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Futures Markets and Macroeconomics: Empirical Evidence from China

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ABSTRACT

This paper uses the methods of Granger causality test, cointegration relationship test, error correction model and shock response function in cointegration correlation theory, and uses the monthly data from 2003.1 to 2023.5 to study the role and influence of futures market variables (price index, total turnover, total open interest) on sixteen macroeconomic variables. The results show that the three indicators of the futures market have a guiding effect on industrial added value, net export, fiscal revenue and fiscal expenditure at the same time. The price index and total turnover also have a guiding effect on the interbank 7-day interest rate and the RMB real effective exchange rate index. The total turnover and total open interest also have a strong guiding effect on the total import and export volume, the investment amount of fixed assets, and the total retail sales of social consumer goods. The price index also has a strong guiding effect on the producer price index, total loans, and the exchange rate of the US dollar against the RMB. The total open interest also has a strong guiding effect on the total loan. The cointegration test and error correction model show that in the short and long term, the futures market variables have a strong or weak quantitative impact on twelve macro variables, and the shock response function curve shows that the futures market variables have different impact effects on twelve macro variables. It shows that the futures market has a relatively strong impact on the macroeconomy, but there is still much room for improvement in the scope and depth of influence. It is suggested that the futures market should make efforts in terms of variety expansion, internationalization and supervision to further promote the comprehensive development of the domestic macroeconomy.

Keywords: Futures Market, Granger Causality Test, Cointegration Test, ECM Model, Shock Reaction

INTRODUCTION

After more than 30 years of development, China's futures market has continued to expand its market scale, enhance its market influence, and continuously improve its ability to serve the real economy. According to data released by China Futures Association, In 2022, the domestic futures market traded 6.768 billion lots (unilateral) and 534.9 trillion yuan, the global futures market traded 83.848 billion lots, and the domestic futures market accounted for 8.07% of the world's total trading volume, of which the domestic commodity futures and options trading

volume was 6.616 billion lots, accounting for 72.3% of the total global commodity futures and options trading volume of 9.153 billion lots. In the global exchange trading volume ranking, four domestic futures exchanges ranked in the top 25 in terms of trading volume. By the end of 2022, the number of futures and options listed in the domestic futures market reached 110, including 93 commodities (65 futures and 28 options) and 17 financial (7 futures and 10 options). In 2022, more than 1,000 listed companies participated in the hedging business. "Insurance + Futures" has been written into the Central Document No. 1 for eight consecutive years. The futures market, which has the basic functions of price discovery, risk management and resource allocation, plays an increasingly important role in the process of high-quality macroeconomic development.

The development of the futures market has a significant impact on the development of China's macroeconomy, and further study of the role and degree of influence of the development of the futures market on the macroeconomy has important theoretical and practical guiding significance for the future development of the futures market.

LITERATURE REVIEW

There are many domestic literatures on the impact of futures market on macroeconomics, basically focusing on the impact of futures price index and commodity futures price on a single macro variable or part of a macro variable.

Some domestic literature has studied the impact of commodity price index on macroeconomic variables, such as Wang and Wang (2001) found a one-way causal relationship between commodity futures price index, consumer price index and consistent synthetic index. Zhang et al. (2006) empirically tested the leading indicator effect of agricultural futures price index on CPI.

Cai and Hua (2007) research believe that there is a long-term equilibrium relationship between China's futures market index and GDP index. Liang (2008) studied the impact of commodity futures price index on consumer price index through econometric methods. Hu and Ding (2009) used the method of establishing a VAR model to study the impact of random changes in agricultural futures price indices on macroeconomic variables CPI, interest rates, exchange rate fluctuations, and the contribution rate of agricultural futures price indices to macroeconomic variable fluctuations. Zhou and Song (2011) studied the relationship between commodity indices and PPI indices and found that there is a certain leading lag relationship between commodity indices and price indices. Chang (2014) conducted an empirical study on the relationship between China's industrial futures price index and industrial producer price index (PPI), and believed that China's industrial futures price index and PPI have a long-term stable proportional relationship, and the change of China's industrial futures price index guides the change of PPI. Liu (2014) empirically analyzes the relationship between commodity futures price index and CPI macroeconomic variables. The empirical study of Feng and Li (2014) found that commodity futures price index has obvious guiding effect on prices, GDP, interest rates, and RMB exchange rates. Chen (2017) studied the impact of industrial futures price index and industrial product production price index on railway freight volume, industrial electricity consumption, and social financing volume. Chen (2018) conducted an empirical test on the relationship between futures price indices and inflation in the United States and China, and

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believed that futures prices have a more significant and advanced impact on inflation trends. Li (2019) used the SVAR model to quantitatively analyze the impact of commodity price fluctuations on China's macroeconomy, and analyzed the transmission mechanism of international commodity price fluctuations to China's macroeconomy based on the DSGE model.

Some domestic literature studies the impact of crude oil prices on some macroeconomic variables, such as Hou and Qi (2009) who believe that the uncertainty of oil price fluctuations can significantly inhibit the investment and consumption behavior of enterprises and consumers, increase unemployment, and ultimately bring about a decline in GDP growth and an increase in inflation. Liu and Song (2013) argue that the impact of rising oil prices has a greater negative effect on output. Yu et al. (2017) found that the impact of oil price uncertainty can not only explain about 12% of the fluctuations in fixed asset investment, but also have a short-term inhibitory effect on fixed asset investment. Feng et al. (2018) found that the ex-factory price of industrial products in China is significantly affected by international oil prices and lasts for a long time. Li (2022) research believes that international oil price fluctuations have an impact on China's economy, when international oil prices rise, GDP decreases significantly, consumer price index increases significantly, A-share stock price index decreases significantly, and economic vitality shows a downward trend.

Some domestic literature studied the impact of futures market development, futures price and futures trading volume on macroeconomic variables, such as Dong (2006) empirically studied the real role of China's futures market volume on the current national economic growth. Zheng and Wu (2016) studied the intrinsic relationship between the development of China's futures market and economic growth, and believed that economic growth promoted the stable development of the futures market, while the counter-effect of the development of the futures market on economic growth needs to be strengthened. Cheng (2021) Based on the ADL-MIDAS model, high-frequency commodity futures prices are used to predict exchange rates and inflation, and it is believed that China's commodity futures prices have a certain predictive effect on the two macroeconomic variables of RMB effective exchange rate index and PPI. Zhang and Shi (2021) found that the rise in international commodity prices will cause a decline in China's real output in the early stage, but it will increase the level of domestic real output after 3 months, higher international commodity prices will aggravate China's inflation, and the positive fluctuation of international commodity prices will increase the level of RMB interest rates by increasing inflation and increasing real output and other transmission channels, while the impact of international commodity price changes on people's real exchange rates is not significant.

There are also many foreign literatures on the impact of futures markets on macroeconomic variables, some of which focus on the impact of international oil prices on macroeconomic variables, such as Berument and Tasc (2002) studied the impact of oil price fluctuations on inflation in Turkey. Blanchard and Gali (2007) used the VAR model to analyze the correlation between oil price fluctuations and inflation and economic activity in the United States, the United Kingdom, France, Germany, Italy, and Japan. Chen, Shiu-Sheng and Chen, Hung-Chyn (2007) used data from 19 industrialized countries to study the transmission mechanism of oil price fluctuations to inflation over different periods of time in different countries. Korhonen

and Mehrotra (2009) used the SVAR model to study international oil price fluctuations and their impact on economic variables such as exchange rates, interest rates, and inflation. ITO (2010) explored the cross-effect of international oil price fluctuations and Russia's macroeconomy through empirical testing, and the results showed that there is a positive correlation between international oil price fluctuations and Russian economic growth in statistical sense, opposite to the exchange rate of the ruble. Kiani (2011) studied the impact of international oil prices on Pakistan's macroeconomy, arguing that rising oil prices will lead to inflation, government budget deficits, and a decline in foreign exchange rates, and that the rise in international oil prices will cause huge macroeconomic shocks to developing countries like Pakistan. Gómez-Loscos et al. (2012) studied the relationship between macroeconomics and oil prices in G7 countries and found that the impact of oil price shocks on the economy has been much smaller than the negative impact of the oil boom in the 70s of the 20th centuries on the economy. Nusair (2016) found that different countries are affected by different economic effects of international oil price fluctuations, Kuwait and Qatar real GDP in the same direction as international oil price fluctuations, international oil price increases lead to domestic GDP increase.

Some foreign research focuses on commodity futures prices and the impact of commodity futures price indices on single macroeconomic variables. Some scholars have studied the impact of commodity futures prices on economic growth, such as Frankel et al. (2010), Tsvetanov et al. (2016), Ge & Tang (2020). Some scholars have studied the effect of futures prices on the money supply, such as Browne et al. (2010), Hammoudeh et al. (2014), and others have studied the effect of futures prices on interest rates, such as Frankel (2006), Akram (2009), Belke et al. (2014). Some scholars have studied the relationship and impact of futures price indices on inflation, such as Bhar et al (2008), Acharya et al. (2010), Fernandez (2014), Gospodinov (2016), Wei (2019).

Some foreign research focuses on the relationship and impact between commodity futures prices and multiple macro variables. For example, Hess et al. (2008) studied the possible correlation between the CRB index and GSCIZ index and macro variables such as real GDP, real income, employment rate, and industrial production, and found that most macroeconomic variables have a significant positive correlation with futures prices during economic downturns, but the correlation is basically zero during active economic periods. Moreira (2014) studied the correlation between commodity price indices and expected interest rates, CPI, exchange rates, and GDP, and pointed out that high volatility in commodity prices reduces the level of GDP and raises inflation expectations. Andreasson et al. (2016) studied the correlation between 16 commodity futures contracts and speculation, exchange rates, SP500 index, market volatility and policy uncertainty, and found that energy futures are the cause of exchange rate and SP500 index changes, and different types of commodity futures have different effects on different macro variables.

In summary, the literature on the impact of the futures market on macroeconomic variables at home and abroad basically focuses on the research on the impact of single variables such as futures market price index or futures price on a single variable or part of the macroeconomic variable, from the futures market price index, turnover, open interest multiple variables affect the macroeconomic multiple variables research has not yet been, this paper uses cointegration

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related theoretical models to conduct a comprehensive quantitative study on the impact of the futures market on the domestic macroeconomy, and deeply studies the impact of the futures market on the domestic macroeconomy. It is expected to provide theoretical and practical guidance for the development of the futures market.

METHODOLOGY

Granger Causal Relationship Test

Causal Relationship was proposed by Granger (1969) and its basic idea is If $X = \{ x_t \}$ and $Y = \{ y_t \}$ are two random time series, and then,

$$X_t = \{ x_{t-s}, s \geq 0 \} \tag{1}$$

$$Y_t = \{ y_{t-s}, s \geq 0 \} \tag{2}$$

Represent the entire time series to the moment t, respectively. If $X_{t-1} \bigcup Y_{t-1}$ predict X_t is more accurate than X_{t-1} prediction, it is considered Y causally related to X . Vice versa. Then Geweke, Meese, and Dent (1983) proposed mathematical models for testing causality as follows:

$$y_t = a_{10} + \sum_{i=1}^{m} a_{1i} y_{t-i} + e_{1t} \tag{3}$$

$$y_t = a_{20} + \sum_{i=1}^{m} a_{2i} y_{t-i} + \sum_{j=1}^{k} b_{2j} x_{t-j} + e_{2t} \tag{4}$$

Here a_{1i} and a_{2i} are y_t and y_t the regression coefficients with the lagging values, b_{2j} is y_t and x_t the regression coefficient and its lagging value. e_{1t} and e_{2t} is white noise. Testing one-way causation from x_t to y_t is testing the null hypothesis for b_{2j} as follows: H_0 : b_{2j} =0(j=1,2,...,k), then

$$F = \frac{(ESS_1 - ESS_2)/m}{ESS_1/T - (k+m+1)} \tag{5}$$

In the above equation, ESS_1 and ESS_2, respectively, the sum of squares of the residuals in the least square's regression equation of the above model. T is the number of samples for the time series y_t . Under the confidence probability α, if $F > F_\alpha$, rejects the hypothesis H_0 and considers that there is a causal relationship for x_t to y_t .

Conintegration Test

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.

Engle and Granger(1987) suggested using a two-stage regression method to solve the non-stationary of time series, which was widely adopted early because it was easy to calculate, but its disadvantage is that under small samples, the error of parameter estimation is large, and when there are more than two variables, there may be multiple cointegration relationships between variables, this method cannot find all possible cointegration vectors, and its analysis results are not easy to interpret. Johansen and Juselius (1988) proposed to test the cointegration relationship between multiple variables based on the maximum likelihood estimation method (MLE) under the VAR system, and the Johansen test is superior to the Engle and Granger method.

The Johansen method tests whether the characteristics of cointegration between variables, it is a not priori assumption that the number of cointegration relationships between three or more variables, and the number of cointegration relations is only the result of hypothesis testing. Johansen (1988), Johansen and Juselius (1990) argued that the existence of a cointegration relationship can be determined by the eigenroot maximum statistic and the trace statistic, given the null hypothesis that "at most r cointegration relations". If this statistic exceeds the critical value, the null hypothesis is rejected, i.e., there is a r+1 cointegration relationship.

Consider a VAR model of order p as follows:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{6}$$

where y_t is a k dimensional vector containing nonstationary I (1) variables. x_t is a vector of d dimensions. ε_t is disturbance vector. We can rewrite VAR to the following form:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \tag{7}$$

Where $\Pi = \sum_{i=1}^{p} A_i - I$, $\Gamma_i = -\sum_{j=i+1}^{p} A_j$. Granger theorem states that if the coefficient matrix $\prod$ rank $r < k$, then there is an $k \times r$ order matrices α and β. Their rank is all r , then $\Pi = \alpha\beta'$, and $\beta' y_t$ is stable. where r is the number of cointegration relations (cointegration rank) and each column of β is a cointegration vector. The elements in α are the adjustment parameters in the vector error correction model VEC.

