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The Impact of RMB Exchange Rate Fluctuation on China's Stock Market: An Empirical Analysis of the Data after the 2015 New Exchange Reform in China

Haoxiang Yang[1,*], Xiaohui Tao[2], Zhichun Li[3]

[1]Secretary of Board of Directors, Shenzhen Wanhe Securities Co., Ltd., Shenzheng, Guangdong, China, 518000.
[2]Assistant Professor, Accounting Ph.D., Jinan University International Business School, Zhuhai, Guangdong, China, 519000.
[3]Risk Management Supervisor, Shengye Capital Co., Ltd., Guangzhou, Guangdong, China, 510000.
** Corresponding author*

Abstract: *In this paper we investigate the impact of RMB exchange rate changes on the A-share market after China's 2015 new exchange rate reform. The data selected for the exchange rate of the Shanghai Composite Index and the USD against RMB is from August 11, 2015 to August 11, 2016. After the test of smoothness, we adapt the econometric methods such as Granger causality test, VAR model test, cointegration test, multivariate regression analysis and impulse response analysis to analyze the impact of RMB exchange rate changes on the A-share market Conduction mechanism.*

Keywords: *Exchange rate changes, Transmission mechanism, Stock market risk, Cross-market transfer*

1. Introduction

The change of the stock price index in a certain period of time can reflect the change of the national economic operation situation. This correlation makes the stock price index as a “barometer” of the national economy and can effectively reflect the current decline and rising of the national economy. The People's Bank of China announced on August 11, 2015 that it would adjust its quotation system with immediate effect and launch a new round of exchange reform. Taking the middle price of RMB exchange rate against the U.S. dollar as an example, before the daily opening of the inter-bank foreign exchange market, the market maker referred to the closing exchange rate of the previous day's inter-bank foreign exchange market and considered the changes in the supply and demand of foreign exchange and the exchange rates of major international currencies. And the Trading Center offered the middle price quotation (hereinafter referred to as “Xinhui Reform”). On the very day, the RMB exchange rate started to fall, ending the cumulative increase of RMB against the U.S. dollar in the past 10 years to reach 33%. Subsequently, in just a dozen trading days, the Shanghai Composite Index fell from 3927 points to 2927 points, showing the impact of the exchange rate movements on the stock market. After the test of the data's stability, this paper analyzes the transmission mechanism of the change of the RMB exchange rate to the A-share market through the comprehensive applications of various econometrics methods such as Granger causality test, VAR model test, cointegration test, multivariate regression analysis and impulse response analysis.

2. System, literature and research hypothesis

2.1 The Change of RMB Exchange Rate System

In the transition from a planned economy to a market economy in China, the choice of exchange rate system has undergone many changes.

The RMB exchange rate system from the establishment of the China to the reform can be divided into the following three periods:

The first period was from 1949 to 1952. The floating exchange rate management system was the main exchange rate management system adopted by the government during this period. The exchange rate was adjusted by domestic and foreign changes and a specific exchange rate system was formulated according

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to the price comparison method. The second period was from 1953 to 1972. During this period, China's exchange rate was relatively stable. By adopting this strategy of linking up with some national currencies, China adjusted the exchange rate between the RMB and that country's currency according to the actual situation when some currencies of the above countries appeared to appreciate or devalue. The third period was from 1973 to 1979. In the 1970s, under the impact of the oil crisis, the U.S. dollar continued to devalue. The Bretton Woods system collapsed and the floating exchange rate system was widely spread in various western countries. At this period, in order to stabilize the RMB exchange rate, the People's Bank of China implemented the exchange rate system pegged to the currency basket. After calculating the change of the average exchange rate of the currency basket, the People's Bank of China raised or lowered the RMB exchange rate accordingly.

