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Foreign Exchange Reserves Demand Model Based on Chinese Government Utility Maximization and Analysis of Chinese Foreign Exchange Reserves*

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Abstract

At the end of 2010 China's foreign exchange reserve reached $2847.34 billion, the author designs the maximum government utility function when consider the China government buys a part foreign exchange if company earns, it means that the China government will increase Ren-Min-Bi Yuan. And it will cause inflation. The inflation will cause disutility to government. Finally it gets the optimal fuction. VAR Regress finds the fitted value and actual value of foreign exchange reserves is nearly equal within 99.8%. The thesis gets the long term equilibrium relation of the nature logarithm of variables by VEC model, which are foreign exchange reserves, standard error of export, marginal propensity to import, the opportunity cost for foreign exchange reserves, marginal output to export. Using the sample datas in China 1980-2006 and VEC, we can find that 1) the government-holding foreign exchange reserves has positive correlation with the export standard error, 2) the government-holding foreign exchange reserves has positive correlation with the marginal propensity to import. The data and regression method are all different, but all have the positive correlation between the foreign exchange reserves and export standard error.

Keywords: Foreign Exchange Reserves, Demand Model, Chinese Government, Utility Maximization

1. Introduction

This template, In order to study demand model of optimal foreign exchange reserves based on Chinese government utility maximization and analysis of Chinese foreign exchange reserves, the thesis arranges as the followings: the first section designed the demand model of optimal foreign exchange reserves based on Chinese government utility maximization, the second section analyzed the unit root test and cointegration of optimal foreign exchange reserves based on government utility maximization, the third section analyze VAR and VEC model of optimal foreign exchange reserves based on government utility maximization, the fourth section is the summary of this thesis.

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2. Demand Model of Optimal Foreign Exchange Reserves Based on Chinese Government Utility Maximization

In order to study the demand model of optimal foreign exchange reserves based on Chinese government utility maximization, the thesis arrange as the followings: First, the authors analyzes the significance and objectives of the research, then review the literature simply. Based on Kelly, Michael G. (1970), consider the China government buy part foreign exchange as oreign exchange reserves if company earn oreign exchange, it means that the China government will increase supply of Ren-Min-Bi Yuan, and it will cause inflation. The inflation will cause disutility to government that is a negative government utility, combining with the outputting fluctuation, the foreign exchange reserves make the resource to be unused and lead to a negative social welfare, then design the following government utility function. Finally get the demand model of optimal foreign exchange reserves based on government utility maximization.

2.1. Significance and Objectives of the Research

2.1.1. Research Significance

December 31, 2003, the Chinese government completed the capital injection of $45 billion foreign exchange reserve into Bank of China and Bank of Construction. This capital injection played a substantial role in stabilizing and strengthening China's domestic banks. At the end of 2010 China's foreign exchange reserve reached $2847.34 billion, which had played an important role in supporting Chinese REN MIN BI YUAN (RMB) appreciation. In an open economy, a foreign exchange reserve is an important index to study a country's international economic relations; it reflects results of the macroeconomic operation and functions as an important means of macroeconomic control. The foreign exchange reserve in fact affects many aspects of macro economy: it helps to understand a country's macroeconomic operation; the adjustment of the reserve level can achieve domestic and international economic balances and realize the established macroeconomic objectives. A country's foreign exchange reserve should fit its actual economic development. A sufficient foreign exchange reserve can ensure a country's international payment capability, its ability to intervene in the foreign exchange market, as well as its international credibility. At the same time, an excessive foreign exchange reserve can lead to the waste of its resources. This is because owning a sizable foreign exchange reserve by a country means providing foreign countries with some of its own resources while giving up opportunities to use foreign recourses to increase its domestic investment and economic development. It is true that a limited foreign exchange reserve will negatively affect domestic economic development, the government's capabilities to intervene in the foreign exchange market and to balance international revenue and expenditure. All this can weaken a country's capability to meet international capital shock and to avoid financial crisis, which will not help, in our case, China's financial enterprises/companies to 'get into the world.' Therefore, the study of the optimal scale of a country's foreign exchange reserve is crucial to the country's credibility, stability as well as to understanding the international financial environment into which Chinese financial enterprises/companies are entering.

2.1.2. Research Objectives

The thesis finishes the following researches, the author designs the maximum government utility function when consider the China government buys part foreign exchange if company earns, it means that the China government will increase Ren-Min-Bi Yuan, and it will cause inflation. The inflation will cause disutility to government. Then it gets the optimal foreign exchange reserves. Finally unit root test, cointegration test, vector autoregressive model analysis, vector error correction model analysis and the long term equilibrium relation of the variables which the optimal foreign exchange reserves function include.

2.2. Literature Review

The Heinz Robert Heller (1966) constructed the demand of reserves. Heller's model is the beginning of cost revenue. After that time, many scholars have developed Heller's pattern and obtained their results. He pointed out that holding the reserves exist opportunity cost. The expression is the loss of investment benefit owing to holding reserves. When marginal cost equals to marginal proceeds，international reserve achieved the proper scope [1].

Clark (1970) has extended Heller's method and developed a random pattern, considered the opportunity cost for holding foreign exchange reserves, then constructed the government utility function. He reached: 1) the random error item of standard error has positive correlated between foreign exchange reserves and optimal foreign exchange reserves; 2) It has negative correlated between optimal foreign exchange reserves and marginal propensity to import; 3) The opportunity cost for holding foreign exchange reserves more, the optimal foreign exchange reserves less [2].

Kelly. Michael G. (1970) thought that holding foreign exchange reserves has an opportunity cost. According to this, he constructed the utility function. At last, he achieved the optimal foreign exchange reserves function be means of the utility function. He found that there has positive correlated between the foreign exchange reserves holding by government and the standard error of export, in the same time has positive correlated with the average propensity to import [3].

Guobo Huang (1995) has collected the economic data about China during 1980 to 1990. He researched the international reserve scale of China by using of ECM and discovered that: 1) The Chinese foreign exchange reserve has the negative correlation with import, that is when the import increased the foreign exchange reserves will reduce; 2) It has negative correlation with average propensity to import, that is when the average propensity to import increased the foreign exchange reserves will reduce; 3) The Chinese government has an ability to adjust the foreign exchange reserves, but the ability will reduce without considering the net foreign exchange reserves of China Bank [4].

Yu Yongding (1997) found Chinese foreign exchange reserves are higher than reasonable and optimal foreign exchange reserves [5].

Wu (1998) combined the ratio analysis method and the factor analysis method to study the determinant of reasonable Chinese foreign exchange reserves. He assumed that the Chinese demand foreign exchange reserve consists of four aspects: foreign exchange demanded for imports, foreign exchange demanded for repaying the total foreign debt balance, exchange demanded for profits return from foreign direct investment and foreign exchange reserves demand for the country's intervention in the foreign exchange currency market. He also established a linear equation model. The purpose of his thesis was to determine reasonable foreign exchange reserves for China, so he did not determine the equation's parameters with time-serial data or test the equation [6].

According to Xu (2001), the amount of currency in circulation imposes a more notable impact on the foreign exchange reserve in the short-term than does money and quasi-money. In addition, he also found that a long-term equilibrium relationship between the average propensity to import and the demand for foreign exchange reserves does not exist, yet the variation of a short-term average propensity to import exerts comparatively notable negative impacts on foreign exchange reserves. The reason is that under the current foreign exchange supervision system, an increase in imports means that a country would have to sell more foreign exchange, which would result in a decrease in the volume of foreign exchange reserves that are held [7].

Victoria miller (2006) support China to use foreign exchange reserves to save Chinese banks and Asian bank [8]. M. Ramachandran (2006) finds the asymmetric control over capital flows and asymmetric intervention in favour of strengthening export competitiveness in an era of persistent capital inflows seem to be responsible for large stockpile of reserves in India [9].

Adnan Kasman and Duygu Ayhan (2008) find that exchange rate Granger causes foreign exchange reserves in the long-run nominal [10].

Victor Pontines and Ramkishen S. Rajan (2011) find that Asian central banks react more strongly to currency appreciations than depreciations and more to nominal effective exchange rates (NEERs) than to bilateral US dollar rates. This rationalizes the relative exchange rate stability and the sustained reserve accumulation in the region [11].

2.3. Design of Government Utility Function

2.3.1. Kelly, Michael G. (1970) Design of Government Utility Function

Kelly, Michael G. (1970) designed the government utility function without considering the China government buys part foreign exchange if company earn, it means that the China government will increase Ren-Min-Bi Yuan, and it will cause inflation. The inflation will cause disutility to government.

Because the change of foreign exchange reserves equal to export increment subtract import increment, so

$$\Delta Rt = \Delta Xt - \Delta Mt \quad (1)$$

where R is the foreign exchange reserves, X is the export, M is the import.

