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**Price Linkage between International Price of Crude Palm Oil (CPO)  
and Cooking Oil Price in Indonesia**

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# **Price Linkage between International Price of Crude Palm Oil (CPO) and Cooking Oil Price in Indonesia**

Amzul Rifin<sup>\*</sup>

## **Abstract**

Cooking oil in Indonesia is considered to be one of the staple food of Indonesian people. In the beginning of 2008, the price of cooking oil in Indonesia has increased significantly. One of the reasons is the increase of Crude Palm Oil (CPO) price in the international market. The objective of this research is to investigate the impacts of international price of CPO on the domestic price of CPO and cooking oil. Three specific objectives are included (1) To test whether international price of CPO and domestic price of CPO and cooking oil are related through cointegration tests, (2) To test the causal relationships between international price of CPO and domestic price of CPO and cooking oil and (3) To analyze how domestic price of CPO and cooking oil food prices respond to a change in international price of CPO

The result indicates that international price of CPO, domestic price of CPO and cooking oil price are not cointegrated. In addition, using the Granger causality method, it shows that international price of CPO influence the domestic price of CPO and cooking oil price. Meanwhile, domestic price of CPO and cooking oil price affects each other.

**Keywords:** crude palm oil, vector autoregression (VAR), granger causality, impulse response

**JEL Codes:** Q17, F14

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## **Introduction**

Palm oil is considered to be an essential product in Indonesia. Besides one of the major exporting commodity from Indonesia, palm oil is also the main raw material for cooking oil. Palm oil usage for cooking oil is the largest with 75.85 percent in 2003 (CIC, 2004).

In Indonesia, cooking oil is one of the staple food of the Indonesian people. Therefore the price of cooking oil is controlled by the government. In the beginning of 2008, the price of cooking oil has risen dramatically. In anticipating the rise, the government has taken several policies. One of the policies is to increase the export tax of crude palm oil (CPO), in order to maintain the availability of CPO for the domestic market especially for producing cooking oil. The government issued Ministry of Finance Decree No 09/PMK.011/2008 and revised in December 2008 with the issue of Ministry of Finance Decree No 223/PMK.011/2008 which impose higher export tax rate when the international price of CPO increase.

The government also issued Ministry of Finance Decree No 118/PMK.011/2007, No 14/PMK.011/2008 and No 15/PMK.011/2008 concerning the value added tax of cooking oil. The decrees mentioned that the government will pay the value added tax on both packaged and non packaged cooking oil sold domestically. By paying the value added tax, the price of cooking oil is expected to decrease by 10 percent, which is the same amount as the value added tax.

Despite several policies taken by the government, the price cooking oil is still high. In the month of March 2008, the price of cooking oil still reached the highest point of Rp 12444/kg. Cooking oil producers blame the rise of cooking oil price on the

high price of CPO in the international market which at that time reached US\$1172.50/ton, meanwhile the domestic price of CPO reached Rp 9687/kg.

There a lot of studies concerning the price linkage and asymmetric price transmission between the same commodities in the foreign and domestic market (see Meyer and von Cramon-Taubadel, 2004; Frey and Manera, 2007). On the other hand, only several studies concerning price linkage between different but related product . Such as, Baffes and Ajwad (2001), Baffes and Gohou (2005) and Pan, Mohanty and Fadiga (2007) study the price linkages between cotton and polyester prices. Baffes and Gohou (2001) study shows that there exists a strong co-movement between polyester and cotton price. In addition, crude oil price has stronger effect on polyester price than cotton price. Meanwhile Pan, Mohanty and Fadiga (2007) study reveals that the polyester price responds asymmetrically to cotton price changes.

The objective of this research is to investigate the impacts of international price of CPO on the domestic price of CPO and cooking oil using a vector error correction (VEC) model approach. Three specific objectives are included:

1. To test whether international price of CPO and domestic price of CPO and cooking oil are related through cointegration tests.
2. To test the causal relationships between international price of CPO and domestic price of CPO and cooking oil.
3. To analyze how domestic price of CPO and cooking oil respond to a change in international price of CPO by estimating impulse response.

The remainder of this paper proceeds as follows, the next section discusses the palm oil industry in Indonesia followed by research methodology used in this research. The next part describe the data used in this research, followed by the cointegration tests, Vector

Autoregression (VAR) result, Granger-Causality tests and impulse response functions. Finally, implication of the model on the domestic price of CPO and cooking are discussed.

