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## Article

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## GENERAL AND APPLIED ECONOMICS | RESEARCH ARTICLE

# The determinant, efficiency, and potential of Indonesian palm oil downstream export to the global market

Hansen Tandra<sup>1</sup> and Arif Imam Suroso<sup>2\*</sup>

**Abstract:** This study aims to investigate the determinants, efficiency, and potential of Indonesian palm oil downstream exports to the global market during 2012–2020. The stochastic frontier gravity model (SFGM) has been used to estimate the determinants, efficiency, and potential of palm oil downstream exports. The determinants show that the gross domestic product (GDP) importer, Indonesia's GDP per capita, the bilateral exchange rate, colonialization, and World Trade Organization (WTO) membership have a positive and significant impact on Indonesia's palm oil downstream exports. Nevertheless, there are negative and significant effects from Indonesia's GDP, geographical distance between Indonesia and trading partners, the importer's GDP per capita, and landlocked countries. In addition, the results reveal that no destination countries have maximum efficiency. Moreover, Indonesia has 148 countries that can be classified as trade potential growth in the global market. Therefore, there is a vast potential for the export of Indonesian palm oil downstream in the global market.

**Subjects:** International Trade (incl; Agriculture & Related Industries

**Keywords:** agriculture; business analytics; downstream products; stochastic frontier analysis; trade

## 1. Introduction

Palm oil has become an important commodity in Indonesia. The contribution of palm oil to the gross domestic product (GDP) was 3.5% (GAPKI, 2022). Oil palm plantation is a source of employment that could increase welfare through improvement of household income and subsequently living standards (Acosta & Curt, 2019; Suroso & Ramadhan, 2014). Furthermore, production of palm oil contributes to economic development at various organizational levels, including private businesses, state-owned enterprises (BUMN), and smallholder groups (Purnomo et al., 2020). Moreover, there has been a significant rise in global palm oil production over the past three decades driven by the position of palm oil in the global market and in Indonesia, which is highly competitive at the firm and country-levels (Pahan et al., 2011). Therefore, the palm oil industry is

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one of the main agricultural sectors that support the Indonesian national economy (Tandra et al., 2021).

Indonesia has been the largest exporter of palm oil in the global market for the last two decades. According to (UNcomtrade, 2022), the quantity of Indonesian palm oil exports reached 25.94 million tons with a total value of USD 17.37 million or 55.48% shares toward the global market in 2020. This quantity and value of these exports are the highest when compared to exports from other countries. Indonesia and Malaysia are two countries with high competitiveness in the export of palm oil to the global market (Tandra et al., 2022). Therefore, Indonesia has the potential to develop its exports in the future. This potential is also supported by the versatility of palm oil. Currently, palm oil is the most widely produced and consumed vegetable oil commodity in the world (Food and Agriculture Organization (2022). Palm oil has various uses from raw material into processed food, cosmetics, and biofuels, and also enjoys the advantage of lower market prices compared to other commodities (Majid et al., 2021); hence, it is the most sought-after vegetable oil product. Moreover, the palm oil consumption has grown due to the positive trend between population and demand for energy based on renewable sources (Khatun et al., 2017). In the case of Indonesia, the development of the palm industry has been only concentrated on upstream products, dominantly exporting palm oil and palm kernel oil exports, which constitute 72,3% of the exports when compared to the downstream products (UNcomtrade, 2022). The national palm oil downstream policy is divided into three classes, namely 1) the oleofood complex, 2) the oleochemical complex, and 3) the biofuel complex (Ministry of Industry, 2021). This policy aims to accelerate Indonesia into becoming one of the countries that influence global palm commodity prices (Pohan, 2015).

The country has already utilized the downstream policy to implicate faster economic growth (Lewer & Van den Berg, 2003). The other policy must be applied to support the downstream market diversifying export destination markets and shifting the main export destinations to non-traditional countries or developing markets (Sabaruddin, 2017). The determination of export destination country is also an important practice to ensure the sustainability of export performance. Indonesia has implemented the downstream policy to increase the export performance of palm oil downstream products since 2011 (GAPKI, 2017). In Table 1, the export is relatively higher than the import from 2012 until 2020, confirming the availability of surplus palm oil downstream products. The export destinations outside ASEAN are more than those among the ASEAN countries, indicating that the expansion of palm oil downstream exports to the global market should be prioritized.

**Table 1. Trend of Indonesian palm oil downstream products trade (million USD)**

**Palm Oil Downstream Products**

Year	Export	Import	Net Export	Net Export Growth (%)	Export Inside ASEAN	Export Outside ASEAN
2012	6,257	1,256	5,001	-	1,178	5,079
2013	6,308	1,341	4,967	-0.68%	1,446	4,862
2014	6,950	1,313	5,637	13.49%	1,249	5,701
2015	5,165	1,191	3,974	-29.50%	1,019	4,146
2016	6,059	1,346	4,713	18.60%	1,256	4,802
2017	7,059	1,275	5,784	22.72%	1,352	5,708
2018	8,086	1,641	6,445	11.43%	1,305	6,782
2019	7,052	1,530	5,522	-14.32%	1,207	5,846
2020	7,161	1,214	5,947	7.70%	1,232	5,929

Source: UNcomtrade (2022)

Specifically, Figure 1 reveals the trend of Indonesian palm oil downstream trade. There is a positive trend between the total export and the net export, while the import trend is negative, which means that the product has more potential export performance. The liberalization of global trade and economic globalization also influence global trade in palm oil and its downstream products, probably due to involvement in trade agreements to promote export. The major exporters of palm oil actively signed various trade agreements with importing countries to reduce trade barriers, related to tariffs and non-tariff measures (Ahmad Hamidi et al., 2022). In early 2022, Indonesia enforced a restriction policy for raw materials, indicating that palm oil must be processed first before export to the global market. Based on empirical evidence in Indonesia, exports in the industry sector have short-term and long-term impacts on economic growth (Asbiantari et al., 2018).

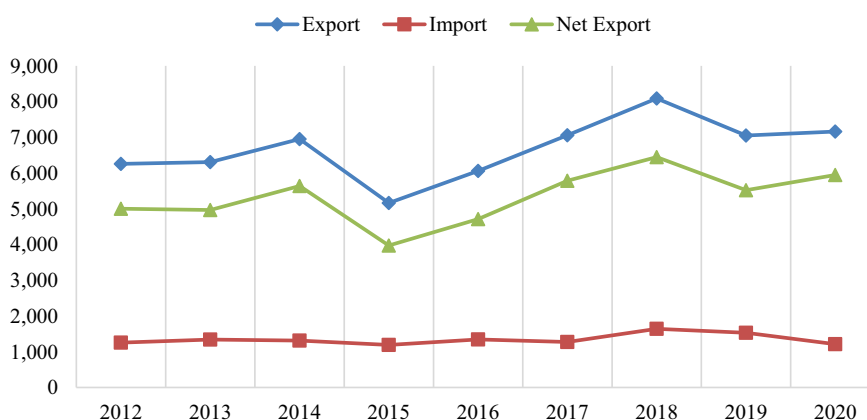
In developing countries, industry exports must be considered due to the positive effect on the national economy (Mehrara & Baghbanpour, 2016). Therefore, the palm oil downstream exports from Indonesia to the global market must be observed clearly based on the identification of export determinants, evaluation of the export efficiency in the current market, and identification of the potential export destination countries.