After the reform and opening up, in order to promote the development of the market economy, the development of the RMB exchange rate regime can be divided into three periods:

The first period was from 1980 to 1993. The official RMB exchange rate system implemented by the People's Bank of China was a dual exchange rate system: trade internal settlement price and non-trade open market price. The system of foreign exchange swap was implemented in all parts of the country starting from 1980, and the dual track pattern in the foreign exchange market began to take shape. There was a situation that the foreign exchange swap market exchange rate and the official exchange rate coexisted. The second period was from 1994 to 2005. Since January 1994, the People's Bank of China started to implement a single, managed, floating exchange rate system based on the market supply and demand, resulting the merge of the dual exchange rate system. RMB exchange rate maintained a steady growth in the foreign exchange market, even during the Asian financial crisis. The relaxed and fixed exchange rate system was the basic state of China's exchange rate system. The third period was from 2005 to 2015. In July 2005, China began to make reference to a basket of monetary policies to adjust the reform of the RMB exchange rate formation mechanism to a floating exchange rate system. At the same time, the price of RMB against the U.S. dollar was adjusted at a revised parity of 8.10 Yuan to 1.0 U.S. dollar, and the exchange rate of RMB against the U.S. dollar fluctuated between 0.3% and 0.3%. However, there has been a situation where the market exchange rate has fluctuated significantly over a long period of time and no self-correction could be made. The fourth period was from 2015 to the present. The People's Bank of China announced on August 11, 2015 that a new round of reform would be launched. Before market opening of the daily inter-bank foreign exchange market, the market maker referred to the closing exchange rate of the previous day's inter-bank foreign exchange market and considered the supply and demand of foreign exchange jointly with the international exchange rate of major currencies. Then the China Foreign Exchange Trade Center provided the middle price. To sum up, under the different characteristics of economic development in different periods, the change of the RMB exchange rate system to the boundary points before and after the reform is mainly divided into two stages, which can be specifically broken down into six periods.

Table 1 China's exchange rate system changes

First Stage:Before the Reform	
1949-1952	Implemented the price comparison method
1953-1972	Separated from the price comparison method, the implementation of stability linked method
1973-1979	Implement pegged currency basket exchange rate system
Second Stage:After the Reform	
1979-1993	Implemented the official exchange rate, foreign exchange rate swap double exchange rate system
1994-2005	Implemented the floating exchange rate regime, which was essentially a more accommodative and pegged exchange rate regime
2005-2015	With reference to a basket of monetary systems, implemented a managed floating exchange rate system based on market supply and demand
2015-Present	With reference to a basket of currencies, implemented the floating exchange rate system further driving the market-based exchange rate mechanism

2.2 Literature and Hypothesis

During the Asian financial crisis, the exchange rate changes in many countries are negatively related to the stock market index. Thailand, Philippines, Indonesia Bissau baht shield, Malaysia ringgit devalued in international speculators attack, and the market exchange rate volatility conducted to the stock market,

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leading to the Asian markets' cliff falling style. RMB against US dollar exchange rate data and current Shanghai composite index data were collected from August 2015 to August 2016. After stacking the charts of these two data sets, we found that RMB exchange rate and the A share index may be negatively correlated. Accordingly, the following hypothesis is proposed.

H1: The fluctuation of RMB exchange rate has negative correlation with Shanghai Composite Index.

Tsagkanos(2013)et al has conducted empirical test of the EU's and the US's stock price and exchange rate data after the financial crisis, and found that there was cointegration between them. When Deng Shen and Yang Chaojun (2008) studied the relationship between the exchange rate and the stock market between July 21, 2005 and March 20, 2007, they found that there was a long-term and stable equilibrium relationship between the nominal exchange rate of the Shanghai Stock Exchange and the nominal exchange rate of the RMB, with obvious cointegration relationship. In a given research area, there may be cointegration between the currency market and the stock market. Accordingly, this paper makes the following hypothesis:

H2: RMB exchange rate and the Shanghai Composite Index has a significant co-integration relationship.

