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RESEARCH PAPER

Examining the Determinants, Efficiency, and Potential Export of Indonesia's Plantation Commodities to G-20 Countries

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Abstract

Consisting of 70.50% of the world's GDP and 58.37% of the world's population, countries participating in the G-20 have the potential to be a very profitable export market for Indonesia's plantation commodities. However, the value of Indonesia's plantation commodity exports to countries in the G-20 tends to fluctuate and has even declined during certain periods. So, this paper aims to analyze the determinants, efficiency, and potential of Indonesia's plantation commodity exports to G-20 countries for the 2005-2020 period. The Stochastic Frontier Gravity Model (SFGM) and Random Effect (RE) models are estimated simultaneously to ensure the robustness of the results. Model estimates show that the GDP of exporters, GDP of importers, GDP per capita of importers, and population of importers have a positive effect on the flow of trade in Indonesian plantation commodities to countries in the G-20. Conversely, trade costs have a negative impact on Indonesia's plantation commodity exports. Another finding is that Indonesia's plantation commodity exports to countries in the G-20 have not been efficient with an average efficiency value of 52.45%. The implication is that there are still untapped opportunities to increase exports. Based on the calculation of export potential, the trading partner countries with the largest export potential are the United States (US$ 1,020.586 million), China (US$ 462.557 million), Japan (US$ 219.557 million), and Brazil (US$ 111.339 million). Based on the results, efforts to maximize Indonesia's plantation commodity export potential should be focused on countries with large economies and populations, and low trade costs.

Keywords: Export Efficiency, Export Potential, G20, Panel Data, Stochastic Frontier Gravity Model.
JEL Classification: F1, F4, Q1.

1. Introduction

The agricultural sector plays an important role in the economic and social development of Southeast Asian countries like Indonesia (Liu et al., 2020).

Indonesia's geographical conditions contribute to its comparative advantage and specialization in the production and export of agricultural commodities, especially plantations (Rum and Rijoly, 2020; Tety et al., 2022). The total export value of Indonesian plantation commodities such as cocoa, coffee, tea, mate, and spices (HS 09 and 18) will reach US$ 2.912 million in 2021. The export value of Indonesian plantation commodities has fluctuated in the last 10 years, with a decreasing trend of 0.6% per year (Trademap, 2022). This shows that even though geographically Indonesia has advantages, in the era of trade globalization, this comparative advantage must be maintained by increasing productivity through innovation and strengthening institutions involved in exporting agricultural commodities in Indonesia (Sulaiman et al., 2020).

Other efforts that can be made to increase exports of plantation commodities are through optimizing traditional markets and diversifying potential markets (Wahyudi and Maipita, 2019). This can be done through involvement in global cooperation in order to develop exports of Indonesian plantation commodities. One of the global collaborations that Indonesia participates in is the G-20 forum. The G-20 forum is an association of several countries with the largest GDP and population in the world, controlling 70.50 percent of the world's total GDP and 58.37 percent of the world's population (Astuti et al., 2022). Countries that are part of the G-20 forum which have a large GDP and population, can be optimized as trading partners because they will affect the amount of demand for exports from Indonesian plantation commodities (Noviyani et al., 2019; Syachbudy, Firdaus and Daryanto, 2018). Trade relations between Indonesia and G-20 countries have been established for a long time through export-import activities. In fact, G-20 countries have become some of Indonesia's traditional export destination markets (Sabaruddin, 2017). Several countries participating in the G20 forum have already become export destinations for Indonesian plantation commodities, such as the United States, China and India, as well as European countries like the Netherlands, Germany and France, which are very dependent on spices from Indonesia (Sulaiman et al., 2020).

Indonesia's export of plantation commodities (HS 09 and 18) to G-20 countries in the 2005-2020 period fluctuated quite a bit, with a tendency to increase (Figure 1). Even as it increased, in certain periods there were negative fluctuations in Indonesia's plantation commodity exports to G-20 countries. The biggest negative fluctuations occurred in 2013 and 2018 with a decrease of 13.75% and 10.33%, respectively. In addition, since 2018 the increase in Indonesia's exports has not been as large as the previous year as shown by a graph which tends to slope. This should be a concern for Indonesia whose economy is affected by international trade in agricultural commodities, including plantations. In general, a country's export activities are determined by a combination of several factors, both in terms of supply, demand, and other external factors (Effendi, 2014; Ganbaatar et al., 2021; Malau, Ulya, et al., 2022; Nasrullah et al., 2020).

