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Research on Dynamic Relationship Between Interest Rate & Exchange Rate

— Based on the Analysis of Marketization of Interest Rate and Exchange Rate

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Abstract

This paper empirically analyzed the dynamic relationship between interest rate and exchange rate with VAR model and VECM using monthly data from 2008 to 2019. One of the main contributions of this paper is that it concentrated on studying how the marketization of interest rate and exchange rate plays a role in the transmission mechanism between these two rates by dividing the sample into 6 different groups according to the process of the marketization. The results show that there are long-term and short-term equilibrium relationship between interest rate and exchange rate. Also, interest rate could quickly respond to the changes in exchange rate after the marketization, which reflect that the marketization of interest rate is effective in China. However, exchange rate could not effectively respond to changes in interest rate. Thus, the marketization of exchange rate still needs to be improved. In addition, the results show that after marketization, an increase in the interest rate would lead to a decrease in exchange rate now, which could be a reference to the formulation of monetary policies.

Keywords: Marketization; Interest Rate; Exchange Rate; VECM

1 INTRODUCTION

Interest rate and exchange rate have long been two important topics in the finance research field. Prior to 2014, China's interest rate was strictly controlled by the government, which was often criticized by researchers for its negative impacts on China's economic growth and financial risk management. Nowadays, China's interest rate has been basically liberalized after the market-based reform. Besides, the Chinese government is also trying to slowly loose its control on RMB's exchange rate now. It is expected that the market-based reform of interest rate and exchange rate will finally benefit the formulation and implementation of the monetary policy in China.

However, there are still some obstacles that might hinder this conception to come into reality. Firstly, due to some certain shortcomings of the macro environment, the financial system in China is still not efficient enough. Also, compared with the marketization of interest rate, the market-based reform of exchange rate begun relatively late. This time lag between these two reforms might influence the effectiveness of the transmission mechanism between the interest rate and exchange rate in China, which would further erode the effectiveness of some monetary policies. Meanwhile, for China, RMB's exchange rate setting is not the more liberalized the better. Decision on how liberalized it should be to maximize the total utility is also an important issue to discuss.

This paper aims to study the dynamic relationship between interest rate and exchange rate under the background of both China's interest rate and exchange rate reforms. The purpose of this paper is to investigate how the two rates interact with each other and then provide corresponding suggestions according to their transmission mechanism. The methodology includes the typical ADF test, VAR model, cointegration test, VECM, Granger causality test and IRF. Due to this paper innovatively takes China's exchange rate reform into consideration, it will be useful to demonstrate how the marketization of exchange rate and interest rate in China affects the effectiveness of its monetary policies and then the government could adjust its pace of exchange rate reform accordingly to help the interest rate to exchange rate transmission mechanism works more efficiently in China.

2 LITERATURE REVIEW

2.1 Marketization of Interest Rate and Exchange Rate

Many literatures from China studies the marketization process of interest rate and exchange rate, focusing on the impacts brought by it. Ju & Yin (2005) [1] used the Dornbusch model and interest rate parity theory to study the correlation between interest rate and exchange rate. After many times of adjustments, they found that the transmission mechanism was interest rate, domestic economy and finally exchange rate. In another word, they believed interest rate effected exchange rate by affecting domestic economy. The paper also pointed out that the continuous improvement of the exchange rate system has created good conditions for the marketization of the interest rate. Shi (2012) [2], Wang (2013) [3] explored the significance of China's marketization of interest rate and the challenges and opportunities encountered in the process. Wang (2014) [4], Zhao (2015) [5], Ding, Yan & Ding (2018) [6] explored the pace and necessity of the market-oriented reform of RMB's exchange rate in China. Combined with the background of the times, they also provided many suggestions for the liberalization of exchange rate. Chen et. al (2017) [7] pointed out that the transmission of interest rates to exchange rates was relatively limited. In the process of mutual transmissions between interest rates, exchange rates, and capital flows, the interest rate channel was the most unsmooth one. Therefore, they believed the reform of our financial market should follow the process of interest rate marketization, exchange rate reform and capital account opening.

2.2 Dynamic Relationship Between Interest Rate and RMB's Exchange Rate

He & Liu (2005) [8] used the time series from 1979 to 2002 as a sample interval and used the Granger test to study the dynamic relationship between the nominal RMB exchange rate and the nominal interest rate. The results showed that the relation between the two variables is weak and in an irregular state, which to a certain extent explained why monetary transmission mechanism was unsmooth in China. Zhao (2007) [9] used the vector autoregression model (VAR) to test the dynamic relationship between the RMB exchange rate and interest rates. The results showed that there was no price spillover effect between the exchange rate of RMB against the US dollar and interest rates, while there were two-way price spillover effects between the exchange rate of RMB against Euro and between the exchange rate of RMB against Japanese yen and interest rates. Guo (2009) [10] & Lian (2014) [11] have tested the relation between the Sino-US interest rate spread and the RMB-US dollar exchange rate. The former used a linear relationship test, and the latter used a two-zone threshold cointegration test. The results showed that there was indeed a long-term cointegration relationship between these two variables, but the relation in the short term is not significant. In addition, Lian (2014) [11] found that there was a non-linear threshold cointegration relationship between the RMB-US dollar exchange rate and the interest rate spread, and in comparison, the exchange rate was more affected by the interest rate spread. Li (2014) [12] concluded that compared with fixed exchange rate system, the relation between interest rate and exchange rate had indeed been strengthened under the managed floating exchange rate system, but it was still not significant enough if we viewed from an overall perspective. Therefore, she suggested that it was still necessary to continue the marketization of interest rate and exchange rate in China to strengthen the coordination and coherence of domestic policies with other countries. Zhang & Feng (2015) [13] applied the smooth transition regression model to study the relations between interest rate and exchange rate under the framework of interest rate parity. They found that the correlation between interest rate and exchange rate was non-linear and asymmetry.

2.3 Marketization & the Dynamic Relationship Between the Two Rates

In addition, there are also some literatures check the dynamic relationship between interest rate and RMB's exchange rate under the specific background of marketization of interest rate and exchange rate.

