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EXPORT DEMAND OF PALM OIL IN MALAYSIA: ANALYSIS USING ARDL APPROACH

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ABSTRACT
The growth of the palm oil industry in Malaysia has established a demand for exports among trading partners worldwide. As a result, Malaysia has gained a reputation as the world's largest producer and exporter of palm oil. Crude palm oil production in 1980 was 2.50 million tonnes; however, by 2019 it had increased to 19.86 million tonnes due to the high export demand for oil palm products. This study studies the export demand for palm oil in Malaysia from 1991 to 2019 by adopting autoregressive distributed lag (ARDL) for cointegration to analyze the export demand determinant, weighted average trading partner income, Malaysian export price, competitor export price, world export price of palm oil, world export price of soybean oil, and real effective exchange rate. The main findings reveal that the factors that determine Malaysian export demands for palm oil are palm oil price changes and trading partner income. In addition, the study also finds that European restrictions on unsustainable palm oil consumption hurt Malaysia's export demand for palm oil.

Contribution/Originality: This study contributes to the literature by providing evidence of the determinants of export demand for palm oil in Malaysia. Dynamic models are used to identify the relationships between income, price, and exchange rates that can explain the demand for palm oil.

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1. INTRODUCTION
Palm oil is an economically essential and useful vegetable oil that is used as a raw material for food and non-food products. Most of its production occurs in Indonesia and Malaysia, which produce about 83 percent of the global total. The next three most significant producers are Thailand, Nigeria, and Colombia. Malaysian domestic demand for palm oil is mainly for the oleo-chemical and food industries. The amount of palm oil available for export is attained by balancing palm oil's domestic supply and demand. Despite contributing significantly to world palm oil production, Malaysia faces intense competition for market share among other producers, mainly Indonesia. Malaysia's total export of oil palm products increased by 12.1% in 2019, reaching 27.88 million tonnes compared to 24.88 million tonnes exported in 2018. However, total export revenue declined by 4.0% to RM64.84 billion compared to RM67.52 billion in 2018 due to lower prices on the global market. Compared to 2018, the palm oil export volume rose sharply by 12.0%

to 18.47 million tonnes due to higher demand, particularly from India, China, the European Union (EU), Vietnam, and Turkey. India maintained the position it has held since 2014 as the largest importer of Malaysian palm oil with an intake of 4.41 million tonnes in 2019, which amounted to 23.9% of total global palm oil exports. China followed with 2.49 million tonnes (13.5%), then the EU with 2.09 million tonnes (11.3%), Pakistan with 1.09 million tonnes (5.9%), Turkey with 0.71 million tonnes (3.8%), the Philippines with 0.63 million tonnes (3.4%), and Vietnam with 0.60 million tonnes (3.2%).

Price and income elasticity have become a central element in the controversy among empirical studies of export demand. Previous literature such as Reinhart (1995) and Senhadji and Montenegro (1999) suggested that sizeable relative price changes are required for a computable impact on trade patterns to occur. This result is contradicted, however, by the studies of Arize (1990) and Narayan and Narayan (2004), which found that the relative price does not affect export demand. Furthermore, in acquiring the income elasticity of demand, a foreign activity variable is also constituted in the export demand model. The foreign activity variable is the weighted average of trading partner income, gross national product (GNP), and gross domestic product (GDP).

Reinhart (1995); Senhadji and Montenegro (1999); Narayan and Narayan (2004); Chen and Chen (2007), and Abdullah (2011) explained the export demand for Indonesian palm oil exports. Further, Rifin (2010a) examined the export competitiveness of Indonesia and Malaysia's palm oil exports and found that Indonesia's palm oil is income elastic and price inelastic. Hence, Indonesia secured an increasing market share and strong market competitiveness over Malaysia. However, Abdullah (2011) argued that both income elasticity and the price elasticity of demand are inelastic for Indonesian palm oil exports (Rifin, 2010a), suggesting that there might be an availability of substituted goods for Indonesian palm oil export.

