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Do Commodity Futures Prices Affect Monetary Policy: Empirical Analysis from China

Tianchen Gao[1], Wenyu Gao[2], Hui Gao[3*]

[1]Department of Art and Social Sciences, University of Sydney, Sydney, Australia
[2]School of Management, Hefei University of Technology, Hefei, China
[3]Shanghai Futures Exchange, Shanghai, China
Email: *gao_hui1018@163.com

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Abstract

This paper uses the cointegration correlated theory model method and the monthly data from May 2004 to October 2023 to study the role and impact of the Chinese futures market price index (total index and various sub-indices of energy, chemicals, non-ferrous metals, grains, oilseeds and soft commodities) on Chinese monetary policy variables (reserve ratio, net money supply of open market, interbank lending rate, USD/RMB exchange rate, money supply M0, M1 and M2). It is found that the total commodity futures price index and the non-ferrous index have a strong guiding effect on the monetary policy variables except for the net money supply of open market operations. All other sub-indices have a strong impact on individual monetary policy variables, except for oilseeds, and generally speaking, the total commodity price index and the non-ferrous commodity price index have a greater impact on monetary policy. The cointegration test and error correction model show that in the long and short term, various indices of futures prices have different quantitative effects on monetary policy variables, and the shock response function curve reflects that each index of futures price has different delayed effects on monetary policy variables, indicating that the overall impact of futures price index on monetary policy variables is greater, but the role of different sub-indices is different. Therefore, taking a variety of measures to balance the development of the futures market and better enhance the impact of the futures price index on monetary policy will help improve the implementation effect of monetary policy and better promote the development of macroeconomy.

Keywords

Commodity Price Index, Monetary Policy, Causality Test, Cointegration Test, ECM Model

1. Introduction

After more than 30 years of development, China's futures market has made great achievements, with more than 130 futures and options currently listed (as of December 2023), and the price discovery and hedging functions of the futures market have been continuously improved, and the ability to serve the real economy has been continuously strengthened.

The development of the China's futures market is of great significance to the development of the national economy, and the operation of the futures market has a certain impact on the macro monetary policy. Monetary policy is implemented by the People's Bank of China, which affects the money supply, and indirectly affects aggregate demand through the PBOC's regulation of money supply, interest rate and credit supply in the economy, so as to achieve an ideal equilibrium between aggregate demand and aggregate supply. China's monetary policy generally includes credit policy, interest rate policy, and foreign exchange policy. The implementation of monetary policy is generally carried out through monetary policy tools, including open market operations, deposit reserves, central bank loans, interest rates, and exchange rates. The effective implementation of monetary policy plays an important role in macroeconomic regulation and control, and the analysis of the impact of the futures market on monetary policy has important theoretical significance for the development of the futures market and the effective implementation of monetary policy. This paper attempts to use the cointegration correlated econometric model to conduct a quantitative and empirical analysis of the specific situation of the China's futures market affecting monetary policy, and hopes to obtain some valuable conclusions for the reference of relevant decision-making departments.

The article is organized as follows: Part I: Introduction. Part II: Related research progress and literature review. Part III: research methods and models; Part IV: Empirical Analysis; Part V: Conclusions and Recommendations.

2. Literature Review

There is a large amount of literature on the relationship between commodity futures prices and macro monetary policy at home and abroad, and most of them focus on the impact of macro monetary policy on futures prices, and there are relatively few literatures on the impact of futures prices on monetary policy.

There are many domestic literatures on the role and impact of domestic and foreign monetary policies on commodity futures prices, For example, Zhang and Wang (2011) analyzed the guiding role of China's monetary policy on the international commodity futures index, and found that the guiding role of China's monetary policy on the international commodity futures index is significant, and the guiding role of the metal price index is more obvious. Wang (2013) empirically analyzed the impact of China's monetary policy shocks on commodity futures prices using the SVAR model, and argued that loose monetary policy shocks would stimulate the rise of commodity futures prices. Chen (2015) studied the long-term equilibrium and short-term dynamic relationship between China's monetary policy variables, M1, M2, interest rate, credit and commodity prices, and believed that there is a long-term equilibrium relationship between copper futures prices and monetary policy variables, and the impact of monetary policy on copper futures prices is significant in the short term, among which the relationship between Ml and copper futures prices is closer, and the impact effect of interest rates is not significant enough. Wang and Chang (2015) empirically found that in the recession period, the price of commodities is mainly affected by supply and demand, and the impact of monetary policy is small. During the economic recovery period, the impact of US monetary policy, especially the level of US money supply, is more significant, while during the period of economic expansion, the impact of China's monetary policy, especially the level of money supply, is more significant. Zhang and Fan (2017) conducted an empirical study on the relationship between monetary liquidity and oil prices, and found that there is a trade-off between China's expansionary monetary policy and the rise in oil prices. The impact of global liquidity on the price of crude oil in the world market is weakening, and the indirect impact of China's liquidity on the real price of crude oil is increasing. Chen et al. (2017) empirically analyzed the nonlinear impact of China's monetary policy on the commodity market, and found that there are significant regional transformation characteristics in China's commodity price fluctuations, and monetary policy shocks can well explain commodity price fluctuations, but the mechanism of action is obviously different. Unexpected changes in the money supply will reinforce the expected impact of the money supply on commodity markets, while unexpected changes in interest rates will weaken the expected effect of interest rates. Li et al. (2017) used the path analysis method to find that monetary policy has a strong positive correlation with the price of agricultural products, and the indirect impact of money supply level on the price of agricultural products through the income of urban residents is significantly stronger than the direct impact. Zhang et al. (2018) studied the impact of China's monetary policy on international oil prices, showing that the impact of China's monetary policy on oil prices through money supply and interest rates is increasing day by day, and the impact of China's monetary policy is deepening, in which M2 and oil prices show the same direction and the short-term impact is expanding. The impact of interest rates on crude oil prices in China also shows an increasing trend, but there are certain differences in different periods. Chen et al. (2019) empirically studied the impact of China's monetary policy on commodity prices using MCMC simulation and SV-TVP-VAR model, and the results showed that China's monetary policy can affect commodity prices in both direct and indirect ways. Long et al. (2019) used the panel data model and GMM model to estimate the impact of various factors on domestic commodity price changes, and used the NARDL model to investigate the asymmetric impact of contractionary monetary policy on commodity prices. The results show that multiple factors such as macroeconomics, monetary policy, and financial speculation affect domestic commodity prices. Contractionary monetary policy has a greater impact on commodity prices than loose policy. Huang (2021) empirically analyzes the impact of China's monetary policy on commodity prices under different lead times and different time points. The results show that quantitative instruments and commodity prices move in the same direction, and the long-term impact is significant, and their transmission mechanism has a certain time lag. Price-based instruments and commodity prices move in the opposite direction, but the correlation is not significant enough, and the higher China's dependence on foreign goods, the higher the impact of China's monetary policy. Jiao (2022) found that the unexpected negative impact of U.S. monetary policy on China's commodity futures prices was found through the event study method, VAR model and MS-VAR model. The U.S. central bank information shock has a positive impact on Chinese commodity futures prices. In the dimension of monetary policy period, the impact of US monetary policy accidents on China's commodity futures prices during the conventional monetary policy period is greater than that during the quantitative easing period.

There are few literatures on the impact of commodity futures prices on monetary policy in China, such as Yu and Yin (2005), who used six variables including international oil prices, GDP growth rate, fiscal expenditure, M2, CPI, and one-year deposit interest rate to construct vector autoregressive models, and investigated the effects of rising and falling oil prices on the above economic variables under linear and nonlinear models, respectively. Fu et al. (2009) conducted an empirical analysis of the impact of international commodity price fluctuations on China's monetary policy. It is believed that changes in international commodity prices will have an important impact on China's currency demand, especially in the context of the continuous expansion of China's commodity market and the increasing degree of internationalization, the mechanism of international commodity price fluctuations affecting China's commodity spot and futures markets, and then affecting China's monetary policy has gradually taken shape. Wei (2015) re-examined the U.S. forward-looking Taylor rule based on commodity futures trading data, and evaluated the strength of commodity futures indices to interpret static data such as target interest rate values.

