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Analysis of the Dynamic Relationship of the Futures Prices of Rubber in Shanghai and Tokyo

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Abstract

The current natural rubber futures market is mainly selling in Shanghai Futures Exchange (SHFE) and Tokyo Commodity Exchange (TOCOM). TOCOM dominated rubber prices in the past decades. However, the trading volume of SHFE's rubber futures exceeded that of TOCOM after nearly 10 years of market development. The correlation between rubber futures price in SHFE and TOCOM were analyzed to examine their competitiveness against global rubber futures market. A number of guidelines were offered to investors according to price correlation.

Many scholars use the Grainger causality to test price correlations in futures markets. We collected the daily continuous rubber futures prices in SHFE and TOCOM from 2012 to 2016 based on previous studies. The Grainger causality test provides the following results: TOCOM is the Grainger causality ofSHFE is received, and SHFE is the Grainger causality of TOCOM is refused. Thus, a one-way causal relationship exists between the two rubber futures markets. This analysis indicates that the rubber prices of SHFE can lead that of TOCOM, which means that SHFE's rubber futures market will become more competitive in the global rubber futures market. The following suggestions should be considered to further improve the natural rubber futures market of SHFE: China should strengthen supervision of the futures market; the Futures Law should be improved and passed as soon as possible; investors should pay more attention to the trends of rubber prices in SHFE and strengthen analysis of the fundamentals of the rubber industry in China.

Keywords: Natural Rubber Futures; Price Correlation; Grainger Causality Test

1. Introduction

1.1 Brief introduction of natural rubber

Natural rubber is widely used in tires, medical supplies, and large-scale industries. Natural rubber is extremely tough and can maintain its original state with mechanical stretching. Natural rubber can resist corrosion, has excellent mechanical properties and high temperature and pressure pit. Natural rubber is better than industrial raw materials and synthetic rubber products.

1.1.1 Supply situation of China's natural rubber market

China introduced rubber trees in 1904. Hainan, Yunnan, and Guangdong provinces (as shown in Table 1) are the main production areas of natural rubber in China. Natural rubber production fluctuated slightly in recent years, but production remained at 800 thousand tons.

Table 1 China's domestic rubber production in 2008–2012 Unit: %

PROVINCE	2008	2009	2010	2011
HaiNan	50.64	49.62	50.14	49.51
YunNan	46.94	48.22	47.86	48.4
GuangDong	2.36	2.1	1.94	2.06
GuangXi	0.06	0.06	0.05	0.03

Data source: China Statistical Yearbook

1.1.2 Demand situation of China's natural rubber market

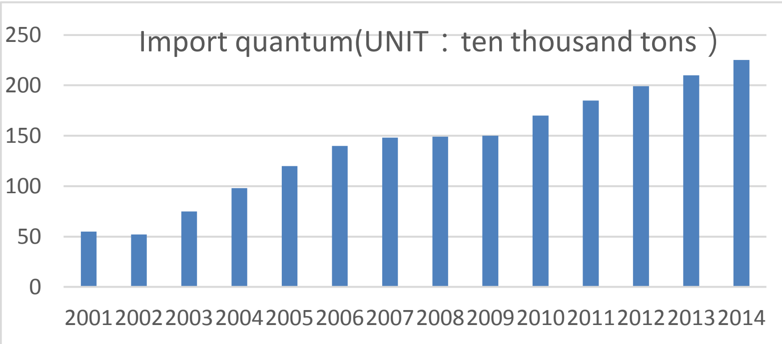

Figure1.Import quantity of natural rubber in China
Data source: China customs database

The import quantity of natural rubber in China steadily increased from 2001 to 2014. Thus, we can speculate that the demand for natural rubber in our country will increase with the development of the economy. This development will increase the ratio of import dependence to the risk of the natural rubber market.

1.2 Purpose and significance of the study

This study uses the Grainger causality test to analyze price correlations between the rubber futures markets of Shanghai Futures Exchange (SHFE) and Tokyo Commodity Exchange Market (TOCOM). The resultmeans that SHFE's rubber prices lead that of TOCOM.

This study suggests that China should seize the favorable situation of the rubber futures market of Shanghai and improve the competitiveness and pricing power of the rubber market against the international natural rubber market. Rubber futures investors should pay attention to SHFE.

