VOLIATILITY CONTAGIONEFFECTFOREXCHANGE RATE AND FOREIGN EXCHANGE RESERVE IN CHINA: A DIAGONAL BEKK GARCH APPROACH

[1]XIANGQING LU, [2]ROENGCHAITANSUCHAT, [3]CHARUK SINGHAPREECHA, [4]JIRAKOM SIRISRISAKULCHAI

[1,2,3,4] Chiang Mai University, Faulty of Economy, Chiang Mai Thailand
E-mail: [1] xiangqing_lu@cmu.ac.th, [2] roengchaitan@gmail.com

Abstract - The present study attempts to clarify the effectiveness of China's foreign exchange reserve intervention on its central parity exchange rate. Using a bivariate diagonal BEKK GARCH framework, the study helps to understand the volatility contagion effect between exchange rate and foreign exchange reserves in China's economy between December 1999 and December 2020. The results evidence that two variables are not simply linear or causality buta dynamic correlation and presence the strong volatility contagion. Besides having significant policy implications, the study finding would be beneficial for investors and traders.

Keywords - Exchange rate, China's Foreign Reserve, Volatility Contagion, Diagonal BEKK.

I. INTRODUCTION

In recent years, China's influence in the world trading system has increased, the volume of international trade and investment denominated in yuan is also growing. Until 2018, China exports reach an all-time high at $2,655.59 Billion dollars, even in 2019, only a 0.54% decline from 2018 but still the world's largest exporter. In this process, the issue of the RMB exchange rate has been put forward constantly.

Further, many studies given solution recommendations have been based on exchange-rate determination theory, but China is a special case. Review the history, China's exchange rate structure has changed a lot in the past 30 years. The RMB kept a fixing exchange rate from 1994. Then started to peg the US dollar on July 21, 2005, onwards, RMB started rising since China started the market-oriented floating exchange rate system which is based on a basket of currencies. This policy allowed the fluctuation of RMB against USD by 0.3% per day in either direction. And from August 2015 to now. The People's republic bank of China (PBC) reformed the RMB exchange rate mid-price quotation mechanism.

The IMF report in 9th Aug2019 mentions that although the RMB has depreciated against the US dollar, it is generally stable against a basket of currencies. China has sufficient foreign exchange reserves. From Nov 2018, the RMB's real effective exchange rate has depreciated by about 2.5%. China has about $3.2 trillion in foreign exchange reserves, that's why they still enough to continue the transition to a more flexible exchange rate.

The management of foreign exchange reserves is likely to acquire increased prominence among the range of issues facing many central banks. The precautionary demand for reserves is generally regarded as by far the most important for most countries. The question we are trying to investigate here is whether there is a cross-volatility spillover effect between foreign exchange reserve volatility and exchange rate fluctuations? Are foreign exchange reserves effective in preventing and reducing exchange rate risks?In a contrast, what is the impact of the instability of the dollar-yuan exchange rate on China's foreign exchange reserves held in dollars?

II. LITERATURE REVIEW

From 1999 to 2005, China's exchange rate under a fixed exchange rate system, foreign exchange reserves are simply a tool for the government to regulate the currencymarket.Mendoza (2006) thinks maintaining optimal reserves is effectively manage their exchange rates and reduce adjustment costs associated with fluctuation in international payments.

Stieglitz (2006) study the experience from the 1997 SE-Asian crisis that available reserves are benefited to reduce instability of economic.SSBa, BWu,YQZhu(2007) started on the China's reform of exchange rate regime in July 2005, estimates the real effective exchange rate also adopts the theory of elastic price and linear regression analysis, and the results show that the increase of exchange rate flexibility will reduce the degree of China's foreign exchange reserves being restrained by the exchange rate.

Yanjing Liu (2012) test on Panel data regression model, which extends the basis of the model built by Chinn & Frankel (2005). Give the evidence that the more unstable a country's currency is, the lower its share of international reserves will be, because it does not meet investors' requirements for currency

stability. Except for China, Mayuresh S. Gokhale & J. V. Ramana Raju (2013) study causality between exchange rate and foreign exchange in Indian,the results only show a short and weak correlation. TayfurBayat, Mehmet Senturk, Selim Kayhan(2014) investigate the asymmetric relationship between nominal-real exchange rate and foreign exchange reserves of Central Bank in Turkey throughout for 2003m01-2014m01 by nonlinear and frequency domain causality approach, The results find strong evidence of nonlinear cointegration between real exchange rate and Turkey's Central Bank foreign exchange reserves.

