

## **Renminbi Exchange Rate and Capital Flows Interactions in China**

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### **ABSTRACT**

The RMB's exchange rate plays a very important role in China's economic development, more so as the country relies heavily on foreign trade. As RMB's exchange rate regime changes from a fixed exchange rate regime to a completely free floating one, China's plan to open capital accounts is in the pipeline. Evidence point to a relationship between RMB's fluctuation and capital flows. This paper uses vector auto-regression (VAR) model to evaluate the relationship between RMB's fluctuation and capital flows. Combined with the actual situation in China, this study introduces the exchange rate expectations (NDF), Gross Domestic Product (GDP) growth, and interest rate factors into the model. In the past two years, RMB's rate regime reform has moved fast, and the benchmark interest rate and repo-bond's rate are not reflective of the market's true rate. Therefore, the currency market's rate gap between China and the USA is used in the VAR model as rate variables. The results show that the rate variable has a high degree of influence on both exchange rate and capital flow. RMB exchange rate's fluctuation has an influence on capital flow, however, it is not considered significant, especially in relation to the spot exchange rate. This phenomenon is largely due to the intervention of the Central Bank of China in the RMB exchange rate. Under China's special conditions, the spot exchange rate's fluctuation is the government's goal. In this case, the Central Bank's intervention is efficient, but the costs involved are still increasing as the exchange rate regime reform moves forward.

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## INTRODUCTION

China is the third largest economy, after the United States and the European Union. China's economic structure makes it more dependent on foreign trade and it also faces the issue of large of cross-border currency payments and asset allocation. Therefore, it is imperative to understand the relationship between China's exchange rate and the impact of capital flows not only in the context of China itself, but in relation to the rest of the world.

Before the Central Bank of China implemented the exchange rate system reforms in 2005, the exchange rate of RMB was basically tied to the US dollar, with controlled fluctuations. During this period, the influence of cross-border capital flow on the RMB exchange rate fluctuation was very small, or almost negligible. When the exchange rate system was reformed, the RMB exhibited a steady appreciation of the trend, but the extent of its volatility as affected by capital flow remains unclear. In order to stabilise the market, the government must understand the mutual influences of exchange rate and capital flow.

Many articles have focused on this issue (Cai, 2008; Cheung & Fujii, 2014; Funke & Rahn, 2005; Glick & Hutchison, 2008; Ljungwall & Zijian, 2008; Tian, 2016) but most used FDI as the variable (Glick & Hutchison, 2008; Janciková, Raneta, & Braga, 2016; Zhu & Liu, 2010). Others used the Garch model and some analysed the relationship between exchange rates and stock prices (Kai, 2011; Liu, 2007; Tian, 2016). The FDI is a very important

capital flow, and it is easy to these its effect on the exchange rate. However, this data is not easily available. Therefore, this study introduces the concept of capital flow, which is equivalent to capital reserve minus the FDI. This study will identify the interaction between the exchange rate of the RMB and capital flow between January 2006 and December 2015. In order to fully understand the influence of the variables, other variables, such as interest rate caps between China and the USA, non-deliverable RMB forward exchange rate, and gross domestic product growth rate, are introduced into the VAR model.

This paper uses the gap of the China-US currency market interest rate to establish a model that better reflects the real market supply and demand, as previous work in this area only adopts the benchmark interest rate or bond market interest rate of the Central Bank of China. It is argued that this approach is not representative of the real market interest rate levels. This is because much of the research data is contained in the appreciation cycle and therefore cannot reflect the effect of reverse trend fluctuations. This is important when considering that the RMB ended its unilateral appreciation trend in 2014, entering into the two-way volatility; an even entered into the trend of devaluation. This paper used data from this occurrence to fully reflect the impact of changes in the RMB exchange rate.

The relevant theories and research results on exchange rate fluctuation and capital flow are summarised in Section 2. Section 3 discusses data and methods

used, while the results of the analysis will be presented in Section 4. The paper is summarised and concluded in Section 5.

