Interactive Characteristics of Exchange Rate and RMB Internationalization: Based on VAR Model

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Abstract

Since the reform and opening up, China's international status has been increasing, foreign trade transactions have become more and more frequent, and the economy has achieved significant development. In international settlement, it is becoming more and more common to use RMB as the main settlement currency, and the pace of RMB internationalization is accelerating. Among the many influencing factors, the violent fluctuation of exchange rates is a very important factor affecting the stability and internationalization of a country's currency. 2020 saw the outbreak of the New Crown epidemic, which spread globally and had a violent impact on the status and stability of the world's major currencies. In the two years since the outbreak, the RMB exchange rate has also been characterized by significant movements. This paper constructs a VAR model to empirically analyze the impact of exchange rate movements on the internationalization of the RMB by selecting monthly data on the RMB-USD exchange rate and offshore RMB deposits, spanning the period from January 2010 to October 2021. The empirical results suggest that the exchange rate can influence the internationalization process of RMB by affecting the size of offshore RMB deposits.

Keywords

Exchange Rate; Internationalization of RMB; VAR Model.

1. Research Significance

With the continuous strengthening of China's comprehensive national strength, especially after China put forward the "the belt and road initiative" common prosperity initiative, China's foreign trade volume has been increasing. With China's accession to the SDR basket program, people's position in the world monetary system is becoming more and more important. The process of RMB internationalization is accelerating, which has become an important support for China's international position. With the continuous trade friction between China and the United States, the delay in effective containment after the outbreak of the COVID-19 epidemic, the turmoil in Ukraine and Russia and a series of other reasons, the RMB exchange rate has experienced great fluctuations. A series of actions on the part of the Federal Reserve directly affect the rise and fall of the value of RMB, and the exchange rate fluctuates accordingly. Considering that China has gradually opened its capital account to support the free flow of capital, it is of profound practical significance to study the relationship between exchange rate and RMB internationalization under this background.

2. Analysis on the Mechanism of the Interaction between Exchange Rate and RMB

With the development of economics, many theories have emerged. Marxism and Fisher Equation analyze money as a commodity, and analyze the magnitude of money price from the aspects of labor value and supply and demand. Cambridge School's cash balance theory analyzes the relationship between money demand and price from the point of view that money

has the function of value storage, and points out that people decide their own holdings according to the value of money, thus affecting the demand for money. The Keynesian school considers the demand for money from three motives: liquidity, precaution and speculation, and introduces the influence of interest rate on money into the analysis. These economic theories, especially Keynesian liquidity preference theory, have provided solid evidence in supporting the analysis of currency as a commodity or as an asset with storage value, thus analyzing the relationship between RMB internationalization and exchange rate.

According to the classical economic theory, the price of goods and supply and demand are mutually influenced. When we treat RMB as a valuable commodity, the RMB exchange rate is the price of RMB in the international market. When the price of RMB rises, i.e. the expected rise of RMB exchange rate or the expected appreciation of RMB value, foreign investors and RMB holders will be more inclined to hold RMB, thus increasing the demand and proportion of RMB in the international monetary system. On the contrary, when the RMB is expected to depreciate, investors in the international market will tend to reduce the RMB holdings and thus reduce the risk of loss.

When the demand for RMB increases but the supply of RMB remains unchanged, the price of RMB in the international market, i.e. the exchange rate, will rise due to the imbalance between supply and demand. On the contrary, a decrease in demand for RMB will also cause a decrease in RMB exchange rate. This paper considers the foreign holdings of RMB as the proxy variable, and uses the holdings to express the market's desire to hold RMB. The interaction between exchange rate and RMB internationalization can be analyzed by classical economic principles.

