

# The Impact of Macroeconomic Variables on Commodity Futures Prices: An Evidence from Malaysian Crude Palm Oil Futures

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**Abstract:** *The current study aims to fulfil the gap of knowledge in commodity futures by empirically examining the influence of selected macroeconomic variables on the prices of commodity futures particularly Crude Palm Oil Futures (FCPO). Cointegration, Vector Error Correction and Granger causality analyses are used to examine the nexus between macroeconomic variables (interest rate, exchange rate and Industrial Production Index (IPI)) and FCPO from January 1999 to December 2019. Results show that interest rate, exchange rate and IPI have a significant influence on FCPO prices in the long-run. While interest rate and exchange have a negative impact, IPI has a positive impact. VECM results suggest that the macroeconomic variables appear to have no significant short-run causal effect associate with the FCPO prices. Granger causality test indicate that FCPO and exchange Granger cause IPI and act as leading indicators for IPI. The study implicates that policy makers should carefully design policy (monetary and fiscal intervention) to reduce swings in the commodity futures prices to protect hedgers and investors.*

**Keywords—** *Interest rate, Cointegration, Industrial Production Index, Granger Causality, Exchange rate and Vector Error Correction Model.*

## 1. Introduction

Previous studies showed that macroeconomic variables such as Industrial Production Index (IPI), exchange rate and interest rate exert influence on commodity futures prices [6], [15], [25] & [1]. Various approaches have been applied to investigate the link between prices of commodity futures and a wide range of macroeconomic variables.

The price variations of commodity futures have attracted an immense attention in the academic and industrial circles. Various factors such as monetary policy, supply and demand for the underlying assets, and macroeconomic variables can cause the prices of commodity futures to fluctuate [3].

Macroeconomic variables play a significant role in determining the prices of commodities at spot and future [20]. Changes in macroeconomic factors affect the commodity futures prices. [18] maintains that commodity futures prices reflect the market reaction and economic directions considering that the market is efficient. The high volatility of futures prices expresses the ambiguity in the prices, which may adversely affect hedgers, producers and those who are responsible for making macroeconomic policies. Therefore, analysing the influence of IPI, exchange rate and interest rate is important for policy makers to understand the behaviour, interrelations and dynamics and of commodity futures prices. A

clear understanding for the behaviour of futures prices hugely helps policy makers to design monetary and economic policies that could have impact on both financial and economic activities.

The present study examines the impact of IPI, exchange rate and interest rate on Malaysian Crude Palm Oil Futures (FCPO) that are traded at Bursa Malaysia. Commodity futures contracts were proposed to fulfil two economic objectives. First, to discover the price in an efficient way, and second to hedge against the fluctuation of price.

## **2. Literature Review**

This section describes the literature that is related to the study's objectives. At international level, many studies examine the nexus between three macroeconomic variables (IPI, exchange rate and interest) and commodity futures. However, a few studies in Malaysian context show the influence of IPI, exchange rate and interest rate on FCPO prices. Therefore, the current study seeks to fulfil the knowledge gap by extending this research scope to cover FCPO which is the largest global palm oil contracts traded [3].

### **2.1 The Impact of Interest Rate on Commodity Futures**

Many previous studies showed that interest rate changes affect commodity futures prices. [1], [4], [27] & [12] have empirically found that interest rate significantly effects commodity futures prices.

Generally, interest rate exerts negative influence on commodity futures prices through different channels considering that the market is efficient [1], [20], [4] [26] & [11]. Since it is a negative relationship, an increase in the interest causes the prices of commodity futures to fall. This kind of interaction between interest rate and futures prices can be attributed to the behaviour of market participants i.e. investors. If interest rate goes up, the investors will sell futures contracts to hold more money in return to earn high interest rate bearing. As a result, the prices of commodity futures will drop. In an opposite scenario, the investors are expected to demand more commodity futures contracts if the interest rate falls, which makes the commodity futures prices to rise.

### **2.2 Connection between Exchange Rate and Prices of Commodity Futures**

A few studies have investigated how commodity futures react to the changes in the rate of a currency exchange. The results from previous studies show that prices of commodity futres are influenced by fluctuations in the exchange rate. Most studies reveal a positive impact while others find negative influence.

[33] found that exchange rate negatively influences various commodity futures prices such as crude and heating oils. Similarly, [13] empirically proved that Canadian dollar and Euro currencies have negatively affected commodity prices in the USA. [24] argued that inflation can be the underlying cause for the inverse reaction between commodity future prices and exchange rate. They further maintained that the investors prefer to buy more commodity futures contracts if exchange rate goes down particularly in the market of agriculture and energy commodities.

