

Exchange Rate Risk of China's Foreign Exchange Reserve Assets

—An Empirical Study Based on GARCH-VaR Model

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Abstract

As the core economic variable in the process of the integration of world economy, the change of the exchange rate has an important impact on the import and export, foreign exchange reserves, interest rates, capital flows and other macro and microeconomic factors. This paper first analyzes the status quo of RMB exchange rate risk and the advanced experience of exchange rate management of other countries. Then, the empirical method is used to analyze the characteristics of RMB exchange rate fluctuation based on the day-frequency data of USD/RMB, GBP/RMB, EUR/RMB and JPY/RMB from December 2011 to December 2016. This paper also respectively uses the GARCH, TARCH, EGARCH and PARCH model to fit four representative foreign currencies against RMB, and selects the optimal model to calculate VaR value. Finally, validity of the data is verified through the Chi-square distribution test. The empirical results show that the four sequences are non-normal and first-order monotonic sequences. Besides, there is a significantly high-order ARCH effect, and the GARCH family model has a better fitting effect. JPY/RMB is with lower exchange rate risk, while the fluctuation of EUR/RMB is significantly greater than other currencies. According to the international situation of financial market, the status quo of RMB exchange rate and the conclusion of empirical research, this paper puts forward that the marketization and internationalization of RMB exchange rate should be based on improving the financial system and environment. It is also suggested that the government should properly intervene in the foreign exchange market and make good use of the risk measurement model and commercial banks should further develop the financial derivatives to hedge the foreign exchange risk.

Keywords: *Exchange Reserve; Exchange Rate Risk; GARCH-VaR*

1 INTRODUCTION

In recent years, with the development of international financial market, foreign exchange transactions have become much more frequently, leading to large-scale movement of international capital, and the development of electronic information technology has promoted the innovation of financial derivatives. These factors have led to large fluctuations in exchange rates. After China liberalized the financial market, the speed of economic development accelerated, the frequency of RMB fluctuation increased, and the reform of exchange rate system continued to move forward. RMB becomes an international currency. Therefore, it is particularly important to measure the exchange rate risk accurately, forecast and make precaution.

Exchange rate risk refers to the possibility that an economic entity suffers loss or gains from the exchange rate fluctuation in the foreign-currency-related business. At present, Value at Risk (VaR) is one of the most popular methods of risk measurement in the world, and the Basel Accord and the EU capital adequacy ratio use it as the supervision standard. VaR, which is formed on the basis of other traditional methods of risk measurement, is the most applicable and scientific method at this stage, and its basic definition is that under normal market conditions, the maximum loss and benefit of financial assets expected in certain holding period and confidence interval.

The research method of this paper is mainly to use GARCH-VaR method to carry on the empirical research. By

establishing different models of GARCH family, the most suitable econometric models for the exchange rate of RMB are derived from various currencies. The value of each foreign currency is obtained by calculating the VaR value and verifying its validity through the optimal model of the sequence. The next step is to compare various foreign currencies to RMB foreign exchange rate fluctuation risk size, and policy suggestions are proposed. In this paper, the RMB exchange rate risk is measured through GARCH-VaR model. Mainly to the U.S. dollar, the Euro, the Great Britain Pound and the Japanese Yen to the RMB exchange rate analysis, from December 2011 to December 2016, that is, 5 years of RMB exchange rate day-frequency data to be measured and elaborated.

In the study of RMB exchange rate risk, scholars mostly study the exchange rate of USD/RMB, and there is rarely an article that studies multiple foreign exchange rate data. This paper chooses four currencies which have significant influence in the world monetary system to model and analyze the RMB exchange rate risk, so as to make a better choice to avoid the risk by comparing the different currencies. The paper also selected the best risk measurement methods for each country's RMB exchange rate. In addition, when using VaR model to study foreign exchange risk, because the current VaR model has a variety of measures, while most scholars use the same model to analyze all the data, and do not consider the differences between the data and the applicability of different methods to each data, the results are prone to bias. In this paper, GARCH class models are used to calculate VaR value, that is, to select the optimal model suitable for each group of sequences in the GARCH family model to measure VaR value, which improves accuracy, and makes the VaR value more credible and the risk forecast more accurate.

2 LITERATURE REVIEW

After the collapse of Bretton Woods system in 1973, the flexibility of exchange rate system increased, the fluctuation of exchange rate increased, and the foreign exchange risk intensified. Many scholars have carried out both theoretical and empirical researches on this phenomenon. Michael, Dan & Robert (2001) give the definition of exchange rate risk, that is, the volatility of exchange rate and the fluctuation of interest rate among countries cause the risk, and this risk is very similar to other market risks. It is also emphasized that interest rates have a very significant interaction with exchange rates in countries where capital is fully mobile. Szego and Hodder (2002) further analyze the importance of foreign exchange risk measurement from the impact of exchange rate changes on imports and exports. They believe that the appreciation of local currency will weaken the competitiveness of domestic products in the international market, and thus affect the company's cash flow.