Price can be a significant determinant of economic behavior; an increase in export price may create a drop in demand for Malaysian exports. Narayan and Bhattacharya (2019) argued that export competitiveness is primarily gauged through relative domestic and foreign prices over time. Hence, if domestic consumption is higher than export volumes, it increases other countries' opportunities to replace Malaysian palm oil exports. Higher price elasticity implies that Malaysia's exports might be suitable substitutes for competitor exports. Besides competing with other countries over the palm oil market share, there is the threat that other vegetable oils will be used instead of palm oil. Thus, we can anticipate export uptake to rise when palm oil prices are low relative to those of soybean oil (Reinhart, 1995; Senhadji & Montenegro, 1999). Talib and Darawi (2002) also stated that the positive relationship between the price of soybean oil and export demand for palm oil shows that soybean oil is used as a substitute for palm oil and is competitive in terms of price. Meanwhile, the impact of a percentage change in the soybean oil price has a greater effect on palm oil exports than the same percentage change in the palm oil price (Shariff, Rahman, & Amiruddin, 2006). This means that both oils are highly substitutable for each other.

Due to the position of soybean oil as a substitute for crude palm oil (CPO), Prasetyo, Marwanti, and Darsono (2017) reported that the price of soybean oil plays a substantial role in Indonesian CPO exports. Thus, the rising cost of soybean oil leads to less consumption, which triggers world export demand to switch to CPO. However, Indonesia experiences a weak effect on the exchange rate because the Indonesian Rupiah does not respond to an uprise in CPO exports due to the slowness factor in CPO production. In contrast, Malaysia gained greater value-added by exporting CPO derivative products to importer countries rather than selling CPO in its raw form, freeing Malaysia from the import quota of CPO. Meanwhile, the Malaysian financial exchange rate is also significant as a complementary determinant of the quantity of Malaysian palm oil exports. Moreover, Talib and Darawi (2002) mentioned that every 20.0% increment in the Malaysian Ringgit-US Dollar exchange rate increased palm oil exports by about 8.6%. Hence, when the Malaysian currency is weak, it tends to boost export demand for palm oil.

In recent years, the European Parliament passed a resolution on palm oil and deforestation of the rainforest, including an EU ban on vegetable oils in biofuels and certification schemes for imported palm oil with uncertified imports being prohibited (European Parliament, 2017). Wilman (2019) discovered that China and India were not as selective, and their consumption of uncertified palm oil increased. Gan and Li (2014) forecasted that domestic palm oil production would rise from 17.6 million tons in 2009 to 22.2 million tons in 2020 and 26.6 million tons in 2035. Hence, exports are expected to increase to 25.2 million tons in 2035, ensuring that Malaysia remains a significant competitor in the global vegetable oil and biofuel markets.

Given this background, the objective of this study is to investigate the export demand for palm oil in Malaysia. Aside from pricing and income factors, macroeconomic factors such as exchange rate are critical variables to explain the export demand for palm oil. Complementary to a previous study, this paper brings producers insight into price strategizing and competing for market share against other oils and fats. Additionally, this effort ought to serve as a reference for the Government of Malaysia, which is continuously exploring potential new markets to expand the palm oil trade. The remainder of the paper is organized as follows. Section 3 discusses the economic model specification and methods, followed by the empirical results and discussion in Section 4. Finally, conclusions are reported in Section 5.

2. MATERIALS AND METHODS

2.1. Model Specification and Data

The basic model of export demand was proposed by Narayan and Narayan (2004). Specifically, the export demand for Malaysian palm oil can be expressed as follows:

$$lnX_t = \alpha + \beta_1 lnTPI_t + \beta_2 lnxp_t + \beta_3 lncxp_t + \beta_4 lnwxp_t + \beta_5 lnwxps_t + \varepsilon_t \quad (1)$$

where lnX_t is the log of real export of palm oil; $lnTPI_t$ is the log of weighted average trading partner income; $lnxp_t$ is the Malaysian palm oil export price; $lncxp_t$ is the log of competitors' palm oil export prices; $lnwxp_t$ is the log of world export price of palm oil, and $lnwxps_t$ is the log of the world export price of soybean oil.