Based on the interest rate parity model, Zhou (2011) [14] analyzed the transmission effect of China's interest rate and exchange rate under the background of exchange rate marketization. The results showed that an effective transmission mechanism between interest rates and exchange rates had still not been developed yet. Zhu, Wu & Zhou (2011) [15] took the marketization of exchange rate in 2005 and 2010 as two time nodes to established VAR models respectively and studied the effects brought by exchange rate marketization to interest rate and their dynamic relationship. They found that after the exchange rate reform, a certain dynamic relation between the exchange rate

and interest rate did exist, but according to the coefficient, the relation was quite weak. Also, after the reform, a one-way Granger causality from interest rates to exchange rates began to appear. Jiang (2008) [16] did the similar research and found that after marketization of the exchange rate, the dynamic relation between interest rate and exchange rate changed from positive to negative. Chen & Gao (2012) [17] chose the time series before and after the financial crisis in 2008 as two sample intervals to study the volatility information spillover effect between the interest rate and exchange rate. They concluded that before the outbreak of the financial crisis, there was a one-way volatility spillover effect of exchange rate on interest rate. After the financial crisis, two-way effects began to appear. Zhao et al. (2013) [18] focused on the time orders of the marketizations of interest rate and exchange rate. Using a non-linear granger test, they concluded that the exchange rate reform had a significant effect on the dynamic relationship between the two rates, while the interest rate reform had an insignificant effect, and thus pointed out that the pace of exchange rate marketization should be accelerated. Guo (2019) [19] pointed out that under the condition of completely closed capital account, the foreign exchange transmission between the offshore and onshore markets will guide each other and affect each other. With the advancement of the exchange rate marketization process, RMB's exchange rate would rely more on interest rate spread and ended up in regular volatility. The two-way dynamic relation between exchange rate and interest rate would be further highlighted.

2.4 International Evidences

There are quite a large number of foreign literatures that concentrate on studying the relationship between interest rate and exchange rate in other countries, but many of them are out of time and have different research results. Firstly, research on the relationships between these two economic variables can be dated back to the study of the interest rate parity condition. (e.g., Aliber, 1973 [20]; Cumby & Obstfeld, 1981 [21],1984 [22]; Frankel & Levich, 1975 [23]; Frankel & MacArthur, 1988 [24]; Mishkin, 1984 [25]; Ngama, 1994 [26]). The extant literature, however, mainly focuses on the long-run equilibrium relationships between interest rates and exchange rates. The short-run relationships between these two markets are often ignored. Recently, So (2001) [27] studied the dynamic relationships between interest rate and exchange value of the US dollar via a multivariate EGARCH model. He found that in terms of price changes, movements of interest rates had positive effects on movements of exchange rates. However, he also found that changes in exchange rates did not explain changes in interest rates. In terms of volatility spillovers, his research results suggested that there existed volatility spillovers between the two markets and these two markets have short-term dynamic interactions, but the relationships between these two economic variables are not necessarily linear. In contrast to his findings, Baig & Goldfajn (2002) [28] evaluated monetary policy and its relationship with the exchange rate in the five Asian crisis countries and found that there was no evidence that high interest rates led to weaker exchange rates, indicating interest rate change in Asia could not significantly influence the exchange rate. In addition, Patra (2004) [29] employed both Engle-Granger and Johansen tests for presence of cointegration between exchange rate and interest rate for India and US. However, the empirical results could not support the presence of above relationship and they found the results were robust for different measures of real interest rate differentials. Jackman, Craigwell & Doyle-Lowe (2013) [30] used an EGARCH-M model to investigate non-linearities in the reaction of daily foreign exchange activity to the interest rate differential between the U.S. and Barbados, which is a small open economy which has been pegged to the US dollar for over 35 years. The results suggested that changes in the interest differential had a significant and non-linear effect on the Barbadian foreign exchange market. The linear spread term is positive, and so was in line with a theory of uncovered interest parity for an economy with a fixed exchange rate.

3 THEORETICAL FRAMEWORK

3.1 China's Marketization of Interest Rates

The marketization of interest rates means that interest rates are no longer under the strict control of the government. Instead, it will be spontaneously determined by the demand and supply in the money market. Once the marketization of interest rates is fully realized, no entity can become a unilateral decider of the interest rates. The relationship between the supply and demand of funds and the general environment of the financial market will spontaneously adjust the interest rate level. Consequently, banks will gradually lose their advantages in deposit and loan interest

rate margin, and enterprises will no longer be able to enjoy the protection brought by the comparatively lower financing costs. Thus, under the marketization of interest rate, central bank would only be able to set the benchmark interest rate and the market would finally determine the level of interest rate.

In January 2007, the Shanghai Interbank Offered Rate (Shibor) began its official operation. In 2008, the outbreak of the global financial crisis and the European debt crisis made China's interest rate marketization halt. In June 2012, the central bank announced that it would expand the upper floating limit of the deposit interest rate to 1.1 times of the benchmark interest rate, and the lower floating limit of the loan interest rate was adjusted to 0.8 times of the benchmark, which was the first interest rate cut in recent years. On July 5, the lower limit was adjusted to 0.7 times of the benchmark interest rate. In July 2013, the lower limit of the loan interest rate was lowered again. On November 12, 2014, the floating range of China's deposit interest expanded to 1.2 times of the benchmark interest rate and the benchmark interest rate was reduced. From April 10 and May 11, 2015, the floating range was extended to 1.5 times of the benchmark interest rate for successive two times. In addition to expanding the floating range, the government in China adopted many other ways to marketize the interest rate. For example, in October 2015, the ceiling on deposit interest rates for commercial banks and other financial institutions was cancelled by the central bank. Till then, China's interest rate control has basically been liberalized. In May 2018, the central bank issued the first quarter report on the implementation of monetary policy, in which it pointed out that it was necessary and important for the interest rate system to accelerate its change from dual-scheme to one-scheme.

3.2 China's Marketization of Exchange Rates

The nature of the exchange rate is the relative prices of the products of the two countries, which can reflect the changes in these two countries' economic fundamentals. The marketization of the RMB exchange rate means that the determinants of RMB's exchange rate has changed from a fixed exchange rate regime to a floating exchange rate regime. In another word, RMB's exchange rate will be determined by the demand and supply in the international currency market, rather than by the government.

