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Empirical analysis of the impact of RMB offshore market in Hongkong on monetary policy in China

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Abstract
Combined with the Markov regime switching vector autoregressive model (MS-VAR), this paper empirically analyses the nonlinear relationship between the RMB Offshore Market in Hongkong and monetary policy under different regional regimes. The research finds MSIH(3)-VAR(2) model can better describe the relationship between variables. The data are divided into three regimes which are Regime 1(the RMB exchange rate difference between HK offshore market and onshore is negative, the RMB deposit scale in HK declines, the money supply grows slowly), Regime 2(the exchange rate difference is positive, the deposit scale grows slowly, the money supply grows rapidly) and Regime 3(the exchange rate difference is positive, the deposit scale grows rapidly, the money supply grows rapidly). In the three regimes, the changes of the mainland RMB supply are different.
Key words: *RMB offshore market; monetary policy; MS-VAR model; empirical analysis; impulse response analysis*

1 Introduction

1.1 backgroud & related work

With the continuous advance of the RMB internationalization process, the RMB offshore market has achieved leap-forward development. The RMB offshore market in Hongkong(HK), which has become the world's largest offshore financial center, started earliest and began operating RMB deposit and loan business in February 2004. The RMB offshore market price will have an impact on the price of RMB funds in the onshore market, which may impact on domestic monetary policy.

The existing studies suggest that the impact of the offshore market on the central bank's monetary policy is mainly through the three channels: the money supply, interest rates and exchange rates. *Liu Ya et al.*[1] found that the offshore RMB interest rate has a significant volatility spillover effect on the domestic interest rate. *Wu Ge & Pei Cheng*[2] found that the domestic RMB spot exchange rate and HK offshore RMB exchange rate mutual influence each other by using the Granger causality test. From analysing the development of Australian offshore market, *Battellino & Plumb*[3] found that offshore market provides space for commercial banks to hedge the central bank open market operations and weakens the central bank ability of adjusting the monetary base by commercial banks. *He fan et al.*[4] analysed the

offshore RMB market in HK, and thought that offshore market development may weaken the effectiveness of the monetary policy in the mainland. After investigating the development of offshore RMB market in HK, *Zhang Bin & Xu Qiyuan*[5] believed that the development of the offshore RMB market would increase foreign exchange market net foreign currency supply and affect the implementation of the central bank's monetary policy. *The Guangzhou Branch Research Group of the People's Bank of China*[6] demonstrated that the difference in interest rates and exchange rates between the offshore market and the onshore market would affect the monetary policy of the currency issuing countries through expectations.

1.2 Theoretical analysis

According to “The Impossible Trinity”, a country can only choose two among maintaining exchange rate stability, free circulation of capital and independence of monetary policy. a country is more likely to choose the exchange rate and the free flow of capital to have an impact of the independence of monetary policy, then affect the money supply in the mainland.
The central bank implements monetary policy mainly by regulating interest rates, exchange rates, money supply and other intermediary targets to indirectly control the economic operation. The development of offshore money market will inevitably form offshore interest rates and offshore exchange rates, and influence the level of the onshore interest rates and exchange rates, then have an impact on the money supply of the currency issuing countries through cross-border capital flows.

2 Empirical analysis

2.1 Data specification and stationary test

The model constructed included domestic measure of the money supply, the RMB deposit scale in HK offshore market, the RMB interest rate difference and exchange rate difference between HK offshore market and onshore. Due to the availability of data, we chose 123 monthly datas from January 2007 to March 2017 as a sample. The research chose the monthly data of the nominal money supply(M2). Indexes of the RMB deposit in HK(HD) chose current and savings deposit(HSD) and fixed term deposit(HTD) in HK offshore market. Indexes of interest rate in domestic chose 1-month Shanghai Interbank Offered Rate(1M Shibor) and offshore interest rate chose deposit rate; their difference(RR) was the interest rate difference between HK offshore market and onshore. Indexes of RMB exchange rate difference(SS) chose the nominal exchange rate. In addition, in order to eliminate data non-stationary, we took the log of M2，HSD and HTD. The money supply and domestic exchange rate were retrieved from the website of The People's Bank of China; Shanghai Interbank Offered Rate was gained from the WIND database; RMB deposit scale, interest rate and exchange rate in HK offshore market were retrieved from the website of Hong Kong Monetary Authority (HKMA).
Before building the MS-VAR model, it is necessary to test stationary of variables. With the

ADF test, we found that these five types of data are integrated of order one I(1) and reject the hypothetical of non-stationary under the confidential level of 1%, as shown in Table 1.