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Johansen's method is to estimate the Π matrix in the form of unconstrained VAR and then find β, thus testing the cointegration rank, (rank (Π) $= r < k$), to obtain the cointegration vector. There are two test methods for Johansen's test, namely eigen root trace test and maximum eigenvalue test, in which the maximum eigenvalue test has a lower power than the eigen root trace test, so the commonly used method in practice is the eigen root trace test, and the trace statistics of Johansen eigen roots is as follows:

$$Q_r = -T\sum_{i=t+1}^{k}\log\left(1-\lambda_i\right) \tag{8}$$

In the above equation, k is the number of sequences contained in the set of sequences tested, which λ_i is the ith feature root, and r is the number of hypothetical cointegration relations, $0 < r \le k-1$. Test hypothesis:

$H_{0(r)}$: There are at most r cointegration relationships in this set of sequences.

$H_{1(k)}$: At most k cointegration relations.

Since k cointegration relations cannot exist in the k-sequence cointegration test, i.e. the cointegration vector matrix cannot be full-rank, the alternative hypothesis indicates that there is no cointegration relationship.

Error Correction Model

According to Granger Expression Theorem, there are three equivalent expressions of cointegration systems, vector autoregressive VAR, moving average MA and Error Correction Model (ECM), of which ECM can best directly describe the synthesis of short-term fluctuations and long-term equilibrium, and is the most commonly used.

The vector error correction model (VEC) is a constrained VAR model with cointegration constraints in the explanatory variables, so it is suitable for nonstationary sequences with known cointegration relations. When there is a large range of short-term dynamic fluctuations, the VEC expression restricts the long-term behavior of endogenous variables to converge on their cointegration relationships. 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.

Error corrected models are short-term dynamic models. For convenience, consider an ADL(p,q) model with only two variables:

$$y_t = \beta_0 + \sum_{i=0}^{p}\beta_{1i}x_{t-i} + \sum_{j=1}^{q}\beta_{2j}y_{t-j} + \varepsilon_t \tag{9}$$

A simple transformation yields an error-corrected representation as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=0}^{p} \alpha_{1i} \Delta x_{t-i} + \sum_{j=1}^{q} \alpha_{2j} \Delta y_{t-j} + \lambda \left(y - kx \right)_{t-1} + \varepsilon_t \quad (10)$$

The error correction model (10) is only an appropriate deformation of equation (9), which is equivalent to equation (9), and there are many advantages in the form of error correction, Therefore, when the variable sequence is not stable, the problem of pseudoregression can be avoided by using ECM, and when the sequence is cointegrated, the error correction model should be established, and only the differential variable can be used for modeling. Many sequences of variables in the economy are not stationary, and economic theories often assume a long-term equilibrium relationship between certain variables, so cointegration and error correction methods can be used to build models.

Impulse Response Function

In the vector autoregressive (VAR) model, when the disturbance term of the t phase of a variable change, it will produce a series of chain effects on the variables after the t period through the dynamic relationship between the variables, and the impulse response function will describe the dynamic response of the system to the shock (or nascent) disturbance, and judge the time delay relationship between the variables from the dynamic response. Consider a p-order vector autoregressive model:

$$Y_t = A_0 + B_1 Y_{t-1} + \cdots + B_p Y_{t-p} + \varepsilon_t \quad (11)$$

where Y_t is the k-dimensional vector composed of endogenous variables, B_i is the coefficient matrix, A_0 is the constant vector, ε_t is the k-dimensional error vector, and its covariance matrix is Ω , assuming a stationary stochastic process Y_t, then the equation (11) can be expressed as an infinite vector moving average model:

$$Y_t = A_1 + \sum_{m=0}^{\infty} \phi_m \varepsilon_{t-m} \quad (12)$$

where ϕ is the coefficient matrix and A_1 is the constant vector, which can be obtained from the coefficient matrix B_i and the constant vector A_0 in equation (11). As can be seen from equation (12), the i-th row and j-column element of the coefficient matrix ϕ_m represents the m-phase lag response of the ith variable to the unit shock generated by the jth variable, that is, the m-phase impulse 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 exists a non-singular array q such that $qq' = \Omega$, and then (12) can be expressed as follows:

$$Y_t = A_1 + \sum_{m=0}^{\infty} \left(\phi_m q \right) \left(q^{-1} \varepsilon_{t-m} \right) = A_1 + \sum_{m=0}^{\infty} \left(\phi_m q \right) \mu_{t-m} \quad (13)$$

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As can be seen from equation (13), after transformation, the original error vector ε_t becomes the standard vector white noise μ_t . The i-th row j-column element of the coefficient matrix $\phi_m q$ represents the m-phase impulse response of the ith variable in the system to the orthogonal impact of one standard error of the jth variable. The impulse response function of one variable to another variable in the system can be calculated from equation (13).

The impulse response function is the impact effect of the tracking system on an endogenous variable, and the impulse response function describes the impact of adding a standard deviation to the disturbance term on the current and future values of the endogenous variable. Shocks on one variable directly affect that variable and are 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 of 1 unit on economic variables is calculated, and the shock response curve can be made accordingly.

EMPIRICAL ANALYSIS

Variable Selection and Data Processing

Selection of Variables in the Futures Market:

The total volume indicators of the futures market generally include futures market price, futures market volume, turnover, open interest indicators, of which futures market volume and turnover indicators have a high correlation, according to the needs of research, turnover can better reflect the participation of funds in market transactions, so futures market variable selection in addition to futures market price, open interest, trading indicators choose futures turnover as research variables.

Futures Market Prices:

There are many futures market prices, a single commodity futures price cannot represent the overall price of the futures market, therefore, consider the use of futures price index to represent the futures market price, choose the futures market price index as a substitute variable, futures market price index currently in the market has wind futures market price index, NanHua commodity futures price index and CSI commodity price index and three futures exchanges according to their respective listed varieties launched by the relevant commodity price index. According to the needs of the study, we chose the wind commodity price index as a proxy variable for futures market prices. [1]

Transaction Turnover and Open Interest:

We select the total transaction turnover of all futures and options in the domestic futures market as the variable of the transaction amount of the futures market, and select the open interest of all futures and options varieties in the domestic futures market as the open interest variable of the futures market.

[1] Compared with the Wind Futures Market Price Index, South China Commodity Futures Price Index and China Securities Commodity Price Index and the relevant commodity price indices launched by the three futures exchanges according to their respective listed varieties, the Wind Futures Market Price Index can better meet the needs of research from the perspective of data availability and data time period.

Selection of Macroeconomic Variables:

We select economic growth, inflation, investment, import and export, consumption, money supply, interest rates, exchange rates, deposits and loans, fiscal revenue and expenditure and economic prosperity index variables, and comprehensively reflect the basic operation of the macroeconomy by selecting the above variables for research.

Economic Growth:

The variables of economic growth are usually expressed by GDP, and since this study is based on monthly data, GDP is only quarterly and there is no monthly data, we use industrial value added as a proxy variable for economic growth.

Inflation Rate:

Inflation rate indicators generally include consumer price index CPI, retail price index RPI, producer price index PPI index, we choose CPI and PPI as inflation rate variables from the perspective of consumption and production.

Investment:

Investment generally includes investment by state-owned economic units, investment by urban and rural collective economic units, unit investment in various other economic types, and individual investment by urban and rural residents. The variable to measure the scale of investment generally uses the total fixed asset investment of the whole society, so we choose the total fixed asset investment as the investment variable.

Import and Export:

Import and export is an important indicator to measure a country's trade situation, generally including import volume, export volume, total import and export and net export indicators, we consider the overall scale and change, select total import and export and net export as import and export variables.

Consumption:

Consumption generally includes two aspects, production consumption and personal consumption. The total retail sales of consumer goods reflect the consumption of physical goods in the whole society, and are also an important indicator reflecting the operation of the macroeconomy. We select the total retail sales of consumer goods as the consumption variable.

Money Supply:

Money supply is an important macro-financial indicator. China's central bank divides it into three levels, namely, cash in circulation (M0), narrow money supply, M0 plus demand deposits (M1), broad money supply, M1 plus time deposits (M2). We select M0, M1, M2 as money supply variable indicators.

Interest Rates:

The interest rates of the domestic financial market include deposit and loan interest rates, government bond repurchase rates, and interbank lending rates. Since the interest rate of deposits and loans has not been completely liberalized and the degree of marketization is low, the repurchase rate of treasury bonds is more market-oriented than that of the interbank

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lending rate, and the interbank lending rate is also the core interest rate of the money market and a representative interest rate in the entire financial market, which can timely, flexibly and accurately reflect the short-term capital supply and demand relationship of the entire financial market. Therefore, we chose the interbank offered rate as the interest rate variable. Interbank Offered Rate selects short-term interest rate indicators with 1-day, 7-day, 14-day, 21-day and 1-month periods as the research target.

Exchange Rate:

As an important macro-financial indicator, the exchange rate has a relatively large impact on a country's economy, and the variables that measure the change of exchange rate include the USD/RMB exchange rate, the EUR/RMB exchange rate and other major currencies against the RMB exchange rate. In addition, the indicators that comprehensively reflect the exchange rate changes are the RMB exchange rate index, and this study selects the USD/RMB exchange rate and the RMB effective exchange rate index as the exchange rate variable research.

Deposits and Loans:

Deposits and loans are the most important source and way for financial market organizations to provide financial support for economic development. Generally speaking, the basic function of financial market organizations is to accumulate deposits, place loans, optimize capital allocation, and promote economic development. The deposit and loan index is generally expressed by the deposit and loan balance of financial institutions, that is, the deposit and loan data of the bank at the end of the month. We use the balance of deposits and loans of financial institutions as the deposit and loan variables.

Fiscal Revenue and Expenditure:

Fiscal revenue refers to the monetary income obtained by governments at all levels after a certain value distribution from various sources of income within a certain period of time. Fiscal expenditure refers to the monetary expenditure of governments at all levels and a certain period of time for national defense, social administration, culture and education, insurance and health, debt interest, etc. Fiscal revenue and expenditure play an important role in macroeconomic regulation and control, and we select public financial revenue and expenditure as fiscal revenue and expenditure variables.

Economic Prosperity Index:

The economic prosperity index is an indicator used to describe the macroeconomic operation, which currently includes the macroeconomic prosperity index, CICC macro prosperity index, enterprise prosperity index, industry prosperity index, investment prosperity index, etc. From the perspective of data length and comprehensive impact, we selected the macroeconomic prosperity index as the economic prosperity index variable.

Processing and Analysis of Data

Data Processing:

From the perspective of the availability of research data and the selection of target variables, since the overall data of the futures market published on the website of the China Futures Association also includes the futures market volume, turnover and open interest data, the start time can be obtained from January 2003, so the variable data range we selected is unified from

January 2003 to May 2023 in principle, and only the selection time of interest rate indicators is from May 2004 to May 2023. All data selections are monthly. Some of the variable data are selected as daily data, and the processing method is to select the data on the last day of the month as the monthly data of the month. In addition, the treatment of missing data in the process of variable data selection is supplemented by the method of linear difference. Except for industrial value added, inflation rate, and net export index data, other variable indicators are logarithmic. Data sources: National Bureau of Statistics website, China Customs website, People's Bank of China website, China Futures Association website, WIND data terminal.

Descriptive Statistical Analysis:

Descriptive statistics on the selected variables show that the indicator data of each selected variable show a nonnormal distribution, and the specific results are as follows:

Table 1: Descriptive statistical results

	LNFPI	LNFT	LNFOI	IAV	CPI	PPI	NE	LNTIE	LNLMI	LNTRS	LNM0	LNM1
Mean	6.952	11.573	15.795	10.529	2.453	1.932	286.888	7.848	9.942	9.663	10.766	12.512
Median	7.026	11.975	15.884	9.300	2.100	2.490	252.290	8.049	10.142	9.846	10.923	12.645
Maximum	7.429	13.800	17.688	52.339	8.700	13.500	1027.000	8.676	11.319	10.628	11.649	13.427
Minimum	5.906	8.582	14.088	-25.867	-1.800	-8.200	-619.920	6.178	6.875	8.133	9.738	11.152
Std. Dev.	0.335	1.301	0.966	6.789	1.842	4.491	242.662	0.554	0.991	0.750	0.523	0.693
Skewness	-1.450	-0.726	-0.057	0.360	0.842	-0.066	0.506	-0.859	-0.781	-0.490	-0.399	-0.402
Kurtosis	4.697	2.403	1.929	10.927	4.215	2.248	3.940	2.930	2.775	1.907	1.940	1.865
Jarque-Bera	115.326	25.159	11.833	646.816	44.009	5.948	19.505	30.167	25.451	21.999	17.977	19.746
Probability	0.000	0.000	0.003	0.000	0.000	0.051	0.000	0.000	0.000	0.000	0.000	0.000
Sum	1703.276	2835.289	3869.819	2579.678	600.973	473.377	70287.74	1922.949	2435.771	2367.395	2637.597	3065.468
Sum Sq. Dev.	27.461	413.451	227.965	11247.48	828.096	4922.897	14367959	74.936	239.895	137.367	66.747	117.195
Observations	245	245	245	245	245	245	245	245	245	245	245	245