3. Research Status at Home and Abroad

3.1. Research on RMB Measurement

The research on currency internationalization at home and abroad began as early as the end of last century. The International Monetary Fund believes that currency internationalization is a process in which a country's currency can circulate around the world so as to replace the original metal currency, stabilize the international market exchange rate, and can be used as a large amount of foreign exchange held by national authorities. Hartmann [4] further developed Cohen's view [1] that currency internationalization is the extension of the three functions of currency transaction, valuation and storage from domestic to foreign countries. He believed that the extension of the function of international currency should be embodied in the direct or indirect exchange of currency between different countries, and non-residents' choice of the currency as storage currency. Chinese scholars also have some research on currency internationalization. Chen [7] and Liu [10] also believe that currency internationalization is a breakthrough for functions of money's borders. Xu and Liu [13] think that the internationalization of money can be divided into narrow sense and broad sense. In the broad sense, the internationalization of money starts with credit investment, and thus is not limited to a certain function of money. Generally speaking, currency internationalization is the deepening and extension of functions of money. Considering the availability and practicability of the data, this paper follows the explanation accepted by most scholars, believing that RMB internationalization means RMB can circulate in the international market as a currency accepted by most countries to realize functions such as pricing and calculation. The internationalization of RMB is an internationalization of China's sovereign currency.

Referring to the connotation of currency internationalization mentioned above, the value measure and circulation function are the fundamental functions of a currency. To measure the internationalization level of the key functions of a currency can measure the degree of internationalization of the currency to some extent. Bai et al. [5] proposed to measure the degree of currency internationalization through the value measurement function of currency.

However, the measurement of a single functions of money dimension is somewhat biased. At present, many scholars have adopted the method of establishing a comprehensive index system. Zhao [15] subjectively empowered the three major functions of money, Bin et al. [11] objectively empowered the functions of money index, and Peng et al. [12] used the principal component analysis method to analyze the data with national political, cultural and other factors. The dimension and level of scholars' consideration are deepening, trying to better depict the degree of currency internationalization.

3.2. Research on the Interaction between Exchange Rate and RMB Internationalization

At present, there are many researches on the interaction between exchange rate and currency internationalization, but the conclusions reached by scholars are not uniform.

Most scholars think that the fluctuation of exchange rate has a negative impact on the internationalization of currency. Cohen [2] believes that the internationalization of a country's currency cannot be achieved without the supply and demand of the market. A country's authorities should take measures to stabilize the value of the country's currency, thus boosting market confidence and enhancing market demand, in order to promote the process of currency internationalization. The fluctuation of exchange rate will obviously reduce the stability of a country's currency, which is not conducive to the process of currency internationalization. In spite of this, scholars generally believe that currency appreciation has a positive role in promoting currency internationalization. Yu and Wang [14] empirically analyze the impact of RMB's external value on RMB's internationalization. The results show that RMB's appreciation is beneficial to RMB's internationalization.

The research results on the impact of currency internationalization on the exchange rate level can be roughly divided into three categories. One group believes that currency internationalization will promote the appreciation of the country's currency and increase the risk of exchange rate fluctuations. Frankel [3] argues that the internationalization of a country's currency is conducive to increasing the willingness of international investors to hold it, thus promoting the appreciation of the issuing country's currency, which in turn generates more demand when the currency appreciates, thus increasing the channels for currency entry and exit and increasing the magnitude of exchange rate volatility. One group believes that the impact of currency internationalization on exchange rate fluctuations is uncertain. Bai and Deng [6] believe that there is a threshold for the impact of currency internationalization on exchange rate fluctuations. Specifically, when the degree of currency internationalization is high, the exchange rate of the country is hardly affected by this; When a country's currency is not highly internationalized, its exchange rate will be seriously affected. Another group of scholars believe that currency internationalization will reduce the fluctuation range of the country's currency exchange rate. Papaioannou and Portes made a mathematical and physical visual analysis of the exchange rate data of Euro, which showed that before the internationalization of Euro, the fluctuation of the exchange rate of Euro was greater than after the internationalization of Euro, and thus concluded that the currency internationalization would effectively reduce the fluctuation of the currency exchange rate of the country.

According to the above documents, we conclude that the relationship between exchange rate and RMB internationalization is uncertain, and the specific relationship between the two needs further verification.