On the other hand, some studies have identified a positive interaction between oil prices and exchanges rates [31].

### **2.3 The Influence of IPI on Commodity Futures**

Three reasons make the researcher to choose IPI instead of GDP. First, IPI represents a real output of an economy [32]. Second, GDP is a comprehensive indicator that not only represents commodities only but includes services as well [29]. Therefore, services are considered are out of the study's scope. Third, GDP data are only available on quarterly or annual basis while IPI are available on monthly basis.

Due to limited numbers of studies on the relationship between IPI and commodity futures prices, the current study seeks to fulfil the knowledge by investigating the influence of IPI on commodity futures. [10], maintained that it is expected to find a positive relationship between IPI and commodity prices. Underlying commodities for futures are used as input for industry production, which make

underlying commodities as a good proxy for the demand for futures [17]. Therefore, an increase in IPI results in increase in commodity prices.

The findings of previous studies revealed inconsistent results whether IPI has positive or negative impact on the prices of commodity futures. [10] argued that the prices of futures contracts show a positive behaviour towards changes in IPI. However, [9] found that IPI has a negative impact on the carbon future prices.

### 3. Date Collection Procedures

The study analyses monthly data of FCPO, IPI, exchange rate and interest rate spanning from January 1999 to December 2019. Each variable has 240 monthly observations with a total of 960 observations for all variables. Choosing this period was mainly due to abnormal data issues that may occur in the pre-sample period particularly during Asian financial crisis 1997-1998. The period of the study is almost twenty years, which is enough to capture macroeconomic trends in FCPO prices.

The researcher collected data from reliable sources such as Bloomberg for FCPO prices and central bank of Malaysia (Bank Negara Malaysia) for IPI, exchange rate and interest rate.

### 4. Methodology and Empirical Results

The following sub-sections provide a framework for analysing time series data following appropriate statistical methods including, unit root test, cointegration test, Granger causality test and Vector error correction model (VECM).

#### 4.1 Unit Root Test

It is well recognized that macroeconomic time series are not stationary at level [23]. Therefore, Dickey-Fuller test (ADF) (1979) and the Phillips-Perron test (PP) (1988) are approaches that should be applied to ensure that all variables are integrated of the same order.

Table 1: ADF and PP stationarity tests

Variable	ADF				PP			
	Level		1 <sup>st</sup> Difference		Level		1 <sup>st</sup> Difference	
	intercept & trend	intercept	intercept & trend	intercept	intercept & trend	intercept	intercept & trend	intercept
FCPO	-2.32 (0.41)	-1.67 (0.44)	-13.35* (0.00)	-13.38* (0.00)	-2.67 (0.24)	-1.87 (0.34)	-13.38* (0.00)	-13.41* (0.00)
IntR	-3.16 (0.09)	-2.70 (0.07)	-13.45* (0.00)	-13.48* (0.00)	-2.96 (0.15)	-2.79 (0.07)	-13.62* (0.00)	-13.56* (0.00)
ExR	-2.52 (0.31)	-2.36 (0.15)	-12.63* (0.00)	-12.51* (0.00)	-2.55 (0.30)	-2.43 (0.13)	-12.63* (0.00)	-12.49* (0.00)
IPI	-2.29 (0.43)	-1.20 (0.67)	-4.115* (0.00)	-3.962* (0.00)	-2.75 (0.12)	-1.63 (0.46)	-29.15* (0.00)	-29.02* (0.00)

\* indicates significant at 5%, and the critical value for the ADF and PP test with intercept & trend is -3.43, and the value with intercept only is -2.87. The p-values are given in parenthesis

Table 1 reports that all t-statistic values for individual variables at level are greater than the critical values at 5 percent of significance level. Thus, the null hypothesis of non-stationarity at level cannot be rejected and all variables at level are integrated of I (0). Results from ADF and PP show that all variables at first difference are integrated of I (1).

#### - Appropriate Optimal Lag Length Selection

It is essential to determine the correct optimal lag length to ensure that no autocorrelated error is generated [28]. According to Akaike Information Criterion (AIC), using eight lags produces no serial correlation in the residuals of up to p = 12 months (Table 2).

