An Empirical Research on the Relationship of the Palm Oil Futures Prices between China and Malaysia

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Abstract—Malaysia is a major producer and exporter of palm oil in the word while China is a major importer and consumer. In order to study the relationship of the palm oil futuers prices between Buras Malaysia Derivatives (BMD) and Dalian Commodity Exchange (DCE), this article used a series methods such as correlation coefficient, Augmented Dickey-Fuller and Johansesn Cointegration Tests, Granger Causality Tests, Variance Decomposition and Impulse Response Function. The results show that there are long-term cointegration relation and strong correlation on palm oil futuers prices between BMD and DCE. Moreover, the palm oil futuers price of BMD lead that of DCE, but the palm oil futures price of DCE do not lead that of BMD. This study further validates Malaysia has the status of world palm oil fixing prices center. It also suggests that intertemporal arbitrage and cross matket arbitrage opportunities are exist in BMD and DCE palm oil futures markets.

Keywords-Palm oil futures price; Cointegration; Causality Tests; Variance Decomposition; Impulse Response Function

I. INTRODUCTION

Palm oil is one of the major vegetable oil in the world. 2013 world palm oil production reached 55.97 million tons. Between 2000 to 2013, the world's palm oil production rapid growth to 6.5% average annual growth rate, becoming the world's fastest-growing vegetable production. With the rapid increase in production, there was also a strong growth of palm oil trade. The world's palm oil exports reached 43.42 one million tons in 2013, accounting for 77.58% of total output[1].

The rapid development and trade of the world's palm oil production led to the development of the palm oil futures market. In October 2007, palm oil futures listed in Dalian Commodity Exchange (Dalian Commodity Exchange, hereinafter referred to as DCE).Previously, Buras Malaysia Derivatives (Buras Malaysia Derivatives, hereinafter referred to as BMD), Joint Asian Derivatives Exchange (Joint Asian Derivatives Exchange, hereinafter referred to as JADE) and Multi Commodity Exchange of India (Multi Commodity Exchange of India, hereinafter referred to as MCE) lanched palm oil futures trading. Malaysia is the world's major producer and exporter of palm oil, good spot basis has created good conditions for BMD of palm oil futures trading. China is the world's main importer and consuming countries of palm oil. In the nearly six years since palm oil futures has been lanched in DCE, volume and turnover were gradually increasing and DCE palm oil futures market was gradually mature.

Due to fluctuations of one futures market price will be passed to other futures markets, the relationship of influence between the same or similar furutes in different futures market has received lots of attention, mainwhile, cross market arbitrage based on this theory. International and domestic academics performed a large number of studies about the influence relationship between the same or similar furutes in different futures market. Among the studies, agricultural products are mainly focused on soybean, corn, natural rubber and etc. There is no systematic research and discussion on the relationship of the palm oil futures prices between the typical two palm oil futures markets: BMD and DCE. The research on BMD and DCE palm oil futures market price correlation not only has practical significance, but also fill the blank in the related field of research.

II. EMPIRICAL RESEARCH

A. Data Sources and Processing

This artical selects main palm oil continuous contract's daily closing prices of BMD (hereinafter referred to as PRICES_BMD, unit: RMB yuan/ ton) and DCE (hereinafter referred to as PRICES_DCE, unit: Ringgit/ton) as research objects. Due to the holidays are difference between BMD and DCE, in order to keep the sample data pairs, this article deletes data that do not match and then obtains 1154 pairs of data. Among them, DCE's data comes from DCE's website (http://www.dce.com.cn/) while BMD's data comes from Mandarin Financial market software.

B. The Discription of the Relevance of DCE and BMD Palm Oil Futures

Draw the sample data time series line chart in Excel (see Fig .1). Using R3.1.0 to calculate the two time series' correlation coefficient is 0.957, which is very close to 1. The result shows that there is a strong correlation between the two time series of PRICES_BMD and PRICES_DCE. However, the result only shows statistically significant, econometric models are needed to further analyze the dynamic relationship between the two time series.

[1] Data sources: Wind Info.

