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Does RMB Exchange Rate Cause the Sino–US Trade Imbalance? ——Empirical Study Based on Data from 1995 to 2015

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ABSTRACT. *This study explores the relationship between renminbi (RMB) exchange rate and the Sino–US trade balance. We firstly describe the relationship between exchange rate and trade volume through background introduction and literature review. After collecting public data, cointegration test and error correction model were used to conclude that RMB exchange rate is not the cause of Sino–US trade imbalance, and the Granger UK test was used to reinforce this conclusion. Lastly, we use summary and analysis to provide directions and requirements for future research.*

KEYWORDS: *US–China trade, Renminbi, exchange rate, empirical study, ECM model*

1. Introduction

Sino–US trade imbalances have intensified in recent years. Given the increasing Chinese foreign trade surplus, the call for the appreciation of the renminbi (RMB) has set off a new round of exchange rate warfare. Although there is no explicit mention of RMB in this bill, the general belief is that the proposal mainly intends to promote Congress' legislation and urge government departments to levy a high punitive amount on Chinese exports to the US on the ground that 'the renminbi is undervalued' (Handley 2013). China has long been believed to be maliciously and unfairly manipulating the exchange rate by underestimating the RMB exchange rate to maintain high surplus in foreign trade (Monarch 2014).

In accordance with the traditional theory of international trade, if a national currency devaluates, then the relative prices of domestic goods will decline in the international market and competitiveness will increase, thereby benefiting and increasing exports. Moreover, the relative increase in the prices of foreign commodities will be detrimental to and reduce imports. When the balance of trade has been improved, the appreciation of the national currency appreciates will have the opposite effect. Therefore, this research uses the real effective exchange rate of

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RMB from 1995 to 2015, China's real GDP, real US GDP and China's import and export volume to the US.

2. Literature Review

Marwah and Klein (1996) analysed the US dollar exchange rate and foreign trade balance data from 1977 to 1992, and found that if the depreciation of the US dollar has a J-curve effect in the first few quarters, then the trade balance does not follow after a certain period. The improvement worsens accordingly and the conclusion is that the devaluation of the US dollar will worsen trade balances. Miles (1979) believed that if a country has a high level of economic openness, developed financial market and flexible exchange rate mechanism, then the balance of current accounts can be passed through the foreign exchange market and affect the formation of exchange rates. Similarly, changes in exchange rates will also make commodity prices in a country's import and export trade to change eventually, thereby affecting balance of payments. Additionally, exchange rate changes will produce an evident J-curve effect.

3. Empirical Study

3.1 Model Selection and Settings

This study adopts the simplified trade balance model of Rose and Yellen (1989), which is a 'two-state' model. Theory of model setting is incomplete substitution theory. The majority of the studies analysed under this issue are incomplete substitutions. This theory is based on the idea that domestically imported goods cannot be completely replaced with domestic ones, and that domestically exported goods also have their own special characteristics. Judging from the reality of China, some of the county's imports of goods cannot be produced domestically owing to lack of technical resources. Therefore, theory of incomplete substitution does not apply to China. In this model, a country's exports are related to the nominal exchange rate between the two countries, total foreign income and domestic and foreign price levels. By contrast, a country's imports are related to the nominal exchange rate, the country's total income and price level of the two countries.

The exit model is expressed as follows:

$$Ex = f(Y_f, P_d, P_f, e).$$

The import model is expressed as follows:

$$Im = f(Y_f, P_d, P_f, e).$$

We have the following basic regression equation according to the formula:

