

## Article

# The Effect of Logistics Performance Index Indicators on Palm Oil and Palm-Based Products Export: The Case of Indonesia and Malaysia

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**Abstract:** Palm oil is one of the most traded vegetable oils in the global market due to its versatile usage and having a lower price than competitor products. Trade is related to logistics performance as it connects the exporter and importer countries; thus, improving the indicators of logistics also improves the performance of trade, especially in agricultural export. Currently, no study has revealed the effect of logistics performance on palm oil export by considering all the indicators. This study investigates the impact of all the indicators of the logistics performance index on palm oil and palm-based products. Using a panel data regression approach, the extended gravity model is applied in this study to examine Indonesia and Malaysia as the leading exporters of palm oil and palm-based products. The results reveal that all the Logistics Performance Index indicators affect palm oil and palm-based products export in Indonesia and Malaysia. The critical indicators of the Logistics Performance Index in Indonesia are timeliness and tracking and tracing. However, competence and quality of trade infrastructure are the main indicators of Malaysia's palm oil and palm-based products. The future direction of this research is to explore other agricultural commodities and extend the period of the analysis.

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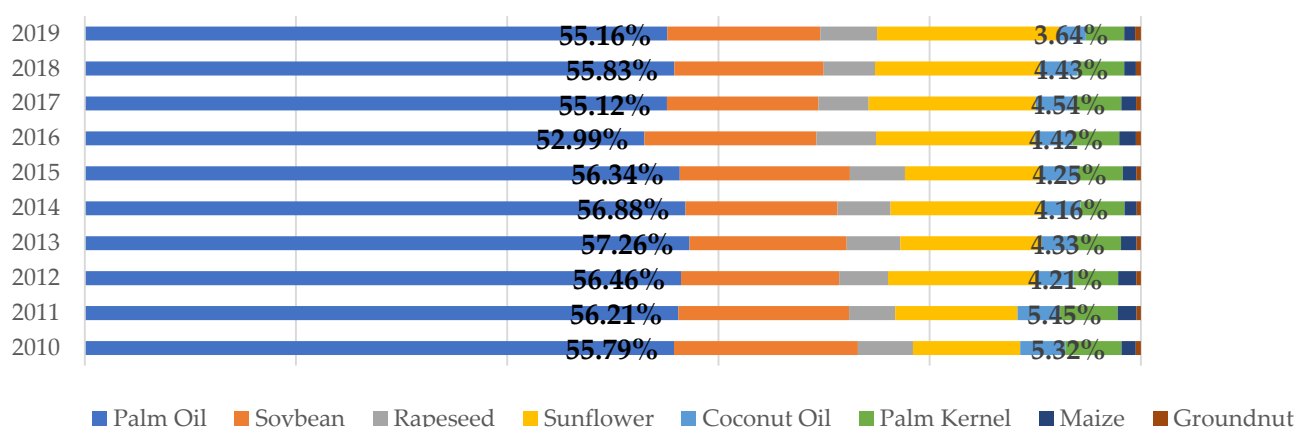


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**Keywords:** business analytics; export; gravity model; logistics performance; palm-based products; palm oil

## 1. Introduction

Logistics is one of the important indicators of international trade. The process of strategically managing the transportation and storage of supplies, components, completed goods, and the accompanying information flow across businesses and their marketing channels is defined as logistics (Christopher 2011). Currently, the World Bank has developed a Logistics Performance Index (LPI) for every country (World Bank 2022). This index has several aspects, namely custom, infrastructure, international delivery, logistics competence and quality, tracking and tracing, and timeliness. Logistics can determine the speed and securement of trade, which has implications for reducing costs (Martí et al. 2014). The efficacy and efficiency of logistics services may have a considerable impact on international commerce, as a lack of logistical infrastructure and operational processes may be a substantial impediment to the unification of global trade (Devlin and Yee 2005). Therefore, logistics is the inflow and outflow of products between countries, both industrial and agricultural products, implying that a better logistics performance will have an impact on a country's trade while export is an essential determinant of the economic growth and development of a country (Singh 2010; Mo 2010). Agriculture export is the engine of economic growth, especially in developing countries (Awokuse and Xie 2015). Vegetable oil fulfills several needs, including food, cosmetics, and energy. Palm oil is one of the vegetable oil commodities with the advantages of lower market price and versatility. Moreover, palm oil is the most frequently traded vegetable oil in the global market (Figure 1).



**Figure 1.** Vegetable Oil Trade in the Global Market. Source: FAOStat (2022).

Unlike manufacturing or service trade, agriculture has several obstacles in the supply chain process, such as time lag for production and perishable products. As agricultural products are necessary for human survival, produced in large quantities, and remote from consumer markets in international trade, the impact of logistics on agricultural export is a relevant issue. Similar to what is presented in the study about soybean trade, palm oil also has the same situation with an oligopoly structure, having a limited number of main producer countries (Indonesia and Malaysia), large consumers, and major food processing companies in several countries (Mendes dos Reis et al. 2020). Indonesia and Malaysia are currently the two largest palm oil producing and exporting countries in the world (FAO-Stat 2022). Both countries have a supply-side contribution of 85% to global palm oil development (Purnomo et al. 2020; Suroso et al. 2021a). However, the demand for Indonesia and Malaysia palm oil is mostly from emerging and developing economies being 87% and 86% (Figure 2), respectively. Moreover, palm oil commodities are exported in several forms of palm-based products, such as oleofood, oleochemical, and bioenergy products (Tan et al. 2009). The Indonesia and Malaysia palm oil industry also have high competitiveness at the firm and global levels (Suroso et al. 2021b; Tandra et al. 2022). Palm oil products are also faced with sustainability issues, thus green marketing of this commodity is important (Machová et al. 2022). Indonesia and Malaysia play a significant role in the export of palm-based products in the global market due to accessibility to palm oil as producer countries and the dependence of the global palm oil supply on them. Palm oil industry could supported the smallholder household income by establishing technology (Suroso and Ramadhan 2014). In Indonesia, palm oil industry contributed for economic growth and poverty alleviation (Pahan et al. 2011). Moreover, these countries have similar characteristics, including sharing a common border and having a dominant Muslim population. This study answers the following three main questions about the importance of logistic performance in the palm oil industry:

