Analysis on Effect of Volume Factor on CNY-CNH Exchange Rate Linkage

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Abstract

Researches regarding CNY onshore and offshore exchange rate linkage have been mainly focused on the discussion of price overflow effect due to a long-term restriction of the source of trading volume data at the foreign exchange market. Meanwhile, the impact of the trading volume on the formation of the two exchange rates was relatively ignored. This paper takes the initiative to introduce trading volume into the CNY exchange rate onshore and offshore price analysis framework. It innovatively applies SEM model and MLMV research method to analyze new characteristics represented in the CNY, CNH and NDF price guidance and formation mechanism of the two markets after the introduction of the trading volume factor. It verifies the complexity in onshore and offshore market linkage process under the impact of trading volume on aspects of statistics and significance. Through improving the study on onshore-offshore CNY exchange rate dynamic transmission mechanism, this paper provides beneficial reference on the policy level for improving monetary policies and optimizing exchange rate volatility management.

Keywords: Volume factor; Offshore market; CNY-CNH exchange rate; Linkage

Introduction

Since 2010, offshore CNY market represented grew quickly and actively promoted the onshore CNY market. At present, the development of onshore CNY market and offshore CNY market generally has the following two obvious trends. First, the offshore CNY market has been constantly expanding with business varieties enriched day by day; second, the onshore exchange rate forming mechanism has been constantly optimized. In particular, after Exchange Rate Reform on Aug. 11, 2015 (hereinafter referred to as "(8.11)", the floating of CNY-USD trading price at the inter-bank spot exchange market increased from 0.5% to 2%.[1] On the other hand, the development of CNY onshore and offshore markets has expanded the gap between CNY-USD onshore spot exchange rate (hereinafter referred to as the CNY) and CNY-USD offshore spot exchange rate (hereinafter referred to as the CNH), thus leading to a constant fluctuation in the CNY market and a great amount of speculation and arbitrage behavior. On January 6, 2016, under the impact of international speculative capital, CNH was depreciated continuously and the difference between CNY and CNH reached a new record at 1600. The depreciation of CNH in only a week was up to 2.28%. CNY was also depreciated by 0.8%. After that, the difference between CNY and CNH was finally narrowed upon the intervention of the Central Bank of China and Hong Kong Monetary Authority. Afterwards, the gap between CNY and CNH reduced. After this event, the linkage effect between CNY onshore and offshore markets became a new hot spot for discussion among foreign and domestic researchers. At the same time, the linkage between the two markets also becomes a key factor considered by the Central Bank of China to develop monetary policies and implement exchange rate management.

The CNY-CNH exchange rate linkage is formed mainly through the following three approaches. First, it may be realized by the non-deliverable forwards (known as NDF in short) market. Namely, onshore financial institutions and offshore financial institutions will have currency arbitrage with NDF market through respective forward markets, thus leading to convergence of CNY and CNH. The second is to guide market expectation. Namely, market traders may have foreign exchange market operations in order to avoid exchange rate risks or make investment based on economic expectation, governmental signals and other factors. The third is cross-border trading settlement. When CNH is weaker than CNY, cross-border import enterprises would like to trade in the onshore market, because less CNY will be paid upon the same amount of USD. The behavior of the import enterprises to sell CNY and buy USD in the onshore market will lead to depreciation of onshore CNY. Similarly, the behavior of cross-border export enterprises to sell USD and buy CNY in the offshore market will also lead to appreciation of CNH. These transactions will finally reduce the gap between CNY and CNH. It can be found that regardless of forward contract delivery, cross-border trading settlement or operation in the foreign exchange market, each approach will cause change of trading volume in CNY.

Judging from onshore trading volume, the daily onshore foreign exchange trading volume in May 2012 was about USD 11 billion. This Figure 1 once exceeded USD 50 billion in August, 2015. Besides, it can also be clearly detected that "8.11" is a significant watershed, before and after which both CNY onshore exchange rate trading volume and onshore-offshore exchange rate spread obviously changed. After "8.11", the gap between CNY and CNY has been expanded and the fluctuation has been intensified. Besides, the onshore CNY trading volume has also obviously increased. New trend of linkage between CNY onshore and offshore markets after "8.11" is hereby reflected (Figure 1). Trading
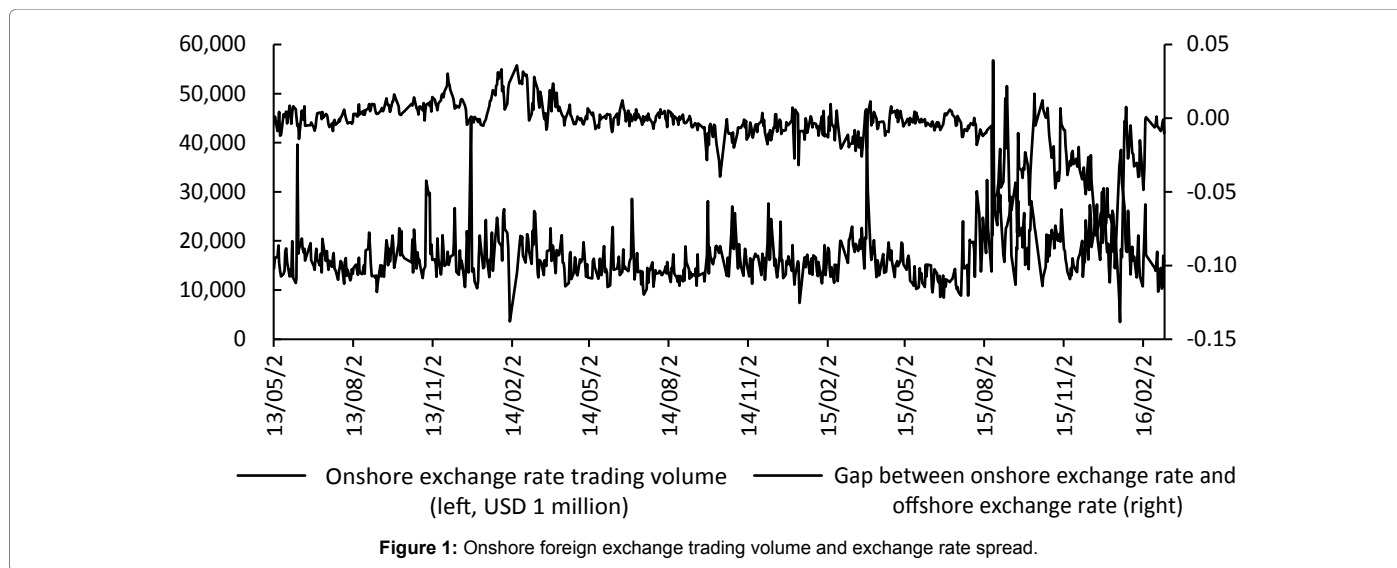
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Figure 1: Onshore foreign exchange trading volume and exchange rate spread.

volume has become a key factor to affect linkage between CNY onshore and offshore markets.