This study is divided into four chapters. The first chapter is the introduction, which presents the research background. The second chapter contains the theoretical basis and literature review. This chapter introduces the theory of the effectiveness, volatility, and price discovery function of the futures market. The third chapter discusses the Grainger causality test. The fourth chapter presents the empirical analysis of the collected data using the Grainger causality test. The fifth chapter summarizes the research conclusion and presents policy suggestions based on the research results.

2. Research of Status

Numerous finance papers have provided profound analyses and basic theories of interrelation between different markets. Eun and Shim (1989) proved that the US stock market is the main source of international transmission and that its variation affects the foreign stock market; however, the variation of the foreign stock market does not explain the reasons for the variation in the US stock market. Theodossiou and Lee (1993) pointed out that the US stock market has a positive transmission to the stock markets of the United Kingdom (UK), Germany, and Canada, and a significant transmission to the stock markets of the UK, Germany, Canada, and Japan. Kearney (2000) also argued that the variation of most stock markets in the world is derived from the variation of the stock market in the US and Japan, then transferred to Europe. Masih (2001) discovered that, whether long or short term, the stock markets of the US, UK, and Japan are the leaders in the world because they account for 75% of the capital in the global market.

With respect to volatility in the futures market, Scholes (1981) pointed out that the differences between spread trade and hedge trade depend on investor demand in the spot market. He also stated that spread traders have speculative demand, indicating that they trade for short-term profits, and the hedge traders buy or sell futures to avoid risks. In addition, Scholes also noted that traditional spread trading has been applied to different products to decrease risk and to increase liquidity in the market simultaneously. Peterson (1997) analyzed the advantages of spread trade, which include providing the arbitrage to test the efficiency of pricing in the futures market and setting up the risk transfer to spread risk by increasing the scope of investment. Therefore, speculative traders entering the futures market can increase the liquidity between products and benefit from pricevolatility. Bernstein (2007) proved that increasing the complexity of spread trade can increase the investment benefit. When the portfolio becomes complex, the investor cannot have real-time information to calculate the price change. Therefore, information asymmetry from the volatility might increase the benefit from the market. If futures price shocks exist, the pricing will deviate because of different expectations. Butterworth et al. (2002) studied the spread trade using the cost of carry model; the variables of their study were the Financial Times Stock Exchange (FTSE) 100 index and the FTSE Mid 250 index. Their study assumed that those two markets comprise more than 90% of the UK stock market, which receives all kinds of information from the market. Their result showed that if the transaction costs are not considered, the benefit can be obtained by spread trade. However, if the fees and Bid-Ask Spread are taken into account, traders will not enter the market because the benefit cannot cover the fee of every deal. Dunis et al. (2006) also studied the spread trade from the West Texas Intermediate (WTI) and Brent blend (a benchmark crude oil from the North Sea), and used the time-series model to estimate the correlations among products. Daigler (2007) discussed the relationships among the cross spread, calendar spread, and trade volume of exchange futures from four kinds of traders in the Chicago Mercantile Exchange (CME), which are individual traders, corporate traders, dealers and hedge traders.

3. Empirical Analysis

3.1 Data and variables

We downloaded the 2012 to 2016 continuous closing prices of rubber futures from the websites of SHFE and TOCOM. We converted the prices in dollars and obtained 544 sets of data by considering the impact of exchange rate based on the corresponding daily exchange rate of US dollar to RMB and US dollar to Japanese yen. For convenience, Shang represents the rubber future closing price of SHFE, Ri represents that of the TOCOM, and LN represents the logarithm of the variable.

3.2 Test of stability

The stationarity of variables in time series should be tested before conducting co-integration and Grainger causality tests. Only when the variables are in the same order can the possibility of co-integration between variables be considered. According to the above theory, we used the ADF method to test whether the variables lnShang and lnRi are stable and check whether the first order between dlnShang and dlnRi is stationary.

The processing with Eviews is presented in Table 2.

Table 2

Variable	ADF statistics	Probability	1% Significant level	5% Significant level	10% Significant level
lnShang	–1.9529	0.308	–3.4421	–2.8666	–2.5695
lnRi	–2.5637	0.103	–3.4421	–2.8666	–2.5695
dlnShang	–24.3333	0	–3.4421	–2.8666	–2.5695
dlnRi	–22.6361	0	–3.4421	–2.8666	–2.5695

ADF statistics calculated by lnShang and lnRi are –1.9529 and –2.5637, respectively, whereas the critical value at the 10% significant level is –2.8666. The ADF statistics of lnShang and lnRi are larger than the critical values of 10%. Therefore, the two time series variables lnShang and lnRi are both unstable.