The early methods mainly include Adeler and Dumas's (1984) ideas based on the assumption that the present value of the future cash flow of the company is the value of the company. The paper proposes to measure the foreign exchange risk by the elasticity coefficient of the company value to the exchange rate fluctuation. In recent years, the study of exchange rate risk tends to use more complex econometric analysis techniques, especially time series analysis technology, and economists begin to explore the pure econometric model to measure the foreign exchange risk. Based on this, scholars have put forward a GARCH-VaR method to measure risk. Mike K.P. So and Philip L.H. Yu (2006) use the GARCH family model to calculate the VaR values of four kinds of exchange rates in 12 markets under different models, and analyze the applicability of various models for different market exchange rates. Mike K.P. So (2006) establishes GARCH models with different distribution types and significant levels for 4 foreign exchange indices, and believes that at 1% significant level, the T distribution was better than the normal distribution and the GARCH model was better than the Risk Metrics model.

In the October 1994, J.P Morgan first summed up the theory and calculation method of VaR model, and many scholars have studied it and developed several methods of calculating VaR model. It is mainly divided into two kinds: parametric method and nonparametric method, and each method has its own hypothesis condition and applicable range. The earliest proposed method is the historical simulation method proposed by Butler and Schachter in 1996, and they believe that future yields of assets can be estimated by nonparametric estimates. Morgan (1996) then comes up with the Monte Carlo method to calculate the VaR value. However, considering the characteristic of the peak and thick tail of financial time series, the theory of calculating VaR value by GARCH class model under non-normal distribution is coming into being. Bams and Lehnert (2005) believe that, although there is a thick tail phenomenon in the exchange rate return sequence, there are very few observations in the tail, so the model of overly complicated tail

will overestimate the VaR value due the overestimation of the tail. It is found that the GARCH (1,1) model under T distribution is the best model for estimating the VaR value of the exchange position, and the GARCH model under stable distribution cannot estimate the VaR value well because of its complicated tail feature. The earliest research on VaR in China is done by Zheng (1997, but because this method starts late in the country, the research mainly concentrates on the stock field with higher marketability degree. Research of this method applied to the exchange rate risk measurement is relatively few. Wu (2013) compares the VaR value calculated by the GARCH class model and the traditional ARMA model, and thinks that the accuracy of the VaR value calculated by the GARCH-M model under T distribution is higher than that of the ARMA model. Gencay and Selcuk (2004) believe that extreme value estimation has higher accuracy than previous parametric method and historical simulation method, by calculating the VaR value of the daily yield of 9 emerging market stock markets.

In the early period, because the U.S. dollar is the base currency directly linked to gold, exchange rate risk is almost non-existent, so in the financial market, risk research on the exchange rate risk is relatively few. After the collapse of the Bretton Woods system, countries began to use floating exchange rate system, foreign exchange risk intensified, the measurement of foreign exchange risk received more attention. In China, VaR method is mainly studied in the relatively mature stock market, while in the foreign exchange market research is still relatively few. Existing empirical study of exchange rate risk has not comprehensively examined the applicability of various VaR methods in measuring RMB exchange rate risk, and is limited to the research of several methods, and ignores the comparison of each method. When studying RMB exchange rate risk, most academics modeled it on the rate of return on the RMB versus USD. While with the development of economic globalization, it is necessary to select several representative data to model and improve the accuracy of RMB exchange rate risk measurement. Therefore, when using VaR model to measure the RMB exchange rate risk, we should satisfy the hypothetical conditions required by each method, and use the corresponding econometric model and quantitative analysis technique accurately. The VaR estimation method then can suitable For different financial series, the suitability of different VaR estimation method should be examined to improve the accuracy and precision of risk measurement.

3 THEORETICAL ANALYSIS

3.1 The GARCH Family Model

The GARCH family model includes GARCH and extended models of GARCH TARCH, EGARCH, PARCH, and GARCH-M. The GARCH model is proposed by Bollerslev (1986) on the basis of the autoregressive conditional variance ARCH model introduced by Engle in the 1986, and is called the generalized autoregressive conditional variance. The hysteresis value is added to the GARCH model, which solves the problem that the parameter estimation is inaccurate when the conditional variance is high in order. Although the GARCH model overcomes the defects of ARCH model, it has its own limitations. In order to depict the characteristics of the peak and thick tail of time series, GARCH includes too many constraints on parameters, such as the requirement that the parameters in the conditional equation are nonnegative. At the same time, the GARCH model does not solve the asymmetry of investors' response to market information.

