Empirical Study on Factors Influencing RMB Exchange Rate Based on Multiple Linear Regression Model

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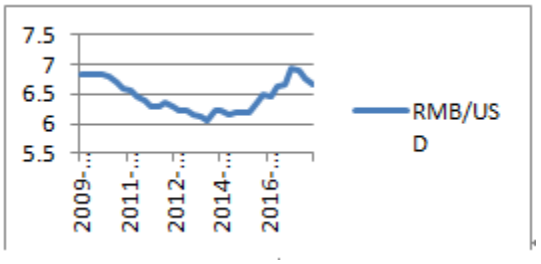
Abstract: With the substantial progress on globalization, recently the rate of RMB has drawn an ever-growing attention of the public. This paper applies econometrics model to explore the possible leading factors of affecting the rate of RMB, which is also based on relevant theories and the situation of China. The results say that the leading factors are PMI, M2 and FER. Significantly, PMI is the most influential factor among them. Nevertheless, FDI, CPI and FBT reveal a non-significant outcome to affecting the rate of RMB. In terms of the conclusion, some proposals are presented to suggest that the government be concerned about the controlling of the export and import, investment decision, the issuance of money, as well as the regulatory framework of foreign exchange reserve management.

Keywords: RMB Exchange Rate, Influencing Factors, Linear Regression Model

1 INTRODUCTION

In recent years, with the continuous advancement of RMB internationalization, the Chinese economy has been developing continuously. However, since September 2015, the RMB exchange rate began to show a significant decline. As can be seen from Fig. 1.1, from June 2015 to December 2016, the highest decline of RMB exchange rate against dollar was up to 9.2%. This high depreciation aroused concern of investors, some capital fled, and China's domestic economic situation faced serious pressure. At this point, the US non-farm payrolls continued to improve, the US economy had a strong recovery trend, and the Fed entered the rate hike cycle. At the same time, with the further expansion of cross-border capital liberalization, the sharp decline in the exchange rate level might further lead to major issues such as large outflow of capital, quick burst of domestic asset price bubble, serious losses in production sector, evaporation of large wealth, and macroeconomic hard landing.



Figue 1.1 exchange rate of RMB against the U.S. dollar data source: Wind database

In general, the healthy development and transformation and upgrading of Chinese economy require a stable RMB exchange rate. The current domestic and international economic situation is relatively grim, so the exchange rate acts as an important hub to regulate economic balance, and the effective stabilization of the RMB exchange rate has become an urgent problem in China's economic development. Therefore, the study of relevant factors influencing RMB exchange rate, explanation and forecast of RMB exchange rate fluctuation, properly coping with the impact from exchange rate fluctuation and selection of effective exchange rate guidance policy are of great practical

significance to realize balanced economic development in China.

2 ANALYSIS METHODS AND PROCEDURES

2.1Theoretical basis

The selection of each variable in this study is mainly based on the purchasing power parity theory, currency analysis theory, and other exchange rate determination theories.

2.1.1 Purchasing power parity theory

Purchasing power parity theory, as one of the most influential theories of exchange rate determination theories, was proposed by Swedish economist Cassel in 1922. According to the theory, any currency in the country can buy a certain amount of goods and services, and although different currencies are different in the purchasing power of goods and services, the ratio of purchasing power of different currencies forms the basis for the exchange rate. The purchasing power parity theory can be divided into absolute purchasing power parity theory and relative purchasing power parity theory, which can be expressed by the following formulas[1].

Absolute purchasing power parity theory: exchange rate = price index of country A / price index of country B

Relative purchasing power parity theory: exchange rate = price index change of country A/ price index change of country B

2.1.2 Currency analysis theory

The currency analysis theory is derived from the purchasing power parity theory. It suggests that the exchange rate changes are due to the imbalance in the currency market, and there are many factors that lead to the imbalance, such as money supply, level of interest rate and level of real national income. These factors affect the exchange rate mainly by influencing the price level of each country. According to the Cambridge Equation, the price level will be affected by the money supply, and the exchange rate is determined by the price level between two countries, so the exchange rate is influenced by the money supply of the two countries. The currency analysis theory links the exchange rate with monetary policy and emphasizes the role of currency [1].