Most of the foreign research literature focuses on the relationship between commodity futures prices and macro monetary policy, and its role and impact, such as Barsky and Kilian (2004), empirically found that the U.S. monetary policy has a certain guidance and forward-looking for commodity prices, and can judge the trend of commodity prices through the trend of monetary policy, and believes that the adjustment and change of monetary policy in the seventies of the last century played a role in the process of rising oil prices during this period. Frankel (2008) further examined in detail the correlation between agricultural prices, mineral product prices, and monetary policy. The results showed that the loose monetary environment under low interest rates directly leads to higher commodity prices. Anzuini et al. (2010) established a traditional vector autoregressive model to explore the impact of U.S. monetary policy on commodity prices, and found that the U.S. quantitative easing monetary policy can boost the rise of commodity prices, but the extent of this impact is limited. Bodenstein et al. (2012) developed a fully set DSGE model using monetary policy shocks and systemic monetary policy responses, and the results show that there is a two-way causal relationship between oil prices and monetary policy. Specifically, oil market events can lead to a systemic response to monetary policy, and changes in monetary policy can also lead to a systemic response to oil prices. Anzuini, Lombardi and Pagano (2013) used the VAR model to study the impact of monetary policy shocks on commodity prices, and found that expansionary monetary policy shocks significantly and slightly raised the composite commodity price index and its components. Ratti and Vespignani (2013) used money supply M2 as a monetary instrument variable to examine the linkage between money supply and real oil prices in China, the United States, and Japan over a 15-year period. Belke et al. (2013) found that there is a long-term positive correlation between commodity prices and global liquidity, and a negative correlation with interest rates. Hammoudeh et al. (2014) empirically analyzed the impact of China's monetary policy on international commodity prices using the Bayesian SVAR model and choosing China's M2 and interest rates, and found that metal raw materials are more responsive to changes in monetary policy, and the impact of interest rate adjustments on commodity prices is much higher than the impact of money supply. Landgraf and Chowdhury (2015) examines the reasons for the rise in commodity prices around 2005 by including emerging economies in the scope of the study and constructing a VEC model, and the demand channel plays a large role in explaining commodity price growth, regardless of whether the BRIC countries selected by emerging economies are included or excluded from the analysis. In addition, excess liquidity also plays a role in the rise of commodity prices, and the impact of different monetary policies on commodity prices varies from one economy to another. Hu et al. (2020) examined the interaction between macroeconomic factors, capital markets, and geopolitical risks in a systemic framework and found that an increase in the Fear Index (VIX) index inhibits commodity returns and increases the volatility of commodity returns.

In summary, the research literature at home and abroad basically focuses on the role and impact of macro monetary policy on commodity futures prices, there are few literatures on the impact of commodity futures prices on macroeconomy and macro monetary policy, and there are almost no studies on the role and impact of domestic commodity futures prices on macro monetary policy, so it is of great theoretical and practical significance to comprehensively analyze and study the impact of domestic commodity futures prices on domestic macro monetary policy. This paper uses cointegration and related theories and models to conduct a quantitative model study on the role and impact of domestic commodity futures prices on monetary policy, hoping to discover the relevant laws and provide a theoretical basis for the development of the futures market and the implementation of domestic monetary policy.

3. Methodology

3.1. Causal Relationship Granger Test

According to the idea of Causal Relationship proposed by Granger (1969) and based on the mathematical model of causality proposed by Geweke, Meese and Dent (1983), the model for testing the causal relationship between commodity futures price index and monetary policy variable is given as follows:

$$y_t = a_{10} + \sum_{i=1}^{m} a_{1i} y_{t-i} + e_{1t} \tag{1}$$

$$y_t = a_{20} + \sum_{i=1}^{m} a_{2i} y_{t-i} + \sum_{j=1}^{k} b_{2j} x_{t-j} + e_{2t} \tag{2}$$

where y_t indicates monetary policy variables, x_t indicates the commodity futures price index, a_{1i} and a_{2i} are y_t and y_t regression coefficient of the lag value, b_{2j} is y_t and x_t regression coefficient of its lag value, e_{1t} and e_{2t} are white noise。Examining one-way causality from x_t to y_t is testing the null hypothesis of b_{2j}, H_0: $b_{2j} = 0$ ($j = 1, 2, \cdots, k$). The diagnostic statistics are as follows:

$$F = \frac{(ESS_1 - ESS_2)/m}{ESS_1/T - (k + m + 1)} \tag{3}$$

In the above equation, ESS_1 and ESS_2 are the sum of squares of the residuals in the least-squares regression equation of the above model, respectively, T is the number of samples for the time series Under the confidence probability α, if $F > F_\alpha$, the assumption H_0 is rejected and it is considered to have a causal relationship from x_t to y_t, that is, the commodity futures price index has a causal relationship with the monetary policy variable.

3.2. Testing and Estimation of Cointegration Relationships

There are many specific technical models for the testing and estimation of cointegration relations, such as the EG two-step method, the Johansen maximum likelihood method, the Gregory Hansan method, the autoregressive distribution lag model (ARDL) method, the frequency domain nonparametric spectral regression method, the Bayes method, and so on. Johansen (1988) proposed a method to test the cointegration relationship between multiple variates using maximum likelihood estimation (MLE) based on VAR systems. The core idea of the VAR model is to consider the relationship between economic variables as a time series without considering economic theory. Consider a VAR model with order *p*:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{4}$$

where y_t is the monetary policy variable and it is a *k* dimensional vector containing a nonstationary I (1) variable. x_t iscommodity futures price index variable and it is a vector of a definite *d* dimension, ε_t is a perturbation vector. We can rewrite VAR as follows:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \tag{5}$$

where $\Pi = \sum_{i=1}^{p} A_i - I$, $\Gamma_i = -\sum_{j=i+1}^{p} A_j$, if the coefficient matrix Π the rank is $r < k$, then there exists $k \times r$ order matrix α and β, whose rank is *r*, then $\Pi = \alpha\beta'$, and $\beta' y_t$ is stable. Where *r* is the quantity of the cointegration relation (cointegration rank), and each column of β is a cointegration vector. The elements in α are the adjustment parameters in the VEC of the vector error correction model. Johansen's method is to estimate the matrix Π in the form of unconstrained VAR, and then find β, so that the cointegration rank, ($\text{rank}(\Pi) = r < k$) is checked, and the cointegration vector is obtained. There are two test methods of Johansen test, namely the characteristic root trace test and the maximum eigenvalue test, in which the power of the maximum eigenvalue test is lower than that of the characteristic root test, so the commonly used method in practice is the characteristic root test, and the trace statistics of Johansen's eigenroots are as follows:

$$Q_r = -T \sum_{i=t+1}^{k} \log(1 - \lambda_i) \tag{6}$$

In the above equation, *k* is the number of sequences contained in the set of sequences tested, λ_i is the eigenroot of step *i*, and *r* is the number of assumed cointegration relations, $0 < r \le k - 1$. Test hypothesis: $H_{0(r)}$: There are at most *r* cointegration relations in this set of sequences. $H_{1(k)}$: There are at most *k* cointegration relationships. Since *k* cointegration relations cannot exist in the cointegration test of *k*-sequence composition, i.e., the cointegration vector matrix cannot be full-rank, the alternative hypothesis indicates that there is no cointegration relationship.

3.3. Error Correction Model (ECM)

According to Granger's expression theorem, there are three equivalent expressions of cointegration systems: vector autoregressive VAR, moving average MA and error correction model (ECM), among which ECM can best describe the synthesis of short-term fluctuations and long-term equilibrium, and is the most widely used. The Vector Error Correction Model (VEC) is a constrained VAR model with cointegration constraints in the explanatory variables, so it is suitable for non-stationary sequences known to have cointegration relations. When there is a wide range of short-term dynamic fluctuations, the VEC expression restricts the long-term behavior of the endogenous variables from converging to their cointegration relationship. Because a series of partial short-term adjustments can correct deviations from the long-term equilibrium, the cointegration term is called an error correction term. The error-corrected model is a short-term dynamic model. An ADL(*p*,*q*) model with only two variables is given as follows:

$$y_t = \beta_0 + \sum_{i=0}^{p} \beta_{1i} x_{t-i} + \sum_{j=1}^{q} \beta_{2j} y_{t-j} + \varepsilon_t \tag{7}$$

wherein, y_t represents the monetary policy variable, x_t represents the commodity futures price index variable, and obtains the error-corrected representation after a simple transformation as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=0}^{p} \alpha_{1i} \Delta x_{t-i} + \sum_{j=1}^{q} \alpha_{2j} \Delta y_{t-j} + \lambda \left(y - kx \right)_{t-1} + \varepsilon_t \tag{8}$$

The error correction ECM form has many advantages, the use of ECM can avoid the problem of pseudo-regression, and the error correction model should be established when the sequence is cointegrated, and only the differential variable can be used for modeling.