After analyzing the daily data of financial crisis in Southeast Asia, Granger (2000) and other foreign scholars found out the existence of the Granger causality between exchange rate and stock market index in some countries. Chinese scholars such as Deng Sang and Yang Chaojun (2008) also verified the changes in exchange rates over a specific period of time were the Granger causes of the Shanghai Composite Index changes in 2017. From the perspective of capital flow, fluctuations in the domestic currency will cause the capital flows both at home and abroad. The hot money inflows or outflows mainly focus on the stock market or other markets with strong liquid assets, thus causing the stock market to fluctuate. Accordingly, this article makes the following hypothesis:

H3: The RMB exchange rate fluctuation is the Granger reason for the change of Shanghai Composite Index.

3. An Empirical Analysis of the Impact of RMB Exchange Rate Fluctuation on the Stock Market

3.1 Sample and data selection

Sample and Data Description: This paper selects the daily data of the Shanghai Composite Index and the exchange rate of RMB against the US dollar from August 11, 2015 to August 11, 2016, collected from Wind Info financial terminals. Each received 246 sets of valid data, excluding the holiday vacancy data, the Shanghai Composite Index, RMB exchange rate against the U.S. dollar.

3.2 Data stability test

The exchange rate data of the Shanghai Composite Index and the RMB against the US dollar are time-series data. The possible linkages between the data itself may cause the unit roots between the data, leading to instability of the sequence. Therefore, we use the "Augmented Dickey-Fuller Unit Root Test" (hereinafter referred to as "unit root method") to test the stability of the time series. After confirming the data's stability, we proceed with the subsequent empirical analysis. As shown in Table 2, there is a unit root in the INDEX and USDCNY exchange rates, indicating the instability of the data series.

Table 2 Unit root test of Shanghai Composite Index (SCI) and RMB / USD exchange rate sequence

Parameter	ADF value	1% level	5% level	10% level	P value
SCI	-2.788487	-3.45695	-2.87314	-2.573028	0.0614
RMB/USD exchange rate	-1.123686	-3.45695	-2.87314	-2.573028	0.7069

The first-order difference was analyzed between the Shanghai Composite Index and the RMB exchange rate against the U.S. dollar before conducting the unit root test.

Table 3 Unit root test of first order differential sequence

Parameter	ADF value	1% level	5% level	10% level	P value
SCI	-14.72976	-3.457061	-2.873190	-2.573054	0.0000
RMB/USD exchange rate	-14.85928	-3.457061	-2.873190	-2.573054	0.0000

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After the first-order difference analysis, the INDEX and USDCNY sequences have been stable and belong to the first-order single whole sequence. In addition, due to the instability of the original data of "INDEX" and "USDCNY", in order to slow down the fluctuation of data series, logarithm processing is performed on two sequences by the mathematical function of EXCEL. "LNINDEX" is used to indicate that the logarithmic number of the Shanghai Composite Index. "LNUSDCNY" is denoted for the logarithmically denominated the exchange rate of RMB against the U.S. dollar. A unit root test is performed again and the test results indicate the stability of the series.

3.3 Cointegration test

3.3.1 VAR test

Var model testing, foundation of cointegration test, is utilized to determine the optimal lag order among parameters. VAR(p)model is :

$$\gamma_t = A_1 \gamma_{t-1} + \cdots + A_p \gamma_{t-p} + BX_t + \varepsilon_t \quad (1)$$

where X_t is the exogenous vector of D dimension, γ_t is the endogenetic variable vector of k dimension, T is the sample number,$\boldsymbol{\rho}$ is the lag order.

First,"LNINDEX""LNUSDCNY"series are tested using Estimate Var tools.