Previous discussion on the linkage between CNY and CNH is mainly based on the price. Scholars tend to focus on leaders and the dominant right of the market and price. Based on the large number of studies in recent years, it is believed that CNY onshore market exchange rate, onshore market trading volume, Hong Kong offshore market and offshore forward exchange rate are in a dynamic transmission mechanism with mutual influence. However, there are a large number of disputes among scholars on the ownership of the dominating right (such as the pricing right) and no unified conclusion has been formed. In fact, the exchange rate market is in the course of constant change. In particular, after "8.11", since the range and direction of price difference change can hardly be determined, it's more difficult to predict CNY price influence path. The linkage between CNY and CNH markets is increasingly complex. Therefore, the overall linkage situation between the two markets can hardly be reflected by considering price factor alone. In addition, after "8.11", the constant expansion and accumulation of the trading volume has become an important factor affecting price forming. Therefore, in order to specify new characteristics of the linkage between CNY and CNH, it is very necessary to introduce the factor of trading volume. Since the trading volume and the price are guiding each other, the interpretation of trading volume data will help us to propose a new idea on the explanation of CNY price forming after "8.11".

Based on above discussion, this paper innovatively introduces the trading volume into the analysis of linkage effect among CNY, CNH and NDF. This paper also takes into account Shanghai-Hong Kong Stock Connect, capital flow caused by exchange rate difference between the two markets and important role of foreign exchange market micro trading information in this mechanism. Research conclusion of this paper will provide useful reference for the Central Bank of China to rationally develop and specify exchange rate management objectives.

Literature Summary

Along with gradual expansion of CNY international application size and scope, discussion on CNY onshore and offshore market linkage has been increasing in domestic and foreign academic circle. These researches mainly focus on offshore NDF market and domestic

spot and forward market linkage and information transmission [1-6]. After the forming of Hong Kong CNY market in July 2010, the linkage mechanism between CNY onshore and offshore markets drew more extensive attentions of scholars. There are still great disputes on topics such as market dominating right in CNY price discovery, remuneration overflow and fluctuation overflow process in the academic circle.

Some studies emphasize the dominating role of CNY onshore market. Youyu and Ying [3] pointed out that, based on evidence that CNY onshore forward exchange rate, spot exchange rate, oversea NDF exchange rate are in coordination relationship only for varieties with relatively short term. Onshore forward exchange rate has remuneration overflow effect for offshore NDF. Based on AR-GARCH model based research, Wu and Cheng [7] believed that onshore exchange rate and offshore exchange rate are influencing each other while the influence of onshore exchange rate on offshore exchange rate is more significant. By Granger cause-effect inspection, Xiaobo and Xiaomei [8] proved that onshore exchange rate price can guide the offshore exchange rate price. Based on VAR-MVGARCH analysis, Xianping and Biao [9], Yun et al. [10] pointed out that in the CNY and CNH interaction process, CNY has larger influence on CNH. Some other studies, however, hold different views. Min and Shusong [5] applied Granger cause-effect inspection to study the remuneration overflow relationship among CNY-USD spot market, onshore interbank forward market and oversea NDF market, and pointed out that the NDF market was at the central position for price information. Chengyu and Bin [11] pointed out that offshore exchange rate fluctuation had more obvious impact on fluctuation overflow than onshore exchange rate fluctuation.

Comparing with researches above, more scholars emphasize that the CNY and CNH are not in one-way influence relationship. While stressing the complexity of interaction among CNY, CNH and NDF, concerns on the forming of interaction mechanism are also given from different perspectives. Wang and Xuefei [4] applied the vector autoregression model (VAR) for research and discovered that the information transmission mechanism between the CNY and CNH forward markets has gradually changed from one-way transmission from offshore market to onshore market into two-way transmission between onshore market and offshore market. Through DCC-MVGARCH model research, Jing [12] pointed out that exchange rates in the three markets (CNY, CNH and NDF) are in interactive

relationship. Based on Bivariate-GARCH model analysis, Maziad and Kang [13] believed that onshore CNY spot rate and CNH spot rate were not in price discovery relationship, but onshore CNY spot rate and NDF exchange rate are in price discovery relationship. Hong Kong CNH market represents certain fluctuation spillover effect for domestic CNH foreign exchange market. Similarly, Tse and Williams [14] believed that CNH and CNY markets were not in price discovery mechanism; however, CNY market and NDF markets are in price guiding relationship which became closer along with the opening of CNH market. Zheng, et al. [15] adopted rolling co-integration to discuss the attribution of CNY exchange rate pricing right and pointed out that onshore market generally held the spot pricing right while the offshore market mastered the forward pricing right; besides, comparing with the price level, onshore and offshore markets were more closely related with each other on the fluctuation level and that fluctuation risk was easier for transmission than price information.

Although previous researches have discussed the linkage between CNY and CNH markets in details based on different empirical approaches and analysis perspectives, it can be clearly seen that the focus of the academic circles over the long term is on the analysis of the dominant right in CNY linkage mechanism. After the formation of Hong Kong offshore market, however, domestic and foreign CNY foreign exchange markets develop quickly with increasingly rich business varieties. The market linkage formation mechanism is much more complex compared with the situation in the early stage. After "8.11", in particular, CNY price fluctuation range and direction became hard for prediction and the linkage between onshore and offshore markets became increasingly complex. The simple analysis on market dominating right can no longer adapt to the complex linkage relationship between CNY onshore and offshore markets. After "8.11", along with the significant increase, CNY market trading volume has become a key variable unable to be neglected to affect CNY price direction. As a result, the discussion of linkage effect between the two markets based on trading volume turns to have practical significance.

