An empirical study on the relationship between canola oil futures and spot yields in China

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Abstract. This paper selects canola oil futures log returns and spot log returns from 2016 to March 2022 in China, and empirically analyzes the relationship between the two based on VAR model, Grand causality test, impulse response, and variance decomposition. The results show that: there is a regression relationship between Chinese rapeseed oil futures returns and spot returns, and they influence each other; the impact of rapeseed oil spot returns on futures returns is weak, and rapeseed oil futures returns have a stronger leading effect on spot returns; the impact between both rapeseed oil futures returns and spot returns is short-term, and the duration is not too long.

Keywords: Canola Oil; Futures Yield; Spot Yield; VAR Model; Empirical Analysis.

1. Introduction

As a large agricultural country, China's stable growth of its national economy in recent years cannot be achieved without the support of agriculture. The market especially future market is playing an increasingly important role in determining the prices of agricultural products. Canola oil is one of the three main oil varieties in China, and its price affects the stable supply of China's canola oil market. Therefore, clarifying the relationship between Chinese rapeseed oil futures and spot plays a positive role in guiding the future development of China's rapeseed oil market, and even the development of Chinese agriculture.

Foreign scholars have conducted a lot of research on the relationship between future and spot market. Kuiper concluded that there is a strong linkage between futures and spot markets by the VECM model. Silvapulle use the crude oil market to conclude that futures prices lead spot prices. Pradhan also finds the long-run equilibrium relationship between spot and futures prices in the Indian commodity market using the RDL boundary test technique.

Chinese scholars have also conducted a lot of research on the Chinese futures market. Hua Renhai took copper, aluminum and rubber, as examples, and concluded that there is a long-run equilibrium relationship between futures and spot prices through cointegration tests. Pang Zhenyan et al. selected the futures and spot price data of eight agricultural commodities, and concluded that the volatility of the agricultural futures market can affect the volatility of the spot price by VECM-BEKK-GARCH model. Liu Xiaotong et al. found the phenomenon that China's corn futures market has a stronger guiding effect on the futures price trend. Support and Wanying Ren selected apples as the research object and used the VAR model to find that there is a long-term equilibrium relationship between apple futures and spot prices. He, Yumei et al. concluded that there is a long-run equilibrium relationship between canola oil futures prices and spot prices by using a binary BEKK - GARCH model.

Based on the research theories of domestic and foreign scholars, this paper will conduct a more comprehensive study and demonstration of the relationship between the relationship between canola oil futures yields and spot yields.

2. Theoretical Foundations

2.1 Economic Basis

There is a certain time difference between futures and spot, which results in the phenomenon that futures prices and spot prices affect each other. And futures prices can be used as a reference price for commodities in the spot market. In addition, a smooth transmission mechanism between futures and spot prices can also reflect the effectiveness of the market.

2.2 Theory underlying the empirical study

To examine the relationship between canola oil futures yields and spot yields from an empirical perspective, this paper mainly adopts a financial time series analysis method based on VAR model, and performs the smoothness test, Granger causality test, impulse response and variance decomposition.

2.2.1 Smoothing test

Stability is the basis of financial time series analysis, and the test of unit root of time series is the test of time series stability. In this paper, the ADF test is used to examine the smoothness of the variables.

2.2.2 VAR model

This model is suitable for predicting interconnected time series systems and for analyzing the dynamic effects of stochastic perturbations on a system of variables. It circumvents the need for a structured model by constructing the model by treating each endogenous variable in the system as a function of the lagged values of all endogenous variables in the system.

$$x_t = \phi_0 + \phi_1 x_{t-1} + \phi_2 x_{t-2} + \cdots + \phi_p x_{t-p} + \varepsilon_t$$
$$\phi_p \neq 0$$
$$E(\varepsilon_t) = 0, \mathrm{Var}(\varepsilon_t) = \sigma_\varepsilon^2, E(\varepsilon_s \varepsilon_t) = 0, s \neq t$$
$$E x_s \varepsilon_t = 0, \forall s < t$$

2.2.3 Granger causality test

Under the condition that past information is included, Granger causality test can effectively conclude whether two variables can influence each other and whether there is Granger causality.

