import growth rate is the same. When the real effective exchange rate increases, the growth of import and export decrease. Since the transformation of exchange regime in 2005, the real effective exchange rate of RMB is continuously rising, from 2005 to 2009; the real effective exchange rate increased from 84.65 to 100.73. In five years it grew by 18.95%. The growth rate of import from 2005 to 2009 dropped from 17.6% to -11.2%. The growth rate of export fell from 28.4% to -16%.

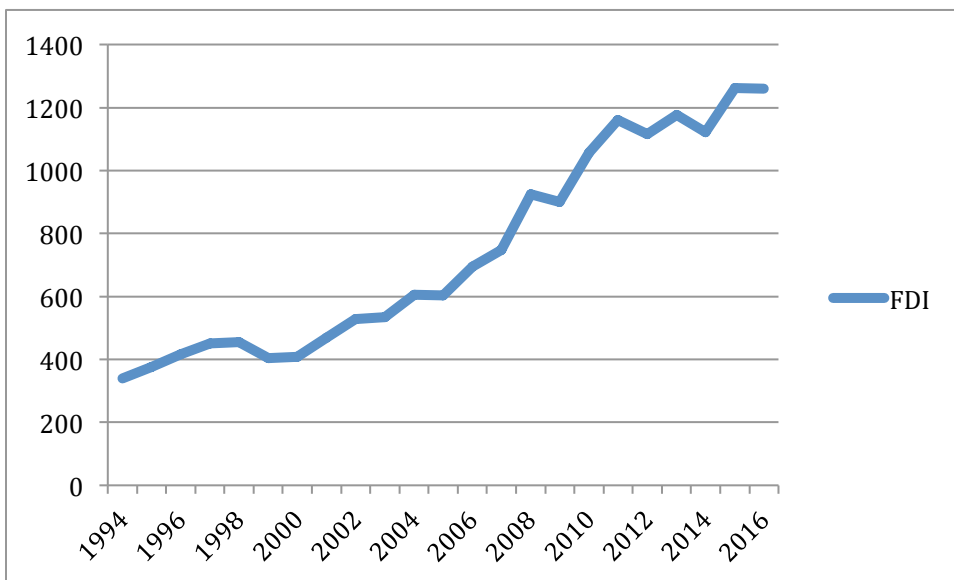




1994-2016 export, import growth rate and real effective exchange rate

#### 4.1.3 Foreign direct investment and real effective exchange rate

We can see that since 1994 the foreign direct investment is increasing rapidly from 33.965 billion dollars to in 1994 to 126.01 billion dollar in 2016. Until August 2016, the total number of foreign-owned cooperation is 850 thousand. The actual foreign investment is 1.72 trillion dollar. We can say that foreign direct investment helps Chinese economy grow continuously and stably.

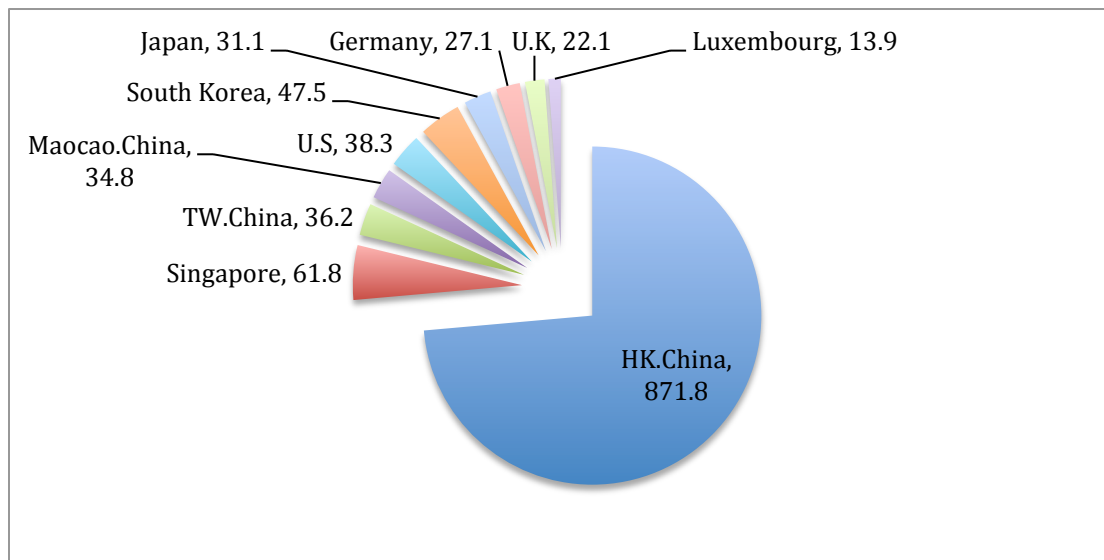


1994-2016 foreign direct investment

From the graph, we can see that after 2005's transformation of exchange rate

regime until 2008, foreign direct investment increased at a very fast rate. Compare to 2007, in 2008 the growth rate of foreign direct investment is 23.58%. In 2008, to reduce the loss from the financial crisis, capital returned to invest domestically. That is the reason why there is a noticeable decline in 2009's foreign direct investment. In 2010, foreign direct investment was better than the peak before the financial crisis. After that, growth is relatively stable.