Anextensivestudy was done by QiuMin Li (2016) estimated the exchange rate volatility under the condition of foreign exchange intervention by GARCH-VaR model. The paper explained the China's foreign exchange reserves are growing fast with the moment the exchange rate decreased after the reform in 2005 and the financial crisis in 2008, the increasing of China's foreign exchange reserves leads to expectations of RMB appreciation. Then the expectations of yuan appreciation have contributed to the increase in foreign exchange reserves. The results show the use of China's foreign exchange reserves intervention, effectively reduce the exchange rate fluctuations in the period from 2008 to 2015.Besides, Uttam Golder, Md. Nazrul Islam, Md. Shahidullah Kayser(2020) study the dynamic correlation via Vector error correction(VEC) model, given the exists of cross-dynamic correlation within exchange rate and foreign exchange reserves.

Countries are known the motives for holding reserves include transaction needs, intervention needs, and wealth diversification (Scott Roger 1993). AndChina's Foreign exchange reserves accumulation reflects the intervention of PBC wants to prevent the currency from appreciation against the dollar to promote export-led growth. In this backdrop, the present study tries to clarify the effectivity of China's foreign exchange reserve intervention on its nominal exchange rate and understand the volatility contagion effect between exchange rate and foreign exchange reserves in the Chinese economy between December 1999 and December 2020 via a diagonal BEKK approach.

III. DATA

The data employed in this study are the monthly data of exchange rate central parity rate and foreign reserve assets in China within the period from Dec1999 to Dec 2020. Each series have 252 observations. The data of the central parity exchange rate obtained from https://cn.investing.com. The data of foreign reserve assets are given from the China Administration of Foreign Exchange and PBC. The monthly returns are computed as the difference of the natural logarithm of two consecutive assets.

Variable	Symbol	Description
exchange rate	EXR	China's nominal exchange rate, which is generated from the onshore market's mid-price quotation mechanism, estimate from the average of the buying and selling prices
foreign exchange	FER	China's official foreign reserves.

Table1: Descriptive of data

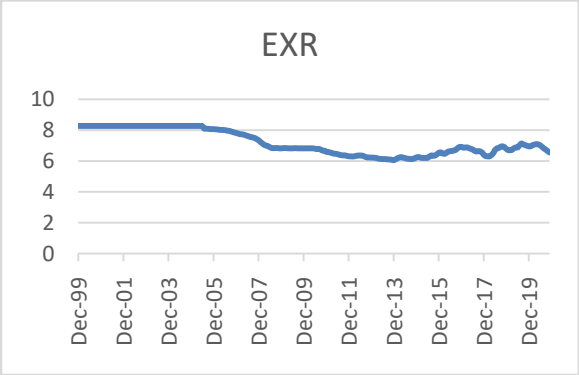

Fig.1 Monthly data of China's exchange rate

In the beginning, the exchange rate almost fixing at 8.27 from 1999 to 2005. by the first reform in July 2005, the EXR curve shows a downward trend. Then influenced by the financial crisis in 2008, the exchange rate reduced to 6.8299. The second exchange rate reform in 2015 , after that, the exchange rate shows a volatility clustering effect (see fig.1).

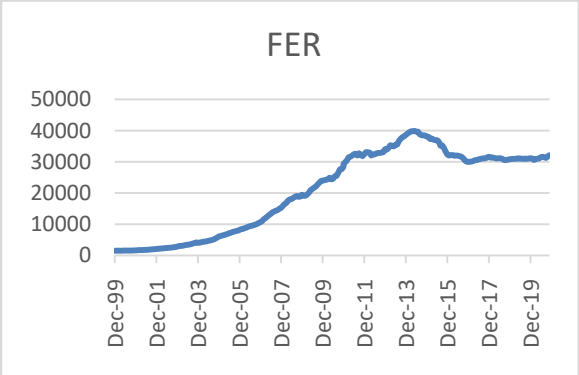

Fig.2Monthly data of China's foreign exchange reserves

China's foreign exchange reserves should be divided into three phases. before 2015, almost all of China's foreign exchange reserves were held in dollars, From

July 2005 to October 2016. China's official reserve assets include foreign currency reserves, a small amount of SDRs, and other reserve assets. In 2016, RMB joinSDR basket, and formally to be an international currency. By analyze the graph as above. China's foreign exchange reserves match thehighest point at 39932.13 Billion dollars in June 2014 then decrease, until March 2017, the curve became a more stable stage.

