Research on exchange rate fluctuation and cross - border RMB business development from the perspective of arbitrage

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Abstract. With the market reform of Chinese currency going forward, especially with the official introduction of RMB into Special Drawing Rights (SDR) basket of currencies on October 1, 2016, significant progress has been made in the internationalization of RMB, and the development of cross-border RMB business has been rapidly advancing. Under the circumstance of accelerating RMB internationalization, the question that how to further strengthen the management of anomalous RMB cross-border circulation caused by exchange rate fluctuations has aroused great concern. This essay focuses on the analysis of the impact of exchange rate fluctuations on the development of cross-border RMB business from the perspective of arbitrage and proposes policy recommendations accordingly.

Key words. Exchange Rate Fluctuation, Cross - border RMB Business Development.

Mainland China's "811" exchange rate reform in 2015 caused a global financial market shock. During the 14 trading days after August 2015, the RMB reference rate devalued by 4.4% against the U.S. dollar. This led to capital outflows beginning in the third quarter of 2015 in Mainland China and a cross-border capital deficit for four consecutive quarters. Until today, "exchange reform" in China has taken place for more than two years. Arbitrage under the background of cross-border RMB trade settlement still continues to occur. The fundamental reason for this is the appreciation and depreciation expectation with the fluctuation of RMB exchange rate and the different RMB interest rates and exchange rates in the domestic and overseas markets. This essay takes the transaction between Hong Kong– the largest and most mature RMB offshore market in the world and Mainland China as the main content of the analysis and discusses the exchange rate fluctuations and the development of cross-border RMB business based on the arbitrage.

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1. The impact of exchange rate fluctuations on the development of cross-border RMB business

(A) Fluctuations in the exchange rate of RMB can affect the distribution of assets and liabilities of economic entities, which has further impact on the development of cross-border RMB business. As a traditional international currency, the function of value reserve among RMB functions cannot be fully played out at present. The choice for overseas enterprises to hold RMB is mainly determined by the yield and risk of RMB. Enterprises are willing to hold RMB when the profit is greater than the risk, and visa versa. Taking the depreciation of RMB exchange rate as an example: the exchange rate of RMB after the "811 Exchange Reform" in 2015 showed a clear trend of depreciation, resulting in less willingness of domestic and foreign enterprises to hold RMB assets. In international trade, since Chinese enterprises do not have dominance and the initiative to negotiate, they can only passively accept the choice of foreign enterprises in the trade settlement method, which to a certain extent also affects the balance of receipts and payment in China's cross-border RMB business. At the same time, the devaluation of RMB is not expected to attract foreign market participants to hold RMB-denominated assets. On the one hand, the reduction of RMB capital's offshore deposits is not conducive to the development of its offshore market; on the other hand, the reduction of RMB capital in the offshore market will increase the financing costs of offshore RMB and lead to less willingness to cooperate between domestic enterprises and Hong Kong enterprises to do RMB businesses related to cross-border funding.

(B) The cross-border arbitrage in the context of RMB exchange rate fluctuations can promote the development of cross-border RMB business to a certain extent. At present, there are two onshore and offshore markets due to the incomplete realization of free RMB convertibility, and the price differences between the markets induce the arbitrage of the market transaction entities.

1. Cross-border Arbitrage Pattern in Depreciation of RMB. When RMB is expected to devaluate, arbitrage using RMB exchange rate's difference occurs mainly in Mainland China and enterprises earn spread through foreign exchange purchasing in Mainland China and overseas foreign exchange settlement. For example, at present, funds can be freely transferred between enterprises' RMB NRA accounts or between RMB NRA accounts and OSA accounts, and there is no need for examination and approval. After verifying the authenticity in the commercial banks, the enterprises can remit the money by purchasing foreign exchange. The "Three Principles of Sales" did not clearly define the content of the specific audit, so banks have more operating space. This arbitrage model will do more harm than good in the current economic situation, which increase the cross-border RMB business volume and the outflow of cross-border capital.