In 2016, Hong Kong China; Singapore; South Korea; U.S; Taiwan China; Macao China; Japan; Germany; U.K and Luxembourg are the top ten foreign direct investment countries in China. Hong Kong's investment takes 73.5% all foreign direct investment.

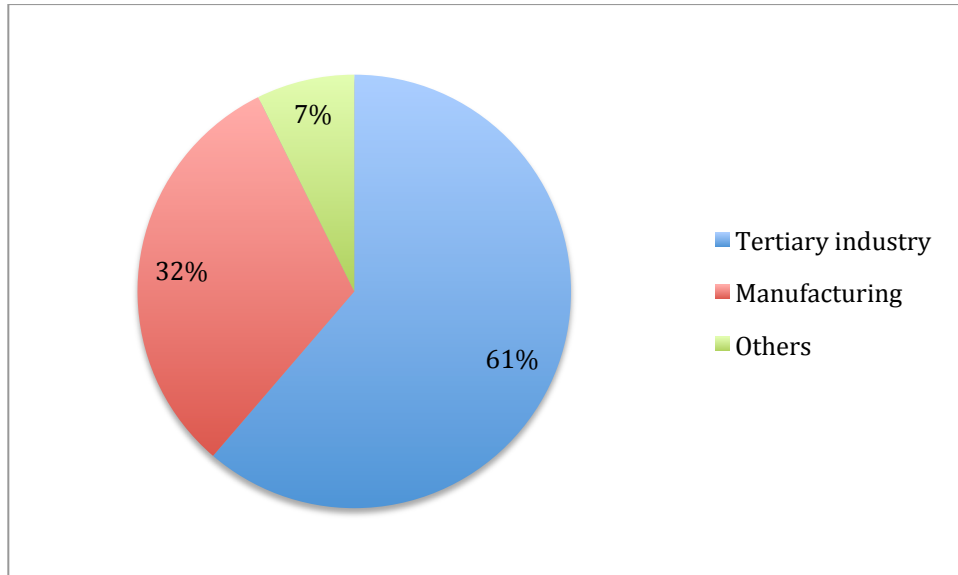


*2016 top 10 foreign direct investment countries*

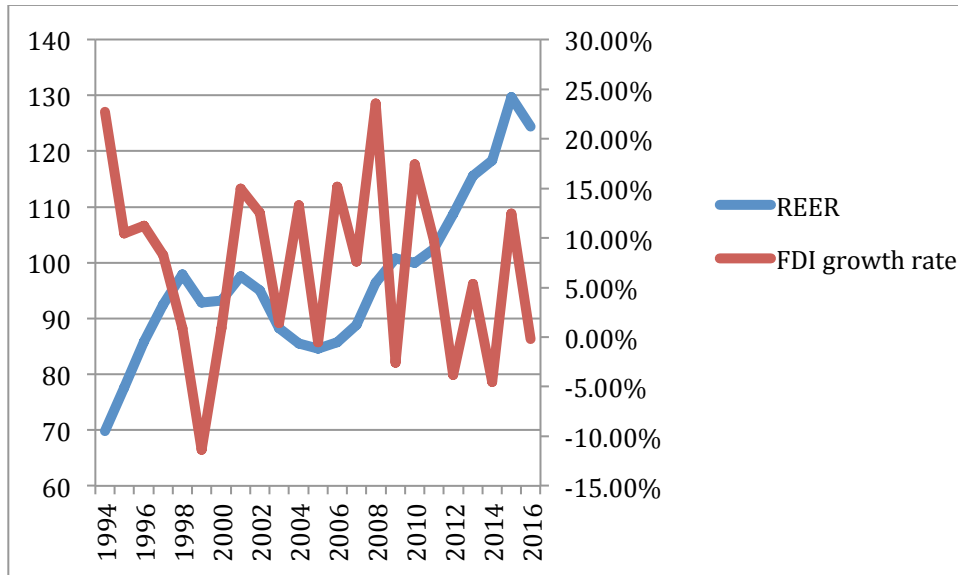
From the graph below we can see that in 2015 61% of foreign direct investment goes to the tertiary industry which is the service sector. 32% of the investment goes to manufacturing. Among the investment to manufacturing, 23.8% that is 9.41 billion dollar goes to high technology manufacturing. This number goes up by 9.5% compared to 2014.

The trend of foreign direct investment and real effective are opposite. When the real effective exchange rate goes up, the growth rate of foreign direct investment goes

down. From 1994 to 1999, the real effective growth rate increased rapidly where the growth rate of foreign direct investment dropped rapidly. After 2005, the foreign direct investment changed violently, where the real effective exchange rate is rising stably.