IV. ECONOMETRIC METHODOLOGY

4.1Unit root test

The Augmented Dickey-Fuller testallows for higher-order autoregressive processes by including Δy_{t-p} in the model. But our test is still if γ=0.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \cdots$$

The null hypothesis for both tests is that the data are non-stationary. We want to reject the null hypothesis for this test, so we want a p -value of less than 0.05 (or smaller).

4.2 Autocorrelation test

The Ljung–Box test may be defined as:

H0: The data are independently distributed (i.e. the correlations in the population from which the sample is taken are 0, so that any observed correlations in the data result from the randomness of the sampling process).

Ha: The data are not independently distributed; they exhibit serial correlation.

The test statistic is:

$$Q = n(n+2)\sum_{K=1}^{h}\frac{\hat{\rho}_k^2}{n-k}$$

where n is the sample size, $\hat{\rho}_k^2$ is the sample autocorrelation at lag k, and h is the number of lags being tested.

4.3Heterosatasticity test

The ARCH effect is concerned with a relationship within the heteroskedasticity, often termed serial correlation of the heteroskedasticity. It often becomes apparent when there is bunching in the variance or volatility of a particular variable, producing a pattern that is determined by some factor. Given that the volatility of financial assets is used to represent their risk, it can be argued that the ARCH effect is measuring the risk of an asset. Given the following model:

$$Y_t = \beta_0 + \beta_1 X_t + u_t$$
$$u_t \sim N(0, \alpha_0 + \alpha_1 u_{t-1}^2)$$

This suggests the error term is normally distributed with zero mean and conditional variance depending on the squared error term lagged one time period. The conditional variance is the variance given the values of the error term lagged once, twice etc.:

$$\sigma_t^2 = \mathrm{var}(u_t \backslash u_{t-1}, u_{t-2} \ldots) = E(u_t^2 \backslash u_{t-1}, u_{t-2})$$

Where σ_t^2 is the conditional variance of the error term. The ARCH effect is then modelled by:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2$$

This is an ARCH (1) model as it contains only a single lag on the squared errorterm, however, it is possible to extend this to any number of lags, if there are q lags it is termed an ARCH (q) model.

4.4Diagonal BEKK model

The general version of BEKK-GARCH modelis given as

$$H_t = C_0^T C_0 + \sum_{k=1}^{K}\sum_{i=1}^{q} A_{ik}^T \varepsilon_{t-i} \varepsilon_{t-i}^T A_{ik} + \sum_{k=1}^{K}\sum_{i=1}^{p} G_{ik}^T H_{t-i} G_{ik}$$

Where H_t is the conditional covariance matrix, ε_t is an N -dimensional error process, which is either directly observed or estimated from the model, A_i and G_i are N × N parameter matrices.

McAleer (2019) pointed out the Full BEKK-GARCH model exists deficiencies and limitations, and Diagonal BEKK is mathematically and statistically preferable to the Full BEKK, the Diagonal BEKK model has an underlyingstochastic process that leads to its specification, and hence satisfies the regularity conditions, including invertibility.

Diagonal BEKK (Engle and Kroner, 1995) is a multivariateGARCH model that permits the explicit and dynamic parameterization of conditional covariances.It reduces the number of parameters estimated by restricting the parameter matrices to be diagonal and addresses the difficulty with VECH by ensuring that the conditional covariance matrix isalways positive definite. The general Diagonal BEKK-GARCH (1,1) Equation namely:

$$Q_t = QQ' + A\varepsilon_{t-1}\varepsilon_{t-1}'A' + BQ_{t-1}B'$$

where A and B are diagonal (or scalar) matrices.