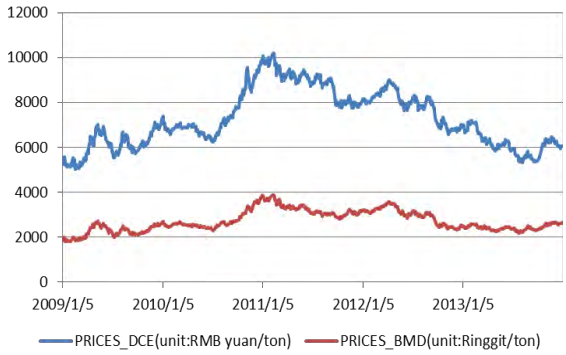

Figure 1. PRICES_DCE and PRICES_BMD time series line chart

C. Stationarity Test

The time series stationarity is the foundation of time series analysis, so firstly analyze the stationarity of the time series by the unit root test. This article use the main unit root test method: augmented Dickey-Fuller (ADF) test to test the original time series and the first order difference time series respectively (see TABLE Ⅰ).

TABLE I. ADF TEST RESULT

variable	ADF statistics	1% standard value	5% standard value	10% standard value	p-value	judgement
PRICES_BMD	0.2172	-2.5670	-1.9411	-1.6165	0.7492	not stationary
PRICES_DCE	-0.0597	-2.5670	-1.9411	-1.6165	0.6628	not stationary
ΔPRICES_BMD	-34.6318	-2.5670	-1.9411	-1.6165	0.0000	Stationary
ΔPRICES_DCE	-34.8906	-2.5670	-1.9411	-1.6165	0.0000	Stationary

TABLE I shows that the ADF statistics of PRICES_BMD and PRICES_DCE are both greater than their corresponding 1% standard value.The p value is 0.7492 and 0.6628 respectively, obliged not to reject the null hypothesis, so the time series are not stationary.

After the first order difference, the ADF statistics of ΔPRICES_BMD and ΔPRICES_DCE are both less than their corresponding 1% standard value.The p value are both 0.0000, obliging to reject the null hypothesis, so the time series are stationary. Two time series are all I(1) sequence, and then test the cointegration relationship between the PRICES_BMD and PRICES_DCE.

D. Johansen Cointegration Test

Cointegration test is to explore whether there is a long-term synergetic trend between the non-stationary time series, to judge the existence of a long-term equilibrium relationship: cointegration relationship between the non-stationary time series. E-G two-step test that based on regression residual stationarity and Johansen test that based on maximum likelihood estimation are often used to test the cointegration. In the practical research, Johansen test is widely used for it overcoming some disadvantages of the E-G two-strp test, so I choose to use Johansen cointegration test in this article.

Determine the optimizing lag number of the VAR model first because Johansen cointegration test is sensitive to VAR's lag number. Test result of PRICES_BMD and PRICES_DCE unconstrained VAR model's lag number is as follows (see TABLE II). TABLE II shows that the unconstrained VAR model's optimizing lag number is 6. According to the relationship between Johansen test's optimizing lag number and VAR model's optimizing lag number, Johansen test's optimizing lag number is 5.

TABLE II. TEST RESULT OF UNCONSTRAINED VAR MODEL'S LAG NUMBER

criteria	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	16.0876	16.0976	16.1141	9699771.0000
2	16.0127	16.0293	16.0568	8999446.0000
3	16.0119	16.0352	16.0736	8992220.0000
4	16.0135	16.0435	16.0929	9006981.0000
5	16.0177	16.0543	16.1147	9044931.0000
6	16.0095	16.0527	16.1241	8970696.0000
7	16.0130	16.0630	16.1453	9002750.0000
8	16.0141	16.0707	16.1640	9012594.0000
9	16.0191	16.0823	16.1865	9057106.0000
10	16.0225	16.0924	16.2076	9088467.0000
selection	6	2	2	6

TABLE III shows the Johansen cointegration test result. Trace statistics is greater than critical value of 5% level under the confidence level of 5%, so null hypothesis is rejected, showing that there exist a long-term equilibrium cointegration relationship between PRICES_BMD and PRICES_DCE.