Table 4 Estimate Var test

	LNINDEX	LNUSDCNY
Log (SCI) (-1)	0.993356	0.001921
LNINDEX(-1)	(0.06492)	(0.00561)
	[15.3013]	[0.34218]
Log (SCI) (-2)	-0.054359	0.000326
LNINDEX(-2)	(0.06386)	(0.00552)
	[-0.85128]	[0.05906]
Log (RMB/USD exchange rate) (-1)	-0.008344	1.092203
LNUSDCNY(-1)	(0.70711)	(0.06115)
	[-0.01180]	[17.8609]
Log (RMB/USD exchange rate) (-2)	-0.209365	-0.088978
LNUSDCNY(-2)	(0.71669)	(0.06198)
	[-0.29213]	[-1.43560]
C	0.896883	-0.023965
	(0.30527)	(0.02640)
	[2.93801]	[-0.90778]
Decisive coefficient	0.952006	0.988444
Adjusted decisive coefficient	0.951202	0.988251
Sum of squares of residuals	0.093994	0.000703
S.E. equation	0.019831	0.001715
Statistics under F distribution	1185.187	5110.858
llr	612.9051	1210.179
AIC information criterion	-4.982829	-9.878520
Schwarz criterion	-4.911166	-9.806857
Dependent variable standard deviation	8.040866	1.871185
Dependent variable mean	0.089774	0.015822
Determinant resid covariance (dof adj.)		1.14E-09
Determinant resid covariance		1.10E-09
llr		1824.505
AIC		-14.87299
Schwarz criterion		-14.72966

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In the Var test results, we use the "Lag length criteria" in the "Lag structure" again to detect values with the lag order from 0 to 8. According to the LR, FPE, AIC, SC, HQ value and system recommendation option in the table below, the sequence is in the first order and the best lag order is the first order.

Table 5 Estimate Var test-optimal lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	955.5024	NA	1.14e-06	-8.012625	-7.983446	-8.000866
1	**1780.703**	**1629.598***	**1.14e-09***	**-14.91347***	**-14.82594***	**-14.87819***
2	1782.253	3.034326	1.17e-09	-14.89288	-14.74699	-14.83408
3	1784.785	4.914972	1.18e-09	-14.88054	-14.67629	-14.79823
4	1785.026	0.464059	1.22e-09	-14.84896	-14.58635	-14.74312
5	1786.109	2.066504	1.25e-09	-14.82445	-14.50348	-14.69509
6	1788.468	4.459437	1.27e-09	-14.81065	-14.43133	-14.65778
7	1789.440	1.822103	1.30e-09	-14.78521	-14.34753	-14.60882
8	1790.552	2.064349	1.33e-09	-14.76094	-14.26490	-14.56103

3.3.2 Cointegration test

According to the above optimal lag order test results, cointegration of the exchange rate of RMB against the US dollar and the Shanghai Composite Index is conducted under the assumption that the first order is the optimal lag order, and the default confidence level is 0.05. The test results are shown in the following table, which can be considered as an obvious cointegration relationship between the exchange rate of RMB against the US dollar and the Shanghai Composite Index, leading to the validation of H2.

Table 6 Cointegration test

Hypothesis No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.052486	13.57708	15.49471	0.0953
At most 1	0.001729	0.422274	3.841466	0.5158

3.4 Granger causality test

The Granger causality test can test whether there is a causal relationship between the USDCNY exchange rate and the Shanghai Composite Index (INDEX), whether the stock-oriented model or the traffic-oriented model is satisfied. Granger causality test is conducted for the above two sequences as shown below:

Table 7 Granger causality test

Hypothesis	Observation	F value	Prob.
The RMB/USD exchange rate is not the Granger reason for the Shanghai Composite Index	245	4.26013	0.0401
The Shanghai Composite Index is not the Granger reason for the RMB/USD exchange rate		5.47065	0.0202

Table 7 indicates that "Shanghai Composite Index(INDEX)","RMB/USD exchange rate(USDCNY)"are the Granger reasons for each other. The interaction between the Shanghai Composite Index and the RMB / USD exchange rate over a period of time is rapid and drastic. When the Shanghai Composite moves up, it will have an impact on the exchange rate of RMB against the U.S. dollar and vice versa. Therefore, the Shanghai Composite Index and the RMB exchange rate against the US dollar are reasons for each other. The test hypothesis H3 is established.