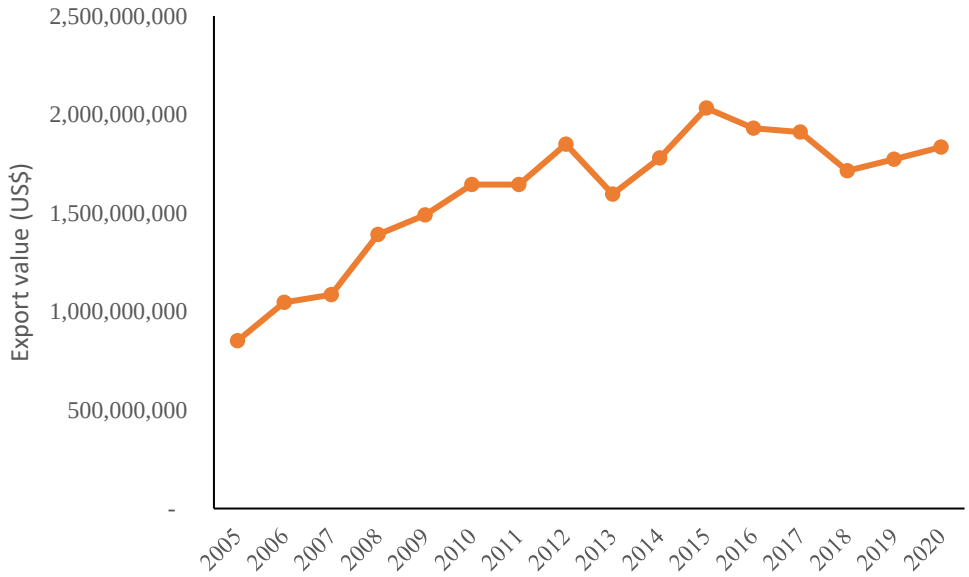

Figure 1. The Value of Indonesia's Plantation Commodity Exports to the G-20 Countries
Source: UN Comtrade (2022).

The exportation of plantation commodities plays an important role in the economic development of Indonesia. Given the importance of plantation commodity exports to the Indonesian economy and the trend of increasing exports of Indonesian plantation commodities to the G-20 countries which tends to slow down, it is important to analyze the factors affecting Indonesia's exports of plantation commodities to the G-20 countries. Analyzing the determinants of Indonesia's plantation commodity exports to the G-20 countries is also important because of Indonesia's involvement in global trade cooperation such as the G20 forum. Not only is this an important opportunity to increase exports, but it can also increase imports as a form of market openness between countries (Putri et al., 2021; Sugiharti et al., 2020).

Previous studies have attempted to analyze the determinants of Indonesia's plantation commodity exports to the G-20 countries, but the output is still partial in the context of commodities and countries. In addition, the effect of the variables on exports is debatable (see (Riyani et al., 2018; Rosyidi et al., 2021; Sanny and Natallya, 2020; Sumiyati, 2020). Analyzing the factors affecting exports is considered still relevant in identifying countries that need special attention to increase exports and countries that still have the potential to expand exports (Abdullahi et al., 2022), so that exports of plantation commodities can continue to grow. Identifying new opportunities in the export of plantation commodities can elevate the contribution of the plantation sector to the national economy. In a broader scope, the first objective of the research was to analyze the factors

influencing Indonesia's plantation commodity exports to G-20 countries, leading to conclusions about the important factors that determined these exports.

On the other hand, previous studies have focused more on analyzing the factors influencing exports, where the basic theory is used as a gravity model (see (Malau et al., 2022; Morland et al., 2020; Nasrullah et al., 2020; Rambe and Malau, 2023; Supriana et al., 2022)). Several studies have also developed a gravity model analyzing the influence of other factors such as trade sanctions (see (Rasoulinezhad, 2019; Rasoulinezhad and Popova, 2017). In addition to analyzing the determinants of exports, this research further analyzed the efficiency and potential of Indonesia's plantation commodity exports to the G-20 countries. Through an analysis of export efficiency, it was found that much of Indonesia's actual exports were able to reach their export potential or the level of gap between actual and potential exports (Abdullahi et al., 2022).

Export efficiency can be measured using the Stochastic Frontier Gravity Model (SFGM) approach (Abdullahi et al., 2021; Atif et al., 2019). The use of SFGM was intended to overcome the limitations of the gravity model with OLS estimates (Kalirajan, 2008), which tended to be biased in estimating potential export values (Noviyani et al., 2019). Based on this investigation, the measurement of export efficiency in the Indonesian context was still very limited, especially for exports of plantation commodities. In fact, there is still relatively little application of SFGM in the international trade literature (Atif et al., 2019). The use of SFGM carried out for the scope of Indonesia measured the efficiency of Indonesia's total exports to 62 trading partner countries (Noviyani et al., 2019) and tested the impact of AFTA on Indonesia's exports to 25 trading partner countries (Effendi, 2014).

Despite the importance of plantation commodity exports to the Indonesian economy, only a few studies have comprehensively addressed plantation exports. As a comprehensive analysis, this study aimed to analyze the factors influencing Indonesia's plantation commodity exports to G-20 countries. Furthermore, the efficiency of Indonesia's plantation commodity exports to G-20 countries for each country and the potential value of Indonesia's plantation commodities exports to the G-20 countries as a whole was analyzed. This research contributes to filling a gap in the literature regarding the study of export efficiency, especially exports of plantation commodities which are still very limited for the scope of Indonesia.

2. Literature Review

The theory of international trade has been developed with several approaches, but in general there are 4 basic reasons for the occurrence of international trade, namely: 1) differences in natural and geographical conditions among countries, 2) differences in production costs, 3) "relative advantages" that a country has; and 4) the effect of production scale (Jerzy and Oleksandr, 2022). Although international trade theory continues to develop, changes in theory in many cases are preceded by changes in international trade practices which have recently become

increasingly complex (Chen, 2022). Many economists have tried to understand the practice of international trade, such as Tinbergen who tried to understand the occurrence of international trade with the approach of Newton's theory of gravity. This approach describes the occurrence of bilateral trade based on the size of the economy represented by GDP and the distance between countries (Atif et al., 2019; Masood et al., 2022). This approach is then known as the gravity model which is widely used to analyze international trade and is carried out by completing the parameters of economic size, distance, and various other parameters that are considered to affect trade.