### **Palm Oil Industry in Indonesia**

Palm oil producers can be divided into three: smallholders, state-owned and private estate. The first large scale of Indonesia's palm oil plantation was set up by the Dutch colony in North Sumatera using the seed from Deli. Soon afterwards, the British traders also set up palm oil plantation in Malaysia using the seeds from Deli. After Indonesia gained independence in 1945, Dutch plantation owners had no longer support from the Dutch colony and several plantations were collapsed. In 1957, the Dutch colonial plantations were transferred to the Perusahaan Perkebunan Baru (New State Plantation Company) and since then the production had declined.

In 1968, the government of Indonesia started to invest again in the palm oil sector through state run companies called Perseroan Terbatas Perkebunan (PTP). During this period the palm oil planted area had increased dramatically. Most of the plantation was located in the North Sumatera province. In the late 1980s, the government began to expand the plantation into the island of Kalimantan and Irian Jaya.

In 1979, the government implemented the PIR (Perkebunan Inti Rakyat) or NES (Nucleus Estate and Smallholder Scheme). Private companies planted palm trees and after three to four years the planted area is transferred to the smallholder farmers (called plasma). The plasma will take care of the planted land under the guidance of the private companies (called Inti). After the tree is producing, the Inti is required to purchase the fresh fruit bunch (FFB) from the plasma which is then processed to CPO.

In 2006, 47 percent of the total planted palm trees is controlled by the private estate followed by small holders (43 percent) and state-owned (10 percent). The private estate has grown thirty times in the period of 1980-2006 with annual average of 15 percent. Meanwhile the state-owned estate in the same period only grew three times with annual average growth of 5 percent. In the 1980's, the state-owned estate dominated the palm tree planted areas, but beginning in the 1990's the position has been taken by the private estate.

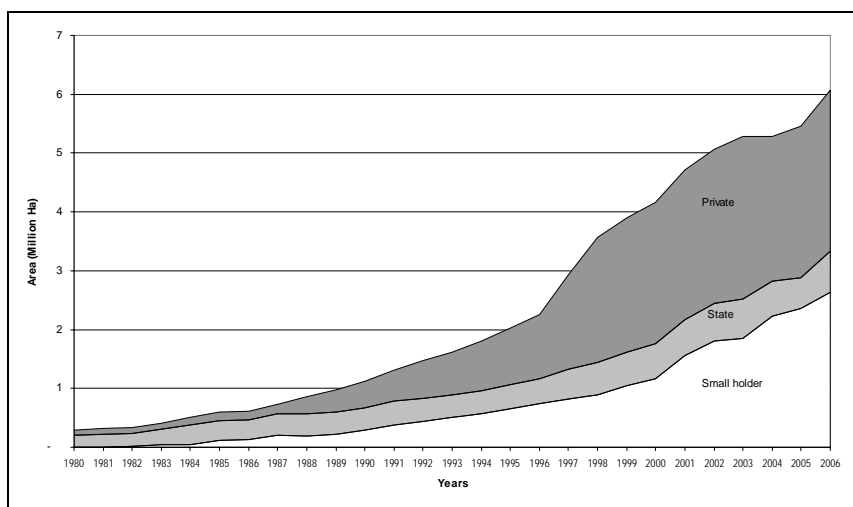


Figure 1. Palm Oil Planted Area of State-Owned, Private and Smallholders, 1980-2006  
Source: Ministry of Agriculture, 2008

Private estate contributed the largest palm oil production in 2006 with 47 percent followed by smallholders (38 percent) and state-owned (14 percent). The smaller contribution of private and smallholders estate in the production compare to the area planted indicate that the state-owned estate has higher productivity. This can be inferred that state-owned company has more experience in palm oil business.

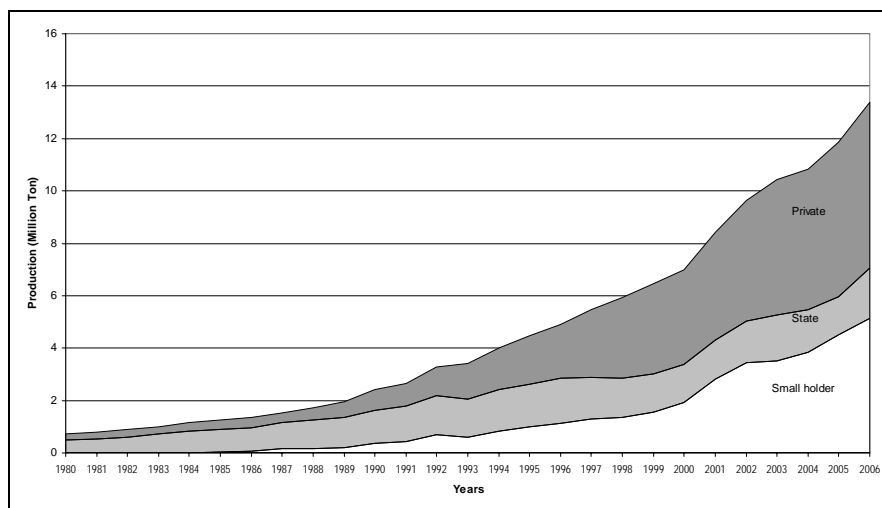


Figure 2. Palm Oil Production of State-Owned, Private and Smallholders, 1980-2006  
Source: Ministry of Agriculture, 2008