3.4. Shock Response Function

The shock response function will describe the dynamic response of the system to the shock perturbation, and judge the time delay relationship between the variables from the dynamic response. Consider an autoregressive model of a p-order vector as follows:

$$Y_t = A_0 + B_1 Y_{t-1} + \cdots + B_p Y_{t-p} + \varepsilon_t \tag{9}$$

where Y_t is the monetary policy variable and it is a k-dimensional vector composed of endogenous variables, B_i is a coefficient matrix, A_0 is a constant vector, ε_t is a k-dimensional error vector, and its covariance matrix is Ω, assuming Y_t is a stationary random process, then Equation (9) can be expressed as an infinite vector moving average model as follows:

$$Y_t = A_1 + \sum_{m=0}^{\infty} \phi_m \varepsilon_{t-m} \tag{10}$$

where ϕ is the coefficient matrix and A_1 is the constant vector, both of which can be found from the coefficient matrix B_i and the constant vector A_0 in Equation (9). From Equation (10), it can be seen that the elements in column *j* of row *i* of the coefficient matrix ϕ_m represent the *m*-period lag response of the *i*-th variable to the unit shock generated by the *j*-th variable, that is, the *m*-phase shock response of variable *i* to variable *j* in the V A R system. Since the covariance matrix Ω of the error vector is positively definite, there is a nonsingular array *q*, then $qq' = \Omega$, Equation (10) can be expressed as follows:

$$Y_t = A_1 + \sum_{m=0}^{\infty} \left(\phi_m q \right) \left(q^{-1} \varepsilon_{t-m} \right) = A_1 + \sum_{m=0}^{\infty} \left(\phi_m q \right) \mu_{t-m} \tag{11}$$

As can be seen from Equation (11), after transformation, the original error vector ε_t becomes a standard vector white noise μ_t. The elements in column *j* of row *i* of the coefficient matrix $\phi_m q$ represent the m-period shock response of the orthogonalized impact of the *i*th variable to the *j*-th variable in the system. From Equation (11), the shock response function of one variable to another variable in the system can be calculated.

Therefore, the shock response function depicts the impact of the shock of adding a standard deviation to the perturbation term on the current and future values of the endogenous variable. The impact on one variable directly affects this variable and is transmitted to all other endogenous variables through the dynamic structure of the VAR model. For the VECM model, the impulse response analysis of economic variables is carried out, that is, the impact of various shocks on economic variables is calculated by one unit, and the shock response curve can be made accordingly.

4. Empirical Analysis

4.1. Variable Selection and Data Processing

4.1.1. Selection of Futures Price Variables

Considering the impact of futures price fluctuations on monetary policy, we can consider commodity futures prices as a selection variable, because there are more than 100 varieties of commodity futures and options listed in the domestic futures market, a single commodity price cannot reflect the basic situation of the market, we can consider choosing commodity price index as a research variable, through comparison, we choose the Wind commodity price index as the research target, in order to further analyze the different impacts of different types of commodity price indices on monetary policy and the intensity of their impacts, The general commodity price index and various sub-indices in the Wind commodity price index, i.e., metals, energy, chemicals, non-ferrous metals and agricultural products, are selected as specific research targets.

4.1.2. Selection of Monetary Policy Variables

Monetary policy generally refers to the general term for the various policies and measures adopted by the central bank to control and regulate the money supply or credit quantity in order to achieve its specific economic goals. From the perspective of policy tools, monetary policy includes: open market operation, deposit reserve policy, central bank loan policy, interest rate policy and exchange rate policy. Our research on the impact of commodity prices on monetary policy focuses on the impact of commodity price volatility on monetary policy instruments. The variables chosen are concentrated on the main variables of the monetary policy instrument.

The domestic monetary policy generally regulates the macroeconomy through quantity and price, among which the quantitative control tool regulates the money supply and regulates the macroeconomy through open market operations and other means. Open market operations have become an important tool for the daily operation of the People's Bank of China's monetary policy, including currency release, currency withdrawal, and net currency release. We choose **open market operation of net monetary release** as a variable for open market operations.

Reserve Policy: By adjusting the reserve requirement ratio (RRR), the central bank affects the ability of financial institutions to supply credit funds, thereby indirectly regulating the money supply. Therefore, we choose the RRR as the RRR policy variable. From the perspective of research needs, we choose the **reserve requirement ratio** (RRR) of large depository financial institutions as a proxy variable.

Central bank loans refer to the loans issued by the central bank to financial institutions, which are an important channel for the central bank to regulate and control the base currency and a traditional policy tool for financial regulation and control. Base money refers to money that has the ability to expand or contract the monetary aggregate exponentially. At the present stage in China, it is mainly composed of three parts: deposit reserves of financial institutions, cash issuance (cash in circulation + cash in stock of financial institutions) and deposits of non-financial institutions (postal savings in the central bank). From the perspective of money supply, there are three levels: M0, M1, and M2, and in order to study, we need to choose M0, M1, and M2 as the proxy variables for the central bank's quantitative control tools.

Interest rate policy is an important part of China's monetary policy, and it is also one of the main means of monetary policy implementation. According to the needs of monetary policy implementation, the People's Bank of China uses interest rate tools in a timely manner to adjust the interest rate level and interest rate structure, thereby affecting the supply and demand of social funds and achieving the set goals of monetary policy. At present, the domestic deposit and loan interest rate is not completely market-oriented, and the **interbank lending rate** is generally selected as the proxy variable of the market-oriented interest rate, and **the 7-day interest rate** is selected as the subject matter through comparison.

Exchange rate policy mainly includes exchange rate policy objectives and exchange rate policy tools. The exchange rate policy tools mainly include the selection of the exchange rate system, the determination of the exchange rate level, and the change and adjustment of the exchange rate level. The exchange rate of RMB against the US dollar is more representative than other exchange rates, so the **exchange rate of the US dollar against the RMB** is selected as the proxy variable of the exchange rate.

4.1.3. Data Processing

Since we have daily and monthly data for the macro monetary policy variables we have selected, such as the bank reserve requirement ratio, the open market operation of net monetary release, the interbank lending rate, and the exchange rate of the US dollar against the RMB, while the selected money supply data has monthly data and no daily data, and the commodity futures price indexes have daily and monthly data, in order to facilitate the needs of research, we select the monthly data as the variable data.

Due to the selection of macro monetary policy data in the interbank interest rate data from the perspective of availability, the data began on May 24, 2004, other financial data are available, and from the commodity futures price index data, the price index that meets the time requirement includes the total commodity futures price index, energy, chemical, non-ferrous metals, grains, oilseeds and soft commodity price index, and does not meet the time requirement of precious metals, coal, coke, steel ore, non-metallic building materials commodity price index, From the perspective of the requirements of the study, the price index that satisfies the time requirement can basically represent the basic situation of the commodity price index, so we choose the time period from May 2004 to October 2023.

Data processing: The daily data of the last trading day of the month is selected as the monthly data of the current month, and the missing data is processed by the method of moving average. Data sources: Wind data terminal, China Futures Association website, People's Bank of China website.

4.2. Descriptive Statistics

The descriptive statistical results for each of the selected variables are given below, as shown in Table 1 below.

According to the descriptive statistics of each of the above variables (Table 2), it can be seen that none of the variables satisfies the normal distribution. Through the correlation coefficient matrix, it can be seen that there is a strong or weak positive and negative correlation between the various indices of commodity futures prices and the various variables of monetary policy.

Table 1. Descriptive statistical results.

