Analysis of Exchange Rate Fluctuations between RMB and US Dollar

Zilin Liu[1, a*], Wentian Wang[2,b], Chunlei Zhao[1,c]

[*]737827170@qq.com[a], S21301072@ahu.edu.cn[b], 1770150920@qq.com[c]

School of International Business and Economics, Shandong University of Finance and Economics, Shandong, Jinan, China[1]
School of Social and Political Science, Anhui University, Anhui, Hefei, China[2]

Abstract: Under the background of rapid development of big data and artificial intelligence technology, mining the information implied in time series data has become an important step for all industries to make decisions. At the same time, using big data for data analysis is a new requirement for economic work in the current rapid development of information technology, which is also an important way to achieve exchange rate analysis. At the 2022 Central Economic Work Conference, it was pointed out that the RMB exchange rate should be basically stable at a reasonable and balanced level, and the financial stability guarantee system should be strengthened. This paper mainly takes the central parity rate of the RMB against the U.S. dollar expressed by the direct pricing method from January 5, 2015 to January 31, 2021 as the research object. Through the GARCH model, it studies and analyzes the changes in the fluctuation of the RMB against the U.S. dollar exchange rate. The results show that there is a "herd effect" in people's expectations of exchange rate changes. At the same time, it finds that GARCH (2,1) and T-GARCH (1,1) predict the results significantly, and puts forward relevant suggestions and countermeasures.

Keywords: Exchange Rate, Dollar, Big Data.

1 INTRODUCTION

Facing the complicated domestic and international environment, the report of the 20th National Congress of the Communist Party of China clearly proposed that we should adhere to a high level of opening up, promote high-quality development, and accelerate the construction of a new development pattern. To better serve the dual cycle strategy and give play the role of the exchange rate as an "automatic stabilizer" in macroeconomic stability and the balance of international payments, which is the key point of unblocked internal and external circulation, the Central Bank clearly declared that it would enhance the flexibility of the RMB exchange rate and promote the reform of the RMB exchange rate formation mechanism.

At the same time, with the deepening of China's exchange rate reform, exchange rate fluctuations not only reflect the changes in the value of the RMB, but also have a signal function that comprehensively reflects the changes in China's economy and foreign economic cycles. Therefore, from the perspective of time series, it plays an important role in macroeconomic regulation and foreign exchange management to capture the regularity of

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exchange rate changes and predict their future changes. The US dollar is one of the most important currencies in the world. Studying the RMB exchange rate fluctuation against the US dollar has become an urgent task to control and effectively prevent exchange rate risks. Based on the analysis of the exchange rate change between RMB and USD, this paper establishes a regression model to predict the future trend of the exchange rate change.

2 LITERATURE REVIEW

The change in the exchange rate is similar to the movement of objects in physics. From the concept of statistics, academic circles use variance/standard deviation, conditional heteroscedasticity and other indicators to measure exchange rate elasticity as the first choice. Levy Yayati and Sturzenegger use standard deviation to measure the volatility of exchange rates of various countries. Based on the data of 183 countries in the world from 1974 to 2001, they calculated the mean value of the absolute value of the monthly rate of change of exchange rate, the standard deviation of the monthly rate of change, and the mean value of the absolute value of the net reserve change relative to the base currency ratio. They determined the exchange rate regimes of different countries according to the combination of three Vars and classified the floating. The three types of intermediate and fixed exchange rate regimes are assigned values of 1, 2 and 3 respectively to indicate the elastic level of the exchange rate [8]. Similarly, Mahradika also uses standard deviation to measure elasticity [9]. Cavoli and Rajan further dynamically measured the standard deviation (variance) of elasticity and used conditional volatility to measure exchange rate elasticity [2]. Bleaney and Tian used root mean square error to measure the level of exchange rate elasticity, and believed that the pegged exchange rate system had a lower root mean square error; The floating exchange rate system had a high root mean square error; The exchange rate fluctuation performance of managed floating exchange rate system is similar to that of independent floating exchange rate system [1]. Some scholars further set exchange rate change rate indicators. Shambaugh (2004) divided the exchange rate regimes of different countries into two categories: pegged and non-pegged, with 2% as the boundary [11]. Reinhart and Rogoff studied the parallel and dual market exchange rate data of 153 countries from 1946 to 2001 in a five-year window period. They classified the elasticity level into five categories and thirteen subcategories by using exchange rate changes and assigned values from 1 to 13 [10].