In 2005, China began to implement a managed floating exchange rate system based on a basket of currencies together with market supply and demand. Since then, RMB's exchange rate has stopped following the US dollar solely and began to use USD as only one of the key currencies. In July 2008, in response to the financial crisis, the exchange rate marketization process was temporarily stopped, and China began to focus on the US dollar again. After the financial crisis, the currencies of many countries have depreciated sharply, while the RMB exchange rate has remained basically stable. In June 2010, with the recovery of the global economy, China stated that it would further promote the reform of the market oriented RMB exchange rate and increase the flexibility of the RMB exchange rate. On August 11, 2015, the central bank announced that the central parity rate of RMB to US dollar was significantly adjusted. At that time, there was an obvious sign of RMB depreciation, with the exchange rate increasing for more than 4%. As a result, the exchange rate of RMB to US dollar began to be weaken and the exchange rate level gradually increased. In May 2017, in order to hedge the pro-cyclical mood of the RMB depreciation, China added a counter-cyclical factor to the RMB-USD exchange rate quotation model to adjust the exchange rate. Many quotation banks for the RMB exchange rate responded to this exchange rate policy and actively adjusted the counter-cyclical coefficient. The introduction of the counter-cyclical factor can effectively alleviate the pro-cyclical behaviors of the market and stabilize market expectations. In January 2018, as the foreign economies stabilized, China's foreign exchange supply and demand conditions and cross-border capital flows stabilized too. Also, at that time depreciation expectations on RMB had been fully released. Therefore, in order to increase the flexibility of two-way exchange rate fluctuations, many quotation banks of the RMB central parity adjusted the counter-cyclical factor to neutral after judging the economic fundamentals and market conditions, which meant the counter-cyclical factor was gradually eliminated in the system.

3.3 The Transmission Mechanism between Interest Rates and Exchange Rates

1) From Interest Rate to Exchange Rate

The impact of interest rates on the exchange rate can be analyzed from the current account and the capital account.

Changes in interest rates affect corporate costs and then exports, causing changes in balance of payments and ultimately exchange rate changes. Rising interest rates will increase the financing costs of domestic enterprises and reduce the competitiveness of export commodities, which will cause or intensify the deficit in the balance of payments, putting pressure on the devaluation of the local currency or directly leading to the devaluation of the local currency. Changes in interest rates will affect the inflow or outflow of arbitrage capitals, resulting in changes in the demand for domestic and foreign currencies, which will finally cause the domestic currency to depreciate or to appreciate. Rising interest rates will trigger arbitrages and a large inflow of international capital. Also, demand for local currencies will rise. Thus, it will increase the balance of payments surplus, further bringing pressure on the appreciation of the local currency or directly leading to the appreciation of the local currency.

2) From Exchange Rate to Interest Rate

The impact of exchange rates on interest rates is still analyzed from both the current and capital accounts. Exchange rate changes will affect the price level of imported and exported goods, change China's balance of payments, and eventually cause changes in interest rates. Devaluation of the local currency will cause the relative price of exported goods to fall and the relative price of imported goods to rise. As a result, the volumes of imports and exports will change, and the balance of payments will have a surplus. Thus, the foreign exchange reserves will increase, followed by another increase in domestic currency investment, leading to an increase in money supply and a decline in interest rate. Changes in the exchange rate will cause investors to have expectations of the future exchange rate, and different expectations will cause different arbitrage capital trends, and eventually cause changes in interest rates. For example, when the RMB depreciates, if most of investors believes that the RMB exchange rate will decline further in the future, then a large amount of capital will flow out and the demand for RMB will fall. In order to prevent excessive depreciation of the currency, the central bank will use open market operations to reduce the money supply, which will lead to rising interest rates. But if most of the investors assume that the RMB will rebound in the future, then it will cause a large inflow of arbitrage capitals. Similarly, to avoid excessive appreciation, the central bank will increase the money supply, which may cause interest rates to fall.

3.4 How Marketization Influences the Transmission Mechanism

1) Marketization of Interest Rate

What we talk about above is the one-way transmission mechanism of interest rate to exchange rate and vice versa, which seems simple and straight forward. However, when combining the processes together, the two-way transmission mechanism between interest rate and exchange rate could become quite complex. The interactions between these two rates will form a two-way, circulated, and dynamic feedback system. Generally, more liberalized the system is, more effective and smooth the transmission mechanism will be, and the linkage effect between these two rates will be more significant. We will analyze their dynamic relationships between them before and after the interest rate marketization respectively to better explain.

Before marketization, the nominal interest rate was tightly controlled by the government. Central bank’s substantial increase in the money supply will lead to an expectation in inflation and a rise in price level. However, the nominal interest rate will remain unchanged due to regulation. Thus, according to Fisher's equation, the actual interest rate will decrease, RMB will depreciate, and the price level will rise in accordance with the rise in the price of imported goods. Hence, the monetary authorities will raise the benchmark interest rate, by which the severe inflation might also be solved.

The transmission mechanism is totally different after marketization. When the interest rate is highly liberalized, if the central bank increases the money supply, each market entity will respond immediately and sensitively. The money supply exceeds the demand, which eventually causes the interest rate to fall. As the interest rate drops, the demand for local currency and its assets will decrease and the demand for foreign currency and its assets will increase, resulting in an increase in the exchange rate, which also means a depreciation in local currency. Consequently, capital outflow will increase, and the money supply will decrease. Then the demand for funds will exceed supply, leading to an increase in interest rate.

2) Marketization of Exchange Rate

Under fixed exchange rate regime, when the domestic market interest rate is higher than the international market interest rate, it will trigger international arbitrage, a large amount of capital will flow in, which will bring pressure on the appreciation of the local currency or directly result in the appreciation of the local currency. In order to stabilize the local currency, the central bank will conduct open market operations in the foreign exchange market by selling local currency and purchasing foreign currency, which may cause the domestic economy to overheat. In the process mentioned above, the central bank uses sterilization to stabilize the exchange rate, which reflects the fact that it could not use flexible monetary policies to adjust the aggregate domestic demand. If the domestic market interest rate is lower than the international market interest rate, capital will flow out, the domestic currency will face pressure for depreciation. In order to maintain exchange rate stable, the central bank will increase interest rate to prevent capital outflows. The rise in interest rate will further affect investment and output. Thus, the external shock to the currency will directly affect the domestic economy.