Various other studies use the gravity model to show that trade among countries is positively influenced by the GDP of the exporting countries, colonial links (Renjini et al., 2017), the GDP of the importing countries (Ganbaatar et al., 2021; Masood et al., 2022; Renjini et al., 2017), continuous countries (Morland et al., 2020), population (Sugiharti et al., 2020) and the presence of FTA (Masood et al., 2022). On the other hand, there are several factors which are considered to have a negative effect on international trade, including distance, including distance (Effendi, 2014; Ganbaatar et al., 2021), landlocked (Masood et al., 2022), and exchange rate (Abidin et al., 2013; Effendi, 2014). The gravity model continues to be developed in research by adding new variables which are adjusted to developments in international trade practices, such as adding the variable sanctions on exports (see Rasoulinezhad, 2019; Rasoulinezhad and Popova, 2017).

In addition to the expansion of analysis variables, the use of the gravity model in international trade analysis has begun to see some criticism by economists. The gravity model fails to estimate the effect of Multilateral Trade Resistance (MTR) such as tariff rates, colonial connections, and common languages in bilateral trade (Abdullahi et al., 2022). In addition, the gravity model is considered to be only suitable for calculating trade data among countries that have normal trade relations and cannot be used to estimate the maximum trade value between countries (Atif et al., 2019). Several studies have calculated the potential export value using errors from the processed gravity model, but in fact the estimated error value is considered to be inaccurate in describing export potential (Noviyani et al., 2019).

To overcome the weakness of this gravity model, (Kalirajan, 2008) offers the concept of a gravity model which combines it with the Stochastic Frontier Analysis (SFA) approach and is known as the Stochastic Frontier Gravity Model (SFGM). SFA is an analytical technique that is widely used in production economics to evaluate the efficiency of a company. In international trade, the SFA approach can be used to estimate efficiency and maximum export potential in bilateral trade (Abdullahi et al., 2021). Besides being able to measure export efficiency, the use of SFGM can also correct economic distance bias which can cause heteroscedasticity problems, so that SFGM will provide results with strong theoretical implications for trade policy (Nguyen, 2022).

The SFGM analysis method is still relatively new, so its use in international trade studies is still limited (Atif et al., 2019). SFGM applications can be found in several international trade studies with different country commodities and objects. From the commodity side, SFGM has been used to analyze agri-food commodities (Abdullahi et al., 2021; Barma, 2017; Xu et al., 2023), rice, and coffee (Nguyen, 2022), downstream palm oil products (Tandra & Suroso, 2023), and chemical products (Atif et al., 2019). For Indonesia, SFGM has been used to measure the efficiency of Indonesia's exports to 62 trading partner countries (Noviyani et al., 2019) and to analyze the impact of AFTA on Indonesia's exports to 25 trading partner countries (Effendi, 2014).

Although there have been studies on international trade using SFGM with Indonesian objects, there have been no studies that focus on analyzing plantation commodities, because other studies (Noviyani et al., 2019) and (Effendi, 2014) typically analyze all aspects of Indonesian export commodities. Studies that use SFGM for the sectoral commodity scope with certain markets such as the G-20 need to be carried out to formulate Indonesia's export development strategy. Apart from being able to find the determinants of exports, the use of SFGM will also show the level of efficiency and potential for the export of Indonesian plantation commodities to G-20 countries. Measurements of efficiency and export potential will fill in the gaps in previous international trade studies, which generally focused on partially analyzing the determinants of exports, both of commodities and certain country objects (see Akbar and Widyastutik, 2022; Asliyana and Setyowati, 2022; Rambe and Malau, 2023; Riyani et al., 2018; Sugiharti et al., 2020; Wardhany and Adzim, 2018). In the end, this research is designed to fill a gap in the literature on the use of SFGM for analysis of Indonesia's trade with G-20 countries, especially the scope of plantation commodities that have not been analyzed in previous studies.

3. Material and Methods

3.1 Model Specification

A gravity model is most commonly used in the context of international trade analysis in order to utilize the basic assumption that trading transactions between two countries is positively influenced by the economic size of the two countries, but negatively affected by the distance between these countries (Abdullahi et al., 2022; Nguyen, 2022). The gravity model is the most popular quantitative method for analyzing trade flows among countries (Baier et al., 2014; Nguyen, 2022). The fundamental formula of the gravity model is:

$$Trade_{ij} = \alpha\,(GDP_i \times GDP_j)/DIS_{ij} \quad (1)$$

where, $Trade_{ij}$ is the trade value between the two countries, namely country i and country j; GDP_i and GDP_j are the economic sizes of country i and country j; and DIS_{ij} is the distance between the two countries, namely country i and country j.

This basic model is transformed into a linear form using logarithms, so that the basic model for Indonesia's plantation exports to the G20 countries is as follows:

$$lnEXP_{ij} = \beta_0 + \beta_1 lnGDP_i + \beta_2 lnGDP_j + \beta_3 lnDIS_{ij} + \varepsilon_{ijt} \quad (2)$$

The gravity model used in international trade research has developed very rapidly and has undergone many modifications. The development of gravity models in the last few decades has become more mature, then forming general linear equations that are easy to use for empirical testing (Li et al., 2020). The basic theory of the gravity model uses distance as a proxy for trading costs. However, trading cost is made up of many components, not just transportation costs which are represented by distance. Trading cost is also affected by product quantity, port waiting time, and quarantine costs. Therefore, this study used the trading cost variable (COT) because it is more representative than distance.