In 2003 to produce 2.6 million ton cooking oil, 3.9 million ton of CPO is needed. About 76 percent of CPO is utilized for cooking, which is the largest compare for oleochemical, soap and margarine (Figure 3). In 2008, it is projected that the CPO for cooking oil will increase by 25 percent, margarine 31 percent, soap 19 percent and oleochemical 2 percent but in terms of total percentage the amount is relatively the same compare to 2003 (Figure 3).

In Indonesia, cooking oil made from palm oil comprises 95 percent of total cooking oil production with the rest made from coconut oil (Infordev, 2006). Cooking oil industry as the largest consumer of palm oil in Indonesia has grown significantly over the years. During the period of 2000-2005, the production of cooking oil made from palm oil grew 10.2 percent in average. In 2005, the total production capacity of cooking oil industry is 9.94 million tons and 76 percent was dominated by 9 groups of companies (Infordev, 2006).



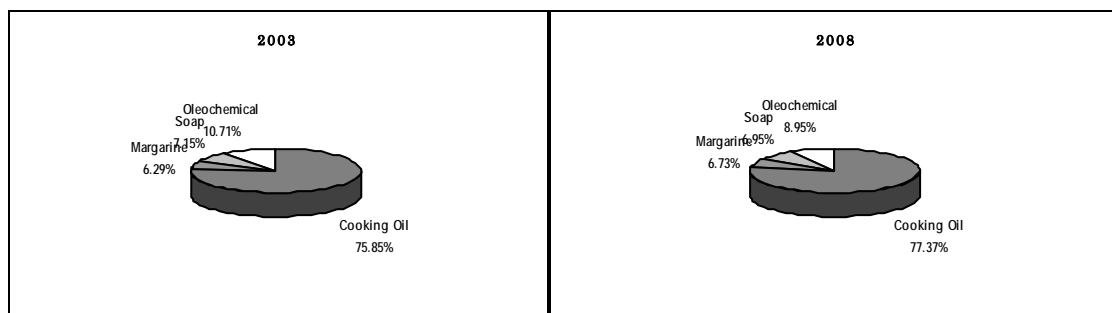


Figure 3. Domestic Consumption Usage of Palm Oil 2003 and 2008  
Source: CIC (2004)

Palm oil is the major exporting product of Indonesia. The exported product can be classified into two products: crude palm oil (CPO) (SITC Rev3 42221) and refined palm oil (SITC Rev3 42229), which include cooking oil. The largest importer of palm oil in 2007 is China, India and Netherlands which contribute about half of the world palm oil import (United States Department of Agriculture, 2008).

In 2007, 73 percent of Indonesia's palm oil production is exported and the rest is for domestic consumption (United States Department of Agriculture, 2008). The main destination of Indonesia's palm oil export is Asia which comprises about 70 percent of total export, followed by Europe by 21 percent and rest of the world by 9 percent. Meanwhile according to countries India, China, Netherlands, Pakistan and Singapore are the main destination of Indonesia's palm oil export (Figure 4). India and China are relatively new market compare to Netherlands which has been a traditional market for Indonesia's palm oil since the 1960's. Indonesia' palm oil export grew 23 percent in average during the period of 1980-2007 with highest export growth to Singapore with 70 percent during the same period. In 2007, Indonesia's palm oil export quantity decrease by 2 percent but in terms of value it increase by 63 percent. The increase in value was caused by the increase in FOB price by 72 percent in 2007.

Palm oil export product consists of two categories, crude palm oil (CPO) and refined palm oil. In 2007, the composition of CPO and refined palm oil export was 48 percent CPO and 52 percent refined palm oil. During the 1990's, Indonesia mainly exported in the form of CPO which has lower value added, in 1990 the composition was 84 percent CPO and only 16 percent refined palm oil.

