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# FACTORS AFFECTING EXPORT DEMAND FOR MALAYSIAN PALM-BASED FINISHED PRODUCTS

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## ABSTRACT

*The encouraging growth in volume and exports of palm-based finished products (PBFP) was directly related to an increase in their demand. It is thus important to investigate the factors influencing such demand. Our study attempts to elucidate this for the Malaysian PBFP in ten (10) major foreign markets, namely, Turkey, China, Iraq, Iran, Singapore, Romania, Australia, Pakistan, Russia, and Saudi Arabia. This study constitutes a panel data analysis for the ten countries using data from 2007 to 2021 using the fully modified ordinary least squares (FMOLS) method. Pedroni and Westerlund cointegration test indicates the presence of a long-term relationship between the variables under study. The empirical results show that Gross Domestic Product (GDP) has a long-term positive influence on the demand for PBFP, with every 1% increase in GDP will increase the demand for palm oil by 0.9%. In addition, population size (POP) also shows a positive sign and is statistically significant at the 1% level, indicating that a 1% increase in POP will lead to a 0.3% increase in PBFP demand. Substitute oil price also has a long-run positive influence where for every 1% increase in the price of both commodities will increase the demand for PBFP by 0.1%. Meanwhile the price of PBFP has a long-term positive influence on its demand. Thus, information regarding the factors influencing the demand for PBFP from our findings may help industry player and, policymakers in formulating strategies to improve the markets, and academicians may also benefit from sharing the knowledge gained from the study.*

**Keywords:** palm oil, palm-based finished products, GDP, export demand and FMOLS

## INTRODUCTION

Palm oil is the most prominent vegetable oil in the global market, surpassing other vegetable oils such as soybean oil, rapeseed oil, and sunflower oil. In 2020, a total of 74.05 million tonnes of palm oil were produced globally from 23.94 million hectares of oil palm area (Oil World, 2021). This represents 34.7% of global oils and fats output but from only 8.1% of global oils and fats producing areas (Figure 1). Although oil palm uses less than a quarter of the area required by other crops but it produces the largest percentage of oils and fats.

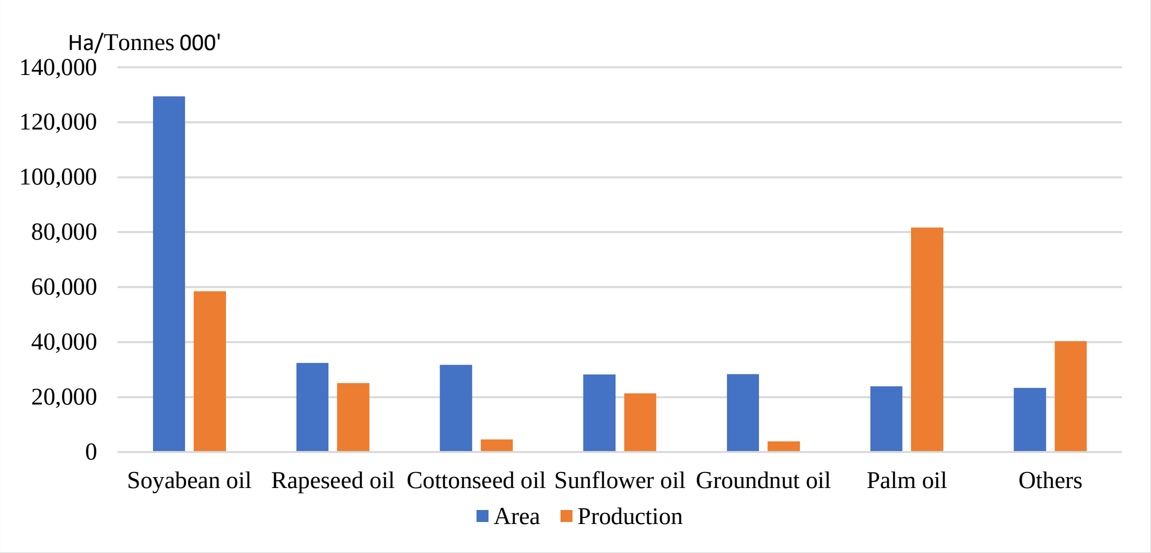


*Figure 1.* Area of major oilseed in 2020 vs production of major oils and fats, 2020

*Source:* Oil World (2021)

Malaysia is the second largest producer and exporter of palm oil in the world after Indonesia. In 2020, the country accounted for 25.8% and 34.3% of world's palm oil production and exports, respectively. Among the major importers of Malaysian palm oil products are India, the European Union (EU) and China (Parveez et al., 2021). India is predominantly importing crude palm oil (CPO), while China is importing more on processed palm oil (PPO) and the EU import mixed CPO and PPO (MPOB, 2020). Given the various applications of palm oil, it is not surprising that the demands for palm oil and palm oil related products have been experiencing rapid growth.

Between 2007 to 2021, export of PPO amounted to 196.30 million tons and accounted for 55.6% of the country's total export of oil palm products (Figure 2). It was followed by CPO with 54.40 million tons (15.4%) and palm-based oleochemical with 39.68 million tons (11.2%). Meanwhile, export of palm-based finished product accounted for 7.28 million tons or 2.1% of total export of oil palm products. In terms of earning over the 15 year-period, palm-based oleochemicals represented the highest value at 18.5% of total export earnings of oil palm products and amounting to only 11.2% of total export volume. It was then followed by palm kernel oil (6.5%) and palm-based finished products (3.0%). Although the last product group contributes the least to the exports of oil palm products, it is defined as one of the high value-added products despite the low export volume. Palm-based finished products thus make better contribution to the national GDP which is also a measure of value addition created within the country.