The current study makes an effort to assess the export of palm oil from Indonesia in terms of its downstream oleofood, oleochemical, and biofuel products. Our first objective is to determine what factors are important for the export of downstream palm oil products, which will lead to a conclusion about those factors. Second, the study of export efficiency is defined as the export performance of a company or country that seeks to produce goods with the fewest possible inputs in order to maximize revenues (Yenilmez, 2013). Through this export efficiency analysis, we could identify the export potential, providing a clear image of the performance of a firm or country in trade activities. A literature-based research has been conducted on palm oil exports over the past few decades. However, research on palm oil downstream exports is still rare, particularly regarding the analysis of determinants, export efficiency, and export potential. We also divided our efficiency and potential export based on continents and economy classifications. Through the findings, policymakers would observe the specific regions for expansion of the palm oil downstream exports.

The paper contains several sections. The second half of this study is devoted to a literature assessment of international trade studies. In the third section, we describe the study's methodological structure. The fourth section addresses the Indonesian palm oil downstream export situation and the study's findings. Finally, section five provides a conclusion of the study and policy recommendations.

**Figure 1. The trend of Indonesian palm oil downstream trade (million USD).**

Source: UNcomtrade (2022)



## 2. Literature review

The research about international trade has become an interesting topic due to the development of a lot of literature over the last several decades. The gravity model is applied to examine the trade flow, especially the bilateral trade between reporter and partner countries. This model has become the workhorse for international trade literature. It has been the popular theoretical framework for confirming factors influencing trade flows. In its basic formulation, bilateral trade is an empirical relationship based on the income size and the geographical distance between the countries (Tinbergen, 1962). This theory has been improved by many scholars, namely (Anderson & Van Wincoop, 2003; Bergstrand, 1989; Deardorff & Stern, 1998; Linnemann, 1966). Currently, this model has been extended by adding several variables related to bilateral trade. In this section, we discuss the previous literature categorized into three subsections including the determinants of export, the export efficiency, and the potential export analysis. We also divide our review into aggregate or single commodities and specific palm oil commodity.

We explore previous studies on the determinants of export. (Natale et al., 2015) examined the determinant export of international seafood trade by using the gravity model equation and considered all the exporters in the global market in the period between 1990 and 2010. The study revealed the positive impacts of GDP, seafood consumption, seafood production, relative trade agreement (RTA), and exporter income on the trade flow. Conversely, the exporter GDP and distance between countries were found to have negative and significant impacts on trade flow. (Braha et al., 2017) explored the export determinants for Albania's agricultural exports by including data from the 46 importing countries from 1996 to 2013. The results showed that the positive determinants of agricultural export are the GDPs of the exporter and the importer, population of the importer, common border, language, landlocked, colony, exchange rate, diaspora availability, and CEFTA. Otherwise, the negative determinants are distance, exporter population, inflation, EFTA, trade agreement with Turkey, and bilateral institutional distance. Furthermore, Abdullahi, Aluko, et al., 2021 examined the factors that influenced agri-food exports between Nigeria and the EU from 1995 until 2019, besides its efficiency and export potential. The study shows that Nigerian food exports are influenced by economic size, per capita income, new EU membership, and distance. Utilizing a panel dataset spanning the years 1996 to 2016, Shahriar et al., 2019 looked at the factors influencing exports in the Chinese meat sector for both China and its importing partners. Their empirical results demonstrated that China's GDP, Chinese language, currency rate, and geographical area are all factors that have a beneficial impact on the flow of pork exports from China. The World Trade Organization (WTO) and the BRI also have an effect on China's pork export flows. For the palm oil commodity, Pujiati et al., 2014 examined the impact of free trade on palm oil exports from Indonesia and Malaysia to 77 partner countries from 1991 until 2011. The results showed that annual palm oil production and Free Trade Agreements (FTA) have a positive and significant effect on Indonesian and Malaysian palm oil exports. However, distance has a negative and significant effect. (Ridwannulloh & Sunaryati, 2018) examined the factors that influenced the export of Indonesian crude palm oil (CPO) to the global market from 1995 until 2016. The results showed that Indonesia's GDP and export destination country's GDP, distance, domestic palm oil consumption, and exchange rates influenced CPO export from Indonesia to major trading partners. (Rosyadi et al., 2020) examined the impact of the roundtable on sustainable palm oil (RSPO) on Indonesian CPO exports by using the gravity model containing the bilateral export between Indonesia and five major importing countries from 1999 to 2018. There is a positive and significant effect of RSPO, importer's GDP, population, and the exchange rate on Indonesia's CPO export. Meanwhile, the negative determinants of Indonesia's CPO export came from population and economic distance.

In export efficiency analysis, there are several previous studies that have been based on the stochastic frontier gravity model (SFGM) for estimating the technical efficiency of exports. (Atif et al., 2019) applied the SFGM for examining the export efficiency of chemical products in Pakistan. The results of his analysis show that the export efficiency analysis reveals that Pakistan's chemical exports are below the optimal level. Moreover, there is an untapped export potential with nearby

countries such as the countries in the Middle East and Europe. (Abdullahi et al., 2022) investigated China's export efficiency for agricultural products to 114 importing countries from 2000 until 2019. The results revealed that China has not achieved maximum efficiency (100%) in its agricultural products export with any importing partners. Most of the importing partners have acquired a relatively high level of efficiency. Among the literatures on palm oil, (Devadason & Mubarik, 2022) investigated the intraregional export flows and export efficiency considering the palm oil and palm-based products as an aggregate. The findings show that both regions have significant unrealized potential and low-efficiency to reach maximum export. (Ahmad Hamidi et al., 2022) revealed that palm oil exports in Indonesia and Malaysia exhibit inefficiencies in the global market since none of the exporter destination countries showed 100% technical efficiency.

Many scholars have also explored the potential of export destination countries. (Abbas & Waheed, 2015) examined the flow of Pakistan's export potential from the gravity model, concluding that Pakistan has potential export to several countries, especially countries in Europe. (Cuyvers et al., 2017) also discussed Thailand's export potential in ASEAN+3 countries, showing that Thailand has a relatively low export market share with only 22% of product combinations to countries with high or medium market share. (Irshad et al., 2018) examined the potential market for rice exports from Pakistan to the global market. His research findings show that Pakistan still has a lot of export potential to 109 countries, which can be gained by increasing the competitiveness of the rice sector in Pakistan. (Sidiq et al., 2019) performed the market potential analysis and identified the determinants of commodity exports from Indonesia to the South Asian region. Five countries, namely India, Pakistan, Bangladesh, Sri Lanka, and the Maldives, were found to be the potential export markets for Indonesia. Several market characteristics are discussed including high competitiveness, good market position, and import demand from export destination countries. Moreover, (Jing et al., 2020) explored the renewable energy trade potential between China and 66 Belt and Road Countries from 2007 to 2017. This study revealed that there are 24 countries with growing trade potential and 26 countries with untapped trade potential. In terms of palm oil, (Ahmad Hamidi et al., 2022) conducted a potential analysis, excluding the technical efficiency. It is shown that there is a huge potential for Indonesia and Malaysia to expand their palm oil exports to India, China, Thailand, and the United States.