For two-variable DBEKK modelLet Ω a 2x2 matrix and equal to QQ'

$$\Omega = QQ' = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}\begin{bmatrix} c_{11} & 0 \\ c_{12} & c_{22} \end{bmatrix}$$

$$Q_t = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}\begin{bmatrix} c_{11} & 0 \\ c_{12} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}\begin{bmatrix} \varepsilon_{1t-1}^2 & \varepsilon_{1t-1}\varepsilon_{2t-1} \\ \varepsilon_{2t-1}\varepsilon_{1t-1} & \varepsilon_{2t-1}^2 \end{bmatrix}\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}\begin{bmatrix} h_{11t-1} & h_{12t-1} \\ h_{21t-1} & h_{22t-1} \end{bmatrix}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}'$$

Where Q_t represent the conditional covariance matrix.After transforming to equations, we get:

$$h_{11,t}(Q1_t) = \Omega_{11} + a_{11}^2\varepsilon_{1t-1}^2 + b_{11}^2 h_{11,t-1}$$
$$h_{12,t}(Q1_t) = \Omega_{12} + a_{11}a_{22}\varepsilon_{1t-1}\varepsilon_{2t-1} + b_{11}b_{22}h_{12,,t-1}$$
$$h_{22,,t}(Q1_t) = \Omega_{22} + a_{22}^2\varepsilon_{2,t-1}^2 + b_{22}^2 h_{22,t-1}$$

where $h_{11,t}$ is represent the conditional variance of asset 1 return, $h_{22,t}$ is represent the conditional variance of asset 2 return, and $h_{12,t}$ is represent the

conditional covariance between asset 1 return and asset 2 return.Under the assumption of conditional normality, the parameters of the multivariate GARCHmodels of any of the above specifications can be estimated by maximizing the log-likelihoodfunction:

$$L(\theta) = -\frac{TN}{2} - \frac{1}{2}\sum_{t=1}^{T}(\log|H_t(\theta)| + \varepsilon_t(\theta)^T H_t(\theta)^{-1}\varepsilon_t(\theta))$$

Where the QMLE of the estimated parameters of Diagonal BEKK are consistent and asymptotic normal.

V. EMPIRICAL STATISTICS

5.1 Descriptive statistics

	REXR	RFER
Mean	-0.000929	0.012043
Median	-8.86E-05	0.010106
Maximum	0.031437	0.061126
Minimum	-0.02525	-0.041555
Std. Dev.	0.006621	0.017526
Skewness	0.645142	-0.003044
Kurtosis	6.918481	3.215187
Jarque-Bera	178.7029	0.486594
Probability	0.000000	0.784039
Sum	-0.23402	3.034730
Sum Sq. Dev.	0.011004	0.077096

Table 2: the monthly data of returns in CNY, FER

From above Table 2, the standard deviation of RFER is greater than REXR, indicating that the fluctuation of variable RFER is greater than FEXR. Skewness for REXR is 0.645142, which is more than zero means that the REXR series skew to the right. Skewness for RFER is -0.003044, less than zero alsovery close to 0, so RFER series skew to the left a little. Kurtosis of REXR is 6.918481, more than 3 so that REXR sequence are demonstrating a leptokurtic distribution which means have excessive kurtosis relative to the normal distribution and look steeper. For Jarque-Bera test, Prob. (REXR)=0, obviously not follow the normal distribution.Kurtosis of RFER is 3.215187, greater than 3 and similar to 3. not a normal distribution, but it's not through even 10% significant level in Jarque-Bera test. the graph of monthly returns for both sequences is shown below (Figure 3).

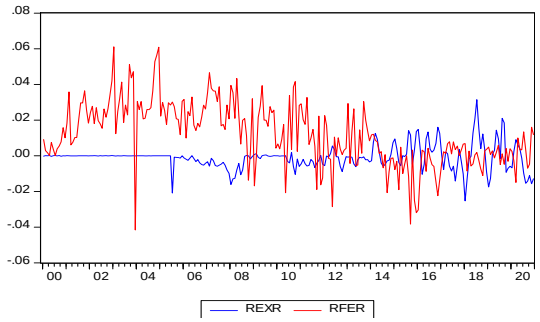

Fig.3the monthly data of returns in CNY, FER

5.2 Unit root test

	t-Stat	1% level	5% level	10% level	Prob*
REXR	-6.119	-3.457	-2.873	-2.573	0.0000
RFER	-3.873	-3.457	-2.873	-2.573	0.0026

Table 3：ADF results

The ADF test results reject the null hypothesis, p-value of both sequences is less than 0.01, which means the series of REXRand RFER are stationary at 1% significant level.

5.3 Autocorrelation and ARCH test

	Logl	AC	PAC	Q-Stat	Prob
REXR	12	0.095	-0.034	155.31	0
RFER	12	0.407	0.055	694.66	0

Table 4：Q-statistic results

Where AC, PAC represents autocorrelation and partial correlationrespectively. The Prob.-value in table 4, all equal to 0, Hence, we reject the null hypothesis and go with the alternative hypothesis that exists an ARCH effect for each of the underlying variables.