2.2Problem description

This study deals with an actual economic problem that a variable is often affected by multiple variables. The object of this paper is the factors influencing the exchange rate, and there are many explanatory variables in the linear regression model. It can be expressed as follows:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 \ldots\ldots \beta_6X_{k+}u$ （2.1.1）

Where, k is the number of explanatory variables, and βj (j=1,2,...,k) is called regression coefficient. The above equation is also called the random expression of the overall regression function. Its non-random expression is

$E(Y \mid X1i,X2i,\ldots Xki,)=\beta0+\beta1X1i+\beta2X2i+\ldots+\beta kX ki$

βj is also called partial regression coefficient, which showsthe change in E(Y), the average of Y, for each changedunit of Xj when the other explanatory variables remain constant,or βj gives the “direct” or “net” effect(excluding other variables) of the unit change inXjon E(Y).

Table 3.3 Description of Indicator Data

Symbol	Description	Data source
USDCNY	USD exchange rate against RMB	CFETS
PMI	Purchasing Managers Index	NBS
FDI	Foreign Direct Investment	NBS
M2	Money Supply	PBOC
FER	Foreign Exchange Reserve	PBOC
CPI1	China Consumer Price Index	PBOC
CPI2	US Consumer Price Index	US DOL
CPI	US- China consumer price index difference	Wind
FBT	Favorable Balance of Trade	Choice

2.3Data collection and organization

This paper selected the monthly data of RMB exchange rate from 2009 to 2016 after the financial crisis in 2008 as the dependent variable, PMI, FDI, M2, FER,CPI and FBT as the main explanatory variables to construct the regression model to

discuss and analyze the factors influencing RMB exchange rate.

The monthly data of macroeconomic indicators was selected from CFETS, NBS, PBOC, DOL and Choice, as follows:

Note: CFETS:

China Foreign Exchange Trade System

NBS: State Statistics Bureau

PBOC: People's Bank of China

DOL: United States Department of Labor

3. EMPIRICAL ANALYSIS OFFACTORS AFFECTING RMB EXCHANGE RATE

3.1Modeling

This paper selected USDCNY as the dependent variable, PMI, FDI, M2, FER,CPI and FBT as the main explanatory variables to construct the econometric linear regression model as follows:

$USDCNY = \beta_0 + \beta_1 PMI + \beta_2 FDI + \beta_3 M2 + \beta_4 FER + \beta_5 CPI + \beta_6 FBT$

Where, β0, β1, β2, β3, β4, β5, and β6 are undetermined coefficients.

3.2Model regression

Using Eviews8 and OLS for model regression, we obtained the following results as follows:

Dependent Variable: USDCNY
Method: Least Squares
Date: 03/19/17 Time: 21:03
Sample: 2009M01 2016M12
Included observations: 96

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.119681	0.442874	18.33405	0.0000
PMI	0.024380	0.004587	5.315189	0.0000
FDI	-5.71E-09	3.52E-09	-1.621734	0.1084
M2	7.76E-07	9.47E-08	8.197170	0.0000
FER	-4.78E-05	2.24E-06	-21.37612	0.0000
CPI	-0.016713	0.003540	-4.720712	0.0000
FBT	-4.85E-10	8.28E-10	-0.585302	0.5598

R-squared	0.943303	Mean dependent var	6.447668
Adjusted R-squared	0.939480	S.D. dependent var	0.266260
S.E. of regression	0.065502	Akaike info criterion	-2.543353
Sum squared resid	0.381855	Schwarz criterion	-2.356369
Log likelihood	129.0809	Hannan-Quinn criter.	-2.467771
F-statistic	246.7894	Durbin-Watson stat	0.386813
Prob(F-statistic)	0.000000		

USDCNY = 8.11968136792 + 0.0243798283781*PMI - 0.00000000570528466246*FDI + .000000776452244902*M2 - 0.0000478306610737*FER - 0.0167134777955*CPI - 0.000000000484585010001*FBT

$R^2 = 0.943303$

F = 246.7894

The T statistics of each explanatory variable are shown in the table below:

Table 5.2 the T statistics of each explanatory variable

explanatory variable	T statistics
β_0C	18.33405
β_1PMI	5.315189
β_2FDI	-1.621734
β_3M2	8.197170
β_4FER	-21.37612
β_5CPI	-4.720712
β_6FBT	-0.585302

3.3 Model test

3.3.1 Test of goodness of fit

The data obtained by the OLS regression showed that R^2=0.94, indicating that 94.33% of the sum of squares were explained by the sample regression equation, and only 5.67% were not explained. So the sample regression line has high goodness of fit of sample points.