Based on our review summary of previous literature, it is established that previous exploration of palm oil only focused on upstream products or combination products between the palm oil and its downstream. There are many researches focused only on the determinants of the palm oil trade aspect, but the studies on efficiency and potential analysis of exports are relatively rare. The research gap is that there are no trade articles related to agricultural downstream products, one of which is palm oil. In this study, we investigated the determinant, efficiency, and potential export of palm oil downstream products without including CPO or its refined form, as the main novelty in this study. We used the econometric model to estimate the future market for downstream Indonesian palm oil products in order to accomplish our three goals. Furthermore, being one of the top exporters of palm oil since 2011, Indonesia may be able to examine its export performance in the downstream palm oil sector with the use of this study.

### 3. Method

#### 3.1. Methodology

This study employed panel data regression based on the gravity model theory of international trade. The gravity model theory of international trade was first introduced by Jan Tinbergen through his 1962 seminal article "Shaping the world economy: propositions for an international economic policy." This article revealed that international trade was determined from economic size and distance between exporter and importer countries (Tinbergen, 1962). The GDP is often used to enhance trade between countries as a proxy for the size of the economy. Additionally, we employed the physical distance as a proxy for transportation costs. The linear form of the traditional gravity model can be described as follows:



$$X_{ij} = \beta_0 + \beta_1 \text{GDP}_i + \beta_2 \text{GDP}_j + \beta_3 \text{DIST}_{ij} + \varepsilon_{ij} \quad (1)$$

In the equation,  $X_{ij}$  is export between reporter (i) and trading partners (j),  $\text{GDP}_i$  is the gross domestic product in reporter country (i),  $\text{GDP}_j$  is the gross domestic product in the trading partner country (j),  $\text{DIST}_{ij}$  is the geographical distance between reporter (i) and trading partners (j),  $\beta$  is the coefficient, and  $\varepsilon$  is the residual term.

There are several factors that must be considered as the other determinants of the export. This model could be extended for a clear and accurate estimation of trade in the last several decades (J. E. Anderson et al., 2001; Górecka et al., 2021; Irshad et al., 2018; Thorpe & Zhang, 2005). We added other variables related to palm oil downstream products to our gravity model. The GDP per capita between Indonesia and trading partners was added to the model for this study as a proxy for the income, implying that a higher income in the country would lead to increased buying. At the same time, we considered the exchange rate due to the important role of international transactions such as the export activity. Dummy variables are also considered in this research including the common border, colonialization, landlocked, FTA, and the membership of the WTO. Therefore, the extended gravity model equation can be depicted as follows:

$$\begin{aligned} \text{LnXPODP}_{\text{indojt}} = & \beta_0 + \beta_1 \text{LnGDP}_{\text{indojt}} + \beta_2 \text{LnGDP}_{\text{jt}} + \beta_3 \text{LnDIST}_{\text{indojt}} + \beta_4 \text{LnGDPC}_{\text{indot}} \\ & + \beta_5 \text{LnGDPC}_{\text{jt}} + \beta_6 \text{LnEXCR}_{\text{indojt}} + \beta_7 \text{FTA}_{\text{indojt}} + \beta_8 \text{WTO}_{\text{indojt}} \\ & + \beta_9 \text{CONT}_{\text{indoj}} + \beta_{10} \text{COL}_{\text{indoj}} + \beta_{11} \text{LL}_{\text{jt}} + \varepsilon_{\text{ijt}} \end{aligned} \quad (2)$$

The  $\text{LnXPODP}_{\text{indojt}}$  is the natural logarithm of export value of Indonesian palm oil downstream products (indo) to trading partner (j) at time t;  $\text{LnGDP}_{\text{it}}$  and  $\text{LnGDP}_{\text{jt}}$  are the GDP for Indonesia (indo) at time t and the GDP for the importer (j) at time t, respectively.  $\text{LnGDPC}_{\text{indo}}$  and  $\text{LnGDPC}_{\text{jt}}$  are the GDP per capita for Indonesia (indo) and for the importer (j), respectively, at time t.  $\text{LnEXCR}_{\text{ijt}}$  is the bilateral exchange rate of Indonesia Rupiah against the currency of the trading partner (j) at time t.  $\text{FTA}_{\text{indojt}}$  is the free trade agreement signed and in effect, with values of 1 = Indonesia trading partners already have FTA and 0 = otherwise.  $\text{WTO}_{\text{indojt}}$  is the WTO Membership between Indonesia (indo) and trading partner countries (j).  $\text{CONT}_{\text{indoj}}$  is the border between Indonesia (indo) and trading partner (j) whereby 1 = there is a border and 0 = otherwise.  $\text{COL}_{\text{indoj}}$  is the colonial relationship between Indonesia (indo) and trading partner (j) with 1 = there is a colonialization relationship and 0 = otherwise.  $\text{LL}_j$  is the country's categorization as landlocked or otherwise (1 = landlocked country and 0 = otherwise).

To obtain the robustness results from this model, we used three estimations in our extended gravity model equation, namely the SFGM, Poisson pseudo-maximum likelihood (PPML), and fixed effect (FE) methods. The SFGM was introduced by (Aigner et al., 1977; Meeusen & van Den Broeck, 1977) to reveal firm efficiency in production economics by stochastic frontier analysis (SFA). Generally, SFA assumes that the potential production limit (PPF) denotes the maximum achievable output level with a fixed input. Operations are described as technically inefficient if they are below the output limit, which means that there is a gap between the actual and optimal possible output levels. However, technically efficient operations at the PPF correlate with observed and at-border output levels. Therefore, technical inefficiency hints at the possibility of further production growth. Consequently, a technically inefficient production function implies the extent to which the actual output is far from the maximum potential output.

In the case of trade (Kalirajan, 2008) applies the SFA to a gravity model equation to describe the trade efficiency, including exports or imports between reporters and trading partner countries. The adoption of this model for estimating trade potential from the operation activities if below the trade frontier is therefore intimated. This estimation provides the countries to select the best priority of trade. The positive or negative error terms that are made by the model affect these bilateral trade frontiers. Different from the production function, the frontier of trade appeared from



the gravity model function by containing the core of gravity variables (income and distance), and several variables are related to the empirical studies. The trade frontier in the case of palm oil downstream product exports can help find the potential export between Indonesia and the trading partner countries. The export frontier is affected by a positive or negative error term value, which implies that the stochastic frontier of export would vary around the deterministic model (Abdullahi et al., 2022; Abdullahi, Huo, et al., 2021; Atif et al., 2019; Ravishankar & Stack, 2014). Consequently, the substantial, theoretical, and policy significance of SFA findings provides a sufficient foundation for their use. When the SFA is added to our extended gravity model in equation (2), the result is the SFGM, which may be written as follows:

$$\begin{aligned} \text{LnXPODP}_{\text{indojt}} = & \beta_0 + \beta_1 \text{LnGDP}_{\text{indojt}} + \beta_2 \text{LnGDP}_{\text{jt}} + \beta_3 \text{LnDIST}_{\text{indojt}} + \beta_4 \text{LnGDPC}_{\text{indot}} + \\ & \beta_5 \text{LnGDPC}_{\text{jt}} + \beta_6 \text{LnEXCR}_{\text{indojt}} + \beta_7 \text{FTA}_{\text{indojt}} + \beta_8 \text{WTO}_{\text{indojt}} + \beta_9 \text{CONT}_{\text{indojt}} + \\ & \beta_{10} \text{COL}_{\text{indojt}} + \beta_{11} \text{LL}_{\text{jt}} + \varepsilon_{\text{indojt}} - V_{\text{indojt}} \end{aligned} \quad (3)$$