Under the floating exchange rate system, the central bank could flexibly choose monetary policy tools to regulate the domestic economy. A decline in domestic interest rate will lead to a large outflow of arbitrage capital, resulting in a depreciation of the local currency. Thus, the volume of imports and exports will also be influenced. Specifically, the exports will increase, and the imports will decrease, by which the domestic exporting enterprises will be benefited. Therefore, the investment and output for domestic economy will increase. With the development of the domestic market, domestic interest rate will rise, preventing capital outflows and becoming attractive to foreign capital. Under the floating exchange rate system, short-term factors such as market expectations will play an increasingly important role. Compared with the fixed exchange rate system, monetary policy under the floating exchange rate system is more autonomous. However, the floating exchange rate system also brings more exchange risk and hedging costs, which could be a challenge to the government's macro-control capabilities. Thus, it is more suitable for countries with strong economies.

4 DATA AND METHODOLOGY

4.1 Research Hypotheses

According to previous literatures and theoretical analysis above, we could find that although different literatures hold different views upon how exactly interest rate and exchange rate interact with each other, almost all the literatures admit that there are long-term equilibrium relationships between these two rates. Therefore, we believe there should also be an equilibrium relationship between China's interest rate and exchange rate. However, due to the China's interest rate and exchange rate are less liberalized compared with many other countries, we assume that the linkage between these two rates might be weak. Meanwhile, considering China's marketization of interest rate and exchange rate recently, we believe the transmission mechanism between these two rates would be more effective and efficient, and interest rate would have more effects on exchange rate.

Therefore, three research hypotheses are raised:

1. There are long-term and short-term equilibrium relationships between interest rate and the RMB exchange rate in China.
2. This equilibrium relationship is relatively weak.
3. The marketization of interest rate and exchange rate will improve the transmission mechanism between these two rates, and the exchange rate would be more connected to the interest rate.

4.2 Variable Selection and Data Sources

There are two variables in this paper, interest rate (I) and exchange rate (E).

Firstly, this paper chooses 7-day Shanghai Interbank Offered Rate (Shibor) to represent the interest rate (I). The data is monthly and is obtained on the last trading day of the month. The interest rate will be represented as R in the following paper. As for exchange rate (E), this paper chooses the central parity of RMB-USD to represent. The data

is also monthly and is obtained on the last trading day of the month. The exchange rate will be represented as E in the following paper.

According to the process of interest rate marketization, this paper divides the time interval into three horizons: (a) July 2008 to June 2012, (b) July 2012 to November 2014, and (c) May 2015 to December 2019. Here are the reasons: firstly, in 2008, the financial crisis caused a stagnation in China's marketization of interest rate, thus it would be reasonable to choose it as the start of the sample time. Secondly, the floating interval for deposit and loan rates were frequently adjusted and expanded in July 2012 and November 2014 to May 2015, which were huge progresses in the process of interest rate marketization. Therefore, dividing the sample time into these three horizons will be appropriate for the research purpose of checking the influences brought by the marketization of interest rate. Similarly, according to the processes of the marketization of exchange rate, the sample time is also divided into three horizons: (a) July 2008 to June 2010, (b) July 2010 to August 2015, (c) September 2015 to December 2019.

4.3 Methodology

This paper uses a VAR model to study the dynamic relationship between the RMB exchange rate and interest rates. This model represents the endogenous variables in each system as a function of the hysteresis value of all endogenous variables. The sample is used to determine the parameters of the multivariable VAR system, according to which the correlation between variables would be obtained.

The specific steps are firstly taking the logarithm of the variables, followed by applying ADF unit root test to check whether they are stationary, building the VAR model, performing Johansen cointegration test after finding out the best lag term to check whether the variables have long-term cointegration relationship and finally building the VECM model. After these steps, this paper performs Granger causality test and generates impulse response function (IRF) to analyze the impacts brought by changes or shocks of each endogenous variable to itself and the other endogenous variable.

The VAR model with lag p:

$$Y_t = c + \sum_{i=1}^{p} \prod_i Y_{t-i} + \varepsilon_t \tag{1}$$

In which, $Y_t = (\ln I_t, \ln E_t)^T$, $c = (c_1, c_2)^T$, $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})^T$ and is white noise.

From the equation above, we could get:

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \prod Y_{t-1} + \theta_t \tag{2}$$

In which, $\Gamma_i = -\sum_{j=i+1}^{p} \Pi_i$, $\Pi = \sum_{i=1}^{p} \Pi_i - 1$, if ΔY_t and ΔY_{t-1} are stationary and variables in Y_t have a cointegration relationship, then the VECM model:

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \beta ECM_{t-1} + \theta_t \tag{3}$$

In which ECM is decided by the long-term equilibrium relationship between $\ln I$ and $\ln E$.

5 EMPIRICAL RESULTS AND DISCUSSIONS

5.1 ADF Test

Before building the model, we perform the ADF test to make sure all the variables in the model are stationary. We use the logarithm of the variables to test. We did the ADF tests for the time series under different time horizons that is divided by the process of interest rate marketization and exchange rate marketization respectively.

1) Interest Rate Marketization: ADF tests

The results are showed in table 5.1 to table 5.3.

TABLE 5.1 INTEREST RATE MARKETIZATION: 2008.07 - 2012.06 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results

$\ln E$	-1.2363	(C,0,3)	-3.5885	-2.9297	-2.6030	Not Stationary
$\Delta \ln E$	-1.4558	(C,0,2)	-3.5885	-2.9297	-2.6030	Not Stationary
$\Delta\Delta \ln E$	-10.4255	(C,0,1)	-3.5885	-2.9297	-2.6030	Stationary
$\ln I$	-3.4404	(C,T,1)	-4.1657	-3.5085	-3.1842	Not Stationary
$\Delta \ln I$	-5.8676	(C,T,1)	-4.1657	-3.5085	-3.1842	Stationary

TABLE 5.2 INTEREST RATE MARKETIZATION: 2012.07 - 2014.11 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results
$\ln E$	-3.1677	(C,0,1)	-3.6891	-2.9718	-2.6251	Not Stationary
$\Delta \ln E$	-5.9174	(C,0,1)	-3.7114	-2.9810	-2.6299	Stationary
$\ln I$	-2.3609	(C,0,1)	-3.6998	-2.9762	-2.6274	Not Stationary
$\Delta \ln I$	-3.5226	(C,0,1)	-3.7114	-2.9810	-2.6299	Stationary

TABLE 5.3 INTEREST RATE MARKETIZATION: 2015.05 – 2019.12 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results
$\ln E$	-1.2363	(C,0,3)	-3.5885	-2.9297	-2.6030	Not Stationary
$\Delta \ln E$	-1.4558	(C,0,2)	-3.5885	-2.9297	-2.6030	Stationary
$\ln I$	-3.4404	(C,T,1)	-4.1657	-3.5085	-3.1842	Stationary

From the tables above, we could conclude that before June 2012, the exchange rate is integrated of order 2, and the interest rate is integrated of order 1. After the first interest rate reform, during July 2012 to November 2014, the exchange rate and interest rate are both integrated of order 1. During May 2015 to December 2019, the exchange rate is integrated of order 1 and the interest rate is stationary.