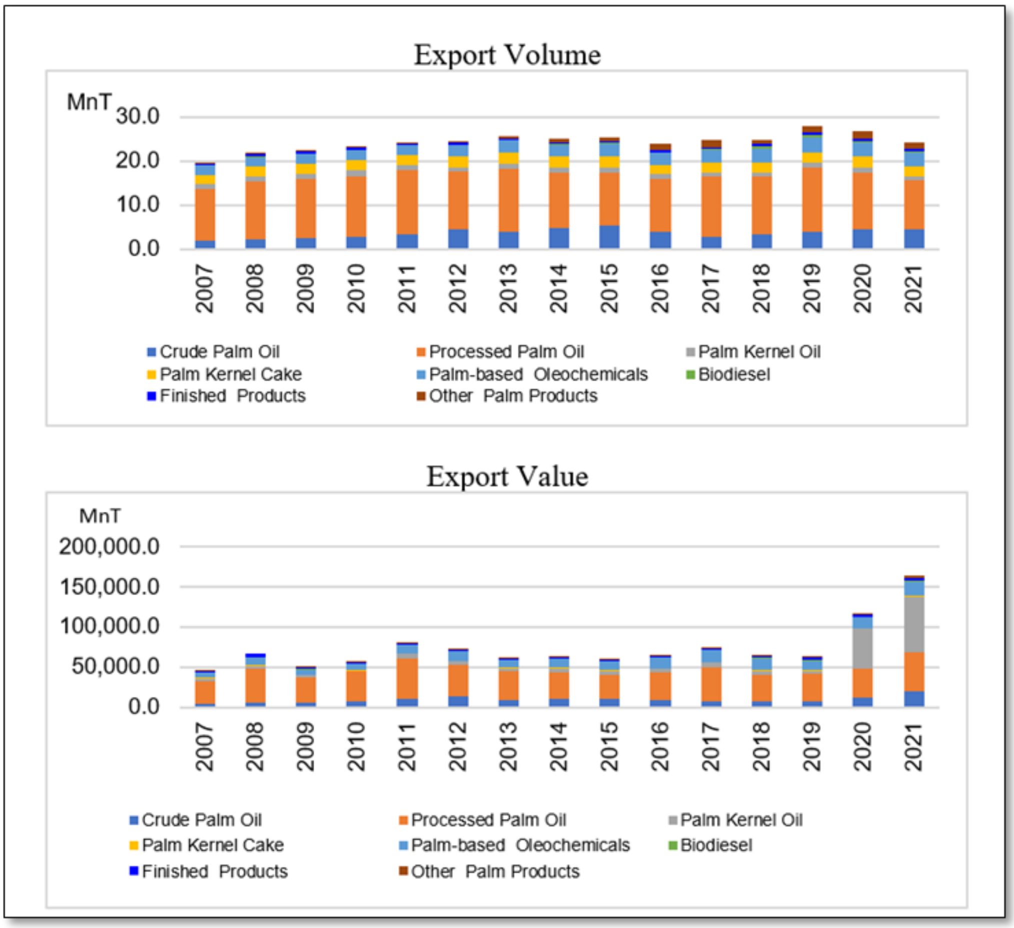


*Figure 2.* Contribution of palm-based finished products, 2007–2021

*Source:* MPOB (2008, 2009, 2011, 2013,2015,201, 2019, 2021)

The major palm-based finished products sold in the domestic market are shortening, cocoa butter substitute, margarine, cocoa butter equivalent, and vegetable ghee or *vanaspati* (Nordin et al., 2012). Palm-based ingredients are extensively used in the manufacture of food products such as margarine, spreads, and chocolates, as well as non-food products including personal care and beauty products, cleaning products, and perfumes (Kushairi & Parveez, 2017). Consumers use all of these products on a daily basis. Palm oil has high-quality due to its melting characteristics, neutral flavour, and firm consistency at room temperature. These characteristics make it suitable for use in the production of creamy fillings in products such as chocolates, as it provides the melt-in-the-mouth sensation. Other daily use merchandises also have palm oil-based products as one of the ingredients, such as acetyl palmitate in lipsticks, stearic acid in shaving gel, and palmityl alcohol in shampoo.

The total production of Malaysian palm-based finished products in 2020 amounted to 302,035 tons, a reduction of 17% compared to 363,123 tons from the previous year. Exports of finished products in 2020 also fell by 31,162 tons or 5.25% to 562,552 tons from the previous year level. Concurrently, the export slightly decreased by 4.1% to 26.72 million tons in 2020 and from 27.88 million tons in 2019. The major palm-based finished products exported in 2020 were shortening at 165,482 tons or 29.3% of the total palm-based finished product exports, followed by vegetable/dough fats at 143,294 tons (25.3%), soap at 131,975 tons (23.3%), cocoa butter substitute at 59,334 tonnes (10.5%), and *vanaspati* at 22,327 tonnes (4.3%). Major importing countries for the Malaysian palm-based finished product are Turkey, China, Iraq, Iran, Singapore, Romania, Australia, Pakistan, Russia, and Saudi Arabia (MPOB, 2020).

In 2020, Turkey was the highest export destination for Malaysian palm-based finished products, with 48,103 tons (or 8.6% of the total palm-based finished product exports), followed by China with 40,585 tons (7.2%), Russia with 28,990 tons (5.2%), and Iraq with 22,357 tons (4.0%). This study aims to identify the determinants of demand for palm-based finished products in the above-mentioned countries. This factor identification is expected to help the industry to penetrate new markets and improve on the export of Malaysian palm oil products. The rest of the article is structured as follows: The following section provides a brief discussion of the literature review on palm-based finished products. This is followed by a description of the research methodology and then the results and discussion. Finally, the discussion will end with the conclusion and policy implications in the last section of the paper.