Suppose that the reaction coefficient of import to export is $f = \mathrm{d}M/\mathrm{d}X$. Suppose that the reaction coefficient of income to export is $g = \mathrm{d}Y/\mathrm{d}X$, where Y is income

Because the marginal propensity to import is

$$m = \mathrm{d}M/\mathrm{d}Y$$

So $f = \mathrm{d}M/\mathrm{d}X = mg = (\mathrm{d}M/\mathrm{d}Y)(\mathrm{d}Y/\mathrm{d}X)$

From Equation (1) we have

$$\Delta R = \Delta X(1-f) \quad (2)$$

$$V(R) = E(\Delta R^2) = V(X)(1-f)^2 \quad (3)$$

V is the variance in Equation (3); Equation (3) suggests that: the variance of foreign exchange reserves equal to the expectation of the squared of change amount of foreign exchange reserves

Use the same arguments that:

$$V(Y) = E(\Delta Y^2) = g^2 V(X) \quad (4)$$

$g = \mathrm{d}Y/\mathrm{d}X$ in Equation (4), where Y is income

The government won't hope to run out the foreign exchange reserves, or we can say that the government hope keep lowest foreign exchange reserves R^1, so its target is to keep enough foreign exchange reserves as more as they can, to make it almost impossible that the foreign exchange reserves they kept lower than their target amount R^1, and satisfied the following Equation,

$$P\left[R < R^1 \middle| E(R), V(R)\right] = e \quad (5)$$

e in Equation (5) is a very minor number, for any arbitrarily given and ruled probability density function, arbitrarily given e, educes $\mathrm{d}E(R)/\mathrm{d}V(R) > 0$, which suggests that if the variance of foreign exchange reserves is greater, in order to keep a arbitrarily given probability e of the ruled foreign exchange reserves R^1, the average of foreign exchange reserves required is greater.

Suppose that probability e is positive with V(R), and is negative with $E(R)^2$, gives:

$$e = cV(R)/E(R)^2 > 0 \quad (6)$$

Equation (6) has characteristic that $\partial e/\partial E(R) < 0$, $\partial^2 e/\partial E(R)^2 > 0$, $\partial e/\partial V(R) > 0$, and for the arbitrarily given e, $\mathrm{d}E(R)/\mathrm{d}V(R)>0$, from Equation (3) and Equation (6) we can get the average level of foreign exchange reserve is that,

$$E(R)=(c/e)^{1/2}S(R)=(c/e)^{1/2}S(X)(1-f) \quad (7)$$

where $S(X)$ is the standard error of the export X

From Equation (4) we can get $g=S(Y)/S(X)$, put $f=mg$ and $g=S(Y)/S(X)$ into Equation (7),

$$E(R)=(c/e)^{1/2}\left[S(X)-mS(Y)\right] \quad (8)$$

Because keeping amount of foreign exchange reserve means the resource being left unused, so it may make output reduced, so the output that the relationship of the government whether keep foreign exchange reserve is,

$$Y^1-Y=Ri \quad (9)$$

where Y^1 is the output of government does not hold foreign exchange reserve, Y is the output of government hold foreign exchange reserve, where R is foreign exchange reserve, i is the opportunity cost for holding foreign exchange reserves.

Kelly, Michael G. (1970) designed the following government utility fuction.

$$U=-a\left[E(Y^1)-E(Y)\right]^2-b\left[(Y)-E(Y)\right]^2$$

2.3.2. Considered the Inflation Made by the Chinese Government Buy Part Foreign Exchange If Company Earn and Design the Government Utility Function

Based on Kelly, Michael G. (1970), consider the Chinese government buy part foreign exchange if company earn, it means that the Chinese government will increase supply of Ren-Min-Bi Yuan, and it will cause inflation. The inflation will cause disutility to government that is a negative government utility.

Combining with the outputting fluctuation, the foreign exchange reserves make the resource to be unused and lead to a negative social welfare, then design the following government utility function.

$$U=-a\left[E(Y^1)-E(Y)\right]^2-b\left[(Y)-E(Y)-\beta\Delta\Pi\right]^2 \quad (10)$$

where $\beta>0$ is a coefficient, Π is the inflation, $\Delta\Pi$ is change amount of inflation or increasing amount. $\left(E(Y^1)-E(Y)\right)$ is the average fluctuation outputs when government does not hold foreign exchange reserve and hold foreign exchange reserve, $\left((Y)-E(Y)\right)$ is the fluctuation of outputs and average outputs.

$\Delta\Pi^2=\delta\Delta R^2$, $\delta>0$ is a coefficeint

$$V(Y)=\left[(Y)-E(Y)\right]^2=S(Y)^2 \quad (11)$$

$$\begin{aligned}\beta\Delta\Pi^2&=\beta\delta\Delta R^2=\mathrm{d}\Delta R^2=\mathrm{d}\left[\Delta X-\Delta M\right]^2\\&=\mathrm{d}\left[\Delta X(1\text{-}\Delta M/\Delta X)\right]^2\\&=\mathrm{d}\left(X-E(X)\right)^2(1-f)^2\end{aligned} \quad (12)$$

$\beta\delta=d>0$ in Equation (12)

$$V(X)=\left(X-E(X)\right)^2 \quad (13)$$

Put Equation (4) $V(Y)=E\left(\Delta Y^2\right)=g^2V(X)$ into Equation (13)

$$V(X)=V(Y)/g^2=S(Y)^2/g^2 \quad (14)$$

Put Equations (9)-(13) into Equation (10), then gets the expectation efficacy function

$$\begin{aligned}E(U)&=-a\left[E(Y^1)-E(Y)\right]^2\\&\quad-b\left[(Y)-E(Y)-\beta\Delta\Pi\right]^2\\&=-ai2E(R)^2-bV(Y)\\&\quad-d\left(X-E(X)\right)^2(1-f)^2\\&=-ai2E(R)^2-bV(Y)^2-dV(X)(1-f)^2\end{aligned} \quad (15)$$

Put Equation (14) in Equation (15), gives:

$$E(U)=-ai^2E(R)^2-bS(Y)^2-d\left[S(Y)^2/g^2\right](1-f)^2$$

2.4. Demand Model of Optimal Foreign Exchange Reserves Based on Chinese Government Utility Maximization

Choose variable $E(R)$ and $S(Y)$, and combine with the constraint condition Equation (8) and design the followinig F fuction.

$$\begin{aligned}F&=-ai^2E(R)^2-bS(Y)^2-d\left[S(Y)^2/g^2\right](1-f)^2\\&\quad+\lambda\left\{E(R)-(c/e)1/2\left[S(X)-mS(Y)\right]\right\}\end{aligned}$$

$$\partial F/\partial E(R)=-2ai^2E(R)+\lambda=0 \quad (16)$$

$$\begin{aligned}\partial F/\partial S(Y)&=-2bS(Y)-2d\left[S(Y)^2/g^2\right](1-f)^2\\&\quad+\lambda(c/e)^{1/2}m\\&=-2bS(Y)-2dS(Y)\left[(1-f)/g\right]^2\\&\quad+\lambda(c/e)^{1/2}m\\&=0\end{aligned} \quad (17)$$

From Equation (16) gets:

$$\lambda=2aiE(R) \quad (18)$$

Put Equation (18) in Equation (17)

$$-2bS(Y)-2dS(Y)\left[(1-f)/g\right]^2 + ai^2E(R)(c/e)^{1/2}m = 0 \quad (19)$$

As a matter of convenience, arranges h as the followings

$$h=(c/e)^{1/2} \quad (20)$$

From Equation (19) and Equation (20) gets

$$S(Y)=\left[ai^2E(R)hm\right]\Big/\left\{b+\left[(1-f)/g\right]^2 d\right\} \quad (21)$$

Put Equation (21) in Equation (8)

$$E(R)= h\left\{S(X)-m\left\{ai^2E(R)hm\Big/\left\{b+\left[(1-f)/g\right]^2 d\right\}\right\}\right\} \quad (22)$$

From Equation (22) gets

$$E(R)= \left[S(X)\right]\Big/\left\{h^{-1}+\left(ai^2m^2h\right)\Big/\left\{b+\left[(1-f)/g\right]^2 d\right\}\right\} \quad (23)$$

Put $f=\mathrm{d}M/\mathrm{d}X=mg$ in Equation (23)

$$E(R)= \left[S(X)\right]\Big/\left\{h^{-1}+\left(ai^2m^2h\right)\Big/\left[b+\left(g^{-1}-m\right)^2 d\right]\right\} \quad (24)$$

Because of $D1=F_{E(R)^2}=-2ai^2<0$
So

$$D1=FE(R)^2\,FS(Y)^2-\left(FE(R)S(Y)\right)^2 = -2ai^2\left[-2b-2d\left[(1-f)/g\right]^2\right]-0^2$$

Conditions as above satisfied binary function approach maximum, that is the government expectation efficacy function $E(U)$ exist a maximum, the optimal foreign exchange reserves based on government utility maximization could fixed by Equation (24).