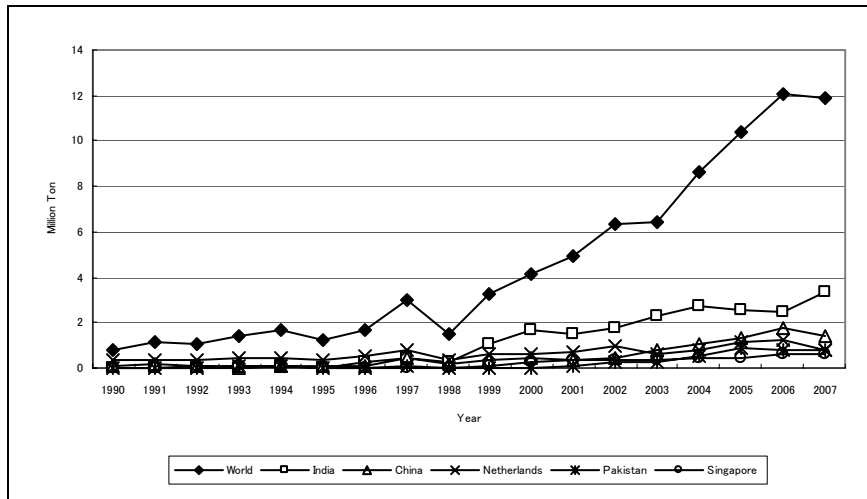


Figure 4. Indonesia's Palm Oil Export, 1990-2007  
Source: UN Comtrade (2009)

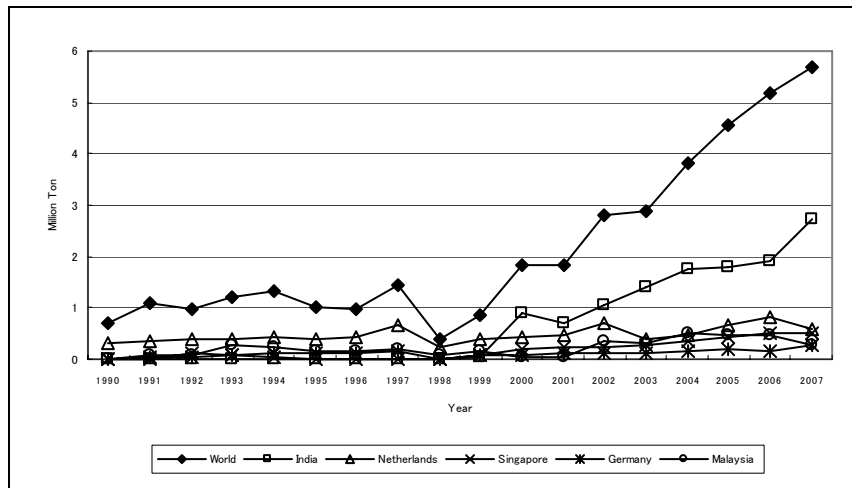


Figure 5. Indonesia's Crude Palm Oil (CPO) Export, 1990-2007  
Source: UN Comtrade (2009)

During the period of 1990-2007, CPO export grew by 23 percent in average (Figure 5). Since 2000, India became the main destination of Indonesia's CPO export and in 2007 the export to India constituted 48 percent of Indonesia's total CPO export.

The refined palm oil export grew 40 percent in average during 1990-2007 (Figure 6). China is the main export destination of Indonesia's refined palm oil export since 2005. China refined palm oil import from Indonesia constituted 19 percent of Indonesia's total refined palm oil export. Different from CPO, Indonesia's refined palm export is more diversified in terms of market destination. Similar to palm oil export, in 2007 refined palm oil export quantity decreased by 11 percent; meanwhile the value increase by 46 percent which is caused by the increase in price.

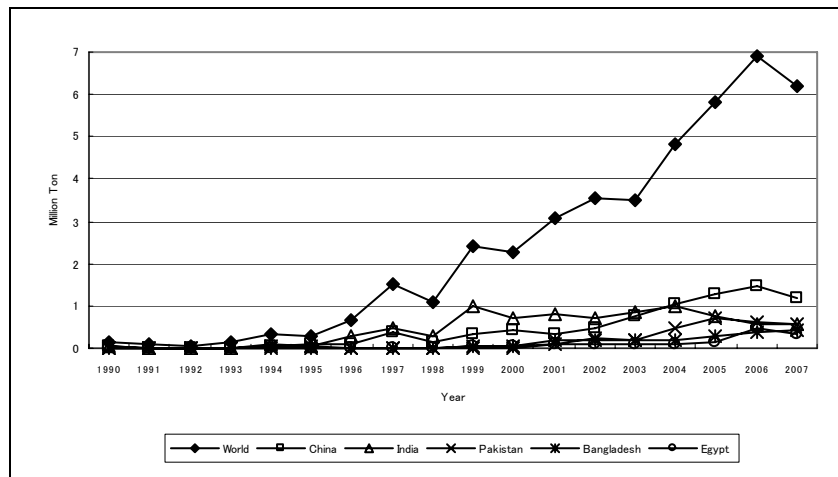


Figure 6. Indonesia's Refined Palm Oil Export, 1990-2007  
Source: UN Comtrade (2009)

