The Determinant of Local Palm Oil Price in Malaysia: Does the Covid-19 Pandemic Matter?

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Abstract. Biodiesel is an alternative fuel and is getting substantial attention globally due to its environmental benefits. Biodiesel is one of Malaysia's downstream movements of the palm oil industry. This industry is well known for its economic contribution to Malaysia's income growth. This study determines the effect of biodiesel price and the Covid-19 pandemic on Malaysia's local palm oil price using the monthly data which covered the period of January 2013 to June 2022. ARDL bound testing was adopted to test for cointegration. The dummy variable represents the lockdown period incorporated in the model. The findings indicate the existence of cointegration among variables. The real exchange rate and industrialization have a negative and significant impact on local palm oil prices, and crude oil and biodiesel prices positively affect Malaysia's local palm oil prices. Interestingly, the impact of biodiesel price on the local palm oil price is higher than the crude oil price. The dummy variable, which represents the Covid-19 pandemic effect, shows a significant positive effect on the local palm oil price in the short and long run. Policies promoting the sustainable development of the palm oil and biodiesel industry will contribute to Malaysia through increased output, employment, and GDP.

Keywords: Malaysia · Biodiesel · Palm oil price · Environmental · Sustainable development goals · Supply and demand

1 Introduction

The growing world's population is continuously increasing the consumption of fossil fuels. In an optimistic view, renewable energies such as biodiesel are getting reasonable encouragement in economic activities, replacing traditional fuel. Research and development on renewable energies are getting more comprehensive due to their environmental benefit. Palm oil is Malaysia's primary biodiesel production feedstock, considered its primary agricultural export commodity. Current data indicates that about 5.87 million hectares of land are utilized for the plantation of palm oil in Malaysia, with a maximum production capacity of 96.97 million tonnes in 2020 (Department of Statistics, Malaysia,

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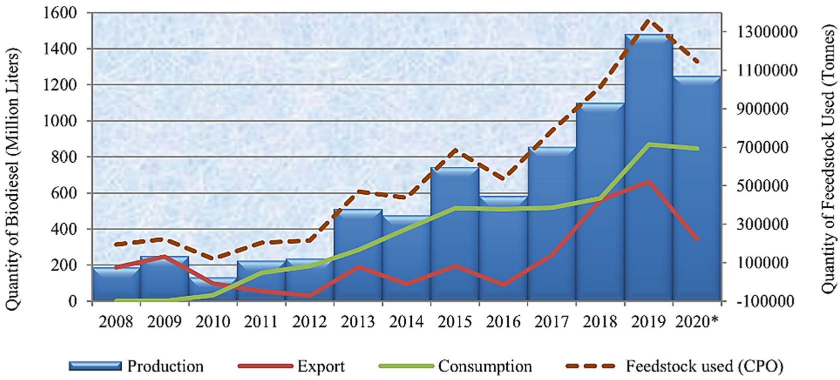

Fig. 1. The Production, Export, and Consumption of Biodiesel and the Feedstock Used in Producing Biodiesel in Malaysia from 2008 to 2020*. Source: USDA Foreign Agricultural Service, 2021. Note: * represent the expected value. CPO stand for crude palm oil

DOSM, 2021). In terms of overall global production, Indonesia is top producer followed by Malaysia, contributing 24.6% of world palm oil production[1].

Based on DOSM (2021), the palm oil contribution an average of 2.77% to the Malaysia's GDP for the period of 2016–2020. Due to the palm oil industry's dynamic growth, this sector is vital to Malaysia's national economy, especially in the oleochemical and biodiesel industries (Lau, Tan, Lee, and Mohamed, 2009). Accordingly, Fig. 1 shows Malaysia's palm production, export, and domestic consumption. Notably, production, export, and consumption show an increasing trend yearly[2].

Even though palm oil production and export volume have been consistent over the years without any significant structural effect (refer to Fig. 1), palm oil prices seem to fluctuate from 2000 onward. This can be viewed in Fig. 2. This fluctuation has seemed to be directed by the demand side of palm oil's commodity. Thus, some researchers such as Applanaidu et al. (2011), Dutta et al. (2021), and Szulczyk, Yap, and Ho (2021) argued that the additional demand created by biodiesel production could be one of the reasons for this instability of the palm oil price (Biofuel International, 2020). This statement is further supported by the data supplied by USDA Foreign Agricultural Services (2021), whereby the feedstock used for biodiesel production in Malaysia is increasing dramatically from 195,000 metric tonnes in 2008 to 1,147,000 metric tonnes in 2021.