The real export of palm oil consists of palm oil and its derivatives, regardless of whether it has been refined or chemically modified. In this study, the real export of the home country, Malaysia, acts as a dependent variable that is affected by the changes in the independent variables: weighted average trading partner income, Malaysian palm oil export price, competitors' palm oil export price, world export price of palm oil, world export price of substitute oil, and exchange rate. In addition, a foreign activity variable, defined as the weighted average trading partner income (*TPI*), is included in the export demand model to obtain the income elasticity of demand. Since high foreign activity leads to an increased demand for exports, the income elasticity of demand is expected to be positive. Following Arize (1990) and Narayan and Narayan (2004), this study examines host country export prices and competitor prices separately.

Occasionally, the demand for a good might be influenced by price changes of other goods. For example, an increase in palm oil prices will make consumers choose substitute products such as soybean oil. For comparison, therefore, the estimation includes the world export price of palm oil (*wxp*) and the world price of soybean oil (*wxps*).

It is frequently argued in the trade literature that exchange rate volatility may explain export demand. For robustness, Equation 2 includes the real effective exchange rate (REER) to estimate the depreciation or appreciation of the country's currency and whether it has a positive or negative impact on the palm oil market in Malaysia. Hence, we extend the augmented export demand model to include the real effective exchange rate (*REER*). The model specifications for the export demand function take the following form:

$$lnX_t = \alpha + \beta_1 lnTPI_t + \beta_2 lnxp_t + \beta_3 lncxp_t + + \beta_4 REER_t + \beta_5 lnwxp_t + \beta_6 lnwxps_t + \varepsilon_t \quad (2)$$

This study covers the period from 1991 to 2019, for which annual time-series data were employed. The dataset was sourced from the World Databank, the World Trade Atlas (WTA), the Malaysia External Trade Development Corporation (MATRADE), and COMTRADE.

2.2. Estimation Techniques

The analysis will use the Auto-Regressive Distributed Lag (ARDL) approach advocated by Pesaran, Shin, and Smith (2001) to determine the cointegration relationships between Malaysian exports, trading partner income, competitor price, export price, substitute price, and exchange rate. This method offers several options for statistical features; for instance, it allows simultaneous testing of the short-run and long-run relationships among the variables in the time-series model. The advantage of this method is that the bounds test approach applies to all data series whether the underlying regressed variables are purely I(0), purely I(1), or mutually cointegrated. The other substantial advantage of the bounds test approach is that it can be used in studies with small sample sizes.

2.3. ARDL Bounds Test for Cointegration and Long-Run Coefficient

If there are no variables in order of I(2), the bounds test procedure can test the hypothesis of cointegration. The null hypothesis states that no cointegration exists, and the alternative hypothesis states the opposite. Two sets of critical values are reported in Pesaran et al. (2001); these provide essential bounds of value for all classifications of the regressors into purely I(0), purely I(0), or mutually cointegrated. If the computed F-statistic lies outside the critical bounds, a conclusive decision can be made regarding cointegration. For instance, if the empirical analysis shows that the calculated F-statistic is higher than the upper bound of critical values, then the null hypothesis of non-cointegration is rejected; however, the hypothesis cannot be rejected if the computed F-statistic is lower than the lower bound. Meanwhile, if the computed F-statistic falls between the lower and upper bound, the results are inconclusive. Narayan's (2005) table is referred to for the cointegration test because it offers lower- and upper-bound critical values.

2.4. Error Correction Model (ECM) for Short-Run Impact

Once a long-run relationship has been established, a further diagnostic test and a stability test are conducted to determine the goodness-of-fit of the ARDL model. Tests for normality of residuals, serial correlation, and heteroscedasticity are applied to the ECM. If the export demand model surpasses all diagnostic tests with an F-statistic of more than 5 percent, the model is considered to be free from problems.

Table 1. Summary statistics of the variables.

