The Impact of International Commodity Price Changes on RMB Exchange Rate

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Abstract. In recent years, the international situation has changed and the Black Swan incident has taken place frequently. The international commodity prices fluctuate obviously. As an important importer of international commodities, China's exchange rate is also affected by commodity prices. This paper will use stationarity analysis, error correction, cointegration test and other methods to quantitatively analyze the linkage between commodity and RMB real exchange rate, and find that the impact of commodity on RMB exchange rate is negative in the short term. At the same time, it is proposed to reduce the adverse risks brought by the changes in international commodity prices to China's exchange rate by strengthening the internationalization of RMB, guarding against changes in the monetary policies of major international countries and increasing the pricing power of RMB for commodities.

Keywords: international commodity price, real effective exchange rate, error correction model, cointegration analysis

1 Introduction

In 2017, China imported 420 million tons of crude oil, 1.075 billion tons of iron ore, 95.54 million tons of soybeans and other commodities respectively. It is clear that China's macro economy will be more and more affected by changes in international commodity prices. In recent years, the international situation has undergone many changes. Under the frequent occurrence of black swan events, the continuous fluctuation of international commodity prices is bound to affect the stability of RMB exchange rate. In the past, most studies are concentrated in the effective exchange rate changes on the influence of commodity prices, mainly in exporter Angle, this article will focus on the use of empirical analysis, study to explain the impact of commodity price fluctuations of RMB exchange rate, commodity prices to prevent the negative impact of the fluctuation of RMB exchange rate, It is of great significance to ensure China's economic security.

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2 Literature review

Peng, Ma and Ma (2022) mentioned in their paper that the frequent adjustment of US interest rates would affect China's domestic commodity prices [1]. Wei Shuguang, Shen Ning, Xu Xiaoreu.(2022) mentioned that if the sanctions against Russia by Europe and the United States were further upgraded to the level of commodities, many institutions predicted that crude oil, European natural gas, aluminum, nickel, oil, wheat, corn and other varieties would rise sharply [2].

Ding and Xiang (2016) The nominal effective exchange rates of China and South Korea have a robust ability to predict domestic commodity prices, but Japan and India are not significant.

In terms of the impact of commodity prices on exchange rates, the domestic Yu and Hu (2004) demonstrated the positive correlation between oil prices and the real exchange rate of RMB by analyzing the influence mechanism between them [4]. Li Zhibin and Zhang Wei (2014) found that commodities such as crude oil and gold had significant impacts on RMB exchange rate fluctuations in both the long and short term [5]. Liu (2016) used multiple cointegration model, error correction model, impulse response function and other analysis methods to find that there is a long-term cointegration relationship between energy and agricultural prices and RMB exchange rate, and agricultural prices and RMB exchange rate are Granger causality [6].

3 Model construction and data processing

3.1 Construction of basic model

An explanation of exchange rates based on the balance of payments theory of the exchange rate determination theory: $S=k(Y+,Y*-,P+,P*-,i-,i*+,Sef+)$. The commodity prices to be analyzed in this paper will affect a country's price level, balance of payments and national income. This paper intends to analyze the impact of price changes of 9 commodities on the effective exchange rate of RMB. Considering that the exchange rate will also be affected by factors such as balance of payments, gross domestic product and consumer price index, but to simplify the analysis, this paper only considers the introduction of the above three factors as control variables, therefore, the function of the linkage relationship between exchange rate and commodity price can be written as follows: $lnRE=\alpha 0+\beta nlnPn+\gamma 1lnCPI+\gamma 2lnGDP+\gamma 3lnBOP+u$

3.2 Variable setting and data sources

International commodity price: refers to the price of material commodities that can enter the circulation field but are not retail links and have commodity attributes for industrial and agricultural production and consumption in the international market.

Real effective exchange rate of RMB: First of all, it should be explained that the nominal effective exchange rate of RMB refers to the exchange rate obtained by weighted average of the bilateral exchange rate of China and other countries' currencies

according to a certain weight (usually bilateral trade volume). After removing the price changes in the nominal effective exchange rate of RMB, the real effective exchange rate of RMB is obtained

paper will make an empirical analysis of the impact of commodity price changes on the real effective exchange rate of RMB. All sample data are selected from January 2011 to December 2021. The International Commodity Price Index is derived from the International Monetary Fund (IMF). The index is based on the monthly data of June 2010 (100), with 132 observations in total. The international commodity price index data includes one general index (weighted average for each product) and nine product categories for each month, for a total of 1320 data. The actual effective exchange rate of RMB (REER) and total balance of payments selected in this paper are derived from the data published by the Bank for International Settlements (BIS). China's CIP data are selected from the National Bureau of Statistics, and China's and other countries' average GDP growth data are selected from the World Bank.