Be convenient order, let

$$k=h-1+\left(ai^2m^2h\right)\Big/\left[b+\left(g^{-1}-m\right)^2 d\right] \quad (25)$$

$$w=b+\left(g^{-1}-m\right)^2 d \quad (26)$$

2.5. Analyze the Optimal Expectation Foreign Exchange Reserve to the Sensitivity of Variable and Parameter Based on Government Utility Maximization

The foreign exchange reserve which government expectation utility maximization $E(U)$ exist a maximum is the optimal expectation foreign exchange reserve $E(R)$, to the sensitivity $\partial E(R)/\partial g$ of reaction coefficient $g=\mathrm{d}Y/\mathrm{d}X$ that income to export, approach the partial derivative.

$$\partial E(R)/\partial g = \left[-S(X)hai^2m^2 2d\left(g^{-1}-m\right)g^{-2}\right]\Big/k^2w^2 \quad (27)$$

When $g^{-1}-m>0$, that is $f=\mathrm{d}M/\mathrm{d}X=mg<1$

$$\partial E(R)/\partial g = \left[-S(X)hai^2m^2 2d\left(g^{-1}-m\right)g^{-2}\right]\Big/k^2w^2<0 \quad (28)$$

When $g^{-1}-m>0$, that is $f=\mathrm{d}M/\mathrm{d}X=mg>1$

$$\partial E(R)/\partial g = \left[-S(X)hai^2m^2 2d\left(g^{-1}-m\right)g^{-2}\right]\Big/k^2w^2>0 \quad (29)$$

When $g^{-1}-m=0$, that is $f=\mathrm{d}M/\mathrm{d}X=mg=1$

$$\partial E(R)/\partial g = \left[-S(X)hai^2m^2 2d\left(g^{-1}-m\right)g^{-2}\right]\Big/k^2w^2=0 \quad (30)$$

So the sensitivity $\partial E(R)/\partial g$ of reaction coefficient ($g=\mathrm{d}Y/\mathrm{d}X$) that optimal foreign exchange reserve to reaction coefficient that import to export is depend on the size of $f=mg$, that is depend on the size of the reaction coefficient $f=\mathrm{d}M/\mathrm{d}X$ that import to export.

The optimal foreign exchange reserve susceptibility $\partial E(R)/\partial m$ to the marginal propensity to import $(m=\mathrm{d}M/\mathrm{d}Y)$, approach the partial derivative.

$$\partial E(R)/\partial m = \left\{-S(X)h2ai^2m^2\left[b+d/g^{-2}-(md)/g\right]\right\}\Big/k^2w^2 \quad (31)$$

When $b<\left[d\left(m-g^{-1}\right)\right]/g=\left[d(1-f)\right]/g^2$

$$\partial E(R)/\partial m = \left\{-S(X)h2ai^2m^2\left[b+d/g^{-2}-(md)/g\right]\right\}\Big/k^2w^2>0 \quad (32)$$

When $b>\left[d\left(m-g^{-1}\right)\right]/g=\left[d(1-f)\right]/g^2$

$$\partial E(R)/\partial m = \left\{-S(X)h2ai^2m^2\left[b+d/g^{-2}-(md)/g\right]\right\}\Big/k^2w^2<0 \quad (33)$$

When $b=\left[d\left(m-g^{-1}\right)\right]/g=\left[d(1-f)\right]/g^2$

$$\partial E(R)/\partial m = \left\{-S(X)h2ai^2m^2\left[b+d/g^{-2}-(md)/g\right]\right\}\Big/k^2w^2=0 \quad (34)$$

The optimal expectation foreign exchange reserve susceptibility $\partial E(R)/\partial S(X)$ to the export standard deviation $S(X)$, approach the partial derivative,

$$\partial E(R)/\partial S(X) = 1/k \quad (35)$$

because $k = h^{-1} + (ai^2m^2h)/b + (g^{-1} - m)^2 d$, so:

$$\partial E(R)/\partial S(X) = 1/k > 0 \quad (36)$$

The optimal expectation foreign exchange reserve susceptibility $\partial E(R)/\partial i$ to the opportunity cost for government holding foreign exchange reserves *i,* approach the partial derivative,

$$\partial E(R)/\partial i = \left\{-2S(X)hai^2 i\left[b + (1-f)^2 d/g^2\right]\right\} < 0 \quad (37)$$

2.6. Brief Summaries

The thesis finishes the following researches:

1) The author designs the government utility function when consider the China government buy part foreign exchange if company earn, it means that the China government will increase Ren-Min-Bi yuan, and it will cause inflation. The inflation will cause disutility to government; 2) The thesis gets the optimal foreign exchange reserves by Maximum the government utility.

3. Unit Root Test and Cointegration Analysis for Demand Variable of Optimal Foreign Exchange Reserves Based on Government Utility Maximization

This thesis takes the unit root test and cointegration analysis for demand variable optimal foreign exchange reserves based on government utility maximization.

3.1. About Data and Express and Process for Data

In order to discuss conveniently, the authors use as the following marks to express the different economic variable in this thesis. Dimension of *R*, *X*2, *S* (*X*), *M*, *dM* is 100 million US Dollar

R is the foreign exchange reserve in China

ER is equal to exchange rate

*X*1 is the export amount per year (Dimension of R, *X*2, *S* (*X*), *M*, *dM* is 100 million RMB Dollars)

*X*2 is the export amount per year

*dX*2 is the export increasing amount per year

E(*X*) is the average value of *X*2

S(*X*) is the absolute value of the deviation between the average value of *X*2 and *X*2

dM is the import increasing amount per year

*Y*2 is GDP =Y1/ER

*dY*2 is the GDP increasing amount per year

$g = \mathrm{d}Y/\mathrm{d}X$, g is the reaction factor from income to export, where Y is income

$i = yt2 - yr$ is the opportunity cost for holding foreign exchange reserves, using the difference between profit rate and the reserve earnings yield before capital tax in China to compotator.

$yt2$ is the profit rate before capital tax in China.

yr is the reserve earnings yield, using one year treasury bill rate-inflation rate in USA $yr = br - ir$

br is one-year Treasury bill yield rate in USA.

ir is the inflation in USA; take the yearly average inflation in USA as the standard.

The value of m, i ,g be changed to the positive value when they are negative value by inserting reasonable value, so we use datas as Appendix **Table 1** to analyze unit root (In order to convenient for readers, shown M, *Y*2, $yt2$, br , ir , $yr = br - ir$, $i = yt2 - yr$ in Appendix **Table 2**.

(The principle is, if the column datas m, g are –0.001, –0.01, –1, –10, –100, then change to 0.1, 0.01, 0.001, 0.001, 0.0001. 0.0001, 0.000001; if the column data i is –0.001, then change to 0.00001)

3.2. About the Unit Root Test for Variable

LNR, LNSX, LNM, LNI, LNG, these variables' defining in several is

LNR = *LOG* (*R*); *LNSX* = *LOG* (*SX*)

LNM = *LOG* (*m*); *LNI* = *LOG* (*i*); *LNG* = *LOG* (*g*)

That is, *LNR*, *LNSX*, *LNM*, *LNI*, *LNG* is the natural logarithm value of *R*, *SX*, *m*, *i*, *g,* from **Figures 1(a) and (b)**. We can see that *LNR*, *LNSX*, *LNM*, *LNI*, *LNG* these variables are very unstable.

Table 1. The results of cointegration test for *LNR, LNSX, LNM, LNI, LNG.*

Eigenvalue	Trace Statistics	5% level critical value	1% level critical value	The null hypothesis: the amount of cointegration equation
0.744664	87.44357	68.52	76.07	0**
0.660712	54.67939	47.21	54.46	be equal or less than 1**
0.557578	28.73762	29.68	35.65	be equal or less than 2
0.303918	9.165804	15.41	20.04	be equal or less than 3
0.019430	0.470908	3.76	6.65	be equal or less than4

The upper results express that there are exist 2 cointegration equations with a 5% significant level.

Table 2. The value of *AIC* and *SC* for *LNR*, *LNSX*, *LNM*, *LNI*, *LNG* with *K* equal to 2, 3, 4.

AIC and *SC*	*LNR*	*LNSX*	*LNM*	*LNI*	*LNG*
		When *K* = 2 the results as follows,			
Akaike *AIC*	0.615183	2.000989	4.456350	3.251926	6.414522
Schwarz *SC*	1.155124	2.540930	4.996291	3.791867	6.954464
		When *K* = 3 the results as follows,			
Akaike *AIC*	-0.336246	2.073180	4.757156	3.469487	5.974624
Schwarz *SC*	0.453663	2.863089	5.547065	4.259396	6.764533
		When *K* = 4 the results as follows,			
Akaike *AIC*	–12.38870	–4.499733	–0.183613	–3.185220	3.734113
Schwarz *SC*	–11.34725	–3.458283	0.857836	–2.143770	4.775563

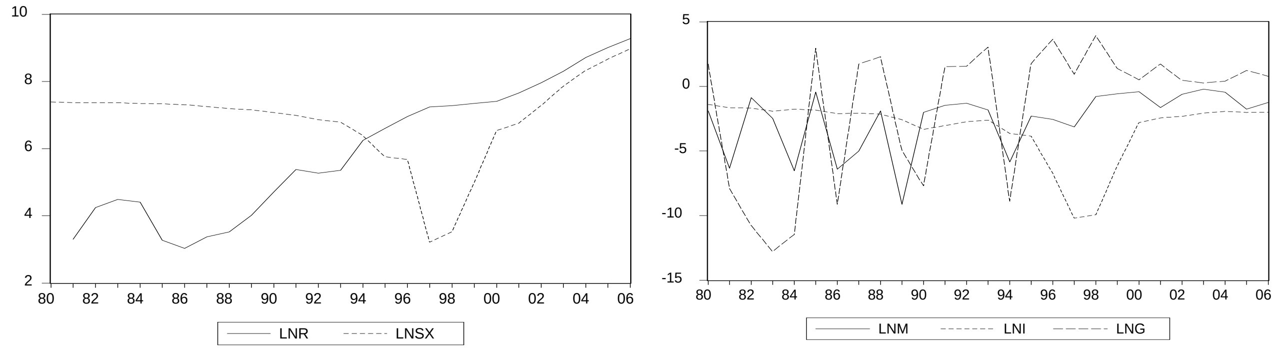

Figure 1. (a) *LNR*, *LNSX*; (b). *LNM*, *LNI, and LNG.*

3.2.1. Unit Root Test for *LNR*

Sequence number ADF test DW

1) $D(LNR) = 0.09218 + 0.01466\ LNR(-1) + 0.46569\ D(LNR(-1)) - 0.28970\ D(LNR(-2))$ 2.11

(0.341475) (0.319634) * (2.085069) (–1.406102)