2.2.4 Impulse response and variance decomposition

Through impulse response, it is possible to find the dynamic shock to each part of the system when a variable is changed. The variance decomposition allows one to understand the degree of contribution of each structural shock to the change in the variable.

3. Discussion

3.1 Data selection

In this paper, we select the daily frequency data of futures price and spot price of Chinese rapeseed oil market from 2016 to 2022. In order to make the data smoother and reduce the heteroskedasticity of the data, we log the futures price and spot price $f_t(m_t) = \ln(p_t/p_{t-1})$, which is converted into the log return of rapeseed oil futures (f_t) and the log return of spot (m_t) for empirical analysis.

3.2 Stability test

To avoid non-stationarity of the variables, which may generate pseudo-regression results for the subsequent model building, we first conduct ADF stationarity tests on the log returns of rapeseed oil futures and spot log returns of rapeseed oil. The results of the ADF test show (Table 1) that both the log return on canola oil futures and the log return on canola oil spot can reject the original hypothesis of a unit root at the 1% confidence level, i.e., they are both smooth series, and thus the next step of VAR model building can be carried out.

Table 1 Results of ADF test for log returns of rapeseed oil futures and spot

Variables	1% critical value	T-statistic	P-value	Test result
Canola Oil Futures Log Yield	-3.438	-3.436319	0.0000	Stable
Canola Oil Spot Log Yield	-3.438	-3.436354	0.0000	Stable

3.3 VAR modeling

Before determining the optimal VAR model, it is necessary to determine the optimal order of the model. According to the EViews software analysis (Table 2), the LR criterion, the FPE criterion and the AIC criterion all choose 5 as the optimal lag order, so the final model is VAR (5).

Table 2. Optimal lag order results

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.10e-08	-12.64761	-12.63798	-12.64395
1	71.77482	1.04e-08	-12.71009	-12.68120	-12.69912
2	30.35453	1.01e-08	-12.73207	-12.68391*	-12.71379
3	15.63237	1.01e-08	-12.73963	-12.67221	12.71403*
4	6.613534	1.01e-08	-12.73833	-12.65165	-12.70542
5	12.85725*	1.00e-08*	-12.74321*	-12.63726	-12.70299
6	4.531350	1.01e-08	-12.73988	-12.61467	-12.69235
7	6.618981	1.01e-08	-12.73863	-12.59415	-12.68378
8	5.240011	1.01e-08	-12.73602	-12.57228	-12.67386
9	7.626416	1.01e-08	-12.73580	-12.55279	-12.66632
10	0.957159	1.02e-08	-12.72894	-12.52667	-12.65215

* denotes the optimal lag order under this criterion

Modeling was performed at the VAR (5) level, and the regression equation obtained is (f_t—Futures Log Yield m_t—Spot Log Yield)

(1)

$$f_t = -0.0746f_{t-1} - 0.0919f_{t-2} - 0.1512f_{t-3} - 0.0726f_{t-4} - 0.886f_{t-5}$$
$$(-2.0571)\quad(-2.4408)\quad(-3.9835)\quad(-1.9137)\quad(-0.23756)$$
$$+0.1922m_{t-1} - 0.2134m_{t-2} + 0.1057m_{t-3} - 0.0079m_{t-4} + 0.1573m_{t-5} + 0.00098$$
$$(3.0928)\quad(3.3842)\quad(1.6666)\quad(-0.1274)\quad(2.5964)\quad(2.2267)$$

(2)

$$m_t = 0.1396f_{t-1} + 0.0675f_{t-2} - 0.0348f_{t-3} - 0.0280f_{t-4} + 0.0078f_{t-5}$$
$$(6.5769)\quad(3.0666)\quad(-1.5680)\quad(-1.2632)\quad(-0.3605)$$
$$-0.1048m_{t-1} - 0.0041m_{t-2} + 0.0591m_{t-3} - 0.0370m_{t-4} + 0.0522m_{t-5} + 0.00049$$
$$(-2.8817)\quad(-0.1129)\quad(1.5934)\quad(-1.0086)\quad(1.4741)\quad(1.9371)$$

According to the regression equation (1), the lag of 1 to 4 periods of the log futures return has a more significant negative impact on the log futures return in the current period. In contrast, the 1-period lag of the spot log return has a strong positive effect on the current futures log return, but at the same time the 2-period lag has a strong negative effect on the current futures log return. Taken together, the overall impact of the spot yield lag term on current futures yields is positive.