*2015 different industries absorb foreign direct investment*



*1994-2016 foreign direct investment growth rate and REER*

## 5. Method

We use the method of VAR model, cointegration test, Granger causality test, impulse response and variance decomposition. From the literature review, we found out that the VAR model is the most common one to conduct this kind of studies. The VAR model can have multiple variables and suitable for time series. We selected the data from the first quarter of 1994 to the last quarter of 2016 to conduct an empirical study of the relationship between Chinese economic growth and RMB real effective exchange rate. For economic growth, economic growth means that the real production increase. In this paper, we use quarterly data of nominal GDP of China from National Bureau of Statistics of China. It is evident there are seasonal fluctuations in the GDP data of China from 1994 to 2016. To remove the seasonal factor, we used X-12-ARIMA seasonal adjustment to achieve the goal. After that, we got a new series. For exchange rate, to get the objective view of the exchange rate, we use the real effective exchange rate. The real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. It is an index. If the number goes up, it means that the currency appreciates. We got the monthly data from Bank for International Settlements and used weighted average method to get the quarterly data of real effective exchange rate of RMB. To correct the heteroscedasticity we used logarithmized data. For import and export trading data we also downloaded the monthly data from 1994 to 2016 from National Bureau of Statistics of China. And then do the same weighted average to get the quarterly data. These two series also appeared to be affected by the seasonal factor. We also use X-12-ARIMA seasonal adjustment to eliminate seasonal factor. We also take the logarithm of these two series. Foreign direct investment (FDI) refers to direct investment equity flows in the reporting economy. It is the sum of equity capital, reinvestment of earnings, and other capital. We still use the monthly data from 1994 to 2016 and sum them up to get the quarterly data. Use the same

method to eliminate the seasonal factor and take logarithm. The reason we use the quarterly data is: since the period is relatively short in a way, to increase the observation and the accuracy.

# 6. Model

## 6.1 Choice of Model

Vector autoregression (VAR) is an econometric model used to capture the linear interdependencies among multiple time series.

The definition of VAR ( $p$ ) is

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + B_x t + \varepsilon_t \quad t=1,2,\dots,T$$

$T$  is the observations,  $p$  is lag,  $\varepsilon_t$  is a  $k \times 1$  vector of error terms satisfying.  $A_t$  is a time-invariant  $k \times k$  matrix.

## 6.2 Gross domestic product (GDP) and real effective exchange rate

### 6.2.1 Data selection

GPD: We choose quarterly GDP data of China from 1994 to 2016. Data is from National Bureau of Statistics of China. And use X-12-ARIMA seasonal adjustment to remove the seasonal factor.

REER: We choose the monthly data from Bank for International Settlements and use weighted average method to get the quarterly data of real effective exchange rate of RMB.

In order to correct the heteroscedasticity we use logarithmized data.

### 6.2.2 Cointegration Test

#### 6.2.2.1 Unit-root test

Before we build a model, we need to make sure that all the time series are stationary.

We use ADF (Augmented Dickey-Fuller) to test for unit root.

	ADF test statistics	1% level	5% level	10% level	Prob.	Result
--	---------------------	----------	----------	-----------	-------	--------

LNGDP	-1.866434	-3.04727	-2.893956	-2.584126	0.3466	Nonstationary
DLNGDP	-6.72005	-3.505595	-2.894332	-2.584325	0	Stationary
LNREER	-0.52024	-3.504727	-2.893956	-2.584126	0.8813	Nonstationary
DLNREER	-4.075126	-3.505595	-2.894332	-2.584325	0.0017	Stationary

(Table 6.1)

From the table above we can see that under 1%, 5% 10% level lnGDP and lnREER both accept the null hypothesis, which means that they are both non-stationary time series. But the first differenced series under 1% level; both of them reject the null hypothesis, which means both of them are stationary.

### 6.2.2.2 Cointegration Test

From the unit-root test we know that it is possible that there is a cointegration between lnGDP, lnREER and DlnGDP.

Since we have relatively fewer observations. We use Engle- Granger two- step method to test for cointegration. First, we use OLS to find out the linear relationship between lnGDP, lnREER and DlnGDP:

$$\ln GDP_t - 1.01364 \ln GDP_{t-1} = -0.133596 \ln REER + 0.494431$$

The t-Statistic, F-statistic and the p values are as follow:

LNGDP=C (1)*LNGDP (-1)+C (2)*LNREER+C (3)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.01364	0.002161	469.038	0
C(2)	-0.133596	0.012893	-10.36177	0
C(3)	0.494431	0.042345	11.67617	0
F-statistic		305338.7		
Durbin-Watson stat		1.232644		

(Table 6.2)

Then create a series of residuals and test it for unit root by ADF

	t-Statistic	Prob.*
--	-------------	--------

Augmented Dickey-Fuller test statistic		-5.925419	0
Test critical values:	1% level	-3.505595	
	5% level	-2.894332	
	10% level	-2.584325	

(Table 6.3)

From the table above we can see that there is no unit root for the series of residuals. The series of residuals is stationary, which means in the equation of linear regression, the three variables have equilibrium in the long run. GDP changes 1% in the first time period, in the next time period, GDP will have a positive change of 1.0088%. REER increase 1%, GDP will decrease 0.0593%.

### 6.2.3 Granger Causality Tests

In this chapter we use Granger Causality test to find out if there is Granger Cause between REER and GDP. The test result is as follow:

Null Hypothesis:	Obs	F-Statistic	Prob.
LNREER does not Granger Cause LNGDP	90	6.07829	0.0034
LNGDP does not Granger Cause LNREER		1.86904	0.1606

(Table 6.4)

From the test result we can see that under 5% confidence level, real effective exchange rate Granger Cause gross domestic product. But gross domestic product does not Granger Cause real effective exchange rate.