## LITERATURE REVIEW

The analysis used to evaluate palm oil demand is dependent on the data, whether it is time series data or panel data. For the former, various methods were adopted in past studies to assess demand for palm oil such as the Ordinary Least Squares (OLS) method (Jazuli & Kamu, 2019; Seng & Ahmad, 2017), two stage least squares (2SLS) technique (Talib et al., 2007; Tety et al., 2009; Applanaidu et al., 2011), and the autoregressive distributed lag (ARDL) technique (Hameed et al., 2007; Hameed et al., 2012; Egwuma et al., 2013; Hameed et al., 2016; Zakaria, 2018; Zakaria et al., 2019). Some studies preferred the ARDL method due to the more robust mode which performs better for small sample size data (Pesaran et al., 2001). Jamilah et al. (2022) adopted the Constant Market Share model (CMS model) to analyse Indonesian CPO export competitiveness in the European Union market. The model is utilised on time series data. This methodology involves a set of statistical indicators that gauge the country's ability to control its contribution of its exports in the importing markets within a particular time span.

To develop a model for panel data some of the studies employed fully modified ordinary least squares (FMOLS) method as suggested by Pedroni (2001) to calculate the long-run co-integration coefficients. Pedroni (2000) demonstrated that, inference in a cointegrated heterogeneous dynamic panel can be allowed by modifying OLS. To transform the residuals from the cointegration regression to eliminate nuisance parameters, non-parametric techniques are exploited using FMOLS setting. With this setting the problems of endogeneity of the regressors and serial correlation in the error term are avoided in order to examine competitiveness of palm oil export through price-nominal exchange rate (Lugo Arias et al., 2020). Hassan et al. (2023) adopted the panel cointegration and Granger causality approaches in analysing panel data when studying the causal relationship between Malaysian palm oil export and the economic factors of the 10 main palm oil importing countries. Upon obtaining the evidence of cointegration, the team subsequently adopted Pedroni fully modified OLS technique to find long-term cointegration evidence between the variables and the related coefficients. The adoption of Pedroni's technique is essential to suppress bias due to endogeneity and serial correlation (Hassan et al., 2023).

It is essential to understand the elements that affect palm oil demand in order to comprehend and provide insight into the changes in market circumstances in the past, as well as the future growth of its demand. Figure 3 illustrates a framework emphasizing the aspects of income, population, exchange rate, palm oil price, and substitute oil pricing that impact the demand for palm oil. Past research has explored and acknowledged a number of market characteristics as the primary determinants of palm oil demand.

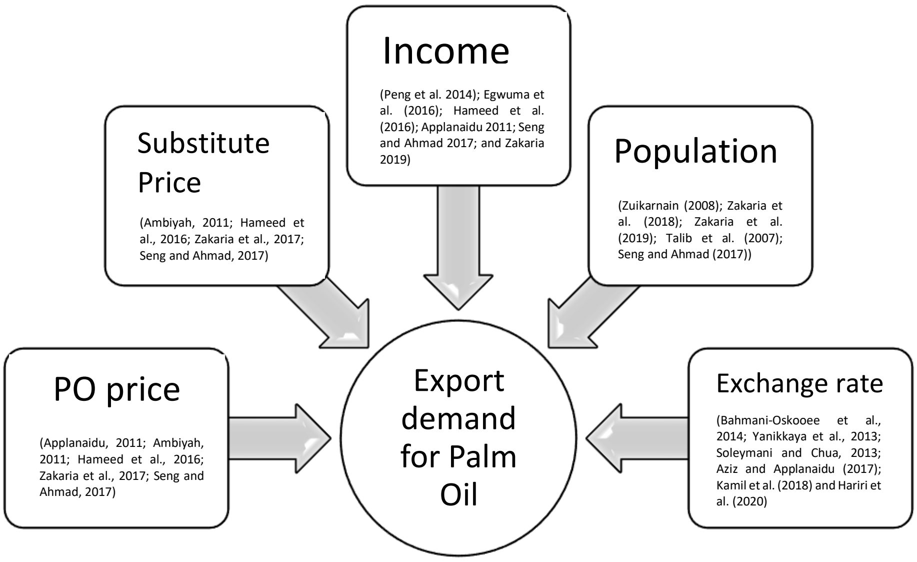


*Figure 3*. Conceptual framework factors affecting demand for palm oil

According to the law of demand, the lower the price of goods, the higher is its demand, ceteris paribus. Thus, as the price of palm oil increases, palm oil demand would decrease. Since palm oil is commonly consumed as food, its low elasticity is thus expected.  Due to its importance as food product, a substantial increase in its price will not considerably affect its demand. In contrast, a large decline in the price of palm oil will not result in a substantial increase in demand since consumers have a finite capacity for its consumption. According to Othman and Alias (2000), the price of palm oil will reflect the shifting structure of consumer demand in the U.S. and European markets. Similar research conducted by Zuikarnain (2008) indicated that the price of palm oil has a significant influence on Malaysian palm oil demand. A study by Lestari and Oktavilia (2020) shows that palm oil consumption has an insignificant effect on palm oil prices compared to other factors such as palm oil production, international CPO prices and coconut oil prices. These findings imply that while price may influence the demand for palm oil, the vice versa is not equally significant, leading to an almost one-way relationship i.e. the consumption is reactive towards price changes but the consumption pattern itself does not significantly affect the price changes.

In addition to its own price, demand on palm oil is also impacted by substitute pricing, or the value of competing products. Increases in the pricing of its substitutes will raise demand for palm oil. Conversely, lowering the prices of substitutes will contribute to a decline in palm oil demand, as customers seek to switch to a similar product but with a lower price. Palm oil is well-known for its use as a cooking oil, but it is also utilised in the production of a variety of food products and household and personal care products, among others. For instance, Applanaidu (2011) revealed that the export price of palm oil and the price of its substitutes have a significant impact on determining its export demand. Past research has also revealed that the price of soybean and sunflower oil exerted a considerable impact on palm oil demand (Ambiyah, 2011; Hameed et al., 2016; Zakaria et al., 2017; Seng & Ahmad, 2017). More recently, Warsito (2020) while analysing the factors influencing Indonesian CPO export to

India, found that the world soybean oil price – the notorious substitute for CPO – significantly and positively affects the Indonesian CPO export value to India.