4. Empirical Analysis

4.1. Research Methods

The process of RMB internationalization is closely related to China's international status and economic development. There may be mutual influence between the two. In order to explore the impact of exchange rate changes on RMB internationalization, based on previous studies, this paper intends to use vector autoregressive model (VAR) to conduct empirical research. Vector autoregressive model (VAR) is more suitable than OLS model because it can take care of the relationship between the variables which are causality and influence each other, and does not need to consider whether the vector is endogenous. In addition, the impulse response analysis of VAR model can more clearly reflect the impact degree and impact effect of the change of one variable on other variables, so it can more intuitively reflect the impact of exchange rate changes on RMB internationalization.

The standard VAR model is constructed as follows:

$$dep_t = a_{10} + \sum_{i=1}^{p} b_{1i} dep_{t-i} + \sum_{i=1}^{p} c_{1i} exr_{t-i} + e_{1t}$$

$$exr_t = a_{20} + \sum_{i=1}^{p} b_{2i} exr_{t-i} + \sum_{i=1}^{p} c_{2i} dep_{t-i} + e_{2t}$$

4.2. Variable Selection and Data Description

In the aspect of variable selection, although some scholars have constructed a relatively complete comprehensive index of RMB internationalization, the index is mostly quarterly or less frequent, and the data set is relatively small. So we still choose to use proxy variables. To some extent, the overseas holdings of RMB is a good proxy variable. Because RMB holdings overseas represent a recognition of RMB function by non-residents. Hong Kong is a special administrative region of our country. It has a different economic system from the mainland. Hong Kong started its relevant business earlier and has accumulated a large amount of valid data, which is relatively easy to obtain. Therefore, we use the balance of deposits of the people of Hong Kong to measure the internationalization level of RMB, which is indicated by (dep) below.

For the selection of influencing factors, we chose the RMB exchange rate under direct quotations, i.e. based on the spot exchange rate of USD against RMB, which is indicated by (exr) below. Monthly average index is selected as a variable to match the data frequency of RMB internationalization proxy variables. Since the outbreak of the epidemic, the fluctuation range of RMB exchange rate has increased significantly. Although the level of RMB internationalization is also affected by other factors besides the exchange rate, such as the free flow of capital, economic development and the world political situation, etc., these factors are not included in the scope of the empirical study for the time being as this paper mainly explores the impact of exchange rate changes including the epidemic period on RMB internationalization.

This paper selects the variables as shown in the table to conduct empirical research. All the AND variables are monthly data. The sample period is from January 2010 to October 2021. A total of 142 groups of samples constitute the data set.

Table 1. Variable selection and description

Variable name	variable symbol	data source	unit
Average exchange rate of USD against RMB	exr	People's Bank of China	-
Size of RMB deposits in Hong Kong	dep	Hong Kong Monetary Authority	million

4.3. VAR Model Construction

4.3.1. Stability Test and Order Determination of Time Series

According to our analysis, the relationship between the fluctuation of exchange rate and the internationalization of RMB may be mutually causal. In order to avoid the pseudo regression and ensure the effectiveness, we conduct the stationarity test before constructing the VAR model. The most common ADF test is used here. The original assumption is that the tested variable sequence has unit root and is non-stationary sequence. If the sequence of variables in the test cannot reject the original hypothesis, a first-order difference test is performed to indicate the order of the integer. This article takes the action of Stata16.

Table 2. ADF test results

variable	ADF test t value	critical value			Number of differences	conclusion
		1%	5%	10%		
dep	-3.169	-3.496	-2.887	-2.577	0	stable
exr	-1.362	-3.496	-2.887	-2.577	0	Not smooth
dexr	-6.988	-3.496	-2.887	-2.577	one	stable

The results in Table 2 show that dep passed the ADF test and is a stationary sequence. The first-order difference of the exr sequence shows that the sequence is stable, so the average exchange rate of RMB against USD is single-order and the scale of RMB deposits in Hong Kong is stable. After further verification, the hysteresis order is determined. According to the simplest SBIC criterion, only one order of hysteresis is required. According to the HQIC criterion, a lag of 2nd order is required. Based on the FPE and AIC, a 6-stage lag is required. According to LR, the delay is as much as 10 orders. According to the simplest SBIC, it may be too concise to only need to lag by 1 order, and it will lose more sample size according to the LR criterion. In this paper, considering the number of samples, the second-order hysteresis is chosen according to the order of the HQIC criterion after the trade-off, and the VAR(2) autoregressive model of dep and dexr is constructed. See Table 3 below for specific inspection results.