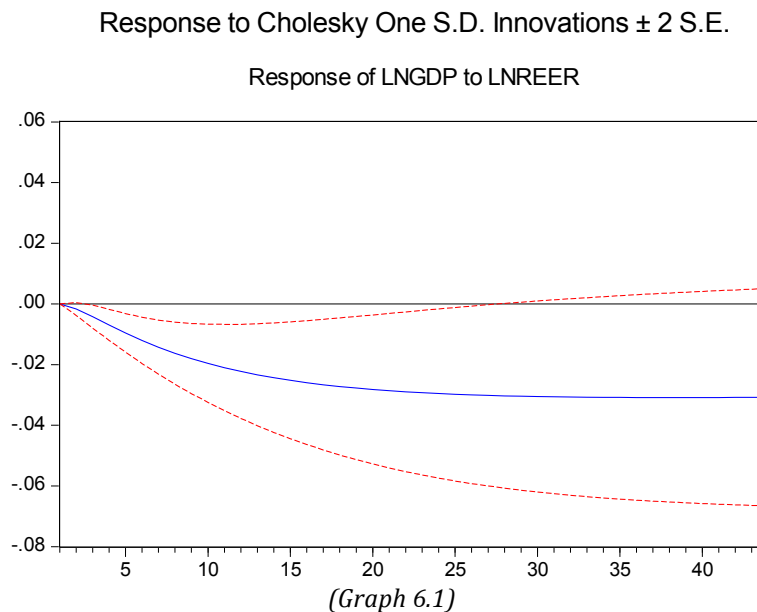
### 6.2.4 Impulse response

From previous tests we can see that there is cointegration between lnREER and lnGDP. From Granger Causality test we can see that lnREER does Granger Cause lnGDP. We use the impulse response to see the reaction of lnGDP to lnREER. We are trying to find out in the REER equation after adding a standard deviation to the stochastic error, how impulse like this affect the current value and the future value



of GDP. We use Cholesky decomposition to get the graph as follow:

After GDP received one unit change in REER, at the first period it does not change immediately. From the second period the negative response gradually increase. From period 25<sup>th</sup>, it becomes stable. We can see that in the long run, REER does have an effect on GDP, and it remains around -0.025%.



From the analysis above, it is clear that changes in Chinese RMB's real effective exchange rate has a negative effect on the economic growth. We are going to try to explain this from two channels: export-import and foreign direct investment.

## 6.3 International trades and real effective exchange rate

### 6.3.1 Data selection

Import and export: We choose quarterly import and export data of China from 1994 to 2016. Data is from National Bureau of Statistics of China. And use X-12-ARIMA seasonal adjustment to remove the seasonal factor. We use EX to represent the export and IM to represent import.

REER: We choose the monthly data from Bank for International Settlements and use weighted average method to get the quarterly data of real effective exchange rate of RMB.

In order to correct the heteroscedasticity we use logarithmized data.

### 6.3.2 Cointegration Test

#### 6.3.2.1 Unit root test

First we use ADF (Augmented Dickey-Fuller) to test for unit root. From the following test results, under 1%, 5% 10% confidence level lnEX and lnIM both accept the null hypothesis, which means that they are both non-stationary time series. But the first differenced series under 1% level; both of them reject the null hypothesis, which means both of them are stationary.

	ADF test statistics	1% level	5% level	10% level	Prob.	Result
LNEX	-1.228566	-3.505595	-2.894332	-2.584325	0.6591	Nonstationary
DLNEX	-5.150607	-3.506484	-2.894716	-2.584529	0	Stationary
LNIM	-1.128869	-3.505595	-2.894332	-2.584325	0.7014	Nonstationary
DLNIM	-4.923401	-3.506484	-2.894716	-2.584529	0.0001	Stationary

(Table 6.5)

#### 6.3.2.2 Johansen test

Test between export, REER and GDP.

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.*	Max-Eigen Statistic	0.05 Critical Value	Prob.*
None *	0.286998	38.15866	29.79707	0.0043	30.10617	21.13162	0.0021
At most 1	0.077461	8.052492	15.49471	0.4598	7.175686	14.2646	0.4686

At most 2	0.00980	0.876806	3.84146	0.349	0.87680	3.84146	0.349
	3		6	1	6	6	1

(Table 6.6)

From the test results above we can see that in Johansen test trace statistic and max-Eigen statistic both reject the null hypothesis under 5% significance level. This means there is cointegration between lnEX, lnGDP and lnREER. And then we just use OLS to find the linear relationship between lnEX, lnGDP and lnREER:

$$\ln EX = -1.453334 \ln GDP - 1.774495 \ln REER + 11.2332$$

$$LNEX = C(1) * LNGDP + C(2) * LNREER + C(3)$$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.453334	0.021753	66.81009	0
C(2)	-1.774495	0.127134	-13.9577	0
C(3)	11.23392	0.414257	27.11825	0

(Table 6.7)

Test between import, REER and GDP.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.*	Max-Eigen Statistic	0.05 Critical Value	Prob.*
None *	0.252054	30.8134	29.7970	0.038	25.8478	21.1316	0.01
At most 1	0.04277	4.96559	15.4947	0.812	3.89035	14.2646	0.870
At most 2	0.012009	1.07523	3.84146	0.299	1.07523	3.84146	0.299

(Table 6.8)

From the test results above we can see that in Johansen test trace statistic and max-Eigen statistic both reject the null hypothesis under 5% significance level. This means there is cointegration between lnIM, lnGDP and lnREER. We also use OLS to find the linear relationship between lnIM, lnGDP and lnREER:

$$\ln IM = -1.468467 \ln GDP + 2.139869 \ln REER + 12.58494$$

LNIM=C(1)*LNGDP+C(2)*LNREER+ C(3)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.468467	0.022007	66.72833	0
C(2)	-2.139869	0.128615	-16.6378	0
C(3)	12.58494	0.419083	30.0297	0