2. Cross-border Arbitrage Model for RMB Appreciation. During the appreciation period of RMB, the bank designed a series of corporate trade financing products to help domestic and foreign enterprises to make risk-free arbitrage by using RMB onshore, offshore interest rate and exchange rate difference. Among them, the products for receiving payment in cross-border transfer is the most representative, with

which domestic banks can get higher foreign exchange rates by running overseas settlement after receiving the clients' payment in foreign currency. The business procedures are simple and for enterprises they raise the settlement price and gain additional earnings from exchange rate differences. This shows that cross-border arbitrage has promoted the development of cross-border RMB business to a certain extent and enhanced the willingness of domestic and foreign enterprises to hold RMB, which is beneficial to the formation of a RMB-denominated global trading network.

(C) The Positive Feedback Effect of RMB Exchange Rate Expectation. The short-term appreciation and depreciation of RMB will have a short-term impact on the development of RMB business. If it is difficult for market transaction entities to form a consensus on the trend of the RMB exchange rate, space for arbitrage will decrease. When more consistent judgments appear in the market, however, the convergent actions will push the expectations into reality and improve the judgment confidence on the next phase, and that is the positive feedback effect. Through positive feedback effect, the expectation has a broader impact on the development of cross-border RMB business. Expected RMB appreciation will enhance the willingness of the overseas transaction entities to hold RMB, while the rising willingness in holding RMB will further promote RMB appreciation and create a new round of cycle. On the contrary, the expected devaluation of RMB will lead the market entities to sell off RMB in large quantities and speed up the devaluation of RMB, thus further leading to the trend of domestic and overseas assets in foreign currency and liability in local currency.

2. The reasons for the arbitrage under the background of cross-border RMB business development

(A) RMB Interest Rate Differences. At present, the interest rate of Hong Kong-RMB is usually lower than the domestic RMB interest rate. At this point, Hong Kong companies can transfer RMB to domestic affiliated companies to settle in order to obtain spread. In particular, at present, the central bank implements macro-prudential management of full-scale cross-border financing and integration of domestic and foreign currency. Domestic financial institutions and enterprises can independently conduct cross-border fund of local and foreign currency within the cross-border financing ceiling linked to their capital or net assets. Due to the differences in interest rates in Hong Kong and Mainland China, more and more domestic enterprises choose to raise fund in RMB overboard.

(B) System Differences of Currency Exchange Rate. The formation mechanism of Hong Kong dollar and domestic RMB exchange rate is different. Hong Kong uses the linked exchange rate system, which is first quoted by major market-making banks and set the opening price of the foreign exchange market on that day by taking the average without the three highest and three lowest. The Hong Kong dollar's strategy is to nail the dollar. The domestic RMB exchange rate system refers to a basket of currencies to adjust, and the central bank does not publicize the specific weightings of the currency and weighting-changing mechanism. Due to the different

formation mechanism of exchange rate, there are differences in the caliber of onshore and offshore RMB to US dollar exchange. Domestic RMB is affected by many both domestic and international factors, resulting in two-way fluctuations in the exchange rate of the U.S. dollar, but there is no such fluctuation in the exchange rate system of the Hong Kong dollar. Therefore, there will be a certain exchange rate between Hong Kong dollar to U.S. dollar and the domestic RMB exchange rate to U.S. dollar, and the size of the exchange rate difference will continue to fluctuate. It is this fluctuation of exchange rate differences that brings arbitrage to RMB - U.S. dollar.

(C) Difficult to Verify the Authenticity of Trade. Under the background of RMB cross-border settlement, to get the market rate difference between at home and abroad, the domestic enterprise can remit RMB to associated overseas enterprises or middlemen through trade contract, then use overseas affiliates or middlemen to purchase foreign exchanges and pay the ultimate receiver. Although the central bank bans such business, due to the authenticity of cross-border import and export businesses is difficult to be effectively audited, some enterprises can still handle such cover draft and other abnormal trading through entrepot trade and other ways.