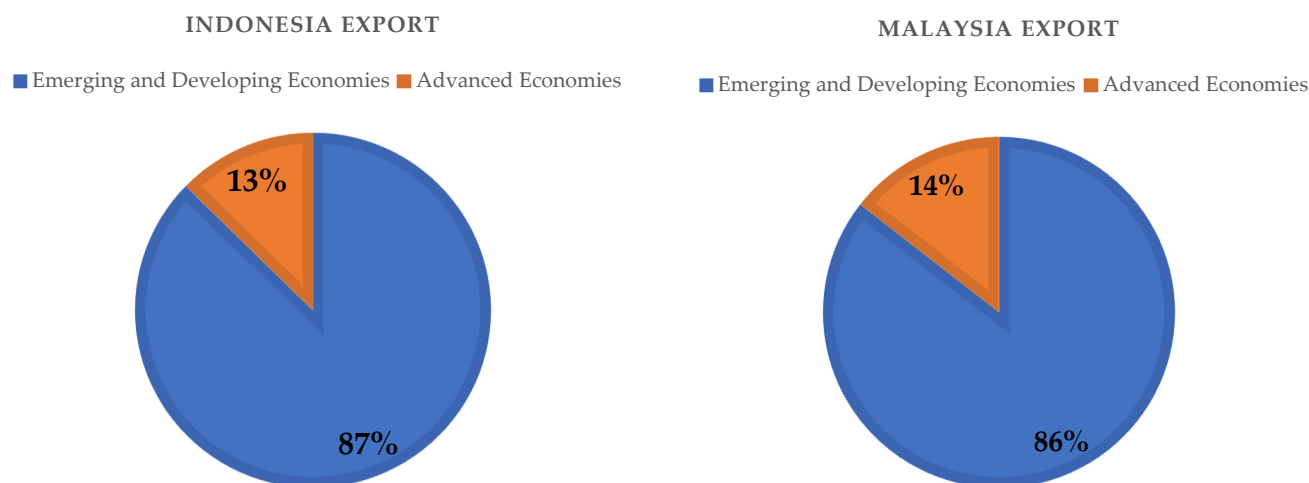
RQ1: How does the LPI of palm oil affect the export of the main producer and exporter countries?

RQ2: How does the LPI of palm-based products affect the export of the main producer and exporter countries?

RQ3: How does the LPI of palm oil products affect the export of the main producer and exporter countries to emerging and developing countries?

To answer these research questions, we consider the six indicators of LPI—infrastructure, customs, international shipments, logistics, quality and competence, tracking and tracing, and timeliness. This approach describes the impact of logistics on a commodity supply chain, specifically for palm oil. The goal of this paper is to examine the effect of LPI based on the World Bank indicators of the palm oil trade of Indonesia and Malaysia with their partners from 2010 to 2018. The panel regression analysis is applied in this

study. The study considers the palm oil trade activities of Indonesia and Malaysia with partner countries as the main object to answer the research questions. We use these countries because of their advantages in palm oil export and having similar characteristics, such as sharing a border and having a Muslim dominant population. The contribution of this study is that it examines the influence of all the LPI indicators on palm oil with gravity models and statistical estimators. The remainder of the paper is designed as follows. Section 2 presents the literature review; Section 3 is the research methodology about the gravity model and sample; Section 4 presents the results; Section 5 discusses the results, and finally, Section 6 presents the conclusions and implications of the study.



**Figure 2.** Indonesia and Malaysia's Export of Palm Oil and Palm-Based Products to Developing and Advanced Countries. Source: UN Comtrade (2022) and IMF (2022) Classification.

## 2. Literature Review

Logistics is critical at both the micro and macro levels, meaning that logistics services may meet consumer expectations by providing exceptional services at both the micro and macro levels to drive a country's economic development (Abu Bakar et al. 2014). The movement of commodities across borders is a critical factor in trade activities among national economies. Studies about the role of logistics infrastructure in international trade have significantly progressed in the last decades. Overall, the gravity model equation has been mostly applied in previous research. Felipe and Kumar (2012) revealed that there have been significant improvements with various gains (28% until 3%) in Central Asia trade by increasing trade facilitation through the World Bank LPI. There is an increase in any aspect of the LPI has a significantly positive effect on a country's trade volume (Martí et al. 2014). Moreover, LPI is important for Africa, South America, and Eastern Europe. Bensassi et al. (2015) found that LPI is important for the analysis of international trade flows, especially the bilateral exports of 19 Spanish regions. Gani (2017) demonstrated that the overall logistics performance is positively and significantly correlated with international trade activities, such as export and import. Wang and Choi (2018) found that exporting and importing nations' LPIs are positively connected with trade volume, and the LPI of exporting countries has a positive impact on trade probability. Lim and Jun (2019) indicated that refining any of the aspects of the LPI can lead to significant growth in a country's trade and has a greater effect on the exports of low-income countries. Furthermore, exports to Korea improve when the LPI of the trading partner country is higher. Host et al. (2019) also found a significant relationship between LPI and trade, specifically the LPI of exporter countries seems to be more essential than that of the importer countries.

Buvik and Takele (2019) discovered that improvement in any LPI indicator can lead to essential growth in the export of African countries. Moreover, they revealed that African countries have the lowest LPI score, especially in the quality of trade and transport-related infrastructure as well as customs and border clearance. Mendes dos Reis et al. (2020) demonstrated that there is a positive impact and a significant correlation between logistics performance and soybean exports, recommended that all LPI indicators must be involved, and developed replication studies for different commodities. Luttermann et al. (2020) found a statistically significant relationship between logistics performance and trade, as well as FDI. Currently, logistics performance has not been frequently considered in describing the attractiveness of countries as trading partners or investment targets. Furthermore, they recommended that future research should explore the impact of logistics performance on other commodity trade aside from soybean. Bugarčić et al. (2020) revealed that there is a positive and significant effect of logistics on bilateral trade between Central and Eastern European countries, and better logistics increases bilateral trade and decreases trade costs. Kaplan and Bozyiğit (2021) demonstrated that all logistic performance factors, excluding service quality, have a positive influence on Turkey's overseas commerce by conducting seven regression analyses. Darmanto et al. (2021) also revealed that the average value of the six indicators of LPI does not influence Indonesia's palm oil export. According to the above-mentioned findings, relevant study on the relationship between logistics performance and local or international trade has revealed positive results. Górecka et al. (2022) indicated that all logistics performances are highly significant and have positive impacts on the export of liquid energy products when the energy commodities are more difficult and expensive to transport and store. However, it seems to be insignificant for solid and gas goods.

