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Analysis of Indonesian palm oil export supply to Egypt: error correction model approach

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ABSTRACT

Palm oil is a product of full benefits and has many economic contributions. The prospect of palm oil in the international market of vegetable oil trade is up-and-coming, prompting the Indonesian government to spur export palm oil development. Indonesian palm oil exports to Egypt are expected to fulfill the strong demand for various food and non-food applications of palm oil for Egyptian domestic market needs. This article describes the most crucial determinant influencing the Indonesian palm oil export supply to Egypt. The current study overcomes the problem of time series data; such as spurious regression and non-stationary data through cointegration. The research involves testing the existence of a long-term equilibrium relationship between the variables and estimating an Error Correction Model (ECM). The results showed that there was a long-term equilibrium relationship between the variables. The findings show that the Indonesian palm oil export supply to Egypt is significantly influenced by international prices, domestic production volume, interest rates, and the Rupiah exchange rate against the Egyptian Pound. The policy recommendation to maintain the exchange rate at a reasonable level needs to be carried out to increase Indonesian palm oil exports to Egypt. On the other hand, a low-interest rate can be an alternative to promoting policies to increase exports.

Keywords: Cointegration, Egypt, Error Correction Model, Export, Palm Oil

INTRODUCTION

Palm oil is a popular commodity from the plantation sub-sector in Indonesia. Palm oil is a main non-oil and gas export commodity in many industries and an important foreign exchange earner for the Indonesian economy. Palm oil is economically essential, and versatile edible oil is critical for food and non-food industries. All of the destinations of Indonesian palm oil export countries; wherein have personal desires and characteristics in processing Indonesian palm oil because those commodities have numerous advantages (Rosyadi *et al.,* 2021). One of the substantial Indonesian palm oil export markets is Egypt; this country is developing rapidly and is now vital for Indonesian palm oil export. Indonesia believes that controlling the trade in palm oil commodities in Egypt will be the entry point to dominate the African market. Palm oil, sunflower oil, and soybean oil are important vegetable oils imported into Egypt for food consumption with a total import value of 8,8 billion pounds, representing about 90.6% of the total import value of oils and fats. (Kamel and Muhammad, 2015). Indonesian Palm oil continues to maintain its competitive position in Egypt for food consumption and raw material of industrial because of its relatively low price compared to other vegetable oils. The Egyptian food and derivative product industry is heavily dependent on Indonesian palm oil. Egypt has shown an increase in Indonesian palm oil export since 2006, and there was a sharp increase in 2014, which tends to be stable at above 90 thousand tons until 2020. It happened because the domestic production of vegetable oil in Egypt has not been able to fulfill the local demand. According to the Ministry of Trade Indonesia (2021), the demand for Indonesian palm oil in Egypt continues to increase, in line with the increasing Indonesian palm oil consumption by the Egyptian people. Indonesia is expected to increase the supply of export volume to Egypt to fulfill the Egyptian market demand.

According to previous research on palm oil export modeling, the most influencing factors to explain the export supply of plantation products are production volume, interest rates, consumer income in the destination market, domestic prices, international prices of exported products, and exchange rates *(*Mulyani *et al.,* 2021). In case of an increase in production volume, they result in more availability of products, which causes an abundance supply of domestic and foreign products. The fluctuating volume of palm oil production will affect the export volume. The interest rate is assumed to be part of the production and export financing, affecting costs that will impact the value of exports. High-interest rates will also tend to increase the cost of financing production, thereby reducing the ability of domestic producers to borrow and finance their business productivity (Cookey & Eniekezimene, 2020).