Table 3. Test Results of Optimal Lag Order of the Model

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-1522.85				7.60E+07	23.8258	23.8439	23.8704
1	-1271.36	502.99	4	0	1.60E+06	19.9587	20.013	20.0924*
2	-1264.62	13.48	4	0.009	1.50E+06	19.9159	20.0064*	20.1387
3	-1262.14	4.9575	4	0.292	1.60E+06	19.9397	20.0664	20.2516
4	-1261.14	2.0013	4	0.736	1.60E+06	19.9865	20.1495	20.3876
5	-1255.68	10.918	4	0.027	1.60E+06	19.9637	20.1629	20.4539
6	-1246.75	17.855	4	0.001	1.5e+06*	19.8867*	20.1221	20.4661
10	-1234.58	11.663*	4	0.02	1.60E+06	19.9465	20.3267	20.8823

Note: * represents the optimal hysteresis order selected for a criterion.

4.3.2. Model Parameter Estimation and Stationarity Test

(1) Model parameter estimation

Using Stata16 to perform the VAR regression operation results in estimates that can write a standard VAR model as follows:

$$dep_t = 19489.44 + 1.278977 dep_{t-1} - 0.3036158 dep_{t-2} - 110085.1 dexr_{t-1} - 21343.06 dexr_{t-2}$$

$$dexr_t = -0.0200414 + 2.383837dep_{t-1} - 10.7998dep_{t-2} + 0.5009982dexr_{t-1} - 0.0817038dexr_{t-2}$$

In order to ensure the reliability of the model, we use Stata16 to carry out the coefficient joint test. The results show that the coefficients of the whole three equations are highly significant. After raglan maturity test, we also believe that the residual of the model is a white noise process.

(2)VAR stationarity test

Starting from the classical regression analysis model of economics, the variables involved in the regression are required to be stable time series, which requires the expected value of the variables to be zero and the variance to be stable. However, two random walk variables may also have perfect fit, so in order to avoid leading to absurd conclusions, we need to test the stationarity of VAR model. The test results show that the reciprocal of the characteristic roots of the model constructed in this paper are all located in the unit circle, which proves that the VAR(2) model in this paper meets the stability requirements, and the second-order lag period set in this paper is reasonable.

4.3.3. Impulse Response Analysis

Impulse response analysis can more clearly see the degree of response of variables in the model to changes in other variables. Based on this, this paper conducts impulse response analysis on the model to better explain the economic significance of the parameters and clarify the interaction and dynamic characteristics of variables. This paper mainly studies the interaction between exchange rate changes and RMB internationalization, and sets a period of 20 periods. The results are shown in the following figure.
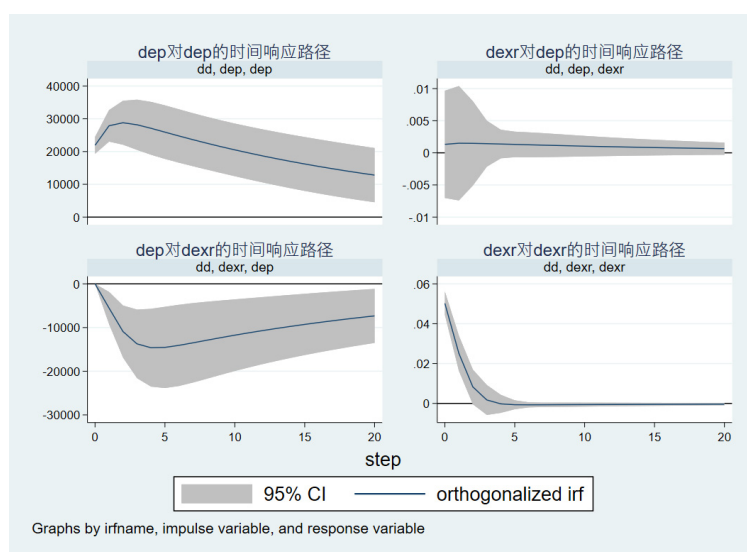

