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An Empirical Analysis of the Foreign Exchange, Savings and Money Supply

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Abstract: **It adopts foreign mature vector autoregressive model, set up foreign exchange reserves, residents' savings and three variables such as the M2 measure of money supply model to explore residents' savings, foreign currency impact on money supply. It uses Granger causality test model, etc. The comprehensive study is on the above three variables. Studies show that foreign exchange reserves, savings and broad money M2 does exist among some long-term relationship.**

Keywords: VAR; Granger causality test; Money supply; Household savings; Foreign exchange reserves

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1. Introduction

In recent years our country's economic sensitivity to foreign increases as the increasing degree of economic is opening to the outside world. Influenced by various factors, China's foreign exchange reserve has a direct contact with money supply change [1]. Especially the foreign exchange management system reform since 1994, subject to compulsory written guarantee system and based on the foreign exchange market supply and demand of a managed floating exchange rate system, the situation is more apparent. China's foreign exchange reserves topped $100 billion in December of 1996, $200 billion in October 2001. At the end of February 2006, China's foreign exchange reserves total scale has reached $853.6 billion, overtaking Japan's first in the world. At the end of 2012, China's foreign exchange savings is $3.311589 trillion. Large increase of foreign exchange reserves, which greatly enhanced our foreign payment ability, improve China's comprehensive national strength, identified both at home and abroad to our country macroeconomic policy and the confidence of value of RMB stable, is advantageous to the foreign capital inflows and so on. In certain significance of increasing of foreign exchange reserves and its positive effects at the same time, we should also see the rapid growth of foreign exchange reserves will bring some potential negative impacts on our economy. The huge foreign reserves have a great significant impact on the money supply and monetary policy in China. On the one hand, the balance of payments surplus and large capital inflows led to a surge of foreign exchange reserves, but it also caused by a surge of foreign exchange, monetary base on the too fast, the money supply increases, the potential crisis of inflation, etc. On the other hand, the rapid growth of foreign exchange reserves and changing the money supply mechanism make the central bank's monetary policy operation difficulty and reduce monetary policy effectiveness.

At the same time, there is some inertia relationship between residents' savings and money supply. Since the reform and opening, our country residents' savings has maintained high growth. From 1978 in 21.06 billion to 1992 in 1.17594 trillion to 2006 in 16.1587 trillion to 2012, 399.551 quadrillion Yuan, in such a short period of time increased by hundreds. Even not consider the factor of inflation; the growth speed also is very shocking. Many economists and the relevant departments have paid a great attention on the present status of high foreign exchange savings, high savings. What's the relationship between the three, high foreign exchange savings, high savings and money supply [2].

Above all, the paper will systematically discuss four parts. Part 1: build up the relationship between reserves of foreign exchange savings and the money supply through EVIEWS statistical software. Part 2: through the Granger causality test to rule out the false relationship associated with foreign exchange reserves and household savings and money supply through the Granger causality test. Part 3: through forecasting known value further verify its effect. Part 4: put forward some proposals according to the conclusion and the deficiency existing in.

2. Model Introduced

2.1. VAR (Vector Auto Regression)

The traditional econometric method is the model describing the relationship between variables based on economic theory. However, it's usually not enough to provide a rigorous explanation to the dynamic relationship between variables by economic theory. And endogenous variable can appear in the left side of

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the equation and can also appear in the right. This make estimation and inference becomes more complicated. In order to solve these problems and there is a non-structural way vector autoregressive model (VAR) proposed by Sims (1980) to establish a relationship between each variable model. VAR is the model based on the statistical properties of the data. VAR model regard each endogenous variable in the system as the function of the lag value of all the endogenous variables in the system to construct the model. And VAR model extend the single variable regression model to vector auto regression model composed of multivariate time series of variable. VAR model is one of the easiest to operation model in dealing with the analysis and prediction of multiple related economic indicators. And under certain conditions, the multivariate MA and ARMA model can also be converted into VAR model. In recent years more and more economists pay great attentions to VAR model [3].

