The Impact of Prolonged Low Brent Crude Oil Prices on CPO Price Movement

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Article history:
Received: 31 May 2017
Accepted: 15 June 2017
Available online: 1 Sept. 2017

ABSTRACT

The article highlights the movement of crude palm oil (CPO) price in the world market and seeks to find various significant factors affecting it. Focus is given to Brent crude oil (BCO) price and the impact of BCO's prolonged low price on CPO price movement. Both prices of CPO and BCO have moved in tandem ever since the introduction of palm-based biodiesel and the implementation of the Envo Diesel programme in March 2006, indicating that BCO affects the development of CPO price. In addition, due to the complexity of the oils and fats sector, CPO price is also found to be affected by other time-varying factors, such as soyabean oil (SBO) prices, palm oil (PO) supply and exports. SBO is a strong competitor of CPO due to the substitutability factor and competes for the same markets of the global edible oils sector. Meanwhile, from the supply perspective, any increase in PO supply can cause its price to be bearish in the market. In addition, any decline in PO exports to major importing countries, especially India, China and European Union (EU), can also depress CPO price. The results of the bound test for the CPO price model indicate the existence of a long-run relationship between CPO price and SBO price, BCO price, CPO production and PO export. At the same time, the short-run analysis found that BCO and SBO prices have a positive relationship with CPO price. The results indicate that in the short-run, CPO price will increase when BCO and SBO prices increase. BCO price is able to have a high impact on CPO price, especially during the high BCO price regime. However, when BCO price declines and remains stable below USD 50/barrel, its impact on CPO price movement becomes weak. As a result, the impact of prolonged low BCO prices on CPO price movement will only be marginal; thus, CPO price can still be bullish in the market place if SBO price increased, if PO supply availability declines and export increases in the market place.

Keywords: crude palm oil, Brent crude oil, biodiesel, time-varying factors, bound test and supply availability.

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INTRODUCTION

It is apparent that crude palm oil (CPO) has set a pattern of very erratic movements in its price in the past. This situation is synonymous to price volatility which is known to depend on several time-varying factors. One of the factors is the supply and demand factor which, theoretically, can determine the price for a commodity (in this case, CPO) in the world market. A surge in price will be realised if there is strong demand while a price dip will result if the supply of palm oil (PO) grows much faster than its demand. Another factor worth mentioning is the price of its major substitutable product, *i.e.* soyabean oil (SBO). Due to the substitutability factor, SBO is well-known as a strong competitor of CPO, and has influenced the price of the latter since many decades ago. There are also other influential factors, such as climate, market sentiments, and the price of Brent crude oil (BCO) especially after the introduction of palm-based biodiesel and the implementation of the Envo Diesel programme in March 2006.

CPO price movement in the period from January 2014 to June 2017 is shown in *Figure 1*. From March 2014 until August 2015, a downward trend is recorded. CPO was traded lower by 9.6% or RM 230/t to reach an average of RM 2153.50/t in 2015 as compared with the average price of RM 2383.50/t in 2014. In 2015, the highest traded price was in January at RM 2301.50/t while the lowest price was in August at RM 1975/t. It is observed that the price recovered in 2016 as it tracked a positive accelerating trend although the price in January was lower at RM 2257/t, down by 14.8% as compared with RM 2301.50/t in the same month of 2015, but higher than in December 2015 at RM 2154.50/t. The price continued to accelerate positively until the end of 2016 although some erratic movements were observed along the way. The lower price in January 2016 was mainly due to weaker BCO and world vegetable oil prices, *i.e.* prices of soyabean and rapeseed oils. The acceleration of CPO price in 2016 was due to lower CPO production as a result of dry weather caused by the *El Niño* climate phenomenon which lowers palm fruit yields, as well as bullishness in the world market for other vegetable oils, especially SBO prices, and the weaker Ringgit against the US Dollar which made PO cheaper than other vegetable oils in the world market.