3. Empirical analysis of the impact of exchange rate fluctuations on cross-border RMB business development

3.1. State space model

This essay selects the state space model to carry on the empirical analysis. This model can incorporate unobserved variables (state variables) into observable model and use strong efficient recursive algorithm for some variable parameter estimate that is not easy to be observed. Because many of the factors influencing exchange rate fluctuations are unobserved, this essay uses the state space model to better analyze the impact of exchange rate changes on cross-border RMB business development. The general state space model is as follows:

The measurement equation is: $y_t = d_t + z_t a_t + u_t$, $t = 1, 2, ..., T$ where z_t represents the $k \times m$ matrix, T represents the length of the sample, called the measurement matrix, d_t represents $k \times 1$ vector, u_t represents $k \times 1$ vector, and is a continuous unrelated perturbation term with mean 0, co-variance matrix H_t, that is: $E(u_t) = 0$, $\text{var}(u_t) = H_t$.

The equation of state is: $a_t = T_t a_{t-1} + c_t + R_t \varepsilon_t$, $t = 1, 2, ...T$ Here, T_t represents $m \times m$ matrix, which is called the state matrix; R_t represents the $m \times g$ matrix; c_t represents the $m \times 1$ vector; ε_t represents the $m \times 1$ vector, which is a continuous unrelated perturbation term with mean 0, co-variance matrix Q_t, that is $E(\varepsilon_t) = 0$, $\text{var}(\varepsilon_t) = Q_t$.

3.2. empirical analysis

1. Indicators. This essay considers the availability of index selection, and selects one of the economic and financial indicators that has been proven to be good for

many times in the existing literature, that is "Cross-border Trade RMB Settlement Amount (PTS)" as the dependent variable, and selects the following five Indicators "Domestic RMB Appreciation and Depreciation (ER), Trade Scale (TD), Offshore RMB Appreciation and Depreciation Expectations (EA), Offshore RMB Market Development Depth (OS) and Domestic and Foreign Spreads (DR)" as the independent variables. The indicators are described in Table 1. Sample data is the monthly data from July 2009 to June 2016.

Table 1. Indicators Affecting the Development of Cross-border RMB Business

Indicator's name	Explanation of Indicator	Note
Cross-border Trade RMB Settlement Amount (PTS)	China and Hong Kong, Cross-border RMB Regular Closing / Total Import and Export Trade between China and Hong Kong	As the largest and most mature RMB offshore market in the world, Hong Kong has a certain representation.
Domestic RMB Appreciation and Depreciation (ER)	The difference between RMB real effective exchange rate and base exchange rate	The base period is the end of May 2010
Trade Scale (TD)	Trade Size between China and Hong Kong / Total Trade in China	
Offshore RMB Appreciation and Depreciation Expectations (EA)	Difference between the monthly average of Hong Kong offshore market NDF one-year exchange rate and the base period	The base period is May 2010
Offshore RMB Market Development Depth (OS)	Hong Kong RMB deposits / bank deposits in Hong Kong	As the largest and most mature RMB offshore market in the world, Hong Kong has a certain representation.
Domestic and Foreign Spreads (DR)	The difference between one-year Shibor and one-year Libor	

2. Empirical analysis process. After tests of the mutation point, the stability and the cointegration and set the VAR model, it is found that the two variables, DR and TD, have no significant impact on the development of cross-border RMB business. Other variables have the significant impact. Therefore, this essay focuses on the analysis of the impact of offshore RMB Appreciation and Depreciation Expectations (EA), offshore RMB Market Development Depth (OS), domestic RMB Appreciation and Depreciation (ER) and their impact on cross-border RMB settlement. So the designed measurement equation of state space model and state equation is adjusted as follows:

Measurement equation:

$$\ln PTS = c + SV_{1,t} \times \ln ER_t + SV_{2,t} \times \ln EA_t + SV_{3,t} \times \ln OS_t + \mu_t.$$

Using OLS to give the initial value for c and μ_t in the above measurement equation, where, $SV_{1,t}$ $SV_{2,t}$ $SV_{3,t}$ respectively, are the sensitivity (ie elasticity) of RMB settlement volume of cross-border trade at various time points to expectation of offshore RMB appreciation and depreciation the devaluation of RMB in Mainland China, the development depth of offshore RMB market.