According to regression equation (2), the lag-1 and lag-2 futures yields have a strong positive impact on current spot yields, indicating to some extent that futures yields guide spot yields. In addition, the lag-1 period of the spot log yield has a negative effect on the current spot yield, but the overall effect is not significant.

In summary, futures yields and spot yields influence each other, but futures yields guide spot yields more strongly.

3.4 Granger causality test

Granger causality tests are conducted to explore whether there is a Granger causality relationship between the two variables and also to test whether it is consistent with the conclusions drawn from the VAR model.

Based on the data in the table, it can be seen that in the equation explained by the spot log return on the futures log return, the p-value is 0.0079, which rejects the original hypothesis at 1% confidence level, indicating that the spot log return is the Granger cause of the futures log return. Similarly, the logarithmic futures return is also the Granger cause of the logarithmic spot return.

Table 3. Results of Granger's causality test

Original hypothesis	F-statistic	P-value	Conclusion
Granger's reason why the log return on spot is not the futures log return	4.86626	0.0079	Reject the original hypothesis
Granger's reason why the log futures return is not the spot log return	27.4259	2.E-12	Reject the original hypothesis

3.5 Impulse Response and Variance Decomposition

Impulse response analysis and variance decomposition are further performed in order to explore the extent to which each variable affects each and the other.

Impulse responses reflect the dynamic impact of changes in external shocks on the system. From Figures 1 and 4, it can be seen that both futures returns and spot returns respond immediately and positively to their own shocks in the first period with a response of 0.14% and 0.07%, but then both show a rapid decline in the second period and generate a negative response. However, the responses remain flat after seven periods, indicating that futures and spot yields do not have a long-term impact.

Figure 2 reflects the impact of spot yields on futures yields. The impulse response function shows that the overall response is relatively flat. This indicates that spot has a small impact on futures and that the impact on futures is not immediate and short-lived.

Figure 3 reflects the impact of futures yields on spot yields. The impulse response function shows that the first period has the sharpest response, with a positive response of 0.05%. However, the response gradually decreases with time and levels off in the seventh period. This indicates that the impact of futures returns on spot returns is sharp and fast, but the duration of the impact is also relatively short and does not cause long-term effects.

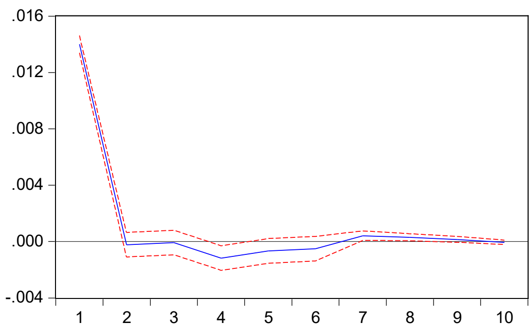

Figure1. Impulse response function of futures returns due to futures log return shocks

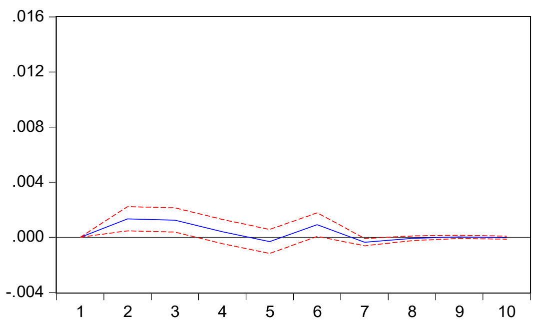

Figure2. Impulse response function of log log returns due to spot log return shocks