A partial analysis of the impact of the six LPI indicators on agriculture commodities is inconclusive, especially analysis of palm oil and palm-based products. The empirical studies on palm oil only conducted the analysis using the average value of LPI. Unlike previous studies, we examine the impact of LPI on palm oil and palm-based products while considering the six indicators of LPI and comparing two main producer countries. We also investigate the impact of the six indicators of LPI on the total export of palm oil and palm-based products to emerging and developing economies. Based on the findings of several studies, we assume that logistics performance has an impact on palm oil and palm-based products export from Indonesia and Malaysia.

### 3. Methodology

The gravity model theory for international trade is applied in this study with a panel data approach. This model is regarded as the most popular and successful framework in economics (Yotov et al. 2016). The gravity model has been developed over the years as an essential tool for international trade with other flagship trade theories (Irshad et al. 2018a). The basic concept of the gravity model of international trade originated from Tinbergen (1962), who pioneered the gravity equation, which is drawn from Newton's universal law of gravity. It may be used to approximate the number of bilateral trade flows between two countries. Several scholars have improved this model by introducing additional variables to the basic model (Linnermann 1966; Learner 1970), have developed the constant elasticity of substitution and monopolistic competition in gravity models (Bergstrand 1990), and have added dummy variables to the gravity model (Mátyás 1997; Martínez-Zarzoso and Nowak-Lehmann 2003). The earlier form of the gravity equation is as follows (Tinbergen 1962):

$$\text{Log}X_{ij} = \alpha + \beta_1 \text{LogGDP}_i + \beta_2 \text{LogGDP}_j + \beta_3 \text{LogDIS}_{ij} + \varepsilon_{ij} \quad (1)$$

where  $X_{ij}$  denotes exports from country  $i$  (exporter country) to country  $j$  (importer country);  $\text{GDP}_i$  and  $\text{GDP}_j$  represent the exporter and importer countries' gross domestic products (GDP), respectively.  $\text{DIS}_{ij}$  denotes the geographical distance between the exporter and importer countries, which serves as a proxy variable for trade costs.  $\varepsilon_{ij}$  is an error term;  $\alpha$

is regression constant; Log is the natural logarithm of variables; and  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  are parameters.

The benefit of this model is that it allows for the incorporation of additional variables that describe business interactions between the exporter and importer countries (Bensassi et al. 2015). Therefore, we extend the gravity model with several variables related to trade activities. However, in most empirical research, the gravity model includes other variables connecting trading partners, such as population, average price, similar language, border, currency, or colonial past in the last five years (Bui and Chen 2017; Irshad et al. 2018a; Abdullahi et al. 2021; Abafita and Tadesse 2021). Many scholars interested in trade logistics and trade facilitation have started to integrate the LPI into their gravity model after the World Bank issued the first report in 2007 (Felipe and Kumar 2012; Martí et al. 2014; Çelebi 2019; Bugarčić et al. 2020; Mendes dos Reis et al. 2020; Górecka et al. 2022). Numerous studies have introduced the LPI into the gravity model equation, whether specific or general. However, studies that specifically investigate the all effect of the six indicators of LPI on palm oil and palm-based products trade are rare. This study adopts the basic gravity model equation and incorporates the six indicators of LPI and other socio-economic variables in international bilateral trade into it. We estimate three extended gravity models for palm oil export, palm-based products export, and the total export of palm oil and palm-based products into emerging and developing economies. The gravity equation models are as follows:

$$\text{EXP\_PO}_{ijt} = \beta_0 + \beta_1 \text{LogGDP}_{it} + \beta_2 \text{LogGDP}_{jt} + \beta_3 \text{LogDIS}_{ijt} + \beta_4 \text{LPI}_{it} + \beta_4 \text{LPI}_{jt} + \beta_5 \text{WTO}_{ijt} + \beta_6 \text{PTA}_{ijt} + \beta_7 \text{BOR}_{ij} + \beta_8 \text{REL}_{ij} + \varepsilon_{ijt} \quad (2)$$

$$\text{EXP\_POB}_{ijt} = \beta_0 + \beta_1 \text{LogGDP}_{it} + \beta_2 \text{LogGDP}_{jt} + \beta_3 \text{LogDIS}_{ijt} + \beta_4 \text{LPI}_{it} + \beta_4 \text{LPI}_{jt} + \beta_5 \text{WTO}_{ijt} + \beta_6 \text{PTA}_{ijt} + \beta_7 \text{BOR}_{ij} + \beta_8 \text{REL}_{ij} + \varepsilon_{ijt} \quad (3)$$

$$\text{EXP\_SUM}_{ijt} = \beta_0 + \beta_1 \text{LogGDP}_{it} + \beta_2 \text{LogGDP}_{jt} + \beta_3 \text{LogDIS}_{ijt} + \beta_4 \text{LPI}_{it} + \beta_4 \text{LPI}_{jt} + \beta_5 \text{WTO}_{ijt} + \beta_6 \text{PTA}_{ijt} + \beta_7 \text{BOR}_{ij} + \beta_8 \text{REL}_{ij} + \varepsilon_{ijt} \quad (4)$$

where in Equation (2),  $\text{EXP\_PO}_{ijt}$  is the value of palm oil export between exporter country  $i$  and partner country  $j$  in year  $t$  in US dollars. In Equation (3),  $\text{EXP\_POB}_{ijt}$  is the value of palm-based products export between exporter country  $i$  and importer country  $j$  in year  $t$  in US dollars, and in Equation (4),  $\text{EXP\_SUM}$  is the value of the total export of palm oil and palm-based products between exporter country  $i$  and partner country  $j$  in year  $t$  in US dollars.  $t$  represents 2010, 2012, 2014, 2016, and 2018 (this is because the LPI report is published every two years), and  $i$  represents the two exporter countries—Indonesia and Malaysia.  $j$  represents the countries that are the export destination for Indonesia and Malaysia's palm oil and palm-based products, i.e., the importer countries.  $\text{GDP}_{it}$  and  $\text{GDP}_{jt}$  are the GDP of the exporter and importer countries, respectively.  $\text{DIS}_{ijt}$  is the distance between the capital cities of the exporter and importer countries.  $\text{LPI}_{it}$  and  $\text{LPI}_{jt}$  are the LPI score in the exporter and importer countries in year  $t$ , respectively, which are proxied by six indicators—competence and quality, customs, timeliness, shipment, infrastructure, and tracing and tracking. There are dummy variables, including  $\text{WTO}_{ijt}$ ,  $\text{PTA}_{ijt}$ ,  $\text{BOR}_{ij}$ , and  $\text{REL}_{ij}$ . In this case study,  $\text{WTO}_{ijt}$  means that the exporter and importer countries are members of the World Trade Organization (WTO) in year  $t$ .  $\text{PTA}_{ijt}$  is described as a preferential trade agreement (PTA) between the exporter and importer countries in year  $t$ .  $\text{BOR}_{ij}$  means that the exporter and importer countries share a common border, and  $\text{REL}_{ij}$  means that the exporter and importer countries have a similar religion with a dominant population, which, in this case, is Islam.  $\beta_0$  is a constant in the regression model;  $\beta_1$ – $\beta_6$  are coefficient regressions of the independent variables. Log is the natural logarithm of a variable. Moreover, the six indicators in the LPI report are separately regressed because of the high correlation in each category.