2) $D(LNR,2) = -0.52131 D(LNR(-1)) + 0.12159\ D(LNR(-1),2) - 0.02565 D(LNR(-2),2)$ 1.69

(–2.052857) * (0.506699) (–0.121333)

3.2.2. Unit Root Test for *LNSX*

Sequence number ADF test DW

1) $D(LNSX) = 0.002402\ LNSX(-1) + 0.324335\ D(LNSX(-1)) - 0.065271\ D(LNSX(-2))$ 2.00

(0.108364)* (1.479004) (–0.295998)

2) $D(LNSX,2) = -0.7834\ D(LNSX(-1)) + 0.1059\ D(LNSX(-1),2) + 0.0627\ D(LNSX(-2),2)$ 1.98

(–2.485189)* (0.387888) (0.277638)

3.2.3. Unit Root Test for *LNM*

Sequence number ADF test DW

1) $D(LNM) = -0.143051 LNM(-1) - 0.835517 D(LNM(-1)) - 0.539727 D(LNM(-2))$ 1.74

(–0.971128)* (–4.473790) (–3.287342)

2) $D(LNM,2) = -1.981791 D(LNM(-1)) + 0.173656 D(LNM(-1),2) - 0.19828 D(LNM(-2),2)$ 1.67

(–3.172415) * (0.389723) (–0.957421)

3.2.4. Unit root test for *LNG*

Sequence number ADF test DW

1) $D(LNG) = -0.542661 LNG(-1) - 0.255728 D(LNG(-1)) - 0.089202 D(LNG(-2))$ 2.17

(–2.255491)* (–1.092668) (–0.466460)

2) $D(LNG,2) = -2.456410 D(LNG(-1)) + 0.726233 D(LNG(-1),2) + 0.220260 D(LNG(-2),2)$ 2.21

(–4.895653)* (1.992495) (1.146552)

3.2.5. Unit Root Test for *LNI*

Sequence number	ADF test	DW
1) $D(LNI) = -0.040487LNI(-1) + 0.815233D(LNI(-1)) - 0.543165D(LNI(-2))$ $(-0.738903)^{*} \quad (4.669897) \quad (-2.958116)$		1.83
2) $D(LNI,2) = -0.678647D(LNI(-1)) + 0.566184D(LNI(-1),2) - 0.119654D(LNI(-2),2)$ $(-2.764549)^{*} \quad (3.078573) \quad (-0.540322)$		1.95

3.3. About the cointegration analysis for variable

Although from **Figures 1(a) and (b)** we can see, *LNR*, *LNSX*, *LNM*, *LNI*, *LNG*, these variables are very stable, their first difference,such as *DLNR*, *DLNSX*, *DLNM*, *DLNI*, *DLNG* are very stable, these five variables exist a similar change cycle, that exist cointegration relation, see to **Figure 2**

The results of cointegration test for *LNR*, *LNSX*, *LNM*, *LNI*, *LNG* see to **Table 1.**

3.4. Brief Summarizes

Unit root test the nature logarithm of variables which the optimal foreign exchange reserves function include, the thesis find they are I(1),they exist co integration.

4. Using VAR and VEC Model Analysis of the Equilibrium Foreign Exchange Reserves Demand Based on Chinese Data between 1985 and 2006

This section finishes the following researches: VAR and VEC Model Analysis of the equilibrium Foreign Exchange Reserves Demand Based on Chinese data between 1985 and 2006.

4.1. Choosing the Maximum Lag periods in VAR Model of Equilibrium Foreign Exchange Reserves

4.1.1. Using *AIC* and *SC* to Choose *K* Value in VAR Model

Method 1, Using *AIC* to choose *K* value

$$AIC = \log\left[\sum_{t=1}^{T}\hat{u}_t^2/T\right] + 2k/T$$

$\hat{u}_t$ is the residual error, *T* is the sample capacity; *k* is the maximum delay section. The principle of choosing *K* value is made *AIC* value minimum through *k* value increasing.

Method 2, Using SC to choose *K* value

$$SC = \log\left[\sum_{t=1}^{T}\hat{u}_t^2/T\right] + (k\log T)/T$$

$\hat{u}_t$ is the residual error, T is the sample capacity; *k* is the maximum delay section. The principle of choosing *K* value is made *AIC* value minimum through k value increasing.

Because of the limit of sample *T*, *K* is equal to 4 at most, seeing from the change of AIC and SC, when *K* = 4, the values of *AIC* and *SC* are minimum. So *K* = 4 is the best choice with the limit of sample *T*.

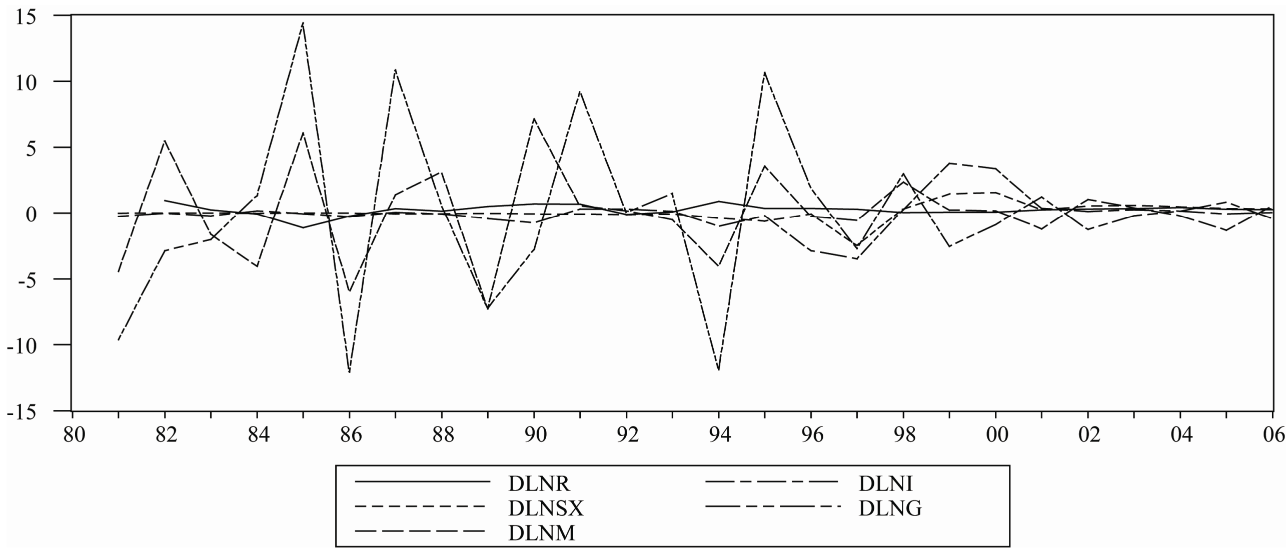

Figure 2. *DLNR, DLNSX, DLNM, DLNI, DLNG* using VAR Equation regressed and the actual results.

4.1.2. VAR Model of Equilibrium Foreign Exchange Reserves Demand Based on Chinese Data Between 1985 and 2006

Because $K = 4$ is the best choice, VAR model of equilibrium foreign exchange reserves demand based on Chinese data between 1985 and 2006 used $K = 4$, when the variable delayed 4 sections, that is when $K = 4$ the Equtions as follows,

LNR = 1.158208*LNR(–1) – 0.7595609028*LNR(–2) + 1.275854675*LNR(–3) – 0.41874649*LNR(–4) – 0.5326487006*$LNSX$(–1) + 0.04889939537*$LNSX$(–2) + 0.272843226*$LNSX$(–3) – 0.039302859*$LNSX$(–4) – 0.01712404005*LNM(–1) – 0.1990991828*LNM(–2) – 0.1133346012*LNM(–3) – 0.0394768086*LNM(–4) + 0.3329742763*LNI(–1) + 0.1276036813*LNI(–2) – 0.1739915379*LNI(–3) + 0.0949172971*LNI(–4) + 0.0309059384*LNG(–1) + 0.07122490394*LNG(–2) + 0.05650023494*LNG(–3) + 0.01177553108*LNG(–4) + 1.07792509