4 Empirical test and result analysis

4.1 Correlation coefficient test

By examining the correlation coefficients between the effective exchange rate of RMB and various commodity price indices, it can be found that the correlation coefficients of the general index (AL) and agricultural products (G), agricultural raw materials (R), mineral products (M), precious metals (P), chemical fertilizers (F), energy (E), oil (O), natural gas (N) and coal (C) are all negative.

4.2 Stationarity test

In order to verify the reliability of the above correlation, a cointegration test is required. These variables were first tested for stationarity and the results are shown in Table 3. * in the table indicates rejection of the original assumption at a significant level of 5%

The results of ADF test show that these 13 variables are first-order difference stationary at 5%. Then the Johansen test is used to cointegrate the actual effective exchange rate of RMB with 13 variables, and the results are shown in Table 2. In the table, λmax represents the maximum eigenvalue statistic, r represents whether there is a cointegration relationship, * * represents rejecting the original hypothesis at a significa nt level of 5%.

Table 1. Johansen cointegration test (self-generated)

null hypothesis		Statistic	5% threshold
		λ max	λ max
combined index	r ≤ 1	0.94 jin	8.18
agricultural product	r ≤ 1	0.59 jin	8.18
Agricultural raw materials	r ≤ 1 **	7.83	8.18
minerals	r ≤ 1	0.88 jin	8.18

precious metal	r ≤ 1	1.25	8.18
chemical fertilizer	r ≤ 1	0.62 jin	8.18
energy	r ≤ 1	3.01	8.18
petroleum	r ≤ 1	5.56	8.18
natural gas	r ≤ 1	0.58 jin	8.18
coal	r ≤ 1	4.05	8.18
CPI	r ≤ 1 **	6.61	8.18
Ratio of GDP growth	r ≤ 1	3.70	8.18
BOP	r ≤ 1	4.79	8.18

From Johansen's test results, it can be seen that there is a cointegration relationship among the price index of agricultural raw materials, CPI and the RMB real effective exchange rate, but other categories of products cannot reject the original assumption. The conclusion shows that the time series of commodity price index and CPI of agricultural raw materials and the time series of RMB real effective exchange rate keep a balanced relationship in the long run.

4.3 Error correction model

According to the AIC minimum criterion, the optimal lag period of agricultural raw materials is 1, and the optimal lag period of CPI is 2. Next, this paper will build error correction models around these two products for further analysis. First, in order to examine the relationship between raw material price and RMB real effective exchange rate in the short term, an error correction model is established between raw material price index and RMB exchange rate:

$$\Delta \mathrm{In}(R_t) = \alpha_0 + \alpha_1 \Delta \mathrm{In}(\mathrm{REER}_t) + \alpha_2 \sum_{s=1}^{1} \Delta \ln(REER_{t-s}) + \alpha_3 \sum_{s=1}^{1} \Delta \ln(R_{t-s}) + \alpha_4 H_{t-1} + \varepsilon_t$$

$$\Delta \ln(REER_t) = \beta_0 + \beta_1 \Delta \ln(R_t) + \beta_2 \sum_{s=1}^{1} \Delta \ln(REER_{t-s}) + \beta_3 \sum_{s=1}^{1} \Delta \ln(R_{t-s}) + \beta_4 H_{t-1} + \delta_t$$

Among them, δ in (rt) is the first-order difference of the logarithm of the price index of agricultural raw materials, δ in (rt-s) is the lag s period of the first-order difference of the logarithm of the price index of agricultural raw materials, and s is the number of lag periods; T represents the selected data time; δ in (REERT) is the first-order difference of the logarithm of RMB exchange rate, δ ΔIn(REERt-s) is the first-order difference lag S period of the logarithm of RMB exchange rate; Ht-1 is the error correction term; α and β are regression coefficients; α4 is the coefficient of the error correction term, which indicates the correction force of the error term when the price index of agricultural raw materials deviates from the equilibrium, and the symbol represents the direction of adjustment; εt and δt are residual terms, which obey the standard normal distribution. The estimation results of the model are shown in Table 3 and Table 4.