The EGARCH model proposed by Nelson in 1991 solves the problems above and not only reduces the parameter nonnegative requirement but also reflects the leverage effect. The EGARCH model is the exponential GARCH model. The exponential setting makes the predicted conditional variance nonnegative and reduces the constraint on the parameters.

The GARCH-M model adds the idea of risk premium. People generally think that the greater the risk, the higher the expected return. GARCH-M set the standard deviation as exogenous variable into the equation of conditional mean value, which satisfies the requirement that the risk premium should be reflected in the expected return.

The TARCH model uses virtual variables to set thresholds, which can reflect asymmetric effects and prove the leverage effect. The PARCH model is the standard deviation GARCH model. The GARCH model is the simulation of the difference between the opposite side and the standard deviation, and the influence of the difference is different, so secondary power of the standard deviation is simulated.

3.2 The VaR Method

1) Formula

The formula is expressed as:

$$\text{Prob} (P \leq \text{VaR}) = 1-C \quad (1)$$

P - the loss of financial assets during the holding period

VaR - the risk value under confidence degree *C*

C - the significant level

Its essence is to forecast the market risk on the basis of historical data, not the concrete value but the probability distribution.

2) Calculation

There are three methods of calculating Var, the history simulation Method (historical simulation), the covariance method (variance covariance) and Monte Carlo simulation (Monte Carlos simulation).

The historical simulation method is the most simple and intuitive method in three methods and does not need to make the yield distribution feature hypothesis, but the historical simulation method is influenced by the data selection. If the selected data time span is too long or may contain the extreme situation cannot accurately respond to the actual situation. If the time span of the data selection is too short, the data may be inadequate, and the prediction result is not convincing. The Monte Carlo simulation method is similar to the historical simulation method, which is mainly based on the historical data to predict the future market factors, and the former is based on the parameters of the previous market factors. The common disadvantage of this approach is to assume that the historical situation and future situation are the same to make predictions. The covariance method and the first two methods are completely different in their computational concepts. This method is based on the assumption that the data obeys the normal distribution and the same variance, which is not always in accordance with the actual situation and there is a large error, which will underestimate the risk.

At present, the GARCH family model can better depict the characteristics of the peak and thick tail, conditional variance and non-independent of financial sequence.

3.3 The GARCH-VaR Model

Because the financial time series data has the characteristic of the peak and thick tail, the Var value can be reduced by using the conditional variance of the GARCH class model to reduce the underestimation of the risk. The basic formula is:

$$r_t = x'_t \beta + \varphi \delta + \varepsilon_t \quad (2)$$

$$h_t = \omega + \sum_{j=1}^p \beta_j h_{t-j} + \sum_{i=1}^q \alpha_i \varepsilon_t^2 - i \quad (3)$$

$$\varepsilon_t = v_t \sqrt{h_t} \quad (4)$$

$$\text{VaR} = p_{t-1} Z_\alpha \sqrt{h_t} \quad (5)$$

h_t - the conditional variance

v_t - a random variable with independent distribution, could be a standard normal distribution, generalized error distribution (GED) distribution or T distribution

Z_α - determined by the form of a sequence distribution.

Due to the asymmetry of the fluctuation of the return sequence, EGARCH or TGARCH are sometimes used. GARCH-VaR modeling programs include:

- Verifying data smoothness with ADF test (Augmented Dickey–Fuller test)
- Verifying sequence correlation with q statistic
- Using ARCH-LM to carry out conditional variance test

- Selecting the optimal model with maximum likelihood method
- Using the optimal model to find the degree of freedom T of T distribution
- Calculating Var value by the decimal point T
- Verify the validity by the Chi-square test

4 EMPIRICAL ANALYSIS

4.1 Selection & Statistic Characteristics of RMB Exchange Rate Data

1) RMB Exchange Rate Data Description

This paper selects the median exchange rate of RMB versus USD, EUR, GBP and JPY. The data selection date is from December 1, 2011 to December 30, 2016. At the same time, in the measurement process, calendar effect is not considered due to different regional holidays.

2) Statistical Characteristics of RMB Exchange Rate Data

Table 1 shows the statistical characteristics of RMB exchange rate data in each currency, and it can be seen from the table that the volatility of the JPY is the smallest, and that other currency exchange rates are more discrete and the gap is not obvious.