Table 2: Results of the Optimal Lag Length Selection

Lag	AIC
0	-8.718469
1	-18.45579
2	-18.68078
3	-18.66447
4	-18.64658
5	-18.67708
6	-18.66965
7	-18.71779
8	-18.71876*
9	-18.63242
10	-18.57318
11	-8.718469
12	-18.45579

\* indicates lag order selected by the criterion  
AIC: Akaike Information Criterion

Table 3 reports the result of the LM serial correlation test for the residuals. The p-values of the LM test demonstrates that the residuals from unrestricted VAR model are not serially correlated up to  $p = 10$ .

Table 3: LM Tests for VAR Residuals

Lags	LM-Stat	Prob
1	22.43863	0.1296
2	10.83665	0.8195
3	13.68579	0.6221
4	21.86557	0.1476
5	25.47871	0.0665
6	22.13341	0.1389
7	23.88568	0.0920
8	15.51721	0.4871
9	19.12175	0.2624
10	21.33907	0.1658

#### 4.2 Cointegration Test

Two or more variables can be cointegrated if their linear combination does not have a stochastic trend [28]. The linear combination cointegration equation reveals an existent long-run relationship among variables.

To ensure that variables are cointegrated, they should be integrated of order  $I(1)$ . Johansen-Juselius test (1990) is one of the recommended methods to test for integration. Johansen-Juselius is a unique approach for two reasons. First, all variables in the VAR model are treated endogenous. Second, it is a one-step calculation that allows to overcome a bias could be resulted from using similar approaches such as Engle-Granger test.

The following equation represents general model of Johansen-Juselius test [14]:

$$(1)$$

We can rewrite equation (2) to include error correction:

$$(2)$$

Cointegration is existed if  $\Pi$  has rank  $r$ ,  $0 < r < k$ , [5]. Trace and eigenvalues statistics are used to determine the rank of matrix  $\Pi$  as follows:

$$(3)$$

$$(4)$$

Equation (3) tests that:

H0: rank,  $(\Pi) \geq r$ , at most  $r$  groups of cointegration vectors,

H1: rank  $(\Pi) \leq r$

Equation (4) tests the following hypothesis:

H0: rank  $(\Pi) = r$ ,

H1: rank  $(\Pi) = r + 1$

Table 1 shows that all variables are integrated of I (1). Akaike Information Criterion (AIC) indicates that eight lag length is appropriate (see Table 2) because no serial correlation will appear up to  $p = 10$  months (see Table 3).

Table 4: Trace Statistic

Unrestricted Cointegration Rank Test (Trace)					
Hypothesized No. of CE(s)		Eigenvalue	Trace Statistic	0.05 Critical Value	P-Value
$H_0$	$H_1$				
$r = 0$	$r \geq 1$	0.232063	57.69776*	47.85613	0.0000
$r \leq 1$	$r \geq 2$	0.083384	15.31355	29.79707	0.4052
$r \leq 2$	$r \geq 3$	0.012756	2.089972	15.49471	0.9766
$r \leq 3$	$r \geq 4$	0.000907	0.324312	3.841466	0.6693

*r indicates the number of cointegrating relationships*  
*Trace test indicates 1 cointegrating eqn(s) at the 0.05 level*  
*\* denotes rejection of the hypothesis at the 0.05 level*

Table 5: Maximum Eigenvalue Statistic

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)					
Hypothesized No. of CE(s)		Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P-Value
$H_0$	$H_1$				
$r = 0$	$r = 1$	0.232063	42.38421*	27.58434	0.0000
$r \leq 1$	$r = 2$	0.083384	13.22358	21.13162	0.1497
$r \leq 2$	$r = 3$	0.012756	1.765661	14.26460	0.9707
$r \leq 3$	$r = 4$	0.000907	0.324312	3.841466	0.6693

*r indicates the number of cointegrating relationships*  
*Max-eigenvalue 1 cointegrating eqn(s) at the 0.05 level*  
*\* denotes rejection of the hypothesis at the 0.05 level*

The results show that there is at least one cointegrating vector and thus there is a long-run relationship between macroeconomic variables (IPI, exchange rate and interest rate) and FCPO prices. Furthermore, there should be at least one direction of causality among variables in the system. Finding a long-run equilibrium relationship is consistent with the large empirical studies including [15], [20], [34], [27], [4], [11], [25], [9] & [16].

The long-run equilibrium relationship between selected predictor variables and FCPO prices can be represented as linear functions. There is at least one cointegration vector which is normalized using the coefficient of the log of FCPO.