In the past, restricted by high-frequency data acquisition, trading

the main reference of this paper, Evans and Lyons [16] introduced micro order flow as the analysis variable as a decisive factor for exchange rate for research.[2] Through building a multi-currency model (9 kinds of currencies), it was pointed out based on real evidence that the order flow was in linkage effect with the price forming mechanism of multiple markets [17]. On this basis Evans [18] researched the dynamic mechanism between the trading volume (transaction flow) and the exchange rate mechanism. The theoretical framework was built through the micro-founded general equilibrium and consequently, it was detected that the forming of different market exchange rates was highly related to trading volume. Zhichao, et al. [19] adopted the vector auto-regression (VAR) model to study the micro dynamic structure of Chinese foreign exchange market. It was detected that order flow reflected excessive demands in the CNY foreign exchange market and affected long-term level and short-term fluctuation of CNY exchange rate. Cheung and Rime [20], introduced order flow as an important variable into the study of CNY onshore and offshore linkage. Data from Reuters D2000-2 platform were selected and it was detected that the order flow was in linkage relationship with CNH and CNY exchange rate formation (short-term, long-term market). It was also pointed out that CNH backflow and order flow can be used for the prediction of official CNY parity rate. Although above researches are just limited to Hong Kong offshore market and data for research are usually limited to individual market marker which cannot reflect total trading volume of the entire foreign exchange market, it provide new idea and perspective for us for in-depth survey and CNY onshore and offshore market linkage.

Based on existing research achievements and combining with actual situation of China's foreign exchange market, this paper innovatively studies the functional positioning of trading volume in linkage between CNY onshore and offshore markets. The purpose is to improve the interpretation framework for onshore and offshore CNY exchange rate dynamic mechanism. The innovation and contribution of this paper are mainly reflected on the following aspects (Figure 2). Based on onshore market exchange rate data (China Foreign Exchange Trade System), this paper takes the lead to introduce trading volume into CNY-CNH-
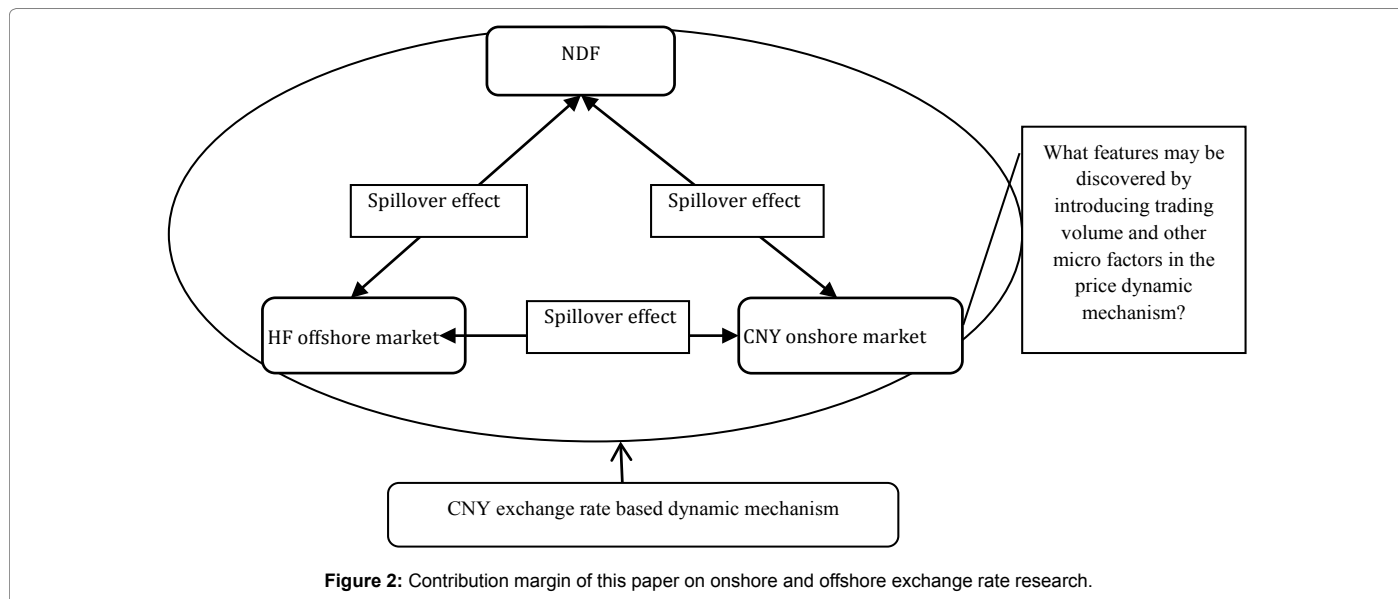

Figure 2: Contribution margin of this paper on onshore and offshore exchange rate research.

volume had relatively limited impact on linkage between CNY onshore and offshore markets. In particular, research on the linkage between the exchange rate and the trading volume is quite rare (Figure 2). As

[2]The order flow will reflect situation of all orders of market traders, including order buy-sell direction, order quotation, order size. Not all orders will lead to transaction. Order flow information acquired by some brokers through off-site OTC market can hardly represent the trading volume of the entire foreign exchange market.

NDF dynamic influential mechanism and sufficiently considers roles of Shanghai-Hong Kong Stock Connect, the microstructure of the foreign exchange market and other factors in this mechanism. Judging from the research method, SEM is an effective method to establish, evaluate and inspect the causal model. It can improve the effectiveness and robustness of regression results. This paper innovatively applies MLMV model under SEM method for CNY foreign exchange market research, trying to research the function of trading volume in the linkage of different markets. This paper will provide new ideas for the academic circle to investigate the exchange rate forming mechanism between onshore and offshore markets. Features of interaction between CNY and CNH will be explored different from previous studies thus providing reference for the Central Bank of China for mastering foreign exchange pricing right and promoting the internationalization of CNY.

