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Interdependence between Agricultural Futures: Evidence from Malaysian Physical CPO and CBOT Futures

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Abstract

Since palm oil and palm oil-based products remain as Malaysia's largest contributor in terms of export earnings, this paper will focus on the price of Malaysian crude palm oil (CPO) paired together with Chicago Board of Trade (CBOT) agricultures futures commodities which include Soybean (SOY), Corn (CORN) and Soybean Oil (BO). All prices are then converted into return form. In order to identify the interdependence of both spot and future commodities, Vector Error Correction Model **(**VECM) approach have been used on the data. This paper also will show how Unit Root Test and Johansen Cointegration Test have been applied to this time series data.

Keywords

Crude palm oil, Soybean, Corn, Soybean oil, CBOT, interdependence, VECM

Introduction

The commodities market is one of the pivotal role in the economic development especially for developing country. Malaysia also have its own commodities market and still enhancing from day to day.

For decades, Malaysia is well-known of goldmine for natural resources such as palm oil, rubber, timber and so on. Malaysia has successfully leveraged on these natural treasures by turning it into long-term profit making commodities. This can lead this country to become a developed country same like other ASIAN country such as Japan and Singapore.

On 2013, Minister of Plantation Industries and Commodities (MPIC) Dato Sri Douglas Uggah Embas affirmed that the commodities market sector as one of the nation's main economic pillars (Yvonne Tuah, 2013). Yvonne also state that Malaysia's economy has become dependent on commodities. Its means for any significant decline in commodity prices could pose immediate risks in terms of deficits in current and fiscal accounts and this will impact the economic growth.

Department of Statistics Malaysia showed that the palm oil commodities and commodity-based product based on year 2012 have been contributed RM73.262 billion to Malaysia's earnings exports which carry 57.48 per cent of the total exports of Malaysia' commodities and commodity-based products. (Yvonne Tuah, 2013).

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The origins of organized futures trade in the world have been recorded in Chicago Board of Trade (CBOT) in USA in 1865. According to Ashok, Tirtha and Siraj (2017), CBOT was initially established as a spot wheat market in 1848. They state that the major exchanges trading in agricultural commodities are Chicago Board of Trade (CBOT), Chicago Mercantile Exchange (CME), Minneapolis Grain Exchange (MGE) and Intercontinental Exchange (ICE) Futures US (refer to Annexure 5 for details). In addition, 73 percent of the total agricultural contracts in USA being traded in CBOT. This make CBOT as a largest exchange in terms of agricultural futures trade.

India is one of the popular country who studied the efficiency of agricultural markets. Narsimhulu, Satish, and Satyanarayana, (2016) have make a study on the price efficiency in Indian commodity markets for three agricultural commodities which is chana, chilli, and turmeric, which are traded in National Commodity and Derivatives Exchange Ltd. (NCDEX) for the year of 2004 till 2013.

Moving to Malaysia, CPO is one of the agricultural commodity that have been traded in Bursa Malaysia Derivative Berhad (BMD). Since 1993, BMD provides, operates and maintains equity, interest rates, bond, agricultural commodity (crude palm oil and palm kernel), metal commodities (gold and tin) futures and options market trading and settlement services (Bursa Malaysia, Derivative). According to Rahman (2012), he claim that there exist a stable long-run and short-run relationships between spot prices of the Malaysian crude palm oil market with production, stock and export by using Johansen's co-integration and vector error-correction model. Zainudin (2018) state that there exists correlation between CPO with interrelated futures and also CPO with non-interrelated futures which covering both agricultural and energy futures contracts.

By looking into other agricultures future commodities, in India, soybean, soybean oil and soymeal is called as soybean complex. Sahai and Pailwar (2015) proved that the futures trading of soybean complex in India depends highly on the price signals generated by overnight price spikes in the Chicago Board of Trade (CBOT) market. This can prove that there is a price association between grain markets in the US and India.

Hence, this research tries to go beyond all the literatures mentioned above by establishing the interdependence of Malaysian physical CPO with the CBOT future as per listed in Table 1.