Income is another element that influences palm oil demand. A rise in income will boost the purchasing power of individuals and households which will in turn raise their disposable income, hence raising the demand for palm oil. The majority of empirical studies suggests that income has a considerable impact on palm oil demand. In general, researchers estimate income using nominal or real gross domestic per capita (GDP), gross national product (GNP), or per capita income (Peng et al., 2014). In a study by Egwuma et al. (2016), palm oil price and income level were shown to be significant determinants of palm oil demand in Nigeria. Hameed et al. (2016) revealed that wealth positively affects the demand for palm oil in six Asian nations, which is consistent with the findings of numerous other studies (Applanaidu, 2011; Seng & Ahmad, 2017; Zakaria, 2019). Income of the palm oil exporting countries like Indonesia and Malaysia are also able to affect the import of palm oil into particular group of countries, for example, North American countries such as USA, Canada and Mexico. Tandra et al. (2022a) showed that the GDP of Malaysia and/or GDP of Indonesia, among other factors, are significantly affecting palm oil import in the North American countries in the long and short term.

The size of the population can also affect the demand for palm oil. In general, a growing population will boost the demand for palm oil, as more people will consume the product and thus increase the need for vegetable oils. Population as variable was included in the model by Zuikarnain (2008), while other variables, such as palm oil and soy oil prices, remained the same as recorded in earlier research. The study indicated that palm oil and soybean oil prices, and population had a substantial impact on the demand for Malaysian palm oil. A study by Zakaria et al. (2018) concluded that price competitiveness, income and the price of substitutes had a significant impact on the demand for palm oil in Turkey. Similar results were observed by other researchers but in different geographical locations. Similarly, Zakaria (2019) stated that GDP, population and palm oil pricing substantially impact palm oil consumption in the Balkan nations. These findings are consistent with those of Alias et al. (1992), Shamsudin et al. (1994), Talib et al. (2007), and Tandra et al. (2022b). However, Seng and Ahmad (2017) differed slightly in elaborating the determinants of palm oil demand by classifying the internal and external variables that influence palm oil demand into two groups. The internal factors are the variables within local control, such as export prices and currency rates. In contrast, the external determinants consist of the economic expansion of trading countries and the substitution or complementary prices.

Earlier studies also considered the exchange rate as one of the factors influencing demand for palm oil. According to Bahmani-Oskooee et al., 2014, exchange rate exerts a significant negative impact and indirectly decrease export volume, in agreement with the findings of Yanikkaya et al. (2013) and Soleymani and Chua, (2013) who established that the variable significantly influences trade. Aziz and Applanaidu (2017) who focused on the palm oil industry found that real palm oil prices produced significant negative effects on the real exchange rate, and affected indirect influence on demand for palm oil. Hariri et al. (2020) also agreed that the exchange rate influenced export of palm oil. A study on the impact of exchange rate on palm oil export by Kamil et al. (2018), involving 261 companies registered with the Malaysian Palm Oil Board, however revealed that the fluctuation of the Malaysian Ringgit did not significantly affect the export volume of palm oil products. However, a study from Nigeria suggests a strong linkage between exchange rate and palm oil export (Omosehin & Osabuohien, 2022).

Palm oil is not only traded in the form of crude and refined oils but is also as ingredients in various applications as cooking/frying oil, margarine, *vanaspati*, and shortening (Dian et al., 2017). Palm oil has high suitability as a major component in margarine and shortenings because it is naturally semi-solid and can be further modified through fractionation, interesterification, hydrogenation, and blending (Idris & Sahri, 2007). Margarines were originally derived from lard and other fat sources and were widely consumed globally until the 1970s and 1980s (Sánchez-Muniz & Cuesta, 2003). In addition, the product is a cheaper alternative to butter and is also used in cooking and food preparation (Morris & Vaisey-Genser, 2003). Several studies on the demand for margarine, such as Jensen and Bevins (1991), found that beside price and expenses, other factors such as changes in demography, lifestyle, and health concerns also influenced the demand for butter, margarine, and other oils. Huffman et al. (2010) found that consumers preferred health-promoting attributes in products. In addition, Gould (1997) revealed that over 90% of consumers reacted to price changes in their decision-making to purchase butter, margarine, or butter/margarine blends. Another study in Hungary shows that the consumer utility and willingness to pay for margarine reduced by the increase in the salt and fat content of the margarine, lending further support on the claim of health concern as one of the factors behind palm-based products demand (Czine et al., 2020).

Palm oil and its elements are also suitable for confectionery applications, such as in soft chocolate, chocolate syrup, ice cream, cream coating, and confectionery filling (Hassim & Dian, 2017). Similarly, palm oil is used as a stabiliser in the manufacturing of peanut butter as it improves the oil holding capacity of the product (Hinds et al., 1994; Aryana et al., 2003). Further, palm-based finished products are also used as replacement for cocoa butter, and is currently gaining high market demand due to its price competitiveness. The limited number of cocoa trees cultivated has led to an unstable supply of cocoa butter thus leading to an increase in its price due partly to the growing demand from the confectionery industries (Naik and Kumar, 2014). The cocoa butter substitute is produced from a mixture of palm mid-fraction oil, palm kernel oil, and palm stearin. The physicochemical properties of this mixture are comparable to that of cocoa butter (Biswas et al., 2017).

Although palm oil is commonly used in the food processing industry it also has a wide range of non-food uses, particularly in the production of soap and detergents, pharmaceutical products (Ghazali et al., 2007) and cosmetics. Soap production is one of the most significant applications of oils and fats which were traditionally dominated by tallow and coconut oil. Due to the similarities in fatty acid compositions, palm and palm kernel oil provide suitable and competitive alternatives as a raw material for soap making (Basiron, 2002).