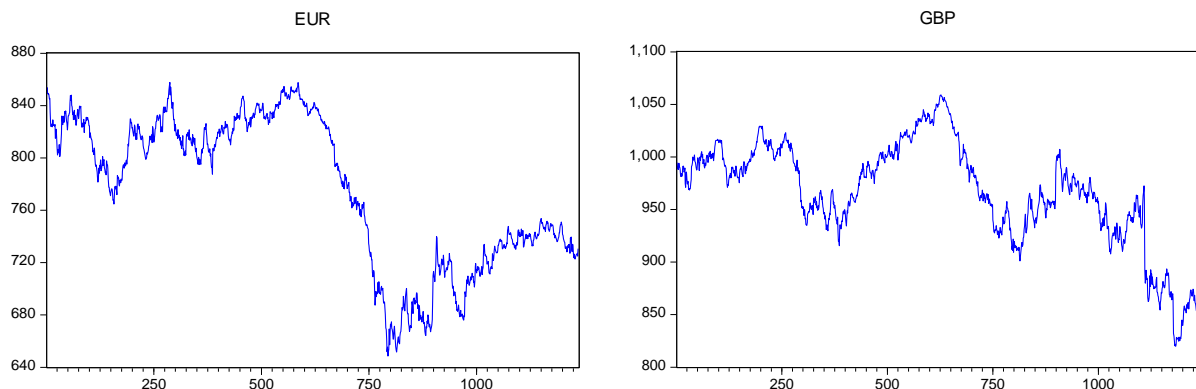
TABLE 1 STATISTICAL CHARACTERISTICS OF THE DAILY AVERAGE VALUE OF THE RMB EXCHANGE RATE BY COUNTRIES

Data	EUR	GBP	USD	JPY
Maximum	857.7200	1059.0400	695.0800	8.2846
Minimum	648.5200	819.8200	609.3000	4.9085
Mean	775.7793	967.0727	630.4497	6.2973
Median	793.7000	972.6450	628.0400	6.0683
Std.Dev	56.7699	48.4607	19.7693	0.9743

4.2 GARCH-VaR Model Hypothesis Test

1) Test of Data Smoothness

It is necessary to test the stability of time series for modeling analysis. In this paper, an ADF test (Augmented Dickey–Fuller test) is used to verify that. The original hypothesis is that the sequence is not stable and the ADF test equation does not contain constant term and trend term. Figure 1 shows the chart of four time series data. It can be seen from the graph that the range of data volatility is small. The dollar experienced a continuous devaluation, while the EUR and GBP shocks more intensely. Table 2 finds that the sequence ADF statistics are greater than the critical values of different test levels. On this basis, we continue to carry out the test, that is, the unit root test of each sequence, and found that in the 1%, 5% and 10% significant level, in the first-order difference after the ADF statistics are less than the corresponding statistics, so reject the original hypothesis. Four sets of data is a stationary sequence with a unit root.



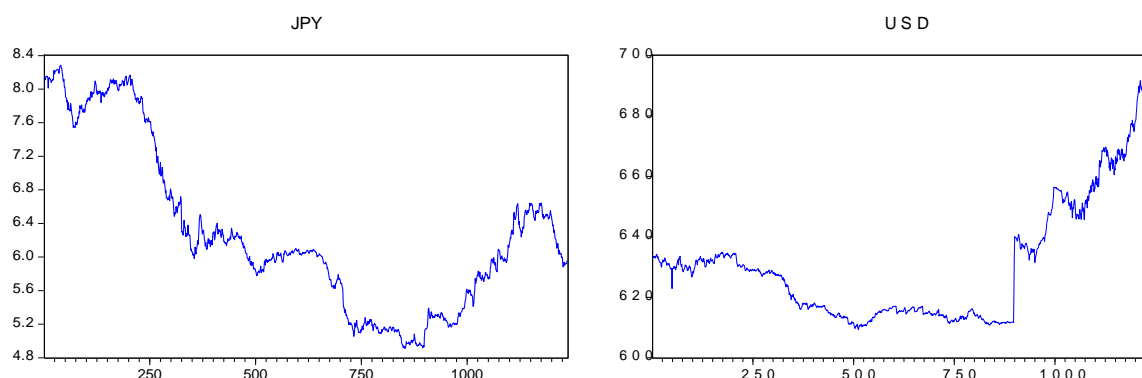


FIG. 1 THE TREND CHART OF FOUR CURRENCIES ON THE DAILY AVERAGE VALUE OF RMB EXCHANGE RATE

TABLE 2 DATA SMOOTHNESS ADF UNIT ROOT TEST RESULTS

Variables	USD	1st Difference USD	EUR	1st Difference EUR	GBP	1st Difference GBP	JPY	1st Difference JPY
ADF Statistics	2.082808	-32.6525	-1.46186	-35.4932	-1.08895	-32.9846	-1.97983	-32.9722
Critical Value	1%	-3.43543	-3.43543	-3.43543	-3.43544	-3.43543	-3.43544	-3.43543
	5%	-2.86367	-2.86367	-2.86367	-2.86367	-2.86367	-2.86367	-2.86367
	10%	-2.56795	-2.56796	-2.56796	-2.56796	-2.56796	-2.56796	-2.56796
P Value	1.0000	0.0000	0.5530	0.0000	0.7220	0.0000	0.2960	0.0000
Result	Unstable	Stable	Unstable	Stable	Unstable	Stable	Unstable	Stable