TABLE III. JOHANSEN COINTEGRATION TEST RESULT

H_0	Eigenvalue	λ_{trace}	Critical value of 5%	p-value
r=0	0.01137	16.33799	15.4947	0.0373
r≤1	0.00279	3.20794	3.8415	0.0733

A VAR(6) model that building based on the unconstrained VAR model's optimizing lag number is as follows:

$$\begin{aligned} RICES\_DCE = {} & 0.7279 PRICES\_BMD.11 + 0.7677 PRICES\_DCE.11 - 0.5060 PRICES\_BMD.12 \\ & (7.198) \quad (18.815) \quad (-3.925) \\ & + 0.2077 PRICES\_DCE.12 - 0.2434 PRICES\_BMD.13 + 0.0501 PRICES\_DCE.13 \\ & (4.076) \quad (-1.869) \quad (0.971) \\ & - 0.0296 PRICES\_BMD.14 - 0.0597 PRICES\_DCE.14 + 0.0141 PRICES\_BMD.15 \\ & (-0.228) \quad (-1.160) \quad (0.109) \\ & + 0.0282 PRICES\_DCE.15 + 0.0557 PRICES\_BMD.16 - 0.0035 PRICES\_DCE.16 \\ & (0.554) \quad (0.542) \quad (-0.087) \\ & + 18.7860 const \\ & (1.031) \end{aligned} \tag{1}$$

The t value of each coefficient is shown in brackets. R^2 of this model is equal to 0.9937, and adjusted R^2 is equal to 0.9936.

Upon testing, characteristic root values of the VAR(6) model are 0.9952, 0.9911, 0.6665, 0.6562, 0.6562, 0.5941, 0.5941, 0.5579, 0.5579, 0.4621, 0.4621 and 0.3487. They

all in a unit circle(see Fig .2), so VAR(6) model is a stationary system.

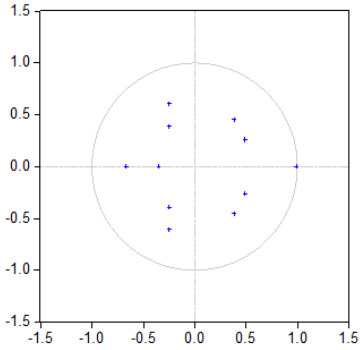

Figure 2. Characteristic root values of VAR(6)

E. Granger Causality Tests

In order to test the preceding relation between PRICES_BMD and PRICES_DCE which contained cointegration relationship, Granger causality tests is needed. Test results are shown in TABLE IV. In the test of PRICES_BMD not guides PRICES_DCE, p value is equal to 0.0000, rejecting null hypothesis under 1% significance level and thinking PRICES_BMD is the Granger cause of PRICES_DCE. On the contary, we can not reject null hypothesis under 1% significance level and thinking PRICES_DCE is not the Granger cause of PRICES_BMD.

TABLE IV. TEST RESULTS OF GRANGER CAUSALITY TESTS

H_0	F statistics	p-value
PRICES_BMD not guides PRICES_DCE	8.8781	0.0000
PRICES_DCE not guides PRICES_BMD	2.6262	0.0156

F. Variance Decomposition

Variance decomposition is to analyze the impact contibution of each variable's revise update on VAR system variables. The basic idea is to devide all the endogenous variables' volatility from system according to their causes into several components, thus obtaining each imformation's relative important degree on model endogenous variables[2].

To study the two markets' impact contribution to PRICES_BMD and PRICES_DCE, I decomposited the variance of PRICES_BMD and PRICES_DCE(see TABLE V). When lag period is 1, the total variance of PRICES_BMD are all explained by BMD. With the increasing of lag period, variance explained by BMD slightly reducing and finally trends toward 97.1474%. This implies the contribution rate that comes from BMD itself nearly occupied all the contribution rate. For PRICES_DCE, when lag period is 1, 52.6023% of the total variance can be explained by DCE. With the increasing of lag period, variance explained by DCE gradually reducing to 23.4461%, while variance explained by BMD gradually increasing to 76.5539%. This implies BMD contribution a lot to PRICES_DCE's volatility so that it has a significant explanatory power on the influence of PRICES_DCE.