There is a similarity between equations (3) and (4). By excluding the error term  $(\varepsilon_{\text{indojt}} - V_{\text{indojt}})$ ,  $\varepsilon_{\text{ijt}}$  can be defined as a double-sided error term, meaning that there is a statistical noise by estimation residuals,  $N(0 \sim \sigma^2 e)$ . Conversely,  $V_{\text{indojt}}$  is a single-sided error term that is estimated to be a normal distribution,  $N(\mu \sim \sigma^2 u)$ , which is the measure of technical inefficiency. We also used the calculation of technical efficiency by (Battese & Coelli, 1995), whose equation is as follows:

$$E[\text{EXP}(-V_{\text{indojt}}) | \varepsilon_{\text{indojt}} + V_{\text{indojt}}] = \frac{1 - \phi[\sigma_* + \gamma(\varepsilon_{\text{indojt}} + V_{\text{indojt}})/\sigma_*]}{1 - \phi\gamma(\varepsilon_{\text{indojt}} + V_{\text{indojt}})/\sigma_*} \cdot \exp\left[\gamma(\varepsilon_{\text{indojt}} + V_{\text{indojt}}) + \frac{\sigma_*^2}{2}\right] \quad (4)$$

In this equation,  $\Phi(\cdot)$  represents the density function,  $\gamma$  denotes the efficiency and was estimated with values between 0 and 1. An efficiency value of 0 indicates that there is inefficiency; therefore, there is the possibility of trade with the stated factors in equation (4). However, if the value of efficiency is 1, then there is evidence of maximum efficiency. We also analyze the export potential by dividing the value between actual and potential value.

We also checked our SFGM estimation with PPML and FE approaches. The PPML method was also used in the gravity model analysis to address the zero-trade observation and heteroskedasticity issues (Motta, 2019; Santos Silva & Tenreiro, 2006, 2011). Moreover, all observations are weighted identically, leading to a positive mean (Gómez-Herrera, 2013). Furthermore, the FE approach was applied in this study to control the unobserved heterogeneity component that is constant over time and which affects each individual (pair of countries) of the panel in a different way (Andrews et al., 2006; Gómez-Herrera, 2013). However, we eliminate the time-invariant variables of the gravity equation, implicating the models to drop these variables, including distance, colony, common border, and landlocked countries.

In export potential, we compared the predicted value with the actual value of the export. The predicted value was obtained by gravity equation SFGM estimation between Indonesia and the importing countries, specifically for this study. Equations (5) provide the methodology for export potential analysis as follows:

$$\text{XPODPP} = \frac{\text{Actual Value of Export}}{\text{Predicted Value of Export}} \quad (5)$$

In this equation, XPODPP is the palm oil downstream export potential. The classification of potential export value was based on (Jing et al., 2020). There are three categories, namely 1) trade potential mature, 2) trade potential growing, and 3) trade potential untapped. The first category is the trade potential mature, often referred to as over trade. When  $A > 1.20$ , the two trading partners have very close trade ties, and their trade potential is mature. Second is trade

potential growing. When  $0.80 < A < 1.20$ , trade relations between the two trading partners are strengthened, and their trading opportunities increase. The third is trade potential untapped, which is usually called under-trade. When  $A < 0.8$ , there are weak trade relations between the reporter and the trade partner, indicating significant untapped trade potential between the two countries.

#### 4. Data

The panel dataset contains the bilateral palm oil downstream product exports from Indonesia to 155 importing countries from 2012 until 2020. The selection of importing countries is based on the availability and value of palm downstream products in the observation year, meaning that the importing countries have an existing relationship for palm oil downstream exports with Indonesia. We also distinguished and grouped the bilateral export Indonesia and importer countries into two categories, namely 1) continents and 2) economy classifications. The matrix of the sample distribution is shown in Figure [Figure 2](#). The palm downstream product export data applied for this study were acquired from the UN Comtrade database.

The list of palm oil downstream products is classified and shown in Appendix [1](#). Data on GDP and GDP per capita (in constant 2015 USD) were obtained from the World Development Indicators by the World Bank (World Development Indicator, [2022](#)). The geographical distance, common border, and colonial were obtained from Research and Expertise on the World Economy database (Mayer & Zignago, [2011](#)). The bilateral exchange rates are official exchange rates of local currency units (Rupiah) to importers' currency and were sourced from (UNCTAD Stat, [2022](#)). Regarding our several dummy variables, the landlocked countries were identified from (World Atlas, [2021](#)), the FTA was also acquired from (ARIC ADB, [2022](#)), and the WTO Membership requirements were obtained from the website of the WTO (WTO, [2022](#)) about the list of membership and observer countries. The summary of variables is shown in Table [2](#), comprising the symbol, description of variables, unit, expected sign, and source. Table [3](#) presents the descriptive statistics of the variables used in the model.

Based on descriptive statistics, all of these variables have a low standard deviation, indicating the low variation of each variable. However, a higher value of the standard deviation is found in the natural logarithm of the bilateral exchange rate ( $\text{LnEXCR}_{\text{indojt}}$ ) with 2.774. The lowest value of the standard deviation is the natural logarithm of GDP per capita in Indonesia ( $\text{LnGDPC}_{\text{indojt}}$ ), which is 0.086.

#### 5. Results and discussions

##### 5.1. The structure of Indonesian palm oil downstream product export market

This study provides the detailed statistics of Indonesian palm oil downstream product exports before examining the estimation results. Figure [Figure 3](#) reveals the top 10 destination countries for Indonesia's palm oil downstream exports. China is the main export destination country with 24.5% share of exports, followed by Netherlands (9.9%), USA (8.1%), Malaysia (8.1%), and India (5.4%). There are several destination countries with export shares below 5% including Singapore

**Figure 2. The matrix of sample distribution.**

Source: (Statistic Times, 2019) and (International Monetary Fund, 2022)

Continent/Economies	Advanced Economies	Emerging and Developing Economies	Total by Continents
Asia	5	34	39
Oceania	2	11	13
European	22	11	33
America	2	26	28
Africa	0	42	42
Total by Economies	31	124	155