$$\ln Y = \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3.$$

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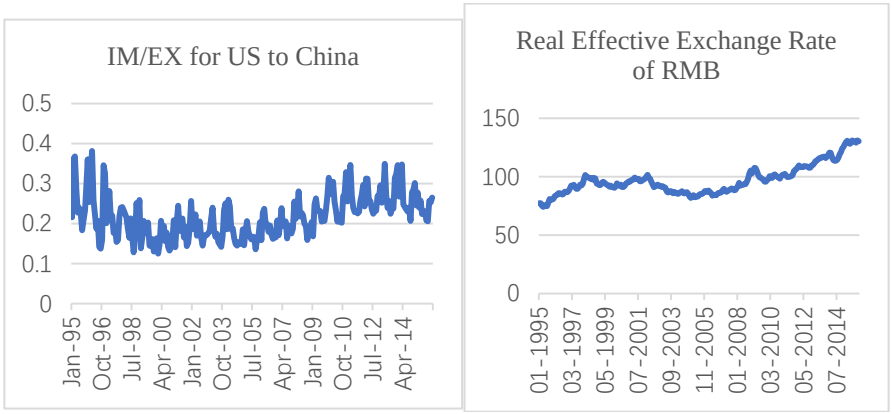
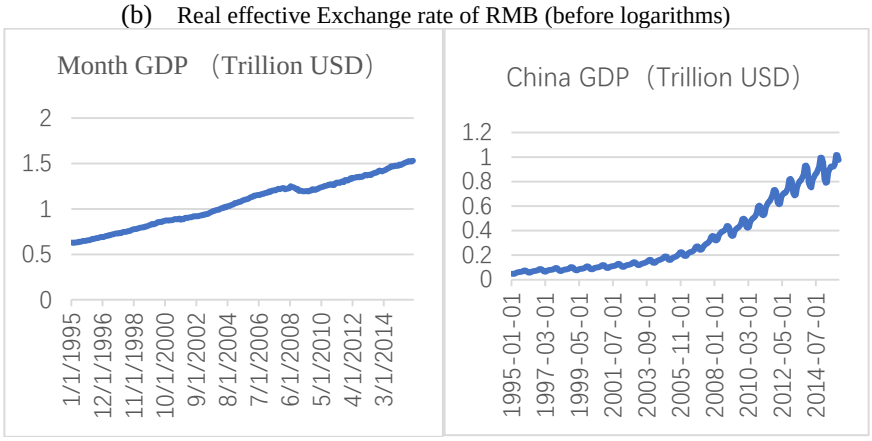
The data used in this study are the monthly data from January 1995 to December 2015, thereby avoiding the shortcomings of taking substantially few quarterly or annual data sample sizes and lack in statistical credibility.



(a) (b)

(a) Ratio of US imports and exports to China (before logarithms)
(b) Real effective Exchange rate of RMB (before logarithms)



(c) (d)

(c) China's monthly GDP (before logarithms)
(d) US' monthly GDP (before logarithms)

Figure 1 Tendencies for the variables

In particular, Y is the logarithm of the US monthly exports to China and US to China's monthly imports. The source of the data is the China Economic Net statistics database. Ln X_1 is the logarithm of the real effective exchange rate of RMB for the base period 2010. The source of the data is the Bank for International Settlements statistics. Ln X_2 is the logarithm of the real GDP data for the US based on 2011. We also used EVIEWS 8 to convert those quarterly data to monthly data.

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The data source is the US Department of Commerce's website. Ln X_3 is the logarithm of China's real GDP data based on the 2011 base period. We likewise used EVIEWS 8 to convert the quarterly data to monthly data. The data source is the China National Bureau of Statistics.

3.2 Stationarity Test

The data we used in this study are time series, and the stability and non-stationarity of the time series should be analysed. The test methods of stationarity mainly include traditional and modern methods, which are represented by autocorrelation and unit root tests, respectively. This study chooses to use the ADF unit and test method to test the stability of each variable. The stability of each variable in the model is tested. The first-order difference test at the 5% level is significant, which is below than the corresponding critical values. Thus, all variables are stationary.

3.3 Cointegration Analysis

Cointegration means that some linear combinations of multiple non-stationary economic variables are stable, thereby revealing a long-term equilibrium relationship among the variables. If multiple nonstationary variables have cointegration, then these variables can be combined to form a stationary sequence that can be used to describe the equilibrium relationship between the original variables. The regression model built by these variables makes sense if and only if there are cointegration among multiple nonstationary variables. Therefore, cointegration test is also an effective method to distinguish between true and pseudo regressions.