Research Methodology

According to the principle of economics, price and trading volume are endogenous factors in any market. They not only have the inertia of "self-realization", but also have the function to realize equilibrium price after interaction. However, in previous studies, due to the lack of sum data on trading volume of onshore and offshore markets, it was hard to have in-depth study of pricing forming at the two markets based on the trading volume. Cheung and Rime [20] tried to introduce trading volume data in exchange rate research process. However, their data sources were restricted to some individual traders and the situation of the entire foreign exchange market cannot be represented. In this study, trading volume summary data provided by China Foreign Exchange Trade System (CFETS) provides us with important data basis for in-depth discussion of relevance between CNY price and trading volume.

Modeling and variable selection

Since the establishment of Hong Kong offshore market, many scholars have studied the linkage between onshore exchange rate and offshore exchange rate. The results show that onshore exchange rate and offshore exchange rate are in mutual influential mechanism while the influence degree and direction are different.

Therefore, under the dynamic influence mechanism of CNY, CNH and NDF (Figure 2), the onshore exchange rate function can be worked out as below:

cny=F(ndf,cnh,ϵ)

Similarly, the offshore exchange rate influence function should be:

cnh=F(ndf,cny,ϵ)

Where, cny refers to onshore CNY exchange rate, cnh refers to Hong Kong offshore CNY exchange rate, ndf refers to offshore forward exchange rate and ϵ refers to other impact items affecting exchange rate. For variable selection for impact items, two problems cannot be ignored. The first is the cross-border flow of assets in large quantity caused by the establishment of Shanghai-Hong Kong Stock Connect; the second is the influence of trader heterogeneity on exchange rate upon continuous promotion of foreign exchange marketization.

While studying Hong Kong offshore market, the launch of Shanghai-Hong Kong Stock Connect is an important factor that cannot be ignored. The essence of Shanghai-Hong Kong Stock Connect is the cross-border flow of capital between onshore and offshore markets. Conceptually, exchange rate is the ratio between currency units of the two countries on the purchasing power. The subject compared is the general price level of the home country and the sovereign states

of other currencies. As a result, there is theoretically no onshore and offshore exchange rate pricing right. Due to inland capital project control and the restriction of cross-border capital flow, while CNY entering the offshore market, the two markets are artificially separated to form CNY and CNH. When large price different appears between CNY and CNH, the price difference will be reduced upon settlement way selection by domestic and foreign traders. Therefore, as for the selection of capital flow agent variables, in addition to interest rate difference and exchange rate difference between the two markets, Shanghai-Hong Kong Stock Connect AH premium index closing price is also adopted to describe capital cross-border flow situation between onshore and offshore markets after the initiating of Shanghai-Hong Kong Stock Connect.

Meanwhile, in order to explore functions of trading volume in CNY onshore and offshore exchange rate markets from a more microscopic perspective, CNY foreign exchange market trading direction variable SAR is adopted in this paper as the agent variable for the heterogeneity of traders in Chinese foreign exchange market.[3] Different traders will judge next step operation based on SAR performance. Specifically, when the currency is appreciating and the exchange rate is higher than SAR, the market will send the position building signal. When the exchange rate further rises and SAR curve fluctuates upwards constantly, it means that the exchange rate is in ascending trend and the market will send the signal of accumulating. On the other hand, when the current is deprecating and the exchange rate is lower than SAR, the exchange rate will decrease in short term and the market will send the signal of selling; when the currency further depreciates and the SAR curve moves downwards, it means that the exchange rate is in descending trend and the market will select short-selling for profit-making. Based on above scenario analysis, the model on the mutual influence between the trading volume and the foreign exchange rate is built as below based on the supply-demand theory:

cny=F(ndf,cnh,cp,sar,q)

cnh=F(ndf,cny,cp,sar,q)

q=F(ndf,Δr,cnh,cp,sar,cny,ed)   (1)

Where cny refers to onshore CNY exchange rate, cnh refers to Hong Kong offshore CNY exchange rate, ndf refers to offshore forward exchange rate, q refers to onshore CNY foreign exchange trading volume, Δr refers to interest rate difference between onshore and offshore markets, cp refers to Shanghai-Hong Kong Stock Connect AH premium index, sar refers to onshore and offshore trading direction variables, ed refers to cny and cnh exchange rate difference.

Hypothesizing

In order to explore the role of trading volume in CNY exchange rate dynamic mechanism, the research method of hypothesizing and verification is adopted to check volume-price relationship in the foreign exchange market so as to detect difference between actual results and logical assumption.

Hypothesis 1: the trading volume of onshore CNY market has larger influence on onshore CNY exchange rate closing price than the influence on offshore CNY exchange rate closing price.

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[3]SAR (Stop and Reverse) is the simplest and commonest analysis tool in America technical master WELDER analysis system. It is a system emphasizing both time and price. Through analysis and research of foreign exchange price amplitude and time, it may set stop point from time to time to observe foreign exchange selling opportunities. It helps investors for effectively safeguarding profit and restricting loss.

Hypothesis 2: the exchange rate can function on the trading volume only based on flexible floating. After "8.11", effect of exchange rate at the two markets on the trading volume has increased.

Hypothesis 3: capital flow and exchange rate expectation first of all function on the trading volume of the foreign exchange market and then, the trading volume will act on the exchange rate of the two markets. Namely, the driving force of capital flow is from exchange rate difference between CNY and CNH. At the same time, onshore and offshore interbank rate may also act on capital cost and leverage as the exogenous variable. Besides, NDF affecting price expectation of the two markets will first of all act on the trading volume and then on the exchange rate of two markets via the trading volume.

Based on above hypothesis, this paper tried to build the following model. To facilitate understanding later, symbols of all variables adopted are summarized in Table 1. Time sections are introduced as below (Table 2).

As shown in the Table 2 above, considering fundamental change of

the linkage between the two markets and the interaction between the two markets and the trading volume after "8.11", data is divided in to two stages based on the time serial in this project (Figure 3).