Variable	Mean	Std. Deviation	Min.	Max.	Obs.
LNX	8.6120	0.6961	7.3893	9.7647	29
LNGDP	9.8846	0.3368	9.3093	10.4202	29
LNXP	6.3965	0.3832	5.5547	7.0180	23
LNCXPI	6.2682	0.4114	5.3936	6.9754	24
LNCXPT	6.4417	0.4273	5.4806	6.9527	22
LNREER	4.6096	0.1113	4.4441	4.8130	29
LNWXP	6.3781	0.3758	5.6611	7.0845	29
LNWXPS	6.5053	0.3689	5.8235	7.1683	29

Table 1 presents the summary statistics of the variable series used in the cointegration analysis. It is clear from Table 1 that the variables *X*, *TPI*, *xp*, *cxpindo*, *cxpthai*, *wxp*, *wxps*, and *reer* display an upward trend for the 1991–2019 period under study. All the variable series show a considerable degree of standard deviation.

3. RESULTS AND DISCUSSION

3.1. Unit Root Test

Stationarity underlies statistical inference; thus, a vital aspect of any time-series analysis is to establish the stochastic properties of all variables. Hence, relevant test statistics are determined using the conventional augmented Dickey-Fuller (ADF). The results in Table 2 show that the test statistics exceed the critical values, which reflects that all variables [*x*, *TPI*, *gdp*, *xp*, *cxp*, *wxp*, *wxps*, *reer*] are stationary in their first difference.

Table 2. Unit root test results.

Variable	Level				First Difference			
	ADF	1% critical value	5% critical value	10% critical value	ADF	1% critical value	5% critical value	10% critical value
LNX	-1.652	-3.736	-2.994	-2.628	-4.486***	-3.743	-2.997	-2.629
LNGDP	-1.147	-3.736	-2.994	-2.628	-3.656***	-3.743	-2.997	-2.629
LNXP	-2.137	-3.750	-3.000	-2.630	-4.234***	-3.750	-3.000	-2.630
LNCXPI	-1.591	-3.750	-3.000	-2.630	-3.838***	-3.750	-3.000	-2.630
LNCXPT	-1.600	-3.750	-3.000	-2.630	-3.286***	-3.750	-3.000	-2.630
LNREER	-1.884	-3.736	-2.994	-2.628	-4.404***	-3.743	-2.997	-2.629
LNWXP	-2.064	-3.736	-2.994	-2.628	-4.764***	-3.743	-2.997	-2.629
LNWXPS	-1.956	-3.736	-2.994	-2.628	-4.898***	-3.743	-2.997	-2.629

Note: *** denotes significance at the 1% level.

3.2. Bounds Tests for Cointegration

To achieve a more robust result, the export demand model must check cointegration existence using a different choice of variable. Table 3 shows the results of the ARDL bounds test using the F-statistic test. They are compared to the critical values (restricted intercept and no trend) reported by Narayan (2005), where the long-run forcing variable is determined for small samples. The computed F-statistic with real exports (*x*) as the dependent variable, 53.246, is higher than the upper bound of the critical value of 5.5840 at a 1% level of significance in Model (1). Also, this study indicates the significant role of the exchange rate in the export demand model. Hence, the equation in Models (5), (6), and (7) rejects the null hypothesis of no cointegration at a 1% level of significance. This result contradicts the hypothesis, implying that long-run relationships exist between the variables. Two variables are cointegrated if they have a long-term or equilibrium relationship (Gujarati & Porter, 2009). As shown in Table 3, all equations conclusively rejected the null hypothesis of no cointegration, indicating long-term relationships between the variables.

Table 3. ARDL bounds test of cointegration.

Model	F-Statistics
Model 1: $lnx = f(TPI, xp, , cxpi)$	53.246***
Model 2: $lnx = f(TPI, xp, cxpi, wxp)$	99.673***
Model 3: $lnx = f(TPI, xp, cxpi, wxps)$	63.884***
Model 4: $lnx = f(TPI, xp, cxpi, wxp, wxps)$	84.829***
Model 5: $lnx = f(TPI, xp, cxpi, reer)$	45.486***
Model 6: $lnx = f(TPI, xp, cxpi, reer, wxp)$	83.859***
Model 7: $lnx = f(TPI, xp, cxpi, reer, wxps)$	52.824***

Critical Values for ARDL Modelling Approach						
k	1%		5%		10%	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
(1), k=3	4.280	5.840	3.058	4.223	2.525	3.560
(2)(3)(5), k=4	4.134	5.761	2.910	4.193	2.407	3.517
(4)(6)(7), k=5	3.976	5.691	2.794	4.148	2.334	3.515

Note: *** denotes a significance level of 1%. Critical values are extracted from Narayan (2005).
k is the number of exogenous variables in the equation.