The gravity model has the advantage of being able to include other additional variables that are thought to affect trade relations between exporters and importers (Bensassi et al., 2015). Based on previous studies, there are several variables that must be considered as determining factors for exports of Indonesian plantation commodities to G-20 countries (Atif et al., 2019; Effendi, 2014; Noviyani et al., 2019). In addition to GDP and trading costs, this study used the importer's GDP per capita, population of the importing country, and exchange rates. GDP per capita of importers was used as a proxy for the purchasing power of the people of trading partner countries, implying that a higher GDP per capita of importers will increase Indonesia's exports of plantation commodities. The importer population also influences the export flow of Indonesian plantation commodities, because a larger importing country population will increase trade flows. The use of exchange rate variables plays an important role in international transactions. The use of these variables causes Indonesia's plantation commodity export model to G-20 countries to undergo adjustments in the form of the following equation:

$$lnEXP_{ijt} = \beta_0 + \beta_1\, lnGDPit + \beta_2 lnGDP_{jt} + \beta_3 lnGDPCAPIM_{jt} + \beta_4 lnPOP_{jt} + \beta_5 lnRER_{jt} + \beta_6 lnCOT_j + \varepsilon_{ijt} \quad (3)$$

where, EXP_{ijt} is Indonesia's export value of plantation commodities (i) to the destinated country (j) in year (t), $GDPit$ is Gross Domestic Product (GDP) of Indonesia in year (t), GDP_{jt} is the Gross Domestic Product (GDP) of importer (j) in year (t), $GDPCAPIM_{jt}$ is GDP per capita of importer (j) in year (t), POP_{jt} is population of importer (j) in year (t), RER_{jt} is Rupiah exchange rate against currency of destination country (j) in year (t), COT_j is cost incurred by importer in conducting trade (j), and ε_{ijt} is the error term.

Although the gravity model is commonly used in international trade analysis, its estimates are not based on the maximum possible limit on trade among countries (Atif et al., 2019). Several studies calculate the value of potential exports using errors from the estimation results of the gravity model, but the results are not precise in describing potential exports (Noviyani et al., 2019). Furthermore, the

estimation of the gravity model using OLS tends to be biased because the OLS estimation results represent a centralized value or the middle value of the data set used, not an upper limit value. A study by Kalirajan, (2008) proposed a SFGM model that combines Stochastic Frontier Analysis (SFA) production analysis and the gravity model. This model allows for estimation of efficiency and export potential in bilateral trade (Abdullahi et al., 2021). SFGM is different from the conventional gravity model because SFGM has two error terms, where one error term indicates the value of trading inefficiency and the other error term is an error caused by other factors that are not expected in the model (Noviyani et al., 2019). The basic model of the frontier approach is (Effendi, 2014):

$$X_{ij} = f(Z_i; \beta) exp(v_i - u_i) \quad (4)$$

where *Xij* is the export value of country *i* to country *j*, *f (Zi; β)* function consists of factors influencing bilateral trade potential (*Zi*) and *β* is the estimated parameter, *vi* is the error term, which is implicitly outside the trade boundary, and *ui* is an error term including an economic distance bias as a trading constraint.

Thus, the econometric model used in this study is:

$$\begin{aligned} lnEXP_{ijt} = {} & \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnGDPCAPIM_{jt} \\ & + \beta_4 lnPOP_{jt} + \beta_5 lnRER_{jt} + \beta_6 lnCOT_j + (v_i - u_i) \end{aligned} \quad (5)$$

Equation is equal to equation (4) but the error term component is divided into *ui* and *vi*. *vi* is a two-sided error indicating statistical interference based on an estimation error which follows normally distributed assumptions. *ui* is a one-sided error that includes economic distance bias as a trade barrier, and it results in differences in actual and potential exports in trade between two countries. Therefore, Indonesia's export efficiency to each G-20 country can be calculated on the following equation (Xu et al., 2023):

$$\begin{aligned} Export\ efficiency_{ij,t} &= \frac{Actual\ export_{ij,t}}{Potential\ export_{ij,t}} = \frac{Exp(X_{ij,t}\beta + v_{ij,t} - u_{ij,t}}{Exp(X_{ij,t}\beta + v_{ij,t})} \\ &= Exp\ (-u_{ij,t}) \end{aligned} \quad (6)$$

The export efficiency value varies from 0 to 1, where a value of 1 means that actual export has reached their potential export value (Atif et al., 2019; Noviyani et al., 2019). Therefore, Indonesia's potential export can be calculated by following equation:

$$Potential\ export_{ij,t} = \frac{Actual\ export_{ij,t}}{Export\ Efficiency_{ij,t}} \quad (7)$$

To verify the gravity model's result, panel data regression with a Random Effect (RE) approach is frequently used to obtain gravity estimates because this approach calculates for unobservable heterogeneity and controls Multilateral Trade Resistance (MTR) phenomenon (Abdullahi et al., 2022; Atif et al., 2019). Apart from the Random Effect (RE), there are other approaches to panel data regression analysis, namely Pooled Least Squared (PLS), and Fixed Effect (RE). Therefore,

this study tried to compare the gravity model coefficients with the result of panel data regression from the following equation:

$$lnEXP_{ijt} = \beta_0 + \beta_1\, lnGDPit + \beta_2 lnGDP_{jt} + \beta_3 lnPOP_{jt} + \beta_4 lnTO_{jt} + \beta_5 lnRER_{jt} + \varepsilon_{ijt} \quad (8)$$