In the literature on agricultural trade, income is the primary driver of agricultural trade in the international market (Baiardi *et al.,* 2015). A larger GDP and a more remarkable similarity between countries are associated

with a more significant probability of trade creation (Baier *et al.,* 2019). Apart from income, prices are also an essential determinant of exports. Price is one of the variables in the export destination market; it is widely recognized that the price in the export destination country become a key role in international trade. Stable prices and a favorable exchange rate can be more significant drivers of exports (Sugiharti *et al.,* 2020). Commodity prices usually are divided into domestic and international prices. Unexpected changes in prices can cause behavioral variations in export volumes. Palm oil has the highest price uncertainty risk, affecting fluctuating world price (Setyowati *et al.,* 2021). On the other hand, due to price fluctuations, fluctuating exchange rates seem to influence exports of agricultural products (raw or at least unprocessed) more significantly, especially in developing countries (Baiardi *et al.,* 2015). According to Álvarez-Díaz *et al.,* (2018), there are contradictions because several studies show that fluctuations in exchange rates are not directly reflected in export prices; exporters usually tend to maintain prices to increase or maintain their market share.

On the other side, it founds that only a few cases of Egypt are relevant to studying determinants of international agriculture trade, especially vegetable oil commodities. The research about Egyptian agriculture by El-Rasoul *et al.* (2021), found between real agriculture GDP and real agriculture imports have a positive influence, also for real agricultural imports and the dollar exchange rate, which no longer applies the economic principle, proves that the floating exchange rate become not effective as Egypt imports commodities and services at high costs because the depreciation of the Egyptian pound. Zaki *et al.* (2019) found that the depreciation real exchange rate increases the value of exports without affecting the total exports; fact that the price has a more significant effect than a quantity effect: depreciation lowers the export price of foreign currency, but does not increase its export quantity. Many factors are suspected to influence and can impact the supply of Indonesian palm oil exports to Egypt, and it is crucial to know their influence. The results of this research are expected to provide policy recommendations and helpful information regarding palm oil export supply to Egypt for the government, readers, and related parties.

MATERIAL AND METHODS

Analyzing the supply of palm oil exports to Egypt uses quantitative data in secondary time-series data for 31 years from 1990 to 2020. The annual data includes the volume of Indonesian palm oil exports, interest rates, exchange rates, international and domestic palm oil prices, and GDP. The data sources in this study were Ministry of Agriculture, Directorate General of Plantations, Central Bureau of Statistics, Commodity Futures Trading Regulatory Agency, Food and Agriculture Organization Statistical, and International Trade Center, UN Comtrade, Fred Stlouisfed, World Bank, Exchange Rate.

In time-series data, if the data is not-stationary, then causing the regression results are doubtful or called spurious regression (Herranz, 2017; Jin, *et al.,* 2017). So it is necessary to test stationary data, If a case is found that the variable is non-stationary, the estimation of the simple regression equation can lead to spurious regression. Spurious regression shows a regression equation estimated to have a high significance but has no meaning (Granger & Newbold, 1974).

In the first step, the Augmented Dickey-Fuller (ADF) test is used to determine whether the data is stationary and in particular to determine the degree of integration of the variables. We will explore the existence of long-term relationships through cointegration analysis on the second step. Cointegration can be identified in several ways; one is using the two-step Engle-Granger (Prasetyo *et al.,* 2017; Wong *et al.,* 2017). The basic equation for the cointegration test for this research is written in equation (1); then the residual is used to calculate the Engle-Granger value.

$QE = f(PPi, PPd, Qd, ER, IR, GDP)$. (1)

Or it can be written in the form below:

$QE = \beta_0 + \beta_1 PPi + \beta_2 PPd + \beta_3 Qd + \beta_4 ER + \beta_5 IR + \beta_6 GDP$……(2)

Alternatively, it can be written in a natural logarithmic form as follows:

$LnQE = \beta_0 + \beta_1 LnPPi + \beta_2 LnPPd + \beta_3 LnQD + \beta_4 LnER + \beta_5 LnIR + \beta_6 LnGDP$……(3)

If the test results of second step are stationary at the level, it means that Cointegration can be used as an Error Correction Term (ECT). However, the coefficient should be a negatively significant value in order that a predefined equation can be used complete with the ECM model (Zhang *et al.,* 2015). The general model of the ECM equation is as follows:

$Dyt = \beta_0 + \beta_1 Dxt + \Upsilon(x_{t-1} - y_{t-1}) + \mu t$.....(4)

Notes :

Dyt : First Difference of Y

yt : Dependent Variable
Dxt : First Difference of X
xt : Independent Variable
t : Error term

To find out the specifications of the ECM as a valid model can be seen in the results of the residual statistical test of the regression equation (4). If the ECT coefficient is negatively significant, the model specifications observed in ECM are valid. Following Granger's method, the researcher defines the related Error Correction Model (ECM) in equation (3). So the ECM model in this research can be seen in equation (5).

$D(LnQE) = \beta_0 + \beta_1 D(LnPPi) + \beta_2 D(LnPPd) + \beta_3 D(LnQD) + \beta_4 D(LnER) + \beta_5 D(LnIR) + \beta_6 D(LnGDP) + B_7 ECT_{(t-1)}$ .....(5)

Notes :

QE	= volume of Indonesian palm oil exports to Egypt (tons)
PPi	= international palm oil price (US$/kg)
PPd	= domestic palm oil price (Rp/kg)
QD	= volume of domestic palm oil production (tonnes)
ER	= exchange rate (exchange rate) Rupiah against Egyptian Pound
GDP	= Real GDP Egypt
IR	= Indonesia Interest rate
ECT	=Error Correction Term
0	= constant
D	= (first difference)

The above equation is built based on the test results that all variables are stationary within a certain degree (difference) shown by D notation. The ECT coefficient must have a negative sign and be statistically significant (Granger *et al.,* 2000). This condition is needed to strengthen the long-term relationship between the dependent variable (QE) and the independent variables (PPi, PPd, QD, IR, ER, and GDP). If the ECT value is small, the correction process towards long-term equilibrium will be fast. Furthermore, the regression model was tested using the classical assumption tests and statistical tests (coefficient of determination, simultaneous test, and partial test).

RESULTS

Overview of Indonesian Palm Oil Export Supply Volume:

In the last two decades, Indonesia has become a dominant palm oil importer on the global market. However, not all countries consistently import Indonesian palm oil due to various factors. Egypt is an important destination for Indonesian palm oil export country because it has had an increasing volume of Indonesian palm oil export supply to this country since 2006 and it increased significantly in 2014. There has been a significant demand from Egypt due to the price of Indonesian palm oil, which is more competitive than other vegetable oils.

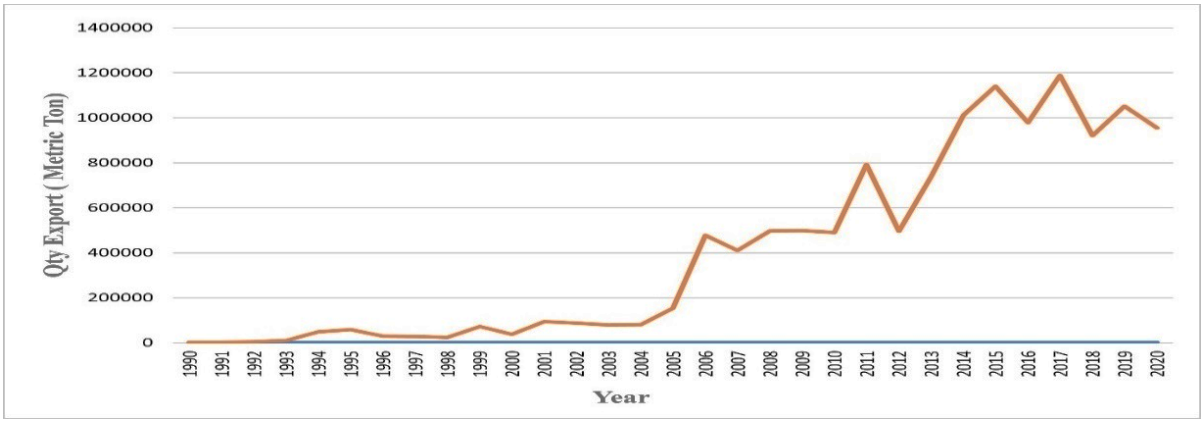

Fig. 1. Development of Indonesian Palm Oil Export Supply Volume to Egypt for the period 1990-2020