3.3.2 Significance test of variables

For a multiple linear regression model, the equation has a significant overall linear relationship, which accounts for no significant effect of each explanatory variable on the explained variables. Therefore, the significance test must be carried out for each explanatory variable to determine whether it can be retained in the model. If a variable has no significant effect on the explained variable, it should be removed to build a simpler model. The most commonly used in the significance test is t test. For the variable X_j (j = 0, 1, 2, 3, 4, 5, 6), the following hypotheses were made:

H0: $\beta_j = 0$ (j = 0, 1,2,3,4,5,6), H1:$\beta_j \neq 0$ (j = 0, 1,2,3,4,5,6)

Given the significance level α=0.05, the degree of freedom n-k-1=89, check the t distribution table, we get:

$$t_{1-\frac{\alpha}{2}}(n-k-1) = t_{0.025}(89) = 1.9870$$

As can be seen from Table 3.1, the corresponding T statistics of β0, β1, β2, β3, β4, β5, and β6 are

18.33405,5.315189, -1.621734,8.197170, -21.37612, -4.720712, and -0.585302 respectively. The absolute values of the T statistics of β0, β1, β3, β4, and β5 are greater than 1.9870, indicating that these coefficients are significant and should reject the original hypothesis, and the absolute values of β2 and β6 are less than 1.9870 and should accept the original hypothesis.

This means that PMI, M2, FER and CPI have a significant effect on the explained variable USDCNY, while FDI and FBT have no significant effect.

3.3.3 Significance test of regression equation

H0: $\beta_j = 0$ (j = 0, 1,2,3,4,5,6) andH1: β_j (j = 0, 1,2,3,4,5,6) are not completely 0.

Given the significance level, check the F distribution table

$$F_{0.05}(6,89) = 2.20$$

As can be seen from the above regression results, F=246.7894, and because F=246.7894>F(6,89)=2.20, the original hypothesis H0: $\beta_j = 0$ (j = 0, 1,2,3,4,5,6) should be rejected, indicating that the linear relationship of this regression equation is significant below the level of 95%.

This means that PMI, M2, FER and CPI have a significant effect on the explained variable USDCNY.

3.4Model modification

As a result of the above regression, FDI and FBT have no significant effect on USDCNY, so these two variables were deleted to modify the regression model.

Eviews8 and OLS were used again for the model regression to obtain the optimal model as follows:

USDCNY = 7.92156388115
- 0.0000484190042158*FER
+ 0.000000712304553596*M2
+ 0.024718116196*PMI
- 0.015074437856*CPI

Adjusted
R-squared = 0.938916
F-statistic = 366.0616

The modified model has high goodness of fit, and the significance test of variable and regression equation can be passed.

3.5 Multiple co linearity test

The multiple co linearity test of the explanatory variable is one of the most important test criteria for the econometric test. The multiple co linearity test of the regression equation is used to avoid uncertain parameter estimate, infinite variance of parameter estimate and irrational meaning of parameters timate to ensure the effectiveness of the model [2].

3.5.1 Correlation coefficient test of explanatory variable

The correlation coefficient of the explanatory variable is obtained by Eviews8, and the correlation coefficient matrix is shown in Table 3.3:

Table 3.3 Correlation

	CPI	FER	PMI	M2
CPI	1.000000	0.783012	-0.577798	0.963481
FER	0.783012	1.000000	-0.501594	0.704900
PMI	-0.577798	-0.501594	1.000000	-0.551147
M2	0.963481	0.704900	-0.551147	1.000000

As can be seen from the above figure, there is high correlation between explanatory variables M2 and CPI, and there is inevitably serious multiple co linearity.

3.5.2 R Square test

R Square test was used to test the multiple co linearity of the regression model to remove each explanatory variable, and then by comparing the explanatory variable that has the least effect on the model fitting effect, that is, the coefficient of determinationR^2can be checked to ultimately determine the explanatory variable that causes multiple co linearity.

When the explanatory variables PMI, M2, and FER are removed from the model, the regression fitting effect is better. In the model, when the explanatory variable CPI is removed, the goodness of fit is the closest to that when the explanatory variable CPI is included. This shows that there is co linearity between CPI and other explanatory variables, that is, explanatory variable CPI is the cause of multiple co linearity.

3.5.3 Overcome multiple co linearity

As can be seen from the above, explanatory variable CPI is the cause of multiple co linearity, so it is removed. After that, the regression result is as follows:

The optimized regression model is as follows:

USDCNY=6.3839462638+
0.0272455128001*PMI+
0.000000358453669941*M2
- 0.000053206490975*FER

3.6Heteroskedasticity test

Due to the complexity of macroeconomic data, the model may have heteroskedasticity, which leads to invalid parameter estimate, meaning less variable significance test and even invalid model prediction. The heteroscedasticity test of explanatory variables is one of the most important test criteria for econometric test to ensure the effectiveness of the model [19].