	LNM2	LNL	LND	LNER	LNIB1	LNIB7	LNIB14	LNIB21	LNIB1M	LNRI	LNR	LNE	LNEMI
Mean	13.669	13.311	13.640	1.935	0.785	1.022	1.063	1.125	1.175	4.459	8.953	9.051	4.602
Median	13.847	13.396	13.793	1.921	0.796	1.028	1.073	1.115	1.192	4.513	9.205	9.269	4.605
Maximum	14.85	14.638	14.827	2.114	1.614	2.111	2.143	2.103	2.292	4.667	10.070	10.539	4.758
Minimum	12.155	11.810	12.063	1.809	-0.211	-0.122	-0.036	-0.051	0.000	4.184	7.265	7.000	4.459
Std. Dev.	0.803	0.845	0.806	0.097	0.355	0.362	0.408	0.434	0.364	0.153	0.723	0.891	0.040
Skewness	-0.337	-0.161	-0.349	0.718	-0.240	-0.279	-0.233	-0.297	-0.334	-0.375	-0.663	-0.457	0.078
Kurtosis	1.807	1.738	1.847	2.281	3.485	3.832	3.197	2.936	3.694	1.621	2.245	2.070	5.963
Jarque-Bera	19.170	17.313	18.551	26.345	4.441	9.572	2.449	3.415	8.859	25.169	23.777	17.350	89.896
Probability	0.0009	0.0004	0.0004	0.000	0.109	0.008	0.294	0.181	0.012	0.000	0.000	0.000	0.000
Sum	3348.925	3261.179	3341.818	474.104	179.780	234.145	243.512	257.683	269.249	1092.556	2193.507	2217.477	1127.597
Sum Sq. Dev.	157.317	174.154	158.420	2.2834	28.670	29.914	38.003	42.910	30.205	5.734	127.661	193.744	0.386
Observations	245	245	245	245	229	229	229	229	229	245	245	245	245

Note: FPI represents futures price index, FT represents total futures market turnover, FOI represents total open interest in futures market, IAV represents industrial added value, CPI represents consumer price index, PPI represents producer price index, NE represents net exports, TIE represents total imports and exports, LMI

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represents total investment in fixed assets, TRS represents total retail sales of consumer goods, M0 M1 M2 represents money supply M0 M1 M2, L represents total loans, D represents total deposits, ER represents the USD/RMB exchange rate, IB1 IB7 IB14 IB21 IB1M represents the interbank offered rate 1-day, 7-day, 14-day, 21-day, 1-month interest rate, RI represents the RMB real effective exchange rate index, R represents fiscal revenue, E represents fiscal expenditure, and EMI represents macroeconomic prosperity index. LN means logarithm.

Correlation Analysis:

The following analyzes the correlation between the three variables of the futures market and all the selected macroeconomic variable indicators, and the specific calculation results are as follows:

Table 2: Correlation coefficients results

Variables	LNFPI	LNFT	LNFOI
LNFPI	1.000	0.387	0.295
LNFT	0.387	1.000	0.874
LNFOI	0.295	0.874	1.000
IAV	0.089	-0.470	-0.540
CPI	0.156	-0.217	-0.296
PPI	0.189	-0.270	-0.169
NE	0.137	0.545	0.662
LNTIE	0.459	0.906	0.878
LNLMI	0.217	0.812	0.771
LNTRS	0.263	0.877	0.937
LNM0	0.302	0.877	0.939
LNM1	0.290	0.881	0.954
LNM2	0.270	0.882	0.957
LNL	0.258	0.866	0.963
LND	0.273	0.884	0.960
LNER	-0.338	-0.807	-0.570
LNIB1	0.242	0.211	0.102
LNIB7	0.318	0.315	0.165
LNIB14	0.293	0.315	0.142
LNIB21	0.302	0.300	0.148
LNIB1M	0.234	0.219	0.086
LNRI	0.118	0.869	0.886
LNR	0.321	0.858	0.869
LNE	0.243	0.835	0.858
LNEMI	0.210	-0.218	-0.174

The correlation results show that the commodity futures price index is only negatively correlated with the exchange rate, and has a positive correlation with other indicators to varying degrees. The turnover of the futures market has a negative correlation with industrial added value, CPI, PPI, exchange rate and macroeconomic prosperity index, and shows a positive correlation with other variables to varying degrees. The open interest of the futures market has a negative correlation with industrial added value, CPI, PPI, exchange rate and macroeconomic prosperity index, and shows a positive correlation with other variables to varying degrees.

According to the comprehensive comparison of the correlation between the three variables of the commodity market and the three variables of money supply, the relationship between money supply M2 and the three commodity market variables is relatively strong, so we choose money supply M2 as the research index of money supply. From the comparison of the correlation between the short-term interest rate of interbank interest rate of 1 day, 7 days, 14 days, 21 days and 1 month and the three commodity market variables, the correlation of the 7-day interbank rate is the strongest, so we choose the 7-day interbank rate as the research indicator of interest rate variables.

Model Empirical Analysis

Unit Root Test:

We perform a root-of-unit test for stationarity for each variable data selected. The methods of unit root test generally include DF, ADF, PP test, etc., and this paper adopts the commonly used ADF test method[2]. The specific test results are as follows:

Table 3: Unit root test results

Variable	Augmented Dickey-Fuller test statistic	Test type (c, t, n)	1% level	5% level	10% level	Durbin-Watson stat	whether or not stable
LNFPI	-2.957762	(c, t,2)	-3.996431	-3.428503	-3.137665	1.997381	NO
LNFT	-1.440102	(c,0,14)	-3.458719	-2.873918	-2.573443	1.996861	NO
LNFOI	-0.187332	(c,0,14)	-3.458719	-2.873918	-2.573443	1.947563	NO
IAV	-2.175452	(c,0,12)	-3.458470	-2.873809	-2.573384	1.962850	NO
CPI	-1.576226	(0,0,14)	-2.575055	-1.942212	-1.615780	2.030078	NO
PPI	-3.396859	(c, t,2)	-3.996431	-3.428503	-3.137665	1.951444	NO
NE	-1.363781	(c, t,13)	-3.998280	-3.429398	-3.138192	2.036829	NO
LNTIE	-2.078153	(c,0,13)	-3.458594	-2.873863	-2.573413	2.022377	NO
LNLMI	-0.300163	(c, t,12)	-3.998104	-3.429313	-3.138142	1.933960	NO
LNTRS	0.247831	(c, t,13)	-3.998457	-3.429484	-3.138243	2.012759	NO
LNM2	-0.937508	(c, t,12)	-3.998104	-3.429313	-3.138142	1.939892	NO
LNL	-0.433676	(c, t,15)	-3.998635	-3.429570	-3.138293	1.921882	NO
LND	-1.097556	(c, t,12)	-3.998104	-3.429313	-3.138142	2.014670	NO
LNER	-1.278260	(c, t,12)	-3.998104	-3.429313	-3.138142	1.966321	NO
LNIB7	-3.021021	(c, t,2)	-3.999180	-3.429834	-3.138449	1.996028	NO
LNRI	-1.500327	(c, t,2)	-3.996431	-3.428503	-3.137665	1.989867	NO
LNR	-1.320773	(c, t,13)	-3.998280	-3.429398	-3.138192	2.022105	NO

[2]In the inspection selection of the standard, we adopt: to ensure that the residual terms are not related, the AIC criterion and SC criterion are used at the same time as the best time lag standard, and the hysteresis length is the best length when the value of both values is the smallest at the same time. In addition, for questions such as whether to include trends, selection criteria: observe through the timing diagram of variables, if the series seems to contain a trend (determined or random), there should be both constants and trends in the sequence regression. If the series does not exhibit any trend and has a non-zero mean, there should be only constants in the regression. If the series fluctuates at zero mean, the test regression should contain neither constants nor trends.

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LNE	0.115984	(c, t,13)	-3.998280	-3.429398	-3.138192	2.009292	NO
LNEMI	-0.386262	(0,0,11)	-2.574925	-1.942193	-1.615791	1.994330	NO
D(LNFPI)	-13.02741	(0,0,0)	-2.574513	-1.942136	-1.615828	2.015036	YES
D(LNFT)	-5.082889	(c,0,13)	-3.458719	-2.873918	-2.573443	1.998616	YES
D(LNFOI)	-3.748905	(0,0,13)	-2.575055	-1.942212	-1.615780	1.943805	YES
D(IAV)	-6.366019	(0,0,15)	-2.575144	-1.942224	-1.615772	2.013536	YES
D(CPI)	-5.351610	(0,0,13)	-2.575055	-1.942212	-1.615780	2.025315	YES
D(PPI)	-7.468638	(0,0,1)	-2.574553	-1.942142	-1.615825	1.966999	YES
D(NE)	-4.486547	(0,0,15)	-2.575144	-1.942224	-1.615772	1.989421	YES
D(LNTIE)	-3.357852	(c,0,12)	-3.458594	-2.873863	-2.573413	2.033587	YES
D(LNLMI)	-3.076792	(0,0,12)	-2.575099	-1.942218	-1.615776	2.006235	YES
D(LNTRS)	-4.741572	(c, t,13)	-3.998457	-3.429484	-3.138243	2.011712	YES
D(LNM2)	-6.902150	(c, t,7)	-3.997418	-3.428981	-3.137946	1.952101	YES
D(LNL)	-7.963721	(c,0,1)	-3.457286	-2.873289	-2.573106	2.018052	YES
D(LND)	-3.569700	(c,0,9)	-3.458225	-2.873701	-2.573327	2.016324	YES
D(LNER)	-2.977263	(0,0,11)	-2.574968	-1.942199	-1.615787	1.965785	YES
D(LNIB7)	-14.89132	(0,0,1)	-2.575234	-1.942236	-1.615764	2.016072	YES
D(LNRI)	-9.938692	(0,0,1)	-2.574553	-1.942142	-1.615825	1.992910	YES
D(LNR)	-3.031555	(0,0,13)	-2.575055	-1.942212	-1.615780	2.017863	YES
D(LNE)	-2.617374	(0,0,15)	-2.575144	-1.942224	-1.615772	2.011764	YES
D(LNEMI)	-7.172534	(0,0,10)	-2.574925	-1.942193	-1.615791	1.994184	YES

Note: C in the test type (c,t,n) indicates the intercept term, and c=0 indicates no intercept, t indicates the temporal trend, t=0 indicates that there is no trend item, n represents the lagging order, and D represents the first-order difference (the following analogues). * Indicates that it is nonstationary at 5%, 10% significance levels.

The above unit root test results show that except for PPI at 5%, 10% significance level, other variables are nonstationary at 1%, 5%, 10% significance level, and all selected variables are stable at 1%, 5%, and 10% significance levels after first-order difference.

Granger Causal Test Results:

We test the causal relationship between the selected macroeconomic variables and the futures market variables (futures price index, total futures market turnover, total open interest in the futures market), and the specific results are as follows:

Table 4: Granger causal relationship test Results

Null Hypothesis	Sample	F-Statistic	Prob.
IAV does not Granger Cause LNFPI	241	0.89249	0.4691
LNFP does not Granger Cause IAV		2.24102	0.0654
IAV does not Granger Cause LNFT	241	1.58083	0.1802
LNFT does not Granger Cause IAV		2.64640	0.0343
IAV does not Granger Cause LNFOI	241	1.54463	0.1901
LNFOI does not Granger Cause IAV		3.07411	0.0171
CPI does not Granger Cause LNFPI	243	2.73269	0.0671

LNFPI does not Granger Cause CPI		2.04755	0.1313
CPI does not Granger Cause LNFT	243	2.60017	0.0764
LNFT does not Granger Cause CPI		2.15337	0.1183
CPI does not Granger Cause LNFOI	243	2.15788	0.1178
LNFOI does not Granger Cause CPI		1.34659	0.2621
PPI does not Granger Cause LNFPI	243	0.87426	0.4185
LNFPI does not Granger Cause PPI		32.6262	3.E-13
PPI does not Granger Cause LNFT	243	0.77354	0.4625
LNFT does not Granger Cause PPI		0.96819	0.3813
PPI does not Granger Cause LNFOI	243	3.19345	0.0428
LNFOI does not Granger Cause PPI		0.97149	0.3800
NE does not Granger Cause LNFPI	243	0.07415	0.9286
LNFPI does not Granger Cause NE		5.10226	0.0068
NE does not Granger Cause LNFT	243	2.03057	0.1335
LNFT does not Granger Cause NE		19.6513	1.E-08
NE does not Granger Cause LNFOI	243	0.94590	0.3898
LNFOI does not Granger Cause NE		18.2223	4.E-08
LNTIE does not Granger Cause LNFPI	243	0.65698	0.5194
LNFPI does not Granger Cause LNTIE		2.12130	0.1221
LNTIE does not Granger Cause LNFT	243	20.0398	9.E-09
LNFT does not Granger Cause LNTIE		17.8041	6.E-08
LNTIE does not Granger Cause LNFOI	243	4.93150	0.0080
LNFOI does not Granger Cause LNTIE		19.6132	1.E-08
LNLMI does not Granger Cause LNFPI	243	0.88046	0.4159
LNFPI does not Granger Cause LNLMI		2.17899	0.1154
LNLMI does not Granger Cause LNFT	243	0.42019	0.6574
LNFT does not Granger Cause LNLMI		13.3481	3.E-06
LNLMI does not Granger Cause LNFOI	243	3.84980	0.0226
LNFOI does not Granger Cause LNLMI		22.3544	1.E-09
LNLMI does not Granger Cause LNFT	243	0.42019	0.6574
LNTRS does not Granger Cause LNFPI	243	0.93392	0.3944
LNFPI does not Granger Cause LNTRS		0.84592	0.4304
LNTRS does not Granger Cause LNFT	243	4.74797	0.0095
LNFT does not Granger Cause LNTRS		5.67007	0.0039
LNTRS does not Granger Cause LNFOI	243	2.81834	0.0617
LNFOI does not Granger Cause LNTRS		3.76898	0.0245
LNTRS does not Granger Cause LNFT	243	4.74797	0.0095
LNM2 does not Granger Cause LNFPI	244	0.06397	0.8005
LNFPI does not Granger Cause LNM2		0.13406	0.7146
LNM2 does not Granger Cause LNFT	244	13.2652	0.0003
LNFT does not Granger Cause LNM2		2.15844	0.1431
LNM2 does not Granger Cause LNFOI	244	11.5742	0.0008
LNFOI does not Granger Cause LNM2		0.86007	0.3546
LNL does not Granger Cause LNFPI	241	1.73996	0.1420
LNFPI does not Granger Cause LNL		4.60732	0.0013
LNL does not Granger Cause LNFT	241	10.1003	1.E-07