TABLE V. Results of variance decomposition

Affected price	Lag period	Influences of different markets on the prices（%）	
		BMD	DCE
PRICES_BMD	1	100.0000	0.0000
	10	98.6247	1.3753
	50	97.9512	2.0488
	100	97.6928	2.3072
	300	97.2608	2.7392
	500	97.1663	2.8337
	800	97.1474	2.8526
PRICES_DCE	1	47.3977	52.6023
	10	63.7055	36.2945
	50	67.1725	32.8275
	100	70.2811	29.7189
	300	75.3816	24.6184
	500	76.3646	23.6354
	800	76.5539	23.4461

G. Impulse Response Function

Impulse response function is to analyze system variables' reaction degree and duration after impacted by an endogenous variable. In this article, it is to explore the degree of affect that random errors of PRICES_BMD and PRICES_DCE after impact have to their current value and future value. Draw the impulse response function graph(see Fig .3 and Fig .4). As we can see in Fig .3, in the first day, PRICES_DCE's reaction to a new standard error information from itself is 101.0481, and then increases to 104.4408 before gradual decline; PRICES_DCE's reaction to a new standard error information from PRICES_BMD is 0.0000 in the first day and soars to 22.2837 in the second day, final it presents a slowly descend tendency. PRICES_BMD's reaction to new information from itself and PRICES_DCE in the first day are 29.4262 and 27.9325 respectively, then they all present a declining curve.

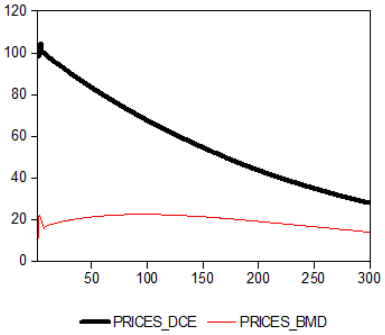

Figure 3. Impact on PRICES_DCE from the two markets

[2] Fang Deng, Vector autoregression model(VAR) : VAR and its Eviews implementation.

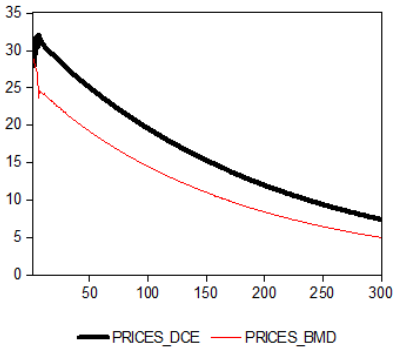

Figure 4. Impact on PRICES_BMD from the two markets

III. CONCLUSION

By analyzing the relationship between BMD and DCE palm oil futures prices during January 1, 2009 to December 31, 2013, this research gets the following conclusion:

1) A highly correlation exsits between BMD and DCE palm oil futures prices.

From time series plot and correlation coefficient, in between the two markets' palm oil futures prices there exist a trend similarity and correlativity obviously. The empirical study shows that PRICES_BMD time series and PRICES_DCE time series are integrated of order 1, and there exist a long-term equilibrium cointegration relationship between the two time series by Johansen cointegration test, thereby building the VAR model. In the VAR model of two markets palm oil futures prices, adjusted R^2 is equal to 0.9936. Model fitting effect is good and it passes the unit root test, so the model is a stationary system. High correlativity and tendency between BMD and DCE palm oil futures prices provide a basic condition for palm oil futures cross market arbitrage.

2) Granger causality tests further validates Malaysian has the world's palm oil fixing prices center status; Variance decomposition and impulse response function show that intertemporal arbitrage and cross matket arbitrage opportunities exist.

There is an obvious one-way causality relationship between BMD and DCE palm oil futures prices, that is, PRICES_BMD guides PRICES_DCE, and not vice versa. This implies that BMD palm oil futures prices change will necessarily impinge on DCE palm oil futures prices. In the long run, BMD and DCE palm oil prices have a cointegration relationship. In the short run, palm oil futures prices trend may appear some small deviation which provide arbitrage opportunities for hedgers and institutional investors.Although China dominates in the international palm oil consumer market, China is influenced by Malaysia a lot in fixing price of palm oil. For Malaysia, palm oil futures listed in DCE further promotes China-Malaysia trade and commerce and extends the influece of BMD in Asia main sales areas. For China, DCE palm oil futures provides the function of hedging and strengthen domestic related enterprises and individuals' ability to resist risk. In some sense, it improves Chinese right of discourse in the international palm oil trade. Malaysia as international palm oil futures fixing prices center is an economic system formed through long-term development. DCE is a "shadow market" of BMD at present. China is willing to gradually increase the influence in the international palm oil price market. This not only needs a more international futures market, but also needs to implement macro control under the market rules and build a loose development environment for the futures market.

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