$LNSX$ = –3.9380606*LNR(–1) + 3.35668*LNR(–2) – 0.607910938*LNR(–3) + 0.5289359612*LNR(–4) + 1.752410011*$LNSX$(–1) + 0.7814465787*$LNSX$(–2) – 0.96916476*$LNSX$(–3) + 0.3469152308*$LNSX$(–4) + 0.02346185581*LNM(–1) + 0.380843381*LNM(–2) + 0.02583196853*LNM(–3) – 0.1368834866*LNM(–4) – 0.2797186513*LNI(–1) – 1.013477322*LNI(–2) + 1.247770225*LNI(–3) – 0.455388757*LNI(–4) – 0.05458893085*LNG(–1) – 0.03839642266*LNG(–2) + 0.1945562552*LNG(–3) + 0.2417625189*LNG(–4) – 1.52559448

LNI = – 8.618872*LNR(–1) + 9.4407164*LNR(–2) – 6.7190925*LNR(–3) + 3.102998318*LNR(–4) + 5.061829074*$LNSX$(–1) – 1.173982425*$LNSX$(–2) – 1.455715567*$LNSX$(–3) + 2.734477293*$LNSX$(–4) + 0.6480708563*LNM(–1) + 1.557535337*LNM(–2) + 0.2412607597*LNM(–3) – 0.09576680591*LNM(–4) – 2.139039105*LNI(–1) – 0.4181240894*LNI(–2) + 2.005046131*LNI(–3) – 1.968406804*LNI(–4) – 0.342939926*LNG(–1) – 0.1883294592*LNG(–2) + 0.4212904271*LNG(–3) + 0.355278824*LNG(–4) – 21.58283256

LNG = 14.175261*LNR(–1) – 18.4748659*LNR(–2) + 8.1032935*LNR(–3) + 3.35161008*LNR(–4) – 10.54483977*$LNSX$(–1) + 2.411978668*$LNSX$(–2) + 5.86210599*$LNSX$(–3) – 2.55802967*$LNSX$(–4) – 0.0052018235*LNM(–1) – 1.774668358*LNM(–2) – 1.075279662*LNM(–3) – 1.741231895*LNM(–4) + 5.55427464*LNI(–1) – 0.9994607549*LNI(–2) – 2.685201432*LNI(–3) + 1.629023047*LNI(–4) – 0.157488914*LNG(–1) – 0.186127449*LNG(–2) – 0.8664866224*LNG(–3) + 0.02690099581*LNG(–4) – 10.87342161

Using LNR equation in VAR equation set to forecast the foreign exchange reserve in China (FR), the forecasting values of FR and the actual values of R are shown in **Figure 3 and Table 3.**

See from Table 3 the forecast error is very minor, from 0.02% to 0.1%, and the forecasting is highly accurate, from 99.98% to 99.99%.

4.2. VEC Model Estimation of Equilibrium Foreign Exchange Reserves Demand Based on Chinese Data Between 1985 and 2006

Because all the values LNR, $LNSX$, LNM, LNI, LNG are I(1), also exist co integration, so exist a error correction model.

4.2.1. Determining the Delay Section in the VEC Model of the Equilibrium Foreign Exchange Reserves Demand Based on the Chinese Data between 1985 and 2006

Because when $K = 1$

Akaike Information Criteria	15.69124
Schwarz Criteria	17.65466
When $K = 2$	
Akaike Information Criteria	13.59685
Schwarz Criteria	16.80585

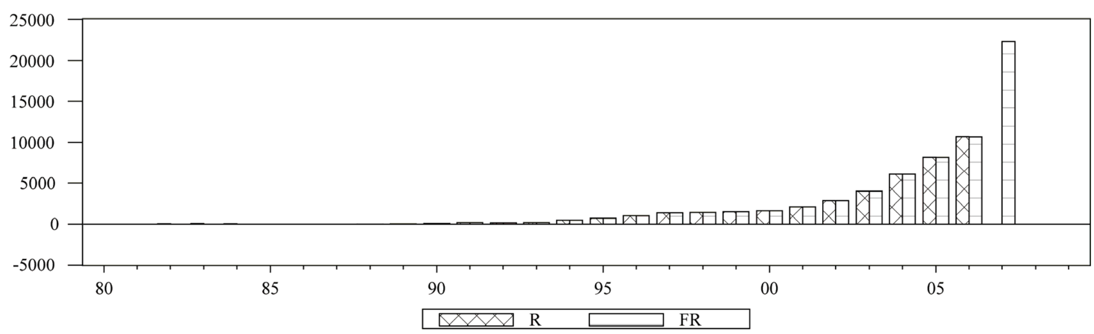

Figure 3. The forecasting values of *FR* and the actual values of *R*.

Table 3. Forecast error between the value of *FR* and *R*.

obs	*RESID*	*R*	*FR*	*ES*
1985	0.01	26.44	26.435	0.0002
1986	0.01	20.72	20.709	0.0006
1987	0.01	29.23	29.222	0.0003
1988	0.01	33.72	33.71	0.0003
1989	0.02	55.5	55.485	0.0003
1990	0.07	110.93	110.86	0.0006
1991	0.11	217.12	217.01	0.0005
1992	0.12	194.43	194.31	0.0006
1993	0.11	211.99	211.88	0.0005
1994	0.31	516.2	515.89	0.0006
1995	0.64	735.97	735.33	0.0009
1996	0.72	1050.3	1049.6	0.0007
1997	1.02	1398.9	1397.9	0.0007
1998	1.09	1449.6	1448.5	0.0008
1999	1.11	1546.8	1545.7	0.0007
2000	1.39	1655.7	1654.3	0.0008
2001	1.62	2121.7	2120.1	0.0008
2002	2.16	2864.1	2861.9	0.0008
2003	4.09	4032.5	4028.4	0.001
2004	2.81	6099.3	6096.5	0.0005
2005	12.3	8188.7	8176.4	0.0015
2006	7.54	10663	10656	0.0007
2007			22283	

So $K = 2$ is the best choice of cointegration equation and error correction model with the limit of sample capacity, gets the VEC model as follows,

4.2.2. VEC Model Estimation Results of Equilibrium Foreign Exchange Reserves Demand Based on Chinese data between 1985 and 2006

4.2.2.1. Delay section $K = 1$

$D(LNR) = -0.02082643444*(LNR(-1) - 0.81557953*LNSX(-1) - 0.91636494*LNM(-1) + 0.71058393*LNI(-1) - 0.047428193*LNG(-1) - 0.3588416363) + 0.25008865*D(LNR(-1)) + 0.1427340478*D(LNSX(-1)) + 0.02230181302*D(LNM(-1)) - 0.06450460302*D(LNI(-1)) - 0.02126208418*D(LNG(-1)) + 0.1450919242$

$D(LNSX) = 0.03164245422*(LNR(-1) - 0.815579531*LNSX(-1) - 0.9163649488*LNM(-1) + 0.710583936*LNI(-1) - 0.0474281939*LNG(-1) - 0.358841636) - 0.2036237*D(LNR(-1)) - 0.64870222*D(LNSX(-1)) + 0.0517247267*D(LNM(-1)) + 0.5572220392*D(LNI(-1)) - 0.02544716867*D(LNG(-1)) + 0.1589121152$

$D(LNM) = 1.220107884*(LNR(-1) - 0.8155795318*LNSX(-1) - 0.9163649488*LNM(-1) + 0.710583936*LNI(-1) - 0.0474281939*LNG(-1) - 0.358841636) + 0.88863089*D(LNR(-1)) - 0.9519198157*D(LNSX(-1)) - 0.008114850993*D(LNM(-1)) + 0.2931732124*D(LNI(-1)) + 0.04427418309*D(LNG(-1)) - 0.1860917443$

$D(LNI) = -0.3332935656*(LNR(-1) - 0.81557953*LNSX(-1) - 0.9163649488*LNM(-1) + 0.710583936*LNI(-1) - 0.047428193*LNG(-1) - 0.358841636) + 0.03138545*D(LNR(-1)) - 0.6885940951*D(LNSX(-1))$

$- 0.07677391686*D(LNM(-1)) + 0.7975711815*D(LNI(-1)) - 0.08023819174*D(LNG(-1)) + 0.07411662228$

$D(LNG) = 2.164457793*(LNR(-1) - 0.8155795318*LNSX(-1) - 0.9163649488*LNM(-1) + 0.710583936*LNI(-1) - 0.0474281939*LNG(-1) - 0.35884163) - 0.64807905*D(LNR(-1)) - 2.3799935*D(LNSX(-1)) + 0.7679206802*D(LNM(-1)) + 0.8411639391*D(LNI(-1)) - 0.3874419347*D(LNG(-1)) + 0.7787188403$

The long term equilibrium relation of these variables LNR, LNSX, LNM, LNI, LN are,

$LNR (-1) = 0.8155795318*LNSX (-1) + 0.9163649488*LNM (-1) - 0.7105839363*LNI (-1) + 0.04742819394*LNG (-1) + 0.3588416363$

4.2.2.2. Delay Section $K = 2$

$D(LNR) = 0.0210919311*(LNR(-1) - 8.39646148*LNSX(-1) - 6.53172328*LNM(-1) + 9.319611202*LNI(-1) + 5.921618915*LNG(-1) + 72.52744886) - 0.4199163335*D(LNR(-1)) + 0.02744055717*D(LNR(-2)) + 0.178363838*D(LNSX(-1)) - 0.07798941*D(LNSX(-2)) + 0.1637*D(LNM(-1)) + 0.100098*D(LNM(-2)) - 0.210331*D(LNI(-1)) + 0.043212*D(LNI(-2)) - 0.13208757*D(LNG(-1)) - 0.07503047391*D(LNG(-2)) + 0.3559304786$