VAR model representation as follows:

$$\boldsymbol{Y}_t = \boldsymbol{\mu} + \boldsymbol{\Pi}_1 \boldsymbol{Y}_{t-1} + \boldsymbol{\Pi}_2 \boldsymbol{Y}_{t-2} + \ldots + \boldsymbol{\Pi}_k \boldsymbol{Y}_{t-k} + \boldsymbol{u}_t,$$

$$\boldsymbol{u}_t \sim \text{IID}\ (\boldsymbol{0}, \boldsymbol{\Omega}) \qquad (1)$$

Among them

$$\boldsymbol{Y}_t = (y_{1,t} \quad y_{2,t} \ldots \quad y_{N,t})'$$

$$\boldsymbol{\mu} = (\mu_1 \quad \mu_2 \ldots \mu_N)',$$

$$\boldsymbol{\Pi}_j = \begin{bmatrix} \pi_{11.j} & \pi_{12.j} & \cdots & \pi_{1N.j} \\ \pi_{21.j} & \pi_{22.j} & \cdots & \pi_{2N.j} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{N1.j} & \pi_{N2.j} & \cdots & \pi_{NN.j} \end{bmatrix}, j = 1, 2, \ldots, k$$

$$\boldsymbol{u}_t = (u_{1\,t} \quad u_{2,t} \ldots u_{N\,t})',$$

$\boldsymbol{Yt}$ is N×1 order column vector time series. μ is N×1 order constant column vector. $\boldsymbol{\Pi 1}, \ldots, \boldsymbol{\Pi k}$ are all N×N order parameter matrix. Each element is not autocorrelation. But there may be related namely between the random error term of different equations.

Because on the right side of each equation of the VAR model only contains the lagging value endogenous variable and they are not related with u_t. So we can use the OLS method to estimate each equation in turn. Parameter estimators we get have consistency.

2.2. Granger Causality Test

Co-integration test shows that there is a long-term equilibrium relationship between variables. But causal relationship needs further examination. If the variable *X* helps predict *Y*, according to regression of the value of Y plus the value of X can significantly enhance the capacity of the interpretation of the regression, X is the Granger cause of Y. Otherwise X is not the Granger cause of Y. The test model is:

$$y_t = C + \sum_p \alpha_i \Delta y_{t-i} + \sum_q \beta_i \Delta x_{t-i} + \varepsilon_{ti} \qquad (2)$$

The null hypothesis: *X* is not the Granger cause of *Y*. $H_0 : \beta_1 = \beta_2 = \ldots = \beta_q = 0$. If the null hypothesis is established, there are: $y_t = C + \sum_p \alpha_i \Delta y_{t-i} + \varepsilon_{ti}$.

The sum of squared residuals the equation (2) is SSE_1, the sum of squared residuals the equation (2) is SSE_0. Then $F = \dfrac{(SSE_1 - SSE_0)/q}{SSE_0/(T-q-p-1)}$ conform to *F* distribution of degree of freedom of (*q*, *T* - *p* - *q* -1). T means sample size. The p and q respectively y and x lag order. The lag order can be determined by Akaike information criterion (AIC). Compare the size of *F* statistic and the critical value can be inspection result. If *F* is greater than the critical value would reject null hypothesis H_0: *x* is the Granger cause of *y*. If *F* is less than the critical value cannot reject null hypothesis that means *x* is not the Granger cause of *y*.

3. Data and Index Interpretation

3.1. Data Interpretation

Usually, we first calculate economic time series of logarithm or logarithm change before analysis for two reasons. Reason 1, many economic series, such as GDP, have approximate exponential growth. The sequence in the long run tends to be at a certain percentage per year on average growth. So the sequence of the logarithm is approximating linear growth. Reason two, the standard deviation of many economic events sequence is approximation proportional to its level. The standard deviation can be represented by the percentage of horizontal sequence. This can make the standard deviation of logarithmic sequence approximately as constant.

This paper sample interval is 1991-2012, a total of 21 samples, which all the raw data are from the national bureau of statistics official website. This article uses the statistical analysis software EVIEWS6.0 version. All data is inputted by human. Variables adopt the broad money supply logarithmic form LM2, foreign exchange reserves logarithmic form LFOR, and savings deposit balance logarithmic form LSAV. All data have been adjusted for consumer price index, the CPI of actual data, the formula for LM2 = LN (M2/CPI).The other two equation use the same method.