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3.5 Impulse response analysis

In order to further analyze the impact of the exchange rate between RMB and the US dollar and the fluctuation of the Shanghai Composite Index, this paper analyzes the response of the Shanghai Composite Index to the impact of various variables through the impulse response function. The two sequences of "LNINDEX" and "LNUSDCNY" from August 11, 2015 to August 11, 2016 are tested using the impulse response function, which is shown in Fig. 1.

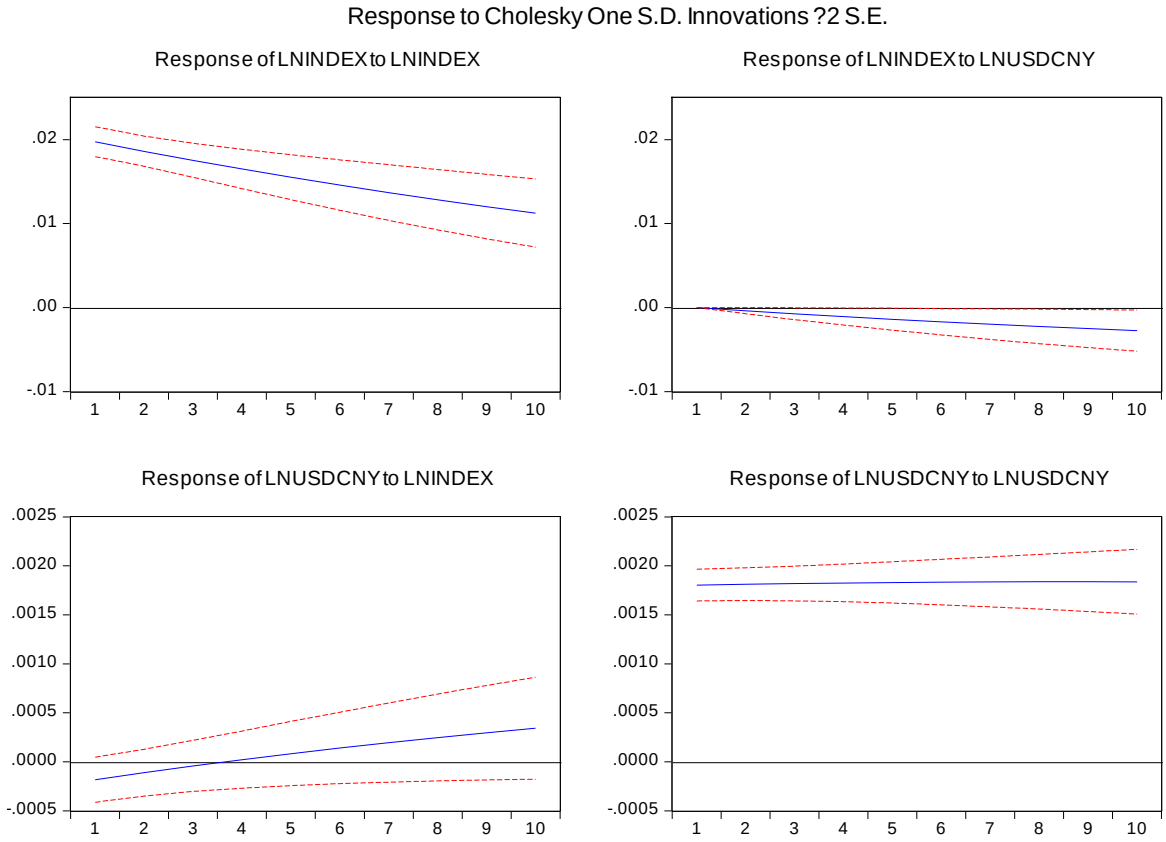

Figure 1 Impulse response result graph

As can be seen from Fig 1, after Shanghai stock market's positive impact on its own, Shanghai Composite Index shows a positive feedback in the first period, which is consistent with the expected theory under asymmetric information. Any early-stage information is quickly reacted and digested in the context of efficient financial markets, with declining influence in subsequent periods. After the RMB exchange rate against the US dollar positively impacts the Shanghai Composite, the exchange rate of RMB against the U.S. dollar has no effect on the Shanghai Composite Index in the first phase, with its impact becoming negative and its influence gradually increasing over time. In the tenth phase the impact reaches the maximum. After the Shanghai Composite Index has a positive impact on the exchange rate of RMB against the US dollar, the Shanghai Composite Index negatively affects the exchange rate of RMB against the U.S. dollar from the first phase to the third phase, but its negative impact gradually decreases. From the fourth phase, the Shanghai Composite Index has gradually increased its impact on the exchange rate of RMB against the U.S. dollar from zero to a positive one, and the positive impact has continued to increase. In the tenth phase, the impact reaches its maximum. The main reason leading to this positive and negative alternation is that the positive impact of the exchange rate of RMB against the U.S. dollar on both sides of the first to the tenth is the positive impact of the RMB against the U.S. dollar on its own.

3.6 Multiple regression analysis

Most of the references verify the one-way or two-way relationship between exchange rate and stock market by means of cointegration test and Granger causality test. However, few scholars take advantage of the multivariate model to comprehensively analyze the relationship among multiple variables. This