$D(LNSX) = 0.009946085465*(LNR(-1) - 8.396461487*LNSX(-1) - 6.531723289*LNM(-1) + 9.3196112*LNI(-1) + 5.921618915*LNG(-1) + 72.52744886) - 0.9757317399*D(LNR(-1)) + 0.2452650037*D(LNR(-2)) + 0.0633299*D(LNSX(-1)) + 0.622115*D(LNSX(-2)) + 0.063976*D(LNM(-1)) + 0.03197*D(LNM(-2)) + 0.34938*D(LNI(-1)) - 0.553054*D(LNI(-2)) - 0.09832038718*D(LNG(-1)) - 0.0638524772*D(LNG(-2)) + 0.2518144464$

$D(LNM) = -0.028990184*(LNR(-1) - 8.396461487*LNSX(-1) - 6.531723289*LNM(-1) + 9.319611202*LNI(-1) + 5.921618915*LNG(-1) + 72.52744886) + 3.9950447*D(LNR(-1)) - 0.9449371943*D(LNR(-2)) + 0.23898574*D(LNSX(-1)) + 0.55443735*D(LNSX(-2)) - 1.12316*D(LNM(-1)) - 0.6771437*D(LNM(-2)) + 0.3818*D(LNI(-1)) - 0.830993*D(LNI(-2)) + 0.2355717803*D(LNG(-1)) + 0.09248289596*D(LNG(-2)) - 0.6183532604$

$D(LNI) = - 0.01178074236*(LNR(-1) - 8.3964614*LNSX(-1) - 6.531723289*LNM(-1) + 9.319611202*LNI(-1) + 5.92161891*LNG(-1) + 72.5274488) - 0.1287365454*D(LNR(-1)) - 0.5332005646*D(LNR(-2)) - 0.04472733462*D(LNSX(-1)) + 0.3249581422*D(LNSX(-2)) + 0.0638542*D(LNM(-1)) + 0.0026686*D(LNM(-2)) + 0.852404135*D(LNI(-1)) - 0.72172054*D(LNI(-2)) - 0.052984839*D(LNG(-1)) + 0.002247385*D(LNG(-2)) + 0.1702761775$

$D(LNG) = -0.3047102393*(LNR(-1) - 8.396461487*LNSX(-1) - 6.531723289*LNM(-1) + 9.319611202*LNI(-1) + 5.921618915*LNG(-1) + 72.52744886) + 14.95319432*D(LNR(-1)) - 4.995081418*D(LNR(-2)) - 3.7942098*D(LNSX(-1)) + 0.42273224*D(LNSX(-2)) - 1.7528*D(LNM(-1)) - 1.626889*D(LNM(-2)) + 2.911406*D(LNI(-1)) + 0.211057*D(LNI(-2)) + 1.112724587*D(LNG(-1)) + 0.8964220686*D(LNG(-2)) - 1.644163043$

So the long term equilibrium relation of these variables *LNR(–1)*, *LNSX(–1)*, *LNM(–1)*, *LNI(–1)*, *LNG(–1)* are

$LNR(-1) = 8.396461487*LNSX(-1) + 6.531723289*LNM(-1) - 9.319611202*LNI(-1) - 5.921618915*LNG(-1) - 72.52744886$

The upper equation express that, the elasticity that the Chinese foreign exchange reserves to export standard deviation (SX) is 8.396461487, it means that the export standard deviation increased 1%, the foreign exchange reserves will increase 8.396461487%.The elasticity that the Chinese foreign exchange reserves to the marginal propensity to import (m) is 6.531723289, it means that the marginal propensity to import increased 1%, the foreign exchange reserves will increase 6.531723289%.It can be explained that, the marginal propensity to import means the unit output increased will caused more import, so more reserves are necessary for the need of import.

The elasticity of the Chinese foreign exchange reserves to the net opportunity cost (*i*)[1] is –9.319611202, it means that the net opportunity cost of hold foreign exchange reserves increased 1%; the Chinese foreign exchange reserves will reduce 9.319611202%.

The elasticity between the foreign exchange reserves and the reaction coefficient of income to export is –5.921618915, it means that the reaction coefficient of income to export increased 1%, the foreign exchange reserves will reduce 5.921618915.

It can be explained that, the reaction coefficient of income to export is g increased, means that the increased unit export will lead to the unit output increase, and then increased the export lead to the foreign exchange re-

[1]net opportunity cost = return rate of capital – return rate of Chinese foreign exchange reserves.

serves increase, so the government should cut the holding foreign exchange reserves to make the government utility maximization.

3.2.2.3. Compared the Forecasting the Foreign Exchange Reserves with the Actual Foreign Exchange Reserves in the Long Term Equilibrium Relation with Delay Section $K = 1$ and $K = 2$

Suppose that *FLLNR* is the forecast of *LNR* in the long term equilibrium relation with delay section $K = 1$, gives the equation,

$$FLLNR = 0.8155795318*LNSX(-1) + 0.9163649488*LNM(-1) - 0.7105839363*LNI(-1) + 0.04742819394*LNG(-1) + 0.3588416363$$

FLR is the forecast of *R* in long term equilibrium relation, gives the equation,

$$FLR = 2.718\wedge FLLNR$$

Suppose *FLLNR*2 is the forecast of *LNR* in long term equilibrium relation with delay section $K = 2$, gives the equation,

$$FLLNR2 = 8.396461487*LNSX(-1) + 6.531723289*LNM(-1) - 9.319611202*LNI(-1) - 5.921618915*LNG(-1) - 72.52744886$$

*FLR*2 is the forecast of *LNR* in long term equilibrium relation with delay section $K = 2$, gives the equation,

$$FLR2 = 2.718\wedge FLLNR$$

The results of forecasts are shown in **Table 4 and Figure 4.**

Table 4. The values comparing between the forecasting foreign exchange reserves and Actual foreign exchange reserves in long term equilibrium relation with delay section *K* = 1 and *K* = 2.

ar	*R*	*FLR*	*FLR2*	*RESID*	*DR*	*R/FLR*
1981	27.08	304.1448779	304.1448779	–277.1	–0.911	0.089
1982	69.89	3.929199758	3.929199758	65.961	16.787	17.787
1983	89.01	520.8666099	520.8666099	–431.9	–0.829	0.1709
1984	82.2	127.0019411	127.0019411	–44.8	–0.353	0.6472
1985	26.44	2.931360374	2.931360374	23.509	8.0197	9.0197
1986	20.72	1598.467981	1598.467981	–1578	–0.987	0.013
1987	29.23	4.615698492	4.615698492	24.614	5.3327	6.3327
1988	33.72	25.47169536	25.47169536	8.2483	0.3238	1.3238
1989	55.5	455.7770815	455.7770815	–400.3	–0.878	0.1218
1990	110.93	0.557141842	0.557141842	110.37	198.11	199.11
1991	217.12	539.6117699	539.6117699	–322.5	–0.598	0.4024
1992	194.43	1037.334284	1037.334284	–842.9	–0.813	0.1874
1993	211.99	886.7690989	886.7690989	–674.8	–0.761	0.2391
1994	516.2	507.0328202	507.0328202	9.1672	0.0181	1.0181
1995	735.97	10.75360771	10.75360771	725.22	67.439	68.439
1996	1050.29	320.0219763	320.0219763	730.27	2.2819	3.2819
1997	1398.9	1991.527008	1991.527008	–592.6	–0.298	0.7024
1998	1449.6	1641.464691	1641.464691	–191.9	–0.117	0.8831
1999	1546.8	17435.01253	17435.01253	–15888	–0.911	0.0887
2000	1655.7	4232.041229	4232.041229	–2576	–0.609	0.3912
2001	2121.7	1524.305782	1524.305782	597.39	0.3919	1.3919
2002	2864.1	487.0255929	487.0255929	2377.1	4.8808	5.8808
2003	4032.5	1658.261504	1658.261504	2374.2	1.4318	2.4318
2004	6099.3	3153.68506	3153.68506	2945.6	0.934	1.934
2005	8188.7	3401.096381	3401.096381	4787.6	1.4077	2.4077
2006	10663.4	1489.350917	1489.350917	9174	6.1598	7.1598

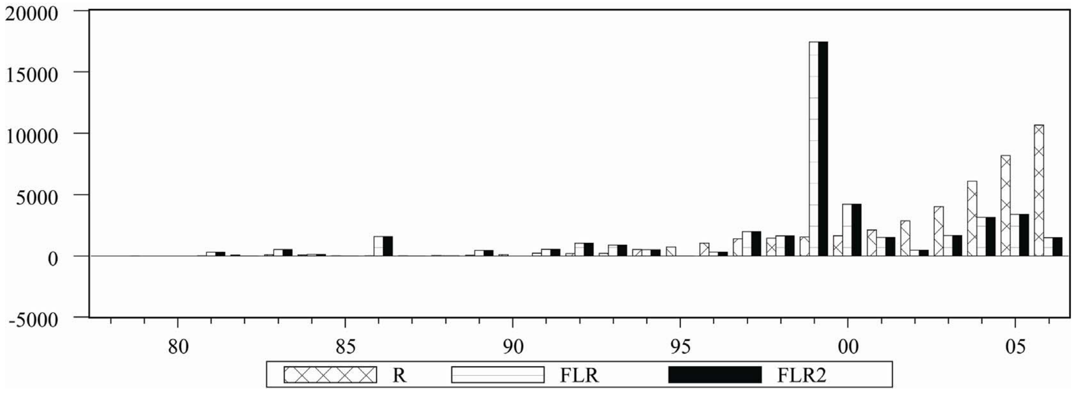

Figure 4. The values comparing between the forecasting foreign exchange reserves and Actual foreign exchange reserves in long term equilibrium relation with delay section $K = 1$ and $K = 2$.