2) Exchange Rate Marketization: ADF tests

The results are showed in table 5.4 to table 5.6.

TABLE 5.4 EXCHANGE RATE MARKETIZATION: 2008.07 – 2010.06 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results
$\ln E$	-4.2633	(C,T,1)	-4.5715	-3.6908	-3.2869	Stationary
$\ln I$	-1.6350	(0,0,0)	-2.6742	-1.9572	-1.6081	Not Stationary
$\Delta \ln I$	-3.8527	(0,0,1)	-2.6797	-1.9580	-1.6078	Stationary

TABLE 5.5 EXCHANGE RATE MARKETIZATION: 2010.07 – 2015.07 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results
$\ln E$	-3.1188	(C,0,1)	-3.5440	-2.9108	-2.5930	Stationary
$\ln I$	-4.5029	(C,0,1)	-3.5420	-2.9100	-2.5926	Stationary

TABLE 5.6 EXCHANGE RATE MARKETIZATION: 2015.08 – 2019.12 - ADF

Variable	ADF	(C, T, L)	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Results
$\ln E$	-3.1677	(C,0,1)	-3.6891	-2.9718	-2.6251	Not Stationary
$\Delta \ln E$	-5.9174	(C,0,1)	-3.7114	-2.9810	-2.6299	Stationary
$\ln I$	-2.3609	(C,0,1)	-3.6998	-2.9762	-2.6274	Not Stationary
$\Delta \ln I$	-3.5226	(C,0,1)	-3.7114	-2.9810	-2.6299	Stationary

From the tables above, we could conclude that before the exchange rate reform in 2010, the exchange rate is stationary, and the interest rate is integrated of order 1. After the reform, during July 2010 to July 2015, both the interest rate and exchange rate are stationary. During August 2015 to December 2019, both the interest rate and exchange rate are integrated of order 1. Thus, we could build the VAR model based on the data.

5.2 VAR Model

1) Interest Rate Marketization: VAR model

The results of the VAR models under the marketization of interest rate are showed in table 5.7.

TABLE 5.7 INTEREST RATE MARKETIZATION: VAR

	ln *E*	**ln *I***	**ln *E***	**ln *I***	**ln *E***	**ln *I***
	2008.07 - 2012.06		2012.07 - 2014.11		2015.05 - 2019.12	
$\ln E\,(-1)$	1.143723	-15.51242	1.471909	-45.56918	1.334896	0.018487
	(-0.16151)	(-18.2074)	(-0.16955)	(-13.3124)	(-0.14359)	(-0.40216)
$\ln E\,(-2)$	-0.04509	-64.86461	-0.534645	41.5889	-0.457604	0.380172
	(-0.23724)	(-26.7437)	(-0.16214)	(-12.7305)	(-0.14052)	(-0.39359)
$\ln E\,(-3)$	-0.123179	75.63334				
	(-0.15758)	(-17.7636)				
$\ln I\,(-1)$	-0.002871	0.628538	0.002668	0.226217	-0.019142	0.764447
	(-0.00121)	(-0.13598)	(-0.00238)	(-0.18711)	(-0.03362)	(-0.09416)
$\ln I\,(-2)$	-0.000663	-0.104012	-0.000686	0.021436	0.0155	0.127282
	(-0.0016)	(-0.18044)	(-0.00242)	(-0.1903)	(-0.02903)	(-0.0813)
$\ln I\,(-3)$	0.001106	-0.098555				
	(-0.00129)	(-0.14495)				
c	0.047495	9.353276	0.111137	8.24496	0.236472	-0.645944
	(-0.03843)	(-4.33235)	(-0.07162)	(-5.62311)	(-0.08482)	(-0.23756)
Akaike AIC	-9.030292	0.419711	-9.431225	-0.704602	-6.218777	-4.158918
Schwarz SC	-8.749255	0.700747	-9.191256	-0.464632	-6.018037	-3.958178

From the tables above, we could find that no matter it is before or after the marketization of interest rate in 2012, the coefficient between exchange rate and lagged interest rate are all small, indicating that interest rate could not influence exchange rate significantly. Also, before the reduction of interest rate in 2012, the optimal lag between interest rate and lagged exchange rate is 3 with the coefficient of 75.633, indicating that the current changes in exchange rate will be reflected in interest rate in three months. After the reform in 2012, the optimal lag between interest rate and lagged exchange rate becomes 2, indicating the changes in exchange rate will be reflected in interest rate in a shorter time, which is a good sign resulting from the marketization. Also, the coefficient between the interest rate and the first order lagged exchange rate has increased, and the coefficient between the interest rate and the second order lagged exchange rate has decreased, indicating with the marketization, the exchange rate could have more influences on interest rate. Comparing the results before and after the reform in 2014, we could find that with that marketization process, the influences from interest rate to exchange rate have been strengthened while the relationship from interest rate to exchange rate has been weakened.

2) Exchange Rate Marketization: VAR model

The results of the VAR models under the marketization of exchange rate are showed in table 5.8.

TABLE 5.8 EXCHANGE RATE MARKETIZATION: VAR

	ln *E*	**ln *I***	**ln *E***	**ln *I***	**ln *E***	**ln *I***
	2008.07 - 2010.06		2010.07 - 2015.07		2015.08 - 2019.12	