2) Test of Normality

The VaR model assumes different distribution forms to fit the actual distribution, such as normal distribution, T distribution and GED distribution. The normal distribution is most simple and convenient, which can reduce many computational processes, because it can determine the distribution form by means of mean and variance. However, the empirical research shows that the time series data shows the characteristics of the peak and thick tail, which does not conform to the normal distribution hypothesis. Therefore, T distribution and GED distribution can increase the accuracy of the tail metric. It is necessary to check the normal distribution of the sequence for the accuracy of the calculation of VaR statistics. In this paper, the normal distribution is tested by J-b test. The formula is:

$$JB = \left(\frac{N}{6}\right) \left[S^2 + \frac{(K-3)^2}{4}\right] \quad (6)$$

n - the sample capacity

S - skewness

K - kurtosis,

JB statistic obeys the Chi-square distribution of degrees of freedom of 2, if the JB statistic is greater than the critical value, the original hypothesis that the distribution is the normal distribution is refused.

TABLE 3 J-B STATISTIC DATA RESULTS

Variables	EUR	GBP	USD	JYP
Jarque-Bera	324.9274	39503.5900	49149.4400	2858.7130
Probability	0.0000	0.0000	0.0000	0.0000
Peak Degree	5.436079	30.4352	33.43414	10.42587
Degree of Bias	0.312307	-1.975657	2.687651	-0.320311

As can be seen from Table 3, the skewness of each sequence is not equal to 0 and the kurtosis is greater than 3 (the kurtosis and skewness of the normal distribution are 3 and 0 respectively). It can be preliminarily judged that the sequence does not conform to normal distribution and has the characteristics of sharp peak and thick tail. From the J-b statistics, the adjoint probability is less than 1% of the significant level, so reject the original hypothesis. This further proves that the sequence data does not obey the normal distribution. Therefore, this paper uses the VaR value

of GARCH Model, T distribution to measure the RMB exchange rate risk, in order to better depict the tail characteristics and improve the accuracy of measurement.

3) Sequential Correlation Test

In this paper, Q statistics are used for sequence correlation test, and the formula is:

$$Q = N \sum_{i=1}^k \rho_i^2 \quad (7)$$

ρ_i - the I-order autocorrelation coefficient

n - the sample size

q - progressively in the Chi-square distribution

k - Degree of freedom + number of autocorrelation parameters.

TABLE 4 THE CORRELATION TEST OF RMB EXCHANGE RATE

Lag Period	GBP		USD		EUD		JYP	
	Q Statistics	P Value	Q Statistics	P Value	Q Statistics	P Value	Q Statistics	P Value
1	0.006	0.937	0.018	0.893	0.003	0.954	0.002	0.965
2	0.756	0.685	4.439	0.109	0.302	0.860	0.793	0.673
3	3.143	0.370	5.968	0.113	0.303	0.959	1.154	0.764
4	3.791	0.435	8.735	0.068	1.574	0.814	2.288	0.683
5	6.409	0.268	10.126	0.072	2.337	0.801	3.403	0.638
6	6.566	0.363	10.598	0.102	2.424	0.877	5.319	0.504
7	6.685	0.462	11.029	0.137	6.197	0.517	5.326	0.620
8	6.686	0.571	12.684	0.123	6.379	0.605	5.887	0.660
9	6.793	0.659	12.965	0.164	6.446	0.695	7.938	0.540
10	8.379	0.592	16.608	0.083	10.773	0.375	10.474	0.400
...
36	44.707	0.151	43.328	0.187	37.119	0.417	38.273	0.367

It can be seen from Table 4 that the adjoint probability of the autocorrelation coefficient q statistic is much greater than 1% in the case of a significant level of 1%, so the original hypothesis that the sequence is irrelevant is accepted. Meanwhile, the value of Q statistic increases with the increase of lag period, which indicates that RMB exchange rate is moving towards white noise.

4) Test of Conditional Difference Variance

Because variance is an important parameter for calculating VaR value and has time variability, we use the GARCH class model to characterize the conditional variance. Next, the variance test is performed on the square of the residual sequence to select the optimal value of the model estimate var. This paper verifies the variance by verifying the existence of arch effect. ARCH-LM can test whether the sequence has an arch effect.