3.2 Data Description

To find out the determinants and efficiency levels of Indonesia's plantation commodities exports to the G-20 countries, an econometric model was used. This consisted of several variables, including Indonesia's plantation export value (USD), GDP of Indonesia (USD), real GDP of importer (USD), GDP per capita of importer (USD), population (people), real exchange rate (IDR/LCU), and trade cost (US$) (Table 1). This study used panel data from trade in Indonesian plantation commodities with 18 trading partners of the G-20 countries in the 2005-2021 period. However, this study limited plantation commodities to only HS 09 (tea, coffee, spices, and cashew) and HS 18 (cocoa and its derivatives) which Indonesia exported to trading partner countries, namely the United States, South Africa, Saudi Arabia, Australia, Brazil, Argentina, China, the United Kingdom, Italy, India, Germany, Japan, South Korea, Canada, French, Mexico, Russia, and Turkey. Data was obtained from various sources, namely UN Comtrade, Center d'Etudes Prospectives et d'Information (CEPII), World Bank, United Nations Conference on Trade and Development (UNCTAD), and The Economic and Social Commission for Asia and the Pacific (UNESCAP).

Table 1. The Variables and Data Sources

Data	Data Description	Unit	Data Source
The value of plantation commodities exports	The sum of Indonesia's HS 09 and HS 18 export value	USD	UN Comtrade
GDP exporter/importer countries	Gross Domestic Product of exporter/importer at market price	USD	World Bank
GDP per capita importer countries	Gross Domestic Product per capita of importing countries	USD	World Bank
Population	The number of populations in each country	People	World Bank
Real exchange rate	The ratio of Indonesian Rupiah to importing country's currency	IDR/LCU	UNCTAD
Trade cost	The cost that must be paid by the importing countries to carry out trade activities between countries	US$	UNESCAP

4. Results and Discussion

4.1 Factors Affecting Plantation Commodity Export of Indonesia towards G-20 Countries

The descriptive statistics of the variables used in this study are presented in Table 2 with several important points. First, the data used was balanced, namely 288 observations for all variables. Second, there was no large variations in all variables. This can be seen from the relatively small standard deviation value. Third, all the variables used had good minimum and maximum observation ranges.

Table 2. Descriptive Statistic

Variable	Obs	Mean	Std.Dev	Min	Max
Export Value	288	17.4170	1.4811	12.4103	20.4426
GDP Exporter	288	27.3386	0.2390	26.933	27.3576
GDP Importer	288	28.1875	0.9606	26.3126	30.6230
GDP per capita Importer	288	9.7877	1.0073	6.5720	11.1295
Population	288	18.4174	1.1197	16.8308	21.0676
Real Exchange Rate	288	7.617	2.0234	2.0619	9.9260
Trade cost	288	5.1813	0.2743	4.5386	5.9567

Source: Research finding.

To identify the factors influencing Indonesia's plantation commodity exports to the G-20, the SFGM maximum likelihood estimator was utilized, as well as Random Effect (RE). Both models were used to guarantee the robustness of the estimation results. The feasibility of SFGM was shown by the value of the gamma coefficient (γ) which was close to 1 (0.9346). The high value of γ also confirmed that SFGM was an appropriate choice to explain variations in Indonesia's plantation commodities exports to G-20 countries (Vinh and Phuong, 2022). Gamma (γ) measures the ratio of export variations caused by export inefficiencies to the total variation in exports (Atif et al., 2019; Abdullahi et al., 2022). Based on the Hausman test, RE (Random Effect) was more suitable than FE (Fixed Effect), so the test was continued to the LM test. The LM test was used to select RE or Common Effect. The test results showed the probability value of the LM test was 0.0000 or significant at the 1% significance level, so it can be concluded that RE was better than Common Effect. Therefore, the RE model was used to guarantee the robustness of the estimation results together with the SFGM.

The analysis in this study presented the results of SFGM and RE simultaneously because the signs, values and significance of the coefficients were relatively the same. This supported the robustness of the research results. However, this study focused more on SFGM because it was supported by a large γ (0.9346) so it was better at explaining variations in Indonesia's plantation commodities exports to G-20 countries, while RE was only supported by an R-Square value of 0.4196.

Table 3. The Result of SFGM and RE Estimation

Variable	SFGM		RE	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**
GDP Exporter	0.3810	0.1757**	0.5052	0.1266***
GDP Importer	0.5699	0.2242**	0.9319	0.2697***
GDP per capita Importer	0.3406	0.1784**	0.3623	0.1807**
Real Exchange Rate	-0.0054	0.0728	-0.0413	0.0654
Population	0.3673	0.2117**	0.3113	0.2615
Trade Cost	-0.615	0.2889**	-0.7035	0.2815**
Cons	-14.9868	5.4093***	-27.9869	4.5209***
Mu	-1.4777	5.0283*		
Eta	0.0164	0.0008		
Sigma-squared	2.6087	4.1615		
Gamma	0.9346	0.1042		
Log Likelihood	-187.5523			
Hausman test			0.1341	
LM test			0.0000***	
R-Square			0.4196	

Source: Research finding.

Note: *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Based on Table 3, the GDP of exporters had a positive and significant effect. These results indicated that an increase in Indonesia's GDP would increase Indonesia's exports of plantation commodities to G-20 countries, ceteris paribus. These results are consistent with the basic theory of the gravity model and previous studies which concluded that exporter GDP has a positive effect on export values (Abdullahi et al., 2022; Atif et al., 2017; Ganbaatar et al., 2021; Nguyen, 2022; Supriana et al., 2022). Importers' GDP also had a positive and significant effect, so that an increase in importers' GDP would increase exports of Indonesian plantation commodities to G-20 countries, ceteris paribus. This result is in line with economic theory and several previous studies which reported that importers' GDP has a positive effect on exports (Abdullahi et al., 2021; Assoua et al., 2022; Nasrullah et al., 2020; Renjini et al., 2017; Zainuddin et al., 2020).