## LITERATURE REVIEW

Fisher (1907) was the first to study the interest rate drivers of short-term international capital flow based on David Ricardo's comparative advantage theory. In modern international economics, Fleming (1962) argued that interest rates have an impact on short-term international capital flow from the perspective of international balance of payments in the 1950s, while the interest rate parity theory explains international capital flow from the perspective of both interest rates and exchange rates in the 1960s. The asset-driven theory suggests that short-term international capital flows are not only affected by the level of interest rates, but also by domestic and international risk level and risk appetite of investors in the 1950s. In addition to interest rate drive theory, interest rate exchange rate combined drive theory and assets (Kim, 1999), the theory of monetary policy (the thirties of last century), and so on. This study analyses the driving factors of short-term international capital flows.

Fleming (1962) found that the exchange rate and price levels affect trade in retailers of international capital flows while Eichengreen and Fishlow (1998); Krueger and Yoo (2002) found that there were substantial inflows of international capital before a crisis in Mexico and other countries. The reason for this is national exchange rate of these countries is tied to

the US dollar, making the exchange rate level relatively fixed. Therefore, investors ignore the existence of exchange rate risk, resulting in a large number of international capital flows into these countries. Lipschitz, Lane and Mourrnouras (2002) point out that the exchange rate of a country and its changing trends affect the flow of short-term international capital in their study of countries in transition in Central and Eastern Europe.

Zhou and Sornette (2006) analysed monthly data of international speculative capital inflows out of China between January 1999 and September 2006, and confirmed that the flow of international capital is determined by interest and exchange rates. Zhang and Fung (2007) constructed the triple arbitrage model of interest rate, exchange rate, and asset price. On this basis, using annual data from between 1996 and 2005, this study concludes that China's short-term international capital inflows are in addition to "arbitrage", but also for the "arbitrage" and "set price" of these two motives. Chen, Wang and Cheng (2009) used the ARDL-ECM model to test the relationship between the RMB exchange rate and China's short-term capital flows based on monthly data from January 1999 to June 2008, and concluded that the expected changes in the RMB exchange rate and the difference in interest rates are important influencing factors of short-term international capital flow.

Zhu and Liu (2010) reported short-term international capital inflows would lead to the appreciation of the RMB exchange

rate, which would further influence inflow of short-term international capital. Fan, Morck, Xu and Yeung (2009) used the sample of monthly exchange rate data of China gathered between January 1999 and June 2008, and concluded that arbitrage for exchange rates or interest rates is the main motivation for short-term international capital inflows into China. Their study was based on a construction of a vector autoregressive distribution hysteresis model. In recent years, scholars have studied the relationship between exchange rate marketisation and short-term international capital flow from the perspectives described below.

First, the relationship between exchange rate system and short-term international capital flows. Liu and Liu (2004) pointed out that, under the further opening of capital projects, China can only choose a managed floating exchange rate system. Further, Chinn and Ito (2006) analysed the impact of the reform of RMB exchange rate mechanisms on financial capital flow and trade capital flow, concluding that it would promote the inflow of short-term foreign capital. They also concluded with the RMB nominal exchange rate gradually edging closer to the real interest rate, the RMB exchange rate fluctuations in the dynamic adjustment is conducive to achieving China's international long-term balance of payments.

Wang (2015) concluded the relationship between the RMB exchange rate formation mechanism and the international capital flow is strong. Ding, Tse and Williams

(2014) who analysed Malaysian "exchange reform", concluded that exchange reform is conducive to foreign exchange market price discovery. When the market exchange rate is close to the balance of the case, opening up capital accounts can minimise the devastating impact of capital speculation. Similarly, Dong et al. (2012) noted a certain degree of exchange rate flexibility is an effective instrument for resisting excessive short-term capital flow after the capital account is opened.

The second focus of modern scholars is the impact of RMB appreciation on short-term international capital flow after the exchange rate marketisation reforms. Maziad and Kang (2012) argued the exchange rate market-oriented reforms would lead to the further devaluation of the RMB. Jin et al. (2004) used the general equilibrium analysis, concluding that after the improvement of RMB exchange rate formation mechanisms, the appreciation of the RMB would have a certain attraction for short-term international capital flow. Shu, He and Cheng (2015) further posited the appreciation of the RMB is expected to attract short-term international capital into China's market arbitrage activities, and that when the flow surpasses a certain size, it would adversely affect China's macroeconomics.