The estimation of the models (2, 3, and 4) is performed with the Poisson pseudo-maximum likelihood estimator (PPML) for gravity models originally introduced by Santos Silva and Tenreiro (2006). PPML is often used as an estimator in trade-related

estimations because it solves the problem of zero values in trade between trading partners by allowing zeros, thus avoiding potential bias in research results (Santos Silva and Tenreyro 2011). The covariance method applied in this study is the ordinary approach. Several export destinations of the two countries have a zero value for the export of palm oil or palm-based products from Indonesia and Malaysia.

This study uses balanced panel data, comparing Indonesia and Malaysia as export trade partners. There are 111 countries that import palm oil from Indonesia, and 121 countries import from Malaysia (Appendix A). The data are gathered for 2010, 2012, 2014, 2016, and 2018. For extended research on export to developing countries, only 80 and 88 importer countries trade with Indonesia and Malaysia in palm oil and palm-based products, respectively. The commodities are classified into two groups—palm oil (crude and refined) and palm-based products (Table 1).

**Table 1.** Product Classifications.

Name of Classification	HS Code
Palm Oil and Kernel (Crude and Refined)	1511, 151321, and 151329
Palm-Based Products	1517, 1902, 2105, 40590, 2936, 47, 48, 3215, 3304, 3401, 3402, 3403, 3405, 3909, 3101, 3826, 230660, 270120, and 960990

Source: UN Comtrade (2022).

Indonesia and Malaysia's palm oil commodity export (palm oil and palm-based products) is the dependent variable. Additionally, the total of two classifications is calculated as another dependent variable. There are several independent variables, such as GDP; distance between the exporter and importer countries; LPI with specific indicators; and dummy variables, including WTO, FTAs, common border, and religion. Details of each variable, including the description, source, and expected sign, are presented in Table 2.

**Table 2.** Variable with Indicator, Description, Source, and Expected Sign.

Indicators	Description	Source
EXP_PO	Export value of palm oil with crude and in a refined form in US dollars	UN Comtrade
EXP_POB	Export value of palm-based products in US dollars	UN Comtrade
EXP_SUM	Total export value of palm oil and palm-based products in US dollars	UN Comtrade
Log(GDP <sub>i</sub> )	Natural logarithm of GDP in the exporter country	World Bank
Log(GDP <sub>j</sub> )	Natural logarithm of GDP in the importer countries	World Bank
Log(DIS)	Geographical distance between the capital cities of exporter country i and partner country j in kilometers	Time and Date ( <a href="https://www.timeanddate.com/">https://www.timeanddate.com/</a> ), accessed on 19 July 2022
LPI	LPI is based on a worldwide study of over 5,000 international freight forwarding and logistics firms, which has six categories—competence and quality (CQL), customs (C), timeliness (T), shipments (SHIP), tracking and tracing (TT), and infrastructure (INFS). These component indices have a range of 0 to 5, with 0 being the worst and 5 being the greatest.	World Bank
WTO	Dummy variable with a value of 1 if the exporter and importer countries are members of WTO and 0 otherwise.	World Trade Organization
PTA	Dummy variable with a value of 1 if the exporter and importer countries have a PTA and 0 otherwise.	Asia Regional Integration Center
BOR	Dummy variable with a value of 1 if the exporter and importer countries share a common border and 0 otherwise.	World Atlas Website
REL	Dummy variable with a value of 1 if the exporter and importer countries have a dominant Muslim population and 0 otherwise.	CIA (The World Fact Book)

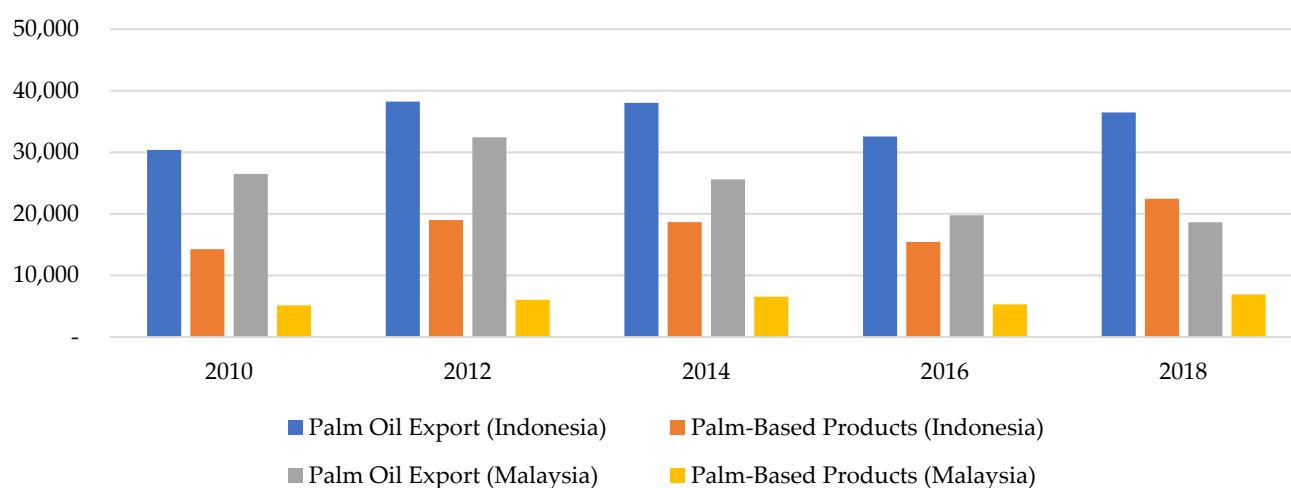
#### 4. Results

This section presents the descriptive statistics of the research variables, comparing Indonesia and Malaysia (Table 3); the performance of palm oil and palm-based products export from 2010 to 2018 (Figure 3); and a separate panel regression for palm oil, palm-based products, and the total export of the two products to developing countries (Tables 4–9). There are six columns with regression of each of the six indicators of LPI on export. Table 3 indicates that Indonesia's export value in palm oil and palm-based products is relatively higher than that of Malaysia, having a higher mean and maximum value, although the observation in Malaysia is higher than that in Indonesia.