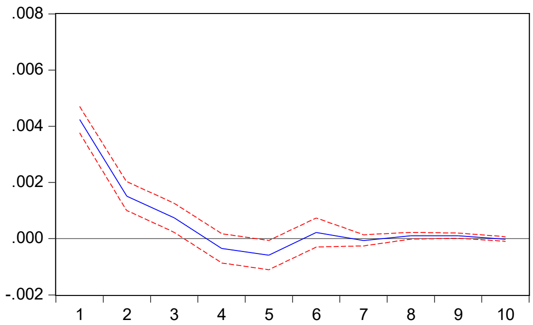

Figure3. Impulse response function of spot log returns due to futures log return shocks

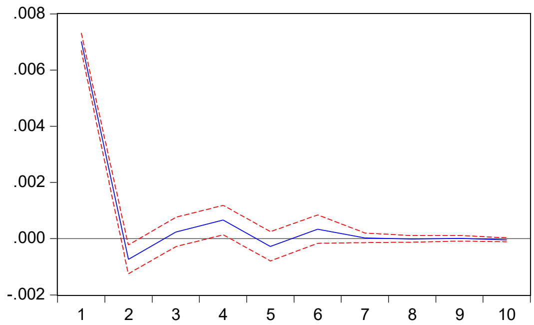

Figure4. Impulse response function of spot log returns due to spot log return shocks

The variance decomposition is used to explain the degree of contribution of each variable, the contribution of the spot log return to the futures is very small until the lag period of 10, when it contributes 2.28%. In contrast, the contribution of spot log returns to futures is 26.73% in the first period and almost 30% at a lag of 10 periods. This indicates that the futures market contributes more to the spot market and its changes also affect the changes in the spot market to some extent.

Table 4. Results of variance decomposition of log returns on futures

Lag period	Standard deviation	Effect from future log returns	Effect from spot log returns
1	0.014008	100.0000	0.000000
2	0.014075	99.08170	0.918304
3	0.014131	98.30012	1.699879
4	0.014186	98.22874	1.771256
5	0.014205	98.18688	1.813118
6	0.014244	97.78058	2.219421
7	0.014255	97.72159	2.278414
8	0.014258	97.72003	2.279974
9	0.014259	97.71984	2.280159
10	0.014259	97.71958	2.280416

Table 5. Results of variance decomposition of spot log returns

Lag period	Standard deviation	Effect from future log returns	Effect from spot log returns
1	0.008194	26.73040	73.26960
2	0.008365	28.91811	71.08189
3	0.008401	29.44380	70.55620
4	0.008434	29.38323	70.61677
5	0.008459	29.69347	70.30653
6	0.008469	29.69296	70.30704
7	0.008469	29.69674	70.30326
8	0.008469	29.70685	70.29315
9	0.008470	29.71729	70.28271
10	0.008470	29.71684	70.28316

4. Conclusion

In this paper, the following conclusions are drawn through time series modeling.

(1) Through VAR model, it is found that the futures return and the spot return influence each other, and the futures return has a stronger leading effect on the spot return.

(2) Through Granger causality test, the log futures return and the log spot return are Granger causally related to each other.

(3) The impulse response function shows that the magnitude of the impact of futures on spot is deeper, but it cannot produce a long-term impact. In contrast, the impact of spot market on futures is weak. The variance decomposition further indicates that futures have a greater degree of influence on spot and spot cannot have a greater influence on futures.

Thus, in the Chinese rapeseed oil market, the rapeseed oil futures market has a closer relationship with the spot market, and the rapeseed oil futures market has a certain guiding effect on the spot market. In order to make the Chinese rapeseed oil market develop better, the government should implement more effective control over the futures market. Secondly, it should insist on market reform, but in the process of reform, it should protect the respective characteristics of the futures market and the spot market, so that both the futures price and the spot price of rapeseed oil can reflect the operation of the rapeseed oil market, thus providing more effective help for the implementation of subsequent policies.

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