5.4 Volatility contagion

In our attempt to examine the magnitude of volatility contagion across two variables, we employ a diagonally restricted BEKK GARCH model. The estimation of the model involves the joint estimation of both its mean as well as variance equations. We specify theconditionalmeanequation as stated below:

$$R_t^{rexr} = \alpha + \lambda R_{t-1}^{rexr} + \rho R_{t-1}^{rfer} + \varepsilon_{t-1}$$
$$R_t^{rfer} = \alpha + \lambda R_{t-1}^{rfer} + \rho R_{t-1}^{rexr} + \varepsilon_{t-1}$$

	Coeff.	Std. Error
α_{rexr}	-0.000227	0.000363
λ_{rexr}	0.663233***	0.068087
ρ_{rexr}	-0.010452	0.016921
α_{rfer}	0.001957**	0.000916
λ_{rfer}	0.66387***	0.047315
ρ_{rfer}	-0.041590	0.098623

Table 5： Conditional Mean Return

Note: ***indicates reject the null hypothesis of at the 1%. significance level; **indicates reject the null hypothesis of at the 5% significance level; *indicates reject the null hypothesis of at the 10% significance level.

$$R_t^{rexr} = -0.0002 + 0.6632R_{t-1}^{rexr} - 0.0105R_{t-1}^{rfer} + \varepsilon_{t-1}$$

$$R_t^{rfer} = 0.0020 + 0.6639R_{t-1}^{rfer} - 0.0416R_{t-1}^{rexr} + \varepsilon_{t-1}$$

Results of conditional mean return equations are reported in Table 5, the estimates of the multivariate model seem plausible in both theory and statistics sense. Each of the coefficients to the autoregressive parameters (coefficients of the mean equations) is less than one in absolute terms, which is consistent, Therefore, the system is covariance stationery.

In the mean equation for the return exchange rate, the coefficients to the first lag of RFXR, i.e. R_{t-1}^{rexr}, is 0.6632, which is positive and significant at 1% level reflects persistence in the exchange rate movements.And that on the lagged foreign exchange reserve, i.e. R_{t-1}^{rfer},is -0.0105, which is negative and insignificant implies there was no significant causal relationship between the two variables. In other words, exists a risk of exchange rate depreciation if increase the foreign exchange reserves, but this risk is not accurately.

In the mean equation for return foreign exchange reserve, the coefficient of 0.6639 on the first lag of foreign exchange reserve is significant at 1% level reflects foreign exchange reserve inertia or persistence in RFER. The negative coefficient of -0.0416 on the first lag of the exchange rate is insignificant implies the expectation of exchange rate appreciation will bring the risk of foreign exchange reserve reduction but this risk is not significant. If the RMB is under pressure to appreciate, the Chinese government's reduction of its holdings of US dollar reserves and the sale of US Treasury bonds may not be effective in reducing the pressure on the RMB to appreciate.

E	C		A		B	
Ccoeff.	10.2632***	-1.0124	00.447135***		00.87934***	
f	(4.45E-07)	(9.82E-07)	(0.077145)		(0.038563)	
		10.08E-05*		00.422163***		00.884140***
		(5.54E-0)		(0.061730)		(0.030326)
Log-likelihood 1774.662						
AIC-14.03715.						

Table 6 Estimated a bivariate diagonal BEKK model

Notes: (1) $A=\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$,$B=\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$,$C=\begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}$ are the coefficients matrix for eq (11).
(2) the two entries for each parameter are their respective parameter estimates, Bollerslev and Wooldridge (1992) robust t-ratio.

(3) ***indicates reject the null hypothesis at the 1% significance level; **indicates reject the null hypothesis at the 5% significance level; *indicates reject the null hypothesis at the 10% significance level.