(Table 6.9)

From tests about we can draw the conclusion that in the long run, there is a negative correlation between RMB's real effective rate and Chinese total export. If RMB appreciates by 1%, the total export will drop by around 1.8%. And if the total export increases by 1%, GDP will decrease by 1.5%. There is a negative correlation between RMB's real effective rate and total import. If RMB appreciates by 1%, the total import will decrease 2.1%. If the total import increases by 1%, GDP will increase 1.59%. Comparing the coefficients between import and export, import is easier affected by the changes in REER. And they fit the  $|D_x| + |D_m| > 1$  condition. This means that the international trades in China fit the Marshall-Lerner Condition so the depreciation of RMB is beneficial for Chinese international trades.

### 6.3.2.3 Granger Causality Tests

In this chapter we use Granger Causality test to find out if there is Granger Cause between import export and real effective exchange rate. The test result is as follow:

	Obs	F-Statistic	Prob.
LNREER does not Granger Cause LNIM	90	9.26225	0.0002
LNIM does not Granger Cause LNREER		1.50434	0.228
LNREER does not Granger Cause LNEEX	90	4.27565	0.017
LNEEX does not Granger Cause LNREER		1.40239	0.2516

(Table 6.10)

From the results, under 5% significance level, the probability of lnREER does not Granger Cause lnIM is 0.0002 reject the null hypothesis. The probability of lnREER does not Granger Cause lnEX is 0.017. The test shows that REER Granger Cause import, and also Granger Cause export.

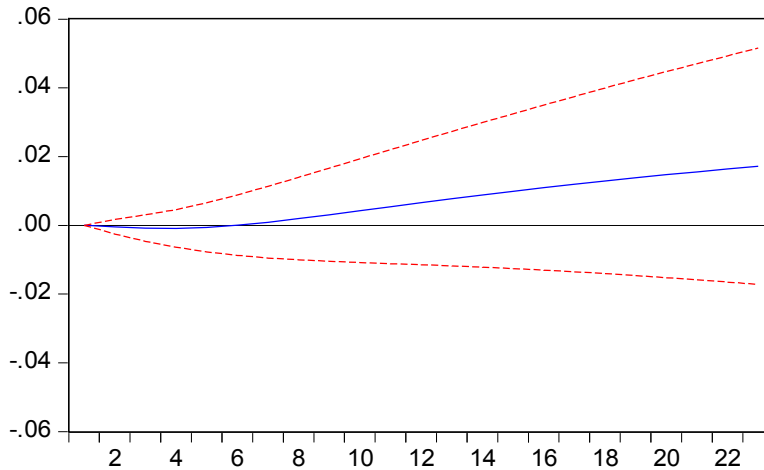
### 6.3.2.4 Impulse response

In order to see that response of GDP to export, export to REER, GDP to import and import to REER. We use the same method as before.

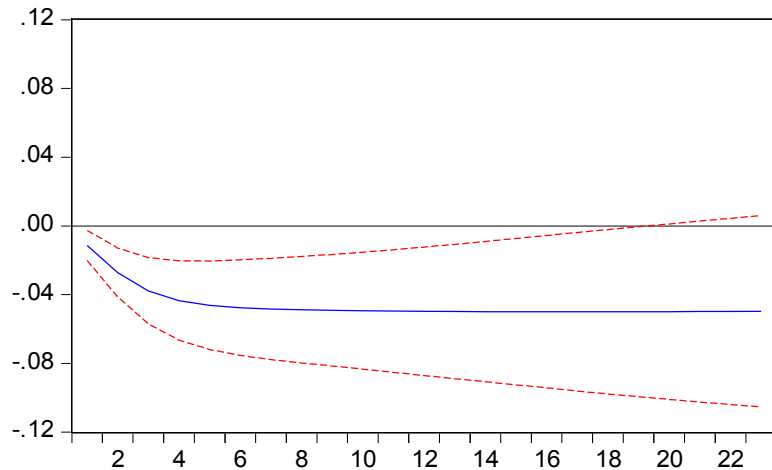
From the graph below we can see, after GDP received one unit change in export, it remains the same for six periods and from the seventh period GDP starts to increase slowly. With time passing by the influence gets more significant. At the 20<sup>th</sup> period, the influence is around 0.02%. This means the increase of export has a constant and positive effect on economic growth.

Response to Cholesky One S.D. Innovations  $\pm$  2 S.E.