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LNFT does not Granger Cause LNL		0.75194	0.5576
LNL does not Granger Cause LNFOI	241	10.2005	1.E-07
LNFOI does not Granger Cause LNL		2.49049	0.0440
LND does not Granger Cause LNFPI	241	1.41712	0.2290
LNFPI does not Granger Cause LND		1.40872	0.2318
LND does not Granger Cause LNFT	241	4.62439	0.0013
LNFT does not Granger Cause LND		0.71559	0.5820
LND does not Granger Cause LNFOI	241	6.10266	0.0001
LNFOI does not Granger Cause LND		1.37746	0.2425
LNER does not Granger Cause LNFPI	243	0.31366	0.7311
LNFPI does not Granger Cause LNER		2.73738	0.0668
LNER does not Granger Cause LNFT	243	3.04485	0.0495
LNFT does not Granger Cause LNER		1.29559	0.2757
LNER does not Granger Cause LNFOI	243	0.30953	0.7341
LNFOI does not Granger Cause LNER		0.46756	0.6271
LNIB7 does not Granger Cause LNFPI	228	7.26365	0.0076
LNFPI does not Granger CauseLNIB7		7.26174	0.0076
LNIB7 does not Granger Cause LNFT	228	0.57831	0.4478
LNFT does not Granger Cause LNIB7		3.92569	0.0488
LNIB7 does not Granger Cause LNFOI	228	1.82881	0.1776
LNFOI does not Granger Cause LNIB7		1.44128	0.2312
LNRI does not Granger Cause LNFPI	241	0.66028	0.6202
LNFPI does not Granger Cause LNRI		4.85027	0.0009
LNRI does not Granger Cause LNFT	241	0.48102	0.7497
LNFT does not Granger Cause LNRI		3.86639	0.0046
LNRI does not Granger Cause LNFOI	241	3.95206	0.0040
LNFOI does not Granger Cause LNRI		0.32735	0.8595
LNR does not Granger Cause LNFPI	244	0.06315	0.8018
LNFPI does not Granger Cause LNR		4.86406	0.0284
LNR does not Granger Cause LNFT	244	14.8377	0.0002
LNFT does not Granger Cause LNR		56.8837	9.E-13
LNR does not Granger Cause LNFOI	244	14.4772	0.0002
LNFOI does not Granger Cause LNR		32.5602	3.E-08
LNE does not Granger Cause LNFPI	243	0.32381	0.7237
LNFPI does not Granger Cause LNE		3.06277	0.0486
LNE does not Granger Cause LNFT	243	2.22393	0.1104
LNFT does not Granger Cause LNE		21.0520	4.E-09
LNE does not Granger Cause LNFOI	243	6.07458	0.0027
LNFOI does not Granger Cause LNE		37.5412	7.E-15
LNEMI does not Granger Cause LNFPI	243	0.67124	0.5120
LNFPI does not Granger Cause LNEMI		0.02806	0.9723
LNEMI does not Granger Cause LNFT	243	0.16314	0.8496
LNFT does not Granger Cause LNEMI		0.50108	0.6065
LNEMI does not Granger Cause LNFOI	243	1.97621	0.1409
LNFOI does not Granger Cause LNEMI		0.08116	0.9221

Through the above Granger causality test, the following conclusions can be obtained, at a significance level of 10%, the futures price index (LNFPI) has a significant guiding effect on industrial value added (IAV), producer price index (PPI), net exports (NE), total loans (LNL), dollar-renminbi exchange rate (LNER), 7-day interbank offered rate (LNIB7), RMB real effective exchange rate index (LNRI), fiscal revenue (LNR) and fiscal expenditure (LNE), and there is no significant guiding effect on other macroeconomic variables.

At a significant level of 10%, the total turnover of the futures market (LNFT) has a significant guiding effect on industrial added value (IAV), net export (NE), total import and export (LNTIE), fixed asset investment (LNLMI), total retail sales of consumer goods (LNTRS), 7-day interbank rate (LNIB7), RMB real effective exchange rate index (LNRI), fiscal revenue (LNR), fiscal expenditure (LNE). There is no significant guiding effect on other macroeconomic variables.

At a significant level of 10%, the total open interest of the futures market (LNFOI) has a significant guiding effect on industrial added value (IAV), net export (NE), total import and export (LNTIE), fixed asset investment (LNLMI), total retail sales of consumer goods (LNTRS), total loans (LNL), fiscal revenue (LNR), fiscal expenditure (LNE), and there is no significant guiding effect on other macroeconomic variables.

In summary, through the Granger causality relationship test, it can be seen that the futures market indicators (futures price index, total turnover, total open interest) also have a guiding effect on industrial added value, net exports, fiscal revenue and fiscal expenditure in macroeconomic variable indicators. In addition, the futures price index and the total turnover of the futures market also have a guiding effect on the 7-day interbank lending rate, and the RMB real effective exchange rate index. The total turnover of the futures market and the total open interest of the futures market also have a strong guiding effect on the total import and export volume, fixed asset investment and total retail sales of social consumer goods. The futures price index and the total open interest of the futures market also have a strong guiding effect on the total loans. The futures market price index also has a strong guiding effect on the producer price index and the exchange rate of the US dollar against the RMB. The three futures market indicators have a weak guiding effect on other macroeconomic variables.

Long-Term Cointegration Test Between Futures Market Variables and Macroeconomic Variables:

We test the cointegration relationship between the non-stationary time series of the above futures market variable indicators (futures price index, total turnover, total open interest) and domestic macroeconomic variable indicators, and because it is a cointegration relationship test between multiple variables, we use the maximum likelihood estimation method (MLE) proposed by Johansen, and Johansen's test is better than the method of Engle and Granger. From the above Granger causality test, it can be seen that the futures market variable indicators LNFPI, LNFT, LNFOI are all Granger causes of domestic macroeconomic variable indicators IAV, NE, LNR, LNE. The futures market variables LNFPI and LNFOI are the Granger reasons of LNIB7 and LNRI. The futures market variables LNFT and LNFOI are the Granger reasons of the domestic macroeconomic variable indicators LNTIE, LNLMI and LNTRS. Futures market variables LNFPI and LNFOI are the Granger reasons for domestic macroeconomic changes to LNL. The futures market variable LNFPI is the Granger reason for the domestic macroeconomic

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variable indicator PPI and LNER. Therefore, the long-term relationship between endogenous variables and domestic macroeconomic variables is tested respectively. We consider the following cointegration tests separately as follows:

The cointegration test of futures market variable indicators LNFPI, LNFT, LNFOI and domestic macroeconomic variable indicators IAV, NE, LNR, LNE, LNE, respectively:

Through the cointegration test, the optimal hysteresis order is selected, and finally the cointegration equations corresponding to the largest characteristic roots are selected as follows:

Table 5: The long-term cointegration equations of IAV, NE, LNR and LNE

variable	LNFPI	LNFT	LNFOI	TREND	c	Trend and constant selection	Lag order interval selection
IAV	6.203 (1.892)	-1.339 (0.990)	3.622 (2.368)	0.096 (0.029)	62.584	Linear trend and constant	1 to 2
NE	83.078 (72.382)	-87.282 (37.875)	224.977 (90.681)	0.479 (1.120)	2892.556	Linear trend and constant	1 to 2
LNR	-0.073 (0.163)	0.442 (0.086)	-0.832 (0.210)	-0.013	-15.840	Quadratic trend and constant	1 to 4
LNE	-0.041 (0.091)	0.284 (0.048)	-0.448 (0.114)	0.013 (0.001)	11.563	Linear trend and constant	1 to 2

From the above cointegration equation, it can be concluded that in the long run, the futures market price index rose by one percentage point, the industrial added value increased by 0.06 units, the net export increased by 0.831 units, fiscal revenue fell by 0.073 percentage points, and fiscal expenditure fell by 0.041 percentage points. In the long run, the total turnover of the futures market rose by one percentage point, the industrial added value decreased by 0.013 units, the net export decreased by 0.873 units, the fiscal revenue increased by 0.442 percentage points, and the fiscal expenditure increased by 0.284 percentage points. In the long run, the total open interest of the futures market rose by one percentage point, the industrial added value rose by 0.036 units, net exports increased by 2.25 units, fiscal revenue fell by 0.832 percentage points, and fiscal expenditure fell by 0.114 percentage points.

The futures market variables LNFPI and LNFOI are cointegration tests with domestic macroeconomic variables LNIB7 and LNRI, respectively:

Through the cointegration test, the optimal hysteresis order is selected respectively, and finally the cointegration equations corresponding to the largest characteristic roots are selected as follows:

Table 6: Long-term cointegration equations of LNIB7 and LNRI

Variable	LNFPI	LNFOI	TREND	c	Trend and constant selection	Lag order interval selection
LNIB7	-0.407 (0.308)	-0.852 (0.306)	0.012 (0.004)	15.800	Linear trend and constant	1 to 2
LNRI	2.060 (0.668)	-0.576 (0.293)				1 to 3

The above cointegration test results show that in the long run, the futures market price index rose by one percentage point, the7-day interbank offered rate fell by 0.407 percentage points, and the RMB effective exchange rate index increased by 2.060 percentage points. In the long run, the total open interest in the futures market rose by one percentage point, the 7-day interbank offered rate fell by 0.852 percentage points, and the RMB effective exchange rate index fell by 0.576 percentage points.

The cointegration test of futures market variables LNFT and LNFOI and domestic macroeconomic variable indicators LNTIE, LNLMI and LNTRS, respectively:

Through the cointegration test, the optimal hysteresis order is selected respectively, and finally the cointegration equations corresponding to the largest characteristic roots are selected as follows:

Table 7: Long-term Cointegration equation of LNTIE, LNLMI and LNTRS

Variable	LNFT	LNFOI	TREND	c	Trend and constant selection	Lag order interval selection
LNTIE	0.346 (0.050)	-0.623 (0.133)	0.010 (0.002)	12.487	Linear trend and constant	1to2
LNLMI	0.508 (0.100)	-0.883 (0.266)	0.015 (0.003)	16.212	Linear trend and constant	1to2
LNTRS	0.385 (0.071)	-0.869 (0.193)	0.016 (0.002)	16.932	Linear trend and constant	1to4

The above cointegration test results show that in the long run, the total turnover of the futures market increased by 1 percentage point, the total import and export volume increased by 0.346 percentage points, the fixed assets investment increased by 0.508 percentage points, and the total retail sales of consumer goods increased by 0.385 percentage points. In the long run, the total open interest of the futures market rose by 1 percentage point, the total import and export volume fell by 0.623 percentage points, the fixed assets investment in fixed assets fell by 0.883 percentage points, and the total retail sales of consumer goods fell by 0.869 percentage points.

Cointegration test of futures market variables LNFPI, LNFOI and domestic macroeconomic variable indicators LNL:

Through the cointegration test, the optimal hysteresis order is selected respectively, and finally the cointegration equations corresponding to the largest characteristic roots are selected as follows:

Table 8: Long-term Cointegration equation of LNL

Variable	LNFPI	LNFOI	TREND	c	Trend and constant selection	Lag order interval selection
LNL	0.134 (0.324)	0.638 (0.109)		4.116 (2.230)	constant	1 to 4

The above cointegration test results show that the futures market price index increased by 1 percentage point, and the total loan volume increased by 0.134 percentage points. Futures

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market total open interest rose by 1 percentage point and total loans rose by 0.638 percentage points.

The cointegration test of futures market variables LNFPI and domestic macroeconomic variable indicators PPI and LNER respectively:

Through the cointegration test, the optimal hysteresis order is selected respectively, and finally the cointegration equations corresponding to the largest characteristic roots are selected as follows:

Table 9: Long-term Cointegration equations of PPI and LNER

Variable	LNFPI	TREND	c	Trend and constant selection	Lag order interval selection
PPI	2.438 (3.543)	-0.009 (0.01665)	13.885	Linear trend and constant	1to1
LNER	0.270 (0.007)				1to4

The above cointegration test results show that in the long run, the futures market price index rose by one percentage point, the producer price index rose by 0.024 units, and the exchange rate of the US dollar against the renminbi rose by 0.270 percentage points.