BCO price has played a significant role in influencing CPO price after the introduction of palm methyl ester as a palm-based biodiesel product. Hence, there exists a relationship between the two prices. After implementation of the biodiesel programme, the relationship has either been strong, medium or weak, depending on the market situation for both products. A strong positive relationship between them occurs especially during a high BCO price regime, making palm biodiesel products economically viable in the market. However, an increase in demand for palm biodiesel products reduces PO stock levels and increases CPO price in the world market. Meanwhile, a weak relationship between both prices can be observed especially during a low BCO price regime, particularly when the palm biodiesel product

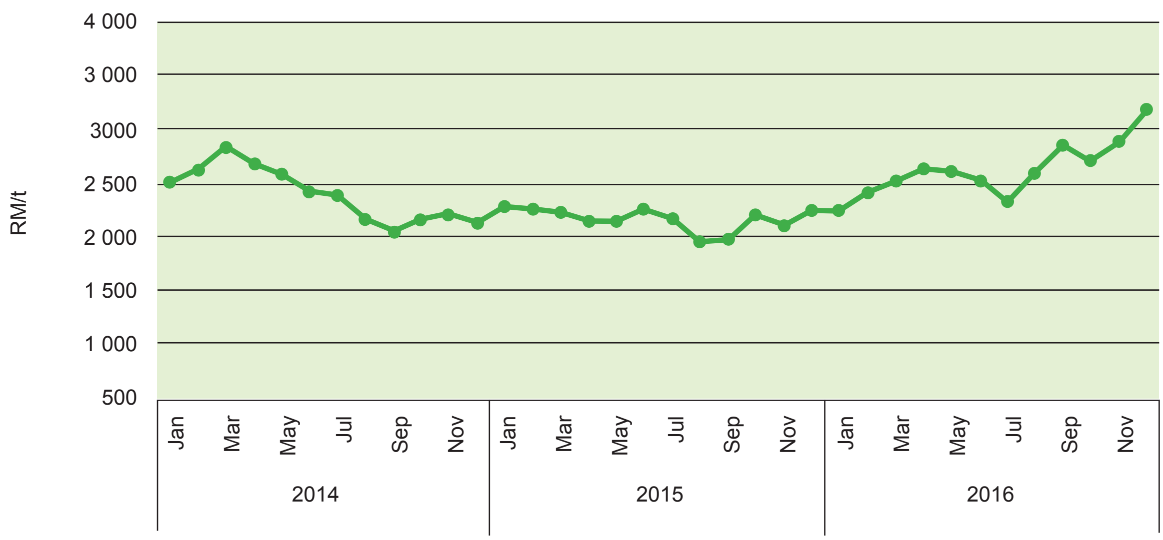

Figure 1. Monthly crude palm oil (CPO) price trends.

is economically unviable in the market due to considerably cheaper petroleum diesel.

Figure 2 clearly shows that both CPO and BCO prices generally moved in tandem after implementation of the biodiesel programme (in March 2006) from January 2007 to January 2017 with a strong and positive correlation coefficient of 0.7863 as compared with 0.4872 in the period before implementation of the biodiesel programme (January 2000 to December 2006). The strong correlation occurred as a result of inclusion of palm methyl ester as a substitute product for petroleum diesel in the world market. Thus, when BCO price increased, the demand for palm methyl ester also increased, leading to an increase in CPO prices.

Figure 2 also depicts two instances when BCO experienced a drastic decline in price, *i.e.* in 2008 and in 2014. In the second instance in 2014, the price started to decline to USD 97/barrel in September, dipping below USD 100/barrel. It continued its downtrend reaching USD 30/barrel in January 2016. At the same time, CPO price also down-trended to below USD 800/t. It was observed that after two years of prolonged low BCO prices (below USD50/barrel), the price of CPO started to diverge and de-couple from the BCO price. Thus, if the price of BCO continues to be low in the world market, will CPO price be negatively affected as well in the long-term? To answer this question, this study will examine the impact of prolonged low BCO prices on CPO price movements in the long-term.