**Table 3.** Descriptive Statistics.

Variables	Indonesia (N = 555)				Malaysia (N = 605)			
	Mean	Max	Min	Std Dev	Mean	Max	Min	Std Dev
VO_EXP	$1.47 \times 10^8$	$5.00 \times 10^9$	0	$4.95 \times 10^8$	$9.09 \times 10^7$	$2.85 \times 10^9$	0	$2.88 \times 10^8$
POB_EXP	$7.47 \times 10^7$	$3.37 \times 10^9$	0	$2.24 \times 10^8$	$2.30 \times 10^7$	$4.44 \times 10^8$	0	$5.32 \times 10^7$
LOG(GDP <sub>i</sub> )	27.529	27.672	27.350	0.104	26.464	26.606	26.265	0.117
LOG(GDP <sub>j</sub> )	25.273	30.657	20.557	2.054	25.185	30.657	20.557	2.038
LOG(DIS)	9.088	9.894	6.786	0.548	8.994	9.887	5.756	0.656
CQL <sub>i</sub>	2.926	3.210	2.470	0.257	3.380	3.466	3.300	0.066
CQL <sub>j</sub>	2.915	4.320	1.394	0.626	2.904	4.320	1.394	0.629
C <sub>i</sub>	2.638	2.870	2.430	0.150	3.165	3.368	2.900	0.160
C <sub>j</sub>	2.769	4.208	1.111	0.617	2.757	4.208	1.111	0.619
SHIP <sub>i</sub>	2.959	3.230	2.820	0.144	3.475	3.644	3.350	0.101
SHIP <sub>j</sub>	2.932	4.180	1.363	0.512	2.924	4.235	1.363	0.513
T <sub>i</sub>	3.546	3.670	3.460	0.083	3.750	3.917	3.460	0.171
T <sub>j</sub>	3.385	4.520	2.024	0.575	3.380	4.796	2.024	0.577
TT <sub>i</sub>	3.098	3.300	2.770	0.178	3.411	3.582	3.150	0.158
TT <sub>j</sub>	3.005	4.378	1.560	0.633	2.997	4.378	1.560	0.637
INFS <sub>i</sub>	2.707	2.919	2.540	0.166	3.417	3.559	3.150	0.141
INFS <sub>j</sub>	2.849	4.439	1.238	0.713	2.832	4.439	1.238	0.712
WTO	0.910	1.000	0.000	0.287	0.916	1.000	0.000	0.278
PTA	0.458	1.000	0.000	0.499	0.580	1.000	0.000	0.494
BOR	0.063	1.000	0.000	0.243	0.033	1.000	0.000	0.179
REL	0.270	1.000	0.000	0.445	0.281	1.000	0.000	0.450

There is zero trade for Indonesia and Malaysia, which is the minimum value. In Figure 3, the palm oil export in Indonesia and Malaysia fluctuates. However, Indonesia and Malaysia's palm-based products export improved from 2010 to 2018. Malaysia palm oil and palm-based products export experienced a significant decrease from 2012.



**Figure 3.** The Comparison of Palm Oil and Palm-Based Products Export in one million US dollar. Source: UN Comtrade (2022).

Tables 4 and 5 present the estimate for Indonesia in palm oil and palm-based products, finding a positive and significant impact of the GDP of the exporter; the GDP of the importer; and some dummy variables, such as WTO and religion. There is a negative impact of the distance between the capital cities of the exporter and importer countries and some dummy variables, such as PTA and the sharing of a common border. However, these variables have a positive effect in the case of palm-based products.

**Table 4.** The Regression Results (Indonesia's Case and Palm Oil Export).

Variables	CQL	C	SHIP	T	TT	INFS
Constant	2.526 ***	−12.316 ***	−56.634 ***	−10.435 ***	102.7406 ***	−23.514 ***
Ln(GDP <sub>i</sub> )	0.362 ***	0.898 ***	2.720 ***	0.901 ***	−3.584 ***	1.317 ***
Ln(GDP <sub>j</sub> )	0.683 ***	0.684 ***	0.683 ***	0.729 ***	0.714 ***	0.710 ***
Ln(Dis)	−1.575 ***	−1.560 ***	−1.632 ***	−1.523 ***	−1.525 ***	−1.521 ***
CQL <sub>i</sub>	0.414 ***					
CQL <sub>j</sub>	−0.331 ***					
C <sub>i</sub>		0.514 ***				
C <sub>j</sub>		−0.452 ***				
SHIP <sub>i</sub>			−1.285 ***			
SHIP <sub>j</sub>			−0.412 ***			
T <sub>i</sub>				−0.232 ***		
T <sub>j</sub>				−0.773 ***		
TT <sub>i</sub>					2.884 ***	
TT <sub>j</sub>					−0.536 ***	
INFS <sub>i</sub>						−0.030 ***
INFS <sub>j</sub>						−0.421 ***
WTO	2.240 ***	2.273 ***	2.232 ***	2.415	2.348 ***	2.321 ***
PTA	−0.229 ***	−0.201 ***	−0.223 ***	−0.195 ***	−0.222 ***	−0.213 ***
BOR	−1.551 ***	−1.460 ***	−1.612 ***	−1.358 ***	−1.403 ***	−1.416 ***
REL	0.555 ***	0.501 ***	0.579 ***	0.494 ***	0.513 ***	0.566 ***
N	555	555	555	555	555	555
R-Squared	0.264	0.255	0.281	0.272	0.252	0.225
Likelihood Ratio (LR)	1.74 × 10 <sup>11</sup>	1.76 × 10 <sup>11</sup>	1.73 × 10 <sup>11</sup>	1.78 × 10 <sup>11</sup>	1.77 × 10 <sup>11</sup>	1.76 × 10 <sup>11</sup>

Note: \*\*\* = significant at 1%.



The standard variables in the gravity model include GDP and the distance between the exporter and importer countries. The additional variables whose effect is calculated include WTO, religion, PTA, and sharing of a common border. Regarding the LPI variables, in the case of palm oil, we find a positive and significant impact of the quality and competence of trade (CQL), customs (C), and tracing and tracking (TT) of the exporter countries.