## Research Methodology

The methodology used in this research is based on cointegration analysis of time series data. In this study, econometric analyses were conducted through four steps. First, unit root tests is performed on each series to assess the stationarity of each variable. Second, the Johansen methodology is conducted to test the cointegration relationships

between the variables. Third, Granger causality tests is performed on possible causal relationships between each series. Finally, we estimated the impulse response functions and variance decomposition of domestic prices for a change in international price of CPO.

### ***Unit Root Tests***

Unit root test, applying the Augmented Dickey Fuller (ADF), was used to test whether the variables were stationary or not. The test is perform by “augmenting” the preceding three equations by adding the lagged values of the dependent variable  $\Delta Y_t$  (Gujarati, 2003). The ADF test consists of estimating the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots(1)$$

where  $\varepsilon_t$  is a pure white noise error term and where  $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$ . The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms in order the error term in the equation is serailly uncorrelated. In ADF,  $\delta=0$  is tested and the ADF test follows the same asymptotic distribution as the DF statistic, so the same critical values can be used (Gujarati, 2003).

### ***Cointegration Tests***

If the variables are considered to be a non stationaty variables, the next step is to check whether the variables are cointegrated. When variables are cointegrated it means that the variables have long term relationship between them. One of the method to test cointegration is the Johansen method (Enders, 1995). Consider a vector autoregression (VAR) of order p

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + B X_t + \varepsilon_t \dots\dots\dots(2)$$

where  $Y_t$  is a k vector of non-stationary I(1) variables,  $X_t$  is a d vector of deterministic

variables, and  $\varepsilon_t$  is a vector of innovations. The VAR equation above can be written as,

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + B X_t + \varepsilon_t \dots\dots\dots (3)$$

where

$$\Pi = \sum_{i=1}^p A_i - I \quad \Gamma_i = - \sum_{j=i+1}^p A_j$$

Granger's representation theorem states that if the coefficient matrix  $\Pi$  has reduced rank  $r < k$ , then there exist  $k \times r$  matrices  $\alpha$  and  $\beta$  each with rank  $r$  such that  $\Pi = \alpha\beta'$  and  $\beta'Y_t$  is  $I(0)$ .  $r$  is the number of cointegrating relations (the *cointegrating rank*) and each column of  $\beta$  is the cointegrating vector. Johansen's method is to estimate the  $\Pi$  matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of  $\Pi$  (Eviews 5 Users Guide, 2004).

In calculating the number of cointegrating relations ( $r$ ), it can be calculated using the following two test statistics (Enders, 1995):

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \dots\dots\dots (4)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \dots\dots\dots (5)$$

where

$\hat{\lambda}_i$  = the estimated values of the characteristics roots obtained from the estimated  $\pi$  matrix

$T$  = the number of observations

The  $\lambda_{trace}$  tests the null hypothesis that the number of distinct cointegration vector is less than or equal to  $r$  against a general alternative, meanwhile  $\lambda_{max}$  tests the

null hypothesis that the number of cointegrating vectors is  $r$  against the alternative of  $r+1$  cointegrating vectors (Enders, 1995).

### **Vector Autoregression (VAR)**

The vector autoregression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach treats every variable as endogenous variables and the exogenous variables are the lagged values of all endogenous variables in the system (Pindyck and Rubinfeld, 1998). Then the system is estimated using the OLS.

Letting  $x_1, x_2, \dots, x_n$  be the endogenous variables and  $z_1, \dots, z_m$  be the exogenous variables, a VAR is given by the following set of  $n$  linear equations:

$$\begin{aligned} x_{1,t} &= a_{10} + \sum_{j=1}^p a_{11j} x_{1,t-j} + \sum_{j=1}^p a_{12j} x_{2,t-j} + \dots + \sum_{j=1}^p a_{1nj} x_{n,t-j} + \sum_{j=0}^r b_{11j} z_{1,t-j} + \dots + \sum_{j=0}^r b_{1mj} z_{m,t-j} + \varepsilon_{1t} \\ &\vdots \\ x_{n,t} &= a_{n0} + \sum_{j=1}^p a_{n1j} x_{1,t-j} + \sum_{j=1}^p a_{n2j} x_{2,t-j} + \dots + \sum_{j=1}^p a_{nmj} x_{n,t-j} + \sum_{j=0}^r b_{n1j} z_{1,t-j} + \dots + \sum_{j=0}^r b_{nmj} z_{m,t-j} + \varepsilon_{nt} \end{aligned}$$