Equation of state:

$$SV_{1,t} = \alpha_1 + \beta_1 SV_{1,T-1} + \xi_{1,t},$$

$$SV_{2,t} = \alpha_2 + \beta_2 SV_{2,T-1} + \xi_{2,t},$$

$$SV_{3,t} = \alpha_3 + \beta_3 SV_{3,T-1} + \xi_{3,t}.$$

The initial value of parameters α_i β_i and $\xi_{1,t}$ $(i = 1, 2, 3)$ in the above three state equations are given by the first-order autoregressive model.

Write the state equation into state space model by Eviews software:

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param c(1)-1.85c(2)-4.5 ,
@signal log(PTS) = c(1)+sh1* log(ER(-5))+sh2* log(EA(-4))+sh3* ,
log(OS(-7))+[var = exp(c(2))] ,
@state sh1 = sh1(-1) ,
@state sh2 = sh2(-1) ,
@state sh3 = sh3(-1)  .
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The initial values of the unknown parameters c (1) and c (2) are obtained by establishing the general regression equation EQ01: using the constant term -1.85 as the initial value of c (1), and finding the variance of the equation residual $=$ h, then z $=$ log (h) $= -$ 4.5, take z as c (2) for the initial value. In the procs, selecting the Make State Series generates the state vectors sh1F, sh2F, sh3F, respectively, as proportion of the RMB cross-border trade settlement, the expectation of offshore RMB market appreciation and devaluation, the domestic RMB appreciation and depreciation, offshore market development depth's dynamic elasticity $SV_{1,t} SV_{2,t} SV_{3,t}$. After Using Eviews to do the math, we know that the Z-statistic coefficients of the three state equations estimated by the state-space model are significant (Table 2).

Table 2. variable parameters' results

State variables	Final State	Root MSE	zStatistic	Prob.
SV1(OS)	0.944527	0.043158	23.59268	0.0000
SV2(ER)	0.067352	0.002957	11.65874	0.0000
SV3(EA)	0.766394	0.086432	1.23514	0.0018

3. The empirical results' explanation. The results of Table 2 show that the ranking of the importance of cross-border RMB settlement amounts is as follows: RMB offshore market's development depth (OS) > Offshore RMB Appreciation and Depreciation Expectations (EA) > Domestic RMB Appreciation and Depreciation (ER); elasticity factor is 0.94, 0.77, 0.07.

First, the higher the proportion of RMB deposits, the greater the promotion effect of cross-border RMB trade settlement. The increase in offshore RMB deposits shows increasing willingness of RMB holders in offshore markets and the acceptance of RMB -denominated settlements, thereby furthering the development of cross-border RMB business. Second, the appreciation and devaluation of RMB in the domestic market has the least impact on the cross-border RMB settlement business. Although RMB has already joined the SDR at present, the market entities are more concerned about the possible losses caused by RMB devaluation. The devaluation of RMB brings more influence on the business volume of cross-border RMB trades than appreciation. However, the expectation of offshore RMB appreciation and devaluation is expected to slow down the long-term effect on the cross-border RMB settlement.

4. The analysis of arbitrage under the background of cross-border RMB business development

Through analyzing the above empirical results, we choose the development depth of RMB offshore market development and the expected change of offshore RMB exchange rate to analyze the cross-border RMB arbitrage.

4.1. The impact of development depth of RMB offshore market on arbitrage

Between June 2010 and June 2016, the RMB settlement amount in the RMB offshore market in Hong Kong showed a clear upward trend (Figure 1). This implies that the RMB offshore market in Hong Kong continues to expand in depth. The increase in the RMB supply has made it more convenient for domestic enterprises to obtain offshore financing against domestic guarantee from Hong Kong by using the RMB letter of credit. Coupled with the relatively low interest rate in the Hong Kong market, it is more likely that arbitrage of offshore financing against domestic guarantee using RMB letter of credit will occur under this background.

