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**Interactions of the Spot Exchange Rates between the RMB**

**Onshore and Offshore Markets**

人民元オンショア為替レートとオフショア為替レートとの相互作用

(要 旨)

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## Chapter 1 Introduction

Before 2009, the Chinese Renminbi had been forbidden to exposure in the international markets because of strict authority controls by Chinese government. US dollars denominated transactions between Chinese companies and a foreign entity. The 2008 financial crisis rounded the alarm of China, in order to get rid of the U. S. dollar control, Renminbi internationalism, as a Pilot Scheme of Cross-Border Trade Settlement, has been initiated and has undergone several landmarks during the last 10 years. It has surely accelerated the international use of Renminbi over the past few years. In 2017, the Phoenix International said the RMB was ranked sixth in global trading and payment settlement. China has become the second largest economy in the world.

In market participant's eyes, the RMB transacted in Hong Kong is different from the RMB in China, thus the RMB traded in Hong Kong was coined as CNH instead of the usual trading symbol CNY. In this way, people use "RMB" as a general reference to the Chinese currency renminbi, while CNY and CNH refer to the RMB currencies transacted, respectively, onshore and offshore.

Anyhow, as Feng and Zhang propose (2017), the development of the offshore RMB market has not only promoted the RMB's internationalization, but also has affected the onshore RMB market. Santana Nyekano (2016) points out, when the value of CNH was more than that of the CNY, investors in China imported from Hong Kong thus increasing CNH deposits, and when CNY grew in value more than CNH, the investors spent their earnings on the mainland, which had the effect of reducing their CNH deposits. Based on the above, this paper aims to investigate the interactions between CNY and CNH from three aspects.

The paper's first intention is to investigate the Renminbi (RMB) spot exchange rates against USD to test the interaction between the onshore and offshore markets. The empirical results will show the spillover effect in mean, and how the volatility differs in different periods. If there is the bidirectional interactions between CNY and CNH spot exchange rate, we want a proof of the information superiority of Chinese government by edging the CNY market over the offshore one, at the same time, readjusting the exchange rate of the CNY based on the CNH changes in exchange rates in line with market expectations.

The second intention is to reveal whether the exchange rate trading band blocks correlation between the onshore and offshore exchange rate by evidence from RMB market. Based on 5-minute of spot exchange rate data of the two markets, this paper adopts seemingly unrelated VAR model and DVEC-GARCH model with the dummy variable, to analyze the effects of the exchange rate reform after March 17, 2014.

The third intention is to explore whether the Chinese government has intervened in the RMB offshore market. The paper makes use of the 1-minute data between August 3, 2015 and February 5, 2016 for analysis. The method employed is the impulse response function, to analyze influences between variables in VAR model by observing its characters and study the accumulative effects among the CNH and CNY exchange rate.

The finding is that there are some positive effects brought by the intervention. When the Chinese authorities buy RMB and sell dollars on a large scale to intervene in the offshore market,

the CNH exchange rate becomes appreciated, which is close to the CNY exchange rate, and the spread is narrowed, then the government's purpose of stabilizing RMB exchange rate is achieved.

The thesis consists of six parts:

**Chapter 1** provides an introduction, which briefly introduces the background of the Renminbi internationalization and the outline of the thesis. **Chapter 2** gives the literature review over the interactions between the onshore and offshore markets. **Chapter 3** deals with the empirical analysis over interactions between the CNY and CNH markets. **Chapter 4** concerns that the exchange rate trading band blocks correlation between the onshore and offshore exchange rate by evidence from RMB market. **Chapter 5** investigates the possible interventions from the Chinese authorities on CNH markets in narrowing the spread of foreign exchange rates between the CNY and CNH markets. **Chapter 6** makes a conclusion with summaries and suggestions for the government to make future policies.

## **Chapter 2 Literature Review**

As Weller says (2016), "though China has reformed its currency policy to allow a more market-determined exchange rate over the last few years, policymakers still have significant influence over the yuan's value". This utters the voices of most scholars. Empirical studies prove it and many have found a unidirectional influence, that is, the domestic market holding the pricing power of RMB over that of the CNH (Zhu and Liu, 2012), or the CNY price has the leading role over that of the CNH (He and Zhang). Upon the previous studies, the author plans to investigate more from the following three aspects: the interactions, the interventions and the spread.

### 2.1 Interactions: unidirectional vs bidirectional

The current research about interactions of the spot exchange rates between CNY and CNH markets can be classified into four categories: the ones that study spot exchange rate along with forward exchange rate and NDF, the ones study it with forward exchange rate, and the ones with NDF, and the ones focusing on spot exchange rate. This means the references on this topic are limited in number.

The present research related to interactions between the RMB onshore and offshore markets shows two different perspectives: one view claims a unidirectional correlation from the CNY exchange rate to that of the CNH, i.e. the onshore RMB spot rate guiding that of the offshore (Xiong, 2011; Maziad, & Kang, 2012; Zhang, & Zhong, 2014; Yang, 2014). It is not applicable in reverse. The other view is that, being affected by the new exchange rate reform, the relations between the onshore and offshore spot rate is dynamic and time-varied, tending to change from unidirectional correlation to bidirectional interactions, between which the CNY market plays a leading role (Deng, 2016). In terms of research methods, the previous study involves two: the Granger Causality Test (Xiong, 2011; Yang, 2014; Owyang, Wong, & Horowitz, 2015) or the Garch Model (Leung, & Fu, 2014; Maziad, & Kang, 2012).