$\ln E\,(-1)$	0.102364	58.53999	1.239495	-3.065996	1.440977	-0.14476
	(-0.17551)	(-72.0389)	(-0.1254)	(-12.7174)	(-0.14267)	(-0.42622)
$\ln E\,(-2)$	0.207453	-84.81585	-0.476051	-43.6704	-0.571631	0.563546
	(-0.16569)	(-68.0107)	(-0.19286)	(-19.5589)	(-0.14508)	(-0.43342)
$\ln E\,(-3)$			0.181625	44.9511		
			(-0.1206)	(-12.2312)		
$\ln I\,(-1)$	-0.001029	0.97347	-0.000402	0.445357	0.05141	0.632478
	(-0.00069)	(-0.28331)	(-0.00123)	(-0.12516)	(-0.05418)	(-0.16186)
$\ln I\,(-2)$	0.000783	-0.223916	-0.000145	-0.089418	-0.052956	0.255705
	(-0.00063)	(-0.25709)	(-0.00131)	(-0.13276)	(-0.05107)	(-0.15256)
$\ln I\,(-3)$			0.000149	-0.043772		
			(-0.00124)	(-0.12551)		
c	1.326113	50.60243	0.100013	4.121135	0.249116	-0.679998
	(-0.36169)	(-148.457)	(-0.0249)	(-2.52524)	(-0.0978)	(-0.29218)
Akaike AIC	-11.74108	0.293477	-9.150675	0.087781	-6.321963	-4.133182
Schwarz SC	-11.49239	0.542173	-8.904187	0.334269	-6.115098	-3.926317

From the tables above, we could find that no matter it is before or after the marketization of exchange rate in 2010, the coefficient between exchange rate and lagged interest rate are all small, indicating that the dynamic relationship from interest rate to exchange rate is still very weak. Also, before the reform in 2010, the coefficients between interest rate and lagged-1 and lagged-2 exchange rate are 58.54 and -84.816 respectively. After the reform, the coefficients see a decline but are still significant, indicating the influences from exchange rate to interest rate are weakened after the reform. Comparing the results before and after the reform of exchange rate in 2015, it could be concluded that the influences from interest rate to exchange rate is strengthened but the influences from exchange rate to interest rate is significantly weakened.

5.3 Johansen Test

1) Interest Rate Marketization: Johansen Test

The results of the Johansen test under the marketization of interest rate are showed in table 5.9 to 5.11.

TABLE 5.9 INTEREST RATE MARKETIZATION: 2008.07 - 2012.06 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ-max	5% Critical Value
$r = 0^*$	0.315745	17.67186	15.49471	17.4535	14.2646
$r \leq 1$	0.004736	0.218364	3.841466	0.218364	3.841466

TABLE 5.10 INTEREST RATE MARKETIZATION: 2012.07 - 2014.11 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ -max	5% Critical Value
$r = 0^*$	0.378818	17.90513	15.49471	15.85554	14.2646
$r \leq 1^*$	0.170574	5.049591	3.841466	5.049591	3.841466

TABLE 5.11 INTEREST RATE MARKETIZATION: 2015.05 - 2019.12 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ -max	5% Critical Value
$r = 0^*$	0.251426	16.18756	15.49471	15.33131	14.2646
$r \leq 1$	0.067736	3.156246	3.841466	3.156246	3.841466

According to the Johansen test's results in the tables above, we could conclude that before the reform in 2012, there is at most 1 cointegration equation between interest rate and exchange rate. During July 2012 to November 2014, the

null hypotheses are both rejected, so there are at least 2 cointegration equations between the two rates, which means there is a long-term cointegration relationship. During May 2015 to December 2019, the floating interval of the interest rate were adjusted and expanded for many times. According to the test results, there is at most 1 cointegration equation between interest rate and exchange rate, indicating there is still a long-term cointegration relationship.

2) Exchange Rate Marketization: Johansen Test

The results of the Johansen test under the marketization of exchange rate are showed in table 5.12 to 5.14.

TABLE 5.12 EXCHANGE RATE MARKETIZATION: 2008.07 - 2010.06 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ-max	5% Critical Value
$r = 0^*$	0.625165	22.77879	15.49471	20.60665	14.2646
$r \leq 1$	0.098265	2.172137	3.841466	2.172137	3.841466

TABLE 5.13 EXCHANGE RATE MARKETIZATION: 2010.07 - 2015.07 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ-max	5% Critical Value
$r = 0^*$	0.303159	37.10708	15.49471	21.31066	14.2646
$r \leq 1^*$	0.23489	15.79641	3.841466	15.79641	3.841466

TABLE 5.14 EXCHANGE RATE MARKETIZATION: 2015.08 - 2019.12 - JOHANSEN TEST

Hypothesized No. of CE(s)	Eigenvalue	Trace Statictic	5% Critical Value	λ-max	5% Critical Value
$r = 0^*$	0.251639	17.32385	15.49471	17.59479	14.2646
$r \leq 1^*$	0.133442	5.729051	3.841466	5.729051	3.841466

According to the Johansen test's results in the tables above, we could conclude that before the reform in 2010, there is at most 1 cointegration equation between interest rate and exchange rate. After the reform in 2010, the null hypotheses are both rejected, so there are at least 2 cointegration equations between the two rates, which means there is a long-term cointegration relationship. During August 2015 to December 2019, according to the test results, there is at most 2 cointegration equation between interest rate and exchange rate, indicating there is still a long-term cointegration relationship.

5.4 VECM

After Johansen test, we build the VECM under different time horizons to check the short-term relationship between interest rate and exchange rate. Results are showed in tables below.

1) Interest Rate Marketization: VECM

The results of the VECM models under the marketization of interest rate are showed in table 5.15.

TABLE 5.15 INTEREST RATE MARKETIZATION: VECM

Error Correction	$D(\ln E)$	$D(\ln I)$	$D(\ln E)$	$D(\ln I)$	$D(\ln E)$	$D(\ln I)$
	2008.07 - 2012.06		2012.07 - 2014.11		2015.05 - 2019.12	
CointEq1	-0.020158	-4.982418	-0.100381	-2.457474	-0.138222	0.481432
	(-0.01025)	(-1.15515)	(-0.04432)	(-3.78381)	(-0.0523)	(-0.14809)
$D(\ln E(-1))$	0.164119	-10.54296	0.725127	-52.87529	0.587719	-0.373041
	(-0.15528)	(-17.4934)	(-0.18713)	(-15.9743)	(-0.15184)	(-0.42997)
$D(\ln E(-2))$	0.111617	-75.00429	-0.358627	4.71414	0.049304	-0.238835
	(-0.14932)	(-16.8218)	(-0.19886)	(-16.9759)	(-0.15263)	(-0.4322)
$D(\ln I(-1))$	-0.00052	0.206756	0.004451	-0.485427	0.056615	-0.305893