Most published empirical analysis in this area focused on the influence of exchange rates and the appreciation of the RMB on short-term international capital flow. However, the impact of exchange rate market reforms and exchange rate

fluctuation on short-term international capital flow is analysed from a qualitative point of view, involving less empirical content. This study however, will construct a VAR model to analyse the impact of exchange rate and capital flow on short-term international capital flow. In addition, most studies in this area were conducted prior to 2010; this empirical analysis is not reflective of the impact of China's accelerated exchange rate market reform on short-term international capital flow. Therefore, the period of the present is between January 2006 and December 2015, using monthly data, in order to generate more accurate conclusions.

## METHODS

For the purpose of this study, we first determined the choice of exchange rate variables and capital flow variables: the central parity of the RMB exchange rate, announced daily by the central bank. Capital Flows = Incremental Foreign Exchange Reserves - Current Trade Foreign direct investment (FDI). This data was obtained from Central Bank of China. Non-deliverable RMB Forward Rate- monthly data on the forward exchange rate between RMB and the US dollar is due in one year. This data also comes from Central Bank of China. Gross Domestic Product Growth - the monthly data of China's GDP growth rate comes from China's Statistical Office. China and the United States money market interest rate level difference was obtained

from Central Bank of China. The scope of the study period is from January 2006 to December 2015, using monthly data. Since the VAR (Vector Autoregressive) model used in this study was based on its 1970 model, all the variables are regarded as endogenous variables. The initial model coefficient does not impose any constraints, that is, each equation has the same explanatory variable, which is the lagged value of all explanatory variables in a number of periods. The VAR model is a powerful analytical tool in economic analysis that involves multivariate and constrains that affect each other. Both the prediction and corresponding analysis of the pulse show great advantages. Therefore, in this study, the VAR model was selected to analyse the interaction between capital flow and exchange rates.

## RESULTS

### Step 1: Unit Root Test

The first step is to confirm stability of data, as the VAR model relies on this. Prior to this, the unit root test is used to verify the exchange rate of the RMB, the difference between the US and Chinese money markets (rgap), the NDF, the gross domestic product growth rate (GDP), and the stability of five-time series data of capital flow. In order to prevent the pseudo-regressions that may occur in time-series data after the stationary test, (if a non-stationary phenomenon occurs) the differential processing on the time-series data will be performed.

