財金論文叢刊
2023 年 12 月，第 39 期，54-61

Linkage Relationship between Natural Rubber Futures Price, the Climate and Other Factors [1]

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Abstract

As an important strategic material in China, natural rubber is widely used in economic construction and national defense industry. Rubber futures is a financial derivative based on natural rubber. The price formed in the futures market has a certain reference value for the spot market. Therefore, the study of the price changes of rubber futures play a vital role in commodity prices and market situations.

Considering both economic and climatic factors, through the dynamic analysis of the expression analysis, impulse response function and variance decomposition, this paper comprehensively studies the fluctuation of influencing factors on the price of rubber futures and comprehensively analyzes the factor variables affecting the price of natural rubber futures in China and their equilibrium relationship. This paper conducted a regional two-level test on the natural factors in the main reclamation areas by the daily data of the same period in China and comprehensively explores the effect of various natural factors on the price of natural rubber futures.

Key words: Rubber Futures; Climate; Impulse Response Function; Variance Decomposition; Two-Level Test

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1.This paper was subsidized by Fund Project of Yunnan Provincial Funded of Education Research Fund Project "Key Technologies for Poverty Alleviation and Pricing Decision of Yunnan Province's Plateau Characteristic Agriculture Based on Big Data and Artificial Intelligence Perception Analysis" (NO:2021J0573).
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1.Introduction

Due to the limitation of China's geographical location, few areas are suitable for planting natural rubber, and the output is only limited to a small number of areas such as Hainan, Yunnan, and Guangxi. Although China is the world's largest importer and consumer of natural rubber, it lacks international pricing power and can only passively accept the risks brought by the price fluctuation of natural rubber. Therefore, the changes of the exchange rate and political factors will also affect the price of natural rubber, resulting in huge fluctuations. At the same time, the downstream enterprises of natural rubber are faced with great risks of price fluctuation of raw materials. This paper hopes that through the research on the linkage relationship between the price fluctuation of domestic natural rubber futures market and its influencing factors, it can provide some theoretical support for judging the future price trend of domestic natural rubber and scientific theoretical basis for the introduction of relevant national and local policies on natural rubber price and improving the risk control mechanism of natural rubber price fluctuations.

Trostle (2010) believes that the reasons for the price fluctuation of agricultural products are overly complex, which is often the result of the joint action of multiple reasons. In addition to the traditional factors affecting supply and demand, such as population structure, consumption preference and cost changes, it also includes emerging factors such as speculation and financialization. Timmer (2009) believes that with the rapid economic growth and the improvement of the per capita income in developing countries such as China and India, people's demand structure for food has changed. The increase in demand for animal protein leads to an increase in feed demand, which leads to an upward trend in the price of agricultural products. Amir and Seyed(2013）conducted a study using the VAR model. Results show that financial policies have long-term price effects on agricultural products and agricultural sectors. Bailliu, Kano and Schembri (2007) and Roache (2010) believed that the exchange rate change can explain the price fluctuation of agricultural products. Ciaian and Kancs (2011) used a time series to analyze the price of crude oil and agricultural products, and came to the conclusion that an increase of $1 per barrel in the price of crude oil would increase the price of agricultural products by about $1 per ton. Saban (2011) used linear and nonlinear equations to study the relationship between international crude oil prices and corn, wheat, and soybean prices. Results show that no linear relationship exists between the international crude oil price and the prices of the three agricultural products, but there is a continuous one-way nonlinear relationship. Gohin and Chantret (2010) believed that there is a significant and positive correlation between the prices of major international agricultural products and energy prices due to the cost driving effect. Baek and Koo (2010) made an analysis on the effect between crude oil and agricultural product prices. Results show that the short-term and long-term effect of international crude oil price on agricultural product price is overly different. Lobell, Sibley and Ivan Ortiz-Monasteri (2012) emphasized the effect of climate change on crops. It is reported that climate warming will lead to early maturity and yield reduction of crops, and the accumulation of crop quality will decline.

