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Research Article

Using Multiple Regression Model and Principal Component Analysis on Exchange Rates: The Case of Chinese RMB

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Abstract

With China's economic development, RMB exchange rate plays an increasingly important role in China's economic development. In recent years, due to the changes in the form of international relations and domestic policies, especially after the RMB has become a world currency, the exchange rate of RMB reflects the external value of RMB and the strength of China's economic strength, which will also have different effects on the international economy and domestic economy. Based on the relevant data of RMB exchange rate with other common currencies from April 17 to May 16, this paper takes RMB exchange rate as the research object, uses MATLAB to build charts and models to judge the trend of RMB exchange rate and get the real effective exchange rate, and uses principal component analysis to analyze the seven major Factors Affecting RMB exchange rate from 2009 to 2018. Then the multiple regression model was constructed for the key factors. Finally, the key factors combined with the domestic and international form of grouping analysis, gives the relationship between the RMB exchange rate and the influencing factors, and finally comes to the conclusion that the RMB exchange rate has the characteristics of two-way volatility, and the development of RMB exchange rate has the trend of steady increase.

Keywords: Exchange Rate; Chinese RMB; Principal Component Analysis; Multiple Regression Model

Introduction

The definition of exchange rate is the value ratio after the exchange between two currencies. Exchange rate can reflect the external value of a country's currency. At the same time, the exchange rate of a country's currency can also reflect its economic strength and international status. The change trend and fluctuation of exchange rate have great guiding significance for a country to establish its economic development policy. In recent years, the scale of China's foreign trade continues to expand, and its position in the global economy is getting higher and higher, and its exchange rate changes have attracted more and more international attention.

Chinese economists have done a lot of research on the fluctuation of RMB exchange rate. Through reading the analysis results of experts, it is found that the expert's; research on the RMB exchange rate is based on the numerical model. However, in the research on the RMB exchange rate, we can find that the quantitative model analysis is somewhat one-sided, that is, the factors considered are relatively few, which leads to the corresponding error in the analy-

sis of the results. Therefore, through the introduction of principal component analysis, this paper analyzes and selects many factors that affect the RMB exchange rate, and then uses Bayesian discrimination and multiple regression equation to establish a multiple linear regression model, which makes a more comprehensive analysis of the trend and influencing factors of the RMB exchange rate.

Methodology

Modeling

Variable selection

Domestic experts show that under the background of RMB becoming an international currency, the influencing factors of RMB exchange rate fluctuations are mainly reflected in seven aspects: GDP x_1Foreign exchange reserves x_2 Output gap x_3 The interest rate gap between China and the United States x_4 International inflation gap x_5 International business trip x_6 Real effective exchange rate x_7 Among these seven factors, the most important is the real effective exchange rate x_7 It can be explained that if a country has close economic an d cultural exchanges with other countries in the world, its currency will also be recognized, thus enhancing the international status and utilization rate of its currency, resulting in the appreciation of its own currency. So we can use the total amount of import and export and GDP to evaluate the status and influence of a country in the national economy.

Model setting

Multiple linear regression model

According to the choice of variables, we can use the international unified exchange rate Y As a dependent variable, GDP x_1 Foreign exchange reserves x_2 Output gap x_3 The interest rate gap between China and the United States x_4 International inflation gap x_5 International business trip x_6 Real effective exchange rate x_7 , β_1、 $\beta_2 \cdots \beta_7$ are the coefficients of the equation, R is the set of real numbers. At the same time, the random error term is introduced Other random factors were expressed and the following model was established.

$$Y = \varepsilon + \beta_1 x_1 + \beta_2 x_2 \cdots + \beta_7 x_7 \ (1) \ (\beta_1、\beta_2 \cdots \beta_7 \in R) \text{-------}(1)$$

Principal component analysis

Principal component analysis is a method of mathematical dimension reduction, which finds out a few comprehensive variables to replace the original many variables, so that these comprehensive variables can replace the information of the original variables as much as possible, and they are not related to each other. Then these variables are combined into a group of new independent comprehensive variables to replace the original variables.