Response of LNGDP to LNEEX



Response of LNEEX to LNREER

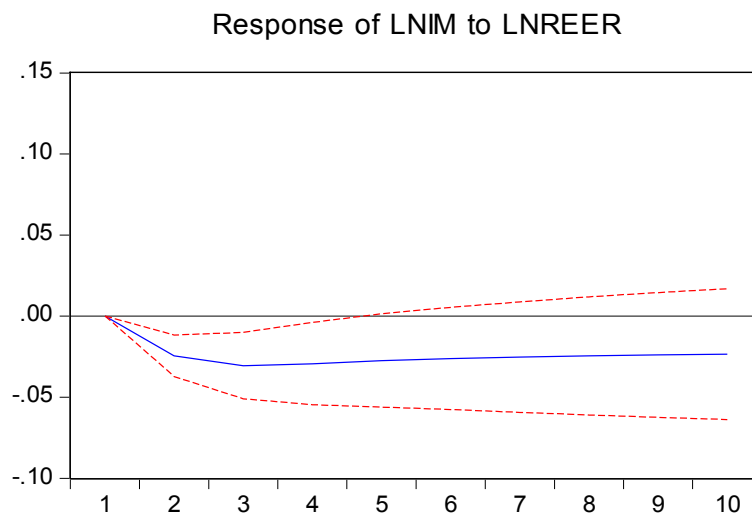
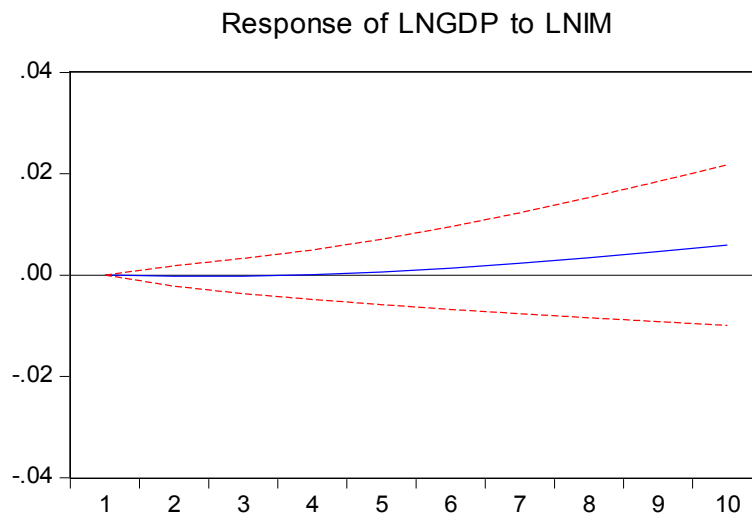


(Graph 6.2)

When export received one unit change in REER, export reacts immediately. From the first period to the fourth one it decreases rapidly. After that it keeps decreasing. The decrease is by around 0.05%. The graph above shows us clearly that the appreciation of RMB has a constant negative effect on export. The real effective rate affects GDP through export.

When GDP received one unit change in import, GDP reacts immediately, from the first period the GDP starts to increase and slowly increases after that. The increase becomes bigger and bigger. At the 22<sup>nd</sup> period it increased by 0.015%. So import has a lasting positive effect on GDP.

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



(Graph 6.3)

When import received one unit change in REER, it stays the same for the first period. In third period it decreased to the lowest point by around 0.6%. From fourth period it increased very slowly. In the 22<sup>nd</sup> period it decreased by around 0.5%. We can say that in the long run the effect will fade with time until it's zero again.

### 6.3.2.5 Variance Decomposition

We use the method of variance decomposition to decompose both import and export. Since both GDP and real effective exchange rate have effects on import and export. We hope can find which factor is more important to import and export.

First, we decompose lnEX:

Variance Decomposition of LNEX:			
Period	S.E.	LNREER	LNGDP
1	0.044701	6.442053	10.15608
2	0.075357	15.25101	15.23672
3	0.101778	22.14851	19.42413
4	0.124956	26.81453	22.53926
5	0.145513	29.89173	24.76983
6	0.163989	31.97658	26.35588
7	0.180833	33.4533	27.49182
8	0.196391	34.547	28.31594
9	0.21091	35.38821	28.92211
10	0.224574	36.05483	29.37317

(Table 6.11)

In the beginning the real effective rate's influence is only around 6.5%, with time passing by it increased rapidly. At the tenth period the influence reached 36%. In the beginning the percentage of GDP is 10.1%. It also gradually increased. By the end of tenth period the influence is 29.3%. Both exchange rate and GDP are important to export.

And then we decompose lnIM. At first the influence of REER is already 20%, by the sixth period the percentage is around 54%. After that the influence slightly decreased but remain stable around 53%. At the first period GDP has no influence on import and increases slowly after the first period. But always remains below 2%.

Variance Decomposition of LNIM:			
Period	S.E.	LNREER	LNGDP
1	0.057791	20.01674	0
2	0.095277	41.92506	0.620679
3	0.125503	50.06525	1.278258
4	0.150296	52.83193	1.679407
5	0.171667	53.7018	1.882046
6	0.1908	53.87575	1.971116
7	0.208332	53.76521	1.999344
8	0.224637	53.52205	1.994431
9	0.239956	53.21184	1.970807
10	0.254457	52.86788	1.936373

(Table 6.12)

## 6.4 Foreign direct investment and real effective exchange rate

### 6.4.1 Data selection

FDI: We choose quarterly FDI data of China from 1994 to 2016. Data is from National Bureau of Statistics of China. And use X-12-ARIMA seasonal adjustment to remove the seasonal factor.

REER: We choose the monthly data from Bank for International Settlements and use



weighted average method to get the quarterly data of real effective exchange rate of RMB.

In order to correct the heteroscedasticity we use logarithmized data.

## 6.4.2 Cointegration Test

### 6.4.2.1 Unit root test

First we use ADF (Augmented Dickey-Fuller) to test for unit root. From the following test results, under 1%, 5% 10% confidence level lnFDI accepts the null hypothesis, which means that it is a non-stationary time series. But the first differenced series under 1% level; it rejects the null hypothesis, which means it is stationary.