Table 1 JJ Cointegration Analysis Results

Hypothesized		Trace	0.05
No. of CE(s)	Eigenvalue	Statistic	Critical Value
None *	0.315009	118.8202	47.85613
At most 1	0.051122	25.36788	29.79707
At most 2	0.036252	12.40642	15.49471
At most 3	0.013214	3.285717	3.841466
Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level			
* denotes rejection of the hypothesis at the 0.05 level			
**MacKinnon-Haug-Michelis (1999) p-values			

The preceding conclusions indicate that the three variables are monotonous on the first-order basis, thereby verifying whether a cointegration relationship exists. Cointegration test methods mainly include the EG two-step and Johansen test methods. However, the Johansen test is used to test the cointegration relationship among variables because the EG two-step method may be unable to find all cointegration vectors correctly, and this research has at least two variables.

ISSN 2706-6827 Vol. 2, Issue 4: 25-32, DOI: 10.25236/IJFS.2020.020404

Eigenvalues and trace statistics reject the test that there is no cointegration hypothesis, but we cannot reject the assumption of at most one cointegration vector. Therefore, the variables have a first-order cointegration, thereby indicating their long-term equilibrium relationship. The standard cointegration equation is provided as follows:

Table 2 Cointegration Equation Results

1 Cointegrating Equation(s):		Log likelihood	2379.933	
Normalized cointegrating coefficients (standard error in parentheses)				
EXIM	EXCHANGE	CHINA	US	
1.000000	0.496496	-0.738596	2.052301	

This equation shows $Y = -0.496496 *X_1-2.052301*X_2+0.738596*X_3$ and subverts our original understanding. Firstly, the real effective exchange rate of RMB −0.496496, which means that a 1% increase in the real exchange rate of RMB will lead to a 0.446496% reduction in China's trade balance with the US. This situation is not what people expects.

Secondly, the coefficient of the real GDP of the US is −2.052301. That is, an increase of 1% in the real GDP of the US will lead to a decrease in the import/export ratio of the US to China by 2.894212%. Although this situation seem unreasonable, the increase in the US GDP is due to other sources, particularly investment or consumption. Moreover, the US may spend substantially on China's goods, thereby leading to such a result.

The coefficient of China's real GDP is −0.738596, which is easy to understand. This value shows that a 1% increase in China's real GDP will result in a reduction of China's trade balance with the US by 0.738596%. Accordingly, the increase in China's GDP comes from an increase in exports to the US.

In the long run, the increase in the real effective exchange rate of RMB, rise in the real GDP of the US and the increase in real GDP in China can aggravate the balance of payments in the US. By comparing the coefficients, the coefficient of the real GDP of the US is evidently higher than that of the real effective exchange rate of RMB and coefficient of China's real GDP. Therefore, compared with the other two variables, the real GDP of the US is a markedly important explanatory variable. The real GDP of the US has a significant long-term effect on the trade balance between China and the US, followed by China's GDP and the real effective exchange rate of RMB. The impact of the trade balance between the two countries is extremely small and can even be disregarded.

3.4 Error Correction Model

A long-term equilibrium relationship exists among the real effective exchange rate of RMB, real GDP of the US and real GDP of China and the trade balance between the two countries. However, such a long-term equilibrium is constantly adjusted and maintained during the short-term dynamic process. Moreover, an error

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correction exists among these variables. Mechanisms also prevent long-term relationship deviations from expanding in terms of size and number.

Table 3 Error Correction Model Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003664	0.012375	0.296092	0.7674
$D(X_3)$	0.081287	0.179771	0.452170	0.6515
$D(X_2)$	-0.189410	1.841791	-0.102840	0.9182
$D(X_1)$	-1.583310	0.729878	-2.169282	0.0310
ECM (-1)	-0.471684	0.052971	-8.904621	0.0000
R-squared	0.256306	Mean dependent var		0.000818
Adjusted R-squared	0.244213	S.D. dependent var		0.185158
S.E. of regression	0.160969	Akaike info criterion		-0.795489
Sum squared resid	6.374121	Schwarz criterion		-0.725261
Log likelihood	104.8339	Hannan-Quinn criter.		-0.767227
F-statistic	21.19528	Durbin-Watson stat		1.942402
Prob(F-statistic)	0.000000			