### **Granger Causality Test**

Granger Causality test is a procedure for testing whether current and lagged values of one time series help predict future values of another time series (Stock and Watson, 2007). For example there is a VAR model for  $X$  and  $Y$  as follows:

$$Y_t = \sum_{i=1}^n \alpha_i X_{t-i} + \sum_{j=1}^n \beta_j Y_{t-j} + u_{1t} \dots \dots \dots (6)$$

$$X_t = \sum_{i=1}^n \lambda_i X_{t-i} + \sum_{j=1}^n \delta_j Y_{t-j} + u_{2t} \dots \dots \dots (7)$$

Basically the Granger test is the the F-statistic testing the hypothesis that the coefficients on all the values of one of the variables in Equation 6 and 7 are zero which means that these regressors have no predictive for the left hand variable beyond that

contained in the other regressors (Stock and Watson, 2007). In this test, there are four possible cases (Gujarati, 2003):

1. Unidirectional causality from X to Y is indicated if the estimated coefficients on the lagged X in Equation 6 are statistically different from zero as a group and the set of estimated coefficients on the the Y in Equation 7 is not statistically different from zero.
2. Unidirectional causality from Y to X is indicated if the estimated coefficients on the lagged Y in Equation 7 are statistically different from zero as a group and the set of estimated coefficients on the the X in Equation 6 is not statistically different from zero.
3. Feedback or bilateral causality exists when the sets of Y and X coefficients are statistically significant different from zero in both regressions.
4. Independence occurs when the sets of Y and X coefficients are not statistically significant in both regressions.

### ***Impulse Response Function***

The impulse response function traces out the response of the dependent variable in the VAR system to shocks or change in the error term (Gujarati, 2003).

### **Data Description**

The empirical analysis is conducted using monthly data from January 2000 until June 2008. Data for international price of CPO is obtained from the International Financial Statistics (IFS) of IMF, domestic CPO price and cooking oil price is gathered from the Ministry of Trade. All variables are expressed in nominal terms and take the

form of natural logarithm for the estimation using Eviews 5.1. Table 1 provides simple descriptive for each variable. Meanwhile Figure 7 and 8 plot the variables in the graph.

Table 1. Descriptive Statistics for International Price of CPO (INT), Domestic Price of CPO (DOM) and Cooking Oil Price (COOK), January 2000 – June 2008.

<b>Variables</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
INT	459.96	205.81	233.04	1146.90
DOM	4195.75	1885.45	1848.25	10169.53
COOK	5449.64	2019.61	3212.00	12444.00

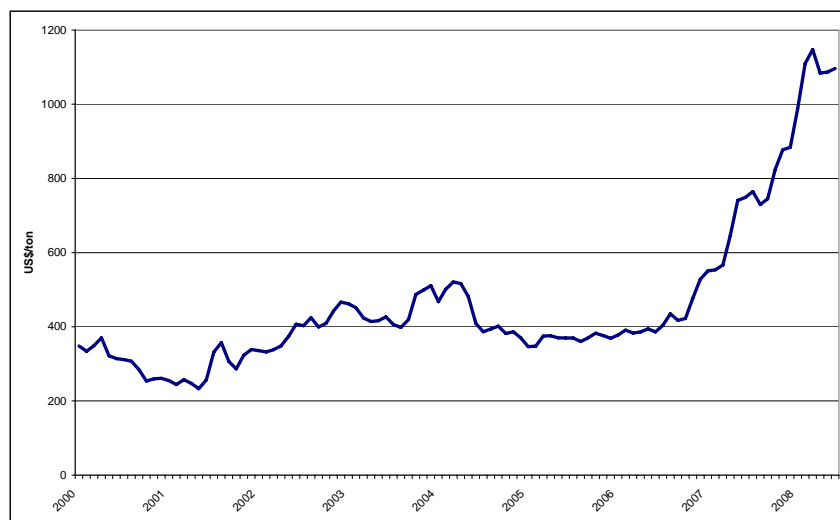


Figure 7. International Price of CPO (US\$/ton), January 2000 – June 2008  
Source: International Financial Statistics, International Monetary Fund