Table 1 – Unit-Root-Testing Results

Variables	ADF value	Critical value	（C,T,K）	Conclusion
lnm2	-7.967011	-4.03631	（C,T,1）	Stationary
lnhtd	-3.061469	-2.583898	（0,0,1）	Stationary
lnhsd	-5.161291	-2.583898	（0,0,1）	Stationary
rr	-9.504512	-2.583898	（0,0,1）	Stationary
ss	-7.840072	-2.583898	（0,0,1）	Stationary

Data source: Eviews7.2 software running test results

2.2 MS-VAR Model Selection

The MS-VAR model is extended to the P order autoregressive of the M dimensional time variable based on the finite order VAR(P) model. Depending on whether the mean, the intercept, the autoregressive parameters and the variance rely on the state of the transferred variable, MS-VAR model can be expressed in 16 formats, such as MSM-VAR, MSI-VAR, MSMH-VAR, MSIH-VAR and MSIAH-VAR. In the condition of different equations, there is a big difference between the division of the interval and the determination of the correlation coefficient, so the best form of the MS-VAR model needs to be determined.

By analyzing the data and combining the principle of the minority to the majority, the optimum lag stage of VAR model was determined 2 and the selection process is not provided here due to length limitations.

According to the changing trend of the RMB deposit in HK, the development of the RMB offshore market in HK can be divided into three regimes: HD declines in Regime 1(R1); HD grows slowly in Regime 2(R2); HD grows rapidly in Regime 3(R3). This paper determined the appropriate MS-VAR model according to the principles of AIC, SC and HQ. Table 2 shows the value of each index in different form model.

Table 2 – the determine of the appropriate MS-VAR model

		LogL	AIC	SC	HQ
linear	VAR(2)	1416.358	-23.69842	-22.99017*	-23.41088
nonlinear	MSI(3)-VAR(2)	1559.5353	-23.9599	-21.9937	-23.1612
	MSIH(3)-VAR(2)*	1658.9243	-25.0882*	-22.4361	-24.0109*
	MSM(3)-VAR(2)	1527.3122	-23.436	-21.4697	-22.6373
	MSIAH(3)-VAR(2)	1721.4981*	-24.4796	-19.5412	-22.4737

Data source: OX software runs on the Givewin2 platform, the same below

Limited to space, Table 2 does not list the values of the indicators in all models. About optimal MSIH(3)-VAR(2) model, LR linear statistics is 260.7824, the P values of chi square statistic and Davies test are both 0.0000, which said that the nonlinear model is appropriate.

3 Result & discussion

3.1 Empirical analysis on MS-VAR model

3.1.1 Analysis on parameter estimation results

This paper used OX-MSVAR software package running on the Givewin2 platform to estimate and test parameters. Table 3 shows the intercept, standard deviation and mean of the corresponding variables in the every regime.

Table 3 – Parameter estimation results under optimal model

		dm2	dhtd	dhsd	rr	ss
Intercept	R1	0.013673	-0.024981	-0.009061	0.008956	-0.00875
	R2	0.028428	-0.021452	-0.025735	0.011096	0.004471
	R3	0.027632	0.052168	0.008542	0.004159	0.004404
Standard Deviation	R1	0.006879	0.027566	0.090717	0.002766	0.021844
	R2	0.011081	0.039111	0.045050	0.007797	0.011684
	R3	0.006255	0.096687	0.073490	0.004943	0.005143
Mean	R1	0.008142	-0.009081	-0.014445	0.030026	-0.033977
	R2	0.015070	0.008861	0.005075	0.033163	0.021730
	R3	0.014204	0.084930	0.143279	0.025667	0.022471