It can be obtained by variable selection $x_1, x_2, x_3, x_4, x_5, x_6, x_7$ For the 7 random variables (7 indicators) involved in the actual problem, record.

$$X = (x_1, x_2, x_3, x_4, x_5, x_6, x_7)^T \text{ ------(2)}$$

$$E(X) = (E(x_1), E(x_2), E(x_3), E(x_4), E(x_5), E(x_6), E(x_7))^T \text{ -------- (3)}$$

(1) The covariance matrix is as follows $\sum = (\delta_{ij})_{p \times p}$ Of which

$$\delta_{ij} = \frac{1}{n-1} \sum_{k=1}^{n} (x_{ki} - E(x_i))(x_{kj} - E(x_j)) \quad (i,\ j = 1,2 \cdots\cdots 7) \text{ ------- (4)}$$

(2) Set the variable again $x_1, x_2, x_3, x_4, x_5, x_6, x_7$ After linear transformation, a new synthetic variable is obtained $y_1, y_2, y_3, y_4, y_5, y_6, y_7$ That is:

$$\begin{cases} y_1 = l_1^T x = l_{11} x_1 + l_{12} x_2 + \cdots + l_{17} x_7 \\ y_2 = l_2^T x = l_{21} x_1 + l_{22} x_2 + \cdots + l_{27} x_7 \\ \qquad \vdots \\ y_7 = l_7^T x = l_{71} x_1 + l_{72} x_2 + \cdots + l_{77} x_7 \end{cases} \text{-------(5)}$$

So, it is called y_1Is the first principal component,y_2Is the second principal component, y_7 It is the seventh principal component. Principal component is also called principal component, coefficient l_i $(i = 1,2 \cdots\cdots 7)$ It is called principal component coefficient.

Model solution

Because there are many kinds of currency in the world, the statistical steps are too complex and impractical. In order to maximize the amount of sample information to represent the original amount of information, we use the principal component analysis method in 1.2.1 to calculate the annual GDP x_1 Foreign exchange reserves x_2 Output gap x_3 The interest rate gap between China and the United States x_4 Principal component analysis of four indicators shows that the top four currencies of contribution rate vector are: US dollar, Australian dollar, British pound and euro. This paper makes statistics on the exchange rates of US dollar, Australian dollar, British pound, euro and RMB (the convertible currency value per RMB) from April 17 to May 16.

Table 1

	Dollar	Euro	Pound	Australian dollar		Dollar	Euro	Pound	Australian dollar
April 17th	0.15531	0.1278	0.10986	0.19992	May 2nd	0.15419	0.12757	0.11093	0.19763
April 18th	0.15537	0.12793	0.11017	0.19984	May 3rd	0.15397	0.12727	0.11077	0.19875
April 19th	0.15502	0.1283	0.11033	0.20061	May 4th	0.15406	0.1282	0.11132	0.19988
April 20th	0.15486	0.12829	0.11017	0.20041	May 5th	0.15406	0.128	0.1106	0.19873
April 21st	0.15557	0.12804	0.10998	0.19837	May 6th	0.1539	0.12787	0.11043	0.19922
April 22nd	0.15586	0.12847	0.11037	0.19904	May 7th	0.15362	0.12762	0.10985	0.1981
April 23rd	0.15541	0.12777	0.11101	0.19813	May 8th	0.15336	0.128	0.11077	0.19825
April 24th	0.15475	0.12828	0.11141	0.19881	May 9th	0.15327	0.12807	0.11118	0.19769
April 25th	0.15452	0.12871	0.11111	0.19947	May 10th	0.15313	0.12783	0.11113	0.19829
April 26th	0.15447	0.12859	0.11123	0.2003	May 11th	0.15284	0.12789	0.11113	0.19998
April 27th	0.15448	0.12806	0.11105	0.19903	May 12th	0.1527	0.12819	0.1111	0.20034
April 28th	0.15442	0.12849	0.1118	0.20013	May 13th	0.15254	0.12819	0.11119	0.20022
April 29th	0.15452	0.12745	0.11082	0.19891	May 14th	0.15263	0.1281	0.11114	0.19946
April 30th	0.15434	0.12729	0.11072	0.19812	May 15th	0.15286	0.12878	0.11129	0.20086
May 1st	0.15423	0.12757	0.11091	0.19853	May 16th	0.15311	0.12896	0.11076	0.19983

It can be seen from the above data that: in the past month, the exchange rates of US dollar, Australian dollar, British pound, euro and RMB have two-way volatility, but the overall trend is not the same. Although the exchange rate of RMB and Australian dollar fluctuated, the exchange rate on May 16 was the same as that on April 17 and tended to be stable on the whole; The exchange rates of RMB, US dollar and euro are on the decline; The exchange rate between RMB and pound sterling fluctuates slightly, but the exchange rate on May 16 is higher than that on April 17. Considering the overall volatility, the exchange rate tends to be stable.