3.3. Long-Run Relationship between Export of Palm Oil and Other Controlled Variables

Evidence for the long-run relationship between real export and its variables with an optimum number of lags selected using the Schartz-Bayesian Criterion (SBC) is shown in Table 4. In columns (1-6), a significant long-run relationship appears between *TPI*, *cxpi*, *xp*, *wxp*, and export demand. The coefficient of *TPI*, which proxies for average trade partners' income, is positive and significant. A 1% increase in the trade partner's income increases export demand by between 0.2% and 0.5%, suggesting that trade partners' income plays a significant role in determining the export demand for palm oil.

Table 4. The long-run result using the selected ARDL model.

Variable	Dependent Variable: Export Demand of Palm Oil					
	(1)	(2)	(3)	(4)Dummy	(5)Dummy	(6)Dummy
LTPI	0.250 (0.109)**	0.405 (0.172)**	0.055 (0.178)	0.474 (0.183)**	0.505 (0.182)**	0.555 (0.289)*
LXP	-1.218 (0.226)***	-1.281 (0.209)***	-1.098 (0.281)***	-1.098 0.235***	-1.158 (0.244)***	-0.635 (0.327)*
LCXPI	1.067 (0.368)***	0.876 (0.470)*	1.733 (0.444)***	1.245 (0.307)***	1.274 (0.343)***	-0.634 (0.327)***
LREER	-	0.369 (0.350)	-0.317 (0.349)	-	0.061 (0.279)	-0.474 (0.310)
LWXP	1.175 (0.375)***	1.665 (0.398)***	-	0.913 (0.253)	1.077 (0.352)***	-
LWXPS	0.280 (0.245)	-	0.672 (0.259)**	0.148 (0.169)	-	0.458 (0.247)
Bannedyear	-	-	-	-0.095 (0.062)	-0.095 (0.0761)	-0.204 (0.102)*
Constant	-1.632 (0.876) *	1.665 (0.398)	1.230 (2.445)	-4.222 (1.945)	-4.830 (2.452)	-1.741 (2.752)
Adjusted R^2	0.958	0.956	0.934	0.964	0.9618	0.9436
Durbin Watson Test	2.219	2.217	2.197	1.642	1.557	2.261
BG-LM Test	0.483	0.459	0.399	0.329	0.206	0.317
White test	0.401	0.401	0.401	0.401	0.401	0.401

Note:*, **, and *** denote a significance level of 10%, 5%, and 1%, respectively. The figure in parentheses (…) refers to the *t*-ratio.

Table 5. The result for short-run impact.

Variable	Dependent Variable: Export demand of Palm Oil of Palm Oil				
	(1)	(2)	(3)	(4)	(5)
LTPI	0.1347 (0.1141)	0.2058 (0.0939)**	-0.0369 (0.1718)	0.3317 (0.1437)**	0.0464 (0.1504)
LXP	-0.8543 (0.2227)***	-1.0014 (0.1839)***	-1.2356 (0.2394)***	-1.0484 (0.1695)***	-0.9227 (0.1504)***
LCXPI	1.3195 (0.3523)***	0.8768 (0.3133)***	2.2824 (0.2679)***	0.7172 (0.3945)*	1.4562 (0.3848)***
LREER	-	-	-0.4723 (0.3301)	0.3021 (0.2848)	-0.2661 (0.2931)
LWXP	-	0.9657 (0.2976)***	-	1.3626 (0.3039)***	-
LWXPS	0.6149 (0.2025)***	0.2304 (0.2008)	-	-	0.5645 (0.2110)***
ECM(-1)	-0.7753 (1.0435)	-1.6327 (0.8761)*	3.6660 (2.6490)	-4.0443 (0.5021)	1.2304 (2.4455)

Note: *, **, and *** denote a significance level of 10%, 5%, and 1%, respectively. The figure in parentheses (…) refers to the *t*-ratio.