Conditional variance-covariance equations capture the volatility and cross volatility among the two variables.there are coefficients for the constant matrix C, ARCH term (matrix A), and GARCH term (matrix B). the estimated coefficients of the diagonal BEKKGARCH model as table 6. Specifically, conditional variances-covariances implied by the Diagonal BEKK Specification are presented below.

$$h_{11,t} = 1.26319 + 0.1999\varepsilon_{1t-1}^2 + 0.7732h_{11,t-1}$$
$$h_{12,t} = -1.0124 + 0.189\varepsilon_{1t-1}\varepsilon_{2t-1} + 0.778h_{12,„t-1}$$
$$h_{22,„t} = 1.08268 + 0.1782\varepsilon_{2,t-1}^2 + 0.7817h_{22,t-1}$$

The coefficients of the ARCH term and GARCH term indicate cross-volatility effect and own-volatility effect respectively. The own-volatility effect is under the dominant influence of its own past shocks and volatility (one lag),and cross-volatility effect under the influence of the news that came from other exogenous variables. The sum of the coefficients ARCH term and GARCH term in the above conditional variance-covariance equation is less than 1 indicate the stability condition of the variance.At the same time, the sum is close to 1, the process slightly oscillates around the mean value, and shows the effects of long memory in the two series.

$h_{11,t}$represents the conditional variance of the return in the exchange rate, corresponding toARCH term coefficient is 0.1999, GARCH term coefficient is 0.7732, all passed the significance test at the 1%

level. It shows that the volatility of the return in the exchange rate is affected by both its own-volatility effect and the cross-volatility effect. it is mainly affected by its own volatility in the previous period. Because GARCH term coefficient 0.7732 is greater than the ARCH term coefficient 0.1999. $h_{22,,t}$represents the conditional variance of the return in foreign exchange reserve, the coefficients 0.1782, 0.7817 are at 1% level of significance. This means the volatility of RFER is affected by both the own-volatility effect and cross volatility effect but mainly affected by its own past shocks.

$h_{12,t}$ represents the conditional covariance for the REXR andRFER,the significant coefficients imply the conditional covariance between two variables is affected by both exogenous and its own persistence. Coefficient of ARCH term as $a_{11}a_{22} = 0.1782$, coefficient of GARCH term as $b_{11}b_{22} = 0.7817$. Fundamentally, as indicated by the ARCH term and GARCH term corresponding to the diagonally restricted BEKK GARCH equations, we could infer that there exists volatility contagion withinChina's foreign exchange reserve with its exchange rate. It is also observed that the covariance for China's exchange rate and its foreign exchange reserve, the own-volatility persistence is higher than the cross-volatility effect.

The coefficienta_{11} in Table 6is larger than a_{22} means that dealers in China's exchangerate market must pay greater attention to the news coming from the Chinese government on the management of foreign exchange reserves.Which is proved again the volatility within two markets is contagious. Coefficient b_{22} has a higher value than b_{11} . This means that the shocks on China's foreign exchange reserve market last longer than in China's central parity exchange rate market in terms of future market volatility.Figure 4 is the graph for combined variance and covariance level.

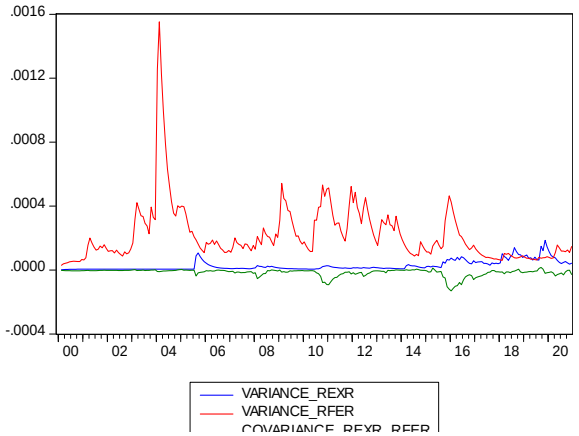

Fig.4Conditional variance-covariance

5.5. DYNAMIC CORRELATION

Figure5 is the dynamicCorrelation for the return in the exchange rate and the change of China's foreign exchange reserve. This indicates there is a time-varying correlation coefficient between the returns of the two variables. The correlation coefficient is a fluctuation between (-0.798416, 0.204077), indicating that the relationship between exchange rate and foreign exchange reserves in China is not completely positive or negative. most of the time is negative skewness.

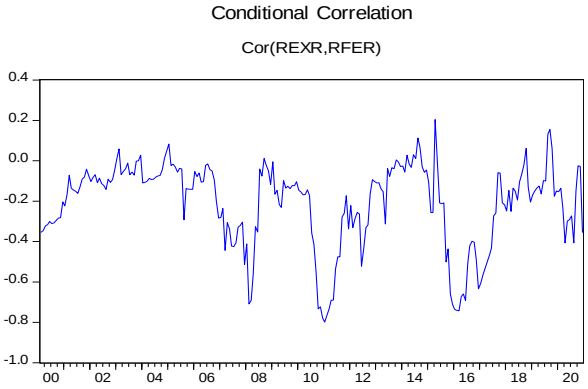

Fig.5Dynamic Correlation

Observe some special time nodes in figure 5, We can relate them to specific events:

In 2005, China's first exchange rate regime so that the coefficients in this time began to show a significant negative correlation coefficient from 0 to -0.3.