Based on the figure above, it can describe that the volume of Indonesian palm oil exports in 1990 – 2005 to Egypt tended to be low, with an average is only 48 thousand tons; the lowest export volume also occurred during this period in 1991 with the total quantity of only 25 tons. A sharp increase in the volume of palm oil exports occurred from 2005 to 2006, from 151 thousand tons to 476 thousand tons. It is interesting because Indonesia has expanded its market share to Egypt since 2005 with an increase in significant value. Furthermore, the volume of palm oil exports tended to be stable from 2006 to 2020, during which time there was an insignificant increase and decrease in palm oil exports.

Unit Root Test (Stationerity) and Degree of Integration Test:

The Error Correction Model, as described above, is a tool that has several stages. Stationary and cointegration criteria must be fulfilled before using ECM analysis. If the research finds a non-stationary variable in the equation, it will bias the results and lead to wrong conclusions. This study uses Augmented Dickey-Fuller (ADF) to test whether the data is stationary.

Table 1. Stationerity test of data at the Level level

Variable	Egypt	
	T Statistics	**Prob.**
LNQE	-1.783239^{ns}	0.3812
LNPPD	-1.919376 ^{ns}	0.3191
LNPPI	-1.834554 ^{ns}	0.3573
LNQD	-1.623791 ^{ns}	0.4585
LNIR	-0.780508 ^{ns}	0.8058
LNER	-1.778760 ^{ns}	0.3833
LNGDP	-1.592908 ^{ns}	0.4713

Note: ns : non significant

The significance level can be determined by comparing the t-stat value variable and the MacKinnon critical value (Mackinnon, 1996). If the t-stat value of the variable is less than the MacKinnon critical value, it means the data is stationary. The test results show that the variable is not stationary at the level. The next step is to test the degree of integration by doing the first differentiation of the variables. Based on table 2, it was found that all research variables were stationary at the first difference. Therefore, it can be concluded that the data is integrated in the first order I(1).

Table 2. Stationerity Test of Data on First Difference

Variable	Egypt	
	T Statistics	**Prob.**
D(LNQE)	-6.059107*	0.0000
D(LNPPD)	-5.823710*	0.0000
D(LNPPI)	-5.649127*	0.0001
D(LNQD)	-5.637448*	0.0001
D(LNIR)	-5.917824*	0.0001
D(LNER)	-5.364940*	0.0001
D(LNGDP)	-3.272576*	0.0257

Note: D is the first difference, * Indicates significance at 5% level

Cointegration Test

This study used the Engle-Granger (EG) cointegration test. The initial stage is the regression of the equation to be studied to obtain the residual. Next, the residual result is tested for the existance of unit root with Augmented *Dickey-Fuller (*ADF). The absolute ADF statistical value is then compared with the critical value. If the statistical value is greater than the critical value, the observed variables are cointegrated. Table 3 shows that the residual is stationary at the level because of the absolute ADF t-stat. value is greater than the critical value of 5%. So there is cointegration at the level, and the last step of ECM modeling requirements is fulfilled.

Table 3. Cointegration Test Result

Augmented Dickey-Fuller test statistics	Egypt	
	t-Stats.	Prob.
	-3.535766*	0.0138
Critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

Note : * Indicates significance at 5% level

ECM Estimation:

The ECM model can be formed because it has been proven that there is cointegration between independent and dependent variables. This cointegration shows a long-term equilibrium relationship between the independent and dependent variables, which may be unbalanced in the short term.