	ADF test statistics	1% level	5% level	10% level	Prob.	Result
LNFDI	-1.168555	-3.505595	-2.894332	-2.584325	0.685	Nonstationary
DLNFDI	-9.677522	-3.506484	-2.894716	-2.584529	0	Stationary

(Table 6.13)

### 6.4.2.2 Cointegration Test

Since we have relatively less observations. We use Engle- Granger two- step method to test for cointegration. First, we use OLS to find out the linear relationship between lnFDI, lnREER and lnGDP:

$$\ln FDI = 0.526477 \ln GDP - 0.114677 \ln REER - 0.056767$$

The t-Statistic, F-statistic and the p values are as follow:

LNFDI=C (1)*LNGDP +C (2)*LNREER+C (3)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.526477	0.027277	19.30082	0
C(2)	-0.114677	0.159419	-0.719343	0.4738
C(3)	-0.056767	0.519457	-0.109282	0.4738
F-statistic		503.8287		
Durbin-Watson stat		1.3876		

(Table 6.14)

Then create a series of residuals and test it for unit root by ADF

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.427472	0
Test critical values:	1% level	-3.503879	
	5% level	-2.893589	
	10% level	-2.583931	

(Table 6.15)

From the table above we can see that there is no unit root for the series of residuals. The series of residuals is stationary, which means in the equation of linear regression, the three variables have equilibrium in the long run. FDI increases by positive 0.526%. GDP will have positive change of 1%, REER increase 1%, FDI will decrease 0.115%.

#### 6.4.2.3 Granger Causality Tests

We use Granger Causality test to find out if there is Granger Cause between import export and real effective exchange rate. The test result is as follow:

	Obs	F-Statistic	Prob.
LNREER does not Granger Cause LNFDI	90	0.3608	0.6982
LNFDI does not Granger Cause LNREER		2.03664	0.1368

(Table 6.16)

From the test result, under 5% significance level, the probability of lnREER does not Granger Cause lnFDI is 0.6982, the probability of lnFDI does not Granger Cause lnREER is 0.1368.

#### **6.4.2.4 Impulse response**

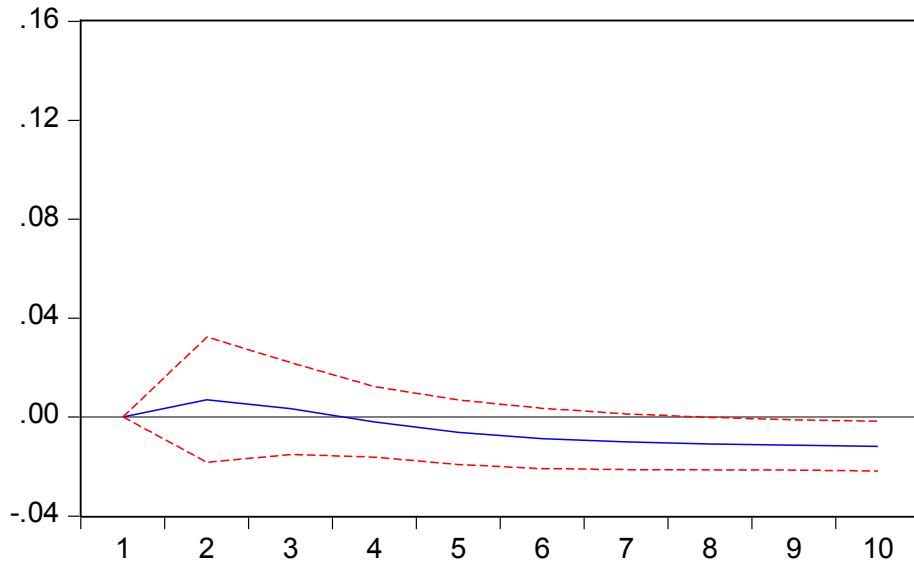
To see that response of GDP to FDI and FDI to REER. We use the same method as before.

When foreign direct investment received one unit change in REER, foreign direct investment does not react in the first period. It starts to increase in second period to 0.007%. After that it decreases slowly to -0.012% in the tenth period. Real effective exchange rate has a slow constant and negative impact on foreign direct investment in the long run.

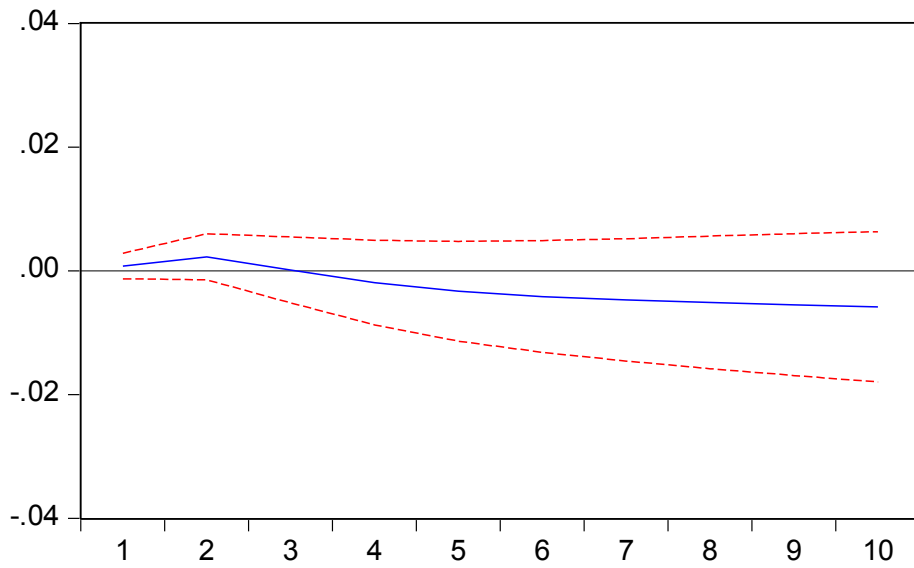
When GDP received one unit change in foreign direct investment, GDP reacts immediately, from the first period the GDP starts to increase slightly until second period to 0.003%. After the second period, it starts to decrease and continue to decrease. At the tenth period, it decreases to -0.007%. Foreign direct investment has a slow constant and negative impact on GDP in the long run.