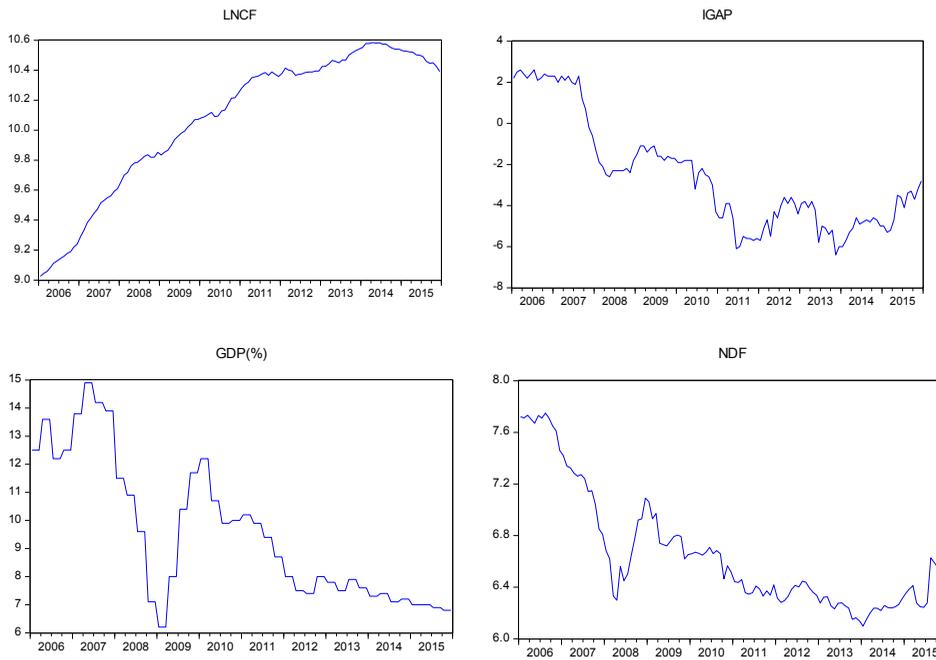


Figure 1. Graph of capital flow; Gap of interest rate; GDP growth; NDF

Table 1  
P value of  $I(0)$  and  $I(1)$

Variables	I (0)		I (1)	
	T-Statistics	P-Value	T-Statistics	P-Value
RGAP	-1.812816	0.3728	-11.18045	0.0000
lnRATE	-3.379162	0.0136	-2.436460	0.0041
lnNDF	-2.325910	0.1656	-10.22684	0.0045
lnGDP	-1.365056	0.5970	-4.633863	0.0002
CAPITAL FLOW	-1.856967	0.3516	-13.01571	0.0000

**Step 2: Selection of Lag Order**

Taking the AIC as the final selection criterion, this paper selected the lag order as the fourth order.

Table 2  
Lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-11.55675	NA	9.27e-07	0.298320	0.420371*	0.347832*
1	26.74421	72.46129	7.30e-07	0.058663	0.790968	0.355738
2	48.36461	38.95568	7.78e-07	0.119557	1.462117	0.664193
3	89.81608	70.95296	5.82e-07	-0.176866	1.775948	0.615333
4	126.3081	59.17618	4.80e-07*	-0.383929*	2.179140	0.655832
5	140.7560	22.12746	5.93e-07	-0.193802	2.979522	1.093522
6	174.3942	48.48758*	5.24e-07	-0.349446	3.434132	1.185440
7	195.7918	28.91564	5.85e-07	-0.284537	4.109296	1.497911
8	217.9529	27.95085	6.54e-07	-0.233385	4.770703	1.796626

### Step 3: VAR Model Stability Verification

A unit root test was performed on the VAR model, and the reciprocal of the roots of all the models' characteristic equations were obtained. The sum of squares of each set of roots is less than one, which confirms the established VAR model is stable. This is shown in Figure 2, where the roots of the characteristic equation are within the unit circle.

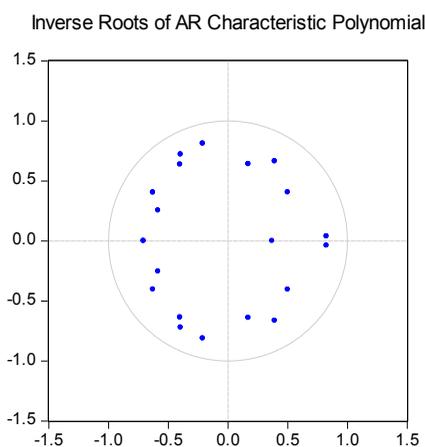


Figure 2. Inverse roots of AR characteristic polynomial

### Step 4: Johansen Co-integration Test and Granger Causality Test Results

Table 3 and Table 4 contain the results of Johansen co-integration test and Granger causality test. From Table 3, it is seen that there are, at most, three co-integration relationships between these variables. The Granger causality test results of RMB capital flows can be seen from the Granger causality test of the flow of capital. If the joint test of exchange rate, exchange rate expectation, interest rate differential of China and US money market, and GDP growth rate are at 10%, the null hypothesis will be rejected. With regard to the Granger test, the fluctuation of capital flows is affected by fluctuation of the aforementioned factors, whereas the interest rate difference of the China and US money markets has a significant Granger effect on capital flow. The probability of exogenous fluctuations of RMB spot exchange rate fluctuations and the impact of NDF on the volatility of capital flow is 0.1815 and 0.3570 respectively, which indicates that the expected effect

of RMB exchange rate on capital flows is weaker than that of the spot exchange rate. At the same time, the fluctuation of GDP growth rate has little effect on the fluctuation of capital flow.