This paper investigates the relevant data from 2009 to 2018, and uses principal component analysis and multiple linear regression model to analyze the GDP x_1 Foreign exchange reserves x_2 Output gap x_3 The interest rate gap between China and the United States x_4 International inflation gap x_5 International business trip x_6 Real effective exchange rate x_7 Seven factors are analyzed, and the following table shows the relevant data from 2009 to 2018 (the data is calculated by searching, with some errors).

Principal component analysis was used to analyze the above data:

$$\delta_{ij} = \frac{1}{n-1}\sum_{k=1}^{n}(x_{ki} - E(x_i))\,(x_{kj} - E(x_j)) \quad (i,\ j = 1,2\cdots\cdots 7) \text{ ----------(6)}$$

After solving the co matrix, the correlation coefficient is used to solve the formula:

$$\rho_{xy} = {Cov(X,Y)}\Big/{\sqrt{D(X)D(Y)}}, \rho_{xy} \epsilon [-1,1] \text{ -------(7)}$$

The correlation coefficient is obtained as follows.

Result and Discussion

Finally, we have to produce a gap α_1 Real effective exchange rate α_2 International inflation gap α_3 International business trip α_4 The contribution rate of these four factors exceeds 90%.

Then using the multiple linear regression model in 1.2.1 and the data in the table. the production gap is obtained α_1 Real effective exchange rate α_2 International inflation gap α_3 International business trip α_4 The multiple regression model was as follows.

$$\gamma = 4.3525 + 0.1874\alpha_1 + 0.04253\alpha_2 - 1.0357\alpha_3 - 1.0425\alpha_4$$

Table 2

	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
GDP (100 million yuan)	914327.1	831381.2	743408.3	686255.7	644380.2	588141.2	537329	483392.8	410354.1	347934.9
Foreign exchange reserves (US $100 million)	30727.12	31399.49	30105.17	33303.62	38430.18	38213.15	33115.89	31811.48	28473.38	23991.52
Output gap (%)	1.897	2.043	1,986	1.874	2.041	2.376	3.294	4.162	0.102	-0.8141
Real effective exchange rate (logarithm)	0.796	0.809	0.952	1.278	1.297	0.783	0.127	-0.462	-0.617	-0.82
International inflation gap (%)	0.427	1.438	-0.997	1.746	0.897	1.157	0.362	1.062	2.879	0.837
International business trip (logarithm)	5.387	5.486	5.217	5.086	4.893	4.328	3.892	3.351	2.854	1.996
Actual utilization of foreign capital (US $100 million)	14440000	13813500	13496600	13103500	12600100	12626700	11956200	11758600	11171600	11601100

Table 3

1	0.7454	0.8159	0.4058	0.8326	0.7959	0.7349
0.7454	1	0.5978	0.7726	0.7208	0.7017	0.6936
0.8159	0.5978	1	0.8929	0.8964	0.8885	0.7261
0.4058	0.7726	0.8929	1	0.9048	0.8523	0.7684
0.8326	0.7208	0.8964	0.9048	1	0.8958	0.7341
0.7959	0.7017	0.8885	0.8523	0.8958	1	0.8128
0.7349	0.6936	0.7261	0.7684	0.7341	0.8128	1

Conclusions and Suggestions

From the above model, we can see that the symbols of the coefficients in the equation can truly reflect the relationship between the variables. Further, we can find that the RMB exchange rate is negatively correlated with the growth rate of the balance of import and export, that is, if a country's balance of payments continues to run a surplus, its currency will appreciate, which means that the RMB exchange rate will continue to decline. The correlation coefficient between the growth rate of import and export balance and the exchange rate of RMB is - 1.0357 It shows that the RMB exchange rate will decrease when the international inflation gap increases by 1% while other variables remain unchanged 1.0357%; Similarly, RMB exchange rate is negatively correlated with the growth rate of money supply; there is a positive correlation between RMB exchange rate and real effective exchange rate; it has a negative correlation with the growth rate of international business trip [1-5].

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