**Table 2. Variables, description, unit, expected sign, references, and source**

Symbol	Description	Unit	Expected Sign	Source
$XPODP_{indojt}$	The export value of Indonesian palm oil downstream products (indo) to trading partner (j) at time t	USD		UN Comtrade
$GDP_{indot}$ and $GDP_{jt}$	The gross domestic product in Indonesia at time t and the gross domestic product in importer at time t	USD	+	World Development Indicator (WDI)
$DIS_{indojt}$	The distance between Indonesia (indo) and trading partner (j) at time t	Km	-	CEPII
$GDPC_{indot}$ and $GDPC_{jt}$	The gross domestic product per capita in Indonesia (indo) and importer (j) at time t	Ratio	+	World Development Indicator (WDI)
$EXCR_{indojt}$	The bilateral exchange rate of Indonesia Rupiah toward trading partner (j) currency at time t	USD		UNCTAD Stat
$FTA_{indojt}$	The dummy free trade agreement with signed and in effect (1 = Indonesia and trading partners already have FTA and 0 = otherwise)	Dummy (0,1)	+	ARIC. ADB
$WTO_{indojt}$	The dummy WTO Membership between Indonesia (indo) and trading partner countries (j)	Dummy (0,1)	+	WTO
$CONT_{indoj}$	The dummy common border between Indonesia (indo) and trading partner (j) with 1 = there is a border and 0 = otherwise)	Dummy (0,1)	+	CEPII
$COL_{indoj}$	The dummy colonial relationship between Indonesia (indo) and trading partner (j)	Dummy (0,1)	+	CEPII
$LL_j$	The dummy countries are categorized as the landlocked (1 = landlocked country and 0 = otherwise)	Dummy (0,1)	-	World Atlas

Source: Author (2022)

**Table 3. Descriptive statistics**

Variables	Mean	Median	Maximum	Minimum	Std. Dev
XPODP <sub>indojt</sub>	42,201,432	3,495,154	1,99E+09	21	1,58E+08
LnXPODP <sub>indojt</sub>	14.924	15.067	21.410	3.045	2.513
LnGDP <sub>indot</sub>	27.523	27.530	27.679	27.331	0.117
LnGDP <sub>jt</sub>	24.532	24.617	30.623	17.280	2.403
LnDIS <sub>indojt</sub>	9.093	9.213	9.892	6.787	0.568
LnGDPC <sub>indot</sub>	8.142	8.148	8.263	8.000	0.086
LnGDPC <sub>jt</sub>	8.687	8.673	11.528	5.892	1.390
LnEXCR <sub>indojt</sub>	6.484	7.213	10.771	-1.088	2.774
FTA <sub>indojt</sub>	0.126	0.000	1.000	0.000	0.331
WTO <sub>indojt</sub>	0.874	1.000	1.000	0.000	0.332
CONT <sub>indoj</sub>	0.019	0.000	1.000	0.000	0.138
COL <sub>indoj</sub>	0.013	0.000	1.000	0.000	0.113
LL <sub>j</sub>	0.148	0.000	1.000	0.000	0.356

(4.3%), Spain (3.6%), Rep. of Korea (3.0%), Thailand (2.4%), and the Philippines (2.1%). The share amount of these 10 countries accounted for almost 71.3% of the Indonesian palm oil downstream product exports to the global market.

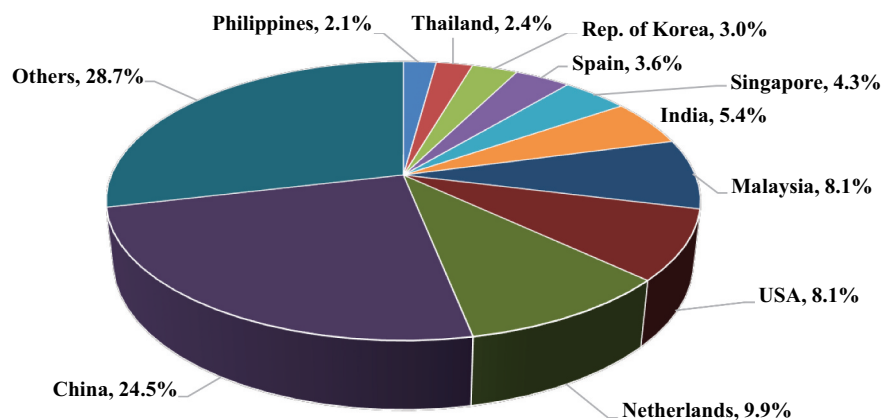
Figure 4 displays the export contribution of Indonesian palm oil downstream products from 2012 until 2020 by three categories. The highest contributions to palm oil downstream exports from 2012 to 2020 came from oleochemicals. In 2020, oleochemicals contributed higher at 68.94%. Oleofood was relatively stable with export shares from 20% until 33%. The highest oleofood contribution was in 2015 with 32.63%, while the biofuel export share declined from 2012 (23.15%) to 2020 (0.34%). The higher export contribution of biofuel is 27.30% in 2013.

### 5.2. The determinant of Indonesian palm oil downstream export

Table 4 shows the factors that influence palm oil downstream export between Indonesia and 155 importing countries in the global markets based on FE, PPML, and SFGM. Based on these results, we found that the SFGM determinants are appropriate in the case of Indonesian palm oil downstream export. This significant influence is due to the value of gamma ( $\gamma$ ) of 0.986, which confirms that the model estimation is decent. The value of  $\sigma^2$  is also significant at 5%, measuring the variance of the overall mean in the long term. . Hence, we only choose the SFGM to determine the influence of key factors on palm oil downstream exports.

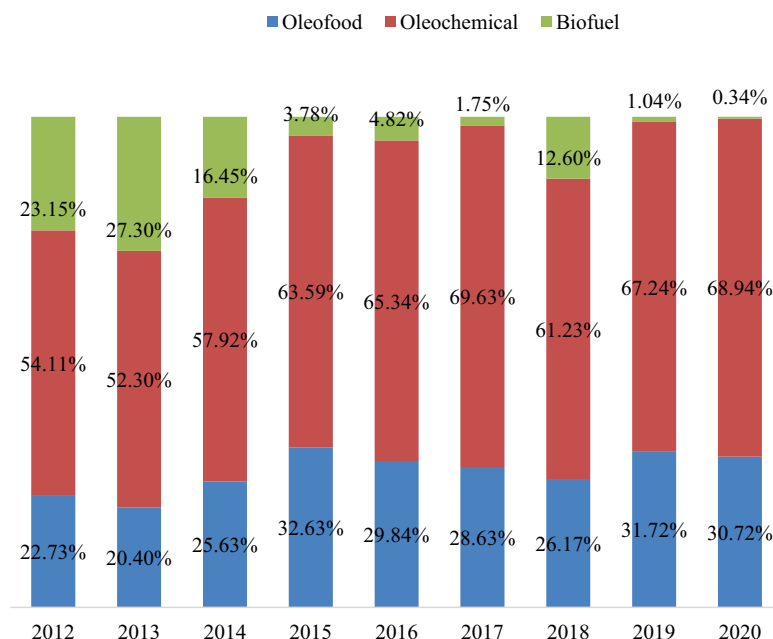
**Figure 3. The Top 10 Indonesian palm downstream product export destinations**

Source: UNcomtrade (2022)



**Figure 4. Export contribution of Indonesian palm oil downstream products.**

Source: UNcomtrade (2022)



Regression-based SFGM reveals that several factors influence palm oil downstream export to the global market. In the primary variable in the gravity model, we found that the GDP of importing countries has a positive effect on downstream exports of palm oil, which means that higher GDP of importing countries could lead to higher export. This finding is similar to the results of previous research (Abafita et al., 2021; Ahmad Hamidi et al., 2022). However, the GDP of Indonesia has a negative sign. In Indonesia, the Ministry of Industry has established a palm oil downstream policy to promote exports and substitute imports based on palm oil utilization (GAPKI, 2017), indicating higher demand in domestic consumption. Nevertheless, distance as the proxy of shipping cost has a negative and significant effect on the exports of palm oil downstream, which shows that higher shipping costs have negative impacts on the export rates. Thus, these variables of gravity are still related to the economic theory and to the findings of similar empirical studies (Abdullahi, Huo, et al., 2021; Kea et al., 2019).