In the literature on gravity models, GDP was used as a proxy for economic size. However, in this study, the economic size of Indonesia and its trading partner countries as members of the G-20 served as a gravity model. The GDP of exporters showed the export capacity of Indonesia's plantation commodities, while the GDP of importers revealed the amount of demand for exports of plantation commodities by G-20 countries. The GDP of exporters and importers, which had a positive and significant effect, showed that the income of the two countries, both exporters and importers, supported the demand and supply conditions for Indonesia's plantation

commodity exports. The sign of a positive and significant coefficient on the GDP of exporters and importers demonstrated that the larger size of the economy encouraged the flow of Indonesia's plantation commodity exports to G-20 countries. Based on these results, Indonesia could focus its efforts on increasing exports of plantation commodities to countries with large economies.

Another interesting result from this study was the importer's GDP coefficient which was greater than the exporter's GDP, both SFGM and RE. Based on these results, the supply response to changes in Indonesia's GDP was smaller than the demand response due to changes in the importing country's GDP. The implication was that importers had greater power to make supply adjustments in response to changes in demand. This was because G-20 countries, as Indonesia's export destinations, were developed countries with very strict export requirements, especially with the existence of Non-Tariff Measures (NTMs). NTMs are more widely enforced by developed countries such as the USA, Japan, and Canada, which have proven to have a negative impact on exports of plantation commodities from developing countries, such as Indonesia (Crivelli and Groeschl, 2016; Darhyati et al., 2017).

In addition to GDP, trading cost was the basic variable of the gravity model whose effect was tested on Indonesia's plantation commodity exports. Trading cost had a negative and significant effect on both SFGM and RE. In the SFGM model, the coefficient obtained was -0.615, while the RE model produced a coefficient value of -0.703. The value of the SFGM coefficient meant that a 1% increase in trading cost would lead to a decrease in the amount of Indonesia's plantation commodity exports to G-20 countries by 0.615%, ceteris paribus. These results are in line with the research of (Eum et al., 2021), which concluded that trading cost had a negative effect on exports of agricultural companies. Research by (Ayuda et al., 2022) also reported that trading cost, as a measure of distance between trading partners, had a negative effect on Latin American Agri-food exports. (Xu et al., 2017) also reported that transportation cost affects the value of Chinese exports. In addition, (Xu and Liang, 2017) also added that trading cost is a determining factor in the share of exports of Chinese manufactured products.

The implication of the coefficient of trading cost being negative was that Indonesia could maximize the export of plantation commodities to G-20 countries with closer distances, so that trading costs could be minimized. Australia, China, India, South Korea, and Japan are several trading partner countries that can be considered because geographically these countries are closer to Indonesia. This implication is supported by research carried out by (Nurdin et al., 2019), which stated that transportation cost significantly affects Indonesian exports. To support international trade, Indonesia also needs to improve the quality of the services and logistics infrastructure. In line with this, (Ahsan et al., 2021), confirmed the importance of increasing the trade facility index to increase exports in Pakistan.

Based on Table 3, this study confirmed the existence of the gravity model indicated by the sign and significance of exporters' GDP, importers' GDP, and trading cost. The gravity model postulates that the GDP of exporting and importing countries has a positive impact on exports, whereas geographical distance or trading cost has a negative impact (Liu et al., 2020; Shobande, 2019). The implication of this finding was that countries with larger economic sizes traded more. The farther the exporter was from the trading partner country, the less goods were traded due to higher transportation costs.

In addition to using the basic variable gravity model, this study also examined the effect of importers' GDP per capita. Several studies used the variables GDP and GDP per capita simultaneously in international trading analysis (see Abdullahi et al., 2021; 2022; Tandra and Suroso, 2023). GDP was a proxy for economic size, while GDP per capita described purchasing power. GDP per capita of importers had a positive and significant effect on SFGM and RE. The results of this study are in line with previous studies which reported a positive effect of importers' GDP per capita on exports (Darhyati et al., 2017; Malau, Ulya, et al., 2022). The implication was that an increase in GDP per capita of importers would increase exports of Indonesian plantation commodities to G-20 countries, ceteris paribus. An increase in per capita GDP encouraged increased purchasing power and consumption, so that to meet this increase importing countries would carry out larger exports. The G-20 forum consists of countries with relatively large GDP per capita, so they become potential markets for the development of Indonesia's plantation commodity exports.

Based on SFGM, the importer population also had a positive and significant effect. As an implication, the increase in the importer population would increase exports of Indonesian plantation commodities. These results are in line with Barma, (2017) who studied exports of Indian agricultural products and Abdullahi et al., (2021) who examined exports of Nigerian agri-food products to 70 of its trading partner countries. The population of importing countries can be a proxy for the market size of trading partner countries (Noviyani et al., 2019), so the results of the analysis showed that the positive effect of population on Indonesia's plantation commodity exports to G-20 countries were logical. Apart from being the combined countries with the largest GDP in the world, the population of the G-20 countries is also quite large, reaching 58.37 percent of the world's population (Astuti et al., 2022). Even countries with the largest populations in the world, namely China, India, and the United States, are also G-20 countries. This condition shows the large market size of G-20 countries, which has a positive correlation with the high number of requests to meet the needs of each country. Therefore, Indonesia's involvement in the G-20 forum should be maximized to increase exports of plantation commodities. The Indonesian government can maximize the existence of trading cooperation to increase trade volume with countries with the

largest populations, such as the ASEAN-China Free Trade Area (ACFTA) and the ASEAN-India Free Trade Area (AIFTA).