### 2.2 Price limit: effective or not

The prime purpose of the price limit, is to cool off the traders' emotion and thus to reduce the price volatility, which hinders the transmission of the stock price information. However, regarding

the effectiveness of price limit, there is some controversy in the academic circle.

Price-limit supporters believe that it provides the opportunity for investors to reevaluate the market information to reduce information asymmetry so to make a rational choice by cooling off traders' overreaction and reducing the volatility of price. Arak & Cook (1997), based on the analysis of the U.S. Treasury bond futures market, concludes that the price limit causes a small price reversal when futures price is close to price limit to make the market stable. Berkman & Lee (2002) use the data of Korean stock market to find that the larger is the price limit, the more volatility of long-term stock price is, meanwhile the trading volume reduces. While otherwise, the stricter is the price limit, the more likely the volatility is restrained. Therefore, the strict price limit in the emerging market is effective.

Opponents argue that price limit is ineffective and will lead to price discovery delay. At the same time, the price volatility restrained by the price limit will be transmitted to the next trading day and cause the volatility spillover. Kim & Rhee (1997) point out in the study on the Tokyo stock market that the price limit increase volatility in the stock market on subsequent days, lead to the delayed price discovery, with the stock trading being interfered.

Being different from stocks market, the foreign exchange market doesn't force the market participants to stop the buying and selling of exchange rate demands, but to achieve the purpose of restraining exchange rate fluctuations by the central bank's intervention, to keep exchange rates at a stable level by market mechanism. In this way, so long as the exchange market has sufficient supplies, the market will be protected from sudden rise or fall, and the spillover would not appear in exchange rate markets. Therefore, the author believes the problems which the opponents of price limit worry about would not emerge, the "price limit" will inhibit the information transmission between the two markets.

### 2.3. Intervention: significant vs insignificant

In some scholars' eyes, the Chinese government the PBOC sets a daily reference rate for the CNY through an opaque process, traders are only allowed to sell or buy the currency within a range of only 2% set by the daily fix. While the CNH enjoys a more liberal trading band, the PBOC does sometimes influence its liquidity by regulating the CNY exchange rate. They describe such a situation of the CNH as a sort of "black market" for the country's currency (Weller 2016) .

Though there is little previous study on the Chinese government's intervention on the CNH foreign exchange rate, the issue of foreign exchange rate intervention by central banks has long been a debate. Some hold positive views. According to Liu (2016), the effectiveness of foreign exchange intervention by central banks has been studied extensively in the past thirty years. In general, it is a matter of controversy and the subject of a vast academic and policy-related literature. For scholars like Friedman (1953), Almekinders and Eijffinger (1996) , Bonser-Neal and Tanner (1996) insist that necessary intervention causes significant positive effects on exchange rate volatilities, but some others hold that central banks officers are lack of professional knowledge in foreign exchange marketplace.

In the process of study, the most embarrassing situation is that the Chinese Central bank has

always been ashamed to release the data concerns the interactions between FX rates of the CNY and CNH. The author has to spend a lot of time searching for data. Moreover, the most difficult thing for the author is to consult the literature relevant to the interventions of the Chinese authorities in the FX rate of the RMB offshore markets. The current information about it has mainly been in the forms of media release and IMF working reports. The last and the most regrettable is that data concerning the intervening the FX rates between the CNY and CNH remains incomplete, too expensive for any academic institutions to buy. Thus, there is still some limits in the work.

### **Chapter 3: Reinvestigation of the Interaction Between the RMB Onshore and Offshore Markets: An Empirical Analysis based on Hourly Data**

Since the global financial crisis in 2008, there has been an urgent need for China to have the Renminbi internationalized for its economic integration into the global financial system as well as freedom from USD hegemony. The internationalization of the Renminbi means the use of currency beyond the jurisdiction of the Peoples' Republic of China and allows nonresidents to hold the Renminbi extensively overseas as a currency for routine payments, settlements, investments, and reserves. During seven years, as a trade settlement currency, the offshore RMB-denominated trade settlement business grew steadily in the international market, the range of holding and using RMB also expanded, an indication that the Hong Kong offshore market played an important role.

As the premier offshore Renminbi business center, the Hong Kong Renminbi offshore market came into being on July 19, 2010, when the People's Bank of China (PBOC) and the Bank of China (Hong Kong) signed the amendment of *Settlement Agreement on the Clearing of Renminbi Businesses*. According to the agreement, RMB deposits in Hong Kong can be transferred between banks, and, for enterprises, the upper limits of currency conversion has been removed. Free trade of various financial commodities such as RMB convertibility, RMB deposits, and the issuance of RMB denominated bonds, have become reality. The paper carries out this study by employing econometric analysis with hourly data from January 3, 2011 to August 10, 2015. Granger Causality Tests and the BEKK-GARCH model are used, one is to testify the causality between CNH and CNY spot exchange rates, the other is to analyze the volatility spillover effects of both markets.