Figure 1. Impulse response analysis diagram

According to the graph shown in fig. 3, the solid line in the graph represents the time path of the response function of a unit pulse shock, and the shaded part is the confidence interval of two standard deviations. The upper left corner of the figure is the path chart of the impact response of the RMB scale dep in Hong Kong to its own impact. We can see that its pulse impact is approximately 21,000 in the first phase, and then increases gradually, reaching a peak around the third phase, and then slowly decreases. This shows that the increase of RMB size in Hong Kong will cause the increase of RMB size in Hong Kong in the following periods, and the elasticity coefficient of growth will increase first and then decrease, but the effect will be positive in the end, indicating that a positive cycle can be generated by increasing RMB size in Hong Kong. In the lower left corner of the figure is the reaction path of the RMB deposit scale

dep in Hong Kong to the impact of the change in exchange rate dexr. The response path is a concave curve, indicating that the positive change in the lower exchange rate of direct quotations will bring a negative impact on the RMB deposit scale in Hong Kong. It can be seen from the figure that the impact in the first phase is zero, then the negative impact increases continuously and reaches a peak in the fourth phase, and then the impact gradually decreases. In this paper, direct quotations is adopted. The larger exchange rate means the devaluation of RMB, which indicates that the devaluation of RMB is not conducive to the expansion of RMB deposits in Hong Kong, that is, a stronger RMB is beneficial to the internationalization of RMB. The relationship embodied here also conforms to our previous Granger causality test.

The upper right corner is the response path of the exchange rate dexr to the impact of the RMB deposit scale dep in Hong Kong. We can see that the impact has only a slight effect at the beginning and then quickly goes to zero. This shows that the RMB deposit size in Hong Kong has no obvious impact on the exchange rate, which is consistent with our previous conclusion. In the lower right corner of the graph is the response path of the exchange rate dexr to its own fluctuations. We can see that the impact impact at the beginning of the period is approximately 0.5, and then the impact becomes smaller and reaches zero in Phase 5. This indicates that the positive change in the exchange rate has a slight supporting effect on the later period of exchange rate increase, and this effect will disappear after the 5th period.

4.3.4. Forecast Variance Decomposition

Impulse response function can distinguish the trend of collaborative change among various variables to a certain extent, and variance decomposition can analyze the structural impact and influence of variable changes on the remaining variables. In order to better analyze the impact of exchange rate dexr on RMB internationalization proxy variable dep, this paper conducts forecast variance decomposition analysis. The results of the analysis are as follows.
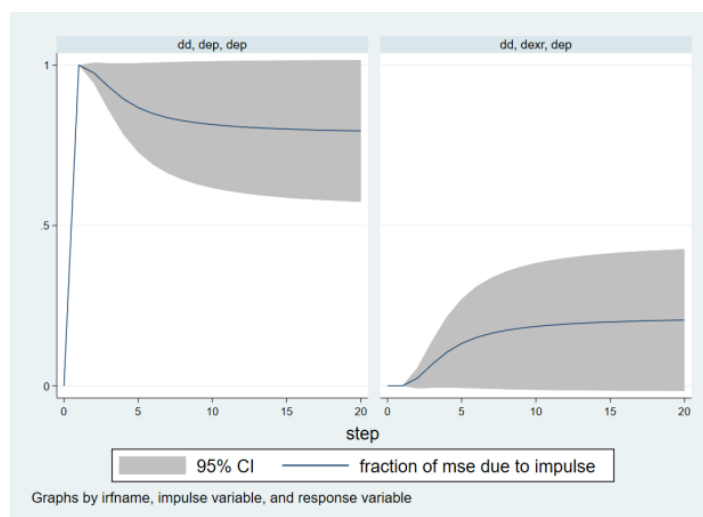