3.2. Index Interpretation

M0, M0 = cash in circulation, the sum of cash of each unit outside the banking system and cash on hand of the residents.

M1: narrow money supply, M0 adds the current deposit in the bank of enterprises, organs, groups, troops, schools and other units.

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M2, the broad money supply, M1 adds deposit in the bank of enterprises, organs, groups, troops, schools and other units and kinds of savings deposits of urban and rural residents in the individual bank and the securities customer deposit.

FOR: foreign exchange reserves. It usually means reserve currency that held by national officials and can be discretionary and convertible. It is a main part of a country's reserves, and it is the important symbol of national macroeconomic regulation and control power.

SAV: savings, personal's deposit of portion of income and foreign currency.

Table 1 Vector auto-regression estimates for model

	LM2	LSAV	LFOR
LM2(-1)	-0.448529	-1.071848	0.618997
	(0.76015)	(0.85033)	(1.53090)
	[-0.59005]	[-1.26051]	[0.40434]
LM_2(-2)	1.257779	1.108575	1.207803
	(0.79021)	(0.88395)	(1.59143)
	[1.59170]	[1.25411]	[0.75894]
LSAV(-1)	0.594303	1.029881	-0.511090
	(0.71233)	(0.79683)	(1.43458)
	[0.83431]	[1.29247]	[-0.35626]
LSAV(-2)	-0.774908	-0.448741	-0.900912
	(0.81367)	(0.91020)	(1.63868)
	[-0.95236]	[-0.49302]	[-0.54978]
LFOR(-1)	0.199692	0.340615	1.039294
	(0.18792)	(0.21021)	(0.37846)
	[1.06265]	[1.62033]	[2.74613]
LFOR(-2)	-0.003846	-0.155793	-0.386230
	(0.14257)	(0.15948)	(0.28713)
	[-0.02697]	[-0.97686]	[-1.34516]
C	3.009175	3.029589	-3.061281
	(1.75213)	(1.95999)	(3.52867)
	[1.71744]	[1.54572]	[-0.86755]
R-squared	0.992304	0.989503	0.986924
Adj. R-squared	0.988752	0.984658	0.980889
Sum sq. resides	0.139570	0.174649	0.566084
S.E. equation	0.103615	0.115907	0.208674
F-statistic	279.3696	204.2417	163.5289
Log likelihood	21.27044	19.02835	7.268685
Akaike AIC	-1.427044	-1.202835	-0.026868
Schwarz SC	-1.078538	-0.854329	0.321638
Mean dependent	12.14950	11.37557	8.229179
S.D. dependent	0.976991	0.935779	1.509465
Determinant resid covariance (dof adj.)		2.44E-07	
Determinant resid covariance		6.71E-08	
Log likelihood		80.03823	
Akaike information criterion		-5.903823	
Schwarz criterion		-4.858304	

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4. The Empirical Process

4.1. Using VAR Model Modeling

In this paper, First, we examine LM2, LSAV, LFOR correlations based on the basic theory of the VAR model and ignored the difference between the endogenous and exogenous variables. We use the VAR model on unconstrained conditions. For the selection of lag length, lagging a little will lose valuable information and make the prediction precision decrease, but join lag too much can increase the uncertainty of estimation. Therefore, the selection of lag length must weigh the additional information of earnings and the cost of estimation additional coefficient.

After checking calculation, based on the principle of AIC and SC are smaller, both considering the simplicity of the model and specific reasons of a small number sample, we establish a VAR model of a lag ii phase of unconstrained conditions. Operation result by using the Eviews6.0 is as follow (Table 1).