According to Ab Rahman (2013), CPO price movement depends directly on four major fundamental factors, namely: 1) PO supply, which is determined by CPO production, PO stocks and PO imports; 2) export demand for oil palm products; 3) prices of close substitute products, *i.e.* soyabean and rapeseed oils, and 4) BCO price. BCO price has fundamentally become an important factor influencing CPO price in the world market, and has resulted from the emerging market for palm biodiesel. Based on the supply and demand factors, CPO price movement reflects equilibrium or volatility. In addition to the above factors, CPO price movement is also subject to market sentiments or price speculation which sometimes can give a higher impact to CPO price in the short-term than the fundamental factors. Moreover, extreme weather phenomena such as *El Niño* and *La Niña*, when they occur in oil palm and other vegetable oils producing countries, will subsequently cause supply disruption and lead to price increases.

Chuangchild *et al.* (2012) studied the factors affecting PO price based on the extremes value approach. The objective of the study was to examine the dependence structure of extreme realisation of growth rate between PO price and the affecting factors, such as SBO and BCO prices. The data used in the analysis spanned from July 1988 to January 2012. The Bivariate Block Maxima and Bivariate Threshold Exceedances approaches were used in the study. The results show that the growth rate of PO and SBO prices had some dependence in extremes, but the growth rate of PO and BCO prices had a fairly weak dependence or was even independent of each other in extremes.

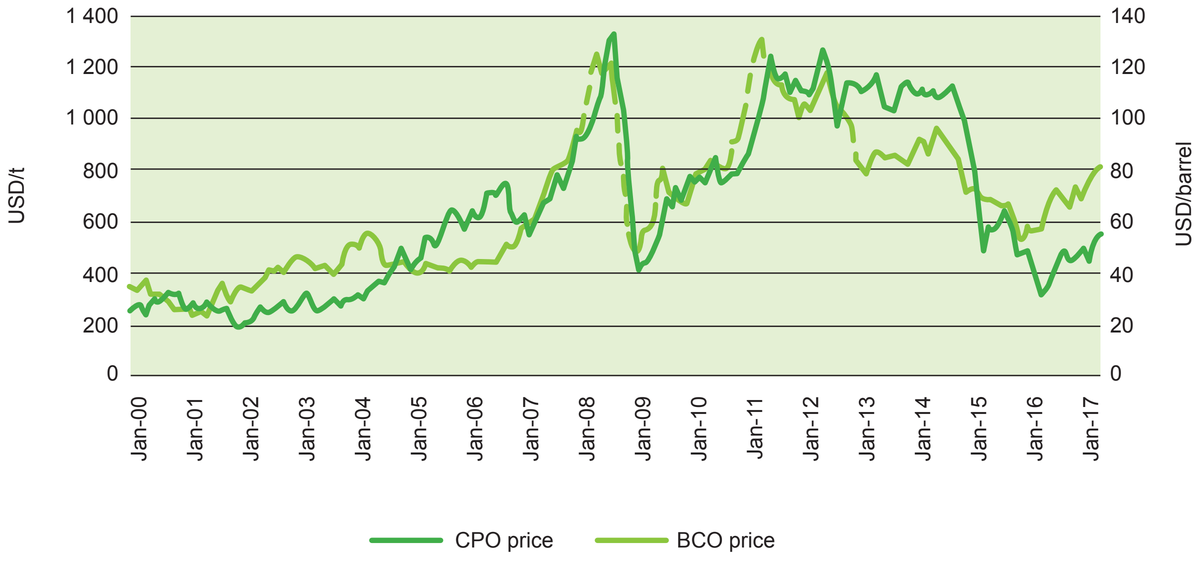

Figure 2. Relationship between crude palm oil (CPO) and Brent crude oil (BCO) prices.

Dewi *et al.* (2009) examined the effect of biodiesel demand on the Malaysian PO market. To simulate the effect of an increase in Malaysian biodiesel demand, an estimated structural econometric model of the country's PO industry was developed using annual data for the period 1980 to 2007. The result shows that the counterfactual analysis of a sustained 70% increase in Malaysian biodiesel demand predicted a direct effect of 0.36% in Malaysian export demand for PO. The indirect effects via the export demand transmission channels were 142.6% decrease in stocks, 21.86% increase in supply, 109.74% increase in CPO price, 9.84% decrease in domestic consumption, and also 0.04% increase in world price.