TABLE 5 ARCH EFFECT TEST

	EUR	GBP	USD	JPY
Order of delay	1	1	1	1
Prob. F(1,1230)	0.0000	0.0394	0.0000	0.0649
Prob. Chi-Square(1)	0.0000	0.0394	0.0000	0.0649

As can be seen from Table 5, the P value is significantly less than the significant horizontal 1% (the P value of GBP and JPY is significantly less than the significant level of 10%) at the time of 1 step lag, so the original hypothesis is rejected and the sequence has an arch effect.

In summary, using the GARCH model to estimate the VaR value can improve the precision and accuracy of the calculation. Through the above tests, it can be concluded that the RMB exchange rate sequence is a first order single integer sequence, and the sequence is irrelevant. Then the paper verifies that the sequence does not obey the normal distribution and has the feature of the sharp peak and thick tail, so the t distribution can be used to characterize the tail character better when calculating the VaR value. Then the arch effect of the sequence is tested, so the conditional variance can be better described by using the GARCH family model.

4.3 Empirical Analysis

In this paper, the maximum likelihood estimation method is used to estimate the parameters of the GARCH family model, and the GARCH, TGARCH, EGARCH and PARCH models in the GARCH family model are respectively established, and the GARCH model of each sequence is selected to estimate the VaR value. The regression equation is:

$$DAUD = C(1) + C(2)*DAUD(-1) \quad (8)$$

$$GARCH = C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1) \quad (9)$$

$$GARCH = C(3)+C(4)*RESID(-1)^2+C(5)*RESID(-1)^2*(RESID(-1)<0)+C(6)*GARCH(-1) \quad (10)$$

$$LOG(GARCH) = C(3 + C(4)*ABS(RESID(-1) / @SQRT(GARCH(-1)))+C(5)*RESID(-1 / @SQRT(GARCH(-1)))+C(6)*LOG(GARCH(-1)) \quad (11)$$

$$@SQRT(GARCH)^C(7) = C(3)+C(4)*(ABS(RESID(-1))-C(5)*RESID(-1))^C(7)+C(6)*@SQRT(GARCH(-1))^C(7) \quad (12)$$

TABLE 6 ESTIMATION OF RMB EXCHANGE RATE BY GARCH FAMILY MODEL

GBP		Equation of Mean Value	Parametric Equation				
Model Parameters		DAUD(-1)	C(3)	C(4)	C(5)	C(6)	C(7)
P Value	GARCH	0.3839	0.0001	0.0000	0.0000		
	TGARCH	0.1206	0.0000	0.0001	0.0000	0.0000	
	EGARCH	0.1863	0.0068	0.0000	0.0011	0.0000	
	PARCH	0.1955	0.0149	0.0000	0.0027	0.0000	0.0000

USD		Equation of Mean Value	Parametric Equation				
Model Parameters		DAUD(-1)	C(3)	C(4)	C(5)	C(6)	C(7)
P Value	GARCH	0.4280	0.0000	0.0000	0.0000		
	TGARCH	0.2519	0.0000	0.0000	0.0143	0.0000	
	EGARCH	0.6844	0.0000	0.0000	0.0358	0.0000	
	PARCH	0.1022	0.0000	0.0000	0.0006	0.0000	0.0000

JPY		Equation of Mean Value	Parametric Equation				
Model Parameters		DAUD(-1)	C(3)	C(4)	C(5)	C(6)	C(7)
P Value	GARCH	0.0127	0.0001	0.0000	0.0000		
	TGARCH	0.0131	0.0002	0.0000	0.9684	0.0000	
	EGARCH	0.0030	0.0000	0.0000	0.6377	0.0000	
	PARCH	0.0077	0.2621	0.0000	0.7228	0.0000	0.0000

EUR		Equation of Mean Value	Parametric Equation				
Model Parameters		DAUD(-1)	C(3)	C(4)	C(5)	C(6)	C(7)
P Value	GARCH	0.3387	0.0000	0.0000	0.0000		
	TGARCH	0.5105	0.0000	0.0000	0.0000	0.0000	
	EGARCH	0.2437	0.0004	0.0002	0.0000	0.0000	
	PARCH	0.0262	0.0466	0.0000	0.0000	0.0000	0.0080

As we can see from Table 6, the pound has the most significant number of parameters in the TARCH model, with the RMB exchange rate at 1% significant levels. The optimal model of the JPY-RMB exchange rate sequence is

GARCH model. The optimal model of GBP against RMB exchange rate is TARCH, and the optimal model of USD/RMB exchange rate and EUR/RMB exchange rates is PARCH.