According to the result output by computer, we can get the relationship expressions by automatically generated between LM2, LFOR and LSAV:

Estimation Proc:

VAR Model:

==========

LM2 = C(1,1)*LM2(-1) + C(1,2)*LM2(-2) + C(1,3)*LSAV(-1) + C(1,4)*LSAV(-2) + C(1,5)*LFOR(-1) + C(1,6)*LFOR(-2) + C(1,7) ------a

LSAV = C(2,1)*LM2(-1) + C(2,2)*LM2(-2) + C(2,3)*LSAV(-1) + C(2,4)*LSAV(-2) + C(2,5)*LFOR(-1) + C(2,6)*LFOR(-2) + C(2,7) -----b

LFOR = C(3,1)*LM2(-1) + C(3,2)*LM2(-2) + C(3,3)*LSAV(-1) + C(3,4)*LSAV(-2) + C(3,5)*LFOR(-1) + C(3,6)*LFOR(-2) + C(3,7) -------c

VAR Model - Substituted Coefficients:

==========

LM2 = - 0.448528533385*LM2(-1) + 1.25777894112*LM2(-2) + 0.594303229566*LSAV(-1) - 0.774907626663*LSAV(-2) + 0.199692454484*LFOR(-1) - 0.00384569836247*LFOR(-2) + 3.00917488145

LSAV = - 1.0718483623*LM2(-1) + 1.10857460101*LM2(-2) + 1.02988079295*LSAV(-1) - 0.448740854126*LSAV(-2) + 0.340614575636*LFOR(-1) - 0.155793144368*LFOR(-2) + 3.02958863556

LFOR = 0.618997436801*LM2(-1) + 1.20780267012*LM2(-2) - 0.511089602583*LSAV(-1) - 0.900912331278*LSAV(-2) + 1.03929387766*LFOR(-1) - 0.386230269214*LFOR(-2) - 3.06128111377

This article only studies LSAV and LFOR impact on LM2, so we choose equation a.

4.2. Granger Causality Test

Granger causality test is a kind of to the pseudo test methods. There is often spurious correlation in the field of economic time series problems, namely no economic sense sequence could calculate the bigger correlation coefficient. To avoid this situation, we can use the model test as below (Table 2).

Table 2 Granger causality tests of variables

Null Hypothesis:	Obs	F-Statistic	Prob.
LM2 does not Granger Cause LFOR	20	0.64879	0.5367
LFOR does not Granger Cause LM2		2.42548	0.1223
LSAV does not Granger Cause LFOR	20	0.51398	0.6083
LFOR does not Granger Cause LSAV		2.76739	0.0948
LSAV does not Granger Cause LM2	20	1.83169	0.1942
LM2 does not Granger Cause LSAV		2.28499	0.1361

The results show that: LFOR is LM2 granger reason of 87.77%; LSAV is LM2 granger reason of 80.58%; LM2 is LSAV granger reason of 86.39%, and LFOR is LSAV granger reason of 90.52%. LM2 LSAV and, therefore, there is a close relationship between LFOR or LSAV and LM2. LFOR and LSAV have very large impact on LM2.

5. Forecast

In order to further verify the accuracy of the model, we can use the model to calculate the predictive value of 1991-2012 as below (Table 3) and compared it with the actual value.

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Table 3 Predictive value of 1991-2012

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Forcaest lm2	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Real lm2	NA	NA	10.36	10.59	10.87	11.12	11.34	11.54	11.72	11.88	12.04
Year	9.84	10.08	10.32	10.54	10.86	11.16	11.39	11.56	11.71	11.81	11.97
Forcaest lm2	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Real lm2	12.19	12.34	12.49	12.62	12.76	12.89	13.02	13.15	13.27	13.39	13.52

Predicted values and the actual value are very close, so the predict ability is very strong.

LM2=-0.449*LM2(-1)+1.258*LM2(-2)+0.594*LSAV(-1)-0.775*LSAV(-2)+0.199*LFOR(-1)-0.004*LFOR(-2) + 3.009

6. Conclusion

Through the analysis of the statistical model above, we may draw the conclusion that LM2, LSAV, and LFOR have a long-term and stable relationship. This research topic has practical significance. We can predict broad money that the national economy needs according to the estimated equation. This can be used as the important reference of macro policy makers. And it is convenient to apply because the use of advanced lagging data. It also shows the importance and the necessity of maintaining high savings ratio in our country at present time, because LSAV has a very big impact on LM2. But high savings ratio may cause other problems, it reduces the current consumption level of residents, limits the people's living standards, finally it is not conducive to the development of the economy.

This paper did not analyze foreign exchange reserves and saving impact on money supply specific. That how to find the best balance point among saving, foreign exchange and money supply and how to exert the function of monetary policy and so on are all we need to be further explored.

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