To find out whether there are interactions between the RMB onshore and offshore spot rate markets, the paper identifies the causality and the volatility spillovers effects, i.e. the information fluidity between the two markets. This paper aims to achieve the four breakthroughs: First, in regards to the sample period, the data covers a period of four and a half years, which is from Jan. 3, 2011 to August 10<sup>th</sup>, 2015, with a larger span, presenting a more complete view of the changing relation between the two markets. Second, differing from the existing results, the paper chooses hourly data of RMB transactions to research the exchange rates between CNY and CNH markets, which can more promptly describe the interactions between the RMB onshore and offshore markets. Thirdly, while studying the relationships in the entire period, it is further split into five sub-periods according to external stimulus and policy variation. The thesis analyzes each sub-period to discover whether the relationship between the CNH and CNY exchange rates changes or not at different times. Fourthly, as far as research methods are concerned, this paper not only adopts Granger

causality to certify the causality of both the entire period and each sub-period, but also employs the BEKK-GARCH model to analyze the volatility spillover effects between the two markets. In this way, we can accurately certify the interactions between the CNY and CNH spot rate exchange, as well as the directions of information transmission between the two markets. The breakthroughs of this paper can provide sufficient evidence as reference to promote the healthy development of the CNH and CNY markets, and at the same time, to prevent financial risks.

As one of the China's national strategies, the establishment and development of the Renminbi offshore are the embodiments of the process to the Renminbi internationalization. It is different from foreign countries in which the emergence of the offshore markets overseas is spontaneous, e.g. Japan, the United States and the U.K. Direct trading can be done between the onshore and offshore markets with no regulation. Therefore, the exchange rates between the offshore and onshore markets are completely interactive and almost equal. The reasons for the Renminbi offshore to be different are as follows: firstly, it is the Chinese government that has promoted the offshore market; secondly, the capital accounts in China has not achieved free convertibility; thirdly, the financial management system is still imperfect. In this way, there are two completely different RMB exchange rate formation mechanisms in the foreign exchange rate markets: one is the onshore exchange rate formation mechanism manipulated by the PBOC, the other is the offshore Renminbi exchange rate formation mechanism determined by the market demand and supply, thus formed the fundamental difference: direct trading is forbidden between CNH and CNY markets due to the regulation of cross-border capital transactions.

But, restrained by the different exchange rate systems and affected by the participants with different trading motivations, there is a certain price gap between the exchange rates of the two markets, possibility of arbitrage will arise for the store of value; especially when under certain circumstances (cross-border RMB trade settlement), indirect transactions can be made between the two markets, which may also lead to arbitrage. At the same time, the foreign exchange settlement derived from export payment via the commercial or bank agents will also generate revenue from the exchange rate spread. Thus the existing arbitrage surely causes interactions between CNH and CNY.

The current studies choose the closing price for data analysis concerning the exchange rate interactions between the onshore and offshore markets. The weakness in these is that the onshore market closes earlier than the offshore. The exchange rate of the offshore market can be influenced by the closing price of the CNY market so, if we analyze using the closing time data, there will be a deviation in the empirical result. Therefore taking the difference in closing time into account, this paper starts with the hourly data, selecting 7 hour points of CNY and CNH exchange rates of simultaneous transactions at 10:00, 11:00, 12:00, 13:00, 14:00, 15:00, and 16:00 from January 3, 2011 to August 10, 2015, as well as the closing price for data analysis in comparison. In doing this, it is hoped that we can obtain more sensitive and accurate interconnects between the two markets.

The CNY is managed floating exchange rate system, restricted by the trading band. The benchmark of the trading band is called "central parity rate" which is announced at 9:15 each day

by the China Foreign Exchange Trading Center. The CNY fluctuates within the upper and lower limits of the specified floating range. The central parity rate of Renminbi is calculated by eliminating the highest and lowest quotations which are requested from the market maker in the interbank system every day, to a weighted average figured out by the China Foreign Exchange Trading Center.

To test the stationary time series used in the analysis, the paper employs the Unit Root Test for analyzing the stability of the exchange rate between the CNH and CNY markets. All the results of the unit root test for the whole period and each sub-period show that, the test for all the level variables accept the hypothesis and the first differenced variables accept the hypothesis. So, both the CNH and CNY exchange rates have one unit root. This paper adopts change rate (the differenced series of the logarithm) for the following econometric models. We first employ the Granger Casualty Test to verify the causalities of both the entire period and the sub-periods between the CNH and CNY exchange rates, and then adopt the BEKK – GARCH model to analyze the volatility spillovers between the two markets. By means of the two methods, we can analyze whether the two markets are interactive, as well as the directions and dimensions of the information transmission between them. In this way, we hope to get a better whole view about the interactions between the spot exchange rates of the CNH and CNY markets. The paper aims to analyze if there is the Granger causality between the CNH and CNY exchange rate at each hour from 10:00 to 16:00 during the entire period and each sub-period. At the same time, by way of contrast, we also analyze the closing price to see if there is causality between the two markets.