Besides, Malaysia introduced the National Biofuel Policy on March 21, 2006. National Biofuel Policy's objective is "to use an environmentally friendly and sustainable energy source to reduce dependency on fossil fuels and stabilize and boost palm oil prices" (USDA Foreign Agricultural Service, 2016). Under the National Biofuel Policy, biofuel production and supply mainly focus on transportation, industry, and exportation. The recent news report from The Malaysian Reserve underlined that B20

[1] On average, the total global palm oil production of Malaysia and Indonesia account for approximately 85–90% (Voora, Larrea, Bernudez, & Balino, 2019; DOSM, 2021).

[2] There is a slight drop in the plantation and production for the year 2020. The decrease rate is about 0.594 and 3.61% for the plantation and production rates, respectively. This drop is expected due to the Covid-19 pandemic's impact on the palm oil industry.

Fig. 2. The Average Palm Oil Price in Malaysia from 1980 to 2021 (RM/Tonnes). Source: Trading Economics, 2022

(blended 20%) bio-diesel would be available throughout Malaysia by next June (Shah, 2021). Accordingly, Plantation Industries and Commodities formal Minister Datuk Dr Mohd. Khairuddin Aman Razali indicates that about 1.06 million tonnes of palm oil are required for the biodiesel program (B20 blended mandate). He added that increasing local biodiesel consumption could reduce carbon dioxide by 3.2 million tonnes, showing the environmental benefits.

This phenomenon shows that the usage of biodiesel is increasing over time. What is the relationship between biodiesel price and palm oil price? These are the interesting questions to be explored. Based on the review that has been done, the investigation of biodiesel prices seems to be very limited in Malaysia. Applanaidu et al. (2011) found that the bio-diesel demand increased palm oil export, domestic price, and palm oil production in Malaysia. Abdullah, Abas, and Ayatollah (2007) explain the influence of biodiesel on the Malaysia's palm oil industry using the statistics. The authors indicate that biodiesel's increasing demand will increase Malaysia's palm oil prices in the coming years. However, empirically, this statement is still unverified in Malaysia.

Besides, no clear evidence of the biodiesel price impact on the price of in the Malaysia's palm oil is presented in the previous study. Hence, this study intended to fulfil two gaps, (1) identifying the impact of the price of biodiesel on the local palm oil prices and (2) estimating the influence of the recent Covid-19 pandemic towards the palm oil local price. These two gaps are the novelty of this study, and the outcomes are essential for the national agendas on Sustainable Development Goals.

2 Theoretical and Modelling Foundation

The fundamental idea is to interlink the commodity price. Biofuel demand and other factors that influence the price are developed from Ricardo's classical theory known as the "*cost of production theory of value*". Ricardo's classical theory argued that the cost of production determined by the commodity's value (Shiozawa, 2016). From the supply perspective, the quantity supply depends on the productivity of the commodity.

It is notable that inputs' marginal productivities would determine the commodity's price in the neoclassical theory. Accordingly, palm oil production input can be defined based on labor input into production (L), capital (K), and the energy used in production (E). Thus, the palm oil production function can be derived as Eq. (1) below:

$$Q_s = f(L, K, E) \tag{1}$$

Interestingly, Sraffa (1960) critiqued the Neoclassical theory of value and price by indicating cost of the capital used in the production factor should be measured based on the prices and not on the quantity. It is mainly because the value of the capital depends on the capital itself, whereby usage of machinery costs higher; however, its contribution towards production is also higher. Furthermore, Sraffa (1960) indicates that the cost is the same as the profit rate in perfect market conditions. So, to capture the cost for each of the production factors in the food production, Eq. (2) derived, as below:

$$TC = uL + hk + bE \tag{2}$$

whereby *u* represents the labour cost in the various levels of the food production chain, h is the rental rate or the interest rate for the capital utilized, and b is defined as the energy price, representing the oil price in this study. Accordingly, the total revenue (TR) can be defined as the quantity of palm oil production (Y) multiplied by the price (P). So, the profit function (π) for the local palm oil able to be defined as Eq. (3):

$$\pi = PY - (uL + hk + bE) \tag{3}$$

Accordingly, profit maximization can be achieved when the MC = MR or, in other words, marginal profit is equal to zero. Thus, Eq. (3) transformed into the first difference condition as below.

$$\frac{\delta\pi}{\delta Y} = \frac{\delta P}{\delta Y}Y + P\frac{\delta Y}{\delta Y} - \left(u\frac{\delta L}{\delta Y} + h\frac{\delta K}{\delta Y} + b\frac{\delta E}{\delta Y}\right) \tag{4}$$