Offshore financing against domestic guarantee is that the domestic companies apply for a domestic bank to open a guarantee letter; domestic banks issue financing letters to offshore centers; the offshore center will then issue loans to overseas enterprises with a guarantee letter; this is the way for domestic enterprises to achieve financing. As the loan spread between Hong Kong and Mainland China is significant, companies can reduce the financing costs. After the domestic enterprise deposits RMB in a domestic bank and requests the bank to issue a RMB letter of credit. After that, on the ground of trading with its overseas affiliate, the enterprise uses the letter of credit to obtain a lower interest rate of RMB capital from a Hong Kong bank to gain spread. As banks in Hong Kong take out RMB loans to enterprises in mainland China, its net debt to the Mainland kept increasing. As shown in Figure 2, the claims of Hong Kong banks on mainland banks gradually rose from 2014 to 2015, reaching the peak in June 2015 and declined after being affected by the "811" exchange rate reform. The overall trend of the bank loans is on rise.
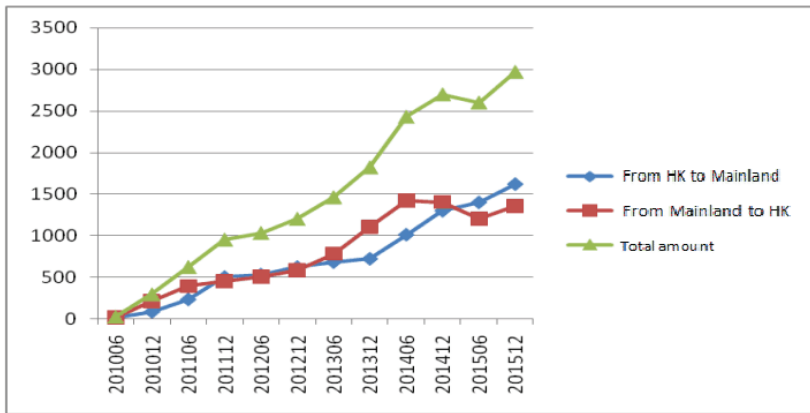
Fig. 1. Hong Kong RMB Offshore Market Settlement Volume (Figure Source: Hong Kong Monetary Authority)
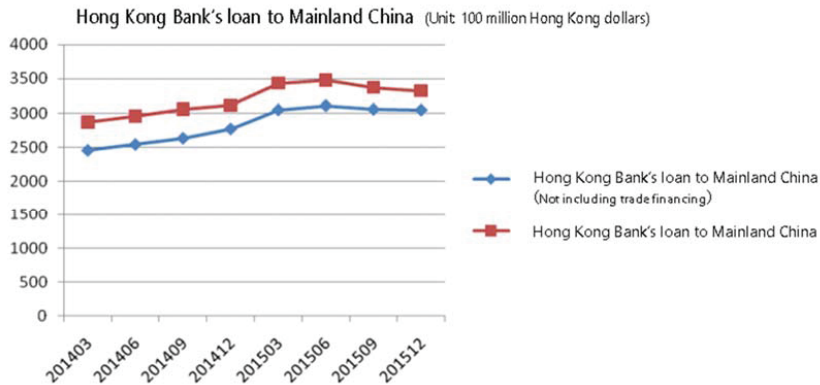

Fig. 2. Hong Kong Bank's loan to Mainland China (Unit: 100 million Hong Kong dollars) (Figure Source: Hong Kong Monetary Authority)

The SWIFT system report shows that the RMB payment accounted for 2.26% of the total global international settlements at the beginning of 2015, ranking No. 5. During the same period, the share of RMB with letter of credit activity was 9.43%, immediately following the USD. This anomaly also shows that the transaction volume of arbitrage through the RMB-denominated offshore financing against domestic guarantee is relatively large.