After the model of each data is established, the arch effect is retested to ensure the elimination of the variance. It can be seen from Table 5 that there is no arch effect in the residual sequence.

TABLE 7 ARCH EFFECT RE-TEST RESULTS AFTER THE ESTABLISHMENT OF GARCH FAMILY MODEL

	EUR	GBP	USD	JPY
Order of Delay	1	1	1	1
Prob. F(1,1225)	0.1237	0.7704	0.8565	0.7348
Prob. Chi-Square(1)	0.1235	0.7702	0.8564	0.7346

1) VaR Value Analysis

After the optimal fitting model of each sequence is obtained, because the data is not normal distribution, the T distribution is established to find the freedom T of each sequence. Then the decimal t can be derived from the degree of freedom T to compute the VaR value of each sequence.

TABLE 8 THE DEGREE OF FREEDOM T AND THE QUANTILE T OF RMB EXCHANGE RATE MODEL

Variables	Degree of Freedom T	Quantile T
GBP	4.467670	2.069317
EUR	5.057270	2.010019
JPY	4.133107	2.112273
USD	4.047026	2.124749

The VaR value of RMB exchange rate under 95% confidence level is obtained by using the GARCH model prediction and the calculated number of decimal points.

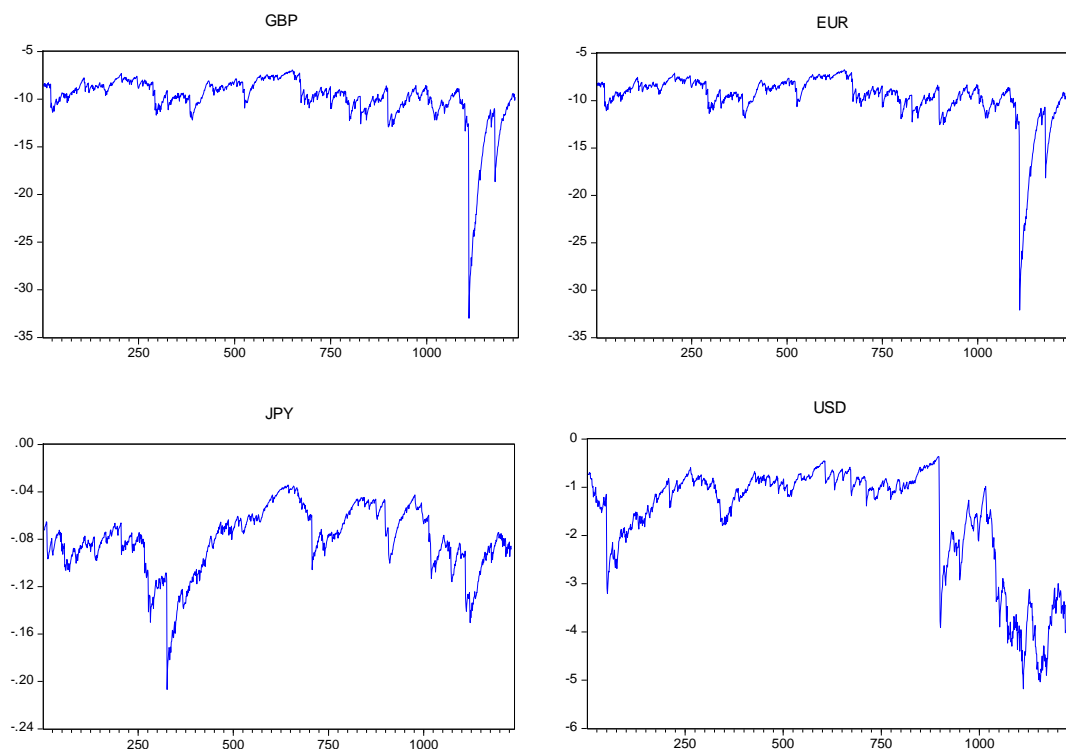


FIG. 2 FOUR GROUPS OF RMB EXCHANGE RATE VaR DETECTION GRAPHICS

From the detection data of VaR, it can be concluded that there is no abnormal value. JPY and USD risk values have a small range of fluctuations, with a smaller degree of dispersion between 0-2 and a minimum risk volatility for JPY. GBP and EUR fluctuate most.

TABLE 9 FOUR GROUPS OF RMB EXCHANGE RATE VAR DETECTION VALUE

Data	Maximum	Minimum	Mean	Median	Std.Dev.
EUR	857.7200	648.5200	775.7793	793.7000	56.7699
GBP	1059.0400	819.8200	967.0727	972.6450	48.4607
USD	695.0800	609.3000	630.4497	628.0400	19.76926
JPY	8.2846	4.9085	6.2973	6.0683	0.974277

2) VaR – Chi-square Test

In order to ensure the validity of the data of empirical research, the paper then carries out the Chi-square distribution test for VaR value. In the case of 95% confidence level and the degree of freedom 1, the key value of the Chi-square distribution is 1310.64, and the key value of f test is 3.003. The key value of the chi-square distribution is much larger than that of the F test, which shows that it is in accordance with the card square distribution and the experimental data is valid.