4.2 Efficiency of Indonesia's Plantation Commodity Export to G-20 Countries

Based on the SFGM results, it was known that the trading partners with the highest export efficiency values for Indonesian plantation commodities were Germany (92.95%), South Africa (90.65%), and Russia (86.45%). Meanwhile, trading partner countries with the least technical efficiency were Argentina (6.26%), Turkey (15.25), and China (20.65%) (Table 4). This condition indicates that Indonesia's exports of plantation commodities to the G-20 countries were not yet optimal, as indicated by the average technical efficiency value of 52.45%. As an implication, Indonesia still has the potential to increase exports of plantation commodities (HS 09 and HS 18) to G-20 countries.

Optimizing the potential for increasing Indonesia's exports to G-20 countries can be done through establishing better trade relations, reducing political disputes, and trade agreements (Atif et al., 2019). In addition, Indonesia must also have a commitment to improving the quality of plantation products that meet quality standards in export destination countries. Commitment to improving the quality of plantation commodities is necessary because most of G-20 countries are developed countries with high levels of consumer awareness. For example, Indonesia's coffee export market share in the European Union was only 4.17%, even though Indonesia is one of the largest coffee producers in the world. The low share of the Indonesian coffee market in the European Union can be caused by the non-fulfillment of sustainability certification which indicates good production standards (Salam & Putri, 2019; Wahyudi et al., 2020).

Table 4. Export Efficiency Level of Indonesia's Plantation Commodities to G-20 Countries

No	Destination Country	Efficiency (%)	No	Destination Country	Efficiency (%)
1	South Africa	90.65	10	Italy	69.32
2	USA	59.85	11	Japan	64.64
3	Saudi Arabia	34.53	12	Germany	92.95
4	Argentina	6.26	13	Canada	43.14
5	Australia	84.76	14	South Korea	23.44
6	Brazil	40.76	15	Mexico	33.57
7	United Kingdom	48.90	16	France	44.41
8	China	20.65	17	Russia	86.45
9	India	84.60	18	Turkey	15.25

Source: Research finding.

After guaranteeing the quality of the products produced, the government also needs to carry out export promotions. For example, in pepper exports to Italy, apart from having to meet the quality standards of the European spice association,

Indonesia must increase promotions, so that it can compete with pepper products from other countries (Nugroho and Prasada, 2020). In the cocoa trade, Indonesia also needs commercial diplomacy and to become a member of the International Cocoa Organization (ICCO) to facilitate access to diplomacy with the European Union in reducing import tariffs on Indonesian cocoa (Inayah et al., 2022). These efforts are expected to increase the efficiency of Indonesia's plantation exports to G-20 countries in Europe such as Italy, the United Kingdom, and France, which respectively only have efficiencies of 69.32%, 48.90% and 44.41%.

An interesting thing to note from this technical efficiency score was Indonesia's technical efficiency with G-20 countries originating from the Asian continent (Saudi Arabia, China, India, Japan, South Korea, and Turkey) which tended to be smaller than countries from other continents. However, there was one Asian country with great technical efficiency, namely India (84.60%). In this case, India is one of Indonesia's potential export markets in South Asia (Ali Nur Sidiq, Findi, & Firdaus, 2019). Indonesian plantation export commodities to India are spice commodities such as pepper, cinnamon, nutmeg, and cloves, which are often used as cooking ingredients in India. On the other hand, the efficiency of Indonesia's plantation exports to China was very low (with a value of 20.65%), even though China is a country with the largest population, which has a potential market for Indonesian products. However, despite having the largest population, China is also one of the world's largest agricultural commodity exporters, so that some of its domestic needs can be met from domestic production. Therefore, Indonesia must implement a strategy in the form of increasing competitiveness in agricultural commodities that cannot be produced by China, so that Indonesia's exports to China can increase (Sulaiman et al., 2020).

4.3 Export Potential of Indonesia's Plantation Commodities to G-20 Countries

Indonesia's plantation commodity export potential in G-20 countries could be calculated using export efficiency data. The export potential gave an indication of the empty space filled by Indonesian plantation commodities in the G-20 countries by increasing the value of exports. Furthermore, those G-20 countries that have the largest potential export values were the United States (US$ 1,020.586 million), China (US$ 462.557 million), Japan (US$ 219.557 million), Brazil (US$ 111.339 million), and England (US$ 114.055 million). If you compare the current export value with the export potential, you will find a gap in exports of Indonesian plantation products in G-20 countries. The export gap can be influenced by the GDP of the exporting country, the GDP of the importing country, the GDP per capita of the importing country, population, and trading cost.