Figure 3 Changes of Onshore/Offshore CNY Exchange Rate Closing Price and Onshore Trading Volume

Note: (1) the upper part is offshore/onshore CNY exchange rate closing price comparison (CNY price of unit USD), the longer black column, the larger price difference; (2) the lower part is the onshore market CNY trading volume (unit: USD 1 million); (3) the vertical dotted line refers to CNY central parity rate Exchange Rate Reform declared on Aug. 11, 2015.

Regression model selection

Based on above null hypothesis and model (1), the simultaneous equations are established as below:

$$py_{t=} \partial_{1t} + \beta_{11}py_{t-1} + \beta_{12}ph_{t-1} + \beta_{13}pn_{t-1} + \beta_{14}q_t + \beta_{15}sy_t + \beta_{16}cp_t + \varepsilon_{1t}$$

Model Symbol	Demonstration Sariables	Interpretation
py	Lclosecny	Onshore CNY exchange rate closing price (difference, logarithm)
ph	Lclosecnh	Offshore CNY exchange rate closing price (difference, logarithm)
pn	Lclosendf1m	Non-deliverable CNY 1-month forward (difference, logarithm)
q	Lcnyv1	Onshore CNY trading volume (day, logarithm)
ed	Lecnycnhd	Onshore and offshore exchange rate closing price difference (logarithm)
rd	Lrcnycnh	Shanghai and Hong Kong interbank rate difference (logarithm)
sy	Lsarcny	Onshore CNY exchange rate stop index (difference, logarithm)
sh	Lsarcnh	Offshore CNY exchange rate stop index (difference, logarithm)
cp	Lstocksh	Shanghai-Hong Kong Stock Connect AH premium index closing price (logarithm
Data source: Wind, Bloomberg and Reuters database.		

Table 1: Symbols and interpretation of variables applied in the model and demonstration.

2015	Aug. 10	Aug. 11	Aug. 12	Price limit in Aug. 10-12
Onshore exchange rate closing price (CNY)	6.2097	6.3231	6.387	-2.85%
Offshore exchange rate closing price (CNH)	6.2148	6.4027	6.4488	-3.77%
Onshore market trading volume	USD 13.749 billion	USD 25.792 billion	USD 56.803 billion	313.14%
HKex futures contracts trading volume	Less than 1000 contracts	8061 contracts, nominal value: USD 0.81 billion	5816 contracts, nominal value: USD 0.58 billion	About 581.6%
Data source: Data of HKex futures contracts trading volume from Hong Kong Exchange; other data from China Foreign Exchange Trade System.				

Table 2: Change of exchange rate and trading volume around "8.11".

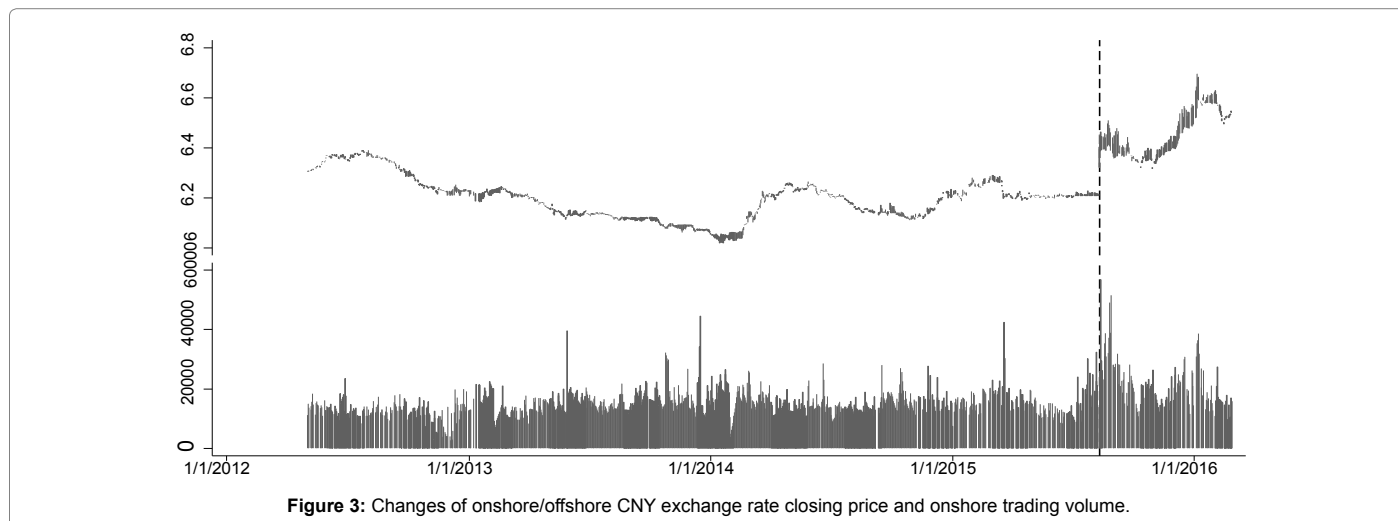**Figure 3:** Changes of onshore/offshore CNY exchange rate closing price and onshore trading volume.

$$ph_t = \partial_{2t} + \beta_{21}py_{t-1} + \beta_{22}ph_{t-1} + \beta_{23}pn_{t-1} + \beta_{24}q_t + \beta_{25}sh_t + \beta_{26}cp_t + \varepsilon_{2t} \quad (2)$$

$$q_t = \partial_{3t} + \beta_{31}py_t + \beta_{32}ph_t + \beta_{33}pn_t + \beta_{34}q_{t-1} + \beta_{35}sh_t + \beta_{36}cp_t + \beta_{37}ed_t + \beta_{38}rd_t + \varepsilon_{3t} \quad (3)$$

According to structural needs in formula (2), SEM (Structural Equation Model) is adopted in this research to verify the structural relationship between the trading volume and the onshore/ offshore exchange rate closing price. This model has the following characteristics: (1) may simultaneously consider and deal with a number of variables; allow the independent variables and dependent variables to have measurement tolerance; support simultaneous estimation of factor structure and factor relationship; (2) SEM support more elastic measurement model; by contrast, traditional regression can hardly distinguish the influence of a number of factors through the regression of one variable; (3) SEM can estimate the fitting degree of the entire model while the traditional regression analysis can only estimate the strength of each path (variable relationship). Therefore, SEM is the approach to establish, estimate and inspect the causal relationship model. It may replace multiple regression, route analysis, factor analysis and covariance analysis to clearly analyze the overall role of an individual index and relationship among various factors.