Table 2. Error Correction Model for Agricultural Raw Materials (self-generated)

Explanatory variable	Interpreted variable	
	D ln(R)	D ln (REER)
	coefficient	coefficient
c	0.346118 jin	0.015393 jin
D (ln(R)(-1))	0.157448 jin	0.094938 jin
D (ln(REER)(-1))	-0.03208	0.389158 jin
H (-1)	-0.091043	-0.003907

Table 3. Granger Causality Test of Agricultural Raw Material Price Index and RMB Real Effective Exchange Rate (self-generated)

null hypothesis	F statistics	P statistics
Ln (REER) is not Granger Cause of ln(E)	0.0487 jin	0.8257 jin
Ln (E) is not granger cause of ln (REER)	2.4113	0.1229 jin

From the error correction results, when the price index of agricultural raw materials is taken as the explanatory variable and the actual effective exchange rate of RMB is taken as the explanatory variable, when the price index of agricultural raw materials deviates from the long-term equilibrium, the adjustment force of the error correction term on the actual effective exchange rate of RMB is -0.091043. From the Granger causality test results, ln(REER) is not the Granger cause of ln(R), and ln(R) is not the Granger cause of ln(REER).

The following examines the error correction model of CPI and RMB exchange rate:

$$\Delta \mathrm{In}(CPI_t) = \chi_0 + \chi_1 \Delta \mathrm{In}(\mathrm{REER}_t) + \chi_2 \sum_{s=1}^{2} \Delta \ln(REER_{t-s}) + \chi_3 \sum_{s=1}^{2} \Delta \ln(CPI_{t-s}) + \chi_4 I_{t-1} + \phi_t$$

$$\Delta \mathrm{In}(REER_t) = \gamma_0 + \gamma_1 \Delta \mathrm{In}(\mathrm{CPI}_t) + \gamma_2 \sum_{s=1}^{2} \Delta \ln(REER_{t-s}) + \gamma_3 \sum_{s=1}^{2} \Delta \ln(CPI_{t-s}) + \gamma_4 I_{t-1} + \varphi_t$$

The first-order difference of logarithm of consumer price index, χ and γ are regression coefficients; $\chi 4$ is the coefficient of the error correction term, which indicates the correction force of the error term when the consumer price index deviates from the equilibrium, and the symbol represents the direction of adjustment; T, φt are all residual terms and obey the standard normal distribution. The estimation results of the model are shown in Table 5 and Table 6.

Table 4. Error Correction Model for Consumer Price Index (self-generated)

Explanatory variable	Interpreted variable	
	D ln (CPI)	D ln (REER)
	coefficient	coefficient
c	0.33618 jin	0.23912 jin
D (ln(CPI)(-1))	-0.14229	-0.37972

D (ln(CPI)(-2))	0.04392 jin	0.12064 jin
D (ln(REER)(-1))	-0.01079	0.44542 jin
D (ln(REER)(-2))	-0.11226	-0.08123
H (-1)	-0.14896	-0.10569

Table 5. Granger Causality Test of Consumer Price Index (CPI) and RMB Real Effective Exchange Rate (self-generated)

null hypothesis	F statistics	P statistics
Ln(REER) is not Granger Cause of ln(CPI)	3.4691	0.06482 jin
Ln(CPI) is not Granger Cause of ln(REER)	0.6867 jin	0.4088 jin

When CPI is the explanatory variable, it can be seen from the error correction results that when the real effective exchange rate between RMB and US dollar deviates from the long-term equilibrium, the adjustment strength of the error correction term to the price index of agricultural products is -0.14896. According to the results of Granger causality test, at the level of 10%, ln(REER) is the Granger cause of ln(CPI), and ln(CPI)b is not the Granger cause of ln(REER).

5 Conclusion

In the selected nine product categories, international commodity prices have a negative impact on RMB REER movements. Both the agricultural raw material price index and the CPI index have a long-term cointegration relationship with the RMB REER, and the RMB REER is the granger cause of the CPI. From the perspective of import and export, as an important import end of international bulk commodities, the price of international bulk commodities increases, the total import of China increases in the short term, the international circulation of RMB increases, and the RMB depreciates. From the Angle of investment and financing, commodity in precious metals, oil and other commodities not only possess properties also have financial attributes, when this kind of commodity prices in the short term, investors will be in China for holding this kind of commodity prices expected, then increase the purchase of this commodity, the international circulation of RMB increase, depreciate the renminbi.

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