Over the past few years, natural-based cosmetics and personal care products have been dominating the market and replacing synthetic products. Besides the naturalness, vegetable oil-based personal care products are acceptable by the market (Ghazali et al., 2006). Nordin et al. (2012) suggested that the expansion of the manufacturing sector, together with the country's growing population and higher per capita income, will sustain the drive-in industry development of the palm-based finished products. Although, most past research had focused on the specialty, type, and acceptance of palm-based finished products, very few had examined the factors influencing demand for these products. Such information is crucial for the further expansion of the market in order to guide the industry into making the right market decisions. On this cognizance, the aim of this study is to examine the demand for Malaysian palm-based finished products using balanced panel data from ten (10) major markets, from 2007 to 2021.

## DATA AND METHODOLOGY

This study focuses on top ten importing countries of Malaysian palm-based finished products (PBFP). The selection was based on the export performance of PBFPs to major destinations, between 2007 to 2021, as reported by the Malaysian Oil Palm Statistics. Data on PBFP was sourced from MPOB statistics. Data on soybean oil price and sunflower oil price were sourced from the United Nations Conference on Trade and Development (UNCTAD) while gross domestic product (GDP), consumer price index (CPI), and population (POP), real effective exchange rate were obtained from the World Development Indicators (WDI). All the variables are transform into natural logarithms. The markets for PBFP used in the study include Turkey, China, Iraq, Iran, Singapore, Romania, Australia, Pakistan, Russia, and Saudi Arabia. To investigate the demand for PBFP, we use the following model:

$$lnPBFP_{it} = \alpha_0 + \alpha_{1i}lnGDP_{it} + \alpha_{2i}lnPOP_{it} + \alpha_{3i}lnREER_{it} + \alpha_{4i}lnPPO_{it} + \alpha_{5i}lnPSOY_{it} + \alpha_{6i}lnPSUN_{it} + w_i + u_{it} \quad (1)$$

The model uses panel linear specification as in Equation 1 with the cross-sectional indicated by the subscript $i$ ($i$ = 1,2...,$N$) while the time period element is indicated by the subscript $t$ ($t$ = 1,1...,$T$). Meanwhile $w$ represents the country fixed effect and $u$ is the stochastic random term.

This study uses the FMOLS method to determine factors influencing the demand for Malaysian PBFPs in ten (10) major markets. FMOLS reliable estimates for small sample size also provide a check of robustness of the results (Bashier, 2014). According to Pedroni (2001) the FMOLS technique generates consistent estimates in small samples and is unaffected by large distortions in the presence of endogeneity and heterogeneous dynamic.

### Panel Unit Roots

In order to conduct the test of panel cointegration the stationarity of the variables should first be considered. The panel unit root test is used to assess whether the series in the model is stationary or otherwise. The purpose of conducting this test is to prevent any estimation bias. Several approaches to the panel unit root test have been proposed and each approach has its own strengths and weaknesses based on the characteristics of the data (Gautam, 2018). According to Mitic et al. (2017), there are two types of panel unit root tests, namely "first generation" and "second generation". The first generation includes the Levin-Lin-Chu test (LLC) and Im-Pesaran-Shin test (IPS), while the most prominent second-generation test is the cross-sectional IPS test (CIPS) proposed by Pesaran (2007). To check the stationary of the variable, this study applies IPS (Im, Pesaran, and Shin) and WM (Maddala & Wu, 1999) panel unit root tests. The IPS is a heterogeneous panel test, while the MW is a non-parametric test, and both are applied to a balanced panel. For cross-sectional dependence, Pesaran (2007) specifically suggested a cross-sectionally augmented IPS known as the CIPS (also known as CADF) method, which follows the common correlated effects.

The CIPS test adds a cross-sectional mean of lagged levels and first-differences to the ADF regression, allowing it to account for cross-sectional dependence. This makes it a more appropriate test for unit roots in panel data where cross-sectional dependence is expected. The equation for the CIPS test can be written as follows:

$$\Delta x_{it} = z'_{it}\gamma + \rho_i x_{it-1} + \sum_{j=1}^{k_i} \varphi_{ij}\, \Delta x_{it-j} + \alpha_i \bar{x}_{t-1} + \sum_{j=0}^{k_i} \eta_{ij}\, \Delta \bar{x}_{t-j} + \nu_{it} \qquad (2)$$

where $\bar{x}_t$ is the cross-section mean of $\bar{x}_{it}$, $\bar{x}_t = N^{-1} \sum_{i=1}^{N} x_{it}$. The cross-sectionally augmented IPS statistic is the simple average of the individual CADF statistics and is defined as

$$CIPS = t - bar = N^{-1} \sum_{i=1}^{N_i} t_i \qquad (3)$$

Where $t_i$ is the OLS $t$-ratio of $\rho_i$ in Eq. (2). The critical values of the statistics are given by Pesaran (2007). The null hypothesis of the CIPS test is that each individual series contains a unit root, against the alternative hypothesis that some (but not necessarily all) individual series are stationary.

**Panel Cointegration Test**

To determine long-run relationship between the variables, this study used two methods for cointegration tests; the Pedroni (1999; 2004) first-generation test and the Westerlund (2007) second-generation panel cointegration test. Asymptotic and finite-sample properties are used in the Pedroni test to examine the null hypothesis of no cointegration in the panel. This approach allows for unit-specific fixed effects as well as deterministic patterns. It considers both pooled within the dimension and group mean between dimension tests. It also allows for long-run and short-run heterogeneity among the panel's individual members. There are two types of panels cointegration test suggested by Pedroni (1999; 2004). The first one is focused on within dimension and also known as "weighted statistics" which involves four statistics: panel *v*-statistic, panel rho-statistic, panel PP-statistic and panel ADF-statistic. The second test is focused on group statistics; group rho-statistic, group PP-statistic and group ADF-statistics. In general, Pedroni (1999) cointegration is as follow:

$$x_{it} = \alpha_i + \rho_i t + \beta_{1i} Z_{1it} + \cdots + \beta_{mi} Z_{mit} + \varepsilon_{it} \qquad (4)$$

Where *x* and *Z* are assumed to be integrated of the order 1 or I(1). The specific intercept term $\alpha_i$ and slope coefficients $\beta_{1i}, \beta_{2i}, \ldots, \beta_{mi}$ vary across individual members of the panel.