During the US subprime crisis in 2008 , the correlation between China's foreign exchange reserves and the exchange rate has been strengthened, between (-0.4, -0.7), indicating that during the financial crisis, the Chinese government took foreign exchange reserve management measures to intervene in its exchange rate fluctuations.

From Dec 2009, a debt crisis started in Greek then erupted in Europe and other countries. A lot of European capital poured into China from 2010 to 2012 , to protect local capital markets Chinese government managing foreign exchange reserves again to intervene in the exchange rate market. We can see the dynamic coefficients reach the lowest point at -0.7984 in Jan 2011.

From 2015 , The financial relationship between China and the United States began to strain. A stock market crash and housing bubble bursting started in Hong Kong then the outbreak on the whole of China. the Chinese government carried out the second exchange rate reform. We can see a sharp decline of the correlation parameters from the highest point0.204077 in Apr 2015 to -0.7429 in Mar 2016

In 2016 China join SDR basket, China opened its foreign exchange market further, that's why we see a

diminishing correlation for the exchange rate and reserves.

Until 2018, Financial frictions between China and the United States are intensifying and developing into a trade war. It can be seen that the fluctuation of the correlation coefficient fluctuates around 0, indicating that despite the intensification of trade conflicts, the Chinese government has chosen to reduce the intervention of foreign exchange reserves on its exchange rate.

From 2019 to 2020, Cov-19 spread from China to the world. Global economic downturn especially, international trade was severely damaged. Such, we can see that the correlation coefficient is strengthened again, indicates the Chinese government's efforts to maintain the exchange rate to adjust the country's economy

VI. CONCLUSIONS

Forex intervention has long been a controversial issuewith China a prime example compared to other countries. Chronic trade surpluses and an export-oriented economic model have made China the workshop of the world, accumulated a large amount of capital in the domestic. This has also led some countries such as the US and Japan to accuse China of being a currency manipulator, but there is no denying that this policy has helped China cope with the impact of the global trade contraction, the financial crisis, and the epidemic.

Using monthly time series data over for 21 years (December 1999 through December 2020), an estimate by a bivariate diagonal BEKK GARCHframework, the study observed the GARCH effects are much stronger as compared to the ARCH effects. Put simply, we evidence strong dependence of current volatility on their one-period lagged volatility as compared to the lagged error terms.Both the exchange rate and foreign exchange reserves in China depend on their own-volatility and partial cross-volatility.Furthermore, the study helps to understand that the foreign exchange reserves and exchange rate is not simply linear or causality but a volatility contagion effect and dynamic correlation. The results validate the presence of a strong time-varying volatility contagion among the foreign exchange reserves and exchange rate in China, especially when it’s economy in response to the crisis.

REFERENCES

[1] Bin, Z., &Qiyuan, X. (2013). 13. RMB’s Internationalization under the System of Limited Exchange Rate and Capital Account Control. In China and the World. 237-253.

[2] Michael John McAleer. (2019). What They Did Not Tell You About Algebraic (Non-) Existence, Mathematical (IR-)Regularity and (Non-) Asymptotic Properties of the Full BEKK Dynamic Conditional Covariance Model. Journal of Risk and Financial Management.

[3] Michael John McAleer. (2019). What They Did Not Tell You About Algebraic (Non-) Existence, Mathematical (IR-)Regularity, and (Non-) Asymptotic Properties of the Dynamic Conditional Correlation (DCC) Model. Journal of Risk and Financial Management,2019,12, 66; doi:10.3390/jrfm12020066.

[4] Ma, M., Du, J., & Lai, K. K. (2013, November). Modeling volatility of exchange rate of Chinese Yuan against US Dollar based on GARCH models. In 2013 Sixth International Conference on Business Intelligence and Financial Engineering (pp. 295-299). IEEE.

[5] McKinnon, R., & Schnabl, G. (2012). China and Its Dollar Exchange Rate: A Worldwide Stabilizing Influence? 1. The World Economy, 35(6), 667-693.

★★★