I analyzed the **Table 4.** to find that: 1) The values of forecasting foreign exchange reserves in long term equilibrium relation with either delay section $K = 1$ or $K = 2$ are the same; 2) The ratio R/FLR is equal to 1 express that the values of actual foreign exchange reserve and long-term equilibrium are the same. If it less than 1, it express that the actual value is less than the long-term equilibrium. If it more than 1, it express that the actual value is bigger than the long-term equilibrium; 3) From Table 4 we can find that the actual foreign exchange reserves bigger than the long-term equilibrium in 1982, 1985, 1987, 1990, 1995, 2002, 2006, and it is steady basically in 1994. The value of actual foreign exchange reserves is much bigger than the long-term equilibrium in these years 1982, 1990, 1995. Because the actual value is much bigger than the long-term equilibrium in 1990, The situation supply basis for Ren-Min-Bi exchange rate reform of China in 1994, Ren-Min-Bi exchange rate select one kind of exchange rate and supervisory floating exchange rate institution.Because the actual value is much bigger than the long-term equilibrium in 1995, the situation supply basis for Ren-Min-Bi free exchange under current account in 1996; 4)From Figure 4 we can see that the Chinese actual foreign exchange reserves are bigger than the long-term equilibrium foreign exchange reserves in 1982, 1985, 1987, 1990, 1995, 2002, 2006.The Chinese actual foreign exchange reserves are bigger than the long-term equilibrium foreign exchange reserves in 1982, 1990, 1995. They are nearly equal in 1994. The Chinese actual foreign exchange reserves are smaller than the long-term equilibrium foreign exchange reserves in 1981, 1986, 1999. The Chinese actual foreign exchange reserves are smaller than the long-term equilibrium foreign exchange reserves in 1999 for weak world economy.

This section chooses the VAR Regress finds the fitted value and actual value of foreign exchange reserves is nearly equal within 99.8%. Finally it gets the long term equilibrium relation of the nature logarithm of variables by VEC model, which are foreign exchange reserves, standard error of export, marginal propensity to import, the opportunity cost for foreign exchange reserves, marginal output to export.

5. Summarizes for This thesis

The thesis finishes the following researches:

1) The author designs the government utility function when consider the China government buy part foreign exchange if company earn, it means that the China government will increase Ren-Min-Bi yuan, and it will cause inflation. The inflation will cause disutility to government.

2) The thesis gets the optimal foreign exchange reserves by Maximum the government utility.

3) Unit root test the nature logarithm of variables which the optimal foreign exchange reserves function include, the thesis find they are I(1),they exist co integration.

4) *VAR* Regress finds the fitted value and actual value of foreign exchange reserves is nearly equal within 99.8%.

5) The thesis gets the long term equilibrium relation of the nature logarithm of variables by VEC model, which are foreign exchange reserves, standard error of export, marginal propensity to import, the opportunity cost for foreign exchange reserves, marginal output to export.

6) The Chinese actual foreign exchange reserves are bigger than the long-term equilibrium foreign exchange reserves in 1982,1985,1987,1990,1995,2002,2006.The Chinese actual foreign exchange reserves are more bigger than the long-term equilibrium foreign exchange reserves in 1982, 1990, 1995.They are nearly equal in 1994. The Chinese actual foreign exchange reserves are smaller than the long-term equilibrium foreign exchange reserves in 1981, 1986, 1999. The Chinese actual foreign exchange reserves are smaller than the long-term equilib-

rium foreign exchange reserves in 1999 for weak world economy.

Different from the Kelly, Michael G. (1970) [3], Kelly, Michael G. (1970) designed the government utility function without considering the China government buy part foreign exchange if company earn, it means that the China government will increase Ren-Min-Bi yuan, and it will cause inflation. The inflation will cause disutility to government. Finally it gets the optimal fuction, we can find through the sample data about 46 countries from 1953 to 1965, (1) the government-holding foreign exchange reserves has positive correlation with the export standard error, (2) it has positive correlation with the average propensity to import [3].

This thesis designed the government utility function when consider the China government buy part foreign exchange if company earn, it means that the China government will increase Ren-Min-Bi yuan, and it will cause inflation. The inflation will cause disutility to government. Finally it gets the optimal fuction, using the sample datas in China 1980-2006 and VEC we can find: 1) The government-holding foreign exchange reserves has positive correlation with the export standard error; 2) It has positive correlation with the marginal propensity to import. The optimal fuction, data and regression method are all different, but all have the positive correlation between the foreign exchange reserves and export standard error, also is consonant with the results about the marginal propensity to import basically.

Different from Guobo Huang (1995), Guobo Huang (1995) collected the correlative economic datas from 1980 to 1990 in China, using *ECM* based on the quarterly datas to research the international reserves scale and discovered that: 1) The Chinese foreign exchange reserve has the negative correlation with import, that is when the import increased the foreign exchange reserves will reduce; 2) it has negative correlation with average propensity to import, that is when the average propensity to import increased the foreign exchange reserves will reduce. The thesis find that the elasticity that the Chinese foreign exchange reserves to the marginal propensity to import (m) is 6.531723289, it means that the marginal propensity to import increased 1%, the foreign exchange reserves will increase 6.531723289%.It can be explained that, the marginal propensity to import means the unit output increased will caused more import, so more reserves are necessary for the need of import.

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Appendix

Table 1. The value of m, g, i after interpolation method estimate and Smoothing.

t	*R*	*ER*	*X*2	*S*(*X*)	*M*	*dM*	*M* = d*M*/d*Y*2	*G* = d*Y*2/d*X*2	*i* = *yt*2 – *yr*
1980	–12.96	1.54	182.7	1620.28	192.9	–27.3	0.14923	5.625417	0.2472
1981	27.08	1.74	220.1	1582.88	213.9	21	0.001775	0.000372068	0.19
1982	69.89	1.94	223.2	1579.78	274.1	60.2	0.418353	0.0000210503	0.1848
1983	89.01	1.99	222.3	1580.68	422.5	148.4	0.083026	0.0000028103	0.1464
1984	82.2	2.79	261.4	1541.58	429	6.5	0.0014615	0.0000105348	0.1708
1985	26.44	3.2	273.5	1529.48	432.2	3.2	0.642079	19.10117	0.1595
1986	20.72	3.72	309.4	1493.58	552.7	120.5	0.0016571	0.00010926	0.1195
1987	29.23	3.72	394.4	1408.58	591.4	38.7	0.006675	5.640101	0.1256
1988	33.72	3.72	475.2	1327.78	533.5	–57.9	0.150211	9.928271	0.1166
1989	55.5	4.24	525.4	1277.58	637.9	104.4	0.000107067	0.0072003	0.0757
1990	110.93	5.22	620.9	1182.08	805.9	168	0.134211	0.000451739	0.0357
1991	217.12	5.41	719.1	1083.88	1039.6	233.7	0.232027	4.581959	0.0483
1992	194.43	5.8	849.4	953.58	1156.2	116.6	0.272804	4.726228	0.0642
1993	211.99	5.81	917.4	885.58	1320.8	164.6	0.162339	21.17035	0.0733
1994	516.2	8.49	1210.1	592.88	1388.3	67.5	0.0028822	0.000138212	0.0261
1995	735.97	8.32	1487.8	315.18	1423.7	35.4	0.100987	5.869338	0.0213
1996	1050.29	8.3	1510.5	292.48	1402.4	–21.3	0.077414	38.41112	0.0012
1997	1398.9	8.28	1827.9	24.92	1657	254.6	0.043478	2.565218	0.000037
1998	1449.6	8.28	1837.1	34.12	2250.9	593.9	0.4542	50.96881	0.000048
1999	1546.8	8.28	1949.3	146.32	2435.5	184.6	0.56634	4.006712	0.0021
2000	1655.7	8.28	2492	689.02	2951.7	516.2	0.664472	1.646936	0.0606
2001	2121.7	8.28	2661	858.02	4127.6	1175.9	0.194794	5.607509	0.0866
2002	2864.1	8.28	3256	1453.02	5612.3	1484.7	0.543956	1.594913	0.0977
2003	4032.5	8.28	4382.3	2579.32	6599.5	987.2	0.806024	1.295293	0.1251
2004	6099.3	8.28	5933.3	4130.32	7916	1316.5	0.63818	1.499975	0.1443
2005	8188.7	8.19	7619.5	5816.52			0.17097	3.424325	0.1321
2006	10663.4	7.81	9691	7888.02			0.289261	2.197084	0.1354