**Table 5.** The Regression Results (Indonesia's Case and Palm-Based Products Export)

Variables	CQL	C	SHIP	T	TT	INFS
Constant	−10.857 ***	−17.191 ***	−8.949 ***	8.459 ***	−44.034 ***	−13.675 ***
Ln(GDP <sub>i</sub> )	0.557 ***	0.796 ***	0.493 ***	−0.331 ***	1.844 ***	0.661 ***
Ln(GDP <sub>j</sub> )	0.740 ***	0.738 ***	0.724 ***	0.755 ***	0.744 ***	0.736 ***
Ln(Dis)	−0.802 ***	−0.802 ***	−0.816 ***	−0.777 ***	−0.788 ***	−0.807 ***
CQL <sub>i</sub>	0.176 ***					
CQL <sub>j</sub>	−0.161 ***					
C <sub>i</sub>		0.132 ***				
C <sub>j</sub>		−0.181 ***				
SHIP <sub>i</sub>			0.209 ***			
SHIP <sub>j</sub>			−0.053 ***			
T <sub>i</sub>				1.620 ***		
T <sub>j</sub>				−0.374 ***		
TT <sub>i</sub>					−0.610 ***	
TT <sub>j</sub>					−0.194 ***	
INFS <sub>i</sub>						0.163 ***
INFS <sub>j</sub>						−0.096 ***
WTO	0.525 ***	0.526 ***	0.464 ***	0.632 ***	0.552 ***	0.500 ***
PTA	0.644 ***	0.651 ***	0.648 ***	0.686 ***	0.645 ***	0.644 ***
BOR	0.175 ***	0.190 ***	0.127 ***	0.227 ***	0.201 ***	0.153 ***
REL	0.328 ***	0.309 ***	0.354 ***	0.286 ***	0.321 ***	0.347 ***
N	555	555	555	555	555	555
R-Squared	0.692	0.694	0.693	0.702	0.689	0.693
Likelihood Ratio (LR)	9.42 × 10 <sup>10</sup>	9.43 × 10 <sup>10</sup>	9.40 × 10 <sup>10</sup>	9.51 × 10 <sup>10</sup>	9.43 × 10 <sup>10</sup>	9.41 × 10 <sup>10</sup>

Note: \*\*\* = significant at 1%.

Similarly, these variables and even other LPI variables such as timeliness (T) and infrastructure (INFS) also have a positive impact on palm-based products. However, for both palm oil and palm-based products, all the LPI indicators of the importer countries have a negative and significant effect. Tables 6 and 7 present the estimates for Malaysia in palm oil and palm-based products. There are different findings about Indonesia; for example, the GDP of the exporter and PTA have a relatively opposite impact in the case of palm oil. In palm-based products, the dummy WTO has a negative effect on export. However, the results of the standard variables in the gravity model are similar to several previous results. Like the case of Indonesia, the six LPI indicators in the exporter country have a positive and significant impact on Malaysia's palm oil export and palm-based products. In the case of palm-based products, these results are also found in the six LPI indicators of the importer country, having a positive and significant effect. However, there is a negative and significant effect of the six LPI indicators on Malaysia's palm oil export.

**Table 6.** The Regression Results (Malaysia's Case and Palm Oil Export).

Variables	CQL	C	SHIP	T	TT	INFS
Constant	18.659 ***	13.251 ***	21.754 ***	9.428 ***	17.219 ***	−4.532 ***
Ln(GDP <sub>i</sub> )	−0.885 ***	−0.384 ***	−0.561 ***	−0.284 ***	−0.569 ***	0.251 ***
Ln(GDP <sub>j</sub> )	0.586 ***	0.574 ***	0.560 ***	0.640 ***	0.612 ***	0.600 ***
Ln(Dis)	−0.543 ***	−0.544	−0.625 ***	−0.493 ***	−0.493 ***	−0.535 ***
CQL <sub>i</sub>	3.326 ***					
CQL <sub>j</sub>	−0.533 ***					
C <sub>i</sub>		1.199 ***				
C <sub>j</sub>		−0.609 ***				
SHIP <sub>i</sub>			0.249 ***			
SHIP <sub>j</sub>			−0.465 ***			
T <sub>i</sub>				1.256 ***		
T <sub>j</sub>				−1.100 ***		
TT <sub>i</sub>					1.099 ***	
TT <sub>j</sub>					−0.717 ***	
INFS <sub>i</sub>						1.124 ***
INFS <sub>j</sub>						−0.517 ***
WTO	2.040 ***	2.002 ***	2.007 ***	2.109 ***	2.062 ***	2.025 ***
PTA	1.053 ***	1.183 ***	0.958 ***	1.285 ***	1.158 ***	1.093 ***
BOR	−0.486 ***	−0.491 ***	−0.623 ***	−0.332 ***	−0.363 ***	−0.544 ***
REL	0.248 ***	0.162 ***	0.333 ***	0.109 ***	0.165 ***	0.251 ***
N	605	605	605	605	605	605
R-Square	0.273	0.282	0.265	0.311	0.273	0.245
Likelihood Ratio (LR)	$9.74 \times 10^{10}$	$9.80 \times 10^{10}$	$9.33 \times 10^{10}$	$1.02 \times 10^{11}$	$9.84 \times 10^{10}$	$9.69 \times 10^{10}$

Note: \*\*\* = significant at 1%.

**Table 7.** The Regression Results (Malaysia's Case and Palm-Based Products Export).

Variables	CQL	C	SHIP	T	TT	INFS
Constant	−6.674 ***	−7.204 ***	−8.077 ***	−14.516 ***	−8.154 ***	−7.403 ***
Ln(GDP <sub>i</sub> )	0.617 ***	0.677 ***	0.683 ***	0.935 ***	0.721 ***	0.698 ***
Ln(GDP <sub>j</sub> )	0.449 ***	0.457 ***	0.448 ***	0.458 ***	0.447 ***	0.443 ***
Ln(Dis)	−0.847 ***	−0.835 ***	−0.833 ***	−0.843 ***	−0.853 ***	−0.835 ***
CQL <sub>i</sub>	0.466 ***					
CQL <sub>j</sub>	0.236 ***					
C <sub>i</sub>		0.082 ***				
C <sub>j</sub>		0.238 ***				
SHIP <sub>i</sub>			0.171 ***			
SHIP <sub>j</sub>			0.431 ***			
T <sub>i</sub>				0.227 ***		
T <sub>j</sub>				0.176 ***		
TT <sub>i</sub>					0.108 ***	
TT <sub>j</sub>					0.248 ***	
INFS <sub>i</sub>						0.078 ***
INFS <sub>j</sub>						0.229 ***
WTO	−0.160 ***	−0.156 ***	−0.198 ***	−0.160 ***	−0.172 ***	−0.161 ***
PTA	0.666 ***	0.643 ***	0.610 ***	0.703 ***	0.661 ***	0.654 ***
BOR	0.232 ***	0.253 ***	0.234 ***	0.264 ***	0.221 ***	0.269 ***
REL	0.150 ***	0.174 ***	0.199 ***	0.084 ***	0.148 ***	0.163 ***
N	605	605	605	605	605	605
R-Square	0.797	0.793	0.805	0.791	0.796	0.795
Likelihood Ratio (LR)	$2.90 \times 10^{10}$	$2.90 \times 10^{11}$	$2.91 \times 10^{10}$	$2.89 \times 10^{10}$	$2.89 \times 10^{10}$	$2.90 \times 10^{10}$

Note: \*\*\* = significant at 1%.