The fundamental reason for the result is that the exchange rate of the CNH reflects not only the changing trend of the RMB, but also the local superiority of the CNY market in information transmission, indicating the interactions between the two markets. The fact that the currency is unified determines the unification and interactions between the CNH and CNY from within, despite the different exchange rate systems. The influence of arbitrage cannot be neglected, though in the case of no-arbitrage, the two markets interact with each other. Price difference between the CNH and CNY caused by the existence of cross-border capital controls becomes the very reason for the speculation opportunity. Market speculators speculate by taking advantage of the loophole of cross-border RMB trade settlement, giving rise to certain interactions in the exchange rates between the CNH and CNY markets. This is an arbitrage of the rate disparity between a restricted China and the free market. If free arbitrage is allowed between the two markets, then the gap should disappear, or near zero. When there is always a spread between the CNY and CNH exchange rates, there is little speculation, a proof that the RMB capital regulation is still effective (Figure2).

The reason is that the CNY market has a closed nature with a managed floating exchange rate system, which limits the trading band, and implies the PBOC will intervene in the onshore market according to the market situation. Therefore, the CNH exchange rate may suggest higher volatility than that of the CNY, which is shown more obviously when there is greater market fluctuation. Due to the intervention of the People's Bank of China, the changes of the CNY exchange rate are suppressed when necessary. With the anticipation of the whole trend of the RMB exchange rate, the offshore participants' demand for selling RMB is still great, therefore investors in the offshore

market will ignore the intervened changes of the CNY exchange rate, CNY's influence over CNH in this case seems to disappear. On the other hand, the offshore market more closely reflects the RMB future trend, even if the CNY exchange rate is intervened upon, the exchange rate of the CNH will still exert influence over that of the CNH. Most researchers claim that the CNY exchange rate is the Granger causality of the CNH one, but while conversely there is no causality. In the author's view, this is because the CNY market closes earlier than the CNH market, so, information will be naturally transmitted to the CNH, causing some deviation in the empirical results.

In order to investigate the information transmission direction between the two markets, we adopt the multiple GARCH model (BEKK-GARCH model) proposed by Engle and Kroner (1995) for testifying the volatility spillover effects of the two markets. Considering the influence of the volatility between various markets, the BEKK-GARCH Model can both analyze the volatility spillover of the different markets, and at the same time, reduce the numbers of the parameters to be estimated, thus guaranteeing the variance-covariance matrix positive definite.

Since the hourly data analysis can remove the effects caused by the different closing time of the two markets, compared with the previous studies, this paper draws different conclusions as follows:

First, the result shows that there is a bidirectional Granger causality between CNY exchange rates and the CNH ones. When the volatility is high, the impacts of the exchange rate from CNY to that of CNH disappears with the onshore intervention.

Secondly, looking at the volatility result, within the opening year of the offshore market, we see the exchange rate of the CNH takes a stronger leading role. After that, the market participants gradually calm down from the fervent demand for CNH market and return to normal, the CNY exchange rates guide the RMB exchange rates for a long time.

Thirdly, based upon the above conclusions, hourly data analysis is a better method for detecting the subtle changes of the spot exchange rates between the onshore and the offshore markets, especially the latter, which signifies more implications of the global market information.

#### **Chapter 4: Does Exchange Rate Trading Band Block Correlation Between the Onshore and Offshore Exchange Rate: Evidence from RMB Market**

Price limit, as one of the important market stability mechanisms in financial market, is usually specifically applied in the stock market. The price limit system was first used in the futures market. Its main purpose is to prevent volatility in financial market for maintaining market stability. Therefore, as the benchmark price, the closing price of the previous trading day allows the stock or futures price to vary within the upper and lower limits during a single trading session. Different countries will settle different benchmark prices and fluctuating range. Likewise, the trading band in the foreign exchange market is also based on the central parity rate which is announced daily by the China Foreign Exchange Trading Center before markets open, allowing the exchange rate to change up and down within it. This shows that the trading band in the foreign exchange market can be considered as another application of price limit in foreign exchange markets. However, there are still differences between the two. The price limit is that when the futures or stock prices rise to the



upper limit or fall to the lower limit, any quotation beyond or below the limits will no longer be traded, but the transaction in the market does not stop with price unchanged. When the fluctuation of exchange rate is near to or reaches limit, the central bank will intervene to make the exchange rate fluctuating within the band. Therefore, there should be differences between the effectiveness of the two similar but different systems concerning the price limit and the trading band.

There have been controversies about the effect of price limit among the academia. Scholars who support the view believe it reduces the price volatility of the stock and prevent severe overreactions. As the transmission of stock price is limited, the response of information on stock price is delayed, and the information flow is restrained. Opponents argue that price limit does not reduce the stock price volatility, but delay price discovery effect and cause volatility spillover on subsequent days. This will increase the price volatility and enhance the market information flow.

Therefore, the effectiveness of price limit is still a debate in the academia. To study its impact and find out how it affects the information flow in the financial market, we choose a different market- China's foreign exchange market, as the research object.