The next step is to adjust the instability sequence and establish the regression equation for variables lnShang and lnRi.

$$lnShang_t = a + blnRi_t + \varepsilon_t$$

ε_t is a residual sequence

Dealing with the above equation with the ADF test, lnShang and lnRi are transformed into stationary variables. Based on Table 4.1, we obtain the ADF statistics of the first order difference of the two variables, –24.3333 and –22.6361, which are all less than the 1% critical values, and reject the null hypothesis. The first-order difference between the two variables shows stability, therefore, satisfy the first-order single integral. Only if the variables are identical can the possibility of a co-integration relationship between the variables be considered. Therefore, the two variables may be co-integrated. The next step is to test the co-integration of the variables.

3.3 Co-integration test

The co-integration relationship test is used to determine whether a long-term equilibrium relationship exists between the prices of Shang and Ri. This test mainly aims to judge the stability of the residual sequence through the ADF test. If the residual sequence is proven stable after testing, a long-term equilibrium relationship exists between Shang and Ri.

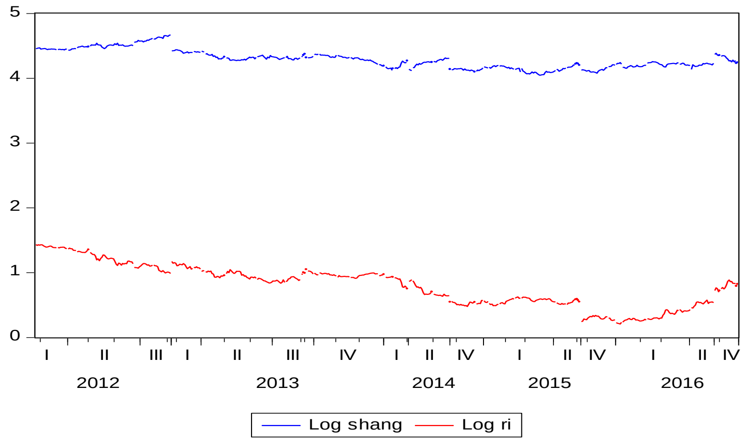

Figure 2 Time series between Shang and Ri

Figure 2 shows that the time sequence diagram and the trend of the two variables are similar and a co-integration relationship may exist between them. However, chart observation alone cannot determine whether a co-integration relationship exists. Statistical calculation is necessary to determine the existence of such a relationship. The co-integration relationship between the variables can be tested by the EG method given only two variables. The following model can be obtained by using the least square method for the variable using Eviews.

$$\ln Shang = 4.01903 + 0.33957 \cdot \ln Ri$$
$$T = (399.1411)\ (29.1704)$$
$$R\text{-squared} = 0.6113$$
$$\text{Adjusted } R\text{-squared} = 0.6106$$
$$\text{Durbin-Watson stat} = 1.976656$$

The same ADF test should be performed for ε. According to the above model, the following residual sequence model formula can be obtained:

$$\varepsilon = \ln Shang - 4.01903 - 0.33957 \cdot \ln Ri$$

The residual sequence is also used to test stability using Eviews software. The following table is established after the ADF test.

Table 3

Variable	ADF statistics	Probability	1% Significant level	5% Significant level	10% Significant level
Residual sequence	–3.242422	0.0182	–3.442186	–2.866653	–2.569554

The regression results and residuals stationarity test show that the ADF statistics of residual sequence is –3.242422, which is less than the 5% significant level (value is –2.866653) and the 10% significant level (–2.569554) and greater than the 1% critical level value of –3.442186. We reject the null hypothesis on the basis of the above theory and we conclude that a co-integration relationship exists between lnShang and lnRi, which proves that a long-term co-integration relationship exists between Shang and Ri.

A co-integration relationship exists in time sequence. According to the formula of the residual sequence model, the Ri coefficient is –0.33957, which means that the Ri price changes on the 1%. Shang will change the –0.33957% value and the amplitude of the Shang price change is less than that of the Ri.