4.2. the impact of the expected change in offshore RMB exchange rate on arbitrage

1. Use off-shore market and onshore market spot exchange spread to arbitrage.

Due to the spot exchange spread between the mainland onshore RMB market and the offshore market in Hong Kong, the following arbitrage mechanism has emerged:
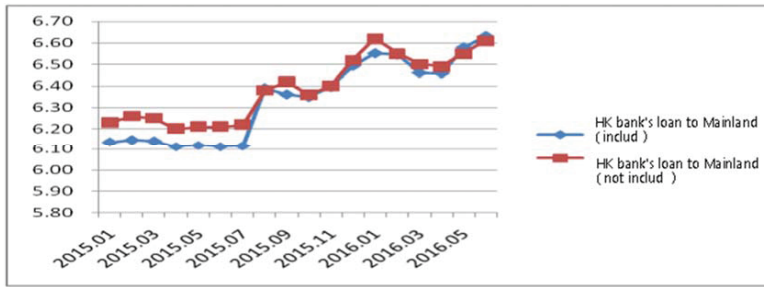
Fig. 3. The spot exchange rate of RMB between Hong Kong offshore market and mainland onshore market (Direct Pricing Method) (Figure Source: Hong Kong Monetary Authority, State Administration of Foreign Exchange, Unit: RMB yuan)
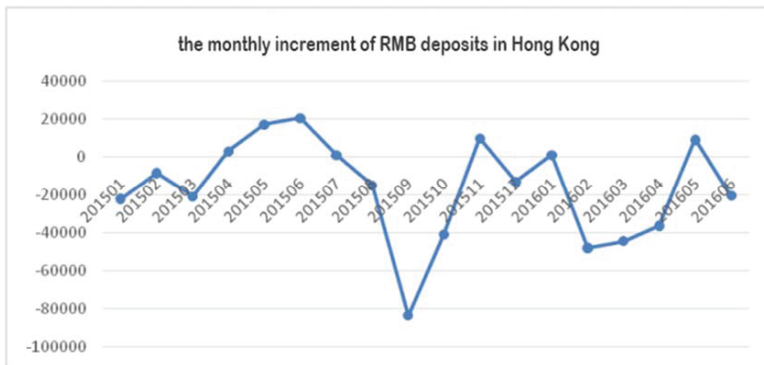

Fig. 4. the monthly increment of RMB deposits in Hong Kong (unit: Million RMB yuan) (Source: Hong Kong Monetary Authority)

When the spot exchange rate of RMB in Mainland China[1]is higher than the spot exchange rate of RMB in Hong Kong, the mainland exporters will settle the USD in the mainland banks and importers will purchase U.S. dollars in Hong Kong for import. When the spot exchange rate in the mainland RMB is lower than in Hong Kong, mainland exporters and importers will make the opposite transaction.

As shown in Figure 3, from January 2015 to July 2015, the RMB off-shore spot exchange rate was significantly higher than the mainland RMB onshore price, while 2 months after October 2015, the gap was significantly smaller. From January to July in 2015, enterprises can easily gain spread by selling in the offshore market after purchasing dollars on the onshore market. As can be seen from Figure 3, in August 2015, the difference between RMB offshore and onshore market prices is large, and this short period is also the peak period for foreign capital to flow out.

2. Using expectation of offshore market RMB appreciation or devaluation to arbitrage.

Under this kind of arbitrage mode, once Hong Kong expects RMB devaluation

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[1]In this essay, direct pricing method is used in spot prices. direct pricing method is: using a certain unit of foreign currency as the standard to calculate how many units to be domestic currency. Most countries in the world, including China, now use the direct pricing method

in the offshore RMB market, traders in the Hong Kong market convert purchased RMB to USD while buying RMB in the future market and selling USD. The yield rate in this arbitrage mode is the difference between the dollar loan rate and the RMB deposit rate. Once the real devaluation of RMB is higher than the difference, the speculators can make a profit.

Before the "811" exchange reform, there had been a strong devaluation expectation of RMB. At this time, Hong Kong's speculative demand for RMB has risen. The spot exchange rate of RMB onshore will be pushed up, resulting in enlarging a spot exchange difference between the RMB offshore and onshore markets. Since 2015, the exchange rate difference between the offshore market and the onshore market has been expanding. From the beginning of 100 bps to the maximum of 1,000 bps after the "811" exchange rate reform, market arbitrage has huge profit margins.