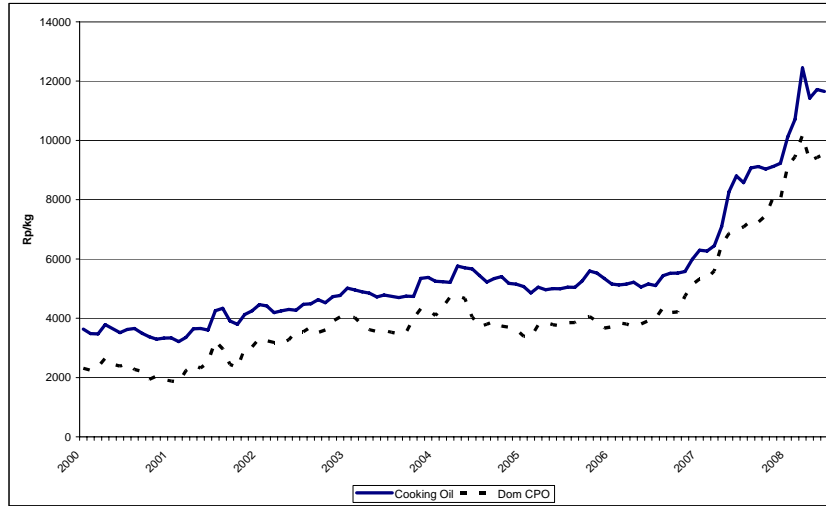


Figure 8. Domestic Price of CPO (Rp/kg) and Cooking Oil Price (Rp/kg), January 2000 – June 2008  
Source: Ministry of Trade

## Empirical Results

In order to test the stationarity of the data, unit root test is conducted. One of the methods in testing unit root is the Augmented Dickey-Fuller (ADF) test (Table 2). Two different ADF equations are calculated to test the presence of unit root, the first model include the constant variable and the second model constant and trend are included. In addition, Akaike Info Criterion (AIC) is employed to calculate the best lag. The results indicate that all of the variables are  $I(1)$  at 10% significance level which means that it is appropriate to conduct the cointegration test on all the variables.

Table 2. Augmented Dickey Fuller Test (ADF)

<b>Variables</b>	<b>ADF test (Constant included)</b>	<b>Lag</b>	<b>ADF test (Constant and trend included)</b>	<b>Lag</b>
<u>Level</u>				
International CPO Price	-0.4707	6	-1.7367	6
Domestic CPO Price	0.1773	6	-1.6365	6
Cooking Oil Price	1.1567	0	-0.8283	0
<u>First Difference</u>				
International CPO Price	-2.8341	5	-9.0477	1
Domestic CPO Price	-4.3452	4	-4.4828	4
Cooking Oil Price	-9.2265	0	-9.3851	0
10% significance level (constant included) = -2.5832				
10% significance level (constant and trend included) = -3.1549				

All variables indicate the I(1), thus, the next step is to test cointegration between the three variables utilizing Johansen Cointegration test. Before applying the Johansen Cointegration test, the number of lag is chosen using the LR test statistic, Final Predictor Error (FPE) and Akaike Information Criterion (AIC). The number of lag chosen is 3. The Johansen Cointegration test uses two tests, trace test and max-eigen value test. The result of the Johansen Cointegration test is reported in Table 3. The results reveal that there is no cointegration between the three variables, which can be shown from the probability column which has higher number than 0.1 or 10 percent significance level.. This implies that there are no long run equilibrium relationship between the three variables.

Table 3. Johansen Cointegration Test

Hypothesized No of Cointegration	Lag	Trace Test		Max Eigen-value Test	
		Trace Statistic	Probability	Max Eigen Statistic	Probability
Intercept (no trend) in CE and test VAR					
None	3	22.7029	0.2610	14.9160	0.2948
At most 1	3	7.7868	0.4885	7.7202	0.4079
At most 2	3	0.0666	0.7963	0.0666	0.7963
Intercept and trend in CE – no trend in VAR					
None	3	34.7127	0.2571	19.7418	0.2582
At most 1	3	14.9708	0.5770	10.4671	0.5690
At most 2	3	4.5038	0.6685	4.5038	0.6685

Considering no cointegration was found in the variables, therefore the VAR model can be calculated by using the first difference without including the error correction term (ECT). In calculating VAR model, the same lag number is employed as in conducting the Johansen Cointegration test. Table 4 represents the result of VAR model estimate.