This finding also discusses other factors outside the gravity equation. The GDP per capita has the opposite impact on the GDP. The GDP per capita of Indonesia has a beneficial impact on downstream exports of palm oil. On the other hand, it has been discovered that the importing nation's GDP per capita has a negative and considerable impact. An increase in Indonesia's GDP per capita could be described as an income per person, and the increase in the persons's income also leads to higher consumption. The GDP per capita has implications on the downstream industry such as increased output and expanding the market to local or global scopes. In the case of palm oil downstream products, there is an opportunity for importing countries to shift from palm oil-based products to other alternatives/competitor products. Therefore, the higher GDP per capita in importers has a negative trend. Palm oil downstream exports are also affected positively and significant by bilateral exchange rate, implying that the escalation of the bilateral exchange rate between Indonesia and the importing country could increase exports. Additionally, this finding also supports earlier results from several kinds of literature (Abdullahi et al., 2022; Pham & Nguyen, 2010; Wahyudi & Anggita, 2015) as well as from the WTO Membership. The effects of the WTO is positive and significant on Indonesia's palm oil downstream export. Participation in the international trade organization improves the trading system and leads to trade enhancement (Irshad et al., 2018). Colonialization also has a positive effect on export, indicating that past similarities from colonialization could be considered to enhance export performance (Koh, 2013). Moreover, being

**Table 4. Estimation results of palm oil downstream exports to global market**

Independent Variables	FE		PPML		SFGM	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
$\ln GDP_{indot}$	-4.580	3.171	-1.529	3.585	-5.102***	0.218
$\ln GDP_{jt}$	1.365**	0.620	0.955***	0.020	0.868***	0.018
$\ln DI_{S_{indojt}}$	-	-	-1.241***	0.063	-0.953***	0.077
$\ln GDP_{C_{indot}}$	6.082	4.271	2.094	4.854	7.200***	0.531
$\ln GDP_{C_{jt}}$	-0.692	0.608	-0.342***	0.028	-0.728***	0.037
$\ln EXCR_{indojt}$	0.133	0.105	0.072***	0.014	0.073***	0.016
$FTA_{indojt}$	0.041	0.371	-0.352***	0.098	0.015	0.131
$WTO_{indojt}$	0.185	0.224	0.416**	0.176	0.313***	0.106
$CONT_{indoj}$	-	-	0.566***	0.106	-0.122	0.271
$COL_{indoj}$	-	-	2.749***	0.083	2.628***	0.298
$LL_j$	-	-	-1.586***	0.301	-2.278***	0.104
Constant	62.945	51.796	30.475	59.228	90.935***	2.638
$\Delta 0$					-66.233***	14.386
$\gamma$					0.986***	0.003
$\sigma^2$					65.822***	13.639
<b>Log-Likelihood</b>					-2338.937	
<b>Hausman Test</b>	0.000		-		-	
$R_2$	0.941		0.913		-	
<b>N</b>	<b>1395</b>		<b>1395</b>		<b>1395</b>	

Notes: \*\* and \*\*\* defined as the significance levels at 5% and 10%, respectively.

landlocked has a negative effect on the export of palm oil downstream products, which implies that any country grouped as landlocked may reduce exports due to transportation availabilities.

### **5.3. Efficiency analysis of Indonesian palm oil downstream export**

Table 5 reveals the average technical efficiency of Indonesian palm oil downstream products from 2012 until 2020 using SFGM. The result of technical efficiency shows that Indonesia has not reached its maximum export potential. This observation is made by displaying the scores of export destination countries operating at less than 100% of technical efficiency. Therefore, there is an opportunity to expand the palm oil downstream exports. The estimation shows five countries with higher technical efficiency including Estonia (80.7%), Malawi (77.3%), Spain (75%), Denmark (74.5%), the United Arab Emirates (73.7%), and Mauritania (73.6%). Meanwhile, lower technical efficiency was also recorded in countries such as China, Macao SAR (5.30%), Ireland (6.80%), Cambodia (15.50%), Namibia (16%), and Finland (16.80%). The average value of the technical efficiency of Indonesian palm oil downstream export is 51.08%

To further examine the effects of technical efficiency, the results were grouped into two classes, namely the continent group and the economic classification group. These groups are shown in Figures 5 and 6. Based on these groups, we found that there is a probability of improving export efficiency by focusing on certain continent or economy classifications.

Figure 5 shows that Oceania is the continent ranked highest in terms of technical efficiency, and this position was held stable from 2012 until 2020. Contrastingly, America is the continent with lowest efficiency, indicating that the export of Indonesian palm downstream is inefficient in this continent. In economy classifications, there is a fluctuation of technical efficiency between advanced economies and emerging and developing economies (Figure 6). However, the group of advanced economies tends to be more inefficient.

### **5.4. Potential analysis of Indonesian palm oil downstream export**

The findings of the gravity regression may be utilized to make an assessment of the potential export for palm oil downstream products between Indonesia and her trading partners. In potential analysis, we have already categorized the importer countries based on continents and economies as shown in Tables 6 and 7, respectively. The export potential analyses only assess the two types of potential, namely trade potential growing and trade potential untapped. In Table 6, Africa is the continent with the highest growing trade potential with 41 countries. However, Europe is the continent with the highest untapped trade potential among the three countries.

Unlike the continent groupings, Table 7 displays the advanced economies with the untapped potential: Four countries are identified. There are also three countries with untapped trade potential among the emerging and developing economies. The advanced economies and emerging and developing economies have 27 countries and 121 countries, respectively, with growing trade potential. Overall, the results reveal that the export of Indonesian palm oil downstream has not been optimized globally. Indonesia's potential trade destinations are located in emerging and developing economies in Africa, indicating that this group must be the priority export market for diversification.

## **6. Conclusion**

Indonesia is one of the producers and exporters of palm oil in the global market. This study examines the export of palm oil downstream products from Indonesia to the global market, represented by 155 importing countries from 2012 until 2020, based on the determinants, efficiency, and potential export analysis. Palm oil is the most traded vegetable oil commodity in the global market. The development of palm oil from an upstream product into a downstream product has already been implemented since 2011 as the initial acceleration of Indonesia's downstream policy. Over the one decade, Indonesia's palm oil downstream products have been exported to the global market. However, Indonesia's export trend relatively fluctuated. SFGM was applied to