The "exchange rate elasticity" constructed from the concept of economics reflects the response mechanism of exchange rate changes to some economic activities. For example, the exchange rate elasticity of foreign exchange reserves constructed by Cavoli, Rajan, Combes, etc. Actually reflects the situation that the change of foreign exchange reserves to adjust the exchange rate will cause the change of exchange rate. Zhang Xiang and others constructed the exchange rate elasticity of money supply based on the Dornbusch model. The functioning of these mechanisms must meet a default premise: a country's foreign exchange market is highly developed and the part of the relevant indicators (such as foreign exchange reserves, monetary volume and interest rate changes) that causes exchange rate changes can be identified (Zhang 2014). The foreign exchange markets of most developing countries, including China, are in transition. Not only may there be market and nonmarket factors in exchange rate changes, but also the extent to which changes in corresponding currencies, interest rates and foreign exchange reserves cause exchange rate changes is opaque. Ignoring these facts, there will be a dilemma similar to that described in Levy Yeyati and Sturzenegger's study that China and India cannot be classified because their exchange rates and foreign exchange reserves are almost stable during the sample period.

Domestic and foreign scholars have conducted in-depth research on the driving factors of exchange rate fluctuations. Lee found that when a country switches to a floating exchange rate system, its exchange rate fluctuations will more reflect macro fundamental factors (Lee 2007). Dabrowski et al. (2014) found that there is a long-term cointegration relationship between the exchange rate and economic fundamentals, and short-term changes in fundamentals will also have a significant impact on the exchange rate [5]. Chou used the variance decomposition method to measure the relative contribution of macro fundamentals in explaining exchange rate fluctuations, and found that the fundamentals have significant explanatory power for exchange rate changes [3]. Xie and Chen proved that observable fundamentals are an important reason for exchange rate fluctuations [12].

It can be found that the literature at home and abroad is mainly based on the classic exchange rate determinants model, using empirical methods to test the correctness of the exchange rate theoretical model. From the perspective of research content, most studies mainly focus on the exchange rate differences between China and the United States, and test the influencing factors of exchange rate based on the VAR model or multiple linear regression. Based on predecessors, this paper will use the GARCH model to analyze the exchange rate fluctuations and adverse movements between China and the United States.

3 DATA SOURCE AND VAR SELECTION

In this paper, 754 observations are selected as the sample space of the central parity rate between RMB and USD expressed by the direct bid method from January 5, 2015, to January 31, 2021, and a series p is established based on this. Then, a logarithmic series r of the central parity rate between RMB and USD is constructed, a conditional heteroscedasticity model is established for the series r, and its volatility is studied.

Data from the official website of the National Bureau of Statistics（http://www.safe.gov.cn） EViews8.0 is used for data processing.

4 ANALYSIS PROCESS

4.1 Establishing Logarithmic Series

Since time series data tends to show an exponethmic yield series is established for the data of the above selected Vars.

In this case, take the logarithm of the data of sequence p to obtain a new sequence r.

The expression entered is: r=logp

4.2 Draw Logarithmic Sequence Sequence Diagram

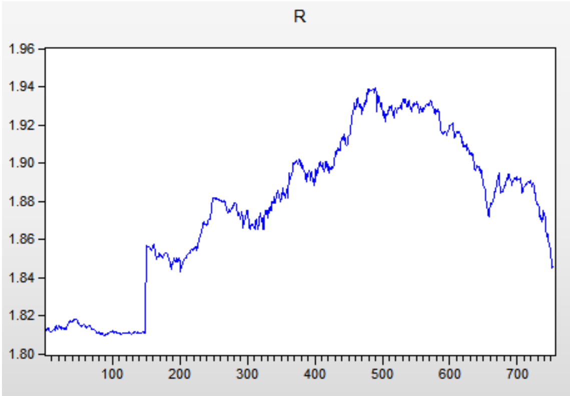
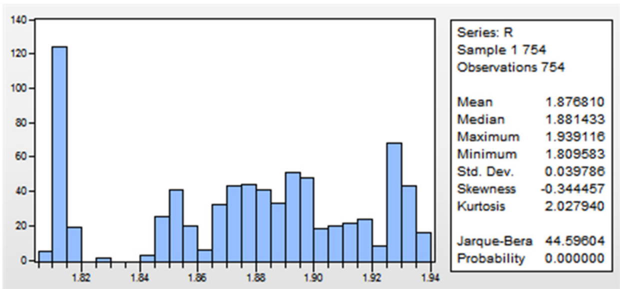


Figure 1: Logarithmic sequence sequence diagr

From the time series diagram of the logarithmic series r of the direct pricing method of RMB against USD, it can be observed that the fluctuation of the logarithmic series of RMB against the USD exchange rate is non-stationary. As shown in Figure 1.