The second-generation panel cointegration test consists of four error correction-based tests developed by Westerlund (2007). The idea is to test the null hypothesis of no cointegration by determining whether the error-correction term in a conditional panel error-correction model is equal to zero. Two of the tests are called group-mean tests and the second pair is called panel tests. The tests are general enough to allow for a large degree of heterogeneity in both the long-run and cointegrating relationships and the short-run dynamics and dependence within as well as across the cross-sectional units (Persyn & Westerlund, 2008). Equation 1 can be transformed into the following error-correction model:

$$\Delta lnPBFP_{it} = c_i + \varphi_{i1} \sum_{j=1}^{p} \Delta lnPBFP_{it-j} + \varphi_{i2} \sum_{j=0}^{p} \Delta lnGDP_{it-j} + \varphi_{i3} \sum_{j=0}^{p} \Delta lnPOP_{it-j} + \varphi_{i4} \sum_{j=1}^{p} \Delta lnREER_{it-j} + \varphi_{i5} \sum_{j=0}^{p} \Delta lnPPO_{it-j} + \varphi_{i6} \sum_{j=0}^{p} \Delta lnPSOY_{it-j} + \varphi_{i7} \sum_{j=0}^{p} \Delta lnPSUN_{it-j} + \phi_i [lnPBFT_{it-1} - \alpha_{1i} lnGDP_{it-1} - \alpha_{2i} lnPOP_{it-1} - \alpha_{3i} lnREER_{it-1} - \alpha_{4i} lnPPO_{it-1} - \alpha_{5i} lnPSOY_{it-1} - \alpha_{6i} lnPSUN_{it-1}] + \varepsilon_{it} \qquad (5)$$

Where $\phi_i$ refers to the rate at which adjustments are made to reach the long-term equilibrium, defined by the equation $PBFP_{it} = -\left(\frac{\alpha_i}{\phi_i}\right) \times x_{it}$ for that series $i$. The $G_\alpha$ and $G_\tau$ test statistics test $H_0: \phi_i = 0$ for all $i$ versus $H_0: \phi_i < 0$ for at least one $i$. These statistics start from a weighted average of the individually estimated $\phi_i$ and their t-ratios respectively. Rejection of the null hypothesis implies evidence of cointegration for at least one entity in the cross-sectional analysis. Meanwhile, the $P_\alpha$ and $P_\tau$ test statistics pool information over all the cross-sectional units to test $H_0: \phi_i = 0$ for all $i$ versus $H_0: \phi_i < 0$ for all $i$. Hence, the rejection of null hypothesis points to evidence of cointegration for the entire panel. However, our primary attention is on the $P_\alpha$ and $P_\tau$ statistics because, as per Westerlund (2007), these statistics possess the greatest power and exhibit the most robustness to cross-sectional dependency.

**Long-Run Cointegrated Regression Estimation**

After confirming the existence of panel cointegration, Pedroni (2001) suggested using FMOLS to get the long-run co-integration coefficients. Pedroni (2000) demonstrated that, inference in a cointegrated heterogeneous dynamic panel can be allowed by modifying OLS. To transform the residuals from the cointegration regression to eliminate nuisance parameters, non-parametric techniques are exploited using FMOLS setting. Therefore, with FMOLS the problems of endogeneity of the regressors and serial correlation in the error term are avoided. According to Mitic (2017), the pooled FMOLS estimator as a modification of standardised OLS is given as:

$$\hat{\beta}_{\mathrm{NT}} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\left(x_{i,t} - \bar{x}_i\right)^2\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(x_{i,t} - \bar{x}_i\right)\left(y_{i,t} - \bar{y}_i\right) \tag{6}$$

The use of FMOLS in panel cointegration analysis was suggested by Pedroni (1996; 2001). The pooled FMOLS estimator as a modification of standardised OLS is given as:

$$\hat{\beta}_{\mathrm{FM}} = \left(\sum_{i=1}^{N}\hat{L}_{22i}^{-1}\sum_{t=1}^{T}\left(x_{i,t} - \bar{x}_i\right)^2\right)^{-1}\sum_{i=1}^{N}\hat{L}_{11i}^{-1}\hat{L}_{22i}^{-1}\left(\sum_{t=1}^{T}\left(x_{i,t} - \bar{x}_i\right)y_{i,t}^{*} - T\hat{\delta}_i\right) \tag{7}$$

where:

$$y_{i,t}^{*} = \left(y_{i,t} - \bar{y}_i\right) - \left(\frac{\hat{L}_{21i}^{-1}}{\hat{L}_{22i}^{-1}}\right)\Delta x_{i,t} + \left(\frac{\hat{L}_{21i}^{-1} - \hat{L}_{22i}^{-1}}{\hat{L}_{22i}^{-1}}\right)\beta\left(x_{i,t} - \bar{x}_i\right), \hat{\delta}_i$$
$$\equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \left(\frac{\hat{L}_{21i}^{-1}}{\hat{L}_{22i}^{-1}}\right)\left(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0}\right)$$

## RESULTS AND DISCUSSION

Results from IPS and MW panel unit root test at level and difference for first-generation are presented in Table 1. The optimal lag length is fixed at lag 1. The results show that all variables are stationary at first difference with trend and without trend for first-generation panel unit root. The results of second-generation panel unit root using Pesaran (2007) are presented in Table 2 using two lag orders. All variables are stationary at first difference for with and without trend.