In addition, under SEM frame, this paper further applies MLMV method which may explore as much as possible useful information from data with missing values. For example, in a 10×10 time sequence, if one variable is missed, regression cannot be realized for data of the entire line by ML, QML or ADF approach no matter whether other 9 values in this line are endogenous or exogenous. By MLMV approach, however, even if a value is missed, other 9 values may also be used for regression analysis. From this point of view, it is more reasonable than ML, QML and ADF estimating approaches in SEM model.

Empirical Results and Analysis

In light of availability of CNH trading volume data, this paper selected 1161sample values from April 30, 2012 to Feb. 26, 2016. All variables have passed unit root stability inspection.

Before SEM regression, statistical description was first of all made for all variables as below (Table 3), and the regression results of formula (2) are as below (Table 4).

CNY and CNH interaction influence analysis

Based on all samples, CNY and CNH influence each other, but the influence of CNH on CNY is larger than the influence of CNY on CNH (0.233>0.131); besides, NDF does not have significant influence on CNY and CNH. This is different from majority previous research results. It is detected in this paper that NDF does not directly act on CNY and CNH. But does it act on CNY and CNH indirectly through other factors?

From the standpoint of different periods of time, after "8.11", mutual influence of CNY and CNH became insignificant. The possible reason may be that after "8.11", the Central Bank of China has initially formed the mechanism of "closing rate + a basket of currencies exchange rate change". Under the function of the CNY central parity rate pricing mechanism, onshore exchange rate tends to converge at the central parity rate. In this way, onshore price will not excessively deviate from the central parity rate. Then, market expectation on the depreciation of onshore exchange rate is weakened. Meanwhile, traders win stronger confidence in onshore exchange rate, thus guiding CNH to converge to CNY. However, due to sudden increase of trading volume of the offshore market and speculative operation of foreign institutions in short term, direct interaction between CNH and CNY is gradually weakened. Trading volume became an important signal transmission channel.

Influence of trading volume on CNY and CNH

Given all samples considered, onshore trading volume has larger influence on CNH than that on CNY (0.748>0.634), based on which hypothesis 1 may be denied (local trading volume has the largest impact on the local price). It can be concluded that trading volume in the market with higher marketization degree has more significant influence on the price.

On the timeline, before "8.11", the influence of the trading volume was larger than the influence on offshore exchange rate (even if such influence is quite weak). This is in line with hypothesis 1. After "8.11", the influence of the trading volume on CNY and CNH has been significantly intensified. The main reason is that the two-way fluctuation elasticity after exchange rate change has been significantly intensified. Under the more marketized mechanism, influence of the trading volume on CNY and CNH has been significantly increased.

Unexpectedly, the influence of trading volume on CNY changed over (from -0.152 to 1.055). This demonstrates that before "8.11", due to low trading volume base, the enlargement of trading volume in the previous day would improve the market expectation on CNY appreciation (CNY value decrease under directly pricing method) so as to represent negative relationship between the two. After "8.11", however, onshore market trading volume quickly increased, CNY two-way fluctuation became more intensified and the foreign exchange market was further marketized. The enlargement of previous day's trading volume of foreign exchange, as a kind of asset, will lead to price descending (CNY data will increase under direct pricing method).

Influence of CNY and CNH on the trading volume

Based on full sample range, the trading volume has obvious "inertia" feature. Namely, trading volume of the previous period will have significant impact on trading volume of the current period. It is also detected in this paper that the influence coefficient of CNY and

Variable symbol	Observation value	Average	Standard error	Min.	Max.
Lclosecny	1,158	0.0000315	0.0011192	-0.0061858	0.018097
Lclosecnh	1,160	0.0000331	0.0017445	-0.0149241	0.0297862
Lcnyv1	1,159	9.622958	0.3154633	7.884677	10.94734
Lclosendf1m	1,160	0.0000342	0.0018332	-0.0149744	0.0408057
Lsarcny	1,158	0.0000355	0.0006674	-0.0046588	0.0074477
Lsarcnh	1,158	0.0000259	0.0011882	-0.0077393	0.0162782
Lcpriceshkah	328	4.892332	0.0694503	4.63027	5.024046
Lecnycnhd	1,159	-0.000546	0.0031399	-0.020886	0.0061835
Lrcnycnh	1,159	3.613788	0.3812807	2.434731	5.080604

Table 3: Full-state statistical description of trading volume and offshore/onshore price and other variables.