Furthermore, the fluctuation of the central parity of the RMB exchange rate is affected by the fluctuation of the aforementioned factors, where the interest rate differential of the China-US money markets is also very significant for the central parity of the RMB exchange rate. In terms of the Granger influences, in particular the fluctuations in capital flow and NDF exchange rate fluctuations on the RMB exchange rate fluctuations, the impact of its exogenous fluctuations in the central parity of the RMB exchange rate is 0.4725 and 0.5983 respectively. Often, exchange

rates are expected to have a strong guiding effect on the spot rate. However, the above empirical analysis shows that the fluctuation of the RMB non-deliverable forward exchange rate is not significant in terms of the Granger test of the RMB spot exchange rate causality. This phenomenon is likely to be related to China's RMB exchange rate regime, which is heavily regulated by Central Bank of China, as well as their intervention in the RMB spot exchange rate. It is likely that this leads to the disruption of the non-deliverable forward exchange rate to the spot rate of RMB exchange rate, making the fluctuations less affected by exchange rate volatility. The GDP growth rate fluctuations, in the Granger test, have little effect on the central parity of the RMB exchange rate fluctuations.

Table 3  
*Unrestricted co-integration rank test (maximum eigenvalue)*

Hypothesised No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.263892	107.0214	69.81889	0.0000
At most 1 *	0.229386	72.70698	47.85613	0.0001
At most 2 *	0.213013	43.52337	29.79707	0.0007
At most 3 *	0.120351	16.69456	15.49471	0.0328
At most 4 *	0.020611	2.332524	3.841466	0.1267

Max-eigenvalue test indicates 4 co-integrating eqn(s) at the 0.05 level

\*denotes rejection of the hypothesis at the 0.05 level

Table 4  
Granger causality test results

Dependent variable: D-CAPITALFLOW			
Excluded	Chi-sq	df	Prob.
DLNGDP	3.390276	4	0.4948
DLNNDP	4.380434	4	0.3570
DLNRATE	6.245557	4	0.1815
DRGAP	15.34168	4	0.0040
All	24.01770	16	0.0891
Dependent variable: DLNRATE			
Excluded	Chi-sq	df	Prob.
D-CAPITALFLOW	3.535579	4	0.4725
DLNGDP	2.713329	4	0.6069
DLNNDP	2.762805	4	0.5983
DRGAP	21.47943	4	0.0003
All	27.51993	16	0.0361

**Step 5: Impulse Response Function**

The depreciation of spot exchange rate (using the direct quotation method of RMB

exchange rate) will bring about a positive impact on capital flow in the second period. This was analysed from two perspectives, first, from the interest parity perspective. In this respect, the exchange rate remains the same and the domestic asset rate of return to attract arbitrage capital inflows positively affects capital flow. Second, the current exchange rate changes on the impact of capital flows did not show any peak between current period and the second period. There is a certain time lag effect with capital accounts, indicating the need for investors to have time to respond. From both short and long-term perspectives, the impact of spot exchange rate on capital flow is both positive and negative. After combining the two, there are no significant trends to be noted.