The results indicate that the coefficient of ECM is −0.472. That is, when short-term shocks deviate from long-term equilibrium, the error correction mechanism will use 0. 472 to adjust the deviation between variables to equilibrium. A total of 47.2% of the adjustments are relatively large. Moreover, the data presented in Table 3 shows that the first-order lag in the real exchange rate of RMB has a negative effect on the trade balance between China and the US, which is −1.5833, which is considerably significant, thereby indicating that the short-term RMB will cause an impact. However, the intensity of the callback is also relatively large. That is, R^2 = 0.26, in which the fitting degree is extremely bad and the T statistic is substantially small. The majority of the variables in the model are not significant. Overall, the real effective exchange rate of RMB, China's real GDP and the real GDP of the US the impact of income and expenditure in the short term is very limited.

3.5 Granger Causality Test

The preceding cointegration analysis indicates a long-term equilibrium relationship among the real effective exchange rate of RMB, China's imports from the US and China's real GDP. However, we should use the Granger causality test to determine whether a causal relationship exists among the variables.

Time series can often have spurious regressions, and there are large correlation coefficients between some sequences, which tend to have strong trends and volatility over time but may not be a large system. The Granger causality test measures whether or not independent's early information contributes to a decrease in the mean square error when predicting y. The result of this rest is used as a criterion for causality. Comparing previous information with and without independent variable, if the mean square error is significantly.

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Table 4 Granger causality test results

Null Hypothesis:	Obs	F-Statistic	Prob.
EXIM does not Granger Cause EXCHANGE	250	1.96853	0.1419
EXCHANGE does not Granger Cause EXIM		13.3510	3.E-06
EXIM does not Granger Cause US	250	0.32708	0.7213
US does not Granger Cause EXIM		2.88422	0.0578
EXIM does not Granger Cause CHINA	250	4.52281	0.0118
CHINA does not Granger Cause EXIM		9.74483	8.E-05
US does not Granger Cause EXCHANGE	250	1.03942	0.3552
EXCHANGE does not Granger Cause US		0.47627	0.6217
EXCHANGE does not Granger Cause CHINA	250	0.25876	0.7722
CHINA does not Granger Cause EXCHANGE		4.87321	0.0084
US does not Granger Cause CHINA	250	4.20139	0.0161
CHINA does not Granger Cause US		0.44266	0.6428

The test results show a causal relationship between the real effective exchange rate of RMB and the trade balance between China and the US. That is, the real effective exchange rate of RMB in the short term will have a certain impact on the trade balance between the two countries. Moreover, the import and export of the US has no effect on its GDP. Table 4 shows that it is rejected. The actual GDP of the US and the Granger cause of the trade balance between two countries show that the real GDP of the US has an impact on its trade balance with China. China's GDP is related to the US' import and export revenues and expenditures. In addition. China's GDP and exchange rate have mutual influence. Lastly, the impact of the US GDP on China's energy has a causal role, but the latter's GDP lacks a significant impact on the US.

Therefore, the core conclusion reached through the Granger causality test is that RMB has a certain influence on the foreign trade of the US. However, the two countries' GDP have a substantial impact on the US' import and export.

4. Conclusion

This study elaborates on the typical phenomena and status quo of RMB exchange rate and trade volume. The trade surplus between the US and China is actually increasing. Accordingly, this research studies the theoretical basis of the connection between exchange rate and trade. The Marshall Lerner condition, J-curve effect, McKinnon's exchange rate and trade balance theories have guiding roles in the analysis of Sino–US trade issues. By mastering the course of China's exchange rate reform after the founding of the People's Republic of China, the country's exchange rate system has been analysed to be moving from strict to loose.

ISSN 2706-6827 Vol. 2, Issue 4: 25-32, DOI: 10.25236/IJFS.2020.020404

An empirical study was conducted using the monthly economic information of China and the US from 1995 to 2015. In particular, this research established a cointegration edition and error correction model, conducted a Granger causality test and used measurement methods to analyse the exchange rate of RMB and the Sino–US trade balance. The results indicated that a long-term relationship exists between the two variables. Moreover, exchange rate has been determined to have an impact on the trade balance between China and the US, although the influence is not as huge as the GDP of the two nations. Lastly, the short-term exchange rate shocks were considerably revisited and has no impact on long-term equilibrium.

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