The extended analysis is used to investigate the total export of palm oil and palm-based products to developing countries. Tables 8 and 9 present the estimations of the cases of Indonesia and Malaysia, respectively. In the case of Indonesia, the gravity model variables, such as GDP and distance, support the previous empirical study results. However, the GDP of the exporter country (Malaysia) has a negative impact on export, implying that export decreases when the GDP of the exporter increases. The dummy variables of both Indonesia and Malaysia have similar results, with WTO and PTA having a positive and significant effect, and the effect of sharing a common border and religion is negative and insignificant. Overall, the LPI indicators of the exporter have a positive and significant effect in two cases. However, the LPI indicators of the importer have a negative and significant impact.

**Table 8.** Indonesia Palm Oil Trade Regression on Developing Countries and Total Export.

Variables	CQL	C	SHIP	T	TT	INFS
Constant	4.534 ***	−8.206 ***	−23.033 ***	−7.671 ***	19.041 ***	−10.707 ***
Ln(GDP <sub>i</sub> )	0.356 ***	0.781 ***	1.378 ***	0.673 ***	−0.273 ***	0.896 ***
Ln(GDP <sub>j</sub> )	0.574 ***	0.614 ***	0.611 ***	0.651 ***	0.614 ***	0.607 ***
Ln(Dis)	−1.449 ***	−1.386 ***	−1.391 ***	−1.326 ***	−1.391 ***	−1.386 ***
CQL <sub>i</sub>	0.164 ***					
CQL <sub>j</sub>	0.382 ***					
C <sub>i</sub>		0.184 ***				
C <sub>j</sub>		0.159 ***				
SHIP <sub>i</sub>			−0.373 ***			
SHIP <sub>j</sub>			−0.165 ***			
T <sub>i</sub>				0.618 ***		
T <sub>j</sub>				−0.168 ***		
TT <sub>i</sub>					0.752 ***	
TT <sub>j</sub>					0.120 ***	
INFS <sub>i</sub>						0.022 ***
INFS <sub>j</sub>						0.119 ***
WTO	1.156 ***	1.265 ***	1.274 ***	1.408 ***	1.272 ***	1.265 ***
PTA	0.207 ***	0.208 ***	0.214 ***	0.265 ***	0.226 ***	0.230 ***
BOR	−1.263 ***	−1.125 ***	−1.146 ***	−0.976 ***	−1.124 ***	−1.115 ***
REL	−0.016 ***	0.046 ***	0.049 ***	0.099 ***	0.053 ***	0.029 ***
N	400	400	400	400	400	400
R-Squared	0.675	0.631	0.628	0.58	0.624	0.626
Likelihood Ratio (LR)	2.45 × 10 <sup>11</sup>	2.43 × 10 <sup>11</sup>	2.43 × 10 <sup>11</sup>	2.43 × 10 <sup>11</sup>	2.43 × 10 <sup>11</sup>	2.43 × 10 <sup>11</sup>

Note: \*\*\* = significant at 1%.

## 5. Discussion

This study examines the impact of the six LPI indicators on agricultural commodities and their derivatives, specifically palm oil and palm-based products. The cases of Indonesia and Malaysia are studied, representing the global supply of palm oil and palm-based products. Although the demand for palm oil is spread all over the globe, the export source is concentrated in these countries. Unlike manufacturing products, there are several disadvantages of agricultural product trade, such as the time gap from cultivation to production and temporary products. This highlights the importance of logistics for delivering and keeping palm oil and palm-based products safely. Therefore, we observe the role of logistics using the LPI by the World Bank from 2010 to 2018. The gravity model approach with balanced panel data regression is applied in this study to analyze the impact of the six LPI indicators.

**Table 9.** Malaysia Palm Oil Trade Regression on Developing Countries and Total Export.

Variables	CQL	C	SHIP	T	TT	INFS
Constant	16.290 ***	11.400 ***	18.364 ***	2.223 ***	11.171 ***	−1.286 ***
Ln(GDP <sub>i</sub> )	−0.722 ***	−0.302 ***	−0.477 ***	−0.014 ***	−0.313 ***	0.164 ***
Ln(GDP <sub>j</sub> )	0.529 ***	0.530 ***	0.515 ***	0.594 ***	0.549 ***	0.540 ***
Ln(Dis)	−0.344 ***	−0.343 ***	−0.354 ***	−0.287 ***	−0.322 ***	−0.334 ***
CQL <sub>i</sub>	2.649 ***					
CQL <sub>j</sub>	−0.124 ***					
C <sub>i</sub>		0.906 ***				
C <sub>j</sub>		−0.209 ***				
SHIP <sub>i</sub>			0.191 ***			
SHIP <sub>j</sub>			−0.032 ***			
T <sub>i</sub>				1.047 ***		
T <sub>j</sub>				−0.725 ***		
TT <sub>i</sub>					0.876 ***	
TT <sub>j</sub>					−0.302 ***	
INFS <sub>i</sub>						0.825 ***
INFS <sub>j</sub>						−0.182 ***
WTO	1.189 ***	1.198 ***	1.150 ***	1.331 ***	1.230 ***	1.199 ***
PTA	1.380 ***	1.427 ***	1.353 ***	1.533 ***	1.429 ***	1.402 ***
BOR	−0.146 ***	−0.162 ***	−0.147 ***	−0.084 ***	−0.113 ***	−0.174 ***
REL	−0.148 ***	−0.160 ***	−0.146 ***	−0.168 ***	−0.161 ***	−0.132 ***
N	440	440	440	440	440	440
R-Squared	0.509	0.491	0.481	0.48	0.484	0.471
Likelihood Ratio (LR)	$9.94 \times 10^{10}$	$9.91 \times 10^{10}$	$9.80 \times 10^{10}$	$1.02 \times 10^{11}$	$9.92 \times 10^{10}$	$9.86 \times 10^{10}$

Note: \*\*\* = significant at 1%.