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paper chooses the exchange rates of the US dollar against the RMB exchange rate with the Shanghai Composite Index, the exchange rate between the U.S. dollar and the RMB, the CPI (consumer price index), the Keqiang index and the RMB Real Effective Exchange Rate Index from August 2015 to August 2016 at the macro and micro levels, M2 (broad money supply) and other variables of the monthly data. Among them, the index of price changes based on the prices of residents' products, labor and services, named the consumer price index (CPI), and is an important indicator of inflation.

The RMB real effective exchange rate index refers to the nominal effective exchange rate adjusted by the relative price level or cost index between the country and the selected country. It is the ratio and the nominal ratio of the domestic price level or cost indicator to the weighted geometric mean of the price level or cost indicator of the selected country.

M2 (broad money supply) corresponds to narrow money and is a form of money supply. The calculation method is M2 = M1 (cash in circulation + check deposit) + savings deposit (including current deposit and fixed deposit).

After performing unit root test on the above variables, the data are logarithmically processed, and a multivariate model is established on the basis of ensuring the data's stability:

$$\mathrm{Ln}\left(\varepsilon_t\right) = c + \alpha_1 \mathrm{Ln}(S_t) + \alpha_2 \mathrm{Ln}(Q_1) + \alpha_3 \mathrm{Ln}(M2) + \alpha_4 \mathrm{Ln}S_1 + \alpha_5 \mathrm{CPT}_1 + \mu_1 \quad (2)$$

where, ε represents the dollar against the RMB exchange rate, $\varepsilon' = \varepsilon \cdot (P/P')$,representing the RMB real effective exchange rate index; P is the consumer price index (CPI); S is the Shanghai Composite Index; Q is grams strong index; M2 represents the money supply.

Table 8 Multiple regression analysis result

Parameters	coefficient	Standard error	T statistic	Prob.
Keqiang index	0.041824	0.029310	1.426940	0.1914
US dollar against the RMB exchange rate	-4.497368	1.889464	-2.380235	0.0445
RMB real effective exchange rate index	1.004848	0.936063	1.073484	0.3144
M2	0.828426	0.495788	1.670929	0.1333
CPI	-0.344987	0.104220	-3.310166	0.0107

Decisive factor	0.730243	The mean of the explained variable	8.026061
Adjusted coefficient of determination	0.595365	The standard deviation of the explanatory variable	0.083480
The standard error of the regression coefficient	0.053102	Chi information guidelines	-2.749473
Residual sum of squares	0.022559	Schwartz guidelines	-2.532185
Llc	22.87158	Information guidelines	-2.794136
Durbin-Watson stat	2.510546		