Table 5. The Gap in Indonesia's Plantation Commodity Exports to the G-20 Countries

No	Trading partner	Current Export (US$)	Export Potential (US$)	Export Gap (US$)
1	USA	610.866.935	1.020.586.480	- 409.719.545
2	China	95.529.460	462.557.292	- 367.027.832
3	Japan	141.960.617	219.622.184	- 77.661.567
4	Brazil	45.385.266	111.339.231	- 65.953.964
5	United Kingdom	55.775.361	114.055.705	- 58.280.344
6	Canada	43.619.134	101.101.719	- 57.482.586
7	France	45.310.575	102.039.354	- 56.728.779
8	South Korea	14.919.351	63.636.645	- 48.717.295
9	Mexico	19.019.032	56.652.603	- 37.633.571
10	Turkey	6.284.485	41.204.088	- 34.919.604
11	Italy	63.869.976	92.136.987	- 28.267.010
12	Argentina	1.606.067	25.674.143	- 24.068.077
13	India	112.301.044	132.736.067	- 20.435.023
14	Saudi Arabia	8.969.144	25.971.238	- 17.002.094
15	Germany	174.498.455	187.736.871	- 13.238.416
16	Australia	68.831.537	81.211.336	- 12.379.799
17	Russia	69.200.140	80.045.580	- 10.845.440
18	South Africa	20.099.928	22.173.149	- 2.073.220

Source: Research finding.

The largest gap in Indonesia's plantation commodity exports occurred in the USA. This gap was caused by the high value of the United States' Coverage Ratio (CR) and Frequency Index (FI) of Non-Tariff Measures (NTMs) for agricultural products, including plantation commodities. Coverage Ratio and Frequency Index of NTMs in the United States were 77.36% and 61.52%, respectively. This value illustrates the stringent procedures that must be met by exporting countries to carry out bilateral trade with the United States, especially regulations related to food safety (Xu et al., 2023). This could also be another factor causing Indonesia to lose its relatively large export potential from the United States, with a value of US$ 409.719 million.

In responding to the gap in Indonesia's plantation commodity exports in G20 countries, Indonesia could encourage stakeholders to increase the application of plantation product certification. The implementation of agricultural product certification will be a catalyst in international trade, namely as a response to the implementation of the Non-Tariff Measures (NTMs) policy. Several certifications that can be implemented on plantation products in Indonesia are: RSPO and ISPO on palm oil, Organic and Geographical Indication on coffee and UTZ Certified and Rainforest Alliance on cocoa. Overall certification has been shown to have a positive effect on exports of plantation products (Ingram et al., 2018; Rosyadi et al., 2020; Wahyudi et al., 2020).

5. Conclusion

This study was aimed at analyzing the determinants, efficiency, and export potential of Indonesian plantation commodities to G-20 countries using data for the 2005-2020 period from 18 G-20 countries. To gain robust results, 2 equations were used with the basic theory of the gravity model, namely SFGM and Random Effect (RE). The feasibility of SFGM was supported by a γ value of 0.9346 or close to 1, so it can be concluded that SFGM was able to explain variations in Indonesia's plantation commodity exports to G-20 countries. Based on the Hausman and LM test, RE was better than FE and Common Effect.

SFGM and RE estimated produced coefficients with relatively similar signs, values and significance so that they supported robust results. In general, this study confirmed the postulates of the gravity model. Based on the SFGM, the GDP of exporters, GDP of importers, GDP per capita of importers, and population had a positive effect on Indonesia's exports of plantation products to G-20 countries, while trading cost had a negative effect on Indonesia's exports of plantation products to G-20 countries. The RE estimation results showed that the GDP of exporters, the GDP of importers, and the GDP per capita of importers had a positive effect on exports of Indonesian plantation commodities, while trading cost had a negative effect on exports of Indonesian plantation products to G-20 countries. These results had the implication that an increase in the GDP of exporters, GDP of importers, GDP per capita of importers, and the population of importers would increase Indonesia's plantation commodity exports, and conversely an increase in trading cost would reduce exports. In line with these results, Rasoulinezhad & Popova, (2017) reported that GDP and population has a positive effect on Iran-Russia trade. Rasoulinezhad, (2019) also reported that GDP has a positive effect on Iranian and Russian exports.

Unlike the general gravity model studies, this study also measured the efficiency of Indonesia's plantation commodity exports to G-20 countries. The results showed that Indonesia's exports to G-20 countries were not yet optimal, as indicated by a technical efficiency score of 52.45. The implication was that Indonesia still has a huge opportunity to increase exports to G-20 countries. As a comprehensive study, based on the value of export efficiency, Indonesia's export potential to G-20 countries was also calculated. The results revealed that countries with the largest export potential were the United States (US$ 1,020.586 million), China (US$ 462.557 million), Japan (US$ 219.557 million), Brazil (US$ 111.339 million) and the United Kingdom (US$ 114.055 million).

This research was considered superior as a comprehensive study because it analyzed the determinants, efficiency, and potential of Indonesia's exports to G-20 countries. Most of the previous studies only focused on the analysis of the determinants of exports, either partially on the country or commodity context. This study also filled in the gaps in the literature regarding the efficiency of international trade, which was still very limited, both in Indonesia and internationally.

Several interesting works are proposed to complement this research. Further research is suggested to examine the effect of various other variables on exports of Indonesian plantation commodities, such as trade sanctions (Rasoulinezhad, 2019; Rasoulinezhad and Jabalameli, 2019; Rasoulinezhad and Popova, 2017). It is interesting to include other additional variables in the gravity model, so that more complete determinants can be determined. In addition to G-20 countries, it is advisable to analyze the efficiency of Indonesia's plantation commodity exports to other trading partner countries. Apart from that, it would be interesting to analyze the export efficiency of other leading Indonesian commodities. The very rapid development of the gravity model leads to many improvements, as was researched by Rasoulinezhad and Jabalameli (2019) who used the Intercountries Trade Force (ITF) theory. The main difference between the ITF and the gravity model lies in the use of the gravity index (GI). This would be very interesting to examine with further research.

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