	LNDRR	NCS	LNIBOR	LNER	LNM0	LNM1	LNM2	LNCI	LNECI	LNCCI	LNMCI	LNGCI	LNOCI	LNSCI
Mean	2.649	149.140	1.019	1.924	10.847	12.617	13.791	7.018	6.974	6.558	7.214	6.059	7.169	6.502
Median	2.741	0.000	1.019	1.918	10.972	12.691	13.936	7.048	7.012	6.535	7.255	6.006	7.132	6.507
Maximum	3.068	14070.00	2.111	2.113	11.649	13.453	14.879	7.429	7.571	7.278	7.654	6.433	7.647	7.031
Minimum	2.015	−11775.00	−0.122	1.801	9.853	11.371	12.367	6.206	6.234	5.944	6.174	5.645	6.914	6.127
Std. Dev.	0.316	3672.425	0.360	0.086	0.483	0.635	0.744	0.243	0.251	0.282	0.287	0.177	0.166	0.170
Skewness	−0.694	0.302	−0.254	0.829	−0.430	−0.456	−0.378	−1.186	−0.559	0.226	−1.546	0.033	0.555	0.382
Kurtosis	2.442	4.875	3.858	2.784	2.076	1.959	1.891	4.564	3.339	2.340	5.680	2.344	2.423	2.948
Jarque-Bera	21.806	37.831	9.700	27.271	15.548	18.677	17.563	78.678	13.300	6.232	163.253	4.235	15.245	5.732
Probability	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.001	0.044	0.000	0.120	0.000	0.058
Sum	619.922	34898.70	238.409	450.205	2538.184	2952.412	3227.163	1642.134	1632.012	1534.645	1688.002	1417.808	1677.601	1521.563
Sum Sq. Dev.	23.209	3.14E+09	30.110	1.734	54.467	93.837	129.085	13.708	14.703	18.560	19.190	7.295	6.404	6.716
Observations	234	234	234	234	234	234	234	234	234	234	234	234	234	234

Note: DRR represents the reserve requirement ratio, NCS represents the open market operationsof net monetaryrelease , IBOR represents the 7-day interest rate of interbank lending, ER represents the exchange rate of the US dollar against the RMB, M0, M1 and M2 represent the money supply M0, M1 and M2 respectively, CI represents the total commodity futures price index, ECI represents the energy commodity futures price index, CCI represents the chemical commodity futures price index, MCI represents the non-ferrous metal commodity futures price index, GCI stands for Grain Commodity Futures Price Index, OCI stands for Oil and Oilseed Commodity Futures Price Index, and SCI stands for Soft Commodity Futures Price Index. LN stands for logarithm, and the following is the same. Source: Author's calculations.

Table 2. Correlation coefficient results.

variables	LNDRR	NCS	LNIBOR	LNER	LNM0	LNM1	LNM2	LNCI	LNECI	LNCCI	LNMCI	LNGCI	LNOCI	LNSCI
LNDRR	1													
NCS	0.103	1												
LNIBOR	0.532	0.122	1											
LNER	−0.874	−0.077	−0.501	1										
LNM0	0.364	0.120	0.313	−0.639	1									
LNM1	0.365	0.105	0.307	−0.622	0.984	1								
LNM2	0.337	0.102	0.286	−0.615	0.990	0.996	1							
LNCI	0.266	0.051	0.3010	−0.339	0.314	0.301	0.282	1						
LNECI	−0.259	−0.017	−0.153	0.292	−0.281	−0.284	−0.300	0.479	1					
LNCCI	−0.085	−0.015	0.054	0.265	−0.586	−0.605	−0.628	0.409	0.688	1				
LNMCI	0.315	0.053	0.318	−0.429	0.454	0.439	0.426	0.976	0.392	0.253	1			
LNGCI	−0.653	−0.040	−0.207	0.439	−0.085	−0.126	−0.099	0.255	0.503	0.289	0.197	1		
LNOCI	0.044	0.083	0.072	−0.145	0.130	0.094	0.090	0.550	0.608	0.457	0.503	0.564	1	
LNSCI	−0.235	0.006	0.142	0.297	−0.424	−0.447	−0.453	0.061	0.347	0.685	−0.046	0.260	0.343	1

Source: Author's calculations.

4.3. Unit Root Test Analysis

We perform a unit root test for stationarity on the selected variable data. The methods of unit root test generally include DF, ADF, PP test, etc., and the commonly used ADF test methods are used in this paper, and the specific test results are as follows (**Table 3**):

The above unit root test results show that the selected variables are non-stationary at the 1%, 5% and 10% significance levels, except for LNM0 and LNM1 which are stationary at the 5% and 10% significance levels after the first-order difference, and the first-order differences of the other variables are stationary at the 1%, 5% and 10% significance levels.

4.4. Granger Causality Tests Analysis

We test the causality between the selected monetary policy variables and the futures market price variables (futures price index and sub-index), and the test method adopts the test method proposed by Granger (1969), and the specific test results are as follows (**Table 4**).

Through the Granger test of the above causal relationship, the following conclusions can be obtained: at the significance level of 10%, the total commodity futures price index and the futures price index of energy, chemicals, non-ferrous metals and cereals are the Granger reasons for the reserve requirement ratio, and all have a strong guiding role. However, the futures price index of oils and oilseeds and soft commodities is not the Granger reason for the reserve requirement ratio, and the guiding effect is weak. At the 10% significance level, the Grain Commodity Futures Price Index is the Granger reason for the net NCS

Table 3. Unit root test results.

variable	Augmented Dickey-Fullertest statistic	Test type (c,t,n)	1% level	5% level	10% level	Durbin-Watson stat	Whether stable or not
LNDRR	−1.482	(c,t,3)	−3.998	−3.429	−3.138	2.014	No
NCR	−2.733	(c,t,12)	−4.000	−3.430	−3.139	2.008	No
LNIBOR	−3.025	(c,t,2)	−3.998	−3.429	−3.138	1.995	No
LNER	−1.199	(c,t,1)	−3.998	−3.429	−3.138	1.987	No
LNM0	−1.936	(c,t,14)	−4.001	−3.430	−3.139	2.070	No
LNM1	−1.532	(c,t,12)	−4.000	−3.430	−3.139	2.079	No
LNM2	−1.474	(c,t,12)	−4.000	−3.430	−3.139	1.939	No
LNCI	0.741	(0,0,1)	−2.575	−1.942	−1.616	2.026	No
LNECI	−2.777	(c,t,1)	−3.998	−3.429	−3.138	1.969	No
LNCCI	−1.682	(c,0,5)	−3.459	−2.874	−2.574	1.998	No
LNMCI	0.841	(0,0,1)	−2.575	−1.942	−1.616	2.019	No
LNGCI	−1.748	(c,t,1)	−3.998	−3.429	−3.138	2.012	No
LNOCI	0.136	(0,0,0)	−2.575	−1.942	−1.616	1.934	No
LNSCI	−0.359	(0,0,5)	−2.575	−1.942	−1.616	2.006	No
D(LNDRR)	−4.665	(0,0,2)	−2.575	−1.942	−1.616	2.027	Yes
D(NCR)	−8.706	(0,0,13)	−2.576	−1.942	−1.616	1.994	Yes
D(LNIBOR)	−15.123	(0,0,1)	−2.575	−1.942	−1.616	2.015	Yes
D(LNER)	−11.300	(0,0,0)	−2.575	−1.942	−1.616	1.993	Yes
D(LNM0)	−3.195	(c,0,14)	−3.460	−2.875	−2.574	2.070	Yes *
D(LNM1)	−2.252	(0,0,6)	−2.575	−1.942	−1.616	1.971	Yes *
D(LNM2)	−6.996	(c,t,7)	−3.999	−3.430	−3.139	1.947	Yes
D(LNCI)	−12.415	(0,0,0)	−2.575	−1.942	−1.616	2.028	Yes
D(LNECI)	−10.633	(0,0,1)	−2.575	−1.942	−1.616	1.999	Yes
D(LNCCI)	−8.851	(0,0,4)	−2.575	−1.942	−1.616	2.002	Yes
D(LNMCI)	−12.501	(0,0,0)	−2.575	−1.942	−1.616	2.021	Yes
D(LNGCI)	−13.031	(0,0,0)	−2.575	−1.942	−1.616	2.014	Yes
D(LNOCI)	−14.784	(0,0,0)	−2.575	−1.942	−1.616	1.974	Yes
D(LNSCI)	−6.604	(0,0,4)	−2.575	−1.942	−1.616	2.006	Yes

Note: In the test type (C, T, N), C indicates the intercept term, and c = 0 indicates no intercept. t represents the time trend, and t = 0 indicates that there is no trend term, n denotes the lag order and d denotes the first-order difference. * indicates non-stationary at the 5% significance level (similar below). Source: Author's calculations.

Table 4. Granger causality tests results.