Error Correction Model (ECM) Analysis of Futures Market Variables Affecting Macroeconomic Variables:

The sequence of variables we study is not stable, if the regression between variables is directly established, it is easy to cause the problem of pseudoregression, the better solution is to differentiate the unstable variable sequence under study to obtain a stationary sequence, and then use the differential stationary sequence to establish a model, this practice has certain defects, the use of differential modeling, will lose long-term information. A more effective method is to use an error correction model. Engle-Granger proved that cointegrated sequences must be represented as error-corrected representations. Therefore, when the variable sequence is cointegrated, an error correction model should be established. Through the analysis of the long-term equilibrium equation of the macroeconomic variables of the above cointegration test, we establish a dynamic error correction model, and the results are as follows:

The short-term error correction model of Futures market variable indicators LNFPI, LNFT, LNFOI affect macroeconomic variable indicators IAV, NE, LNR, LNE:

The following we make the short-term error correction model of futures market variable indicators LNFPI, LNFT, LNFOI affecting macroeconomic variable indicators IAV, NE, LNR, LNE, and the specific results are as follows:

Table 10: Short-term error correction model of IAV, NE, LNR, LNE

ECM	D(IAV)		D(NE)		D(LNR)		D(LNE)
EC	-0.626		-0.442		-0.185		-0.733
	(0.087)		(0.074)		(0.061)		(0.106)
D (IAV (-1))	-0.085	D (NE (-1))	-0.182	D (LNR (-1))	-0.367	D (LNE (-1))	-0.172
	(0.080)		(0.076)		(0.078)		(0.084)
D (IAV (-2))	-0.048	D (NE (-2))	-0.045	D (LNR (-2))	-0.432	D (LNE (-2))	-0.284

	(0.067)		(0.062)		(0.084)		(0.062)
				D (LNR (-3))	0.190		
					(0.081)		
				D (LNR (-4))	-0.169		
					(0.072)		
D (LNFPI (-1))	5.200	D (LNFPI (-1))	-470.316	D (LNFPI (-1))	0.277	D (LNFPI (-1))	-0.549
	(5.096)		(157.561)		(0.205)		(0.333)
D (LNFPI (-2))	10.747	D (LNFPI (-2))	-330.205	D (LNFPI (-2))	0.240	D (LNFPI (-2))	-0.534
	(5.134)		(161.680)		(0.204)		(0.336)
				D (LNFPI (-3))	-0.005		
					(0.205)		
				D (LNFPI (-4))	0.036		
					(0.203)		
D (LNFT (-1))	-1.031	D (LNFT (-1))	167.822	D (LNFT (-1))	-0.108	D (LNFT (-1))	0.022
	(1.206)		(36.441)		(0.053)		(0.082)
D (LNFT (-2))	0.298	D (LNFT (-2))	95.120	D (LNFT (-2))	0.072	D (LNFT (-2))	-0.093
	(1.142)		(36.153)		(0.055)		(0.077)
				D (LNFT (-3))	-0.064		
					(0.052)		
				D (LNFT (-4))	-0.037		
					(0.047		
D (LNFOI (-1))	-0.215	D (LNFOI (-1))	73.342	D (LNFOI (-1))	0.100	D (LNFOI (-1))	0.733
	(2.663)		(82.476)		(0.119)		(0.174)
D (LNFOI (-2))	-1.285	D (LNFOI (-2))	-16.741	D (LNFOI (-2))	0.052	D (LNFOI (-2))	0.510
	(2.761)		(84.306)		(0.119)		(0.183)
				D (LNFOI (-3))	0.295		
					(0.118)		
				D (LNFOI (-4))	-0.128		
					(0.115)		
C	-0.110		2.154		0.0265		0.006
	(0.317)		(9.782)		(0.026)		(0.020)
				@TREND (03M01)	-0.000		
					(0.000)		
R-squared	0.372		0.384		0.584		0.594
Adj. R-squared	0.348		0.360		0.550		0.578
Sum sq. resids	5375.403		5135803.		7.765		22.374
S.E. equation	4.814		148.785		0.187		0.3105
F-statistic	15.268		16.037		17.252		37.709
Log likelihood	-718.562		-1548.883		71.171		-55.277
Akaike AIC	6.021		12.883		-0.435		0.539
Schwarz SC	6.165		13.028		-0.159		0.684
Mean dependent	-0.0554		2.738		0.009		0.010
S.D. dependent	5.959		185.926		0.280		0.478

Note: EC represents the error correction term, C represents the constant term, and the value in parentheses is the standard deviation (similar below).

From the above error correction model of macroeconomic variables and futures market variables, it can be seen that from the short-term dynamics, the first-order difference of industrial added value (D(IAV)) is affected by the first-order differential lag of itself and the logarithms of futures market variables (LNFPI, LNFT, LNFOI) from 1 to 2 orders, and the

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cumulative effects are -0.133, 15.947, -0.733, -1.500 units, respectively, and the influence of error correction terms is -0.626. The first-order differential of net exports (D(NE)) is affected by the first-order differential lag of itself and the logarithms of futures market variables (LNFPI, LNFT, LNFOI) of orders 1 to 2, and the cumulative effects are -0.227, -800.521, 262.942, 56.601 units, and the influence of error correction terms is -0.442 units, respectively. The first-order difference of the logarithm of fiscal revenue (D(LNR)) is affected by the first-order differential lag of itself and the logarithms of futures market variables (LNFPI, LNFT, LNFOI) from order 1 to 4, and the cumulative effects are -0.778, 0.548, -0.137 and 0.319 units, respectively, and the influence of error correction terms is -0.185 units. The first-order difference of the logarithm of fiscal expenditure (D(LNR)) is affected by the first-order differential lag of itself and the logarithms of futures market variables (LNFPI, LNFT, LNFOI) 1 to 2, and the cumulative effects are -0.456, -1.083, -0.071, 1.243 units, respectively, and the impact of error correction items is -0.733 units.

The futures market variables LNFPI and LNFOI affect the short-term error correction models of domestic macroeconomic variables LNIB7 and LNRI, respectively:

Below we make short-term error correction models of futures market variables LNFPI and LNFOI affecting domestic macroeconomic variable indicators LNIB7 and LNRI, respectively, and the specific results are as follows:

Table 11: Short-term error correction model of LNIB7 and LNRI

ECM	D(LNIB7)		D(LNRI)
EC	0.005		-0.003
	(0.038)		(0.001)
D(LNIB7(-1))	-0.316	D(LNRI(-1))	0.285
	(0.073)		(0.068)
D(LNIB7(-2))	-0.235	D(LNRI(-2))	-0.118
	(0.068)		(0.070)
		D(LNRI(-3))	-0.054
			(0.066)
D(LNFPI(-1))	0.447	D(LNFPI(-1))	-0.033
	(0.225)		(0.014)
D(LNFPI(-2))	0.336	D(LNFPI(-2))	0.014
	(0.226)		(0.014)
		D(LNFPI(-3))	-0.036
			(0.014)
D(LNFOI(-1))	0.250	D(LNFOI(-1))	-0.007
	(0.110)		(0.007)
D(LNFOI(-2))	0.088	D(LNFOI(-2))	-0.004
	(0.111)		(0.007)
		D(LNFOI(-3))	-0.002
			(0.006)
C	-0.009		
	(0.014)		
R-squared	0.161		0.176
Adj. R-squared	0.134		0.144

Sum sq. resids	8.771		0.035
S.E. equation	0.201		0.012
F-statistic	5.9717		5.483
Log likelihood	46.462		722.855
Akaike AIC	-0.340		-5.916
Schwarz SC	-0.219		-5.771
Mean dependent	-0.001		0.001
S.D. dependent	0.216		0.013

From the above error correction model of macroeconomic variables and futures market variables, it can be seen that from the short-term dynamics, the first-order difference of the logarithm of the 7-day interest rate of interbank lending (LNIB7) is affected by the first-order differential lag of itself and the logarithm of futures market variables (LNFPI, LNFOI) by order 1 to 2, and the cumulative effects are -0.551, 0783, 0.338 units, respectively, and the impact of the error correction item is 0.005 units. The first-order difference of the logarithm of the RMB effective exchange rate index(D(LNRI)) is affected by the first-order differential lag of itself and the logarithm of futures market variables (LNFPI, LNFOI) by orders 1 to 3, and the cumulative effects are 0.113, -0.055 and -0.013 units, respectively, and the influence of the error correction term is -0.003 units.

The short-term error correction models of the futures market variables LNFT and LNFOI affect domestic macroeconomic variables LNTIE, LNLMI and LNTRS, respectively

The following is a short-term error correction model of futures market variables LNFT and LNFOI affecting domestic macroeconomic variable indicators LNTIE, LNLMI and LNTRS, respectively, and the specific results are as follows:

Table 12: Short-term error correction model of NTIE, LNLMI and LNTRS

ECM	D(LNTIE)		D(LNLMI)		D(LNTRS)
EC	-0.135		-0.389		-0.039
	(0.048)		(0.065)		(0.020)
D(LNTIE(-1))	-0.363	D(LNLMI(-1))	0.030	D(LNTRS(-1))	0.040
	(0.075)		(0.070)		(0.067)
D(LNTIE(-2))	-0.160	D(LNLMI(-2))	-0.137	D(LNTRS(-2))	-0.047
	(0.074)		(0.065)		(0.067)
				D(LNTRS(-3))	-0.048
					(0.066)
				D(LNTRS(-4))	-0.065
					(0.067)
D(LNFT(-1))	0.062	D(LNFT(-1))	-0.150	D(LNFT(-1))	0.007
	(0.032)		(0.101)		(0.015)
D(LNFT(-2))	-0.027	D(LNFT(-2))	-0.233	D(LNFT(-2))	0.024
	(0.032)		(0.098)		(0.016)
				D(LNFT(-3))	0.009
					(0.016)
				D(LNFT(-4))	-0.025
					(0.014)

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D(LNFOI(-1))	0.281	D(LNFOI(-1))	0.918	D(LNFOI(-1))	-0.008
	(0.064)		(0.213)		(0.034)
D(LNFOI(-2))	0.172	D(LNFOI(-2))	0.494	D(LNFOI(-2))	0.053
	(0.065)		(0.221)		(0.035)
				D(LNFOI(-3))	-0.026
					(0.035)
				D(LNFOI(-4))	0.010
					(0.033)
C	0.007		0.002		0.010
	(0.007)		(0.025)		(0.004)
R-squared	0.313		0.313		0.100
Adj. R-squared	0.293		0.292		0.048
Sum sq. resids	2.809		34.885		0.731
S.E. equation	0.110		0.386		0.057
F-statistic	15.254		15.228		1.930
Log likelihood	195.809		-109.022		354.768
Akaike AIC	-1.552		0.967		-2.840
Schwarz SC	-1.437		1.082		-2.637
Mean dependent	0.008		0.012		0.010
S.D. dependent	0.130		0.459		0.058

From the above error correction model of macroeconomic variables and futures market variables, it can be seen that from the short-term dynamics, the first-order difference (D(LNTIE)) of the logarithm of the total import and export volume is affected by the first-order differential lag of itself and the logarithm of the futures market variables (LNFT, LNFOI) by order 1 to 2, the cumulative effects are -0.523, 0.035 and 0.453 units, respectively, and the impact of the error correction term is -0.135 units. The first-order difference (D(LNLMI)) of the logarithm of total fixed asset investment is affected by the first-order differential lag of itself and the logarithm of the futures market variables (LNFT, LNFOI) by order 1 to 2, and the cumulative effects are -0.107, 0.015 and 1.412 units, respectively, and the influence of the error correction term is -0.389 units. The first-order difference (D(LNTRS)) of the logarithm of total retail sales of consumer goods is affected by the first-order differential lag of itself and the logarithm of futures market variables (LNFT, LNFOI) of orders 1 to 4, and the cumulative effects are -0.12, -0.383 and 0.029 units, respectively, and the influence of error correction is -0.039 units.

A short-term error correction model for the impact of LNFPI and LNFOI on LNL and the impact of futures market variables LNFPI on PPI and LNER:

The following is a short-term error correction model for the impact of LNFPI and LNFOI on domestic macroeconomic variable indicators LNL and the impact of futures market variables LNFPI on domestic macroeconomic variable indicators PPI and LNER, and the specific results are as follows:

Table 13: Short-term error correction model of LNL, PPI, LNER

ECM	D(LNL)		D(PPI)		D(LNER)
EC	-0.005		-0.036		-0.002
	(0.001)		(0.009)		(0.003)
D(LNL(-1))	0.104	D(PPI(-1))	0.696	D(LNER(-1))	0.519
	(0.065)		(0.038)		(0.066)
D(LNL(-2))	0.212			D(LNER(-2))	-0.084
	(0.065)				(0.075)
D(LNL(-3))	0.101			D(LNER(-3))	-0.009
	(0.065)				(0.075)
D(LNL(-4))	-0.152			D(LNER(-4))	0.079
	(0.066)				(0.066)
D(LNFPI(-1))	0.010	D(LNFPI(-1))	4.904	D(LNFPI(-1))	-0.008
	(0.007)		(0.616)		(0.008)
D(LNFPI(-2))	-0.004			D(LNFPI(-2))	-0.004
	(0.007)				(0.008)
D(LNFPI(-3))	-0.028			D(LNFPI(-3))	0.006
	(0.007)				(0.008)
D(LNFPI(-4))	-0.012			D(LNFPI(-4))	0.002
	(0.008)				(0.008)
D(LNFOI(-1))	-0.003				
	(0.004)				
D(LNFOI(-2))	0.002				
	(0.004)				
D(LNFOI(-3))	0.012				
	(0.004)				
D(LNFOI(-4))	-0.001				
	(0.004)				
C			-0.043		
R-squared	0.227		0.659		0.244
Adj. R-squared	0.186		0.654		0.218
Sum sq. resids	0.011		81.371		0.013
S.E. equation	0.009		0.583		0.007
F-statistic	5.547		153.748		9.304
Log likelihood	863.776		-211.876		840.326
Akaike AIC	-7.090		1.777		-6.928
Schwarz SC	-6.901		1.834		-6.797
Mean dependent	0.0115		-0.035		-0.001
S.D. dependent	0.008		0.993		0.008

From the above error correction model of macroeconomic variables and futures market variables, it can be seen that from the short-term dynamics, the first-order difference (D(LNL)) of the logarithm of the total loan amount is affected by the first-order differential lag of itself and the logarithm of futures market variables (LNFPI, LNFOI) of the first order of lag 1 to 4, the cumulative effects are 0.265, -0.034 and 0.010 units, respectively, and the impact of the error correction term is -0.005 units. The first-order differential (D(PPI)) of the producer price index

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is affected by the first-order differential lag of itself and the logarithm of the futures market variable (LNFPI) by orders 1 to 1, the effects are 0.696 and 4.904 units, respectively, and the effect of the error correction term is -0.036 units. The first-order difference (D(LNER)) of the USD/RMB exchange rate pair is affected by the first-order differential lag of 1st to 4th order of itself and the logarithm of the futures market variable (LNFPI), with cumulative effects of 0.505 and -0.004 units, respectively, and the effect of error correction terms is -0.002 units.