When $\frac{\delta\pi}{\delta Y} = 0$, the Eq. (4) can be rewritten Eq. (5).

$$0 = -\frac{1}{d}Y + P - \left(u\frac{\delta L}{\delta Y} + h\frac{\delta K}{\delta Y} + b\frac{\delta E}{\delta Y}\right) \tag{5}$$

whereby, $\frac{\delta Y}{\delta P}$ is represent the price elasticity of demand for palm oil. In this case, $\frac{\delta P}{\delta Y}$ in Eq. (4) is illustrated as $-\frac{1}{d}$ in Eq. (5). Besides, the marginal cost of palm oil production is represented by $\left(u\frac{\delta L}{\delta Y} + h\frac{\delta K}{\delta Y} + b\frac{\delta E}{\delta Y}\right)$. So, the Eq. (5) can be transformed into the term of price as below:

$$P = \frac{1}{d}Y + u\frac{\delta L}{\delta Y} + h\frac{\delta K}{\delta Y} + b\frac{\delta E}{\delta Y}$$

$$P = \frac{1}{d}Y + MC \tag{6}$$

Based on the Eq. (6), the price of palm oil in the supply perceptive is affected by the amount produced and MC, representing the cost of labour, capital and energy used.

Besides, as urged by Shiozawa (2016), the theory of value cannot be complete without value theory and international value theory. Shiozawa (2016) questioned how the cost of labour and capital in the production function is determined when the wage level of different kinds of work and qualifications is not uniform. This is the case; the labor cost is not reflecting the cost of the product, and the markup principle of the firms mainly determines it.

Accordingly, the foreign exchange market was introduced into the production function to the marginal cost of the labour market. Hence, this idea can be further explained using the law of one price, whereby the asset value will be the equivalent across the global market (Go *et al.,* 2020). So, arbitrage profitability can be ratified with the same value of the assets and commodities across the market due to the involvement of the exchange rate. So, the capital and labor costs are replaced with the exchange rate value in the model. Accordingly, the supply function of palm oil in Malaysia can be derived as below:

$$QS_t = f\left(P_{ft}, EXC_t, OP_t\right) \tag{7}$$

Based on Eq. (7), the supply side of palm oil (QS_t) is defined as the real price of the local palm oil (P_{ft}), crude oil price (OP_t), and finally the real exchange rate (EXC_t).

Besides, the price of local palm oil, the income level, and other factors influencing the demand is used as determined for the palm oil demand, following the Marshallian demand function (Zaratiegui, 2002). Utility maximization concepts play significant roles towards the consumer's demand where the consumer theory illustrates that the consumer maximizing the utility based on the decision of the preference of goods, changes in the income and price of the good. Thus, the palm oil demand function can write as below, following Kargbo (2005).

$$Qd_t = f\left(P_{ft}, Y_t, Z_t\right) \tag{8}$$

Accordingly, based on Eq. (8), the income (Y_t) and price (P_{ft}) play an essential role in the demand (Qd_t) follows the *unified growth theory*. Besides, other variables that influence palm oil demand are illustrated by Z_t

Accordingly, at the equilibrium level, the demand and supply equations can be expressed as prices as below:

$$Q_{dt} = Q_{st} = P_{ft} \tag{9}$$

Thus, followed Chen, Gummi and Umar (2019), the equilibrium equation can be stated as:

$$P_t = f\left(Y_t, OP_t, EXC_t, Z_t\right) \tag{10}$$

Hence, Eq. (10) accommodates the transmission mechanisms that affect the local palm oil price and demand directly or indirectly. Thus, the local palm oil price is defined as the function of income, oil price, exchange rate, and other relevant variables. The model will be extended by including the role of the biofuel demand, replacing Z_t[3].

[3] The effect of industrialization can be capture by the income (Y_t) in the model. In this case, to reduce the model misspecification issue, new variable to represent the industrialization is not added to the model.

The direct relationship between palm oil and biodiesel price can be explained by the "law of demand and supply," widely used in commodity demand studies (Zhang et al., 2009; Koizumi, 2015; Al-Maadid et al., 2016). The increasing biodiesel production using palm oil will create additional demand in the palm oil industry (Applanaidu et al., 2011). Consequently, the additional demand will increase the demand pressure in the palm oil industry. Accordingly, this could directly influence the local Malaysia's palm oil price. Thus, the model is listed below:

$$PO_t = f(Y_t, OP_t, EXC_t, BP_t) \tag{11}$$

Equation (11) represents the palm price (PO_t) model whereby the biodiesel price (BP_t) incorporated in the model.