The error correction model is presented in this study on the basis of long-term co-integration to reveal the short-term correction relationship between the two variables.

3.4 Error correction model

According to the above analysis, the first-order differences between the dlnShang and dlnRi and the residual sequence epsilon of the time series variables lnShang and lnRi are proven stationary. Therefore, the error correction model is constructed using the least square method of Eviews software.

$$\text{DlnShang} = -0.026173 \cdot \text{ECMt} - 1 - 0.091801 \cdot \text{dlnRi}$$

$$T = \quad (-2.50) \qquad (-2.64)$$

$$R\text{-squared} = 0.025995$$

$$\text{Adjusted } R\text{-squared} = 0.024191$$

$$\text{Durbin-Watson stat} = 2.044418$$

According to the analysis of the above regression model, the error correction coefficient is –0.091801 and the error correction model has a reverse correction mechanism. In the regression of dlnRi, the regression coefficient of –2.64 is statistically significant, which means that the current period of rubber price changes on the East and the effect of glue price changes significantly when short-term price deviation occurs.

3.5 Granger causality test

The tests of stationarity and co-integration relationship show that the lnShang and lnRi time series are unstable, but the difference of dlnShang and dlnRi is stable. The co-integration test shows that the two variables have a long-term equilibrium relationship and the long-term equilibrium relationship can form Grainger relations. Given that the difference in the number of lag periods will affect the detection, the Grainger causality test of the delayed three phase is listed here.

Table 4

	Null hypothesis	F-value	Probability
Lag one period	LRI does not Granger Cause LSHANG	3.78801	0.0521
	LSHANG does not Granger Cause LRI	4.77547	0.0293
Lag two periods	LRI does not Granger Cause LSHANG	1.6734	0.1886
	LSHANG does not Granger Cause LRI	3.03418	0.0489
Lag three periods	LRI does not Granger Cause LSHANG	1.15702	0.3256
	LSHANG does not Granger Cause LRI	2.64911	0.0482

The figures above were calculated using Eviews. In the above table, probability is the probability of F statistics, which means that the probability of making the first kind of error is rejected. The original hypothesis should be rejected if the probability of error is small. The calculated results at the 5% significance levelis 0.0521 more than 5%. Thus, the null hypothesis is accepted. In the probability of lag one periods（LSHANG does not Granger Cause LRI）is 0.0293 less than 5%. Thus, the null hypothesis is rejected. Therefore, the rubber price of TOCOM is not the Grainger reason for the SHFE, but the SHFE is the Grainger reason for the TOCOM at the 95% confidence level. The same result holds true for the two and three lag periods. Therefore, a one-way causal relationship exists betweenthe variables. This finding indicates that the rubber price of the SHFE has a strong influence on the rubber price of the TOCOM.

4. Research Conclusions and Suggestions

4.1 Research conclusions

In this study, we first test the stationarity of data and find that the original data is unstable. After the first-order difference of data, we find that the data satisfy the first-order and single integer, which means that a co-integration relation may exist between the data.

The EG co-integration test shows that a long-term co-integration relationship exists between Shang and Ri from the results of regression and the test of residual stability. The error correction model is proposed based on this result to reveal the short-term correction relationship between the two variables. This finding means that when the short-term price deviates, the change in Shang has a significant impact on Ri. The Grainger test shows a one-way causality between the two variables, that is, Shang is the reason for Ri, while Ri is not the reason for Shang. This finding indicates that the rubber price of the SHEF has a strong influence on the rubber price of TOCOM.

4.2 Suggestions

4.2.1 Suggestions for improving and developing the SHEF

Laws and regulations should be improved. The development of the international influence of China's rubber futures market calls for improvements in the futures law for China's rubber futures market. Existing laws and regulations in the domestic market can no longer meet market development given the development of the futures industry, especially the accelerated pace of internationalization of the futures market. Thus, a law should be implemented as soon as possible. For the CSRC, the purpose of relevant regulations is to supervise the market, but not to consider the development of the market. This finding limits the development of the futures market.

Current market speculation is overweight and the short squeeze phenomenon appears on the market, which is not conducive to China's market development. Therefore, the introduction of market makers into the natural rubber futures market provides a reasonable price after studying the transaction contract. Although Chinese rubber futures trading is increasing gradually in international quantity and influence, we do not have the power to fully grasp the global natural rubber and rubber prices. Therefore, a market maker system should be introduced to enhance the flexibility of the futures market and establish standards to reduce the impact of international speculators.