Table 3 shows that the growth rate of M2 is positive. In R1, the average value is 0.008142, while in R2 and R3, the average level fluctuates at 0.0145, and the growth rate of R2 is slightly larger than that of R3. Generally speaking, the level of M2 shows a trend of growth under the macro-control of the central bank. The growth rates of HSD and HTD, which are obviously different in the three regimes, are negative at R1, -0.014445 and -0.009081 respectively, and the standard deviation of HSD growth rate is smaller, the decline is more stable while HTD have fallen considerably. The average growth rate of deposits at R3 is the biggest, and the growth rate of HSD and HTD reached 0.143279 and 0.084930 respectively. This level is far greater than the average value of R2, indicating that the variation trend of HSD and HTD is approximately the same. The average of RR did not change much between the three regimes. The value is floating up and down at 0.03, and the standard deviation is low in the three regimes. In R2, the standard deviation has a maximum value of 0.007797. The value of R1 is 0.002766. It shows that the fluctuation of SS is far smaller than other indexes. The average of SS is negative in R1, which is -0.033977, and the standard deviation is the largest. It shows that the domestic RMB exchange rate is less than the RMB exchange rate in HK in R1, and the fluctuation is greater. In R2 and R3, the average SS is positive, with no big difference, and its absolute value is less than R1.

Based on the above analysis, R1 describes the state that SS is negative, HD declines, M2 grows slowly; R2 describes that SS is positive, HD grows slowly, M2 grows rapidly; R3 describes that SS is positive, HD grows rapidly, M2 grows rapidly.

3.1.2 Analysis on probabilities of each regime

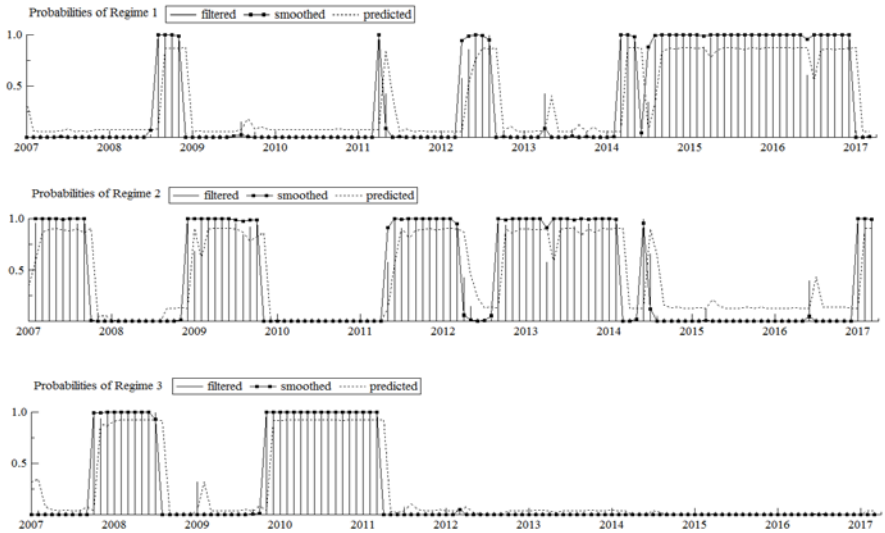

Fig. 1 – Probabilities of each regime

As shown in Fig.1, the MS-VAR model estimates probabilities of each regime. In combination with the graph, a more realistic interpretation of the three regimes can be made.

In R1, SS is negative; HD declines; M2 grows slowly. This status occurs in 2008, 2011, 2012 years, but the duration is short; except for that, this period continued from the beginning of March 2014 until December 2016. In the second half of 2008, the subprime mortgage crisis broke out in the United States. In order to protect exports, China took the policy of "keeping a close watch on the dollar", and the RMB continued to depreciate with the dollar; In April 2012 People's Bank of China expanded the exchange rate of RMB against the US dollar to 1%, appointed foreign exchange bank that the difference between the highest dollar cash selling price provided and the minimum cash purchase price cannot exceed the magnitude of the day the central parity, and the difference range expanded from 1% to 2%. These two indicators expanded by one percentage point in March 2014, reaching 2% and 3% respectively. Expanding the floating range of the RMB exchange rate is conducive to enhancing the floating flexibility of the RMB exchange rate, improving the market formation mechanism of the RMB exchange rate, so that the RMB continues to depreciate. Due to the regulation of the central bank in domestic, the depreciation rate is less than the unregulated offshore market in HK, resulting in SS is negative, so HD have gradually reduced. In The Impossible Trinity, there is an alternative relationship between the effectiveness of monetary policy, the free flow of capital and exchange rate fluctuations. With the fluctuation of exchange rate increasing, monetary policy is more effective.