(6)

SE

(0.0467) (0.09004)  
(0.0541)

t-value

[-3.8380] [-2.4300]  
[5.2005]

Equation (6) represents cointegration equation, where SE indicates standard error. The estimated coefficients resulted from the equation refer to the long-term elasticity because variables are in the logarithmic forms. Coefficients in the equation (6) appear statistically significant and contribute to the long-run equilibrium relationship between FCPO price and the explanatory variables including interest rate, exchange rate, and IPI. The estimated coefficients of interest rate and exchange rate are negative while the coefficient for IPI is positive. Generally, this finding suggests that the estimated coefficients are consistent with respective economic theories .

There is a significant and negative relationship between interest rate and FCPO price as hypothesized by [15]. Finding a negative and significant relationship is in line with most empirical studies such as [15], [20], [26], [4], [1], & [11], [12], & [10] who found a negative correlation between interest rate and commodities. The estimated coefficient of interest rate was 0.18. It implies that when the interest rate increases 1 percentage point (100 basis point), the price of FCPO declines by 0.18 percent. This finding is typically consistent with [8] who found that rising in interest rates by a 100-basis point could lower the prices of various agricultural commodities between 0.12 percent and 0.18 percent.

A possible explanation for the negative relationship might be provided as follows:

First, return offered on the Treasury bill (proxy for interest rate): When the return on Treasury bill increases, investors will shift their financial capital to invest in Treasury bill. Consequently, the FCPO market becomes less liquid, which ultimately causes FCPO price to decline. On the other hand, when the return on Treasury bill decreases, the investor channel capital to FCPO the Treasury bill provides higher return. With more liquidity, the price of FCPO will increase.

According to equation (6), a significant and negative relationship exists between exchange rate and FCPO price. This result is expected and comparable to prior empirical studies, including [13], [33], [1], [25] and [22]. A one percentage point rising in the exchange rate was expected to lower FCPO price by 0.24 percent.

The inverse relationship between exchange rate and FCPO price could be attributed to a diversification risk strategy that is related to hedging and portfolio rebalancing. When the Ringgit depreciates, the investors demand more FCPO in order to diversify the risk of Ringgit depreciation. Consequently, the price of FCPO rises. Another possible explanation for a negative relationship is that a depreciation of the Ringgit versus USD makes the underlying asset, palm oil, and FCPO cheaper for foreign investors. This leads the investor to purchase FCPO. As a result, the price of FCPO goes upwards.

Equation (6) shows that the coefficient of IPI exhibited a positive sign as expected. This result in line with [30], [16], [9], [10] and [19]. Growth in IPI of one percent has an effect of around 0.28 percent increase in FCPO price. This finding is consistent with [10]. According to him, when IPI increases by 1 percent, prices for futures would be increasing by 0.40 percent.

A possible explanation could be lying in the economic expansion, which in turn leads to strong demand for the underlying asset of FCPO. In fact, IPI represents economic activities. When the economic activities are sustainably growing, the demand for commodity market, particularly agricultural, is very strong [9]. This will stimulate more production of commodities because of high demand, which in turn increases their futures prices. Therefore, in case of FCPO, an increase in IPI will rise directly the demand for the underlying asset of FCPO, which consequently leads to increase in FCPO price.

Another possible explanation could be linked to asset allocation strategy. [10] maintained that a good optimal asset allocation strategy is to have various assets, e.g. stocks, bonds and commodity

futures in a portfolio. These three types of assets behave differently to increase in IPI. Stocks and bond negatively react to increase in IPI, while commodity futures positively react [10]. As an optimal asset allocation, when IPI goes up, the investors sell stocks and bonds and heavily invest in commodity futures. As a result, commodity futures, i.e. FCPO price increases.

#### 4.3 Vector Error Correction Model Causality Test

Cointegration test reveals that all variables are cointegrated. Having established long-run association, there is a need to examine the short-run and long-run dynamics of cointegrated variables by using Vector error correction model (VECM). Since all variables are cointegrated, VECM is applied to determine the direction of Granger causality and whether it is long-run or short-run forms of Granger causality.

Before proceeding to analysis, the lag length for p should be determined because the VECM is a more general case of the standard VAR [5].