4.2.2 Advice to investors

Investors in rubber futures should pay increased attention to the price trend of rubber futures of SHFE. At present, the increment of global natural rubber trade is mainly found in emerging market countries. The volume of rubber consumption and imports in China occupy most of the market. China will become a source of global rubber demand and the price fluctuations and rubber pricing power will gradually shift to Shanghai. In China, the price of the rubber is mainly influenced by supply and demand factors. From the supply side, the production of natural rubber in China is limited and the main production area is Southeast Asia. Therefore, when studying the supply side, we should mainly analyze the rubber output of rubber producing countries, such as the Southeast Asian countries, whose output is mainly influenced by domestic policies, weather, and other factors. For the demand, investors should pay attention to the global tire manufacturing industry because rubber is mainly used in tire manufacturing. In 2015, the U.S. magazine “Tire Business” declared that China has 34 enterprises in the top 75 list of global tire enterprises and the country’s sales accounted for 20% of global sales, whereas that of global tire industry giants, namely, Bridgestone, Michelin, and Goodyear, account for approximately 38% globally. Therefore, the three giant tire manufacturing enterprises and China’s tire industry directly affect the global rubber demand. Investors should strengthen the analysis of the rubber supply and demand and grasp the trend of the entire rubber industry better and make correct investment decisions.

According to the long-term co-integration relationship and the residual sequence model, the fluctuation of the rubber future price of SHEF is smaller than that of TOCOM. In terms of hedging, choosing the smaller futures price exchanges can control the market risk caused by the sharp fluctuation of prices. China’s rubber futures will improve in terms of price discovery function and flexibility of products delivery. The active futures market is beneficial for hedging and speculators to reduce the risk of market liquidity given the increasing influence of rubber futures in the international market and the expansion of trading scale and trading volume.

4.3 Summary

This study introduces the rubber futures market from the Grainger causality perspective. A comprehensive analysis of China’s rubber futures market suggests the need to consider additional factors. The rubber industry looks insignificant, but factors can affect the development of the entire country, such as the use of rubber substitutes, recycling of abandoned rubber, and refining of petroleum processing. If we are indifferent to China’s rubber industry, the rubber futures market and spot market cannot improve, which will affect overall economy. Similarly, if the country’s rubber futures market is insufficient in management and market efficiency, the price discovery function cannot play its role effectively and will degrade China’s futures market or will even be restrained by others. If the competitiveness of China’s rubber futures improves, we can guide other futures markets and derive arbitrage profits from investments. This approach can attract additional investors to the China rubber futures market and making China’s rubber futures market more effective and competitive.

References

[1] Bernstein, P.L. (2007), “Capital ideas evolving”. Wiley, 2nd edition.

[2] Butterworth, D. and Holmes, P. (2002).”Inter-market spread trading: Evidence from UK index futures markets.” Applied Financial Economics, Vol. 12, pp.783-790.

[3] Daigler,R.T. (2007), “Spread volume for currency futures” Journal of Economics and Finance, Vol. 31, pp.207.

[4] Dunis, C.L., Laws, J. and Evans, B. (2006). “Trading futures spreads: An application of correlation and treshould filters.” Applied Financial Economics, Vol.16, pp. 903-914.

[5]Eun, C. S. and S. Shim, (1989). International Transmission of Stock Market Movements. Journal of Financial and Quantitative Analysis, 24, 241-257.

[6] Kearney, C., (2000), The determination and international transmission of stock market volatility. Global Finance Journal, 11(1-2), 31-66.

[7]Masih, R. and A.M.M. Masih, (2001), Long and short term dynamic causal transmission amongst international stock markets. Journal of International Money and Finance, 20, 563-587.

[8] Peterson, R. (1997), "Investor preference for futures straddle." Journal of Fincial and Quantitative Analysis, Vol.12, pp. 105-120.

[9] Scholes, M. S. (1981), "The economics of hedging and spreading in futures market." Journal of Futures Markets, Vol.1,pp. 1265-1286.

[10] Theodossiou, P. and U. Lee, (1993), Mean and Volatility Spillovers across Major National Stock Market: Further Empirical Evidence.Journal of Finance Research, 16, 337-350.