In R2, SS is positive; HD grows slowly; M2 grows rapidly. R2 is more frequent and has longer duration. In this regime, the RMB presents a rising trend; some scholars suggested that RMB appreciated strongly during 2005 to 2012, and the central bank had taken a more relaxed monetary policy. RMB appreciation in domestic is less than that in HK offshore

market, so RMB exchange rate in domestic is higher. This phenomenon led to expansion of HD but not obviously, domestic money supply growth rate is greater than R1.

R3 shows the state that SS is positive; HD grows rapidly; M2 grows rapidly. At the end of June 2007, the National Development Bank issued the first RMB bonds in HK; at the end of September 2009, China's Ministry of Finance issued 6 billion yuan bonds in HK. These two economic activities have directly increased HD.

3.1.3 Analysis on regime switching

Table 4 – Regime switching probability matrix duration

	R1	R2	R3	n	Prob.	Duration
R1	0.8770	0.1230	3.01e-09	43	0.3458	8.13
R2	0.0594	0.9018	0.0388	53	0.433	10.18
R3	0.07596	5.75e-07	0.924	27	0.2212	13.17

Table 4 shows that the probability of the economy in R1 is 0.3458 and the probability of maintenance is 0.8770, which means there are still 0.1230 of the probability to R2, but the probability of turning to R3 is almost zero; R2 appeared probability is 0.4430 and maintenance probability is 0.9018, This regime has small probability to transfer to R1 and R3, and a largest number of samples. The average duration of R2 are 10.18 months with high stability; R3, with the smallest probability of occurrence, has a least number of samples, but its 0.9240 maintenance probability is the highest and duration of 13.17 months is the longest. It means that there is a certain economic events causing a lasting effect, demonstrated the above 3 description of R3.

3.2 Impulse response analysis under three Regimes

3.2.1 Impulse response of unit RMB current and savings deposit growth rate shock

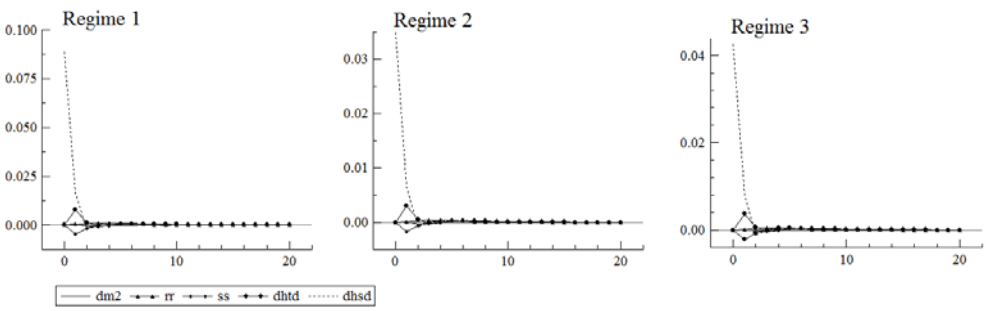

Fig.2– Impulse Response of RMB Current and Savings Deposit Growth Rate Shock

Fig.2 shows that SS and HTD growth rate have small reaction. These reaction is strong in R1, but not last too long. They become stable after 2 months. As for M2 growth rate, it is similar in three regimes: at the first two month, it stays stable; at the 4th month, it drops a little and become negative; 2 months later, it comes back to 0. It proves that the variation of RMB current and savings deposit will affect the exchange rate difference and fixed term deposit, and the RMB supply will also have a slight and short negative reaction.

3.2.2 Impulse response of unit RMB fixed term deposit growth rate shock

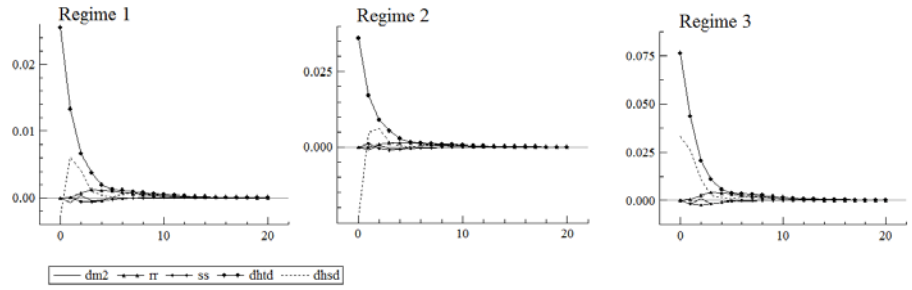

Fig.3 – Impulse response of RMB fixed term deposit growth rate shock

In Fig.3, facing with the shock, HSD growth rate is positive in R1 and R2, while it is negative in R3. It indicates that the changes of two deposits are more similar, while there is a substitution effect between them in R3, which is the stage of RMB bonds issued in HK. The M2 growth rate also has a certain reaction: in the first four months, it changes positive and negative cyclically in all three regimes, and the phenomenon becomes stronger in R3. And the impact of M2 growth rate has a longer time and bigger range than HSD growth rate. It means that HTD has a more influence on M2.