4.3 Column Statistical Graph of Logarithmic Series



Figue 2 Column statistical graph of logarithmic series

From Figure 2, the mean value of the logarithmic series is 1.87681, the standard deviation is 0.039786, and the skewness is -0.344457, which is less than 0, indicating that the distribution of the logarithmic series has a long tail. The kurtosis is 2.02794, which is less than the kurtosis value 3 of the normal distribution, indicating that the logarithmic sequence has the characteristics of a thick tail.

4.4 Unit Root Test

Since the data used in this paper are only the results of logarithmic processing of objective data from statistical data, pseudo regression of non-stationary Vars may occur in the process of econometric analysis of these data. Therefore, a stationarity test should be conducted for these Vars.

With the help of EViews8.0 software, the unit root test was conducted on the logarithmic series r of the RMB US dollar exchange rate. The results are shown in Table 1:

Table 1: Unit root test.

		t-Statistic	Prob.*
ADF test statistic		-1.44	0.56
Test critical values:	1%level	-3.44	
	5%level	-2.87	
	10%level	-2.57	

According to the ADF test results in Table 1, the t statistic is -1.438,773, and the corresponding P value is 0.5642. Therefore, it indicates that the logarithmic series r of the RMB US dollar exchange rate is non-stationary.

Table 2: Unit Root Test after First Order Difference.

		t-Statistic	Prob.*
ADF test statistic		-24.09	0.00
Test critical values:	1%level	-3.44	
	5%level	-2.87	
	10%level	-2.57	

*MacKinnon(1996)one-sided p-values.

According to the ADF test results in Table 2, the t statistic is -24.09146, and the corresponding P value is close to 0. Therefore, it indicates that the first order difference of the logarithmic series r of the RMB dollar exchange rate is stable.

4.5 Sequence Autocorrelation and Partial Autocorrelation Test

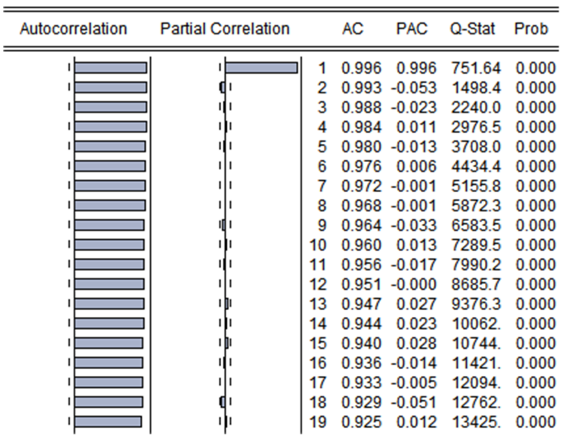


Figure 3 Sequence autocorrelation and partial autocorrelation test

It can be seen from Figure 3 that the autocorrelation Coef of the sequence shows the property of tailing, and the partial autocorrelation Coef shows the property of truncation after the first order, all falling within twice the estimated standard deviation. Therefore, the sequence determines that the model is AR (1).

Table 3:AR(1) Model.