According to Fry (2008), prior to 2002, vegetable oil prices were unrelated to BCO price, which signifies a negative statistical correlation between the two sets of prices; in other words, when BCO prices increased, vegetable oil prices tended to fall. Meanwhile, after implementation and onset of the biofuel programme in 2007, the prices of different oils and fats became more closely linked to each other than ever before. The high correlations between prices of vegetable oils and animal fats leave no doubt that the changes in prices throughout the whole spectrum of products are now very closely linked to changes in BCO prices. Biofuel demand is now so important for vegetable oils as a whole that the BCO price link will remain, even when BCO prices decline. This scenario indicates that BCO price has become part of the price equation due to the biofuel link. As a result, two major factors need be included when analysing PO prices, *i.e.* BCO price and the level of PO stocks.

The general objective of this study was to identify significant factors influencing CPO price in the market. Meanwhile, the specific objectives of this study were to examine the relationship between CPO and BCO prices in the world market, and to analyse the impact of prolonged low BCO prices on CPO price movement in the long-term.

DATA AND METHODOLOGY

Data analysis for this study was based on price data in monthly time series spanning from January 2000 to December 2016. Data used in this study were collected from the Malaysian Palm Oil Board's database (MPOB, 2016) and *Oil World Annual*. The data were analysed using time series regression analysis with the aid of EViews version 8 and Micro-fit Version 1 software. The data used in this study are as follows:

i) CPO price (CPOP);
ii) SBO price (SBOP);
iii) BCO price (BCOP);
iv) Production of CPO (PDO) and
v) Export of PO (EXP).

To ensure accuracy in the analysis, this study first investigated the stationarity property of the variables by employing the unit root tests commonly used in empirical literature, including the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. The reason for using the unit root tests is that generally time series data, such as on CPO, SBO and BCO prices, CPO production and PO export, exhibit trending behaviour or non-stationarity in the mean. Moreover, economic and finance theory often suggests the existence of long-run equilibrium relationships among non-stationary time series variables. If these variables are integrated to the order one I (1), cointegration techniques can be used to model these long-run relationships. Hence, pre-testing for unit roots is often a first step in cointegration modelling.

The study then employed the Autoregressive Distributed Lag (ARDL) bound testing approach to cointegration developed by Pesaran *et al*. (2001) to verify the long-run relationships between variables. This method was chosen for its advantages when there are a small number of observations, as well as the fact that it can be applied irrespective of the order of integration, *i.e.*, integration of order 0 [I(0)] or order 1 [I(1)]. In addition, the ARDL method avoids the larger number of specifications that need to be made in the standard cointegration test. These include decisions regarding the number of endogenous and exogenous variables (if any) to be included in the treatment of deterministic elements, as well as the optimal number of lags to be specified. By employing the ARDL method, it is possible to have different variables that have different optimal lags, which is impossible with the standard cointegration test. Moreover, the model can be used with limited sample data. The estimates of ARDL bound testing CPO price model is as follows:

$$\begin{aligned} \Delta \mathrm{In}CPOP_1 = {} & \alpha_0 + \sum_{i=1}^{N}\beta_1\Delta\ln CPOP_{t-i} + \\ & \sum_{i=1}^{N}\beta_2\Delta\mathrm{In}SBOP_{t-i} + \sum_{i=1}^{N}\beta_3\Delta\mathrm{InBCOP}_{t-i} + \\ & \sum_{i=1}^{N}\beta_4\Delta\mathrm{In}PDO_{t-i} + \sum_{i=1}^{N}\beta_5\Delta\mathrm{In}EXP_{t-i} \\ & \delta_1 CPOP_{t-i} + \delta_2 SBOP_{t-i} + \delta_3\mathrm{In}BCOP_{t-i} + \\ & \delta_4\mathrm{In}PDO_{t-i} + \delta_5\mathrm{In}EXP_{t-i} \\ & + \mu \end{aligned} \qquad \text{Equation (1)}$$

where lnCPOP, lnSBOP, lnBCOP, lnPDO and lnEXP refer to the variables in the model in logarithm form. μ is the symbol of differentiation, is the error/residual (white noise), and α, β and δ are coefficients to be estimated.