Table 1
*First-generation panel unit root tests: Im, Pesaran, and Shin (IPS) and Maddala-Wu (MW)*

| Variable | Model | IPS | MW | IPS | MW |
|---|---|---|---|---|---|
| | | Level | | First Difference | |
| PO | Without trend | –1.11813 | 41.443*** | –8.50671*** | 189.765*** |
| | With trend | –2.33632*** | 48.223*** | –6.54987*** | 142.564*** |
| GDPC | Without trend | 0.18460 | 23.124 | –5.89769*** | 99.976*** |
| | With trend | 0.74537 | 16.154 | –6.73767*** | 88.142*** |
| POP | Without trend | –15.6294*** | 180.017*** | 4.64196 | 70.353*** |
| | With trend | 7.04477 | 35.831*** | –16.0825*** | 78.265*** |
| REER | Without trend | 0.48365 | 26.914 | –4.86036*** | 76.345*** |
| | With trend | 0.87055 | 12.276 | –2.14424** | 64.741*** |
| PPO | Without trend | –1.97824** | 30.959*** | –3.15192*** | 143.609*** |
| | With trend | 1.78769 | 27.055 | –5.13000*** | 92.284*** |
| PSOY | Without trend | –2.80557*** | 47.345*** | –4.38589*** | 146.213*** |
| | With trend | 0.11231 | 35.760*** | –4.26893*** | 93.554*** |
| PSUN | Without trend | –2.80557*** | 49.162*** | –4.38589*** | 238.852*** |
| | With trend | 0.11231 | 71.092*** | –4.268931*** | 175.940*** |

*Note:* *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

Table 2
*Second-generation panel unit root tests: Pesaran (2007) Panel Unit Root Test (CIPS)*

| Variable | Model without trend | | | Model with trend | | |
|---|---|---|---|---|---|---|
| | q =0 | q=1 | q=2 | q=0 | q=1 | q=2 |
| Level | | | | | | |
| PO | 0.530 | –0.107 | 0.783 | –2.454*** | –0.130 | 1.652 |
| GDPC | –0.839 | –1.579* | –2.886*** | 1.596 | 1.359 | –1.595* |
| POP | –3.435*** | –4.761*** | –0.630 | –3.404*** | –2.683*** | 0.973 |
| REER | 0.580 | –0.149 | 1.897 | 0.923 | –0.068 | 1.999 |
| PPO | –2.408*** | –0.547 | –0.348 | –1.532* | –0.368 | –0.826 |
| PSOY | –1.615* | 0.0110 | –4.017 | –0.740 | 1.450 | 4.722 |
| PSUN | –2.411*** | –1.240 | –0.348 | –2.434*** | 0.042 | 0.958 |
| First Difference | | | | | | |
| PO | –6.731*** | –3.730*** | 0.515 | –5.168*** | –3.170*** | 0.837 |
| GDPC | –3.575*** | –2.874*** | 0.348 | –3.673*** | –2.058** | 0.804 |
| POP | –1.658** | –4.171*** | –0.768 | 3.984 | –0.5522 | 0.276 |
| REER | –3.190*** | –1.974** | 1.222 | –1.874** | –1.045 | 2.700 |
| PPO | –8.333*** | –3.428*** | –1.894** | –7.121*** | –3.190*** | –3.232*** |
| PSOY | –5.919*** | –1.955** | 2.069 | –4.418*** | –0.309 | –0.163 |
| PSUN | –8.076*** | –2.390*** | –0.205 | –5.882*** | –1.049 | 1.995 |

*Note:* *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

After testing for stationarity using unit root tests, we employ the panel cointegration test to determine the existence of co-integration relationships among the variables. For this purpose, we use first-generation and second-generation, as presented in Table 3 and Table 4. For the first-generation, we conducted the panel cointegration test developed by Pedroni (1996; 2000). There are seven test statistics proposed including panel *v*-statistic, panel rho-statistic, panel pp-statistic (nonparametric) panel ADF-statistic (parametric), group rho-statistic, group pp-statistic (nonparametric), and group ADF-statistic (parametric). The findings in Table 3 show that four of the seven panel cointegration tests confirm the presence of cointegration among the variables.

Table 3
*Panel cointegration results following Pedroni (2004)*

| | Value | *p*-value |
|---|---|---|
| **Within dimension** | | |
| Panel *v* | –0.763913 | 0.7775 |
| Panel ρ | 2.260636 | 0.9881 |
| Panel PP | –4.378586 | 0.0000 |
| Panel ADF | –2.856452 | 0.0021 |
| **Between dimension** | | |
| Panel ρ | 4.134429 | 1.0000 |
| Panel PP | –6.838833 | 0.0000 |
| Panel ADF | –4.812212 | 0.0000 |

*Note:* *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

Table 4 report on the results from Westerlund's (2007) panel cointegration test which allows for cross-sectional dependence. The empirical results show that for without trend, $G_\tau$ and $P_\tau$ test statistics are significant at 1%. The evidence from this panel test supports the presence of cointegration relationships among the variables in the context of the 10 countries.

Table 4
*Panel cointegration test following Westerlund (2007)*

| | Value | *p*-value |
|---|---|---|
| **Without trend** | | |
| $G_\tau$ | –21.679 | 0.000 |
| $G_\alpha$ | –0.216 | 0.000 |
| $P_\tau$ | –4.658 | 0.000 |
| $P_\alpha$ | –0.278 | 0.000 |

*Note:* *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

Next, we estimate the cointegration relationships between demand for PBFP, GDP, POP, REER, PPO, PSOY and PSUN using FMOLS estimators. The empirical results of the long-run models are presented in Table 5. The results indicate that income, as measured by GDP, has a long-run positive influence on PBFP demand. The model shows that every 1% increase in GDP will increase the demand for PBFP by 0.8% in the long run. The positive relationship between GDP and demand for PBFP shows that it is a normal product. According to Bahri et al. (2018), GDP is a parameter representing market size, thus a positive GDP will generate more demand for palm oil. This finding is also aligned with Hameed et al. (2016), Applanaidu (2011), Seng and Ahmad (2017) and Zakaria (2019) whose findings suggest wealth positively affects the demand for palm oil.