Affected by the subprime crisis, the Chinese government takes active measures to promote the internationalization of RMB, which plays an increasing role in the international stage with its development, after the pilot project of RMB denominated cross-border trade settlement was announced in 2009. On July 19, 2010, the People's Bank of China signed the revised *Settlement Agreement on the Clearing of Renminbi Businesses* with Bank of China (Hong Kong)(BOCHK), Hong Kong officially became RMB offshore market. Since then, offshore markets have experienced a rapid growth of Renminbi as a trading currency for cross-border RMB trade settlement. Meanwhile, CNH, the offshore RMB which can be free trading makes RMB a dual exchange rate regime. Since 2012, there has been rising proportions of RMB international financial valuation and denominated settlement. With the promotion of RMB cross-border policy and the improvement of the RMB offshore market and the clearing system, RMB business has been expanding year by year in the international trade, international finance and foreign exchange reserves. According to the report of BOCHK, the RMB-denominated trade settlement of Hong Kong offshore market has grown tenfold from 369.2 billion yuan in 2010 to 3.841 trillion yuan in 2013. By the end of 2015, the annual value of RMB cross-border trade settlement reached 7.23 trillion yuan, nearly doubled compared with that of the previous year, accounting for 29.36 percent of China's total imports and exports, which increased 4.6 percent in 2014. While in 2015, the trade settlement in Hong Kong accounted for 94.5 percent of the total cross-border transactions. On November 30, 2015, the IMF's Executive Board decided to include RMB in the Special Drawing Rights (SDR), which serves as a significant milestone of RMB internationalization.

As the internationalization of RMB develops, the onshore RMB exchange rate reform has become the focus of attention. Since the establishment of the offshore RMB market, the onshore RMB exchange rate has undergone three reforms. The People's Bank of China (PBOC) announced from April 16, 2012, the average of the daily trading band for RMB exchange rate against the U.S. dollar moved up from 0.5% to 1%. The benchmark exchange rate is "central parity rate" quoted by

the China Foreign Exchange Trading Center at 9:15 a.m. and the onshore RMB exchange rate fluctuates within the range of 1% above and below it. The central parity rate of Renminbi is calculated by eliminating the highest and lowest quotations which are requested from the market maker in the interbank system every day, to a weighted average figured out by the China Foreign Exchange Trading Center.

With an intention of making the onshore RMB more marketization, the PBOC needs to enhance the floating flexibility of the RMB exchange rate, as well as promote the development of the onshore foreign exchange market, then on March 17th, 2014, the PBOC announced the trading band of RMB against the US dollar in the inter-bank spot foreign exchange market will fluctuate from 1% to 2%. After the increase of RMB exchange rate trading band on March 17, 2014, the fluctuation range of onshore RMB rapidly exceeded 1% and remained above 1% after December 2014. On August 11, 2015, the PBOC announced that it will adjust quotation mechanism concerning the central parity rate of the onshore RMB against the U.S. dollar, valuing much on the closing rate of the previous day to make it closer to the law of marketization.

As for the impact of “price limit” on information transmission, the existing research focuses more on the stock market and futures market, while there is almost no research on China’s foreign exchange market. The main reasons for choosing China’s foreign exchange market as the research object are as follows: Firstly, the reform of RMB exchange rate is carried out. Since March 17, 2014, the trading band of the RMB exchange rate against the U.S. dollar in the inter-bank spot foreign exchange market has increased from 1% to 2%. The expansion of the trading band of exchange rate provides a tool for judging the impact of the “price limit” in the foreign exchange market on information transmission. Meanwhile, with the establishment of the offshore RMB market in Hong Kong on July 19, 2010, there emerges an offshore RMB foreign exchange market with a different exchange rate regime from the onshore foreign exchange market and direct trading between two markets are not permitted. In this special circumstance, the expansion of the trading band on one side provides an opportunity for research on the information transmission between onshore and offshore markets. Thirdly, the trading band in foreign exchange markets is basically different from price limits, the latter imposes price limits on to fluctuations of stocks and futures. Therefore, as the opponents predict, there might be volatility spillovers after the price limit day. By means of intervention, the foreign exchange markets maintain exchange rates within the trading band by increasing or reducing supplies in exchange markets, so there will be no spillover or overreactions, excluding the adverse effects of price limits. Finally, with the rising international status of RMB, more and more market participants choose RMB as their trading, investing and reserve currency. Therefore, whether the expansion of the “price limit” have an impact on the information transmission between the offshore market which trade RMB by overseas investors and the onshore RMB market which is controlled by the government will also become the focus of attention of all parties.

Therefore, this paper adopts seemingly unrelated VAR model and DVEC-GARCH model, adds the dummy variable of the policy change to analyze whether the restriction on fluctuation range of

exchange rate affects the information transmission.