Null Hypothesis	Obs	F-Statistic	Prob.
LNCI does not Granger Cause LNDRR	230	3.109	0.016
LNDRR does not Granger Cause LNCI		1.621	0.170
LNECI does not Granger Cause LNDRR	230	4.302	0.002
LNDRR does not Granger Cause LNECI		1.532	0.194
LNCCI does not Granger Cause LNDRR	230	6.064	0.000
LNDRR does not Granger Cause LNCCI		1.015	0.400

Continued

LNMCI does not Granger Cause LNDRR	230	2.321	0.058
LNDRR does not Granger Cause LNMCI		1.362	0.248
LNGCI does not Granger Cause LNDRR	230	2.717	0.031
LNDRR does not Granger Cause LNGCI		0.981	0.419
LNOCI does not Granger Cause LNDRR	230	1.627	0.169
LNDRR does not Granger Cause LNOCI		0.781	0.538
LNSCI does not Granger Cause LNDRR	230	1.843	0.122
LNDRR does not Granger Cause LNSCI		0.703	0.591
LNCI does not Granger Cause NCS	225	1.038	0.411
NCS does not Granger Cause LNCI		0.799	0.617
LNECI does not Granger Cause NCS	225	1.024	0.422
NCS does not Granger Cause LNECI		1.116	0.353
LNCCI does not Granger Cause NCS	225	0.626	0.774
NCS does not Granger Cause LNCCI		0.720	0.690
LNMCI does not Granger Cause NCS	225	1.317	0.229
NCS does not Granger Cause LNMCI		1.124	0.347
LNGCI does not Granger Cause NCS	225	1.823	0.066
NCS does not Granger Cause LNGCI		0.381	0.944
LNOCI does not Granger Cause NCS	225	1.152	0.328
NCS does not Granger Cause LNOCI		0.667	0.739
LNSCI does not Granger Cause NCS	225	0.159	0.998
NCS does not Granger Cause LNSCI		1.374	0.202
LNCI does not Granger Cause LNIBOR	233	7.092	0.008
LNIBOR does not Granger Cause LNCI		7.861	0.006
LNECI does not Granger Cause LNIBOR	233	0.153	0.696
LNIBOR does not Granger Cause LNECI		3.695	0.056
LNCCI does not Granger Cause LNIBOR	233	1.390	0.240
LNIBOR does not Granger Cause LNCCI		4.819	0.029
LNMCI does not Granger Cause LNIBOR	233	7.150	0.008
LNIBOR does not Granger Cause LNMCI		7.953	0.005
LNGCI does not Granger Cause LNIBOR	233	0.987	0.322
LNIBOR does not Granger Cause LNGCI		0.083	0.774
LNOCI does not Granger Cause LNIBOR	233	1.145	0.286
LNIBOR does not Granger Cause LNOCI		1.023	0.313
LNSCI does not Granger Cause LNIBOR	233	1.402	0.238
LNIBOR does not Granger Cause LNSCI		0.304	0.582
LNCI does not Granger Cause LNER	233	3.693	0.056
LNER does not Granger Cause LNCI		3.139	0.078
LNECI does not Granger Cause LNER	233	0.000	0.997
LNER does not Granger Cause LNECI		2.213	0.138
LNCCI does not Granger Cause LNER	233	3.443	0.065
LNER does not Granger Cause LNCCI		2.643	0.105

Continued

LNMCI does not Granger Cause LNER	233	2.033	0.155
LNER does not Granger Cause LNMCI		2.196	0.140
LNGCI does not Granger Cause LNER	233	0.059	0.808
LNER does not Granger Cause LNGCI		0.140	0.709
LNOCI does not Granger Cause LNER	233	0.759	0.384
LNER does not Granger Cause LNOCI		0.023	0.879
LNSCI does not Granger Cause LNER	233	0.057	0.811
LNER does not Granger Cause LNSCI		0.103	0.749
LNCI does not Granger Cause LNM0	230	2.026	0.092
LNM0 does not Granger Cause LNCI		0.567	0.687
LNECI does not Granger Cause LNM0	230	1.627	0.168
LNM0 does not Granger Cause LNECI		0.152	0.962
LNCCI does not Granger Cause LNM0	230	0.560	0.692
LNM0 does not Granger Cause LNCCI		1.953	0.103
LNMCI does not Granger Cause LNM0	230	2.108	0.081
LNM0 does not Granger Cause LNMCI		0.887	0.473
LNGCI does not Granger Cause LNM0	230	0.512	0.727
LNM0 does not Granger Cause LNGCI		1.795	0.131
LNOCI does not Granger Cause LNM0	230	0.373	0.828
LNM0 does not Granger Cause LNOCI		0.410	0.801
LNSCI does not Granger Cause LNM0	230	1.158	0.330
LNM0 does not Granger Cause LNSCI		1.613	0.172
LNCI does not Granger Cause LNM1	230	0.777	0.541
LNM1 does not Granger Cause LNCI		1.317	0.265
LNECI does not Granger Cause LNM1	230	1.369	0.246
LNM1 does not Granger Cause LNECI		1.425	0.227
LNCCI does not Granger Cause LNM1	230	1.802	0.129
LNM1 does not Granger Cause LNCCI		3.259	0.013
LNMCI does not Granger Cause LNM1	230	0.355	0.841
LNM1 does not Granger Cause LNMCI		1.129	0.344
LNGCI does not Granger Cause LNM1	230	2.366	0.054
LNM1 does not Granger Cause LNGCI		1.109	0.353
LNOCI does not Granger Cause LNM1	230	1.012	0.402
LNM1 does not Granger Cause LNOCI		1.462	0.215
LNSCI does not Granger Cause LNM1	230	4.039	0.004
LNM1 does not Granger Cause LNSCI		0.794	0.530
LNCI does not Granger Cause LNM2	230	3.405	0.010
LNM2 does not Granger Cause LNCI		0.964	0.428
LNECI does not Granger Cause LNM2	230	1.868	0.117
LNM2 does not Granger Cause LNECI		0.777	0.542
LNCCI does not Granger Cause LNM2	230	1.183	0.319
LNM2 does not Granger Cause LNCCI		2.327	0.057

Continued

LNMCI does not Granger Cause LNM2	230	3.568	0.008
LNM2 does not Granger Cause LNMCI		1.288	0.276
LNGCI does not Granger Cause LNM2	230	0.766	0.548
LNM2 does not Granger Cause LNGCI		0.950	0.436
LNOCI does not Granger Cause LNM2	230	0.537	0.709
LNM2 does not Granger Cause LNOCI		0.604	0.660
LNSCI does not Granger Cause LNM2	230	1.920	0.108
LNM2 does not Granger Cause LNSCI		0.975	0.422

Source: Author's calculations.

operation, and the Commodity Futures Price Index and other sub-indices are not the Granger reason for the NCS, and only the Grain Futures Price Index has a significant guiding effect on it. At the significance level of 1%, 5% and 10%, the total commodity futures price index and the non-ferrous metal index are the Granger reasons for the 7-day interbank lending rate (LNIBOR), which has a strong guiding effect on it, while other sub-indices have no significant guiding effect on it. At the 10% significance level, the total commodity futures price index and the chemical index are the Granger reasons for the USD/RMB exchange rate (LNER), which have a strong guiding effect on it, while other sub-indices have no significant guiding effect on it. At the 10% significance level, the total commodity futures price index and the non-ferrous metal index are the Granger reasons for the M0 of money supply, which have a strong guiding effect, while other sub-indices have no significant guiding effect on them. At the 10% significance level, both the cereal index and the soft commodity index are the Granger reasons for M1 of money supply, which has a strong guiding effect on it, while the total commodity futures price index and other sub-indices have no significant guiding effect on it. At the significance levels of 1%, 5% and 10%, the total commodity futures price index and the non-ferrous metal index are the Granger reasons for the M2 of money supply, which have a strong guiding effect, while other sub-indices have no significant guiding effect on them.

In summary, the commodity futures price index has a strong guiding effect on the monetary policy variables of the reserve requirement ratio, the 7-day interest rate of interbank lending, the exchange rate of the US dollar against the RMB, and the M0 and M2 of the money supply, but it has a weak guiding effect on the open market operation of net monetary release and the M1. The non-ferrous financial commodity price index of the sub-index has a strong guiding effect on the monetary policy variables, such as the reserve requirement ratio, the 7-day interest rate of interbank lending, and the M0 and M2 of money supply, but has a weak impact on other monetary policy variables. The chemical commodity futures price index has a strong guiding effect on the reserve requirement ratio and the USD/RMB exchange rate, and has a weak impact on other monetary policy variables. The energy commodity futures price index only has a strong guiding effect on the reserve requirement ratio among the monetary policy variables.

The futures price index of cereal commodities has a strong guiding effect on the reserve requirement ratio and money supply M1 among the monetary policy variables. The soft commodity futures price index only has a strong guiding effect on the money supply M1. The futures price index of oils and oilseeds has no significant guiding effect on the monetary policy variables.