3 Data Description

3.1 Data and Variables

The study examines the factors influencing the local palm oil price in Malaysia using the monthly data from January 2013 to June 2022. Monthly data for the palm oil local delivery average price (RM/tonne) is obtained from the Malaysian Palm oil Board (MPOB). The industrial production index (IPI) is used as the proxy for income growth in Malaysia, following Marques and Caetano (2020). The data for IPI is attained from the Department of Statistics Malaysia (DOSM). Conventional variables such as crude oil price and real exchange rate are included as the control variables to overcome any omitted bias in the model. The influence of the crude oil price on the commodity prices does not need special justification since it is well discovered in the literature. The real exchange rate plays a significant role in trading activities as palm oil is traded globally, and an unfavourable exchange rate may impact the price of palm oil. Both the crude oil price (USD/BBL) and the real real exchange rate data are obtained from the World Development Indicator (WDI) and Refinitiv DataStream, respectively. The biodiesel demand is captured using the proxy of biodiesel export price (RM Million), and the data is obtained from MPOB Malaysia. Finally, the Covid-19 pandemic effect on the palm oil price is captured using the dummy variable from 2020M05 onwards, which is known to be the lockdown period of Malaysia's economic activities.

4 Results and Discussion

4.1 Descriptive Statistics, Correlation, and Graphical Representation of Data

Based on Table 1, all the variables are homogeneous since having low variability based on the coefficient of variable (CV). Based on the correlation analysis, the independent variables are not highly correlated to each other. Accordingly, the calculated VIF value is 2.6966 ($LnIPI_t$), 4.7054 ($LnREER_t$), 2.6884 ($LnCO_t$) and 2.0500 ($LnBP_t$), respectively, which can be integrated into the model. Based on Fig. 2, the understudied variables are shown to be non-stationary. Whereby the series is decreasing, whereby the rest of the series shows an increasing trend. The series illustrated that there is a possible structural break, which is due to the Covid-19 pandemic and lockdown in Malaysia. Accordingly, the unit root test with a structural break (Perron, 1994) was adopted since the series shows signs of structural breakage.

Table 1. Descriptive Statistics and the Correlation Test Results

	Palm Oil Price	Industrialization	Crude Oil Price	Exchange Rate	Biodiesel Price
Panel A: Descriptive Statistics of the Variables					
Mean	7.8929	4.8452	4.1038	4.4845	8.1056
Maximum	8.8401	5.0803	4.7241	4.6391	8.8336
Minimum	7.4928	4.6098	2.9565	4.3965	7.7561
Std. Dev.	0.2918	0.0902	0.3502	0.0637	0.2503
CV (%)	0.0370	0.0186	0.0853	0.0142	0.0309
Observations	113	113	113	113	113
Panel B: Correlation Test					
Palm Oil Price	1.0000	0.5372	0.2585	−0.4827	0.8896
Industrialization		1.0000	−0.1106	−0.7150	0.4564
Crude Oil Price			1.0000	0.5416	0.1327
Exchange Rate				1.0000	−0.5116
Biodiesel Price					1.0000

Note: Std. Dev. and Obs. are the standard deviation value and Observation, respectively.

4.2 Unit Root Test With and Without Structural Breaks

To prevent specious regression results, a unit root test with and without a structural break was used (Makun, 2018). Accordingly, the Augmented Dickey-Fuller (ADF) test was used to check for non-stationary among variables and unit root test with a structural break proposed by Perron (1994). Each series was estimated with a time trend at first. The series will be re-estimated using the constant term if the time trend is insignifican and reported in Table 2. Results indicate that all the variables are integrated into order one except for industrialization. However, the unit root test with structural break indicates that all the variables are in I(1), pointing to the price of oil and palm oil increase in 2020M04 and 2020M05, respectively; depreciation of exchange rate value in 2015M09; deindustrialization in 2013M06; and the drop of biodiesel price in 2014M02. However, the break of industrialization and biodiesel price shows insignificant value.

The structural break of palm oil and crude oil prices can be justified by the lockdown of the economic activities in Malaysia mainly reason the Covid-19 pandemic. This effect increases the commodities prices globally. The results indicate the depreciation of the exchange rate of Malaysia at 4.46 MYR per USD in 2015M09 is due to the number of internal and external issues that led to the drop of shaking investors' confidence. One of the issues was the 1MDB scandal concerning the formal Prime Minister of Malaysia (FocusEconomics, 2015) (Fig. 3).