Table 4. Error Correction Model (ECM) Estimation Results

Variable	Coefficient	Std. Error	t-Statistics	Prob.
D(LNPPD)	-2.121058 ns	1.281184	-1.655544	0.1120
D(LNPPI)	2.450938**	1.408853	1.739669	0.0959
D(LNQD)	7.121691*	1.976926	3.602406	0.0016
D(LNIR)	-2.636169**	1.278799	-2.061442	0.0513
D(LNER)	1.821215*	0.642919	2.832730	0.0097
D(LNGDP)	0.239838 ns	10.03809	0.023893	0.9812
ECT(t-1)	-0.659083*	0.144994	-4.545570	0.0002
C	-0.314881	0.476680	-0.660572	0.5157
R-squared	0.601275			
Adjusted R2	0.474409			
F-stat.	4.739419			
Prob(F-stat.)	0.002271			
Durbin-Watson stat	1.900850			

Notes :* Indicates significance at 5% level

** Indicates significance at 10% level

The ECT coefficient measures the regression response for each period that deviates from balance. This study's absolute value of the error correlation coefficient will determine how quickly the balance can be achieved if deviations are obtained. The estimation results in Table 4, where the coefficient of the ECT(t-1) is 0.6591, meaning that the imbalance in the previous period will be corrected by 65.91%, and the balance value will be adjusted within cointegration period. The suitability of the ECM model used can also be seen from the ECT(t-1) coefficient, which is negative and significant so that the ECM model used can be concluded as a valid and good model.

D(LnQE) = – 0.314 – 2.12 D(LnPPd) + 0.245 D(LnPPi) + 7.122 D(LnQD) 2.636 D(LnIR) + 1.821 D(LnER) + 0.240 D(LnGDP) – 0.315 ECT(t-1)

Classic assumption test:

Proving that the ECM regression equation above is BLUE or Best Linear Unbiased Estimaton, it can be concluded the regression are good in estimation, unbiased, and consistent; the classical assumption test must be carried out to provide certainty. Based on table 5, it can be show that the classical assumptions of the ECM have been fulfilled.

Tabel 5. Classic assumption test Result

Classic Assumption Test	Method	Value	Information
Normality	Jarque-Bera	0.896	The probability value > 0.05, it means the data is proven normally distributed
Multicollinearity	Variance Inflation Factor	1.12-5.80	Each independent variable has a VIF value of less than 10, so it means that not found multicollinearity in the error correction model.
Autocorrelation	Breusch-Godfrey Serial Corr. LM Test	0.4702	ChiSquare probability value > 0.05, it can be concluded that there is no autocorrelation found.
Heteroscedasticity	Breusch-Pagan-Godfrey	0.5005	Chi-Square probability value > 0.05, it can be concluded that there is no heteroscedasticity found.

Coefficient of Determination (R^2):

The influences of international market palm oil prices, domestic palm oil prices, domestic palm oil production volume, the Rupiah exchange rate against the Egyptian Pound, domestic interest rates, Egyptian GDP on the volume of Indonesian palm oil exports supply to Egypt is 60%. The rest is 40% is explained by other variables not examined in this research.

Simultaneous Significance Test (F-Test):

The significance value of the Prob (F-statistic) ECM model in Egypt is less than 0.05. So it can be concluded that there is a significant influence between international palm oil prices, domestic palm oil prices, domestic palm oil production volumes, the Rupiah exchange rate against the Egyptian Pound, interest rates, and the GDP of Egypt together on the Indonesian palm oil export volume to Egypt.

Partial Significance Test (T-Test):

The Analysis (Table 4) shows that International prices, domestic production volumes, interest rates, and the Rupiah exchange rate against the Egyptian Pound have a partially significant influence on the volume of Indonesian palm oil exports to Egypt. Conversely, domestic prices and GDP have no significant influence on the Indonesian palm oil export volume to Egypt.