4.5. Cointegration Test Analysis

We test the cointegration relationship between the non-stationary time series of the above-mentioned futures market price variable indicators (futures price total index, futures price sub-indexes) and the domestic monetary policy variables, and because it is a multivariate cointegration relationship test, the commonly used test methods are the maximum likelihood estimation (MLE) method proposed by Johansen (1988) and the method proposed by Engle & Granger (1987). Since Johansen's test is superior to Engle & Granger's method, Johansen's likelihood estimation method is used in this paper.

From the above Granger causality test, it can be seen that the price variable indicators LNCI, LNECI, LNCCI and LNMCI in the futures market are the Granger causes of the monetary policy variable LNDRR. The futures market price variable indicator LNGCI is the Granger reason of the monetary policy variable indicator NCS. The price variable indicators LNCI and LNMCI in the futures market are the Granger reasons for the monetary policy variables LNIBOR, LNM0 and LNM2. LNCI and LNCCI are the Granger reasons for the monetary policy variable LNER. The price variable indicators LNGCI and LNSCI in the futures market are the Granger reasons of the monetary policy variable LNM1, so the long-term relationship between its endogenous variables and the domestic monetary policy variables is tested. The specific test results are as follows (**Table 5**):

Table 5. Cointegration test results.

variable	LNCI	LNECI	LNCCI	LNMCI	LNGCI	LNSCI	TREND	c	Trend and constant selection	Lag order interval selection
LNDRR	−0.383 (2.715)	−1.293 (0.509)	−0.811 (0.811)	4.461 (2.214)			0.019 (0.003)	10.539	Linear trend and constant	1to2
NCS					−852.575 (922.506)		5.160 (2.453)	4679.578	Linear trend and constant	1to4
LNIBOR	1.765 (2.875)			−3.454 (2.441)				13.565	Constant	1to2
LNER	0.795 (0.227)		−0.165 (0.192)					2.580	Constant	1to2
LNM0	−3.487 (0.756)			3.264 (0.676)			0.005 (0.001)	11.137	Linear trend and constant	1to1
LNM1					−0.813 (0.223)	−0.621 (0.265)	0.006 (0.001)	20.828	Linear trend and constant	1to2
LNM2	−3.930 (2.560)			3.833 (2.232)				15.833 (4.204)	Constant	1to4

Source: Author's calculations.

From the long-term cointegration equation of the reserve requirement ratio, it can be seen that the total commodity futures price index, energy, chemical and non-ferrous metal commodity futures price index increased by one percentage point, and the reserve requirement ratio fell by 0.383, 1.293, 0.811 and increased by 4.461 percentage points respectively, and the non-ferrous metal commodity futures price index had the strongest impact on the reserve requirement ratio. From the long-term cointegration equation of the open market operation of net monetary release, it can be seen that the price of grain commodity futures rose by one percentage point, and the open market operation of net monetary release decreased by 8.526 units. From the long-term cointegration equation of the interbank lending rate, it can be seen that the total commodity futures price index and the non-ferrous metal commodity futures price index increased by 1 percentage point, and the interbank offered rate increased by 1.765 percentage points and decreased by 3.454 percentage points respectively. From the long-term cointegration equation of the USD/RMB exchange rate, it can be seen that the total commodity futures price index and the chemical commodity futures price index increased by 1 percentage point, and the USD/RMB exchange rate increased by 0.795 percentage points and decreased by 0.165 percentage points respectively. From the long-term cointegration equation of money supply M0 and M2, it can be seen that the total commodity futures price index rose by one percentage point, while the money supply M0 and M2 fell by 3.487 and 3.930 percentage points respectively. The futures price index of non-ferrous metal commodities rose by one percentage point, and the money supply M0 and M2 rose by 3.264 and 3.833 percentage points respectively. From the long-term cointegration equation of money supply M1, it can be seen that the futures price index of cereal and soft commodity commodities rose by one percentage point, and the money supply M1 fell by 0.813 and 0.621 percentage points respectively.

4.6. Empirical Analysis of the ECM

The variable series is not stationary, if the direct establishment of intervariable regression is easy to cause the problem of pseudo-regression, the better solution is to study the unstationary variable series to differentially obtain the stationary sequence, and then use the differential stationary sequence to establish the model, this practice has certain defects, the use of differential modeling, will lose long-term information. A more effective approach is to use an error-corrected model. We use the method proposed by Engle & Granger (1987), which states that when the variable sequence is cointegrated, an error correction model should be established. Based on the analysis of the long-term equilibrium equation of each variable of monetary policy based on the above-mentioned cointegration test, we establish a dynamic error correction model, and the results are as follows (**Table 6**).

From the above-mentioned short-term error correction model of the monetary policy variable index, it can be seen that from the short-term dynamics, the logarithmic first-order difference (D(LNDRR)) of the reserve requirement ratio

Table 6. Short-term error correction model of monetary policy variable indicators.

ECM	D(LNDRR)		D(NCS)		D(LNIBOR)		D(LNER)
EC	−0.011		−1.512		0.010		−0.002
	(0.002)		(0.196)		(0.019)		(0.003)
D(LNDRR (−1))	0.039	D(NCS (−1))	0.423	D(LNIBOR(−1))	−0.344	D(LNER (−1))	0.300
	(0.066)		(0.173)		(0.067)		(0.068)
D(LNDRR (−2))	0.056	D(NCS (−2))	0.185	D(LNIBOR(−2))	−0.251	D(LNER (−2))	−0.026
	(0.062)		(0.143)		(0.065)		(0.068)
		D(NCS (−3))	0.100				
			(0.105)				
		D(NCS (−4))	0.095				
			(0.073)				
D(LNCI (−1))	−0.015				0.274		−0.012
	(0.052)				(0.536)		(0.016)
D(LNCI (−2))	0.065				−0.564		0.005
	(0.052)				(0.534)		(0.016)
D(LNECI (−1))	0.056						
	(0.018)						
D(LNECI (−2))	0.024						
	(0.018)						
D(LNCCI (−1))	0.051						0.010
	(0.020)						(0.013)
D(LNCCI (−2))	−0.006						−0.009
	(0.021)						(0.012)
D(LNMCI (−1))	−0.054				0.162		
	(0.040)				(0.485)		
D(LNMCI (−2))	−0.040				0.927		
	(0.041)				(0.488)		
D(LNGCI (−1))			−5991.706				
			(7900.700)				
D(LNGCI (−2))			6622.177				
			(7986.440)				
D(LNGCI (−3))			−2910.899				
			(8003.320)				
D(LNGCI (−4))			−10737.380				
			(7914.770)				
C	0.002		−11.395		−0.005		−0.000
	(0.001)		(239.243)		(0.013)		(0.001)
R-squared	0.395		0.564		0.159		0.088
Adj. R-squared	0.365		0.546		0.132		0.060
Sum sq. resids	0.056		2.86E+09		8.926		0.023

Continued

S.E. equation	0.016	3615.151	0.200	0.010
F-statistic	13.001	31.503	6.018	3.082
Log likelihood	633.371	−2195.996	47.993	734.441
Akaike AIC	−5.380	19.266	−0.346	−6.290
Schwarz SC	−5.201	19.416	−0.227	−6.170
Mean dependent	0.001	17.687	−0.001	−0.001
S.D. dependent	0.020	5367.112	0.215	0.011

Note: EC represents the error correction term, C represents the constant term, and the values in parentheses are standard deviations (the following is the same). Source: Author's calculations.