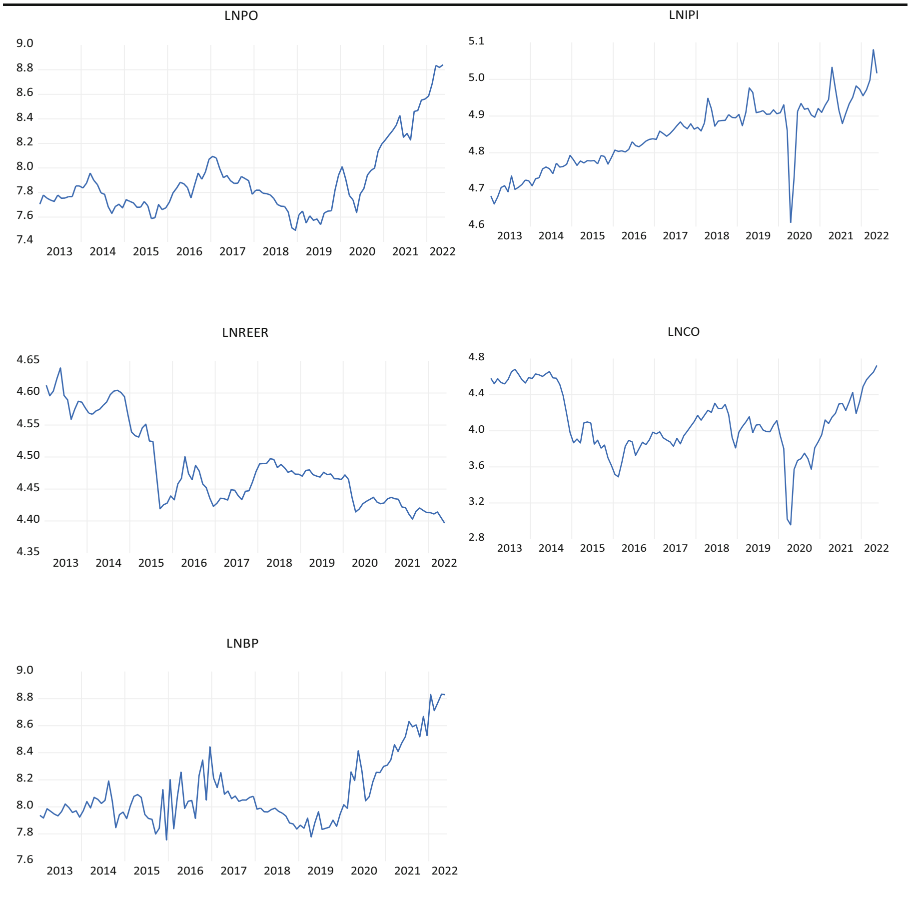

Fig. 3. Variables Understudied at Level Form. Source: Author's illustration using EViews 12.

4.3 Test of Multiple Structural Breaks

Table 3 shows the multiple structural break estimation using the linear model. These results verified the finding of the unit root structural break. Several unknown interruption points are specified in the model using the least squares analysis, following Bai-Perron (1998). The results show that only one significant structural break occurred in 2020M05, known as the pandemic effect, as measured earlier. Accordingly, the model was tested using the OLS method with and without the Covid-19 pandemic effect (using a dummy) for the intrusion of the structural break.

4.4 ARDL Model Estimation and Bound Test Results

Table 4 shows the estimated models, i.e., Model 1 is representative without the pandemic effect and Model 2 incorporated with the effect. The best-fitted model was chosen based on the significant statistics that fulfilled the requirement of the diagnostic test. Model

Table 2. Unit Root Test Results

	Without Structural Break		**With Structural Break**				
Variables	Augmented Dickey-Fuller (ADF) Test		Breakpoint Unit Root Test				Order of integration
	Level	First Differences	Level	Break Year	First Differences	*Break Year*	
Palm oil price$_t$	−0.1886(0)	−9.4667(0)***	−2.5850(0)	2020M05***	−10.3247(0)***	*2020M04***	*I(1)*
Crude oil pricet	−2.2913(1)	−8.1836(1)***	−3.1110(1)	2014M08	−9.8280(0)***	*2020M05****	*I(1)*
Exchange rate$_t$	−2.5401(1)	−8.5013(0)***	−3.8635(1)	2015M05	−9.6662(0)***	*2015M09****	*I(1)*
Industrialization	−4.3715(2)***	-	−2.8973(0)	2014M01	−9.9628(0)***	*2013M06*	*I(1)*
Biodiesel price$_t$	1.0032(5)	−6.3048(2)***	−2.9678(3)	2020M09	−18.8000(0)***	*2014M02*	*I(1)*

Note: (*) (**) and (***) represent significance at the 1, 5, and 10% levels, respectively. () represent the optimum lag length which is auto-selection based on the AIC for the ADF test and breakpoint unit root test. The maximum lag is auto-fixed at 12.