The study then estimated the long-run relationships between variables. The first step was to justify the interval for variables by using F-statistics (variable addition test). The null hypothesis stating no cointegration (H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$) was tested against the alternative hypothesis of there existed cointegration (H_1: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$). Two sets of critical bounds for the F-statistics generated by Pesaran *et al.* (2001) and Narayan (2005) were used, *i.e.* the lower critical bound (LCB) and the upper critical bound (UCB). If the F-statistics is less than LCB, it indicates that no cointegration or long-run relationship exists between the variables under study. However, if the F-statistics is greater than UCB, it means that there is cointegration or long-run relationships between the variables. On the other hand, if the F-statistics is between LCB and UCB, the cointegration test is considered to be inconclusive.

The second step of the ARDL estimation procedure involved estimation of the coefficients of the variables in the equation. The lag selection criterion of the model was based on either Akaike Information Criterion (AIC) or Schwartz-Bayesian Criterion (SBC). Once cointegration was established, the conditional ARDL long-run model can be estimated as follows:

$$\text{In}CPOP_t = \alpha_1 + \sum_{i=1}^{N}\delta_1 \text{In}SBOP_{t-i} + \sum_{i=0}^{N}\delta_2 \text{In}SBOP_{t-i} + \sum_{i=0}^{N}\delta_3 \text{In}BCOP_{t-i} + \sum_{i=0}^{N}\delta_4 \text{In}PDO_{t-i} + \sum_{i=0}^{N}\delta_5 \text{In}EXP_{t-i} + \varepsilon_{t-1} \qquad \text{Equation (2)}$$

The subsequent estimation and model selection were made based on three criteria, namely, the adjusted R-squared, AIC and SBC, to select the maximum length of the interval. Finally, the study sought to look for the short-run dynamic parameters by estimating an error correction model associated with the previously determined long-run estimates. The ARDL error correction model is expressed with the following equations:

$$\Delta\text{In}CPOP_l = \alpha_1 + \sum_{i=1}^{N}\beta_1 \Delta\text{In}CPOP_{t-i} + \sum_{i=1}^{N}\beta_2 \Delta\text{In}SBOP_{t-i} + \sum_{i=1}^{N}\beta_3 \Delta\text{In}BCOP_{t-i} + \sum_{i=1}^{N}\beta_4 \Delta\text{In}PDO_{t-i} + \sum_{i=1}^{N}\beta_5 \Delta\text{In}EXP_{t-i} + \psi ECM_{t-1} + \varepsilon_{t-1} \qquad \text{Equation (3)}$$

where β_1 to β_5 are the short-run dynamic coefficients of the model's convergence to the equilibrium, ψ is the speed of adjustment parameter, and ECM is the error correction term that is derived from the estimated equilibrium relationship of Equation (1). Equation (3) indicates that when there is a shock in the CPO price, the higher the value of the error correction coefficient (in negative terms) the quicker the CPO price adjusts to achieve long-run equilibrium, and vice versa.

To ascertain the goodness of fit of the ARDL model, diagnostic and stability tests were conducted. The diagnostic test examined the serial correlation, functional form, normality and heteroscedasticity associated with the model by employing the Lagrange Multiplier (LM) test.

RESULTS AND DISCUSSION

Unit Root Tests

Prior to testing for cointegration, the study conducted a test on the order of integration for each variable

TABLE 1. UNIT ROOT TESTS

Variable	Level		First difference	
	ADF	Phillips-Perron	ADF	Phillips-Perron
With intercept				
CPOP	-2.7374	-2.6111	-7.7631**	-7.8423**
BCOP	-2.1477	-1.9397	-7.1383**	-7.1512**
SBOP	-2.3711	-2.4415	-7.0545**	-7.2792**
PDO	-2.3424	-3.0826*	-4.1775**	-8.6576**
EXP	-5.1245**	-5.0216**	-13.1924**	-17.8051**
With intercept and trend				
CPOP	-2.9581	-2.7989	-7.7528**	-7.8319**
BCOP	-2.3802	-2.1844	-7.1337**	-7.1469**
SBOP	-2.7508	-2.7220	-7.0736**	-7.2993**
PDO	-2.6646	-2.9693	-4.1855**	-8.7284**
EXP	-5.3592	-5.2640**	-13.2165**	-18.5105**