Being different from stocks market, the foreign exchange market doesn't force the market participants to stop the buying and selling of exchange rate demands, but to achieve the purpose of restraining exchange rate fluctuations by the central bank's intervention, to keep exchange rates at a stable level by market mechanism. In this way, so long as the exchange market has sufficient supplies, the market will be protected from sudden rise or fall, and the spillover would not appear in exchange rate markets. Therefore, the author believes the problems which the opponents of price limit worry about would not emerge. The trading band can restrain the fluctuation of exchange rates, reduce the overreactions of market participants, and suppress the information transmission of exchange rate. While the onshore and offshore renminbi (RMB) are the same as foreign exchange markets but fall into two different trading markets with different exchange rate regimes and cannot be traded directly. Therefore, unlike how it will be functioning in the stock market, the "price limit" will inhibit the information transmission between the two markets.

With different exchange rate regimes and market participants, there is no direct transaction between onshore and offshore RMB exchange rate markets. Since they are ultimately the same currency, there is indispensable information transmission between the two. Different exchange rate regimes, with participants of different trading motivations, there is a certain spread between them, which implies the possibility of arbitrage. Especially under certain conditions (Cross-border RMB trade settlement), transactions can be made indirectly between them, causing arbitrage phenomenon likely. Therefore, there is mutual information transmission between the two markets, the purpose of this article is to discuss whether the information transmission is affected by the trading band of the onshore RMB exchange rate.

The existing empirical studies on the onshore and offshore RMB exchange rates are mainly divided into two categories: The first category study is on the correlation between the CNH exchange rate and the CNY exchange rate. Another category study is on the factors that affect the pricing differential between onshore spot exchange rate and offshore spot exchange rate.

The interaction between the two different markets of onshore and offshore is ultimately caused by the information transmission between two markets. Due to the differences, the two markets react differently to information. The existing studies have analyzed the correlation between the onshore and offshore RMB exchange rates from various aspects, ignoring the correlation between two markets when the onshore spot exchange rate trading band increased. There is almost no literature about the effects of the trading band on information transmission between the two markets. The increase of exchange rate trading band makes the information flow sufficiently between single market and different markets. The increase of information can not only reflect the information of other markets, but also accommodate other markets. Therefore, the influence of "price limit" expansion on correlation and information transmission cannot be ignored. Meanwhile there is not much literature on high-frequency data analysis, which can reflect intraday and short-term effect more exactly. Therefore, based on 5-minute of two market spot exchange rate data, this paper adopts seemingly unrelated VAR model and DVEC-GARCH model with the dummy variable, to analyze

the effects of the exchange rate reform on March 17, 2014.

Three reasons that this paper only focuses on the trading band moved up from 1% to 2% are the follows: the first is that 1% to 2% is relatively larger range of changes, therefore the response to information transmission is more obvious. The second is because of the data, since the author only collected high frequency data after January 1, 2013. The last reason is that the third exchange rate reform focuses on the formation of the RMB's central parity rate, nothing to do with the trading band. Therefore, the author makes data analysis only based on the period in which the trading band increased from 1% to 2%, January 1, 2013 and August 10, 2015 (before the 3<sup>rd</sup> exchange rate reform).

In extreme cases, when CNY's trading band equals 0, the CNY exchange rate remains unchanged, there will be no correlation between the CNH and CNY exchange rate, neither will there be information flow between them. When the trading band of the CNY exchange rate expands from 0 to 0.5%, the CNY exchange rate can fluctuate. So, the local superiority of the CNY exchange rate and changing trend of the CNH exchange rate will increase the correlation between the two markets. In other words, the correlation between the two markets will increase as the trading band of the CNY exchange rate increases from 0% to 0.5%. And the expansion of trading band will increase the exchange rate fluctuation, making the exchange rate more responsive to information and accelerating information transmission. Therefore, as mentioned above, the hypothesis is proposed: when the trading band of the CNY exchange rate increases from 1% to 2%, the correlation between the CNH exchange rate and that of the CNY increases.

We use seemingly unrelated VAR model and DVEC GARCH model and add the policy dummy variable which describe the trading band increase from 1% to 2% on March 17, 2014 to analyze if the trading band have an impact on the correlation and information transmission between the two markets. In terms of the results, both mean equation and variance equation have obtained that the increasing of trading band affect the correlation between the two markets and also strengthened the information flow. In terms of the results, both mean equation and variance equation have obtained the correlation between the two markets and strengthened the information flow between the two markets, which supports the hypothesis of this paper. But there is only unidirectional correlation in mean equation.

#### **Chapter 5: Intervention to Narrow the Spread between CNH and CNY**

In July 2009, the Chinese government initiated Renminbi settlement in some companies among China, Hong Kong, Macao and 10 ASEAN countries. Since then, the RMB settlement between China and Hong Kong has been developing rapidly. The early settlement of RMB in China and Hong Kong made a large number of RMB kept in Hong Kong. Thus, the offshore RMB market was formally established on July 19, 2010.

Different from the “onshore RMB (CNY)” circulating in mainland China, the Renminbi flows abroad with Hong Kong as the center is called the “offshore RMB (CNH)”. Since the exchange rate in the CNY market is controlled by the central bank, the exchange rate in the CNH market is determined by the market, thus RMB is a dual rate system.