Figure 2. Dep Variance Decomposition Diagram of RMB Deposit Size in Hong Kong

According to Figure 3, we can see that the impact of the initial dep on our own body is obvious, but the impact brought by the impact slowly decreased after Phase 2, and finally stabilized at about 75%, which indicates that the RMB internationalization agent variable dep is sensitive to the impact of its own changes and has a positive impact of 75% in the long run. The right figure shows the impact of the exchange rate change on the dep. As can be seen from the figure, the impact of this impact was 0 at the beginning of the period, then slowly increased and stabilized around the 10th period, finally contributing 20% to dep. This shows that exchange rate changes have indeed had a significant impact on the internationalization of RMB over a long period of time.
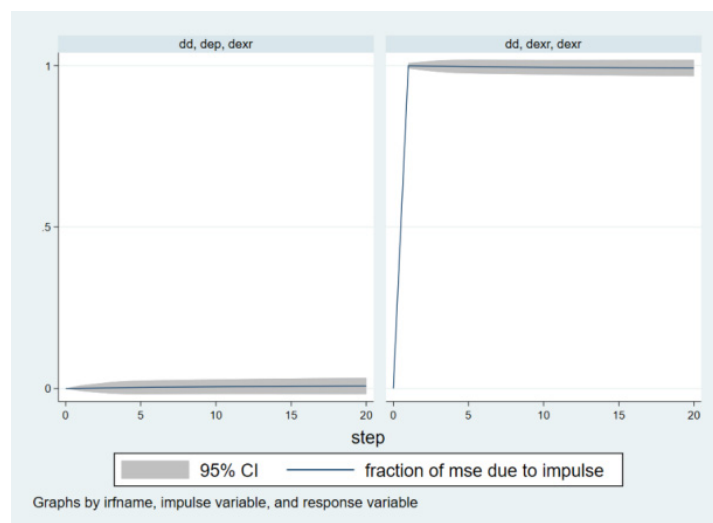
Figure 3. Exchange rate dexr variance decomposition

According to Figure 4, we can see that the exchange rate dexr is hardly affected by the impact of dep. We can conclude that the RMB deposit size in Hong Kong used in this paper has little effect on the impact of exchange rate fluctuations. That is, the efforts made in the implementation of the RMB value storage function cannot well affect the exchange rate. The right figure shows that exchange rate fluctuations are highly sensitive to their own shocks.

The analysis of the above two figures is consistent with the results of our Granger causality test and impulse response test, which shows that we can indeed predict the trend of RMB internationalization through the change of exchange rate, otherwise we cannot achieve good results.

5. Conclusion

This paper uses VAR(2) model to explore the impact of RMB/USD exchange rate change on RMB internationalization under the background of the epidemic. The results show that the change of exchange rate is indeed the cause of RMB deposit size in Hong Kong, but RMB deposit size in Hong Kong is not Granger cause of exchange rate. Based on impulse response and analysis of predicted variance, the above relationship is also confirmed.

According to the above empirical analysis and the summary of relevant literature, we can see that the fluctuation of exchange rate has a certain impact and prediction on the degree of RMB internationalization. The current epidemic situation has not completely subsided, and under the realistic environment of the general trend of strengthening RMB, we should seize the opportunity and vigorously promote the process of RMB internationalization. First, we must maintain steady economic growth. In this year's government work report, GDP grew by 8.1% year-on-year in 2021. GDP grew by an average of 5.1% in the two years affected by the epidemic. The economy still maintained a certain growth rate. Secondly, international cooperation and mutual assistance should be strengthened. Under the background of economic globalization, the economic development of various countries is already closely linked. Geopolitical conflicts and the spread of epidemic diseases are affecting the economic development of the world. At this time, mutual assistance and cooperation are more important. International relations should be handled well to give time and space for national economic development and effectively promote the internationalization of RMB. Finally, to strengthen the country's innovation and development, the international status has greatly affected the RMB internationalization process, and a country's innovation ability has greatly affected a country's

comprehensive national strength. Therefore, we should improve our innovation ability and maintain the stability of RMB value.

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