Note: ** And * are significance levels at 1% and 5%, respectively.
CPOP - crude palm oil price.
SBOP - soyabean oil price.
BCOP - Brent crude oil price.
PDO - production of CPO.
EXP - export of palm oil.

using the ADF and PP procedures to examine data stationarity, and consequently the existence of unit root. *Table 1* shows the ADF and PP tests at level and at first difference with intercept, and with intercept and trend. The results indicate that based on the ADF and PP tests, the calculated t-statistics for EXP was greater than the critical values in their level forms, suggesting that this variable was stationary at level form or integrated of order I(0). On the other hand, for the other variables (CPO, BCO and SBO prices, and CPO production), the calculated t-statistics for these variables were greater than the critical values in their differenced forms, thus suggesting that they were stationary after the first difference or integrated of order I(1).

ARDL Bound Testing

The result of the bound test for cointegration is shown in *Table 2*. The bound test procedure indicates that the optimal lag length for the CPO price model is three. The absence of residual serial correlation also confirmed the correct order of the lag selection. The bound test was based on the Wald test and was conducted against the null hypothesis of the existence of a long-run relationship between the variables. The result of the bound test for the CPO price model indicates the existence of long-run relationships between the variables, as the calculated F-statistics was higher than the UCB value at 5% level of significance (Pesaran, 2001).

Long-run Estimations

The empirical results of the long-run models are presented in *Table 3*. The results indicate that CPO price movement was dependent on all independent variables in the model, namely, BCO and SBO prices, PO export and CPO production. Every 1% increase in BCO price led to an increase by 0.26% in CPO price. Another important factor that explains CPO price movement is the price of SBO. The model indicates that for every 1% increase in SBO price, CPO price will increase by 0.39%. This shows that SBO and PO were close substitutes. The model also shows that CPO price movement was also influenced significantly by PO export. In other words, when PO export increased by 1%, CPO price would increase by 0.80%. Meanwhile, when CPO production increased by 1%, CPO price can be expected to decline by 1.19%.

Short-run Error Correction Models

The short-run ECM from the ARDL model is presented in *Table 4*. The analysis showed that most of the short-run coefficients of the explanatory variables were statistically significant except for ΔCPOP1. In the short-run, BCO and SBO prices had positive relationships with CPO price. The results indicate that in the short-run, CPO price will increase when BCO and SBO prices increase. The ECM-1 is negative and highly significant, showing that there was causality in at least one direction. The coefficient of -0.1916 indicates a medium rate of convergence to

TABLE 2. ARDL BOUND TEST OF COINTEGRATION

Significance level (%)	Critical value* (unrestricted intercept and no trend)	
	Lower bound	Upper bound
1	4.096	5.512
5	3.010	4.216
10	2.548	3.644

Diagnostic tests:

- Max Lag Length : 3
- Wald Test F-Stat : 1664.877**
- LM Test χ^2 : 0.0497

Note: *Based on Narayan (2005), ** Significant at 5% level.
ARDL - Auto Regressive Distributed Lag.
EXP - export of palm oil.

TABLE 3. ESTIMATED LONG-RUN COEFFICIENTS USING ARDL APPROACH

ARDL (3,0,1,1,1) Akaike Information Criterion (AIC)

Variable	Dependent variable: CPOP	
	Coefficient	t-value
BCOP	0.25962	2.4167**
SBOP	0.38789	1.8521*
EXP	0.79702	2.0529**
PDO	-1.1871	-2.7350***

Note: ***,** and * indicates significance level at 1%, 5% and 10%, respectively.
ARDL - Auto Regressive Distributed Lag.
CPOP - crude palm oil price.
BCOP - Brent crude oil price.
SBOP - soyabean oil price.
EXP - export of palm oil.
PDO - production of palm oil.