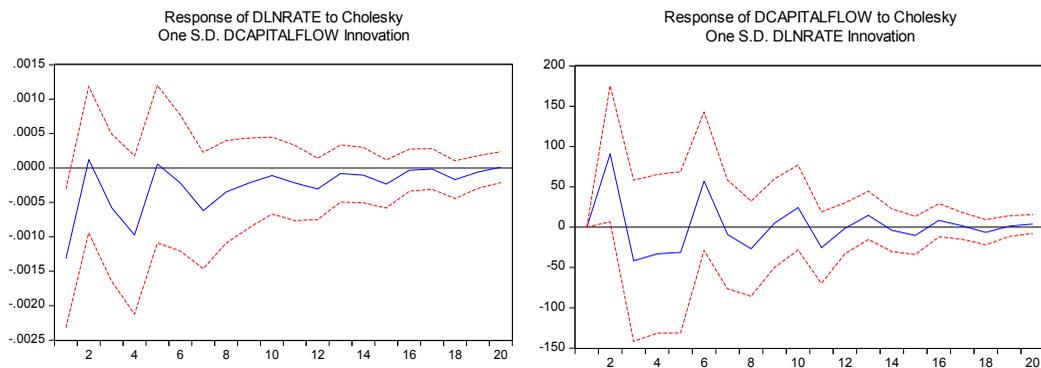


Figure 3. Response of D-capital flow and D-lnrate

## Innovation

As shown in Figure 3, the positive impact of capital flows has a negative impact on the expected RMB exchange rate, which is expected to cause the exchange rate to appreciate. The impact of the peak in the first period indicates that the impact of capital flow on the RMB exchange rate is expected to come about quickly. Additionally, the impact of rapid reduction result in the small fluctuations that stabilise to 12.

## Step 6: Variance Decomposition Results

Variance decomposition is an analysis of the impact of each structure on the contribution of capital flow, focusing on the relative importance of the central parity of RMB and an expected impact of exchange rate movements on capital flow. Since the variance analysis results for capital flow stabilised after the 20<sup>th</sup> period, the variance decomposition results for the period of up

to 20 are shown in Table 5. From Table 5, it can be seen that capital flow is affected by the impact of its own large impact; the first phase of 100%, with a decline evident in the second phase, with ultimate stabilisation at ~81%. The contribution rate of the change of RMB exchange rate (NDF) is only 0.24% and 0.75% in the second and third phases respectively, with an increase to 1.3% in the third period, and a final rise to 1.4%. Overall, the expected change in the RMB exchange rate has little effect on capital flow. While there is a significant lag effect, the impact of delay is about one quarter (3 to 4 months). The impact of the rate of change in RMB exchange rate on the rate of change in capital flows in the second phase of the contribution rate is 3.04%. This slowly increased over time, ultimately stabilising at ~5.46%. This indicates that the central parity of RMB changes have a certain impact on capital flows. This explains the 5% in capital flow changes.

Table 5  
*Variance decomposition results*

Variance: D- CAPITAL FLOW						
Period	S.E.	DCAPITALFLOW	DLNGDP	DLNNDF	DLNRATE	DRGAP
1	415.4148	100.0000	0.000000	0.000000	0.000000	0.000000
5	545.3138	87.55357	3.992377	1.290649	4.073214	3.090191
10	569.7330	81.95004	4.395476	1.387018	5.172065	7.095400
15	571.8761	81.45573	4.480473	1.400167	5.434944	7.228684
20	572.2444	81.39001	4.513178	1.401789	5.468192	7.226825
Variance: D- LN RATE						
1	415.4148	5.762955	0.023665	25.65204	68.56134	0.000000
5	545.3138	6.935890	1.085839	22.06604	56.68268	13.22955
10	569.7330	7.661359	1.680935	22.10858	54.95233	13.59680
15	571.8761	7.837728	1.877277	21.91727	54.59253	13.77519
20	572.2444	7.870695	1.917147	21.96802	54.45325	13.79088

From the result of the variance decomposition of RMB central parity, it can be seen that capital flow fluctuation has a certain impact on the RMB central parity. The first phase of the impact equalled ~5.76%, which gradually increased over time, ultimately stabilising at 7.8%. This 7.8% of the RMB exchange rate changes in the central rate of capital flows can be explained by those changes. At the same time, the RMB exchange rate expectations (NDF) also has an impact on the RMB central parity changes. This effect explains more than 20% of the changes, indicating that the fluctuation of the RMB central parity and forward exchange rate fluctuations are more consistent.

## CONCLUSION

This research has shown the spot rate of RMB is less affected by fluctuation than by the other factors, mainly due to the regulation of Central Bank in China. This also proves that the intervention of the PBOC on the spot exchange rate is effective, but the frequent exchange rate intervention will likely place great pressure on the Central Bank (with regard to base money supply and foreign exchange reserve passive volatility). Therefore, policy recommendations continue to gradually push market-oriented reform of the exchange rate, as the market has become the subject of RMB exchange rate volatility. There is still a strong expected guidance effect on market participants in the spot exchange rate changes. This research can be used in the development of policy, utilising the

effects explained above to manipulate the spot exchange rate to achieve stability.

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