	Before 811	After 811	Whole period
Lclosecny/Onshore CNY closing price←			
L.lclosecny/onshore CNY closing price	-0.130**	-0.295	-0.075
(lagged by a week)	(-2.87)	(-1.33)	(-1.51)
L.lclosecnh/offshore CNY closing price	0.293***	0.194	0.233***
(lagged by a week)	(7.18)	(1.13)	(4.94)
L.lclosendf1m/NDF 1-month future	-0.023	0.13	0.079
Closing price (lagged by a week)	(-0.55)	(0.63)	(1.59)
Lcnyv1/onshore CNY trading volume	-0.152*	1.055***	0.634***
	(-2.08)	(4.49)	(6.16)
Lsarcny/onshore CNY stop index	-0.178***	-0.125*	-0.134***
	(-5.99)	(-2.12)	(-6.13)
Lcpriceshkah/Shanghai-Hong Kong Stock Connect AH	-0.217	0.224*	0.110*
Premium index	(-3.90)	(2.06)	(2.12)
Lclosecnh/Offshore CNY closing price←			
L.lclosecny/onshore CNY closing price	0.247***	-0.284	0.131*
(lagged by a week)	(5.85)	(-1.22)	(2.52)
L.lclosecnh/offshore CNY closing price	-0.053	-0.026	-0.078
(lagged by a week)	(-1.38)	(-0.15)	(-1.57)
L.lclosendf1m/NDF 1-month future	0.007	0.017	0.007
Closing price (lagged by a week)	(0.19)	(0.08)	(0.13)
Lcnyv1/onshore CNY trading volume	0.005	1.233***	0.748***
	(0.08)	(5.20)	(6.65)
Lsarcnh/offshore CNY stop index	-0.205***	-0.466***	-0.354***
	(-7.73)	(-7.74)	(-15.55)
Lcpriceshkah/Shanghai-Hong Kong Stock Connect AH	-0.003	0.223*	0.164**
Premium index	(-0.06)	(1.99)	(2.89)
Lcnyv1/Onshore CNY trading volume←			
Lclosecny/Onshore exchange rate closing price	0.168**	-0.536**	-0.242***
	(2.91)	(-2.84)	(-3.54)
Lclosecnh/Offshore exchange rate closing price	-0.03	-0.994***	-0.599***
	(-0.61)	(-4.38)	(-6.39)
Lclosendf1m/NDF 1-month future	-0.046	1.184***	0.546***
Closing price	(-1.36)	(5.38)	(6.73)
L.lcnyv1/onshore CNY trading volume	0.637***	0.491***	0.608***
(Lagged by a week)	(22.4)	-4.35	-16.63
Lsarcny/onshore CNY stop index	-0.044	-0.182	-0.135***
	(-1.69)	(-1.55)	(-3.63)
Lcpriceshkah/Shanghai-Hong Kong Stock Connect AH	-0.041	-0.101	-0.152**
Premium index	(-0.81)	(-1.24)	(-2.88)
Lecnycnhd/Difference between onshore CNY exchange rate and	-0.056	-0.608***	-0.297***
Offshore CNY exchange rate	(-1.53)	(-4.30)	(-6.48)
Lrcnycnh/Shanghai and Hong Kong interbank rate	0.073*	-0.123	0.007
Difference	(2.47)	(-1.57)	(0.23)
Observed value	1016	143	1159
Log likelihood	49842.93	5984.3958	52465.383
Note: (1) t-value is in the bracket; (2) ***p<0.01, **p<0.05, *p<0.1			

Table 4: SEM regression results.

CNH on the trading volume is a negative value, which means that exchange rate depreciation (under the directly pricing method, CNY and CNH will increase) will driven the decrease of trading volume. It is also detected that the influence of CNH on the trading volume is slightly higher than the influence of CNY on the trading volume (0.599>0.242). By contrast, the influence factor of NDF on the trading volume is a positive figure, which means that NDF price (under the direct pricing method, NDF will increase) with more obvious depreciation trend (future) will more likely to cause enlargement of the onshore trading volume.

Considering different periods, before "8.11", CNY had significant influence on CNY market trading volume while CNH did not have significant influence on the trading volume. After "8.11", the influence of both CNY and CNH on the trading volume has obviously increased. However, similar to the influence of trading volume on CNY (changing from -0.152 to 1.055), the influence of CNY on onshore trading volume has also changed over after "8.11" (form 0.168 to -0.536). This also supports analysis results above. Before "8.11", due to small trading volume base, the fluctuation of CNY was quite small. CNY depreciation of the previous day (under the direct pricing method, the value will increase) would drive the increase of the trading volume. After "8.11", due to the increase of trading volume base, two-way fluctuation of
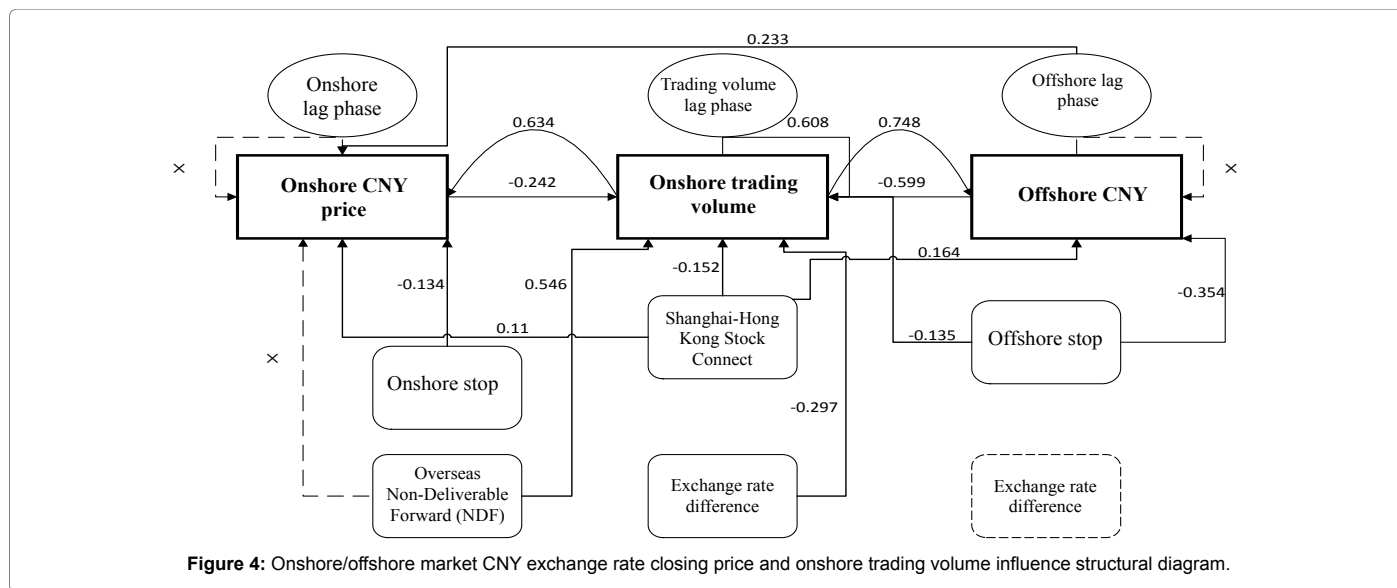
Figure 4: Onshore/offshore market CNY exchange rate closing price and onshore trading volume influence structural diagram.