In this paper, we conduct the EVIEWS regression analysis of the above variables, as shown in Table 8: The Shanghai Composite Index and the dollar against the RMB exchange rate, consumer price index (CPI) and other two variables have a more significant correlation. The Shanghai Composite Index and the US dollar against the RMB exchange rate show a negative correlation, with the correlation coefficient of about -4.50. When US dollar against the RMB exchange rate is increased by 1%, the Shanghai Composite Index falls 4.50%. This is explained by that when the exchange rate between the U.S. dollar and the RMB rises (RMB depreciates), the Shanghai Composite Index shows a downward trend. The Shanghai Composite Index is negatively correlated with the Consumer Price Index (CPI), with a correlation coefficient of -0.34. For every 1% increase in the Consumer Price Index (CPI), the Shanghai Composite Index is down 0.34%. Understandably, when the Chinese economy experienced inflation, the real purchasing power of the RMB causes the devaluation of the RMB and the downward pressure on the Shanghai Composite Index.

Considering all the factors, the above empirical analysis uses a variety of econometric methods to test the daily data from August 11, 2015 to August 11, 2016, and separately examines the long-term equilibrium relationship among variables, positive impact prediction and China's stock market and

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exchange rate market based on an empirical study. The research shows that there is a long-term and stable cointegration relationship between the stock price and the exchange rate for the whole sample period, and the Shanghai Composite Index is negatively correlated with the exchange rate of the RMB against the US dollar. When the exchange rate between the RMB and the US dollar rises (devaluation), the Shanghai Composite Refers to the situation of decline. This is consistent with the conclusion drawn by Wang Bo, Liao Hui and Ma Junlu (2012).

4. Conclusion

In this paper, we select the daily exchange rate data of Shanghai Composite Index and RMB against the US dollar using the econometrics analyzing methods such as unit root test, co-integration test, Granger causality test, vector error correction model, impulse response function test and multivariate regression analysis. This article draws the following conclusion:

First, as far as the current theory of the relationship between the mainstream exchange rate and the stock market is concerned, the traffic-oriented model is in line with the actual situation in China at this stage. Fluctuations in exchange rates are the causes of stock price volatility, which is the result of exchange rate fluctuations. In the study period, the correlation between the Shanghai Composite Index and the RMB against the U.S. dollar shows a negative correlation, that is, the devaluation of the RMB exchange rate accompanied by a fall in the stock market. In 2015, the A-share market rose rapidly and dropped sharply, and the investment risk in the ups and downs was fully released. In the same year, the Federal Reserve announced the rate hike in December. This is the first increase in interest rates by the world's largest economy since 2006. The Sino-US capital market is resonated by the rate hike, causing the outflow of capital in China and the market prices in the domestic stock market and real estate.

Second, there is a clear cointegration relationship between the Shanghai Composite Index and the exchange rate of RMB against the U.S. dollar in the study period, and they are the Granger reason for each other. The interaction between the Shanghai Composite Index and the exchange rate of RMB against the U.S. dollar has been rapid and intense over a certain period of time. Therefore, the depreciation of the RMB exchange rate and the stock market shows a mutually reinforcing trend. China's import and export processing trade accounted for a large proportion of the devaluation of the exchange rate to promote imports of products, reducing the purchasing power of enterprises for imported raw materials, improving the cost of the enterprise, thus affecting the share price of listed companies through the profit.

Finally, through the multiple regression analysis, we identify that there are significant correlations between the Shanghai Composite Index and the two variables of the US dollar against RMB exchange rate, and the consumer price index (CPI): The Shanghai Composite Index and the Consumer Price Index (CPI) show a negative correlation. When China's economy is in an inflationary situation, the exchange rate of RMB declines in the actual purchasing power to promote devaluation of the RMB with the Shanghai Composite Index falling in the situation. In summary, the transmission mechanism of the exchange rate impacting on the stock market can be divided into two types: conduction of current account and transmission of capital account. If the exchange rate fluctuates sharply at this stage, the revaluation of RMB-denominated assets will be triggered. Affected areas of assets, according to the level of liquidity conduction path, have a considerable coverage including the stock market, bond markets, real estate on a decreasing order.

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