2. Affecting Factors

We selected the monthly average value of the main continuous contract (shtj) of natural rubber futures in Shanghai Futures Exchange as the research object. The reason for using monthly data instead of annual data is to improve the accuracy and reliability of the econometric analysis. At the same time, the influencing factors mentioned in the second chapter are selected as effect variables from three aspects: supply and demand factors, economic factors, and natural factors. (1) The producer price index (PPI) is selected to measure the effect of the domestic market on the supply of natural rubber; Select money supply (M2) to measure the change of

market supply and demand; Consumer price index (CPI) to measure the inflation rate; Select the output of rubber tire casing (products) to measure the output of products in downstream industries; (2) WTI crude oil price (WTI) is selected to measure the fluctuation of international crude oil price; The exchange rate (Ex) of RMB against the US dollar is selected to represent the exchange rate change (3), the average humidity (hum), average temperature (Temp) and sunshine hours of the main reclamation areas of Yunnan Province, Hainan Province, and Guangxi Province are selected to measure the natural influencing factors of natural rubber. All data intervals selected are from January 2011 to December 2022.

3. Econometric Model

After screening and dealing with the above influencing factors, this paper deals with the logarithmic return on investment of the futures price of the main continuous contracts of Shanghai natural rubber futures.

$$R_t = \ln\left({}^{P_t}/_{P_{t-1}}\right)$$

According to the AIC and SC criteria, the following var (2) model is constructed.

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \mu_t$$

$$Y_t = \left(\mathrm{r(shtj)}、\mathrm{r(ppi)}、\mathrm{r(m2)}、\mathrm{r(cpi)}、\mathrm{r(product)}、\mathrm{r(wti)}、\mathrm{r(ex)}、\mathrm{r(hum)}、\mathrm{r(temp)}、\mathrm{r(hours)}\right)^{T}$$

Where, C is 10 × Constant sequence vector of order 1, A is 10 × 10th order parameter matrix, μ_t is 10 × Order 1 random error column vector.

Figure 1 is the impulse response diagram obtained according to VAR, that is, the response of domestic natural rubber futures price after being affected by a standard deviation of other variables.

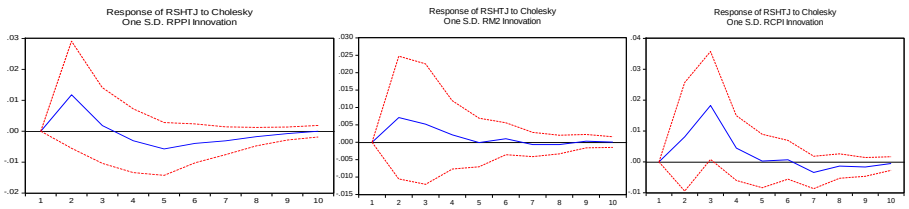

Figure 1-1

Figure 1-2

Figure 1-3

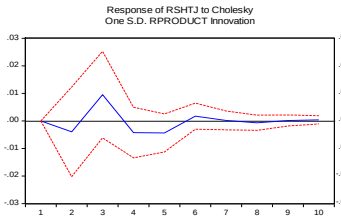

Figure 1-4

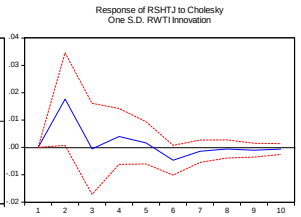

Figure 1-5

Figure 1-6

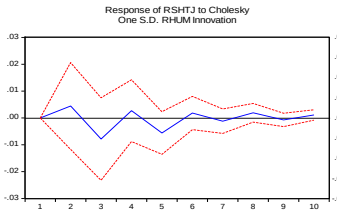

Figure 1-7

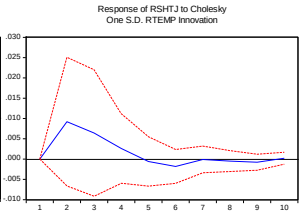

Figure 1-8

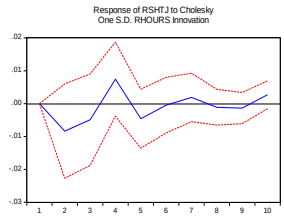

Figure 1-9

Figure 1 Response of natural rubber futures price to various factors

It can be seen from Figure 1-1 and 1-3 that the PPI is similar to CPI. The purchase of natural rubber in the short term will increase the price and tend to be stable in the long term.

Figure 1-2 shows that the increase of money supply meant the increase of market liquidity. With the passage of time, the effect caused by the rise of money supply gradually disappears.

As shown in Figure 1-4 above, the output of downstream industries has a positive feedback on the natural rubber futures price in the long run.