CNY will occur. The central parity rate mechanism helps for stabilizing market expectation on price and the trading volume declines.

Furthermore, from the angle of interaction, price spread between NDF, CNY and CNH of current period and trading volume of previous period will simultaneously act on the onshore trading volume. Among them, NDF exerts the largest influence on trading volume. This phenomenon can rarely be seen before "8.11". It also suggests that the influence of exchange rate difference on the trading volume has been further intensified due to China's domestic stock market volatility and the negative expectation of international hot money on CNY. The trading volume then acts on exchange rate closing prices of the two markets on the next day. In this way, contents of null hypothesis 2 and part of contents of null hypothesis 3 can be supported. It also illustrates that NDF acts on the trading volume through delivery of the forward market and then, the trading volume acts on CNY and NDF.

Influence of SAR and Shanghai-Hong Kong stock connect on the linkage mechanism

According to the entire process of linkage, SAR has significant influence on offshore exchange rate, onshore exchange rate and the trading volume, which indicates that CNY onshore exchange rate contains information of market micro structure and more directly indicates market change (such as the change of the trading direction). The change of SAR will negatively affect the trading volume, which means that when SAR increases, it is specifically reflected in the foreign exchange market that the exchange rate will be in ascending trend and the exchange rate will be appreciated (CNY and CNH will descend under the direct pricing method). There will be more traders for buying or selling based on the trend, thus leading to the increase of trading volume.

Shanghai-Hong Kong Stock Connect AH premium index has positive impact on CNY and CNH and negative impact on the trading volume, which means that the price level of A share market and H share market will converge. Upon the weakening of drive for interest arbitrage in the stock market, capital will flow to the foreign exchange market, thus leading to the increase of trading volume. The entry of large amount of capital will also lead to the increase of vitality of the foreign exchange market, thus, CNY and CNH will descend under the direct pricing method.

Upon further observation, it is detected that the enlargement of trading volume after "8.11" has lead to larger depreciation of CNH (negative influential factor under direct pricing method) than the depreciation of CNY (1.2333>1.055). This also indirectly reflects the pressure of short-term capital outflow. Within the two days around "8.11", the trading volume for CNY selling in HKEX forward contracts increased by 8 times on the first day after "8.11" and increased by nearly 6 times on the second day. Besides, the CNT trading volume in the onshore market increased by nearly 2 times on the first day after "8.11" and increased to 4 times on the second day. It can be concluded that the reaction of Hong Kong offshore market on "8.11" is larger than the onshore market.

In summary, linkage relationship between onshore/ offshore exchange rate and the trading volume can be completely represented in Figure 4. It can be clearly noted onshore market trading volume is closely related to CNY onshore exchange rate and offshore exchange rate. To more clearly compare difference between the actual result and the null hypothesis above.

Conclusion

Due to the limitation of foreign exchange market trading volume data sources and the difficulty for OTC data of overseas market makers to represent the entire foreign exchange market, existing researches on exchange rate linkage between onshore and offshore CNY markets mainly focus on mutual influence of the two markets on the price. Based on CNY onshore trading volume data provided China Foreign Exchange Trade System (CFETS), this paper adopts MLMV model under SEM method to analyze new features represented by CNY, CNH and NDF price guiding and forming mechanism after the introduction of the trading volume. The complexity of onshore/offshore market linkage under the impact of trading volume is verified from the perspective of statistics and significance.

Based on the empirical study above, several distinctive conclusions can be drawn as below: (1) CNY and CNH are in long-term mutual influence relationship. After "8.11", linkage between CNY and CNH was slightly weakened. By contrast, the influence of the trading volume on the two is constantly intensified. There may be two reasons. First, upon the introduction of central parity rate mechanism, CNY represents the convergence trend. Second, the enlargement of trading volume enables

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Page 9 of 9

the appearance of the new media for information transmission between CNY and CNH which is the trading volume. On the other hand, NDF does not have obvious direct impact on CNY and CNH. It should act on onshore trading volume and then indirectly affect exchange rate at the two markets. (2) Due to the inertia feature of trading volume, namely, trading volume of the previous period will affect trading volume of the current period; the influence of CNH on trading volume is larger than the influence of CNY on trading volume. Around "8.11", the influence of CNY on onshore trading volume both influence of CNY on onshore trading volume and influence of trading volume on CNY changed over, which means that the relationship between trading volume and CNY is complex and changeable. (3) It is also detected that the exchange rate difference between onshore and offshore markets will also directly affect onshore market trading volume. In particular, after "8.11", such fluctuation has further intensified. After the provision of Shanghai-Hong Kong Stock Connect, the premium convergence of onshore and offshore stock markets impacts trading volume, CNY and CNH through impact on onshore and offshore capital flow. The change of foreign exchange market microstructure index SAR can also affect trading volume, CNY and CNH through act on trading trend of the foreign exchange market.

Through centralized discussion of trading volume factor and onshore/offshore market price, this paper provides the following reference for improving monetary policies and optimizing exchange rate management. First of all, this research introduces trading volume factor to further improve the discussion on onshore and offshore exchange rate dynamic transmission mechanism. It can be clearly noted that after "8.11" the linkage between CNY and CNH is no longer a simple mutual influence process, but the dynamic linkage in constant changing state. For the management of exchange rate objectives and maintaining balanced exchange rate level, the Central Bank should include the trading volume factor. In case of trading volume abnormality, rationally adjust offer on the next day. In case huge fluctuation of the exchange rate, reduce exchange rate fluctuation through the control of trading volume. Second, due to the complexity and variability of onshore and offshore markets at present, the Central Bank of China should also promptly concern Shanghai-Hong Kong Stock Connect AH premium index, SAR and exchange rate price releasing signal and predict trend of onshore market trading volume based on above indexes to prevent abnormal change of trading volume. Finally, as for sample period, the introduction of the conversion period factor into the central parity mechanism has led to weakened influence of onshore exchange rate on closing price of the previous day and the central parity is guided towards the exchange rate base. The change of the exchange rate mechanism may bring new change to the interaction mechanism among trading volume, CNY and CNH. Therefore, follow-up researches should be performed for in-depth discussion of above phenomenon.

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