3.6.1 White test

White testis simpler than other tests, which not only makes up for the deficiency of other tests but also needs no hypothesis of any prior knowledge of heteroskedasticity, let alone the basis of normal distribution like Breusch-Pagan test[3]. This paper used Eviews8 for White test, as follows:

Heteroskedasticity Test: White

F-statistic	0.862067	Prob. F(3,92)	0.4638
Obs*R-squared	2.624858	Prob. Chi-Square(3)	0.4531
Scaled explained SS	1.953823	Prob. Chi-Square(3)	0.5820

As can be seen from the above result, the statistic nR2=2.624858 and the probability of is 0.4531. According to the chi-square distribution, the corresponding critical value $X^2_{0.05}$=7.81 at significance level below 5% and degree of freedom3.Since nR^2=2.624858<$X^2_{0.05}$=7.81 and 0.4531>0.05, there is no heteroscedasticity in the model.

Thus, the final regression model is as follows:

USDCNY=6.3839462638+.0272455128001*PMI+
0.000000358453669941*M2-
0.000053206490975*FER

In summary, the optimal regression model is obtained in this paper, and the results are unbiased and effective.

4 CONCLUSION

As can be seen from the optimal regression model obtained in this paper, the main factors influencing RMB exchange rate are PMI, M2and FER, while FDI, CPI and FBT have not significant effect on RMB exchange rate.

(1) China's economic prosperity represented by PMI has the greatest effect on RMB exchange rate. PMI is an indicator to measure the eight aspects of manufacturing, including production, new order, commodity price, inventory, employee, order delivery, new export order and import. It is an important subsidiary of leading economic indicators and has high degree of timeliness. At present, more than 20 countries have established PMI system, PMI and its business report has become an important evaluation indicator of world economic operation and a barometer of world economic change. Higher PMI means increasing national income and growing domestic demand, which booms the international trade and leads to a substantial increase in imports, thereby increasing the country's demand for foreign exchange and ultimately devaluating RMB. Therefore, it is of great significance to take reasonable measures to maintain the stability of PMI, such as optimizing production resources, enriching production materials, reducing production costs and improving production innovation.

(2) M2 has the second greatest effect on and is positively related to RMB exchange rate. Too much money will inevitably lead to domestic inflation and the final decline in the purchasing power of domestic currency as well as currency devaluation. On the contrary, the deficient money supply will inhibit economic development and lead to production decline, social demand reduction and commodity price decline, and as a result the purchasing power of domestic currency must increase, resulting in appreciation of domestic

currency. Therefore, a reasonable control of the money supply is one of the prerequisites to ensure long-term stability of RMB exchange rate. The implementation of sound monetary policy and rational determination of monetary aggregate growth rate is an important means of rational control of money supply. The state should adopt macroeconomic regulation and control so that the growth of monetary aggregate relative to the growth of economic aggregate can develop along the dynamic growth path to avoid economic fluctuations and large changes in currency value.M2/GDP dynamic growth path proposed by Han Ping et al. can be a reference to determine the money supply and rational growth rate.

(3) FER is negatively correlated with RMB exchange rate and has a significance effect on RMB exchange rate, which is second only to China's economic prosperity represented by PMI. As an important part of a country's international liquidity, FER plays an important role in interfering with the foreign exchange market and stabling the exchange rate. When the international capital market is turbulent, FER can also be used to alleviate the impact on the domestic financial market and avoid further damage to economic development. However, a country holding too much FER will still face a lot of risks. For example, when the value of foreign currency declines, the real value of FER will decline. In addition, holding too much FER will bring a lot of opportunity costs. Therefore, it is important to improve FER management system, prevent excessive growth of FER and maintain stable RMB exchange rate. It is generally believed that the appropriate scale of FER should meet the following three needs. First, it should make up for the demand of short-term international payments deficit. Second, it should stabilize the exchange rate and maintain financial market stability. Third, it should minimize the opportunity cost of FER while maximizing national economic growth.

(4) It is also important to establish the early warning mechanism of RMB exchange rate. For example, strengthen the forecast of exchange rate changes, grasp the change direction and fluctuation range of exchange rate, strengthen financial market reform, develop derivative products, and transfer risks. Banks can use their own business advantages to provide enterprises with necessary early warning services, and enterprises can establish the exchange rate risk control system. Through the coordinated efforts at macro and micro levels, the exchange rate risk management system should be established to improve China's financial market.

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