As shown in Figure 1-5, the international crude oil price is positively correlated with China's natural rubber futures price in the short term and tends to be negatively correlated in the long term.

It can be seen from Figure 1-6 that the effect of the exchange rate growth on rubber price has been negative for a long time, showing a fluctuating W-shape, while the effect of the RMB exchange rate on natural rubber price is more significant in the current period. After the short-term effect on the unit of the exchange rate, the natural rubber futures price has a greater response, and with the passage of time, the effect of the RMB exchange rate on natural rubber futures price is no longer as strong.

It can be seen from Figure 1-7 that natural rubber is partial toward humidity, in which the average humidity increases, the output of natural rubber increases and the price decreases.

It can be seen from Figure 1-8 that the natural rubber growth environment is at a high temperature and rainy weather. After the temperature rises for a period of time, the natural rubber output decreases and the price increases.

It can be seen from Figure 1-9 above that suitable sunshine is beneficial to the growth, rubber production, and stress resistance of rubber trees. With the increase of sunshine hours, the output of natural rubber increases and the price decreases.

Variance decomposition is used to explain the contribution rate of each factor to evaluate the contribution of each endogenous variable to the predicted variance in the effect of the impulse response to analyze the relative importance of each factor.

Table 1 Variance decomposition test results

Period	RSHTJ	RPPI	RM2	RCPI	RPRODUCT	RWTI	REX	RHUM	RTEMP	RHOURS
1	100.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	92.224	1.3723	0.4968	0.6524	0.1543	3.0787	0.2951	0.1956	0.8400	0.6899
3	87.270	1.3226	0.7198	3.7150	0.9909	2.9007	0.2782	0.7559	1.1739	0.8724
4	86.123	1.3929	0.7515	3.8487	1.1422	3.0089	0.3295	0.8131	1.2205	1.3694
5	85.254	1.6783	0.7438	3.8100	1.3025	3.0023	0.3607	1.0900	1.2111	1.5461
6	84.891	1.8098	0.7492	3.7937	1.3224	3.1853	0.3594	1.1145	1.2343	1.5396
7	84.636	1.8875	0.7494	3.8814	1.3164	3.1883	0.4256	1.1226	1.2285	1.5637
8	84.548	1.9120	0.7520	3.8913	1.3182	3.1857	0.4381	1.1534	1.2286	1.5722
9	84.492	1.9153	0.7520	3.9119	1.3170	3.1920	0.4418	1.1572	1.2327	1.5871
10	84.420	1.9136	0.7514	3.9110	1.3172	3.1925	0.4421	1.1672	1.2328	1.6520

From Table 1, among the six economic factors, the contribution of WTI is the largest in phase 1, accounting for 3.078755%, followed by PPI, accounting for 1.372399%. After phase 10, the contribution of CPI exceeds that of WTI, accounting for 3.911041%, followed by WTI and PPI, accounting for 3.192574% and 1.913681%, respectively, thus exceeding that of other economic factors.

The contribution of the influencing factors of Shanghai rubber futures price is greater in the later stage. Overall, CPI and WTI have the most prominent and obvious contribution, followed by PPI and the product, and natural factors. The contribution of the exchange rate and money supply is far less than other factors.

Results show that the effect of natural factors on the price of natural rubber futures is

insignificant, which is unreasonable in the impulse response. Therefore, using the daily data and two-level test by the main producing areas, we studied whether natural factors have a significant effect on the price of natural rubber futures. The steps are similar to the above test.

The daily data of the main continuous contracts (shtj) of natural rubber futures in the Shanghai Futures Exchange are selected as the research object, and the average humidity (hum), average temperature (Temp), and sunshine hours in Yunnan Province, Hainan Province, and Guangxi Province are selected to measure the natural influencing factors of natural rubber. The main reclamation areas in Yunnan Province include Baoshan, Lancang, Lincang, Mengla, and Simao; The main reclamation areas in Hainan province include Danzhou, Qionghai, and Qiongzhong; The main reclamation areas in Guangxi province include Baise and Qinzhou. All data intervals selected are from January 2008 to December 2019.