After the "811 Exchange Reform", the situation that the RMB FOB surpasses the CIF in a relatively long period of time has been broken and the RMB funds have been diverted from the offshore market to the onshore market. In order to achieve this goal, we need to reduce the supply of overseas RMB funds. As of the end of April 2016, RMB deposits in Hong Kong dropped to 723 billion yuan, while the overall size of RMB funds in Hong Kong narrowed by approximately 11.7% as compared to the end of 2015. During the period, the monthly increment of RMB deposits in Hong Kong from September to October in 2015 was negative. There is a clear correlation with the expectations of RMB devaluation in the Hong Kong market, as shown in Figure 4.

5. The policy recommendations of improving mainland China's government

Mainland China is accelerating the process of RMB internationalization and raise the status of RMB internationally. This is a goal matching the increasingly powerful economy. The exchange rate market-oriented reform, the establishment of the exchange rate market price mechanism is a hurdle for the RMB internationalization and will certainly become more accelerated with RMB joining the SDR. Therefore, how to better handle the fluctuation of RMB exchange rate and evade the significant influence or disruption of arbitrage in the development of RMB cross-border business, we suggest that:

(A) To guide the two-way fluctuation expectation of RMB exchange rate, widen the fluctuation range of exchange rates and promote the balanced development of cross-border people's businesses. First, to avoid the emergence of a single direction of appreciation or depreciation in the RMB exchange market, and to reduce the motivation for the movement of arbitrage funds. In addition, they can also increase short-term fluctuations of exchange rates in a right time, increase arbitrage risks for speculators to curb speculative activities and to promote "real instead of fake" cross-border RMB business. Second, it is necessary to reinforce the awareness of the enterprise's exchange rate risk management, enhance the initiative of enterprises to choose RMB settlement in cross-border trade, and highlight the advantages of evading exchange rate risks by using cross-border RMB business settlement.

(B) to further promote the reform of RMB exchange rate formation mechanism. First, to seize the opportunity of RMB joining the SDR to further improve the formation of a transparent market-trust exchange rate basket mechanism that will allow more marketers to trade on the basis of a basket of currencies. Second, we should further improve the transmission mechanism of the RMB exchange rate, put the exchange rate communication in the position of the major instrument of exchange rate adjustment and enhance the transparency of the exchange rate formation mechanism. The central bank should strengthen communication with the market and improve the availability of RMB exchange rate index data so that the market can judge and consult the validity of a basket of monetary mechanisms.

(C) Strengthen RMB offshore market construction, promote RMB offshore product innovation and improve relevant regulatory regimes. At present, the overall amount of RMB financial products in international financial markets is relatively small. Foreign RMB holders lack the channels for realizing returns and hedging risks, affecting the willingness of international investors to hold RMB, which is not conducive to the growth of cross-border RMB settlement. First, we should put more efforts to build RMB offshore market and increase the number of RMB offshore markets. The second is to innovate and develop overseas RMB financial products (such as RMB bonds) and to promote the effective transmission between RMB onshore and offshore prices, forming a benign linkage between domestic and international markets. The third is to strengthen the regulatory system of RMB capital market and gradually form a series of complete and efficient legal systems to strengthen supervision and prevent risks while cracking down on various types of financial violations.

(D) Strengthening international financial cooperation and giving full play to China's influence and participation in the international financial industry and the market. First, to strengthen cooperation with international financial organizations, to play a dominant position as a major economic power and as RMB in a SDR currency basket; promote the development of international economic and financial reform and play an influential role; the second is to use China to dominate the regional international Financial organizations such as the Asian Infrastructure Investment Bank (AIIB) to carry out international financial innovations, actively improve the rules and order of the international finance and play a leading role in the reform of the international financial order. Third, deepen economic and financial cooperation among countries and promote financial cooperation of the "Belt and Road" participating countries, such as deepening cooperation with Russia's on oil and RMB.

Acknowledgements

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