ECM	D(LNM0)		D(LNM1)		D(LNM2)
EC	−0.086		−0.036		−0.005
	(0.027)		(0.007)		(0.001)
D(LNM0 (−1))	−0.110	D(LNM1 (−1))	−0.287	D(LNM2 (−1))	−0.096
	(0.066)		(0.063)		(0.068)
		D(LNM1 (−2))	−0.185	D(LNM2 (−2))	0.052
			(0.063)		(0.065)
				D(LNM2 (−3))	0.315
					(0.064)
				D(LNM2 (−4))	−0.149
					(0.067)
D(LNCI (−1))	0.071				0.021
	(0.176)				(0.024)
D(LNCI (−2))					0.016
					(0.024)
D(LNCI (−3))					−0.015
					(0.025)
D(LNCI (−4))					−0.027
					(0.024)
D(LNMCI (−1))	−0.126				−0.025
	(0.160)				(0.022)
D(LNMCI (−2))					−0.027
					(0.022)
D(LNMCI (−3))					−0.011
					(0.022)
D(LNMCI (−4))					0.030
					(0.022)
D(LNGCI (−1))			0.045		
			(0.047)		
D(LNGCI (−2))			0.007		
			(0.047)		

Continued

D(LNSCI (−1))		0.016	
		(0.030)	
D(LNSCI (−2))		0.098	
		(0.030)	
C	0.009	0.013	
	(0.004)	(0.002)	
R-squared	0.071	0.192	0.249
Adj. R-squared	0.055	0.166	0.207
Sum sq. resids	0.912	0.092	0.017
S.E. equation	0.063	0.020	0.009
F-statistic	4.334	7.558	5.964
Log likelihood	313.309	576.442	763.732
Akaike AIC	−2.658	−4.922	−6.557
Schwarz SC	−2.584	−4.802	−6.362
Mean dependent	0.007	0.009	0.011
S.D. dependent	0.065	0.022	0.010

Source: Author's calculations.

is affected by the logarithmic first-order difference lag of the total commodity futures price index and the energy, chemical and non-ferrous metal commodity futures price index by 1 to 2 orders, with a cumulative impact of 0.095, 0.050, 0.080, 0.045 and −0.094 percentage points, respectively. The impact of error correction was −0.011 percentage points. The first-order difference (D(NCS)) of the open market operation of net monetary release is affected by the logarithmic first-order difference lag of its own and cereal commodity futures prices by 1 to 4 orders, with a cumulative impact of 0.008 and −130.178 units, respectively, and the impact of error correction items is −0.015 units. The logarithmic first-order difference (D(LNIBOR)) of the interbank interest rate is affected by the logarithmic first-order difference of its own and commodity futures price index and non-ferrous metal commodity futures price index by 1 to 2 orders, with a cumulative impact of −0.595, −0.29 and 1.089 percentage points, respectively, and the impact of error correction items is 0.010 percentage points. The logarithmic first-order difference (D(LNER)) of the USD/RMB exchange rate is affected by the logarithmic first-order difference lag of the total commodity futures price index and the chemical futures price index by 1 to 2 orders, with a cumulative impact of 0.274, −0.007 and 0.001 percentage points, respectively, and the impact of the error correction term is −0.002 percentage points. The logarithmic first-order difference of M0 is affected by the logarithmic first-order difference of the total and commodity futures price index and the non-ferrous metal commodity futures price index, with acumulative impact of −0.110, 0.071 and −0.126 percentage points, respectively, and the impact of the error correction term is −0.086 percentage points. The logarithmic first-order difference of M1 is affected by the logarithmic first-order difference lag of its own and the futures price index of cereals and soft commodities by 1 to 2 orders, with a cumulative impact of −0.472, 0.052 and 0.114 percentage points, respectively, and the impact of error correction is −0.036 percentage points. The logarithmic first-order difference of M2 is affected by the logarithmic first-order difference of the total commodity futures price index and the non-ferrous metal commodity futures price index by 1 to 4 orders, with accumulative impact of 0.122, −0.005 and −0.033 percentage points, respectively, and the impact of the error correction term is −0.005 percentage points.

Therefore, from the short-term dynamic error correction model of the above-mentioned monetary policy variables and futures market price index variables, it can be seen that from the perspective of short-term dynamics, the logarithmic first-order difference of each futures price index has different effects on the logarithmic first-order difference of each variable of monetary policy, among which the logarithmic first-order difference of the total futures price index and the non-ferrous commodity price index has a greater impact on the reserve requirement ratio, interbank lending rate, money supply M0 and M2 logarithmic first-order difference. The logarithmic first-order difference of the USD/RMB exchange rate is greatly affected by the logarithmic first-order difference of the total commodity futures price index, the first-order difference of the open market operation of net monetary release is greatly affected by the logarithmic first-order difference of grain commodity futures prices, and the logarithmic first-order difference of M1 of money supply is greatly affected by the logarithmic first-order difference of the soft commodity futures price index.

4.7. Shock-Response Curves for Monetary Policy Variables

On the basis of the short-term error correction model, the impulse response function is used to analyze the shock response, that is, to analyze the response of the monetary policy variable index to the impact of the futures price variable index. Under the processing of Eviews 10.0 software, the shock response curves were made separately (the horizontal axis in the figure represents the number of lag periods, and the vertical axis represents the degree of shock response). The following is the impact response curve of the monetary policy variable index, the reserve requirement ratio, the open market operation of net monetary release, the interbank lending rate, the exchange rate of the US dollar against the RMB, and the M0, M01 and M2 of the money supply on the variable indicators of each futures price index, and the specific results are as follows:

As can be seen from **Figure 1**, the reserve requirement ratio is positively impacted by the total commodity futures price index and the non-ferrous metal price index, with a lag of 9 months, respectively, and by the energy and chemical price index, with a lag of 2.5 months and 1.5 months, respectively. As can be seen from **Figure 2**, the open market operation of net monetary release is affected by the positive and negative impact of the grain commodity futures price index, which shows a strong positive and negative fluctuation in the first six months, and weakens after six months. As can be seen from **Figure 3**, the interbank lending rate is affected by the positive impact of the total commodity futures price index and the non-ferrous metal commodity futures price index, and the impact lags all by 2.5 months. As can be seen from **Figure 4**, the USD/RMB exchange rate is hit by the positive and negative impact of the total commodity futures price index, with a lag of 3.5 months, and the positive impact of the chemical commodity price index is delayed by 1.5 months. It can be seen from **Figure 5** that M0 is affected by the negative impact of the total commodity futures price index, with a lag of 1.5 months, and by the positive impact of the non-ferrous metal commodity futures price index, the impact lags by 8 months. As can be seen from **Figure 6**, the money supply M1 is affected by the positive and negative shocks of the grain and soft commodity futures price indexes, with a lag of 2.5 months respectively. As can be seen from **Figure 7**, the money supply M2 is affected by the negative impact of the total commodity futures price index with a lag of 3.5 months, and by the positive and negative impact of the non-ferrous metal commodity futures price index, the impact lags for 9 months.

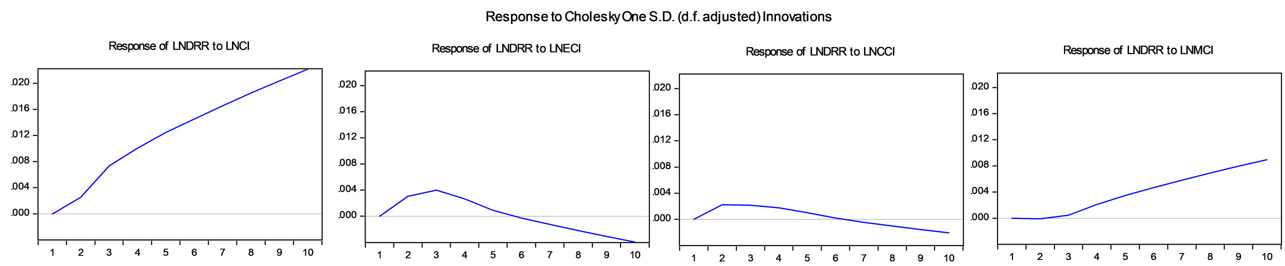

Figure 1. Shock response curve of reserve requirement ratio.

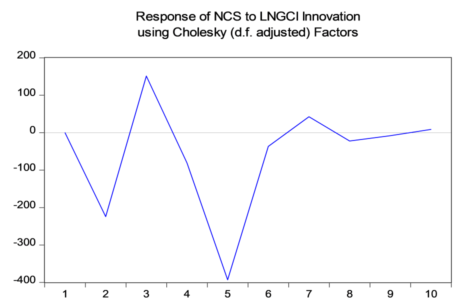

Figure 2. Shock response curve of open market operation of net monetary release.

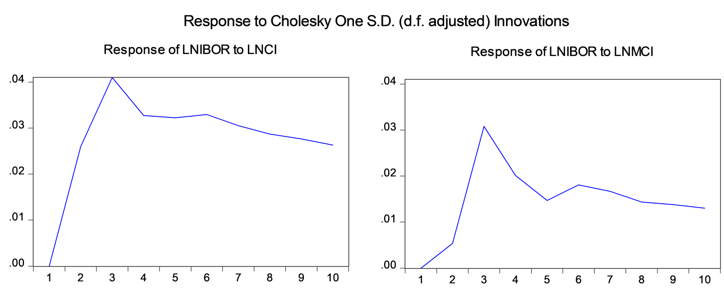

Figure 3. Shock response curve of interbank lending rate.