Table 3. Sequential F-statistic determined structural breaks

Break Test	F-statistic	Scaled F-statistic	Critical values	Break date
*0 vs 1**	305.3117	305.3117	8.58	2020M05
1 vs 2	6.9098	6.9098	10.13	

Source: Author's calculations.
Note: (*) represents the significant value at the 5% level, Bai & Perron (2003), critical values

1 is set to identify the effect of biodiesel demand on local palm oil with other relevant control variables, whereby model 2 identifies the pandemic's role in Malaysia's local palm oil price.

Based on Table 4, the calculated F statistics using the bound test for Model 1 and Model 2 are 2.6928 and 4.1228, respectively. The F statistic value for model 1 is between the critical value of 10%, which is undecided at this level. Accordingly, the existence of the cointegration is decided based on the ECT value. The ECT value for model 1 is −0.4105 and is highly significant. So, it concluded the cointegration among the variables in model 1. However, the F-statistic value of Model 2 rejects the null hypothesis of the bound test at a 1% significant level, indicating that the model is cointegrated.

The optimum lag for model 1 was (5, 5, 2, 5, 5), indicating local palm oil price is influenced by itself up to five lagged; industrialization, real exchange rate and biodiesel price up to five lagged as well; lastly, crude oil price up to two lagged. For model 2, the optimum lag was (5, 5, 4, 5, 2, 2), with a dummy variable to capture the effect of the pandemic on the palm oil price. The palm oil price itself, industrialization and exchange rate influence the dependent variable up to five lags. However, biodiesel price and dummy variable can explain the palm oil up to two and finally crude oil price up to four lagged. Notably, the diagnostic test for both models is good, confirming that the models are not suffering from any statistical issues. Furthermore, the stability test indicates that both models are stable, as shown in Figs. 4 and 5.

Table 4. Results of the Bounds Test (F-Tests)

	Model 1: Without the pandemic effect		Model 2: With the pandemic effect	
Estimated Model	$LnPO_t = f(LnIPI_t, LnCO_t, LnREER_t, LnBP_t)$		$LnPO_t = f(LnIPI_t, LnCO_t, LnREER_t, LnBP_t, dum: 2020M05)$	
Optimal Lag Length (AIC)	(5, 5, 2, 5, 5)		(5, 5, 4, 5, 2, 2)	
F-Statistics (Bound Test)	2.6928		4.1228**	
Significance Level	Pesaran et al. (2001)[a]			
	Critical Values			
	Lower Band	Upper Band	Lower Band	Upper Band
1%	3.74	5.06	3.41	4.68
5%	2.86	4.01	2.62	3.79
10%	2.45	3.52	2.26	3.35
R^2	0.9730		0.9763	
Adjusted R^2	0.9644		0.9679	
Durbin-Watson statistics	2.1475		2.0422	
F-Statistics	112.3260***		116.1171***	
Serial correlation	1.3252 (0.2716)		0.3014 (0.7407)	
Model specification	0.6262 (0.5373)		0.5922 (0.5556)	
Normality	0.4218 (0.8098)		0.8397 (0.6571)	
Heteroscedasticity	0.0132 (0.9869)		0.8124 (0.4466)	

Source: Author's calculations using EViews 12
Note: (***) represent significance at 1%. The lag length is auto-selected based on AIC, and the maximum lag (K) is set at 5. Statistics for the LM test and Ramsey RESET test are based on F-stat

4.5 Short-Run and Long-Run Relationship

After proving the cointegration in Models 1 and 2, the ECT_{t-1} which represents the adjustment speed to the long-term equilibrium, and the short-term coefficient of the variable was estimated. The results are represented in Table 5. The ECT_{t-1} for model 1 is −0.4105 and highly statistically significant. This indicates that 41.05% of the external shock is corrected in one month and required over two months to return to equilibrium. The ECT_{t-1} for model 2 is −0.3734 and highly statistically significant. This indicates that 37.34% of the external shock are corrected in one month, requiring over two and half months to return to equilibrium.