Table 6: Optimal Lag length for VECM

Lag	LogL	AIC
0	849.6915	-13.90608
1	1810.212	-14.18790
2	1848.036	-14.17094
3	1862.454	-14.24847
4	1876.719	-14.25371
5	1895.676	-14.25447
6	1910.956	-14.21166
7	1931.626	-14.20385
8	1947.720	-14.15795
9	1955.344	-14.11750
10	1965.599	-14.46188*

To determine the appropriate lag length for VECM, Akaike Information Criterion suggests to use a lag length of 10 (see Table 6). Corresponding to cointegration model in section (4.2), selection of 10 lags ensures that the residuals are white noise. To support this argument, the analysis proceeds to conduct a serial correlation test for VECM.

Table 7: Breusch-Godfrey Serial Correlation LM Test for the VECM

Lag	LM value	P-value
1	13.99987	0.5987
2	20.67429	0.1914
3	24.39499	0.0812
4	21.90740	0.1462
5	25.86518	0.0802
6	11.56236	0.7735
7	21.18490	0.1715
8	21.82517	0.1489
9	23.74194	0.0953
10	19.05466	0.2658

The results of LM test shows the absence of serial correlation in the residuals up to  $p = 10$  as depicted in the Table 7. All assumptions for the cointegrating vector are maintained as done in the previous section (4.2). The researchers conducted cointegration test and found one cointegrating vector in the VECM model.

Table 8: Vector Error Correction Model

Dependent variable	Independent Variable				ECT (t-ratio)
	$\Delta$ FCPO	$\Delta$ Intr	$\Delta$ Exr	$\Delta$ IPI	
$\Delta$ FCPO	-	6.77 [0.45]	18.68 [0.22]	27.05 [0.20]	-0.090* (-2.380)
$\Delta$ Intr	15.69 [0.40]	-	61.63 [0.34]	8.84 [0.88]	-0.46 (-1.201)
$\Delta$ Exr	17.34 [0.29]	15.20 [0.43]	-	45.20 [0.31]	-.054 (-1.329)
$\Delta$ IPI	18.33 [0.04] *	9.55 [0.84]	17.05 [0.00]*	-	0.405 [0.426]

\* denotes significant at 5% significance level.

(...) denote t-statistic, and [...] represent p-value.

It appears that macroeconomic variables have no significant short-run causal effect associate with FCPO based on the p-values (see the first row of the Table 8). This result is in line with prior empirical studies such as [9] and [25]. Accordingly, all available information on changes from interest rate, exchange rate, and IPI are assimilated in the FCPO price. Thus, the findings support that the future market of FCPO is an efficient market in the short-run particularly with refence to interest rate, exchange rate and IPI variables. This result provides an evidence that the market of FCPO has met the efficient market hypothesis (EMH). This result is consistent with Ahmad [2] and [7] who empirically found the Malaysian futures market efficient.

The error correction term ECT coefficient is significant and has the correct expected negative sign. The ECT is generated from the Johnson cointegration test with the first cointegrating vector normalized on the FCPO price. Finding negative and significant ECT supports the cointegration results as reported in Tables 4 and 5. ECT represents the speed of adjustment. The magnitude of the speed of adjustment is about 9 percent, suggesting that the FCPO price convergence towards its long-run equilibrium within almost 12 months after a shock. In other words, when the cointegrating vector is above the equilibrium, the FCPO price decreases by 9 percent every month to attain equilibrium. This finding implies that error correction is helpful to predict changes in FCPO price.

The FCPO and exchange rate are leading indicators for IPI according to the p-values in the first column in Table 8. The correlation between FCPO price and IPI could reflect the fact that CPO, which is the underlying asset of FCPO, represents a significant part of the manufacturing sector of IPI. An increase in FCPO necessarily leads to increase in IPI and vice versa. On the other hand, FCPO is not a leading indicator of the interest rate and exchange rate as p-value shows in the first column of the table. It is worth to mention that there is no clear view from the prior literature on how interest rate and exchange rate could react to the shocks from FCPO price. Exchange is a leading indicator for IPI. This could be interpreted in the weak of Ringgit against USD. As Malaysia is industrial state, depreciation in Ringgit encourages investor to buy more commodities. High demand for commodities leads IPI to increase as a result for high industrial production. According to [21], exchange rate has an impact on the economic output by boosting trade and increase net export.

#### 4.4 Granger Causality Test

Table 8 shows the F-statistic for Wald test. Based on the p-values of , IPI Granger causes exchange rate in short-run but not vice versa. Malaysian Ringgit is vulnerable to changes in IPI. A possible explanation that is IPI represents the economic growth in the economy. A decrease in IPI would expect to cause interest rate to decrease. This would make saving money less attractive for investors. In this case, and as Malaysia is an open economy, the foreign investors will leave Malaysia to countries where the return on similar instruments such as interest rates are higher. They sell Ringgit and buy other currencies. Consequently, this causes a fall in the value of the Ringgit.