Table 4. Vector Autoregression (VAR) Parameter Estimates

Variables	Dependent Variables		
	$\Delta INT$	$\Delta DOM$	$\Delta COOK$
Constant	0.008358	0.012150 <sup>*</sup>	0.006365
$\Delta INT_{t-1}$	0.559145 <sup>***</sup>	0.451076 <sup>**</sup>	0.267567 <sup>**</sup>
$\Delta INT_{t-2}$	-0.506859 <sup>***</sup>	-0.636257 <sup>***</sup>	-0.248242 <sup>**</sup>
$\Delta INT_{t-3}$	0.129986	0.462948 <sup>***</sup>	0.151044
$\Delta DOM_{t-1}$	-0.076474	0.084610	0.318549 <sup>***</sup>
$\Delta DOM_{t-2}$	0.274003	0.454940 <sup>**</sup>	0.300471 <sup>**</sup>
$\Delta DOM_{t-3}$	-0.020634	-0.313006 <sup>*</sup>	-0.151099
$\Delta COOK_{t-1}$	-0.104819	-0.432702 <sup>**</sup>	-0.420312 <sup>***</sup>
$\Delta COOK_{t-2}$	-0.332234	-0.392707 <sup>*</sup>	-0.122521
$\Delta COOK_{t-3}$	0.278505	0.380419 <sup>**</sup>	0.261568 <sup>**</sup>
$R^2$	0.267742	0.311224	0.408307
F stat	3.575133	4.418106	6.747322

The results indicate that international price of CPO is only affected by its own lag. Meanwhile, domestic price of CPO and cooking oil price is affected by international price of CPO. In addition, domestic price of CPO and cooking oil price is affecting each other.

The Granger Causality test (Table 5) supports the VAR result which shows that there exist a price linkage between international price of CPO and both domestic price of CPO and cooking oil price. On the other hand, domestic price of CPO and cooking oil price has the feedback or bilateral causality.

Table 5. Granger Causality Relationship Test Result

Null Hypothesis	F-statistics	P-value
DOM does not Granger Cause COOK	15.5513	2.9E-08
COOK does not Granger Cause DOM	2.62940	0.05483
INT does not Granger Cause COOK	13.0111	3.7E-07
COOK does not Granger Cause INT	1.30551	0.27742
INT does not Granger Cause DOM	3.73980	0.01382
DOM does not Granger Cause INT	1.50002	0.21980

In order to analyze the magnitude of the effect of international price of CPO to both domestic prices, impulse response function analysis is conducted (Figure 3). The impulse response indicates that a shock in international price of CPO will immediately affect the domestic price of CPO compare to cooking oil price. Cooking oil price will be affected after the fourth month. This shows that domestic price of CPO has more linkage to international price of CPO than the cooking oil price.

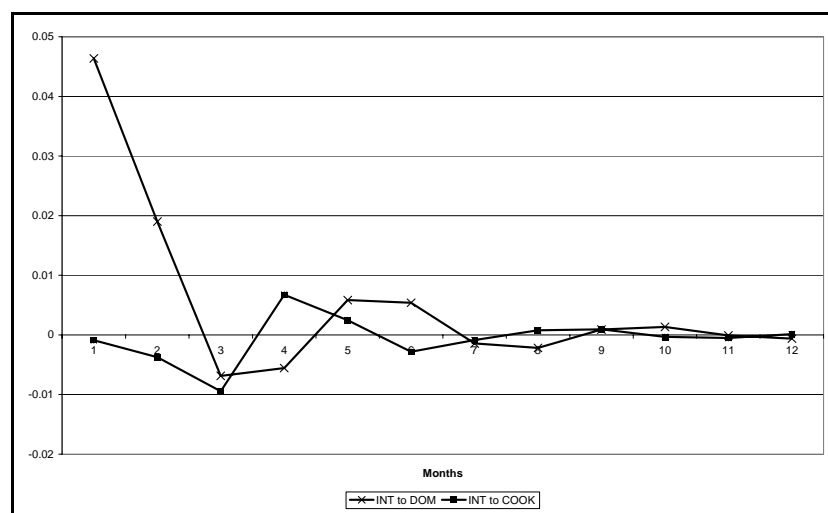


Figure 9. Domestic Price of CPO and Cooking Oil Price Response to a Shock of International Price of CPO

The implication of this research indicates that the international CPO price affect both domestic price of CPO and cooking oil price. Therefore cooking oil producer and the government must anticipate when the international price of CPO beginning to rise since the effect will be immediate. In addition, the domestic price of CPO will be more affected by the change in international price of CPO.

## **Conclusion**

1. The domestic cooking oil price, domestic price of CPO and international price of CPO is not cointegrated. It implies that the three variables have no long-run equilibrium relationship.
2. International price of CPO causes domestic price of CPO and cooking oil price. Meanwhile, domestic price of CPO and cooking oil price affects each other.
3. A change in international price of CPO has immediate and bigger affect on domestic price of CPO compare to cooking oil price.

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