TABLE 4. ERROR CORRECTION REPRESENTATION FOR THE SELECTED ARDL MODEL

ARDL (3,0,1,1,1) based on Akaike Information Criterion (AIC)		
Variable	Dependent variable: CPOP	
	Coefficient	t-value
Constant	1.6325	2.8278***
Δ $CPOP_1$	.04503	0.7153
Δ $CPOP_2$	-0.1309	-2.1072**
Δ BCOP	0.0497	2.2764**
Δ SBOP	1.1737	14.1699***
Δ EXP	-0.1207	1.4947
PDO	1.6325	-2.6412***
ECM_{-1}	-.19156	-3.3062***

Diagnostic tests:

R-Squared	: 0.74225	Schwarz-Bayesian Criterion: -6.7053
Adj.R-Squared	: 0.7179	F-Statistics (7 109): 43.6078***
Durbin Watson	: 2.1078	

Note: ***, ** and * indicate significance level at 1%, 5% and 10%, respectively.
ARDL - Auto Regressive Distributed Lag.
CPOP - crude palm oil price.
BCOP - Brent crude oil price.
EXP - export of palm oil.
PDO - production of palm oil.
SBOP - soyabean oil price.

the equilibrium, which implies that any deviation from the long-run equilibrium is corrected by 19.16% over each month.

CONCLUSION

The price of BCO is a significant factor influencing CPO price movement in the world market. Other influencing factors for CPO price are SBO price, CPO production and export of palm oil in the world market. Both BCO and SBO prices affect CPO price positively. This means that they move in tandem, whereby when BCO and SBO prices increase, CPO price is expected to increase as well in the world market. On the other hand, CPO production is found to be negatively related with CPO price. Nevertheless, SBO and BCO prices have the potential to produce a high impact on CPO price in the short- and long-term periods. In this study, the BCO price was able to have a high impact on CPO price, especially during the high BCO price regime (above USD 100/barrel) when the other factors remained stable. After the BCO price declined and stabilised below USD 50/barrel, the impact on CPO price movement became weak. The impact of high movement in SBO price will translate into high CPO price movement in the world market even when the other factors (*i.e.* BCO price, supply availability and export) remain stable in the market. As a result, the impact of prolonged low BCO prices on CPO price movement will only be marginal. CPO price can still be bullish in the market if SBO price increases, palm oil supply availability declines and palm oil export increases in the market place.

ACKNOWLEDGEMENT

The authors wish to express sincere thanks to the Director-General of MPOB for permission to publish this article.

REFERENCES

AB RAHMAN, A K (2013). Impact of palm oil supply and demand on palm oil price behaviour. Palm Oil Internet Seminar (Pointers on Price Trends). MPOC.

CHUANGCHILD, K; WIBOONPONGSE, A; SRIBOONCHITTA, S and CHAIBOONSRI, C (2012). Factors affecting palm oil price based on extremes value approach. *International J. Marketing Studies, 4(6)*: 54-65.

DEWI, S; ARSHAD, F; SHAMSUDIN, M N and YUSOP, Z (2009). The impact of biodiesel demand on the Malaysian palm oil market. *Prosiding Perkem IV Vol. 1*: 566-576.

FRY, J (2008). Bio-diesel: its impact on CPO pricing link. *Global Oils & Fats Business Magazine, 5(4)*: 34-39.

MPOB (2016). *Malaysian Oil Palm Statistics 2015.* 35th Edition. Ministry of Plantation Industries and Commodities, Malaysia.

NARAYAN, P K (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics, 37(17)*: 1979-1990.

OIL WORLD ANNUAL (2015). *Oil World Annual 2014*. Vol. 2. Hamburg. ISTA Mielke GmbH.

PESARAN, M H; SHIN, Y and SMITH, R J (2001). Bounds testing approaches to the analysis of level relationships. *J. Applied Econometrics, 16(3)*: 289-326.