4.4 Empirical Analysis Summary

In this paper, four groups of RMB exchange rate data are analyzed by GARCH-VaR model. The study was on the average daily price of the pound against the RMB, the USD against the RMB, the JPY against the RMB and the EUR against the RMB.

Through econometric analysis, it is found that:

- It can be observed from the statistical characteristics of the data that EUR and GBP have greater volatility and dispersion than other groups of exchange rate data and have a higher frequency of fluctuations. In contrast, the rest of the exchange rate volatility is more stable, and JPY's risk value volatility is minimal. It can be seen from the time series diagram that the fluctuation range of several groups of data is not big. USD experienced a sustained depreciation, while the rest of the data showed a downward trend.
- GBP, USD, EUR, and JPY all have one unit root, which is a first order single integer sequence.
- By checking the normality of the sequence by j-b statistic, it can be found that the sequence is not normal distribution and has the characteristics of a sharp peak and a thick tail. The sequence correlation test is carried out by Q Statistic, which accepts the original hypothesis that the sequence is irrelevant, and there is no sequence autocorrelation and the RMB exchange rate sequence is gradually moving towards white noise. The high-order arch effect in the sequence is detected by ARCH-LM, which can be eliminated by establishing the GARCH model.
- The GARCH family model of the four groups of RMB exchange rate is established, and the optimal matching model of each group data is selected by maximum likelihood estimation. The optimal model of the JPY-RMB exchange rate sequence is GARCH model. The optimal model of GBP-RMB exchange rate is TARCH, and the dollar-RMB exchange rate and the EUR-RMB exchange rate model are PARCH. The arch effect was then tested and found to have been eliminated.
- By calculating the degree of Freedom T in the t distribution, the number of bits in each group of data can be obtained. The VaR value is predicted by the method of static prediction. USD and JPY have a smaller range of risk value fluctuations, and the degree of dispersion is also smaller between 0-2. JPY has the slightest degree of risk volatility. The standard deviation of the GBP and EUR risk values is significantly greater than other sequences.

Through GARCH-VaR model analysis, it can be proved that the fluctuation of RMB exchange rate has agglomeration and permanence. In addition to the pound against the RMB exchange rate, the other three groups of

exchange rate fluctuations have a certain degree of leverage. The JPY has the lowest risk of exchange rate and its fluctuation range and standard deviation are small. On the contrary, the EUR and GBP fluctuate considerably against the RMB. In summary, the fluctuation of RMB exchange rate can basically reflect the change of supply and demand of foreign exchange market, which shows that the effectiveness of China's foreign exchange market has improved.

5 CONCLUSION

Since the implementation of the floating exchange rate system based on market supply and demand in China since July 21, 2005, the RMB is no longer single pegged to the dollar, and the pace of marketization of RMB exchange rate has been accelerated. In recent years, China has accelerated the process of RMB marketization and internationalization to become an international currency. Thus, the exchange rate risk becomes an important part of financial risk management in China, and it is especially important to measure the exchange rate risk accurately. This paper studies the comparative analysis of four foreign currencies against RMB exchange rate risk, hoping to explain the current situation of exchange rate risk and put forward effective policy suggestions by comparing different currencies against RMB exchange rate risk fluctuation.

This paper first introduces the current situation of RMB exchange rate risk. Because RMB exchange rate has agglomeration and permanence, and is a first order stationary sequence of non-normal distribution, it can be concluded that the Garch-var model has the best measure effect. After that, this paper mainly uses the empirical research method to measure the RMB exchange rate risk. This paper takes USD/RMB, JPY/RMB, EUR/RMB and GBP/RMB daily average price from December 2011 to December 2016, that is, 5-year exchange rate as sample frequency data series, and respectively, using Garch, TARCH, Egarch and Parch models to fit the data. The optimal model for each set of data is chosen to find the Var value, and the validity of the data is validated.

It was found that EUR was the most risky and JPY was the least risky. Combining the empirical research results with the current development status of RMB exchange rate, we can conclude that RMB exchange rate fluctuation is small, because the opening time of China's exchange rate market is not long and not fully marketed, and government intervention still occupies an important position. This paper hence proposes the following policy recommendations:

- From the government level, the Office should accurately use the risk measurement model to strengthen the foreign exchange market construction.
- From the level of commercial banks, they should promote the development of financial derivative products.

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