Impulse Response Function Shock Response Analysis:

On the basis of the short-term error correction model, the impulse response function is applied to analyze the shock response, that is, the response of macroeconomic variable indicators to the impact of futures market variable indicators is analyzed. Under the processing of Eviews 10.0 software, the shock response curves are made separately (the horizontal axis in the figure represents the number of lag stages, and the vertical axis represents the degree of impact reaction).

The macroeconomic variable indicators IAV, NE, LNR, LNE to the futures market variable indicators LNFPI, LNFT, LNFOI shock response curve:

The following is the macroeconomic variable indicators IAV, NE, LNR, LNE to the futures market variable indicators LNFPI, LNFT, LNFOI shock response curve, the specific results are as follows:

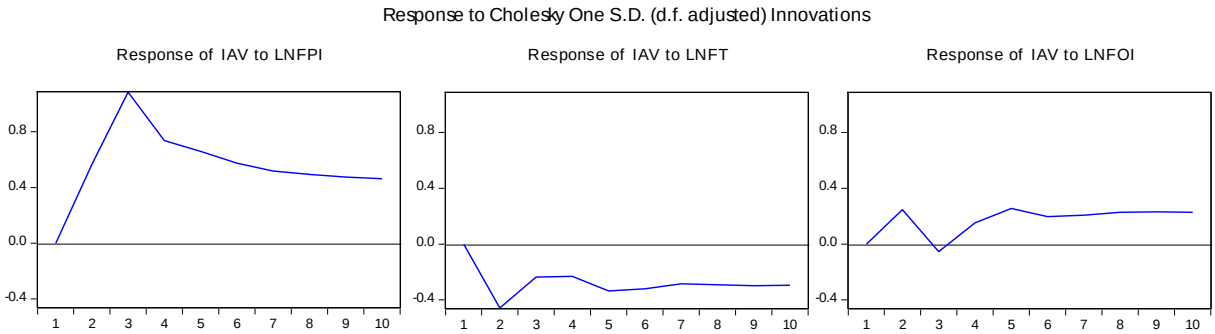


Fig. 1: Response curve of IAV to the three-variable shock of futures market

As can be seen from the above figure, IAV showed a positive trend after being hit by one standard deviation of LNFPI, increasing from the first period, reaching a maximum at 2.5 period, continuing to decrease after that, and stabilizing after 6 periods. After IAV was impacted by one standard deviation of LNFT, it showed a negative trend, and the negative shock strengthened after the first period, gradually weakened after reaching the maximum in the 1.5 period, and stabilized after the 5th period. After the IAV was hit by one standard deviation of LNFOI, it showed a positive trend overall, and the shock strengthened after the first period, gradually weakened after reaching the maximum in the 1.5 period, reached the minimum value in the 2.5 period, gradually strengthened after it, and gradually stabilized after the 5th period.

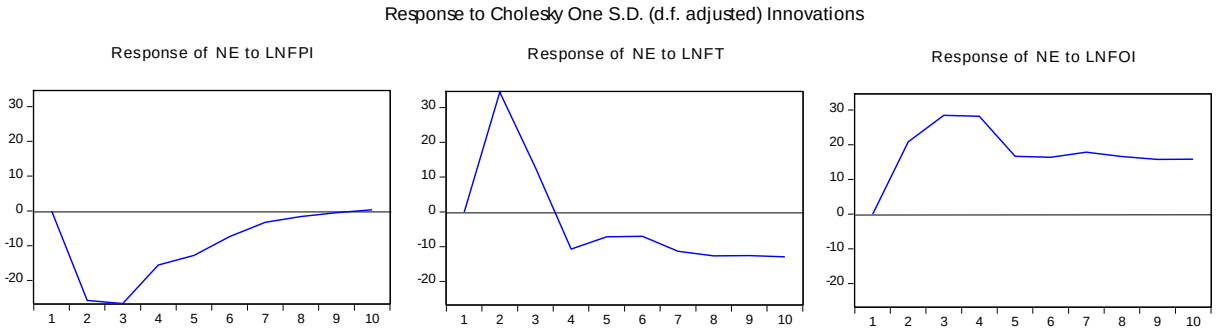


Fig. 2: Response curve of NE to the three-variable shock of futures market

As can be seen from the above figure, NE shows a negative trend after being hit by one standard deviation of LNFPI, increasing from the first period, reaching the maximum negative direction in the second period, and then gradually weakening in the negative direction, tending to 0 in the 9.5 period. After NE was hit by one standard deviation of LNFT, it showed a positive trend, increasing from the first period, reaching a maximum in the 1.5 period, then weakening, reaching the low point after the 3.5 period, showing a negative trend, and then gradually stabilizing. After NE was hit by one standard deviation of LNFOI, it showed a positive trend, increasing from stage 1, reaching a maximum in stage 3, then gradually weakening negatively and gradually stabilizing after period 4.5.

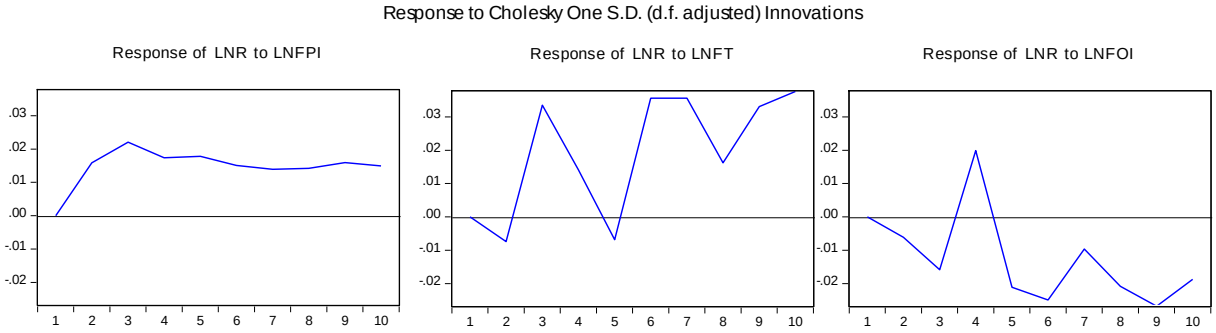


Fig. 3: Response curve of LNR to the three-variable shock of the futures market

As can be seen from the above figure, after LNR is hit by one standard deviation of LNFPI, it shows a positive trend, which increases from the first period, reaches a negative maximum in the 2.5th period, gradually decreases, and tends to stabilize after the 5.5 period. After the LNR is hit by one standard deviation of LNFT, it shows a trend of fluctuation influence, weakening from period 1 to strengthening after period 1.5, reaching a maximum in period 2.5, then weakening, reaching a minimum after period 4.5, then strengthening, reaching a high point in period 6, and then weakening again. After the LNR was hit by one standard deviation of LNFOI, it showed a trend of volatility influence, weakening from period 1 to strengthening after period 2.5, reaching a maximum after period 3.5, then weakening, and weakening after period 6.

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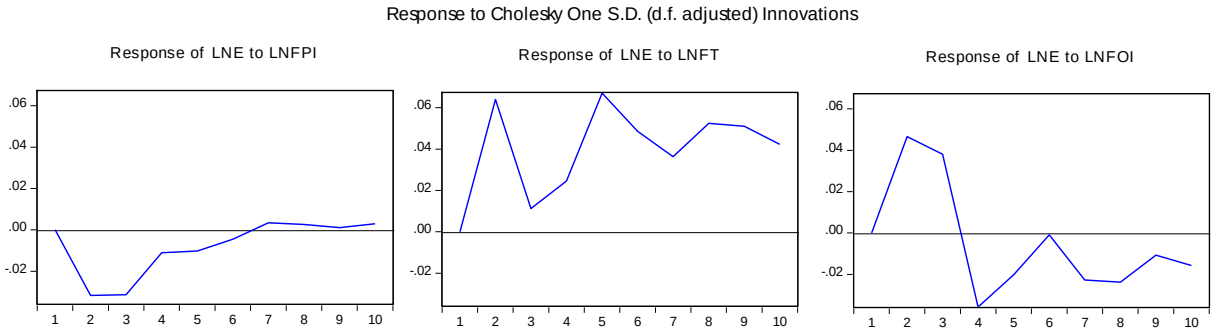


Fig. 4: Response curve of LNE to the three-variable shock of the futures market

As can be seen from the above figure, LNE showed a negative trend after being hit by one standard deviation of LNFPI, increasing from the first period, reaching the negative maximum in the second period, and then gradually weakening, and tending to stabilize after the 6.5 period. After LNE is hit by one standard deviation of LNFT, it shows a positive fluctuation trend, starting from phase 1, reaching a high point in phase 1.5, then weakening, reaching a minimum value in period 2.5, then strengthening, reaching a maximum after period 4.5, then weakening, and stabilizing after period 6. After LNE is hit by one standard deviation of LNFOI, it shows a trend of volatility influence, strengthening from period 1 to reaching a maximum in period 1.5, then weakening, reaching a minimum after period 3.5, then strengthening, and weakening volatility after period 6.5.

Macroeconomic variables indicators LNIB7 and LNRI shock response curves to futures market variables LNFPI and LNFOI:

The following is the impact response curve of macroeconomic variables LNIB7 and LNRI to the futures market variables LNFPI and LNFOI, and the specific results are as follows:

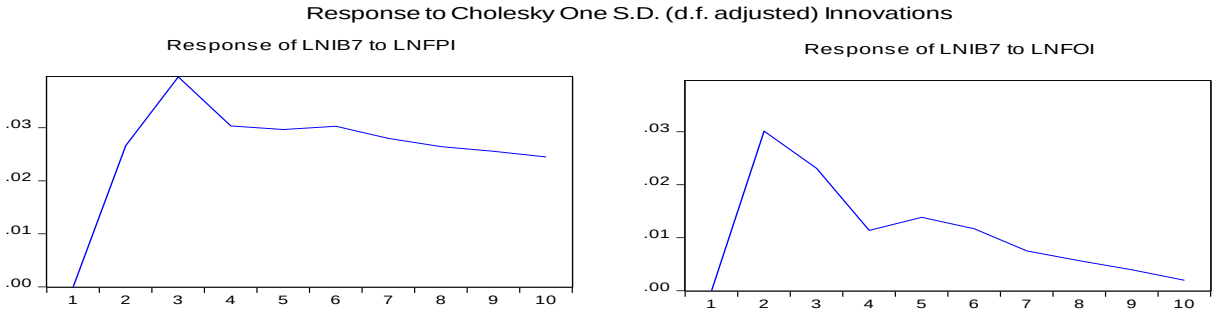


Fig. 5: Response curve of LNIB7 to the impact of futures market price index and open interest

As can be seen from the above figure, LNB7 shows a positive trend after being hit by one standard deviation of LNFPI, increasing from phase 1, reaching a maximum in phase 2.5, then weakening, and stabilizing after phase 3.5. LNB7 showed a positive trend after being hit by one standard deviation of LNFOI, increasing from the first period, reaching a maximum in the 1.5 period, then weakening, and stabilizing after the 3.5 period.

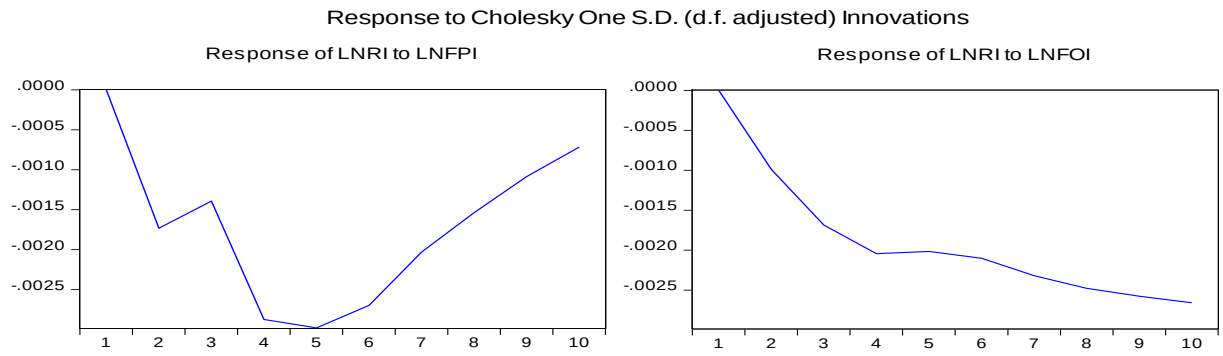


Figure 6: Response curve of LNRI to the impact of futures market price index and open interest

As can be seen from the above figure, LNRI shows a negative trend after being hit by one standard deviation of LNFPI, increasing from period 1, reaching a negative maximum in period 4.5, and then gradually weakening. After LNRI was hit by one standard deviation of LNFOI, it showed a negative trend, increasing from period 1, reaching a negative high in period 3.5, and then gradually stabilizing.