**Table 5. Efficiency of Indonesian palm oil downstream export to global market**

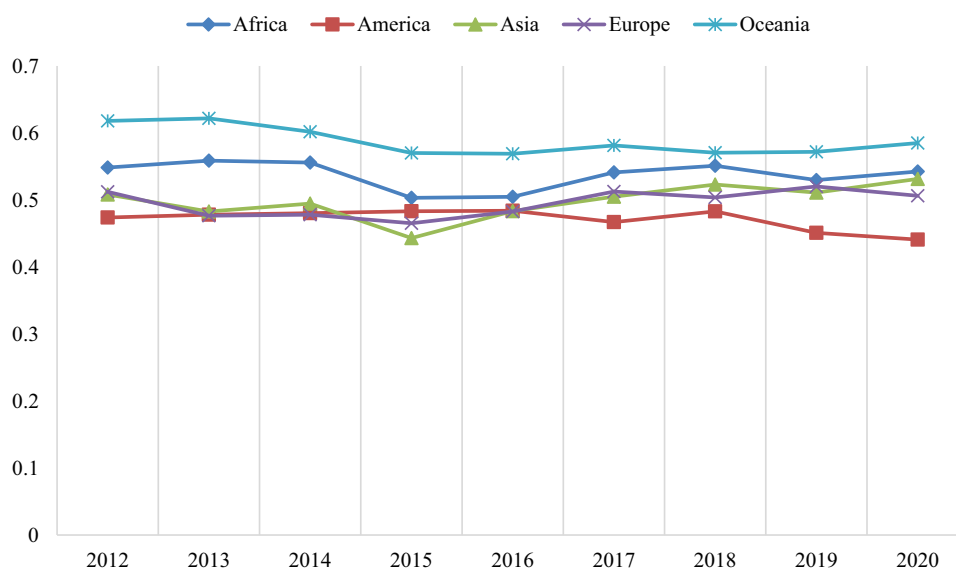
Country	TE	Country	TE	Country	TE
Afghanistan	67.10%	Greece	50.80%	Palau	26.70%
Albania	50.90%	Grenada	61.60%	Panama	56.40%
Algeria	69.90%	Guatemala	21.30%	Papua New Guinea	52.60%
Angola	64.20%	Guinea	44.10%	Peru	49.10%
Argentina	27.30%	Guyana	61.60%	Philippines	56.50%
Armenia	30.00%	Haiti	68.00%	Poland	52.60%
Australia	64.30%	Honduras	26.80%	Portugal	40.50%
Austria	17.30%	Hungary	55.90%	Qatar	38.40%
Bahamas	37.90%	India	45.00%	Rep. of Korea	71.80%
Bahrain	47.90%	Iran	55.90%	Romania	27.60%
Bangladesh	20.90%	Iraq	57.30%	Russian Federation	57.60%
Barbados	70.50%	Ireland	6.80%	Rwanda	51.20%
Belgium	62.80%	Israel	67.70%	Saint Kitts and Nevis	21.80%
Benin	69.50%	Italy	56.70%	Saint Lucia	29.00%
Bolivia (Plurinational State of)	63.60%	Jamaica	72.10%	Samoa	69.10%
Brazil	41.30%	Japan	58.40%	Sao Tome and Principe	64.10%
Brunei Darussalam	53.90%	Jordan	57.00%	Saudi Arabia	58.40%
Bulgaria	66.70%	Kazakhstan	49.70%	Senegal	62.30%
Burkina Faso	63.20%	Kenya	42.20%	Seychelles	41.20%
Cabo Verde	49.30%	Kiribati	70.60%	Sierra Leone	65.10%
Cambodia	15.50%	Kuwait	46.80%	Singapore	72.60%
Cameroon	49.40%	Kyrgyzstan	31.20%	Slovenia	49.80%
Canada	64.20%	Latvia	40.60%	Solomon Isds	66.10%
Central African Rep.	50.80%	Lebanon	62.00%	South Africa	62.60%
Chile	46.20%	Liberia	63.70%	Spain	75.00%
China	62.70%	Libya	57.60%	Sri Lanka	47.10%
China, Hong Kong SAR	52.50%	Lithuania	43.10%	Sudan	44.40%
China, Macao SAR	5.30%	Madagascar	53.40%	Suriname	56.70%
Colombia	48.90%	Malawi	77.30%	Sweden	45.70%
Comoros	42.40%	Malaysia	71.10%	Switzerland	45.80%
Congo	64.20%	Maldives	63.30%	Tajikistan	42.70%
Costa Rica	35.70%	Mali	58.80%	Thailand	59.70%
Côte d'Ivoire	52.10%	Mauritania	73.60%	Timor-Leste	25.60%
Croatia	59.60%	Mauritius	64.30%	Togo	68.10%
Cyprus	17.40%	Mexico	58.70%	Tonga	66.60%
Czechia	39.60%	Micronesia	46.30%	Trinidad and Tobago	67.30%
Denmark	74.50%	Mongolia	67.80%	Tunisia	30.10%

(Continued)

Country	TE	Country	TE	Country	TE
Dominican Rep.	28.10%	Morocco	27.20%	Turkey	59.30%
Ecuador	20.80%	Mozambique	63.50%	Tuvalu	54.00%
Egypt	57.60%	Myanmar	33.90%	Uganda	21.60%
El Salvador	21.90%	Namibia	16.00%	Ukraine	48.90%
Equatorial Guinea	39.80%	Nauru	61.50%	United Arab Emirates	73.70%
Estonia	80.70%	Nepal	28.30%	United Kingdom	50.20%
Ethiopia	64.70%	Netherlands	69.20%	United Rep. of Tanzania	47.40%
Fiji	63.60%	New Zealand	62.80%	Uruguay	54.90%
Finland	16.80%	Nicaragua	36.50%	USA	71.10%
France	49.10%	Niger	48.90%	Uzbekistan	62.40%
Gabon	34.60%	Nigeria	61.40%	Vanuatu	59.80%
Gambia	67.10%	North Macedonia	69.60%	Viet Nam	56.10%
Georgia	45.50%	Norway	43.00%	Yemen	52.90%
Germany	64.80%	Oman	32.50%	Zimbabwe	41.70%
Ghana	66.10%	Pakistan	41.10%	<b>Average Value</b>	<b>51.08%</b>

**Figure 5. The trend of technical efficiency from 2012 to 2020, by Continents.**

Source: Author Calculation (2022)

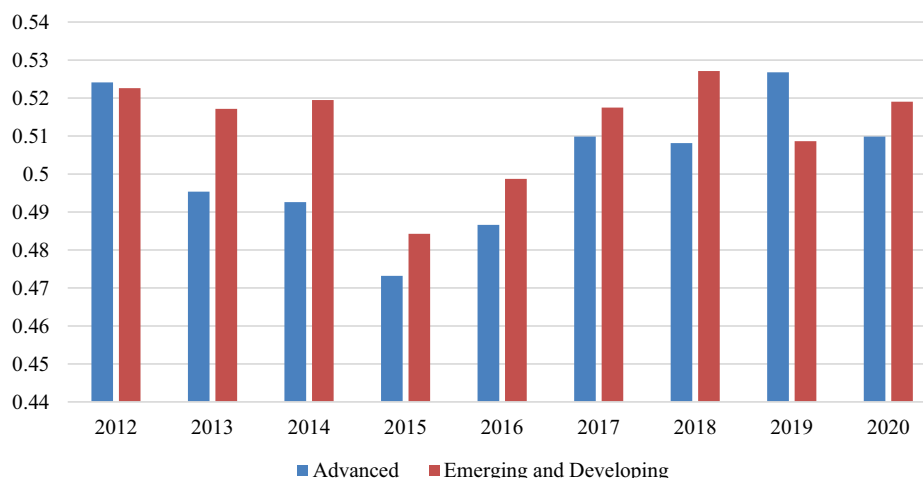


identify the determinants, estimate the efficiency, and search for the potential destination countries for palm oil downstream products.