Table 1: *Summary of Commodities and Exchanges*

Commodities	Code	Exchange
Crude Palm Oil	CPO	Bursa Malaysia Derivatives
Soybean	SOY	Chicago Board of Trade
Corn	CORN	Chicago Board of Trade
Soybean Oil	BO	Chicago Board of Trade

Materials and Method

This empirical investigation will make use of the local delivered Malaysian weekly physical crude palm oil average prices starting from January 2006 to the last week of November 2016 from Futures Broking, Maybank Investment Bank. Both spot and futures daily prices data are transformed into weekly average.

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The futures prices of soybean, corn and soybean oil will be paired with the weekly average spot price of Malaysian crude palm oil CPO data in order to examine the degree of intedeprndence between the commodities. All the prices are converted into Malaysian Ringgit by taking exchange rate into consideration.

By looking on the difference of the data, all prices are transformed in the return form. The calculation of spot and futures return can be shown as below:

$$r_S = \frac{S_t - S_{t-1}}{S_{t-1}} \quad [1]$$

$$r_F = \frac{F_t - F_{t-1}}{F_t - 1} \quad [2]$$

Where r stands for return.

Theoretical Model: In order to examine the degree of interdependence between spot and futures, bivariate pairs were modelled. This model consists of four variables by having RCPO as a function of RSOY, RCORN and RBO.

$$RCPO_t = F(RSOY_t, RCORN_t, RBO_t) \quad [3]$$

Where, RCPO represent return of spot for crude palm oil, RSOY represent return of future for soybean, RCORN represent return of future for corn, RBO represent return of future for soybean oil.

This research will run unit root/ stationary test, Johansen cointegration test and also VECM approach.

Stationary Test: In order to identify the stationary of the data, the study will use two different unit root tests. The tests are Augmented Dickey-Fuller (ADF) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test as suggested by Fadhli, Nurul, Nurmadihah (2011) and (Öncü (2013). Table 2 show the null hypothesis and the alternate hypothesis for both of the test.

Table 2:
Null Hypothesis vs Alternate Hypothesis

ADF	KPSS
$H_0 : y_t \sim I(1)$	$H_0 : y_t \sim I(0)$
$H_1 : y_t \sim I(0)$	$H_1 : y_t \sim I(1)$

$y_t \sim I(0)$ indicate that the series are stationary while $y_t \sim I(1)$ indicate that the series are not stationary. If the test shows that the series are non-stationary, the next step is to test whether the differentiated series are stationary. A stationary first difference series means the series are integrated in order 1 or I(1). If the series are stationary, then co-integration test will take the lead on the following step.

Johansen Cointegration Test: This test will use two approach to determine the number of cointegration vectors which is Maximum Eigenvalue test and Trace test.

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Johansen Cointegration test is one of the earliest approach to VAR is the well-known procedure to measure the long run variables multicollinearity used likelihood ratio (Johansen and Juselius, 1990). The statistical ways to calculate the cointegration is as followed (Fadhli, Nurul, Nurmadihah, 2011):

$$\lambda_{trace}(r/n) = -T * \sum_{i=r+1}^{n} log(1-\lambda_i) \quad [4]$$

Hence the maximum eigenvalue statistics

$$\lambda_{max}(r, n+1) = -T\, log(1-\lambda) \quad [5]$$

Where λ is the Maximum Eigenvalue and T is the sample size with null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of variable in the system for $r = 0,1,2 \ldots n-1$. (Fadhli, Nurul, Nurmadihah, 2011)

Vector Error Correction Model (VECM): By referring on the result of cointegration test, if there is cointegration between series, its means there exist a long-term equilibrium relationship between them. VECM will then been applied to identify the interdependence of the cointegrated series. VECM includes an error correction model which could capture both short-run and long-run effects that would determine the actual value of how the dependent variable evolves over time (Yusupov and Duan, 2010).

This method is used when there is an evidence of long run relationship between the dependent and independent variables. Using VECM is quite common to identify the degree of interdependence (Abu Hassan Asari, Baharuddin, Jusoh, Mohamad, Shamsudin and Jusoff , 2011; Suartika, Suartana, and Darmawan, 2013). The regression equation form for VECM is as follow:

$$r = \alpha + \sum_{i=1}^{m} \beta_i r_{t-i} + \sum_{j=1}^{n} \gamma_i r_{t-i} + \lambda Z_{t-1} + \varepsilon_t \quad [6]$$

Where

r	= return form of spot and futures prices
$\alpha, \beta, \gamma, \lambda$	= coefficients to be estimated
n	= number of lag length as proposed by SIC
ε_t	= residual series of spot and futures at time t
Z_{t-1}	= error correction term

Results and Discussion

The analysis is performed by using EViews 8.0 statistical package software.