Var	Coef	Std. Error	t-Statistic	Prob.
AR(1)	0.13	0.04	3.53	0.00
R^2	0.02	Mean dependent var		0.00
Adjusted R^2	0.02	S.D.dependent var		0.00
S.E.	0.00	Akaike info criterion		-9.50
Res SS	0.00	Schwarz criterion		-9.49
Log likelihood	3571.26	Hannan-Quinn criter.		-9.49
D-Wn stat	2.01			
nverted AR Roots			.13	

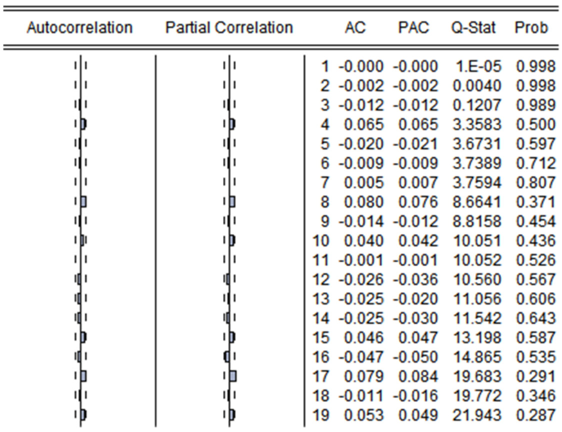
Build model：

$$\mathrm{D}r_t = 0.1278Dr_{t-1} + \hat{\varepsilon}_t$$

(3.5324)

R^2 =0.0159DW=2

Pass the parameter significance test (as shown in Table 3), and check whether the residual error is white noise.



	AC	PAC	Q-Stat	Prob
1	-0.000	-0.000	1.E-05	0.998
2	-0.002	-0.002	0.0040	0.998
3	-0.012	-0.012	0.1207	0.989
4	0.065	0.065	3.3583	0.500
5	-0.020	-0.021	3.6731	0.597
6	-0.009	-0.009	3.7389	0.712
7	0.005	0.007	3.7594	0.807
8	0.080	0.076	8.6641	0.371
9	-0.014	-0.012	8.8158	0.454
10	0.040	0.042	10.051	0.436
11	-0.001	-0.001	10.052	0.526
12	-0.026	-0.036	10.560	0.567
13	-0.025	-0.020	11.056	0.606
14	-0.025	-0.030	11.542	0.643
15	0.046	0.047	13.198	0.587
16	-0.047	-0.050	14.865	0.535
17	0.079	0.084	19.683	0.291
18	-0.011	-0.016	19.772	0.346
19	0.053	0.049	21.943	0.287

Figue 4 Test result of residual error

As shown in Figure 4, the results show that it is a white noise sequence with autocorrelation.

4.6 Perform the ARCH effect test.

Table 4:ARCH Effect Test

F-statistic	165.82	Prob.F(1,749)	0.00
Obs*R-squared	136.13	Prob.Chi-Square(1)	0.00

According to the results in Table 4 and Table 5, it can be found that the logarithmic series r of the RMB US dollar exchange rate has the ARCH effect, rejecting the original hypothesis (H0: a1=a2=...=aq=0, that is, unconditional heteroscedasticity effect).

Table5:RESID^2(-1) Test.

Var	Coef	Std.Error	t-Statistic	
C	0.00	0.00	4.52	0.00
RESID^2(-1)	0.43	0.03	12.88	0.00
R-squared	0.18	Mean dependent var		0.00
Adjusted R2	0.18	S.D.dependentvar		0.00
S.E.	0.00	Akaike info criterion		-19.40
Res SS	0.00	Schwarzcriterion		-19.39
Log likelihood	7287.76	Hannan-Quinn criter.		-19.40
F-statistic	165.82	D-W stat		1.96
Prob(F-statistic)	0.00			

4.7 Perform the GARCH Effect Test

GARCH (1,1), GARCH (2,1) and GARCH (1,2) models were established respectively.

Table 6:GARCH(1,1) Model.

Var	Coef	Std. Error	z-Statistic	Prob.
AR(1)	0.08	0.04	1.77	0.08
	Variance Equation			
C	0.00	0.00	6.15	0.0000
RESID(-1)^2	0.18	0.04	4.82	0.00
GARCH(-1)	0.57	0.07	8.20	0.00
R-squared	0.01	Mean dependent var		0.00
Adjusted R2	0.01	S.D.dependentvar		0.00
S.E.	0.00	Akaike info criterion		-9.62
Res SS	0.00	Schwarz criterion		-9.60
Log likelihood	3622.47	Hannan-Quinn criter.		-9.61
D-W stat	1.90			

Table 7:GARCH(2,1) Model.