3.2.3 Impulse response of unit exchange rate difference shock

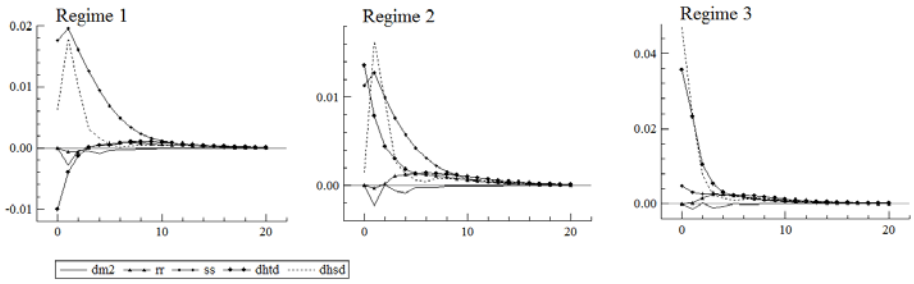

Fig.4– Impulse response of exchange rate difference shock

As shown in Fig.4, for unit SS shock, HTD has obviously different reactions in R1 and R2. The time of reactions are both over 10 months, and tend to balance eventually. It is said that when SS changes from negative to positive, HTD reduces more and more slowly until increases. When SS becomes larger, HTD growth rate will not increase but reduce, however, it won't become negative. For M2, it has a negative correlation. Namely, SS increases, the M2 growth rate fluctuates under 0, and the fluctuation degree weakens gradually.

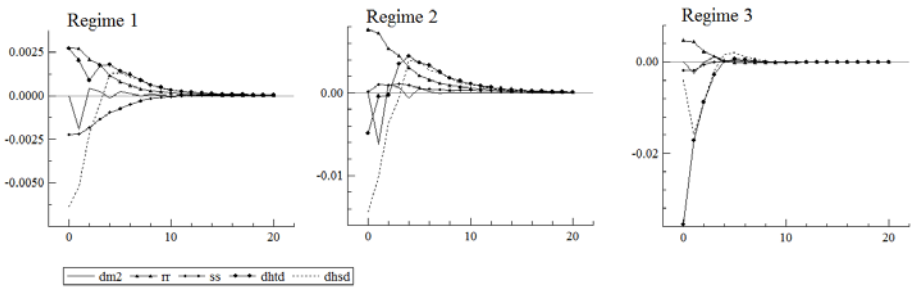

Fig.5– Impulse response of interest rate difference shock

3.2.4 Impulse response of unit interest rate difference shock

In Fig.5, M2 growth rate has a strong reaction. When SS increase, M2 growth rate will reduce and fluctuate around 0 for 8 months, then becomes stable. And the reaction is stronger in R2, while weaker when SS is negative. The response of SS is negative, and become stable after 10 months. As for HD, the response is positive at first, and become negative after 4 months.

4 Conclusions

Using the cumulative impulse response function of each regime, we find that the RMB offshore market in HK has a certain impact on China's money policy. Firstly, the amount of RMB deposits in HK will have a negative impact on China's money supply especially when the exchange rate difference is negative. Secondly, in the stage of RMB devaluation, domestic RMB supply grows slowly. Also, the supply of RMB grows fast when RMB appreciates. Thirdly, The influence of the change of interest rate difference on the domestic money supply is more significant at the stage of RMB appreciation. Fourthly, the issuance of RMB bonds in HK will have a greater impact on RMB deposit, and a minor impact on money supply.

Based on the above conclusions, it is suggested that China should actively respond to the impact of the development of the RMB offshore market in HK on the mainland monetary policy and actively promote the reform of interest rate and exchange rate, thus reducing the impact on monetary policy.

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