Table 6 shows the long-run coefficients of Models 1 and 2. In the long run, Model 1 shows that $LnREER_t$ and $LnIPI_t$ negatively affecting the local palm oil price, and both variables are insignificant. However, one percentage point increase in $LnCO_t$ and $LnBP_t$, respectively, an increase of 0.1989% and 0.9546% in local palm oil prices. The finding is in line with the concept of "*financialization of the commodities*", whereby palm oil positively responds to the crude oil price (Chincarini & Moneta, 2021; Nazlioglu & Soytas, 2012). Furthermore, biodiesel prices play a significant role in stabilizing the

Table 5. Short-run Coefficients and Speed of Adjustment

Model 1				Model 2			
Variable	Coefficient	T-Statistics	Probability	Variable	Coefficient	T-Statistics	Probability
$\Delta LnPO_t(-1)$	0.5717***	4.3985	0.0000	$\Delta LnPO_t(-1)$	0.4137***	4.1173	0.0001
$\Delta LnPO_t(-4)$	0.4557***	4.4121	0.0000	$\Delta LnPO_t(-4)$	0.3990***	4.4911	0.0000
$\Delta LnREER_t(-2)$	1.0815**	2.3928	0.0190	$\Delta LnREER_t(-2)$	1.0301**	2.4778	0.0154
$\Delta LnREER_t(-3)$	−1.0865**	−2.4247	0.0175	$\Delta LnREER_t(-3)$	−1.0028**	−2.3537	0.0211
$\Delta LnREER_t(-4)$	0.8651*	1.9233	0.0580	$\Delta LnREER_t(-4)$	1.1051**	2.5705	0.0120
$\Delta LnIPI_t(-1)$	0.9540***	4.6787	0.0000	$\Delta LnIPI_t(-1)$	0.8784***	3.9087	0.0002
$\Delta LnIPI_t(-2)$	−0.7133***	−3.0218	0.0034	$\Delta LnIPI_t(-2)$	−0.7359***	−3.0374	0.0032
$\Delta LnIPI_t(-3)$	0.5975***	2.8359	0.0058	$\Delta LnIPI_t(-3)$	0.6079***	3.2157	0.0019
$\Delta LnIPI_t(-4)$	−0.5416**	−2.5180	0.0138	$\Delta LnIPI_t(-4)$	−0.5160***	−2.6940	0.0086
$\Delta LnCO_t$	0.1688***	3.5955	0.0006	$\Delta LnCO_t$	0.1925***	4.2913	0.0000
$\Delta LnCO_t(-1)$	−0.1505**	−2.5632	0.0122	$\Delta LnCO_t(-1)$	−0.1544***	−2.7956	0.0065
$\Delta LnBP_t(-1)$	−0.1827*	−1.9048	0.0604	$\Delta LnCO_t(-3)$	−0.1072*	−1.8302	0.0710
$\Delta LnBP_t(-3)$	−0.1900**	−2.1699	0.0329	$\Delta LnBP_t(-1)$	−0.1642***	−2.8459	0.0056
$\Delta LnBP_t(-4)$	−0.1242**	−2.0866	0.0401	ΔDum_t	−0.2425***	−2.7734	0.0069
Constant	2.3539***	3.7643	0.0003	$\Delta Dum_t(-1)$	−0.2658***	−2.7973	0.0065
ECT_{t-1}	−0.4105***	−3.7589	0.0003	*Constant*	4.3042***	5.1363	0.0000
				ECT_{t-1}	−0.3734***	−5.1286	0.0000
R^2	0.5078			R^2	0.5673		
Durbin-Watson	2.1475			Durbin-Watson	2.0422		
F-Statistics	3.9854***			F-Statistics	4.7885***		

Notes: The significance at the 1, 5 and 10% levels are denoted by the asterisks (***), (**) and (*).

Table 6. Long-run Coefficients

Model 1				Model 2			
Variable	Coefficient	T-Stat	Prob.	Variable	Coefficient	T-Stat	Prob.
$LnREER_t$	−1.1860	−1.5955	0.1145	$LnREER_t$	−1.7055**	−2.1283	0.0364
$LnIPI_t$	−0.2213	−0.6010	0.5495	$LnIPI_t$	−0.5746*	−1.8655	0.0760
$LnCO_t$	0.1989**	2.4185	0.0178	$LnCO_t$	0.2099**	2.1751	0.0326
$LnBP_t$	0.9546***	8.5163	0.0000	$LnBP_t$	0.7299***	4.6369	0.0000
				$Dum: 2020M05_t$	0.1694*	1.8038	0.0751

Notes: The significance at the 1, 5 and 10% levels are denoted by the asterisks (***), (**) and (*). Prob. Represent the probability value.

palm oil price in Malaysia. The impact of biodiesel price on the local palm oil price is about four times higher compared to crude oil price in Malaysia.