The results are categorized into three areas: Determinant, efficiency, and potential analysis. First, all the variables in the traditional gravity equation have a significant effect, such as the positive effect of GDP of the importing country and the negative effect arising from Indonesia's GDP and distance between Indonesia and importing country. The additional variables like Indonesia's GDP per capita, the bilateral exchange rate, colonialization, and WTO Membership are positive determinants of Indonesia's downstream palm oil exports. There is a negative and significant effect from GDP per capita of the

**Figure 6. The trend of technical efficiency (2012–2020), by economy classifications.**

Source: Author Calculation (2022)



importers and landlocked countries. Second, the efficiency analysis shows that Indonesia's palm oil downstream export does not maximize the export activity through the value of technical efficiency in the destination countries as it does not realize 100% export activity. Hence, identifying technical efficiency can lead Indonesia to determine the priority countries for increasing the optimum output.

**Table 6. Potential export matrix of Indonesian palm oil downstream (continents)**

Continents	Trade Potential Growing	Trade Potential Untapped
<b>Africa</b>	Algeria, Angola, Benin, Burkina Faso, Cabo Verde, Cameroon, Central African Rep., Comoros, Congo, Côte d'Ivoire, Egypt Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Togo, Tunisia, Uganda, United Rep. of Tanzania, and Zimbabwe <b>(41)</b>	Namibia <b>(1)</b>
<b>America</b>	Argentina, Bahamas, Barbados, Bolivia (Plurinational State of), Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Rep., Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname, Trinidad and Tobago, Uruguay, and USA <b>(27)</b>	Saint Kitts and Nevis <b>(1)</b>
<b>Asia</b>	Afghanistan, Armenia, Bahrain, Bangladesh, Brunei Darussalam, Cambodia, China, China Hong Kong SAR, India, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan Kuwait, Kyrgyzstan, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Rep. of Korea, Saudi Arabia, Singapore, Sri Lanka, Tajikistan, Thailand, Timor-Leste, United Arab Emirates, Uzbekistan, Viet Nam, and Yemen <b>(38)</b>	China Macao SAR <b>(1)</b>
<b>Europe</b>	Albania, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom <b>(30)</b>	Austria, Cyprus, and Ireland <b>(3)</b>
<b>Oceania</b>	Australia, Fiji, Kiribati, Micronesia, Nauru, New Zealand, Papua New Guinea, Samoa, Solomon Isds, Tonga, Tuvalu, and Vanuatu <b>(12)</b>	Palau <b>(1)</b>
<b>Total Countries</b>	<b>148</b>	<b>7</b>

**Table 7. Potential export matrix of Indonesian palm oil downstream (economy classification)**

<b>Economy Classifications</b>	<b>Trade Potential Growing</b>	<b>Trade Potential Untapped</b>
<b>Advanced Economies</b>	Australia, Belgium, Canada, China, Hong Kong SAR, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, Sweden, Switzerland, United Kingdom, and USA <b>(27)</b>	Austria, China Macao SAR, Cyprus, and Ireland <b>(4)</b>
<b>Emerging and Developing Economies</b>	Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Bahamas, Bahrain, Bangladesh, Barbados, Benin, Bolivia (Plurinational State of), Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Cabo Verde, Cambodia, Cameroon, Central African Rep., Chile, China, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Croatia, Dominican Rep., Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Hungary, India, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lebanon, Liberia, Libya, Madagascar, Malaysia, Maldives, Malawi, Mali, Mauritania, Mauritius, Mexico, Micronesia, Mongolia, Morocco, Mozambique, Myanmar, Nauru, Nepal, Nicaragua, Niger, Nigeria, North Macedonia, Oman, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Poland, Qatar, Rep. of Korea, Romania, Russian Federation, Rwanda, Saint Lucia, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Solomon Isds, South Africa, Sri Lanka, Sudan, Suriname, Tajikistan, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Rep. of Tanzania, Uruguay, Uzbekistan, Vanuatu, Viet Nam, Yemen, and Zimbabwe <b>(121)</b>	Namibia, Palau, and Saint Kitts and Nevis <b>(3)</b>
<b>Total Countries</b>	<b>148</b>	<b>7</b>

Third, we have drawn Indonesia's potential export as a country growing in trade potential. However, several countries must be considered due to the untapped trade potential.

This study provides some insights into improving palm oil downstream exports. There is promising improvement of palm oil downstream products in Indonesia through the escalation of industrial capacity and tax policy as well as trade restrictions for raw materials. Therefore, Indonesia will promote trade activities only in downstream products leading to the future positive trend of such products. The exploration of determinants could lead to increase or decrease in exports. Based on our

results, attention toward the positive effect of GDP per capita in Indonesia must be considered as the improvement strategy. This attention can be initiated by shifting the focus on the palm oil industry from the upstream to the downstream sector, leading to the improvement of household consumption. Therefore, policymakers must concern with income per person to maintain consumption as the avenue for increasing industrial output. For stakeholders related to the palm oil industry, the reduction of shipment cost is important for increasing the export value of palm oil downstream. Therefore, cost-efficiency must be implemented for all actors in the supply chain of palm oil. The higher potential of palm oil downstream exports means that the Indonesian palm oil industry could shift from upstream to downstream products, causing a higher value of exports.

The bilateral exchange rate is another area of focus for policymakers since it controls the performance of the national currency in the global market. The bilateral exchange rate is also linked to higher exports in the presence of a stronger national currency. The relationship between trading partners was involved in colonialization. WTO Membership must be preserved due to positive implications for the palm oil downstream exports. Moreover, Indonesia should pay more attention to the negative effect of distance and landlocked countries in order to increase exports to nearby countries that are not landlocked. The efficiency analysis reveals that Indonesia must focus on achieving the maximum technical efficiency for some countries with higher value and expanding the trade with lower value. The focus on emerging and developing economies in Africa has been identified as the solution to escalating palm oil downstream exports.

Some limitations of this study include the observation of exports only in a single country. Several countries, including Malaysia and some developed countries that depend on the palm oil sector, are downstream market leaders in palm oil. This study must be replicated in the future research with diverse exporters to obtain differentiated results. Based on the author's judgment, the palm oil downstream product is limited. However, this product will be developed until other downstream products based on palm oil are created. Future research could re-examine the downstream exports by evaluating new palm oil downstream products. Last but not least, the time and individual of the study must be considered by adding the period or partner countries to gain comprehensive results.

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#### Disclosure statement

No potential conflict of interest was reported by the authors.

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## Appendix

Category	Harmonized System (HS) Code (Six-Digit Level)
<b><i>Oleofood Complex</i></b>	151710; 151790; 151800; 170490; 180400; 180500; 180610; 180620; 180631; 180632; 180690; 190120; 190220; 210500; 293621; 293628 <b>(16)</b>
<b><i>Oleochemical Complex</i></b>	152000; 152200; 290516; 290517; 290519; 290539; 290545; 290559; 291539; 291570; 291590; 291615; 291732; 291734; 291739; 330410; 330420; 330491; 330499; 330510; 340111; 340120; 340213; 340219; 340490; 382311; 382312; 382319; 382370; 382490; 390950; 391310; 391390 <b>(33)</b>
<b><i>Biofuel Complex</i></b>	271020; 382600 <b>(2)</b>

Source: (GAPKI, 2017; MPOC, 2020; Othman et al., 2021; Palm Oil World, 2022)



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