DISCUSSION

The Influencing Factors of Palm Oil Export Supply

Based on the above analysis results, international palm oil prices significantly influence Indonesian palm oil volume exports supply to Egypt. The positive value of the regression analysis follows the theory. Suppose international prices are higher than the domestic prices; in that case, producers in that country are interested in taking advantage of high prices in the global markets and selling their commodities to buyers in other countries (Mankiw, 2008). The relationship between commodity prices and supply has a positive sign, so the high price of global market will encourage producers to offer more commodities and vice versa; If the price increases, the supply of products will also increase.

As expected, domestic palm oil production of Indonesia positively significant influences Indonesian palm oil volume exports to Egypt. Estimating the positive direction on the variable coefficient indicates that any increase in production volume will increase the Indonesian palm oil volume exports to Egypt. When importers like Indonesian palm oil, the demand for the commodity will also increase, so meeting the requirements of foreign demand will generate more profits. The results on the same commodity by Rosyadi *et al.,* (2021) also get a positive effect and significant value of the regression analysis. This follows the theory put forward by Smith regarding the Theory of Absolute Advantage, which proves that high production will affect to the volume of exports. So that when production increases, the availability of palm oil also increases, and foreign supply increases too.

The interest rate has a significant and negative influence on the volume of Indonesian palm oil exports to Egypt. Estimating the negative direction on the variable coefficients indicates that any increase in the interest rate will reduce the Indonesian palm oil volume exports to Egypt. Companies rely on credit markets to borrow in countries with well-developed credit markets. Exports are vulnerable to changes in interest rates, and interest rates negatively influence exports (Chen *et al.,* 2015). A negative influence is assumed where the interest rate as part of production and export financing has a negative influence. When loan interest rates are higher, production costs will increase, reducing the value of exports. Besides that, the export burden is higher, reducing the volume of exports. So artificially low-interest rates can work as an export promotion policy (Tomoda & Kurata, 2015).

Another factor influencing Indonesian palm oil export supply is the Exchange Rate. The Rupiah exchange rate to the Egyptian Pound has a positively significant influence on the volume of Indonesian palm oil exports to Egypt. The estimation of the positive direction on the variable coefficients indicates that any increase in the Rupiah exchange rate against the Egyptian Pound will increase the volume of Indonesian palm oil exports to Egypt. Theoretically, an increase in the exchange rate will reduce the domestic currency in nominal terms and negatively influence export supply. The strengthening exchange rate will result in domestic products being more expensive than foreign products so that the number of exports of a country tends to decrease. On the other hand, there is a possibility of a positive relationship, as quoted from the research by (Berman *et al.,* 2012). In case of currency depreciation for high-performing exporters, it will increase price markup but reduce export volume. So there is a possibility that both have a negative and positive relationship between exports and the exchange rate in various export sectors (Yee *et al.,* 2016). Several studies show an increase in the exchange rate where the depreciation of the domestic currency does not necessarily increase exports in certain domestic countries.

CONCLUSION

Following the results and discussions, the dependent and independent variables had a long-term equilibrium relationship. The volume of Indonesian palm oil export supply to Egypt is positively and significantly influenced by international prices, domestic production volumes, and the Rupiah exchange rate against the Egyptian Pound. On the other side, the volume of Indonesian palm oil export supply to Egypt is negatively significantly influenced by interest rates.

Recommendations:

Indonesia must pay more attention to palm oil, especially to countries with great potential, such as Egypt; maintaining palm oil exports can be an advantage. Government and exporters must commit to being more intensive in developing palm oil exports. The policy of maintaining the exchange rate at a reasonable level needs to carry out to increase Indonesian palm oil export supply to Egypt. On the other hand, a low-interest

rate can be an alternative to promoting policies to increase exports to Egypt. All parties in the Indonesia palm oil supply chain will be motivated to get a reasonable price and be recognized by the global market.

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