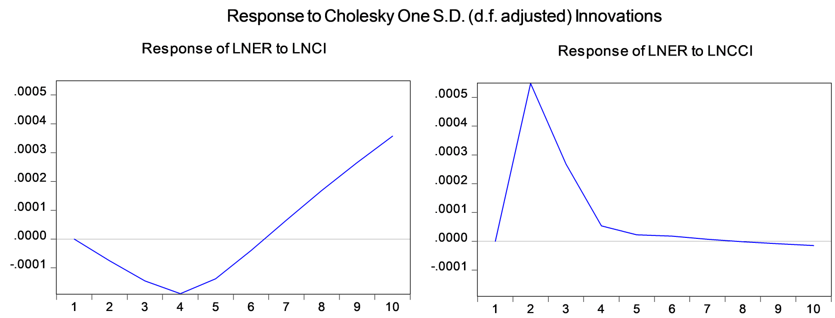

Figure 4. Shock response curve of USD/RMB exchange rate.

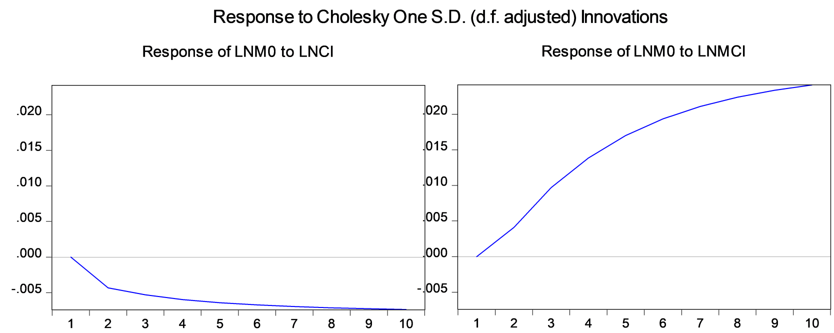

Figure 5. Shock response curve of M0.

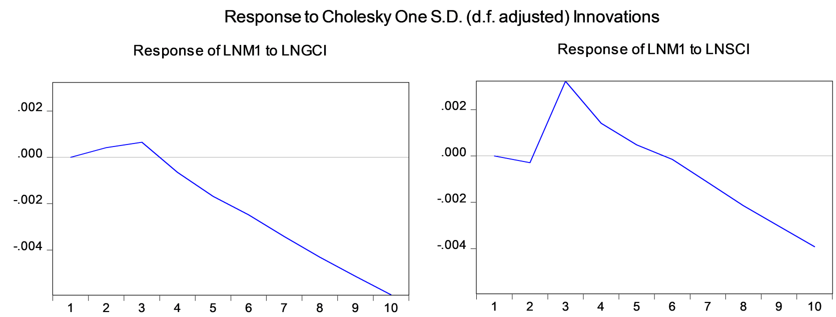

Figure 6. Shock response curve of M1.

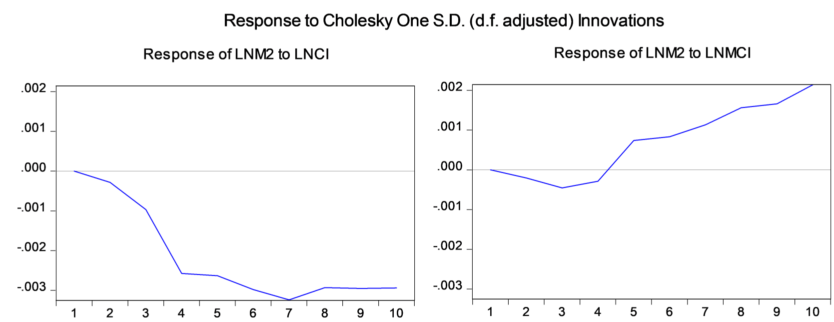

Figure 7. Shock response curve of M2.

5. Conclusion

Based on the Granger causality test, cointegration relationship test, error correction model and shock response function method in cointegration correlated theory, and using the monthly data from May 2004 to October 2023, this paper studies the impact of futures market price index (total index and sub-indexes: energy, chemical, non-ferrous metals, grain, oil and oilseeds, and soft commodity futures price index) on monetary policy variables (reserve requirement ratio, open market operation of net monetary release, interbank lending rate, USD/RMB exchange rate, money supply M0, M1, M2).

The causality test shows that the total commodity futures price index and the non-ferrous metal index have a strong guiding effect on the monetary policy variables reserve requirement ratio, the 7-day interest rate of interbank lending, the exchange rate of USD/RMB, and the M0 and M2 of money supply, but have a weak guiding effect on the open market operation of net monetary release and M1. The chemical commodity futures price index has a strong guiding effect on the reserve requirement ratio and the USD/RMB exchange rate, and has a weak impact on other monetary policy variables. The energy commodity futures price index only has a strong guiding effect on the reserve requirement ratio. The grain commodity futures price index has a strong guiding effect on the reserve requirement ratio and money supply M1. The soft commodity futures price index only has a strong guiding effect on the money supply M1. The futures price index of oils and oilseeds has no significant guiding effect on the monetary policy variables. Therefore, the role of commodity futures price index in different categories on monetary policy is different, and in general, the total commodity price index and the non-ferrous commodity price index have a greater impact on monetary policy.

According to the cointegration test, the total commodity futures price index, energy, chemical and non-ferrous metal futures price indices rose by 1 percentage point, and the reserve requirement ratio fell by 0.383, 1.293, 0.811 and increased by 4.461 percentage points respectively. Grain commodity futures rose by one percentage point, and the open market operation of net monetary release decreased by 8.526 units. The total Commodity Futures Price Index and the Non-ferrous Metals Commodity Futures Price Index rose by 1 percentage point, and the Interbank Offered Rate increased by 1.765 percentage points and decreased by 3.454 percentage points respectively. The total Commodity Futures Price Index and the Chemical Commodity Futures Price Index increased by 1 percentage point, and the USD/RMB exchange rate increased by 0.795 percentage points and decreased by 0.165 percentage points respectively. The total commodity futures price index rose by one percentage point, while the money supply M0 and M2 fell by 3.487 and 3.930 percentage points respectively. The non-ferrous metal commodities futures price index rose by one percentage point, and the money supply M0 and M2 rose by 3.264 and 3.833 percentage points respectively. The futures price index of cereals and soft commodities rose by one percentage point, and the money supply M1 fell by 0.813 and 0.621 percentage points, respectively.

The short-term dynamic error correction model shows that from the perspective of short-term dynamics, the logarithmic first-order difference of each index of futures price has different effects on the logarithmic first-order difference of each variable of monetary policy, among which the logarithmic first-order difference between the non-ferrous commodity price index and the total futures price index has a greater impact on the reserve requirement ratio, the interbank lending rate, and the logarithmic first-order difference of M0 and M2, and the logarithmic first-order difference of the USD/RMB exchange rate is greatly affected by the logarithmic first-order difference of the total commodity futures price index. The first-order difference of open market operation of net monetary release is greatly affected by the logarithmic first-order difference of grain commodity futures prices, and the logarithmic first-order difference of M1 is greatly affected by the logarithmic first-order difference of soft commodity futures price index. The shock response function curve shows that the monetary policy variable is affected by the strong or weak positive or negative lagged shock of the corresponding commodity futures price index.

In short, through empirical analysis, it can be seen that commodity futures prices have a certain impact on different variables of monetary policy, and the impact of commodity futures prices on monetary policy is different in different categories, among which the total futures price index and the non-ferrous commodity futures price index have a greater impact on multiple variables of monetary policy, and the other commodity sub-indices have a strong impact on individual monetary policy variables and have a small impact on most monetary policy variables. The empirical results also show that the development of China's futures market is uneven, relatively speaking, the development of the non-ferrous metal futures market is more mature, which has a greater impact on monetary policy, so the monitoring and prediction of the non-ferrous metal futures market can provide valuable suggestions for macro monetary policy. On the other hand, although China's futures market has developed rapidly and made great achievements, due to the different varieties of listing time and market cultivation and other reasons, there are great differences in the price influence and international competitiveness of different varieties of China's commodity futures, therefore, the development of the futures market still has a long way to go, through continuous promotion of the internationalization of futures varieties, continuous improvement of varieties of trading rules and other measures, and constantly improve the international pricing power of different commodity futures varieties, expand the influence of prices to enhance the impact of commodity price index on monetary policy, effectively play the role of monetary policy, and improve the energy efficiency of serving the real economy.

Statement

The views expressed in this article are solely those of the author and do not represent the views of the author's institution.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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