POP also has a long-run positive influence on the demand for PBFP. Every 1% increase in POP will increase the demand for PBFP by 1.2%. The positive influence of population on PBFP is aligned with the demand theory, which states that the size of the population can also influence the demand for palm oil. The result is in line with those of previous studies (Elam & Uko 1977; Alias et al., 1992; Shamsudin et al., 1994; Talib & Darawi 2002; Shariff et al., 2006; Talib et al., 2007; Hassan et al., 2018; Zakaria et al., 2019; Tandra et al., 2022b).

The coefficient of PPO carries a negative sign and is significant at the 1% level, which shows that a 1% increase in PPO will result in about a 0.3% decrease in the demand for PBFP. The result is supported by past studies on palm oil demand (Hameed et al., 2016, Zakaria et al., 2017; Seng & Ahmad, 2017). The price of substitute price appears to have a significant relationship with demand for PBFP. A 1% increase in PSOY and PSUN will result in about 0.1% increase respectively in demand for PBFP. An increase in the prices of other vegetable oils increases the demand for PBFP as consumers tend to switch from using other vegetable oils to palm oil. The result is consistent with those of previous studies (Ambiyah, 2011; Hameed et al., 2016; Zakaria et al., 2017; Seng & Ahmad, 2017; Warsito 2020). Though Warsito (2020)'s results pointed out that the increase in world soybean price will increase the Indonesian CPO export to India, this will eventually lead to increase in PBFP in India as well since India refines and further processes most imported CPO within its border for local consumption and re-export.

Table 5
*Panel FMOLS long-run estimates*

| Variable | Linear Model |
|---|---|
| GDPC | 0.7823*** |
| POP | 1.1821*** |
| REER | 0.02110 |
| PPO | –0.2547*** |
| PSOY | 0.0495* |
| PSUN | 0.1272*** |

*Note:* *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

## IMPLICATIONS TO THEORY AND PRACTICE

In general, the solid knowledge behind the factors underlying the demand for PBFP gained and reinforced by the empirical outcomes from this study could facilitate policymakers and industry players alike not only in formulating respective public and private strategies but also aligning their respective interests and thus achieving balance between maximising the public welfare while maximising profit from the market.

This study has, amongst others, empirically proven how the increase in population results in a similar increase in the demand for PBFP. Though it is intuitively obvious, the empirical support from this study may lay out a convincing foundation for more granular studies in the future. For example, a study may be conducted in the future to examine the level of health awareness in each of the PBFP export destination and relate these awareness levels with the demand for PBFP, as it may become another explanatory factor for PBFP demand besides the population growth. This is due to the fact that there are increasing health awareness amongst younger population especially in large palm-based product importers such as China. With population growth, the population profile may become much younger and more reflective of the current generational behavior and their more up-to-date concern about health. To put it in other words, as population grows, population age profile changes and health concern increases amongst the PBFP-importing population, the positive population growth and PBFP consumption relationship may not hold for longer as population refrain or reduce consumption of oils and fats in favor of healthier food choice.

Secondly, the study also empirically proves and verifies how competing edible oils like sunflower and soybean prices have positive impact on the demand of PBFP. It is again intuitive to perceive such a notion since the increase in the prices of competing products should also increase the demand for alternatives like PBFP. However, with empirical grasp is now in our hands, a further, more granular questions may be asked; why the sunflower and soybean oils alternative to PBFP in the importing countries are and whether this trend can be sustained perpetually in the future, or it may be subject to other emerging factors. For example, European countries are seldom utilising palm oil for food as the sunflower and soybean oils dominate the food markets there. Palm oil imports into the European market are mostly utilised in the biodiesel industries. Soybean and sunflower oils are again, still alternatives or substitutes to palm oil as they are also utilised in the biodiesel industries there. However, in this case, the debate of health is out of question but there is the debate of sustainability. Palm oil is always in a heated debate in Europe over its claim of non-sustainability and exploitation of labor, being a labor-intensive industry. Thus, switching from soybean or sunflower to palm oil in case of the formers' shortage may not be realised if the palm oil hatred propaganda is high within the importing European country.

## CONCLUSION

This study focused on the demand for palm-based finished products of ten (10) major markets from 2007 to 2020. The results for first-generation panel unit root, IPS and MW from this study show that all variables are stationary at the first difference with trend and without trend. The results of second-generation panel unit root using Pesaran (2007) also show that all variables are stationary at first difference for with and without trend. For the panel cointegration test, both first-generation (Pedroni's cointegration) and second-generation (Westerlund's cointegration) results suggest the existence of a long-run relationship between the variables. The cointegration relationship was estimated using panel FMOLS for ten (10) countries. This study shows that GDP has a long-run positive influence on PBFP demand. It indicates that palm oil is perceived as a normal product by these countries. The model shows that every 1% increase in GDP will increase the demand for palm oil by 0.8% in the long run. In addition, the POP variable shows a positive sign and is statistically significant at the 1% significance level, indicating that a 1% increase in POP will lead to a 0.3% increase in PBFP demand. Substitute prices which are PSOY and PSUN also exert a long-run positive influence on PBFP demand, where every 1% increase in PSOY and PSUN will respectively increase the demand on PBFP by 0.1. In addition, PPO also significantly influences demand for PBFP with negative sign. For every 1% increase in PPO will decrease the demand on PBFP by 0.3%.

Thus, information from this study regarding the factors influencing the demand for PBFP could help industry players, policymakers in formulating strategies to improve its market, and academicians in sharing additional knowledge for further enquiries.

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