Var	Coef	Std. Error	z-Statistic	Prob.
AR(1)	0.17	0.03	5.06	0.00
		Variance Equation		
C	0	0	5.99	0.00
RESID(-1)^2	0.34	0.06	5.85	0.00
RESID(-2)^2	-0.35	0.06	-5.94	0.00
GARCH(-1)	1.07	0.00	500.32	0.00
R-squared	0.01	Mean dependent var		0.00
Adjusted R2	0.01	S.D.dependent var		0.00
S.E.	0.00	Akaike info criterion		-9.74
Res SS	0.00	Schwarz criterion		-9.71
Log likelihood	3668.54	Hannan-Quinn criter.		-9.73
D-W stat	2.09			

Table 8:GARCH(1,2)Model.

Var	Coef	Std.Error	z-Statistic	Prob.
AR(1)	0.07	0.04	1.83	0.07
		Variance Equation		
C	0.00	0.00	5.57	0.00
RESID(-1)^2	0.15	0.03	5.06	0.00
GARCH(-1	-0.09	0.02	-4.36	0.00
GARCH(-2)	0.74	0.05	14.83	0.00
R-squared	0.01	Mean dependent var		0
Adjusted R2	0.01	S.D.dependentvar		0.00
S.E.	0.00	Akaike info criterion		-9.63
Res SS	0.00	Schwarz criterion		-9.60
Log likelihood	3625.78	Hannan-Quinn criter.		-9.62
D-W stat	1.90			

Based on the comparison of the above three models, it can be observed that all parameters of GARCH (2,1) pass the t-test with the best effect. As shown in Table 1, Table 2, and Table 3.

Then consider T-GARCH modeling. As shown Table 9：

Table 9: T-GARCH Model.

Var	Coef	Std.Error	z-Statistic	Prob.
AR(1)	0.09	0.04	1.94	0.05
		Variance Equation		
C	0.00	0.00	7.11	0.00

RESID(-1)^2	0.10	0.03	2.78	0.00
RESID(-1)*2*(RESID(-1)<0)	0.28	0.08	3.33	0.00
GARCH(-2)	0.49	0.07	6.99	0.00
R-squared	0.01	Mean dependent var		0.00
Adjusted R2	0.01	S.D.dependent var		0.00
S.E.	0.00	Akaike info criterion		-9.63
Res SS	0.00	Schwarz criterion		-9.60
Log likelihood	3627.48	Hannan-Quinn criter.		-9.62
Inverted AR Roots		.09		

Finally, the following equation is obtained:

$$\mathrm{D}r_t = 0.088Dr_{t-1} + \hat{\varepsilon}_t$$

$$h_t = 1.26 + 0.952\hat{\varepsilon}_{t-1}^{2} + 0.2779\hat{\varepsilon}_{t-2}^{2} + 0.4946h_{t-1}$$

5 CONCLUSION

This paper takes the logarithmic series of the middle rate exchange rate under the direct pricing method of RMB against USD from January 5, 2015 to January 31, 2021 as the research object, and establishes a GARCH model for it, and draws the following conclusions:

First: Since 2015, the exchange rate of RMB against the US dollar has fluctuated greatly, showing a phenomenon of instability and stability after the first order difference, which is characterized by a thick tail. There is no autocorrelation, but there is significant conditional heteroscedasticity. It shows that there is a "herd effect" in people's expectations of exchange rate changes, that is, when the market expects the exchange rate to appreciate, more people expect the exchange rate to appreciate, and when the market expects the exchange rate to depreciate, more people expect the exchange rate to depreciate.

Second: From the perspective of the prediction ability of the model, GARCH (2,1) and T-GARCH (1,1) have the best prediction effect on the fluctuation of the US dollar exchange rate.

In this regard, we propose the following suggestions:

First: Study and legislate reasonable foreign exchange management policies and regulations. While continuing to promote the reform of the exchange rate formation mechanism, pay close attention to the changes in the ownership of RMB pricing right after the reform of foreign exchange and relevant influencing factors, maintain the gradual and controllable nature of the reform of foreign exchange, and strengthen the financial stability guarantee system.

Second: Establish a dynamic monitoring mechanism for changes in the frequency structure of RMB exchange rate fluctuations. In terms of policy orientation, we should continue to enhance the driving role of macro fundamentals in exchange rate fluctuations and spillovers, maintain the basic stability of the RMB exchange rate at a reasonable and balanced level, and ensure that the impact of market factors on the RMB exchange rate is within a controllable range.

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