The CNH market is a foreign exchange market in which non-Chinese residents participate with a floating exchange rate. And it is free trading Renminbi market without government's manipulation. In contrast, the CNY market is a foreign exchange market for the local Chinese residents, with a managed floating exchange rate system, whose fluctuation moves within the upper and lower limits based on the central parity rate of RMB announce by the People's Bank of China in every morning. When the CNY approaches the upper or lower limits, the People's Bank of China will intervene in the market in order to control the RMB appreciation or depreciation. That is, the CNY market is controlled by the Chinese monetary authorities.

Relying on the dual exchange rate, the Chinese government boosts the liberalization of capital transactions and the diversification of financial products in CNH market, and thus to promote the opening and financial reform in China's domestic market.

On August 11, 2015, the People's Bank of China declared that it would reset the central parity rate quotation mechanism of Renminbi against U.S. dollars, valuing much on the closing price, to have a more market-based central parity rate. Before the reform of the RMB exchange rate, the CNY had remained at the lower level near the lower limit of the central parity price announced by the People's Bank of China. While the CNH fluctuate relatively within the same range. After the announcement of the exchange rate reform, the RMB central parity rate fell by 4.7% in three days. The PBOC explained it is an "one-off depreciation". Affected by the slowdown of China's economy and the rise of US interest rates, the RMB foreign exchange rate is under pressures of RMB depreciation,

The RMB exchange rate has been in depreciation since the exchange rate reform on August 11, 2015 until February 5, 2016. In the meantime, the CNY market is intervened to avoid excessive depreciation. On the other hand, there was a sharp decline in CNH since there is no intervention in the CNH market. Moreover, because direct trading is forbidden between CNH and CNY exchange rate markets makes the spread much larger. By September 8, 2015, the spread between CNH and CNY rose to 0.1254 and on January 7, 2016, the spread reached its maximum of 0.1651.

According to Bloomberg and Reuters etc., the People's Bank of China intervened twice in the offshore market between September 10, 2015 and February 6, 2016 to stabilize RMB. Both Chinese banks and foreign banks are restricted to buy dollars in the offshore markets, suspending Renminbi accounts of cross-border financing in the offshore banks, and then intervene in the market on a large scale by the state-owned banks. The first intervention in the offshore market took place on the 10th, September 2015, with approximately an amount of \$ 1 billion to \$ 3 billion. When the spread reaches its maximum, Chinese authorities intervened again on January 11, 2016, then the spread between CNH market and CNY market was eliminated on December 12. According to the Reuters, the single-day trading volume is 10 times higher than before.

The People's Bank of China does not confirm the intervention, but market participant believe that the Bank of China (Hong Kong) participated in the intervention. Because of the intervention, the free trading advantage of the offshore market no longer exists, which may aggravate the market participants' distrust on the CNH market.

Due to Bloomberg, Reuters etc. reported that Chinese authorities intervene the CNH market, so this paper considers intervention exists. The paper uses minute data of CNH market and CNY market from August 3, 2015 to February 5, 2016, to verify how changes in the relationship between CNH and CNY markets and spread analyze the effectiveness of the offshore market intervention and to estimate the time of intervention and period of intervention which media not report.

Issues about whether or not the Chinese government has intervened in the foreign exchange rate in the offshore market have remained a debate. Vast media release insists on the Chinese government's control on the matter, which has always been kept silent by the Central Bank of China. So it is perhaps something of a mystery as to whether the Chinese monetary authorities maintain untold intervention operations. As little research has been done on the intervention of the Renminbi offshore market, this study has to begin with a literature review about the relevance of the CNH market and CNY market.

The previous study concerns three perspectives. Firstly, unidirectional relevance is recognized, and CNY plays the leading role in the market. Secondly, according to Granger causality test, there is no price discovery relationship between the CNH spot exchange rate and the CHY spot exchange rate. Thirdly, there is no linkage between the CNY market and the CNH market before the August 11, 2015. Since the reform, the linkage has been bidirectional, and CNY plays the leading role in the market.

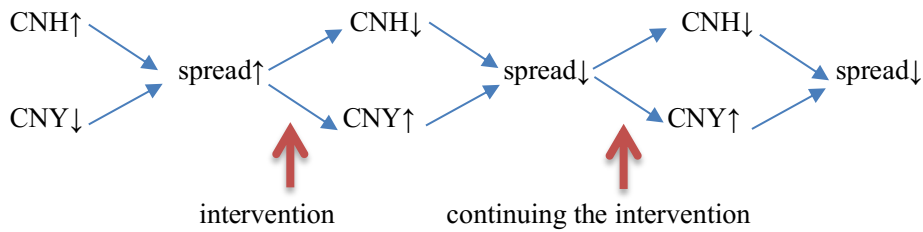
The purpose of intervention in the CNH market is to influence the expectation of CNY depreciation as well as to stabilize the Renminbi exchange rate by narrowing the spread between the CNH and the CHY markets. Therefore, when the spread being suddenly narrowed, according to the change between CNH market and spread to test the intervention effect and to analyze the time points when the Chinese government intervenes in the CNH market. The method employed is the impulse response function, to analyze the possible time points of interventions in the CNH market.