Macroeconomic variables indicators LNTIE, LNLMI, LNTRS response curve to futures market variables LNFT, LNFOI shock:

The following is the response curve of macroeconomic variable indicators LNTIE, LNLMI, LNTRS to the impact of futures market variables LNFT, LNFOI, and the specific results are as follows:

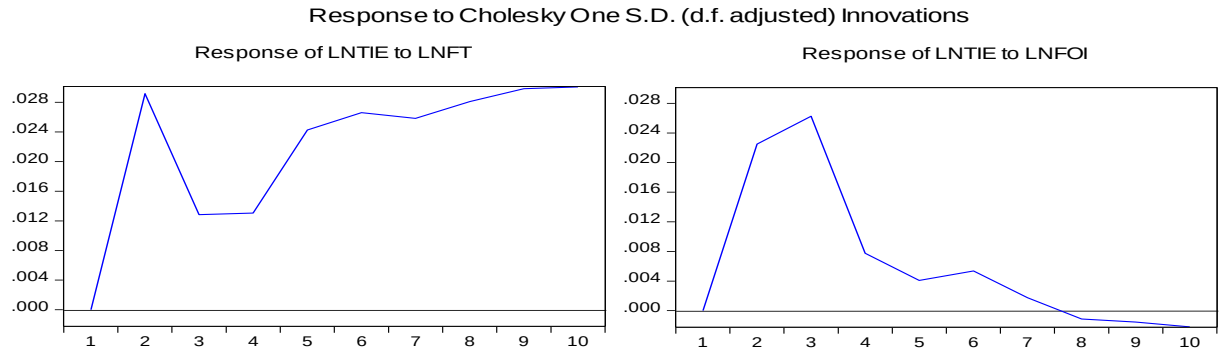


Fig. 7: The impact curve of LNTIE to futures market turnover and open interest

As can be seen from the above figure, LNTIE shows a positive trend after being hit by a standard deviation of LNFT, increasing from the first period, reaching a maximum in the 1.5 period, then gradually weakening, reaching a low point in the third period, gradually strengthening after the 5.5 period. LNTIE showed a positive trend after being hit by one standard deviation of LNFOI, increasing from period 1, reaching a maximum in phase 2.5, then gradually weakening, reaching a low in period 4.5, and then gradually stabilizing.

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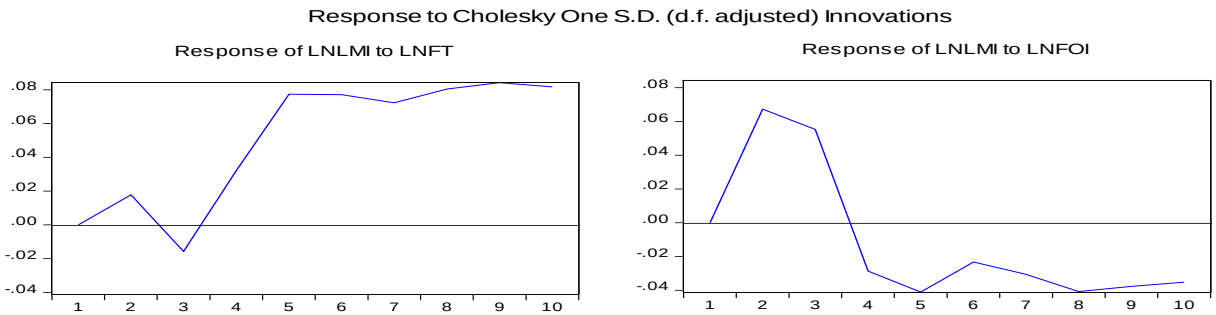


Fig. 8: The impact curve of LNLMI to the impact of futures market turnover and open interest

As can be seen from the above figure, after LNLMI is hit by one standard deviation of LNFT, it increases from phase 1, reaches a high point in phase 1.5, then gradually weakens, reaches a minimum value in phase 2.5, then gradually strengthens, reaches a high point in phase 4.5, and then tends to stabilize. After LNLMI is hit by one standard deviation of LNFOI, it increases from period 1, reaches a maximum at 1.5, then gradually decreases, reaches a minimum at 4.5, and then stabilizes.

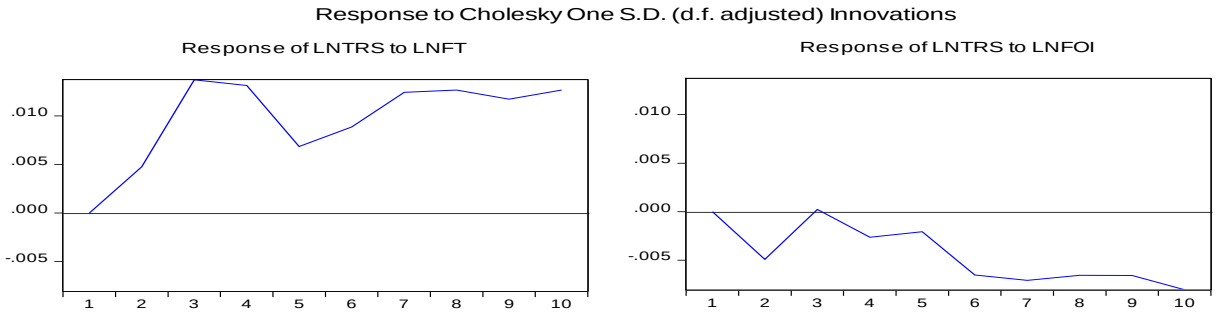


Figure 9: The impact curve of LNTRS to the impact of futures market turnover and open interest

As can be seen from the above figure, after LNTRS is hit by a standard deviation of LNFT, it shows a positive trend, starting from the first period, reaching a maximum in the 2.5 period, then gradually weakening, reaching the lowest value in the 4.5 period, then gradually strengthening, reaching a high point in the 6.5 period, and then stabilizing. After LNTRS is hit by one standard deviation of LNFOI, it shows a negative trend, increasing from period 1, reaching a negative high in phase 1.5, then gradually weakening, reaching a minimum value in phase 3.5, then tending to strengthen, reaching a negative high in period 5.5, and then stabilizing.

As can be seen from the above figure, after LNTRS is hit by a standard deviation of LNFT, it shows a positive trend, starting from the first period, reaching a maximum in the 2.5 period, then gradually weakening, reaching the lowest value in the 4.5 period, then gradually strengthening, reaching a high point in the 6.5 period, and then stabilizing. After LNTRS is hit by one standard deviation of LNFOI, it shows a negative trend, increasing from period 1, reaching a negative high in phase 1.5, then gradually weakening, reaching a minimum value in phase 3.5, then tending to strengthen, reaching a negative high in period 5.5, and then stabilizing.

Domestic macroeconomic variable indicator LNL to futures market variables LNFPI, LNFOI shock response curve:

The following is the domestic macroeconomic variable indicator LNL to the futures market variables LNFPI, LNFOI shock response curve, the specific results are as follows:

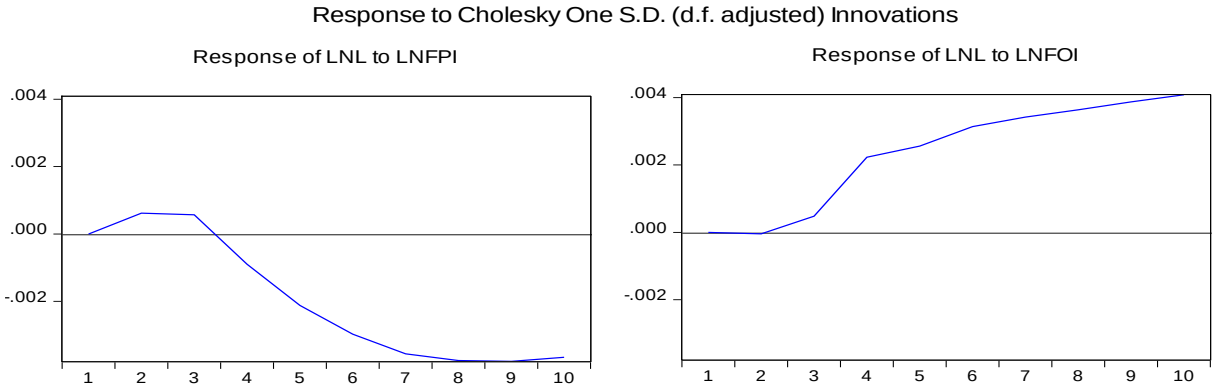


Figure 10: Response curve of LNL to the impact of futures market price index and open interest

As can be seen from the above figure, after LNL is impacted by one standard deviation of LNFPI, it increases from stage 1, reaches a maximum in phase 2, then gradually weakens, turns into a negative shock, reaches a negative maximum in stage 8, and then tends to stabilize. After LNL is hit by one standard deviation of LNFOI, it increases from stage 1 to a high point in phase 3.5, after which the growth rate weakens.

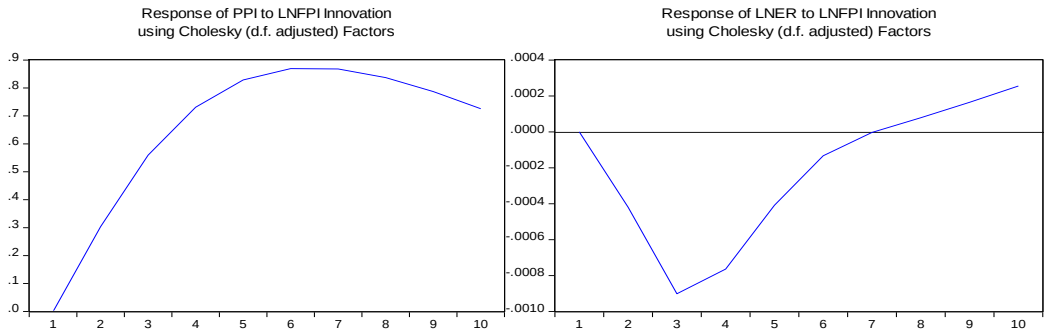


Fig. 11: Response curve of PPI and LNER to the impact of the futures market price index

As can be seen from the above figure, after the PPI is hit by one standard deviation of LNFPI, the response shows a positive trend, increasing from the first stage, reaching a maximum in the 5th period, and then gradually weakening. After LNER is hit by one standard deviation of LNFPI, the response shows a negative trend, increasing from phase 1, reaching a negative maximum at phase 2.5, then gradually weakening, tending to 0 in phase 6.5, and then producing a slow positive effect.

CONCLUSION

This paper uses the Granger causality test, cointegration relationship test, error correction model and shock response function method in cointegration correlation theory, and uses the monthly data from 2003.1 to 2023.5 to study the effect of the three variables of the futures market (futures price index, total turnover, total open interest) on 16 macroeconomic variables

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(industrial added value, consumer price index, producer price index, net export, total import and export volume, fixed asset investment, and total retail sales of social consumer goods, money supply, total loans, total deposits, USD/RMB exchange rate, interbank lending rate, RMB real effective exchange rate index, fiscal revenue, fiscal expenditure, macroeconomic prosperity index).

Through the causality test, it can be known that the three indicators of the futures market have a guiding effect on the industrial added value, net exports, fiscal revenue and fiscal expenditure in the macroeconomic variable indicators. In addition, the futures price index and the total turnover of the futures market also have a guiding effect on the7-day interbank lending rate, and the RMB real effective exchange rate index. The total turnover of the futures market and the total open interest of the futures market also have a strong guiding effect on the total import and export volume, fixed asset investment and total retail sales of social consumer goods. The futures price index and the total open interest of the futures market also have a strong guiding effect on the total loans. The futures price index also has a strong guiding effect on the producer price index and the exchange rate of the US dollar against the RMB. In addition, the guiding effect of the three on other macroeconomic variables consumer price index, money supply, total deposits, and macroeconomic prosperity index is weak.

The results of the cointegration test show that in the long run, the futures market price index rose by one percentage point, the industrial added value increased by 0.06 units, the net export increased by 0.831 units, fiscal revenue fell by 0.073 percentage points, fiscal expenditure fell by 0.041 percentage points, the interbank 7-day offered rate fell by 0.407 percentage points, the RMB effective exchange rate index rose by 2.060 percentage points, and the total loan volume increased by 0.134 percentage points. The producer price index rose by 0.024 units, and the dollar/yuan exchange rate rose by 0.270 percentage points. In the long run, the total turnover of the futures market rose by one percentage point, the industrial added value decreased by 0.013 units, the net export decreased by 0.873 units, the fiscal revenue increased by 0.442 percentage points, the fiscal expenditure increased by 0.284 percentage points, the total import and export volume increased by 0.346 percentage points, the fixed assets investment increased by 0.508 percentage points, and the total retail sales of consumer goods increased by 0.385 percentage points. In the long run, the total open interest of the futures market rose by one percentage point, the industrial added value rose by 0.036 units, the net export increased by 2.25 units, the fiscal revenue fell by 0.832 percentage points, the fiscal expenditure fell by 0.114 percentage points, the interbank 7-day interest rate fell by 0.852 percentage points, the RMB effective exchange rate index fell by 0.576 percentage points, the total import and export volume fell by 0.623 percentage points, and the fixed assets investment fell by 0.883 percentage points. Total retail sales of consumer goods dropped by 0.869 percentage points and total loans rose by 0.638 percentage points.

The results of the error correction model show that from the short-term dynamics, the first-order difference of industrial added value is affected by the logarithmic first-order differential lag of itself and the futures market by 1 to 2 orders, and the cumulative effects are -0.133, 15.947, -0.733 and -1.500 units, respectively. The first-order difference of net exports is affected by the logarithmic first-order differential lag of itself and the futures market by orders 1 to 2, and the cumulative effects are -0.227, -800.521, 262.942 and 56.601 units, respectively.