Stationary Test : Table 3 presents the results of Unit Root Tests by using Augmented Dickey Fuller (ADF) approach while Table 4 is the result of Stationary Test by using Kwiatkowski-Phillips-Schmidt-Shin (KPSS) approach. From Table 3 it is clear that there is no unit root test for all the time series since the p-value is less that 1% significance level. For Table 4, null hypothesis is failed to be rejected since all the p-value is more the 1% level of significance.

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Table 3:
Unit Root Test
Null Hypothesis: Series has a unit root

Augmented Dickey-Fuller test statistic	Prob.*
RCPO	0.0000
RSOY	0.0000
RCORN	0.0000
RBO	0.0000

*MacKinnon (1996) one-sided p-values.

Table 4:
Stationary Test
Null Hypothesis: Series is stationary

Kwiatkowski-Phillips-Schmidt-Shin test statistic	Prob.
RCPO	0.111516
RSOY	0.101233
RCORN	0.179420
RBO	0.201510

Johansen Cointegration Test: In this cointegration test, the answer of whether two variables are cointegrated or not is lied on the value of the trace test and the critical value. Table 5 and 6 below shows the tested null for no cointegration , at most 1, 2 and 3 cointegration at 0.05 level of significance. Both p-value and trace/maximum eigenvalue statistics indicate that the null hypothesis is being rejected. Its conclude that there are cointegration between the four variables of RCPO, RSOY, RCORN and RBO.

The existence of cointegration vector between RCPO and futures means that error correction term can be modelled by using VECM.

Table 5:
Johansen Cointegration Analysis Results: Trace Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.261179	423.9027	47.85613	0.0001
At most 1 *	0.176181	265.2884	29.79707	0.0001
At most 2 *	0.153557	163.7348	15.49471	0.0001
At most 3 *	0.135634	76.37756	3.841466	0.0000

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

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* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 6:
Johansen Cointegration Analysis Results: Maximum Eigenvalue

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.261179	158.6144	27.58434	0.0001
At most 1 *	0.176181	101.5536	21.13162	0.0001
At most 2 *	0.153557	87.35722	14.26460	0.0000
At most 3 *	0.135634	76.37756	3.841466	0.0000

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Vector Error Correction Model (VECM): Using VECM is quite common to identify the degree of interdependence (Abu Hassan Asari, Baharuddin, Jusoh, Mohamad, Shamsudin and Jusoff , 2011; Suartika, Suartana, and Darmawan, 2013). Therefore, the regression equation will be form by using VECM method.

Table 7:
VECM Analysis Results

Cointegrating Eq:	CointEq1
RCPO(-1)	1.000000
RCSOY(-1)	0.035278 (0.15103) [0.23359]
RCCORN(-1)	0.656006 (0.09458) [6.93623]
RCBO(-1)	-2.348494 (0.15009) [-15.6476]
C	0.000231

Standard errors in ( ) & t-statistics in [ ]

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Table 7 shows the summary of degree of interdependence in long run between RCPO and the inter-related futures commodities consists of RSOY, RCORN and RCBO. The long run relationship between all the commodities in the period of 2006 - 2016 is displayed below.

$$RCPO = 0.035278RSOY + 0.656006RCORN - 2.348494CBO + 0.000231 \quad [7]$$

It concludes that, in a long run, any 1 percent change of return in RSOY will cause the return of RCPO to increase by at least 0.035278 percent. For any 1 percent change of return in RCORN will cause the return of RCPO to increase by at least 0.656006 percent. For any 1 percent change of return in RBO will cause the return of RCPO to decrease by at least 2.348494 percent

Conclusions

In conclusion, VECM have showed the interdependence between spot of CPO and CBOT agricultural futures which consist of futures of SOY, CORN and BO. All the selected futures commodities in CBOT showed an impact to the price of CPO. For future studies, researchers should attempt to use panel data and also covering others exchange.

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