For Model 2, 1 percentage point decreased in $LnREER_t$ and $LnIPI_t$ will increase the local palm oil price by 1.7055 and 0.5746, respectively. The inverse relationship

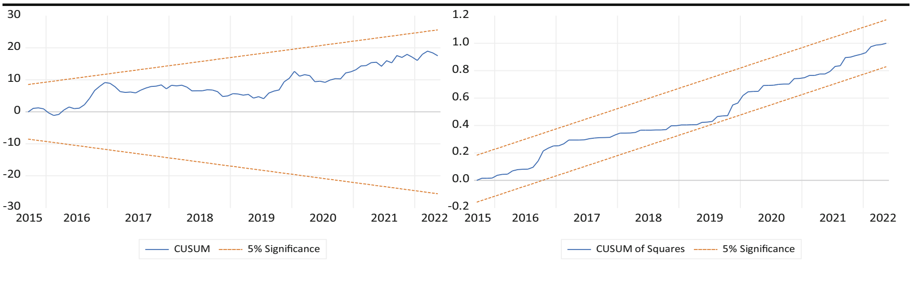

Fig. 4. Stability Test for Model 1

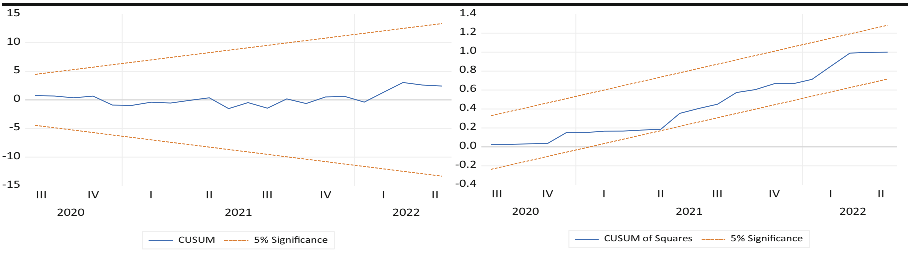

Fig. 5. Stability Test for Model 2. Source: Author's illustration using EViews 12.

between Malaysia's exchange rate and palm oil price is supported by study of Butt et al., (2020). This is due to the benchmark pricing mechanism, mainly traded using USD. When the Malaysian currency devalues, the price of palm oil increases due to higher demand, and vice versa. The financial market is always having the opposite reaction to the commodity market. This explains the long-term adverse effect of industrialization on the palm oil price. Furthermore, one percentage point increase in $LnCO_t$ and $LnBP_t$, respectively, an increase of 0.2099% and 0.7299% in local palm oil prices. Lastly, the Covid-19 pandemic positively affects the local palm oil price, increasing the local palm oil price by 0.1694.

5 Conclusion

ARDL bound testing method has been employed to answer the questions. In addition, structural break takes into account, and multiple structural break tests are employed to identify the significant structural break in the model, which shows a break of 2020M05. This break represents the effect of the Covid-19 Pandemic. To test whether the breaks in the model interfere with the model's parameters, two models have been tested with and without the presence of structural breaks. Interestingly, the structural break effect model generates better results with fulfilled diagnostic and stability tests.

The overall findings indicate the existence of cointegration among variables. The real exchange rate and industrialization have a negative and significant impact on local palm oil prices, and crude oil and biodiesel prices positively affect Malaysia's local palm oil prices. Statistical evidence in this study indicates that the impact of biodiesel price on the local palm oil price is higher than the crude oil price. The dummy variable, which represents the Covid-19 pandemic effect, shows a significant positive effect on the local palm oil price in the short and long run, indicating a pandemic increase in Malaysia's local palm oil price.

This study's empirical evidence may provoke some contributions to the policymakers and the market players to understand the relationship between palm oil prices and biodiesel prices. Hence, the sustainable development of the palm oil and biodiesel industry will contribute to Malaysia through increased output, employment, and Gross Domestic Product (GDP). In addition, policies to promote higher usage of biodiesel domestically and globally are beneficial in boosting the palm oil price in Malaysia.

More studies on the biodiesel industry are needed since it is a young industry in Malaysia, and its potential industrial contribution to the Malaysian economy and environment is enormous. Somehow, the unavailability of biodiesel data stands out in Malaysia. For future research, exploring the price effect of the palm oil industry on the socio-economic side may create some exciting insight due to the role of palm oil as the highly consuming vegetable oil in Malaysia.

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