The first-order difference of the logarithm of fiscal revenue is affected by the logarithmic first-order difference lag of itself and the futures market by order 1 to 4, and the cumulative impact is -0.778, 0.548, -0.137 and 0.319 units, respectively. The logarithmic first-order difference of fiscal expenditure is affected by the logarithmic first-order difference lag of itself and the futures market by orders 1 to 2, and the cumulative effects are -0.456, -1.083, -0.071 and 1.243 units, respectively. From the perspective of short-term dynamics, the first-order difference of the logarithm of the interbank 7-day interest rate is affected by the first-order differential lag of itself and the logarithm of futures market variables (price index, open interest) by 1 to 2 orders, and the cumulative impact is -0.551, 0783 and 0.338 units, respectively; The first-order difference of the logarithm of the RMB effective exchange rate index is affected by the first-order differential lag of itself and the logarithm of the futures market variables (price index, open interest) by 1 to 3 degrees, and the cumulative impact is 0.113, -0.055 and -0.013 units, respectively. From the short-term dynamics, the first-order difference of the logarithm of the total import and export volume is affected by the first-order differential lag of itself and the logarithm of the futures market variables (turnover, open interest) by 1 to 2 orders, and the cumulative impact is -0.523, 0.035 and 0.453 units, respectively. The first-order difference of the logarithm of total fixed asset investment is affected by the first-order differential lag of itself and the logarithm of futures market variables (turnover, open interest) by 1 to 2 orders, and the cumulative effects are -0.107, 0.015 and 1.412 units, respectively. The first-order difference of the logarithm of total retail sales of consumer goods is affected by the first-order differential lag of itself and the logarithm of the futures market variables (turnover, open interest) by 1 to 4 degrees, and the cumulative effects are -0.12, -0.383 and 0.029 units, respectively. From the short-term dynamics, the first-order difference of the logarithm of total loans is affected by the first-order differential lag of itself and the logarithm of futures market variables (price index, open interest) by 1 to 4 orders, and the cumulative impact is 0.265, -0.034 and 0.010 units, respectively. The first-order difference of the producer price index is affected by the first-order differential lag of itself and the logarithm of the futures market variable (price index) by order 1 to 1, and the effects are 0.696 and 4.904 units, respectively. The first-order difference between the pair of USD/RMB is affected by the first-order differential lag of itself and the logarithm of the futures market variable (price index) by orders 1 to 4, and the cumulative effect is 0.505 and -0.004 units, respectively.

The shock response function curve shows that the industrial added value is positively impacted by the futures price index and the open interest, and the negative impact of the turnover is delayed by 2.5 months, 1.5 months and 1.5 months, respectively. Net exports were negatively impacted by the futures price index, positively and negatively impacted by turnover, and positively impacted by open interest, with the impact lagging in 2 months, 1.5 months and 3 months, respectively. Fiscal revenue was positively impacted by the futures price index, and the positive and negative impact of turnover and open interest were lagged by 2.5 months. Fiscal expenditure was positively and negatively impacted by the futures price index and open interest, and was positively impacted by the turnover, and the impact of the impact lagged in 2 months, 1.5 months and 1.5 months respectively. The 7-day interbank offered rate was affected by the positive impact of the futures price index and open interest, and the impact of the impact lagged by 2.5 months and 1.5 months respectively. The RMB real effective exchange rate index was negatively impacted by the futures price index and the open interest, and the impact affected by the impact lagged by 4.5 months and 3.5 months respectively. The total import and

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export volume was positively impacted by the turnover and open interest, and the impact of the impact lagged by 1.5 months and 2.5 months respectively. The investment amount of fixed assets was affected by the positive and negative impact of turnover and open interest, and the impact of the impact lagged by 1.5 months. The total retail sales of consumer goods were affected by the positive impact of turnover and the negative impact of holding volume, and the impact of the impact lagged by 2.5 months and 1.5 months respectively. The total amount of loans was affected by the positive and negative shocks of the futures price index, and the negative impact of the open interest, which lagged behind 2 and 3.5 months, respectively. The producer price index was affected by the positive impact of the futures price index, and the impact of the shock lagged by May, and the USD/CNY exchange rate was affected by the positive and negative impact of the futures price index, and the impact of the shock lagged by 2.5 months.

In summary, the futures market variables have a strong or weak short-term and long-term impact on 12 of the 16 macroeconomic variables selected, thus indicating that the development of the futures market has a huge impact on the macroeconomy, and the futures market has become a relatively important part of the national economic development process, so the development of the futures market is of great significance to the national economy. In order to further expand the role of the futures market in the macroeconomy in terms of depth and breadth, and continuously promote the development of the futures market, the following suggestions are put forward. First, accelerate the listing of futures varieties and continuously expand the coverage of varieties. Although there are currently more than 100 varieties of futures and options in the domestic futures exchange market, there is still a relatively large gap compared with thousands of varieties on the world's leading exchanges, so the domestic varieties for the national economy and people's livelihood have accelerated the launch of corresponding commodity futures and options varieties to serve the industry and serve the development of the national economy. Second, promote the international development of the futures market. Although the internationalization of the domestic futures market has achieved certain results in recent years, and the internationalization of some varieties has been launched, the pricing influence of futures varieties is still insufficient, therefore, the international development of the domestic futures market should be accelerated, and the coverage of international futures varieties should be continuously expanded, from the opening of varieties to introduce international investors to the establishment of delivery warehouses around the world, and continuously expand the pricing influence of domestic futures varieties. Finally, within the framework of the Futures Law, the "five-in-one" supervision should be effectively brought into play to ensure the long-term stable and healthy development of the futures market and better serve the development of the national economy.

References

Achary R N., Gentle P F., Paudel K P. Examining the CRB index as a leading indicator for US inflation [J]. Applied Economics Letters, 2010(17):1493-1496.

Akram Q F. Commodity prices, interest rates and the Dollar [J]. Energy economics, 2009(31):838-851.

Andreasson P., Bekiros S., Nauyen D K., et al. Impact of speculation and economic uncertainty on commodity analysis[J].2016(43):115-427.

Belke A H., Bordonig, Hendricks T W. Monetary policy, global liquidity and commodity price dynamics[J]. North America Journal of Economics and Finance, 2014(28):1-16.

Bhar R., Hamori S. Information content of commodity futures prices for monetary policy [J]. Economic Modelling, 2008(25):274-283.

Blanchard O, Galí J. The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s so Different from the 1970s? [J]. Economics Working Papers, 2007.

Browne F.,Cronin D. Commodity prices, money and inflation[J]. Journal of Economics and Business, 2010(62): 331-345.

Chang Qing. Macro decision-making should refer to futures price index[J]. Price Theory and Practice [J]. 2010(11): 13-14.

Chen Ruihua, Xiao Lina. Futures Price, Inflation Expectation and Economic Policy Control——An Empirical Analysis Based on China's Commodity Futures Market[J]. China Securities and Futures,2018(4): 21-29.

Chen Ruiying. Analysis of the early warning effect of industrial futures price on macroeconomy[J], Rural Economy and Science and Technology, 2017(1):115-116.

Chen, Shiu-Sheng & Chen, Hung-Chyn. Oil prices and real exchange rates[J]. Energy Economics, Elsevier, 2007, 29(3):390-404.

Cheng Zhoulan. Research on the prediction of macroeconomic variables of commodity futures prices in China[D]. Chengdu: Southwestern University of Finance and Economics Master's Thesis, 2021. 6.

Dong Bin. An empirical study on the role of futures market in China's economic development[J]. Modern Management Science. 2006(12):109-111.

Engle, R. F., & Granger, C. W. J. Co-Integration and Error Correction: Representation, Estimation, and Testing [J]. Econometrica, 1987(55):251-276.

Feng Ke, LI Xinxin. An empirical study on the relationship between commodity futures price index and macroeconomic indicators in China[J]. Economics and Management,2014(1):51-55.

Feng Meili, Zhang Zhixin, Liu Xin. Research on the impact of international oil price fluctuation on the ex-factory price of industrial products in China[J]. Price Theory & Practice,2018(8):98-101.

Fernandez V. Linear and nonlinear causality between price indices and commodity prices[J]. Resources Policy, 2014(41):40-51.

Frankel J A, Rose A K. Deteminants of agricultural and mineral commodity prices[R]. HKS Faculty Research Working Paper Series,2010.

Frankel J A. The effect of monetary policy on real commodity prices[R]. National Bureau of Economic Reseach,2006.

Ge Y., Tang K. Commodity prices and GDP growth[J]. International Review of Financial Analysis,2020:101512.
Geweke J, Meese, R and Dent, W. Comparing alternative tests of causality in temporal systems: analytical and experimental evidence [J]. Journal of Econometrics,1983,21 ,161- 196.

Gómez-Loscos A, Gadea M D, Montañés A. Economic growth, inflation and oil shocks: are the 1970s coming back? [J]. Applied Economics, 2012, 44(35): 4575-4589.

URL: http://doi.org/10.14738/abr.1112.15618

Gospodinov N. The role commodity prices in forecasting US core inflation[R] Federal Reserve Bank of Atlanta, 2016.

Granger, C.W.J. Investigating causal relations by econometric models and cross-spectral methods [J]. Econometrica, 1969(37): 424–438.

H Berument H Ta. Inflationary effect of crude oil prices in Turkey, Physica A: Statistical Mechanics and its Applications[J]. Elsevier, 2002, 316(1):568-580. DOI：10.1016/s0378-4371(02)01025-7.

Hammudeh S., Khuong N D., Sousa A. Chinese monetary policy and commodity prices[J]. J. Int. Money Finace,2014(27):61-85.

Hess D., Huang H., Niessen A. How do commodity futures respond to macroeconomic news? [J]. Financial Markets and Portfolio Management,2008(22):127-146.

Hou Naikun, QI Zhongying. Research on the relationship between oil price fluctuation and economic growth dynamics based on oil price shock decomposition[J]. China Soft Science.2009(8): 132-143.DOI: 10.3969/j.issn.1002-9753.2009.08.016.

Hu Qiuling, DING Hao. Analysis of the relationship between China's agricultural futures price index and macroeconomic variable fluctuations[J]. Statistics and Decision.2009(24): 99-102.DOI: CNKI: SUN: TJJC.0.2009-24-037.

Hua Renhai. Research on the relationship between China commodity futures index and GDP index[J]. Financial Theory & Practice,2007(8):3-6.

I Korhonen AN Mehrotra. Real exchange rate, output and oil: Case of four large energy producers[R]. BOFIT Discussion Papers ,2009. DOI：10.2139/ssrn.1428238.

Ito.T. China as number one: how about Reminbi? [J]. Asian Economic Policy Review. 2010.5(2):249-276.

Kiani A. Impact of High Oil Prices on Pakistan’s Economic Growth[J]. International Journal of Business and Social Science, 2011,2(17):209-216.

Johansen, S. Statistical Analysis of Cointergration Vectors [J]. Journal of Economic Dynamics and Control1, 1988 (2): 231-254.

Johansen S and Juselius K: Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money [J]. Oxford Bulletin of Economic and Statistic, 1990(52):169 − 210.

Li Junwen. Research on the macroeconomic effects of international commodity price fluctuation[D]. Chengdu: Master's Thesis, Southwestern University of Finance and Economics,2019.6.

Li Yinan. Study on the impact effect of international oil price fluctuation on China's macroeconomy[D]. Jilin: Master's Thesis, Jilin University, 2022.5

Liang Xiaojuan. Predicting CPI change from futures price change[J]. Economic Management,2008(2):16-21.

Liu Ming, SONG Xiao. The impact of oil price fluctuations on China's macroeconomy: An analysis based on DSGE model[J]. Nankai Economic Research,2013(6):74-96.

Liu Tan. Discussion on the impact and countermeasures of commodity futures prices on China's macroeconomy[J], Financial Economics. 2014(1):116-118, DOI: 10.14057/j.cnki.cn43-1156/f.2014.16.214.

Moreira R R. Commodities prices volatility expected inflation and GDP levels: An application for net exporting economy[J]. Procedia Economics and Finance,2014(14):434-444.

Nusair, Salah A. The effects of oil price shocks on the economies of the Gulf co-operation council countries: Nonlinear analysis[J]. Energy Policy, 2016,91(1):256-267.

Tsvetanov D., Coakley J., Kellard N. Is news related to GDP growth a risk factor for commodity futures returns? Quantitative Finance, 2016(16):1887-1899.

Wei Y. The relationship between oil and nonoil commodity prices and Chinese PPI and CPI: an empirical analysis[J]. Energy Sources, Part B: Economics, Planning, and Policy, 2019(4):125-146.

Yu Jian, Cheng Dong, Zheng Wenping. Energy price uncertainty, fixed asset investment and China's economic fluctuation [J]. Economic Theory and Management, 2017(11):98-112.

Zhang Shuzhong, Li Tianzhong, Ding Tao. An empirical study on the relationship between agricultural futures price index and CPI[J]. Journal of Financial Research,2006(11):103-115.

Zhang Tian Ding, Shi Zhan. The impact of international commodity price fluctuations on China's macroeconomy[J]. Journal of Chang'an University: Social Science Edition,2021(3): 33-45.

Zheng Lufei, Wu Hui. An Empirical Study on the Relationship between Development and Economic Growth of China's Futures Market Based on VAR Model[J]. China Collective Economy,2016, (30):71~73.

Zhiqiang, Wang Xuebiao. China commodity futures price index and economic prosperity[J]. World Economy,2001(4):69-73.

Zhou Zhuohua, Song Wangjiang. An empirical study on the relationship between metal futures price index and PPI in China[J]. Statistics and Decision. 2011(1):80-82.

URL: http://doi.org/10.14738/abr.1112.15618