The above study analyzes the linkage of spot exchange rate, but problems exist as follows. Firstly, if this study analyses the problem of the offshore market intervention, then it is unable to get conclusions by daily data. Besides, the author is intending to test the relation changes between the CNH exchange rate and the spread, but, as in the above discussion, it is difficult to know how it changes if use whole period data.

Therefore, starting with the previous literature, this study analyzes the relevance between the CNH market and the CNY market in the following ways. Firstly, since the intervention time is too short to use daily data, we use minute data from the 3th of August, 2015 to the 5th of February, 2016. Furthermore, the paper only analyzes the problem of the intervention instead of the data of the whole period, that is, to analyze the data when the spread suddenly being narrowed.

$$spread = CNH - CNY \quad (1)$$

As shown in Formula 1, spread is the difference between the CNH and the CNY exchange rate. According to media reports, the main purpose of the intervention was to reduce the spread between CNH and CNY, so to relieve the pressure on the depreciation of the RMB, with a purpose of stabilizing the RMB price.



If intervention exists, in order to reduce the spread, possible method of intervention in the offshore market is to buy the Renminbi, and sell the dollars, or to sell the Renminbi and buy the dollar's in the onshore market. When the spread becomes larger, the Chinese authorities will intervene the CNH or CNY market to make spread narrow. The intervention in the CNH will make the CNH exchange rate change from depreciation to appreciation, with an exchange rate near to that of the CNY, then the spread is narrowed, with the purpose of stabilizing RMB exchange rate being achieved. Therefore, it is possible that the intervention in the CNY makes the CNY exchange rate depreciation and spread narrow. Let's look at the changes in CNH, CNY and spread after the initial intervention. CNH(CNY) will be in a state of appreciation (depreciation), and if the intervention fails to narrow the gap as expected, the Chinese authorities may continue to intervene, for interventions at large degree will influence behaviors of market participants by appreciation (depreciation) in CNH(CNY) exchange rate, somehow meeting the authority's expectations. Therefore, if there exist interventions, the impact of CNH(CNY) on spread is positive(negative).

So, hypothesis 1 is that when the impact of CNH on spread is positive and much greater than that of CNY on spread, along with Bloomberg and the Reuters' report of the Chinese authorities' intervention in the CNH exchange rate, we can assume that the Chinese authorities are more likely to intervene in the offshore market. Hypothesis 2 is that if the impact of CNY on spread is negative and far greater than that of CNH on spread, and there is always the central bank intervention in the CNY market, we suppose that the spread is adjusted by intervention.

According to the above references, it is generally believed that the intervention on the CNH exchange rate might reduce the expectation of RMB depreciation by narrowing the spread between CNH and CNY to stabilize the RMB exchange rate. According to Reuters, the Chinese government has restricted Chinese banks and foreign banks to buy dollars in the offshore market, suspending the cross-border financing of offshore RMB accounts and conducted large-scale intervention through state-owned banks. The People's Bank of China controls the devaluation of the CNH exchange rate by swab-off the RMB liquidity in the offshore market.

The purpose of intervening CNH exchange rate is to stabilize the RMB exchange rate in the offshore market by reducing the spread between the CNH exchange rate and the CNY exchange rate and affecting the expectation of RMB devaluation. Therefore, this paper only analyzes the possible range of intervention, that is, the sharp decline of different periods.

First, we select the period in which the spread decreases more than of 0.0948 (3 times of the standard deviation) within three days. The criteria for period selection is from the maximum value of spread to the minimum value of the spread before sudden reduction, excluding the first abrupt decrease period which is too difficult to analyze.

In the meantime, the sudden narrowing intervals of spread are taken to analyze as intervention potential intervals. Because of the reliability of data, more than 60 data are required, and altogether 4 intervals, including A1、 B1、 B2 and B3, are selected.

According to media reports, the first intervention interval is approximately from 15:00 to 16:30 on September 10, 2015. The selected interval A1 cover the intervals reported. There are two kinds of report about the timing of the second intervention. One is that the intervention began on January 11, 2016 and spread to close to zero on January 12, 2016. Another one is that the intervention took place on January 12, 2016. In combination with this two, it is possible that the selected interval B1, B2 and B3 cover the intervention interval. Therefore, we also infer from the empirical analysis to find out which interval is the intervention interval.

Dealing with minute data between August 3, 2015 and February 5, 2016, this paper analyzes the four intervals in which the spread is suddenly narrowed by using the impulse response function, observing the accumulative effects of influence between the CNH exchange rate and the CNY exchange rate . The impulse response function is a way to express how impulse is given to a variable residual term and how it transmits to other variables, a method used to analyze influences between variables in VAR model by observing its shape.

In this paper, we use impulse response function to analyze the effectiveness of offshore intervention. As a result, among the intervention periods reported by the media, this paper chooses the spread of sudden narrowing intervals, A1, B1, B2, B3. The main reason causing the sudden narrow of the spread is the CNH exchange rate appreciation. At the same time, the intervals A1, B1, B2, B3 are among the intervention period during which Chinese authorities intervened CNH market, reported by Bloomberg and the Reuters, this paper concludes that in the above four intervals, the Chinese authorities is more likely to intervene CNH exchange rate.