Note: Dimension of R, X2, S (X), M, dM is 100 million US Dollar; R is Chinese Foreign Exchange Reserves; ER is the exchange rate; it is Renminbi (RMB)'s amount of a dollar, which comes from The Chinese State Administration of Foreign Exchange website http://www.safe.gov.cn/ model_safe_en/index.jsp?id = 6; And the some data of the table come from: Zhang Xiaopu (2001), *Study on Renminbi* (*RMB*)*'s equilibrium rate of exchange*, China Financial Publishing House, Jan.2001. X2 is the export amount per year; dX2 is the export increasing amount per year; E (X) is the average value of X2; S (X) is the absolute value of the deviation between the average value of X2 and X2; M is the import amount per year; dM is the import increasing amount per year; Y1 is GDP; Dimension of Y1 is 100 million Renminbi (RMB); Y2 is GDP =Y1/ER, ER is Renminbi (RMB)'s amount of a dollar; dY2 is the GDP increasing amount per year; g=dY/dX,g is the reaction factor from income to export, where Y is income; i=yt2–yr is the opportunity cost for holding foreign exchange reserves, using the difference between profit rate and the reserve earnings yield before capital tax in China to compotator. yt2 is the profit rate before capital tax in China.yt2 come from the following thesis:Guoqing Song, Feng Lu, Jie Tang, Hongyan Zhao, Liu Liu (2007), Value on the yield rate of Chinese Capital (1978–2006), China Center for Economic Research (CCER) at Peking University Working paper Series No.C 2007002 (writer finished: Feng Lu)(calculated from the Working paper Series No.C 2007002); yr is the reserve earnings yield, using one year treasury bill rate–inflation rate in USA yr=br–ir; br is one-year Treasury bill yield rate in USA. Please see the following website;
http://www.federalreserve.gov/datadownload/Download.aspx?rel=H15&series=bf17364827e38702b42a58cf8eaa3f78&lastObs=&from=&to=&filetype=csv&label=include&layout=seriescolumn&type=package; ir is the inflation in USA, take the yearly average inflation in USA as the standard. Please see the following web-page: http://inflationdata.com/Inflation/Inflation_Rate/ HistoricalInflation.aspx.

Table 2. The actual value of *M, Y*2, *yt*2, *br*, *ir*, *yr* = *br* – *ir*, *i* = *yt*2 – *yr*.

t	*Y*1	*Y*2	d*Y*2	*M* = d*M*/d*Y*2	*g* = d*Y*2/d*X*	*yt*2	*br*	*ir*	*yr*	*i*
1980	4517.8	2933.636	259.3317	0.14923	5.625417	25.00%	13.86%	13.58%	0.28%	0.2472
1981	4862.4	2794.483	–139.154	–0.1775	–3.72068	22.00%	13.35%	10.35%	3.00%	0.19
1982	5294.7	2729.227	–65.256	0.418353	–21.0503	21.00%	8.68%	6.16%	2.52%	0.1848
1983	5934.5	2982.161	252.934	0.083026	–281.038	21.50%	10.08%	3.22%	6.86%	0.1464
1984	7171	2570.251	–411.91	–0.14615	–10.5348	22.00%	9.22%	4.30%	4.92%	0.1708
1985	8964.4	2801.375	231.1241	0.642079	19.10117	20.00%	7.60%	3.55%	4.05%	0.1595
1986	10275.2	2762.151	–39.2245	–0.16571	–1.0926	16.00%	5.95%	1.90%	4.05%	0.1195
1987	12058.6	3241.559	479.4086	0.006675	5.640101	16.00%	7.10%	3.66%	3.44%	0.1256
1988	15042.8	4043.763	802.2043	0.150211	9.928271	16.60%	9.02%	4.08%	4.94%	0.1166
1989	16992.3	4007.618	–36.1455	–1.07067	–0.72003	10.50%	7.76%	4.83%	2.93%	0.0757
1990	18667.8	3576.207	–431.411	0.134211	–4.51739	5.00%	6.82%	5.39%	1.43%	0.0357
1991	21781.5	4026.155	449.9484	0.232027	4.581959	4.70%	4.12%	4.25%	–0.13%	0.0483
1992	26923.5	4641.983	615.8275	0.272804	4.726228	7.00%	3.61%	3.03%	0.58%	0.0642
1993	35333.9	6081.566	1439.584	0.162339	21.17035	8.00%	3.63%	2.96%	0.67%	0.0733
1994	48197.9	5677.02	–404.546	–0.28822	–1.38212	7.20%	7.20%	2.61%	4.59%	0.0261
1995	60793.7	7306.935	1629.915	0.100987	5.869338	4.50%	5.18%	2.81%	2.37%	0.0213
1996	67884.6	8178.867	871.9324	0.077414	38.41112	2.70%	5.51%	2.93%	2.58%	0.0012
1997	74462.6	8993.068	814.2002	0.043478	2.565218	2.80%	5.51%	2.34%	3.17%	–0.0037
1998	78345.2	9461.981	468.913	–0.04542	50.96881	2.50%	4.53%	1.55%	2.98%	–0.0048
1999	82067.5	9911.534	449.5531	0.56634	4.006712	4.00%	5.98%	2.19%	3.79%	0.0021
2000	89468.1	10805.33	893.7923	0.664472	1.646936	8.00%	5.32%	3.38%	1.94%	0.0606
2001	97314.8	11753	947.6691	0.194794	5.607509	8.00%	2.17%	2.83%	–0.66%	0.0866
2002	105172.3	12701.97	948.9734	0.543956	1.594913	9.50%	1.32%	1.59%	–0.27%	0.0977
2003	117251.9	14160.86	1458.889	0.806024	1.295293	11.50%	1.26%	2.27%	–1.01%	0.1251
2004	136515	16487.32	2326.461	0.63818	1.499975	14.50%	2.75%	2.68%	0.07%	0.1443
2005	182321	22261.42	5774.098	0.17097	3.424325	15.20%	4.38%	2.39%	1.99%	0.1321
2006	209407	26812.68	4551.26	0.289261	2.197084	15.30%	5%	3.24%	1.76%	0.1354

Note: 1. Y2 is GDP =Y1/ER, ER is Renminbi (RMB)'s amount of a dollar, ER come from Appendix **Table 1**; The meaning of Symbol Y1,dY2 and so on are the same from Appendix **Table 1**; Dimension of Y1 is 100 million Renminbi (RMB), Dimension of Y2,DY2 is 100 million US Dollar.

Table 3. The structure of chinese foreign exchange reserves.*

YEAR	AFR#	GRΩ	GPΩΩ	GVΩΩΩ	GV/ AFR	SDRsΨ	SDR_S/AFR
1980	–12.96	1280	600.71	76.89088	–5.93294	NA	
1981	27.08	1267	464.76	58.88509	2.174486	NA	
1982	69.89	1267	314.98	39.90797	0.571011	NA	
1983	89.01	1267	412.84	52.30683	0.587651	NA	
1984	82.20	1267	377.67	47.85079	0.582126	NA	
1985	26.44	1267	316.83	40.14236	1.518244	NA	
1986	20.72	1267	342.57	43.40362	2.094769	NA	
1987	29.23	1267	449.59	56.96305	1.948787	NA	
1988	33.72	1267	451.33	57.18351	1.695834	NA	
1989	55.50	1267	367.6	46.57492	0.839188	NA	
1990	110.93	1267	352.33	44.64021	0.402418	NA	
1991	217.12	1267	366.72	46.46342	0.213999	NA	
1992	194.43	1267	340.8	43.17936	0.222082	NA	
1993	211.99	1267	371.89	47.11846	0.222267	NA	
1994	516.20	1267	385.64	48.86059	0.094654	NA	
1995	735.97	1267	387.56	49.10385	0.06672	5.8	0.007881
1996	1050.29	1267	385.27	48.81371	0.046476	6.18	0.005884
1997	1398.90	1267	340.78	43.17683	0.030865	6.07	0.004339
1998	1449.60	1267	292.27	37.03061	0.025545	6.76	0.004663
1999	1546.75	1267	261.35	33.11305	0.021408	7.41	0.004791
2000	1655.74	1267	285.55	36.17919	0.021851	7.94	0.004795
2001	2121.65	1608	268.35	43.15068	0.020338	8.55	0.00403
2002	2864.07	1929	310.25	59.84723	0.020896	9.92	0.003464
2003	4032.51	1929	356.53	68.77464	0.017055	11.00	0.002728
2004	6099.32	1929	391.99	75.61487	0.012397	12.42	0.002036
2005	8188.72	1929	430.66	83.07431	0.010145	12.58	0.001536

Note: *: The data come from IMF database. #: AFR is the actual Chinese Foreign Exchange Reserves; dimension of AFR is 100 million US Dollar; Ω: GR is the gold Reserves, dimension of GR is 10,000 ounces, and the value of GR is the statistic in the December of each year; ΩΩ: GP is the gold price, we use the price of in the June of each year.dimension of GP is US dollar amount of each ounce; ΩΩΩ: GV is the value of gold, dimension of GV is 100 million US Dollar. Ψ: SDRs is the special drawing right, dimension of SDRs is 100 million US Dollar by our calculated; NA: NA is the data of not available.