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

Response of LNFDI to LNREER



Response of LNGDP to LNFDI



(Graph 6.4)

## 7. Interpretation of test results

From all the test results from above, we can see that in the long run, real effective exchange rate increases 1%, GDP will decrease approximately 0.06%. In the short term, real effective exchange rate is the Granger Cause of GDP. And the impact of exchange rate on GDP is constant and relatively significant.

There is a positive correlation between total export and GDP. Meanwhile, the correlation between total export and real effective exchange rate is negative. When the real effective rate increases 1%, which means the currency appreciates, the total export will decrease around 1.8%. Also in the long run, from the decomposition of variance, the real effective rate has bigger influence on the total export. If total export increases by 1%, the GDP will increase 1.4%. In the short term, real effective exchange rate is the Granger Cause of total export.

There is equilibrium between total import and RMB's real effective exchange rate in the long run. There is a positive correlation between total import and GDP. Meanwhile, the correlation between total import and real effective exchange rate is negative. If RMB appreciates by 1%, the total import will decrease 2.1%

From the test, we found out if foreign direct investment increases by positive 0.526%. GDP will have positive change of 1%, REER increases 1%, and FDI will decrease 0.115%.

## 8. Conclusions

The exchange rate is the connection between domestic and international economy. Nowadays China is developing rapidly. This paper conducted an empirical about how the changes in RMB's exchange rate affect the Chinese economic growth through the quarterly data from 1994 to 2016. We analyzed how the real effective exchange rate affects economic growth through different channels. We applied method of VAR model, cointegration test, Granger causality test, and impulse response and variance decomposition. We have following conclusions:

The appreciation of RMB has a negative effect on Chinese economic growth, but the impact is less important than people imagined.

International trade is vital for one country's economic growth. As the largest export country in the world, exchange rate of Chinese RMB has a significant impact on Chinese import and export. If we look at the data directly, in 1994 the total export was 120.976 billion dollars; the real effective exchange rate index was 69.06. In 2016, the total export is 2098.175 billion dollars, which is 17 times of 1994's number, while the real effective exchange rate index was 124.2, which is only 1.78 times of 1994's number. In the long run, there is equilibrium between total export and RMB's real effective exchange rate. There is a positive correlation between total export and GDP. Meanwhile, the correlation between total export and real effective exchange rate is negative.

There is equilibrium between total import and RMB's real effective exchange rate in the long run. There is a positive correlation between total import and GDP. Meanwhile, the correlation between total import and real effective exchange rate is negative. In theory, the appreciation of RMB is supposed to increase the import, but on the contrary total import decreases. The reason behind this is in Chinese

industrial chain, a lot of import is for purchasing raw material and intermediate products. The reduced demand for export from RMB's appreciation leads to the decrease in import. Also, the income reduction caused by reduced export leads to decrease in domestic demand. These are the two main reasons why appreciation of RMB decreased the total import. In 2016, total import of China is 1587.43 billion dollars, which is almost 11 times of 1994's number. The reason why the appreciation of RMB did not decrease total import is the rapid growth of Chinese economy boosted the demand for foreign products.

From the test, we found out there is a positive correlation between GDP and FDI. But the correlation between REER and FDI is negative. Compare to export and import the changes in FDI is not that significant. But in the short term, real effective exchange rate is not the Granger Cause of foreign direct investment.

Even though we did not cover the consumption, we believed that it should be one of the channels to affect GDP, since the consumption is 44.7% of GDP.

Under these conclusions, we have some advice for the authority:

Authority should try to keep the exchange rate of RMB stable, avoid exchange rate change violently in a short time period. Even if the consumption already take 44.7% of GDP in 2016, but total export still takes 18.7% of GDP, which means Chinese economy still relatively depend on export.

Now the only RMB offshore financial market is in Hong Kong. China should build more offshore financial markets. In the offshore financial markets, China can use RMB settlement. It can avoid the risk in exchange rate that can help international trading firms to avoid risk.

The authority should stimulate consumption and expand domestic demand to get rid of the dependence on export. There are a lot of online retailers are developing fiercely. The government should bring up policies that can help the electronic

commercial enterprises including strengthening the regulation and tax refund.

Recent years the labor cost in China is increasing, the competitive advantage in the labor-intensive industry is gradually disappearing. This situation is forcing China to transform and upgrade its industries to higher-value manufacturing. In the appreciation, process government should hand out subsidy to capital-intensive and technology-intensive industries or have particular tax policy for these sectors.



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