FCPO price Granger causes IPI. A possible explanation for this could lie in the fact that CPO, underlying asset for FCPO, represents a significant part of the manufacturing sector of IPI. According to Otieno et al. (2016), CPO accounts for about 8 percent of total Malaysian GDP . This significant contribution to economic activities comes from CPO which is a part of IPI. Therefore, an increase in FCPO price could have an impact on IPI.

Exchange rate also Granger causes IPI in the short-run. This is could be attributed to the fact that Malaysia is an industrial nation and export many manufactured commodities. A weak Ringgit against USD attract investors to buy more commodities. Consequently, industrial production will be increased to fulfil the high demand, which as a result could exert an impact on IPI.

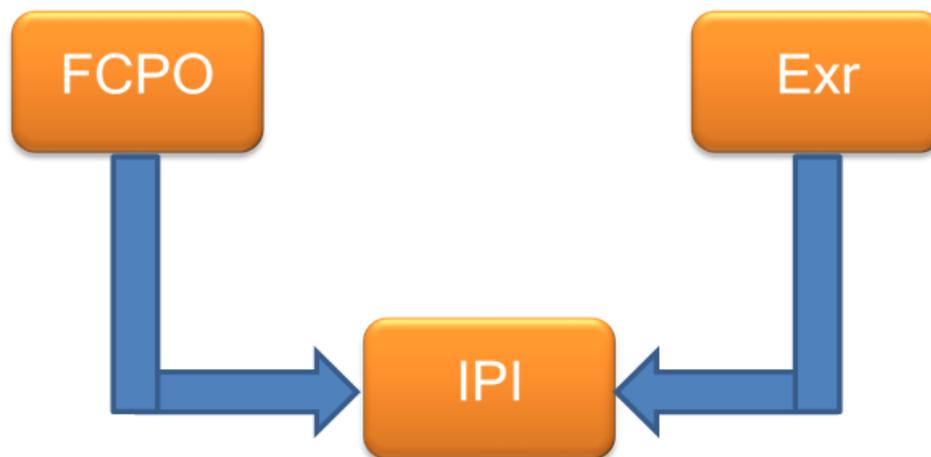


Figure 1: Analysis of Short-run Channels for Granger Causality

### Conclusion, Implication and Contribution

The study seeks to examine the dynamic relationship between commodity futures with reference to FPCO and macroeconomic variables includes interest rate, exchange rate and IPI. The study has empirically fulfilled the above objective and contributed to the existing literature using cointegration, VECM and Granger causality analyses. Results from cointegration suggest that interest rate, exchange rate and IPI exert a significant impact on FCPO prices in the long-run. While interest rate and exchange have a negative impact, IPI has a positive impact. These findings are consistent with the findings of [15], [20], [34], [33] and [13].

In the short-run, the results of the VECM suggest that the macroeconomic variables appear to have no significant short-run causal effect on the FCPO prices. This result supports that the FCPO futures market is an efficient market in relation to the selected macroeconomic variables, which implies that the FCPO market has met the efficient market hypothesis (EMH). The error correction term ECT has a significant negative sign, which indicates that there is a long-run causal effect. The speed of adjustment is 9 percent, suggesting that the FCPO price convergence towards its long-run equilibrium within almost 12 months after a shock. Accordingly, the error correction can be used to predict changes in FCPO price. This result is consistent with [2], [7] and Arshad & Mohamed (1994) who empirically found that the Malaysian futures market is efficient. Granger causality test shows that FCPO and exchange Granger cause IPI and act as leading indicators for IPI.

The study may suggest some implications on the light of current research findings. The significant nexus between macroeconomic variables and commodity futures prices indicates that policy makers should carefully design policy (monetary and fiscal intervention) to reduce swings in the commodity futures prices. As Malaysia is the second largest producer of CPO, policymakers may resort to an effective inventory management of the underlying asset (CPO). Managing inventories in the long-run leads to stabilize the domestic prices. Stable domestic prices would protect participants in the market particularly, producers who are mostly hedgers in FCPO. The investors, producers and hedgers should take informed decisions based on the effect of macroeconomic variables when they invest in the commodity futures.

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