The estimation results reveal that the GDP of the exporter and importer countries has a positive effect in Indonesia. Economic growth can lead to higher demand and supply of agricultural products (Bui and Chen 2017). However, this is slightly different in the case of Malaysia, where its GDP has a negative effect on palm oil and palm-based products trade. An increase in economic growth leads to higher domestic consumption, which is in line with the decline in Malaysia's palm oil and palm-based products export. The distance between the capital cities of the exporter and importer countries has a negative effect due to the cost of trade, implying that a decrease in the distance can lead to an increase in trade, including the export of palm oil and palm-based products. The dummy variables also have a significant effect on palm oil and palm-based products export. In Indonesia, WTO membership and religion have a positive impact on the export of palm oil and palm-based products due to the accessibility and similarity of the culture on trade activities, supporting previous results (Irshad et al. 2018b). Moreover, all the dummy variables have a positive significant effect on palm-based products export. Product diversification makes it possible to fulfill international demand, especially in food, cosmetics, and energy. The form of products (crude and refined palm oil) is considered based on the capacity and capability of the country to cultivate. In the case of Malaysia, only sharing a common border has a negative effect on palm oil export as it leads to competition; for example, both Indonesia and Thailand are palm oil producers. A similar explanation can be provided for the negative effect of WTO membership on Malaysia's palm-based products export as competitors also join this organization. In developing countries, there is a negative effect of sharing a common border and religion, revealing that there is a negative relationship between these variables and the total export of palm oil and palm-based products.

Regarding the logistic indicators, we find that the six indicators of LPI have a significant effect on palm oil and palm-based products in both Indonesia and Malaysia. The LPI indicators of the exporter have a positive impact on export, implying that an increase in the logistics indicators of the exporter can lead to the growth of palm oil and palm-based products export. The focus in logistics improvement depends on the type of product being exported and the country's observations. In Indonesia, in the case of palm oil, enhancing tracking and tracing in the exporter country is more important than other indicators, whereas timeliness is the main indicator for palm-based products. However, in both palm oil and palm-based products, the most essential logistics indicators for Malaysia are competence and quality of logistic services. The results also highlight the important role of logistics performance in improving trade activities in the exporter country. However, several regression results also produce different perspectives as all the logistic indicators of the importer country can lead to a decline in palm oil and palm-based products export. An increase in the logistics of the importer can affect the flexibility of trade in several agricultural commodities, especially in competitive products, such as soybean, rapeseed, and sunflower. Next, we classify the economies of the countries as emerging and developing. The results reveal that all the six indicators of the LPI of both the exporter and importer countries have a positive significant impact in Indonesia. Similar results of the previous regression are found in Malaysia when we focus on the product type. This is because Indonesia has a higher potential export to developing countries, although Malaysia has more export destinations for palm oil and palm-based products. The improvement in land-use for palm oil production is different, implying the Indonesia and Malaysia growth of area harvested between 56% and 26% from 2010 to 2018, based on Indexmundi (2022). Furthermore, both Indonesia and Malaysia must focus on their logistics to increase palm oil and palm-based products export.

## 6. Conclusions

This study evaluates the impact of logistics performance on palm oil and palm-based products export from Indonesia and Malaysia. The results are divided into three groups: palm oil, palm-based products, and the total export of the two products to emerging and developing countries. Overall, the cases of both Indonesia and Malaysia reveal that the GDP of the exporter and importer and the distance between the capital cities of the exporter and importer countries are important variables for palm oil and palm-based products export. Dummy variables such as WTO, sharing a common border, PTA, and religion are important determinants of export. The six LPI indicators, which are the highlight of this study, have a significant effect on trade, especially the improvement of logistics in the exporter countries. These results reveal the negative effect of several LPI indicators.

We recommend that policymakers in Indonesia and Malaysia should improve logistics and infrastructure due to the increasing value of palm oil and palm-based products export as several palm oil-related products are daily needs for the global society. There are some limitations of this study. It uses only two exporter countries and a short period for the analysis. Furthermore, besides vegetable oil, other agricultural commodities must be considered because of their different characteristics. Future research must increase the period of this study as only 2010, 2012, 2014, 2016, and 2018 are used. Moreover, other independent variables related to agricultural commodities trade can be established in future research.

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## Appendix A

**Table A1.** The List of Countries Involved in This Study (Indonesia and Malaysia).

Exporter Countries	Partner
Indonesia	Afghanistan, Algeria, Angola, Argentina, Australia, Bahrain, Belgium, Benin, Brazil, Bulgaria, Cambodia, Cameroon, Canada, Chile, China, China, Hong Kong SAR, Colombia, Comoros, Congo, Côte d'Ivoire, Croatia, Cuba, Cyprus, Czechia, Dem. Rep Congo, Denmark, Djibouti, Dominican Rep., Ecuador, Egypt, Estonia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Hungary, India, Iraq, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Latvia, Lebanon, Liberia, Libya, Lithuania, Madagascar, Malaysia, Maldives, Malta, Mexico, Mongolia, Montenegro, Myanmar, Nepal, Netherlands, New Zealand, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Poland, Portugal, Qatar, Rep. of Korea, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, Solomon Isds, South Africa, Spain, Sudan, Sweden, Switzerland, Syria, Thailand, Togo, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, Uruguay, USA, and Vietnam (111 countries).
Malaysia	Afghanistan, Algeria, Angola, Argentina, Australia, Austria, Bahrain, Belgium, Benin, Bosnia Herzegovina, Brazil, Bulgaria, Burkina Faso, Cambodia, Cameroon, Canada, Chad, Chile, China, China, Hong Kong SAR, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Cyprus, Czechia, Dem. Rep. of the Congo, Denmark, Djibouti, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iraq, Ireland, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Lao People's Dem. Rep., Latvia, Lebanon, Liberia, Libya, Lithuania, Luxembourg, Maldives, Malta, Mexico, Mongolia, Montenegro, Myanmar, Nepal, Netherlands, New Zealand, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Poland, Portugal, Qatar, Rep. of Korea, Rep. of Moldova, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Singapore, Slovenia, Solomon Isds, South Africa, Spain, Sweden, Switzerland, Syria, Tajikistan, Thailand, Togo, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, Uruguay, USA, Uzbekistan, and Vietnam (121 countries).

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