3.1 Impulse response function

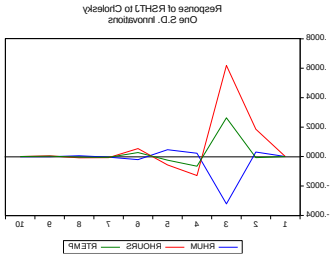

Figure 2-1 Response of Yunnan

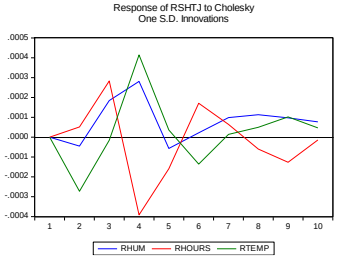

Figure 2-2 Response of Hainan

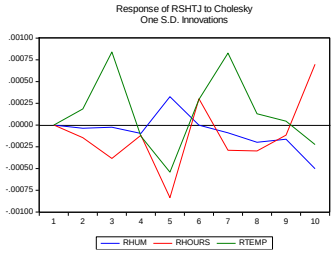

Figure 2-3 Response of Guangxi

Figure 2 Response of natural rubber futures price to natural factors in Yunnan Province, Hainan Province and Guangxi Province

Figure 2-1 shows that when a positive effect is given to natural factors in Yunnan, the impact effects are different. However, they all reached the peak in phase 2, then gradually recovered, and the effect tends to disappear after phase 7. That is, humidity has a negative feedback on natural rubber futures price for a long time, and temperature and sunshine hours have a positive feedback on it.

Figure 2-2 shows that when a positive effect is given to natural factors in Hainan, the response degree of the effect varies. Humidity and sunshine hours have a positive feedback on the price of natural rubber futures, and temperature and have negative feedback on it. It tends to be stable after ten periods of lag.

Figure 2-3 shows that when a positive effect is given to natural factors in Guangxi, the effects are different. Sunshine hours and humidity have an obvious reverse pulling effect on futures prices.

3.2 Variance decomposition

Table 2 shows that the forecast variance of Shanghai rubber futures price caused by the futures price decreases evenly from 100% to 99.80368% in the 10-period forecast. In the initial stage, the natural rubber futures price made a great contribution to itself, but the contribution decreases gradually with the passage of time. For natural attributes, the part caused by hum increased from 0% to 0.033846% in the phase 10 forecast, the part caused by temp increased from 0% to 0.023599% in the phase 10 forecast, and the part caused by hours increased from 0% to 0.138875% in the phase 10 forecast.

Overall, among the three natural factors, the contribution of hours in Yunnan Province is the most prominent.

Table 2 Variance decomposition results of natural factors in Yunnan Province

Period	RSHTJ	RHUM	RHOURS	RTEMP
1	100.0000	0.000000	0.000000	0.000000
2	99.98879	0.000301	0.010886	1.94E-05
3	99.81370	0.032852	0.131640	0.021807
4	99.80694	0.033008	0.136890	0.023165
5	99.80504	0.033690	0.137911	0.023354
6	99.80376	0.033831	0.138828	0.023584
7	99.80373	0.033835	0.138845	0.023592
8	99.80369	0.033845	0.138868	0.023597
9	99.80368	0.033845	0.138875	0.023599
10	99.80368	0.033846	0.138875	0.023599

Table 3 shows that the forecast variance of Shanghai rubber futures price caused by the futures price decreases evenly from 100% to 99.84076% in the 10-period forecast. In the initial stage, the natural rubber futures price made a great contribution to itself, but the contribution decreases gradually with the passage of time. For natural attributes, the part caused by hum increased from 0% to 0.045093% in the phase 10 forecast, the part caused by temp increased from 0% to 0.066594% in the phase 10 forecast, and the part caused by hours increased from 0% to 0.047554% in the phase 10 forecast.

Overall, the contribution of three natural factors in Hainan Province is the same.

Table 3 Variance decomposition results of natural factors in Hainan Province

Period	RSHTJ	RHUM	RHOURS	RTEMP
1	100.0000	0.000000	0.000000	0.000000
2	99.91588	0.028982	0.001175	0.053967
3	99.87006	0.040710	0.032195	0.057032
4	99.84464	0.044571	0.044754	0.066039
5	99.84391	0.045074	0.044777	0.066243
6	99.84171	0.045074	0.046697	0.066521
7	99.84083	0.045084	0.047497	0.066593
8	99.84081	0.045089	0.047503	0.066594
9	99.84077	0.045092	0.047542	0.066594
10	99.84076	0.045093	0.047554	0.066594

Table 4 shows that the forecast variance of Shanghai rubber futures price caused by the futures price decreases evenly from 100% to 98.39572% in the 10-period forecast. In the initial stage, the natural rubber futures price made a great contribution to itself, but the contribution decreases gradually with the passage of time. For natural attributes, the part caused by hum increased from 0% to 0.252468% in the phase 10 forecast, the part caused by temp increased from 0% to 0.621779% in the phase 10 forecast, and the part caused by hours increased from 0% to 0.730032% in the phase 10 forecast.