The results revealed that export prices (*xp*) are negative and significant in all estimations, implying that a 1% increase in export prices leads to a decrease of between 0.6% and 1.2% in the export demand for palm oil. The results are supported by Zakaria and Nambiappan (2019), who found a significant negative relationship between export demand for palm oil and export price in Malaysia. For competitive price, which refers to soybean oil (*cxp*), the result is positive and significant, implying that a 1% increase in the soybean oil price leads to an increase of 0.8%–1.7% in the export demand for palm oil. This is broadly in line with the findings of Awad, Arshad, Shamsudin, and Yusof (2007) and MPOB (2019), who reported declining exports from Pakistan due to higher imports of soybean oil from Brazil.

For control variables, the world export prices for palm oil (*wxp*) and soybean oil (*wxps*) are included in the estimation. The results reveal that the impact of increasing world exports of palm oil is to increase export demand for palm oil. However, the result for world export of soybean oil is inconsistent; specifically, when we include the dummy for banned year, the result is insignificant. Another control variable, real effective exchange rate (REER), has insignificant results across all estimations.

According to Ab Rahman, Nambiappan, and Shariff (2013), palm oil prices are also dependent on unpredictable market sentiments, which time-series data cannot measure. Thus, dummy variables are used as proxies to examine their impact on palm oil prices. The European Parliament resolution on palm oil and deforestation of rainforests restricted unsustainable palm oil from 2015; thus, the long-run relationship is tested using the dummy variable *bannedyear* in the regression model. In columns 4 to 6, the dummy variable *bannedyear* has a negative relationship with export demand as the EU ban causes real exports to decline. European restrictions on unsustainable palm oil have caused their export preference to switch to soybean oil, which is claimed to be more sustainable. The United States and Brazil accounted for 40% of world soybean exports. According to Khir, Balu, and Ain (2017), soybean industries were likely to increase with lower export taxes as soybean production is mainly for export. Soybean oil is thus a major substitute for palm oil.

3.4. Short-Run Impact

The short-run model reviewed in Table 5 reveals a short-run effect on export demand of weighted average trading partner income, Malaysian export price, Indonesian export price, world export price of palm oil, and world export price of soybean oil. The negative symbol of the ECM term indicates the anticipated convergence process in long-run dynamics. According to the statistical result in Table 5, the effect of trade partner income is positive and significant in columns (2) and (4). For the export price of palm oil, the result is consistent in all estimations, revealing that an increase in price decreases the export demand for palm oil. Conversely, the price of soybean oil positively affects the export demand for palm oil. The effect of the world price of both oil palm and soybean oil is also positive, similar to the long-run result. Meanwhile, the results for the real effective exchange rate are still insignificant.

4. CONCLUSION

This paper employed an export demand function to examine the determinants of Malaysia's export demand in the palm oil sector. The ARDL method was used to determine whether long-run relationships exist between real exports, foreign economic activity, Malaysian export price, competitor export price, world export price of palm oil, world export price of soybean oil, and exchange rates. The empirical results for the time-series data covering the years 1991–2019 show that all variables except the exchange rate are significant determinants of Malaysia's export demand.

The foreign income of five trading partner countries – India, China, the Netherlands, Pakistan, and the USA – positively impacts export demand. Malaysian export demands for palm oil are determined by price changes and trading partner income but not by the exchange rate. From a policy perspective, Malaysian policymakers should focus on improving price competitiveness as Malaysia is known as the largest producer of palm oil. Therefore, a slight increase in Malaysia's export price might cause trading partners' preferences to shift to competitor countries. Finally, it is hoped this paper has shed some light on the future growth planning of palm oil so it can maintain its competitive position alongside other oils and fats in the worldwide market.

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