	(-0.00131)	(-0.14784)	(-0.00252)	(-0.21473)	(-0.05379)	(-0.15232)
$D(\ln I(-2))$	-0.00114	0.100415	0.003413	-0.437684	0.058978	-0.132634
	(-0.00126)	(-0.14235)	(-0.00233)	(-0.19864)	(-0.02988)	(-0.08462)
c	-0.00123	-0.149916	-0.000678	-0.061602	0.000243	0.004063
	(-0.00051)	(-0.05747)	(-0.00045)	(-0.03821)	(-0.00159)	(-0.0045)

According to the results above, we could conclude that before the reform in 2012, the coefficient between the exchange rate and lagged-1 interest rate is -0.00052, and the coefficient between exchange rate and lagged-2 interest rate is -0.00114, indicating that there is a short-term relationship between these two rates. The rise in interest rate this month would lead to a decrease in exchange rate 1 and 2 months later. However, this relationship is quite weak during this time horizon. Besides, the coefficient between interest rate and lagged-1 exchange rate is -10.543, and the coefficient between interest rate and lagged-2 exchange rate is -75.0043, also indicating a negative equilibrium relationship between these two rates. Thus, the raise in this month's exchange rate would lead to a reduction in interest rate in 1 and two months.

After the reform in 2012, the efficient between exchange rate and lagged-1 and lagged-2 interest rate is 0.004451 and 0.003413 respectively. We could see that the relationship between these two rates change from negative to positive, but the relationship is still weak. However, the efficient between interest rate and lagged-1 and lagged-2 exchange rate becomes -2.457474 and -52.87529 respectively, indicating the influences from exchange rate to interest rate are weakened.

After the reform in 2014-2015, the efficient between exchange rate and lagged-1 and lagged-2 interest rate is 0.056615 and 0.058978 respectively, the relationship is strengthened compared with the efficient in 2012-2014. However, the efficient between interest rate and lagged-1 and lagged-2 exchange rate becomes -0.373041 and -0.238835 respectively, the influences from exchange rate to interest rate is significantly weakened.

2) Exchange Rate Marketization: VECM

The results of the VECM models under the marketization of exchange rate are showed in table 5.16.

TABLE 5.16 EXCHANGE RATE MARKETIZATION: VECM

Error Correction	$\boldsymbol{D}(\ln \boldsymbol{E})$	$\boldsymbol{D}(\ln \boldsymbol{I})$	$\boldsymbol{D}(\ln \boldsymbol{E})$	$\boldsymbol{D}(\ln \boldsymbol{I})$	$\boldsymbol{D}(\ln \boldsymbol{E})$	$\boldsymbol{D}(\ln \boldsymbol{I})$
	2008.07 - 2010.06		2010.07 - 2015.07		2015.08 - 2019.12	
CointEq1	-0.480539	-153.5597	-0.030567	-3.857506	-0.136619	0.455568
	(-0.27059)	(-116.361)	(-0.01177)	(-1.16346)	(-0.06157)	(-0.1803)
$D(\ln E(-1))$	-0.1625	115.5271	0.364078	-7.204785	0.630213	-0.442433
	(-0.19545)	(-84.0462)	(-0.129)	(-12.7558)	(-0.16038)	(-0.46963)
$D(\ln E(-2))$	0.06909	29.88	-0.134802	-48.93355	0.035915	-0.022724
	(-0.17973)	(-77.2868)	(-0.12987)	(-12.8419)	(-0.1786)	(-0.52298)
$D(\ln I(-1))$	-0.000602	0.091756	0.001315	0.021027	0.049356	-0.301533
	(-0.00067)	(-0.28769)	(-0.00139)	(-0.13777)	(-0.05319)	(-0.15574)
$D(\ln I(-2))$	-0.000255	0.077456	0.000978	-0.052058	-0.012645	-0.20322
	(-0.00067)	(-0.28621)	(-0.00129)	(-0.12732)	(-0.05607)	(-0.16419)
c	-7.98E-05	0.017033	-0.001391	-0.105845	0.000347	0.00605
	(-0.00016)	(-0.06684)	(-0.00043)	(-0.04271)	(-0.00161)	(-0.0047)

According to the results above, we could conclude that before the reform in 2010, the coefficient between the exchange rate and lagged-1 interest rate is -0.000602, and the coefficient between exchange rate and lagged-2 interest rate is -0.000255, indicating that there are short-term relationship between these two rates. The rise in interest rate this month would lead to a decrease in exchange rate 1 and 2 months later. However, this relationship is quite weak during this time horizon. Besides, the coefficient between interest rate and lagged-1 exchange rate is 115.5271, and the coefficient between interest rate and lagged-2 exchange rate is --29.88, also indicating a negative equilibrium relationship between these two rates. Thus, the raise in this month's exchange rate would lead to a

reduction in interest rate in 1 and two months.

After the reform in 2010, the efficient between exchange rate and lagged-1 and lagged-2 interest rate is 0.001315 and 0.000978 respectively. We could see that the relationship between these two rates change from negative to positive, but the relationship is still weak. However, the efficient between interest rate and lagged-1 and lagged-2 exchange rate becomes -7.204785 and -48.93355 respectively, indicating the influences from exchange rate to interest rate are weakened.

After the reform in 2014-2015, the efficient between exchange rate and lagged-1 and lagged-2 interest rate is 0.049356 and -0.012645 respectively, the relationship is strengthened compared with the efficient in 2010-2015. However, the efficient between interest rate and lagged-1 and lagged-2 exchange rate becomes -0.442433 and -0.022724 respectively, the influences from exchange rate to interest rate is significantly weakened.

5.5 Granger Causality Test

From Johansen test and VECM, it could be concluded that there should be some equilibrium relationship between interest rate and exchange rate. Thus, we apply the Granger causality test to the data.

1) Interest rate marketization: Granger causality test

TABLE 5.17 INTEREST RATE MARKETIZATION: GRANGER CAUSALITY TEST

Null Hypothesis	F-Statistic	Prob.	Results	F-Statistic	Prob.	Results	F-Statistic	Prob.	Results
	2008.07 - 2012.06			2012.07 - 2014.11			2015.05 - 2019.12		
ln *I* does not Granger cause ln *E*	3.36811	0.0283	Reject	0.63245	0.5407	Do not reject	0.63245	0.5407	Do not reject
ln *E* does not Granger cause ln *I*	8.30301	0.0002	Reject	5.90584	0.0088	Reject	5.90584	0.0088	Reject

According to the results above, we could conclude that from 2008 to 2012, interest rate and exchange rate is the Grander cause to each other. After the reform in 2012, interest rate does not Granger cause exchange rate, but exchange rate Granger causes interest rate. After 2014, the results are the same with 2012-2014.