Among the three natural factors, the contribution of average temperature in Guangxi Province is the most obvious.

Through the aforementioned analysis, we can draw the following conclusions:

First, from the influence degree of various factors, the PPI has the greatest and most sensitive effect on the domestic natural rubber futures price, followed by CPI and WTI, money supply, and exchange rate, while the influence degree of natural factors is the smallest and the slowest;

Second, from the influence period of various factors, the influence of economic factors on the spot price of domestic natural rubber is concentrated in the short term (10 periods), but not in the medium and long term (after 10 periods), while the influence period of natural factors is insignificant;

Third, from the perspective of the financialization level, the CPI and WTI have a high contribution to the change in domestic natural rubber price, while the contribution of the exchange rate and money supply is low;

Fourth: from the influence degree of natural factors in the main production areas, no difference exists in the sensitivity of domestic natural rubber futures price to the natural factors in various regions, but regional differences will affect the contribution of natural factors to the natural rubber futures price.

Table 4 variance decomposition results of natural factors in Guangxi Province

Period	RSHTJ	RHUM	RHOURS	RTEMP
1	100.0000	0.000000	0.000000	0.000000
2	99.99110	0.007321	7.71E-05	0.001504
3	99.91914	0.019428	0.038667	0.022764
4	99.74935	0.048820	0.089992	0.111833
5	99.33126	0.048560	0.093506	0.526675
6	99.15237	0.061456	0.260393	0.525783
7	99.11240	0.079471	0.261944	0.546187
8	99.00306	0.131839	0.287870	0.577232
9	98.87370	0.167776	0.346089	0.612439
10	98.39572	0.252468	0.730032	0.621779

4. Conclusion

After understanding and analyzing the specific linkage relationship between the economic and noneconomic factors on the natural rubber futures price, it is helpful for the state to compete for the pricing power of natural rubber. At the same time, it can also help relevant enterprises and practitioners in maximizing profits and minimizing losses and making more reasonable decisions. In view of the conclusions, some suggestions are proposed from the following aspects:

(1) Strengthen the professional training of rubber farmers

At this stage, rubber farmers do not know enough about the characteristics of rubber varieties and the climatic conditions in the region, thus preventing them from obtaining greater economic benefits. Therefore, rubber farmers should independently strengthen their professional knowledge and consider the correlation between extreme climate factors and rubber prices; Relevant departments should also correctly guide rubber farmers to apply key science and technology, reduce production costs, and enhance industrial market competitiveness.

(2) Multilateral cooperation among countries

Based on the one belt, one road strategy, China’s ASEAN natural rubber transnational space industry chain is constructed. China should develop core leading enterprises, realize spatial division of labor based on the comparative advantages of transnational regions, and jointly promote the optimization and upgrade of industrial chains to realize the "going out" strategy of China's natural rubber and guarantee the long-term development of natural rubber enterprises. It is also conducive to China's fight for the voice of natural rubber pricing.

(3) Strengthen price and market monitoring

The international natural rubber futures market is still in the leading position in determining the price of natural rubber, and the stability of the domestic natural rubber

futures market depends on the stability of the international natural rubber futures market. Therefore, conducting a real-time observation of the price of the international natural rubber futures market, establishing a monthly and quarterly price statistics system and price reporting system, collecting feedback on the price change and market fluctuation information of the international natural rubber futures market, issuing the price fluctuation risk assessment report of the domestic natural rubber futures market periodically, and establishing an early warning mechanism to guide the domestic natural rubber production and trade is recommended to reduce the market risk damage and protect the interests of rubber farmers and natural rubber enterprises.

(4) Improve the international status of the industry

To improve the voice in the field of natural rubber in China, we must start from two aspects: First, accelerating the process of RMB internationalization. Second, starting from Shanghai Rubber Futures itself, it will become a wind vane guiding the world natural rubber price.

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