2) Exchange rate marketization: Granger causality test

TABLE 5.18 EXCHANGE RATE MARKETIZATION: GRANGER CAUSALITY TEST

Null Hypothesis	F-Statistic	Prob.	Results	F-Statistic	Prob.	Results	F-Statistic	Prob.	Results
	2008.07 - 2010.06			2010.07 - 2015.07			2015.08 - 2019.12		
ln *I* does not Granger cause ln *E*	0.61289	0.663	Do not reject	0.06588	0.9777	Do not reject	0.06588	0.9777	Do not reject
ln *E* does not Granger cause ln *I*	4.98297	0.018	Reject	4.9834	0.0041	Reject	4.9834	0.0041	Reject

According to the tables above, we could conclude that the results are the same during the three horizons, which all indicate interest rate does not Granger cause exchange rate, but exchange rate Granger causes interest rate.

5.6 Impulse Response Function (IRF)

The impulse response function (IRF) is used to measure the impact of a random shock of an endogenous variable on the current value and future values of other variables. From the cointegration test and the VEC model, it can be found that there is a long-term and short-term equilibrium relationship between the exchange rate and the interest rate. At the same time, by observing the correlation coefficient between the regression residuals, it can be found that there is a certain degree of correlation between the residuals of the equation. Thus, we perform the IRF to further analyze.

1) Interest rate marketization: IRF

Due to space limit, the IRF results of interest rate marketization are shown in Appendix 3.1 to 3.6[1]. According to Appendix 3.1, we could find that after a shock to interest rate, the exchange rate does not respond immediately, and

[1] Due to space limit, all appendices can be found on https://www.jianguoyun.com/p/DUX0QpcQhJWfCRiXquID

then the impulse response curve decreases slowly to around -0.004. This means the response is negative to the shock and the response is more furious in the early stages. From Appendix 3.2, we could see when exchange rate receives a shock, the interest rate does not respond immediately either. The response curve decreases to -0.2 first and then bounces back to about -0.1. The whole process is negative. Thus, it could be concluded that before the reform in 2012, the increase in interest rate will decrease the exchange rate and the increase in exchange rate will also decrease the interest rate, but the exchange rate has deeper influence on the interest rate.

From Appendix 3.3, we could see after the reform in 2012, the increase in interest rate will finally lead to an increase in exchange rate, the curve increases quickly in the early stage and slowly decays to around 0.0002. From Appendix 3.4, we could see that the increase in the exchange rate will firstly lead to an obvious decrease in the interest rate. However, the curve climbs back after 2 periods and the influence become positive but insignificant.

From Appendix 3.5, we could see that after the reform in 2014, the increase in interest rate has almost no influence to exchange rate. However, according to Appendix 3.6, when the exchange rate increases, the interest rate will respond immediately. The respond curve firstly decreases to -0.007 and then increases to around 0.012.

To summary, the shock in exchange rate has deeper influence on interest rate. Also, the marketization of interest rate would decrease the influence brought by exchange rate to interest rate and even change the direction from negative to positive.

2) Exchange rate marketization: IRF

Due to space limit, the IRF results of exchange rate marketization are shown in Appendix 3.7 to 3.12. From Appendix 3.7, we could find that before the exchange rate reform in 2010, the increase in interest rate would decrease the exchange rate in the short term but have no effects in the long term. From Appendix 3.8, we could see that the increase in exchange rate will also lead to a reduction in the interest rate. However, by comparing these two figures, we could also conclude that the influences from exchange rate to interest rate is much more significant than the latter to the other.

From Appendix 3.9, we could see that after the exchange rate reform in 2010, when the interest rate increases, the exchange rate is almost not influenced. From Appendix 3.10, it could also be concluded that when the exchange rate increases, the interest rate would still respond quickly and decrease in a short time. However, in the long run, the effects would also disappear.

From Appendix 3.11, we could see that after the exchange rate reform in 2015, the change in interest rate is not likely to cause changes in exchange rate. However, when the exchange rate increases, the interest rate would quickly respond by decrease in the short term and increase in the long run.

6 CONCLUSIONS AND POLICY IMPLICATIONS

From the theoretical and empirical analysis above, here are the conclusions.

Firstly, according to the VAR model and the results of Johansen tests, we could see that there are long-term and short-term equilibrium relationship between interest rate and exchange rate.

Secondly, according to the IRF, exchange rate has a deeper influence on interest rate than interest rate on exchange rate. In another word, interest rate is more easily influenced by exchange rate. This conclusion could reflect that the marketization of interest rate is effective in China and the interest rate could quickly respond to the market. On the other hand, the marketization of exchange rate is not effective enough, because the exchange rate almost has no respond to the change in the interest rate.

Thirdly, before the marketization of interest rate in 2012, the optimal lag number in the interest rate VAR model is 3, which is 2 after the marketization. Therefore, it could be concluded that the marketization did improve the market efficiency and interest rate could respond in a shorter time.

Fourthly, according to the VECM and the IRF, we could see that after the marketization, the influence brought by interest rate to exchange rate change from negative to positive in the long term. This means that before the

marketization, the increase in interest rate would lead to a decrease in the exchange rate, in another word, the appreciation of RMB. This is consistent with the analysis from the capital account. However, after the marketization, the increase in interest rate will also lead to an increase in the exchange rate in the long term, which is consistent with the analysis from the current account. Thus, we could conclude that after the marketization, the current account effects exceed the capital account effect.

The following policy implications are proposed. Firstly, accelerate the process of exchange rate marketization. According to our findings, the marketization of interest rate does improve the transmission mechanism between these two rates, especially for interest rate. However, due to the marketization of exchange rate has not been completed in China, the influence from interest rate to exchange rate is still limited. Therefore, in order to improve the effectiveness of the transmission mechanism between these two rates, accelerating the process of exchange rate marketization would be a good choice. China currently implements a managed floating exchange rate system with reference to a basket of currencies. However, the exchange rate floating space under this system is still limited, so implementing exchange rate target area with a broader floating interval might help improve the flexibility of the RMB exchange rate.

Secondly, now that we have developed a better understanding on how interest rate interacts with exchange rate, the monetary policy could then be more flexible.

Thirdly, it is also necessary to strengthen financial supervision and international cooperation. Only by these measures could China better manage the financial risks and improve the effectiveness of its monetary policies.

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