

## Determinants of Indonesia's International Trade: Evidence from an Extended Gravity Model

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### Abstract

The gravity model is widely used to explain international trade flows based on economic size and geographical distance. However, the role of extended variables such as price competitiveness and free trade agreements remains less clear, particularly in developing countries. This study examines the determinants of Indonesia's international trade using an extended gravity model. Panel data from 38 trading partner countries over the period 2014-2018 are employed. In addition to GDP and distance, this study incorporates the Producer Price Index (PPI) and a free trade agreement (FTA) dummy variable. The model is estimated using a Random Effect Approach. The results show that GDP has a positive and significant effect, while distance has a negative and significant effect on Indonesia's trade, confirming the relevance of the gravity model. In contrast, PPI does not have a significant effect, and the FTA dummy indicates no significant difference in export performance between partner countries with and without free trade agreements. These findings suggest that variables on traditional gravity model remain more influential than PPI and free trade agreement in explaining Indonesia's trade patterns.

**Keywords:** Distance, Free Trade, GDP, Gravity Model, Producer Price Index.

### Abstrak

Model gravitasi banyak digunakan untuk menjelaskan arus perdagangan internasional berdasarkan ukuran ekonomi dan jarak geografis. Namun, peran variabel daya saing harga dan perjanjian perdagangan bebas belum banyak dibahas terutama pada negara berkembang. Studi ini meneliti faktor penentu perdagangan internasional Indonesia menggunakan pengembangan model gravitasi dengan menggunakan data panel dari 38 mitra dagang selama periode 2014-2018. Selain PDB dan jarak geografis, studi ini menggunakan Indeks Harga Produsen (PPI) dan variabel dummy perjanjian perdagangan bebas yang diestimasi menggunakan *Random Effect Model*. Hasil penelitian menunjukkan bahwa PDB berpengaruh positif dan signifikan, sedangkan jarak memiliki pengaruh negatif dan signifikan terhadap perdagangan internasional Indonesia yang menegaskan relevansi model gravitasi. Sebaliknya, PPI tidak berpengaruh signifikan dan variabel dummy menunjukkan tidak ada perbedaan signifikan dalam kinerja ekspor antara negara mitra dengan dan tanpa perjanjian perdagangan bebas. Temuan ini menunjukkan bahwa variabel dalam model gravitasi tradisional menjadi faktor yang lebih berpengaruh daripada faktor Indeks Harga Produsen dan perjanjian perdagangan bebas dalam menjelaskan pola perdagangan internasional Indonesia.

**Kata Kunci:** GDP, Indeks Harga Produsen, Jarak, Model Gravitasi, Perdagangan Bebas.

## INTRODUCTION

Geographical differences lead to variations in resources endowments and patterns of commodity specialization, which encourages countries to engage in international trade. International trade arises as a consequence of globalization, where economic interdependence among countries becomes increasingly inevitable, particularly in trade activities (Tika Carolina & Aminata, 2019). In addition, the mobility of production factor, knowledge diffusion, and technology transfer are additional drivers of international trade. In macroeconomic perspective, international trade plays a crucial role in promoting economic growth, particularly through the implementation of trade liberalization policies (Mdanat et al., 2018). Trade openness allows countries to access larger markets, improve efficiency, and benefit from comparative advantages. Empirical evidence also suggest that more open economies tend to have higher GDP per capita, although differences in income arise, as reflected by Gini index (Cerdeiro et al., n.d.). Therefore, international trade not only enhances consumption opportunities but also contributes in improving national welfare through export and import activities. However, the extent to which trade generates these benefits may vary depending on country specific characteristic and trade structures.

The early development of international trade theory began with mercantilism which emphasized the importance of maximizing exports while restricting imports as a strategy to increase national wealth. Under this view, a country's prosperity was measured by its accumulation of gold and silver reserves through trade surpluses (Nwinye, 2025). However, this perspective was later challenged by classical trade theory. (Adam Smith, 1776), through the theory of absolute advantage, criticized mercantilism by arguing that trade should be driven by market forces rather than government restrictions. According to this view, countries should specialize in producing goods in which they have a cost advantage and import goods that can be produced more efficiently by other countries, this shift marked the foundation of free trade principles. The development of trade theory was further refined by Heckscher-Ohlin theory, which explains that differences in factor endowments across countries determine comparative advantages and trade patterns. Countries tend to export goods that intensively use their abundant production factors and import goods that require scarce factors. Overall, these theories highlight that international trade evolves from protectionist strategies toward efficiency-driven and factor-based specialization, providing the theoretical foundation for modern trade analysis.

Overall, the classical and neoclassical trade theories emphasize that international trade generates gains through specialization and efficiency. However, as international trade has evolved, trade flows are no longer determined solely by production-side advantages. Demand conditions in importing countries, as well as the scale of economic activity and trade costs, also play a crucial role in shaping trade patterns. Therefore, an empirical framework is required to capture these multidimensional determinants of trade. The gravity model, introduced by (Tinbergen, 1962), provides such a framework by explaining trade flows based on economic size and geographical distance, which proxy market capacity and trade costs, respectively. As a result, the gravity model has become one of the most widely used approaches for analyzing international trade patterns (Yotov, et al, 2016).

The gravity model was first introduced by (Tinbergen, 1962), drawing on Newton's law of gravity, which states that the interaction between two objects is proportional to their mass and inversely proportional to the distance between them. In the context of international trade, economic mass is commonly proxied by GDP, while geographical distance represents trade costs between trading partners. Accordingly, GDP and distance are considered the core variables in explaining bilateral trade flows (Paul R. Krugman et al., 2015). Building on this foundation, empirical studies have extended the gravity model by incorporating additional explanatory variables to better capture the

complexity of trade patterns. For instance, variables related to economic development and market openness, such as GDP per capita and trade to GDP ratios are found to positively influence international trade flows. Similarly, common language and historical linkages tend to facilitate trade by reducing transaction costs. In contrast, factors such as geographical distance and exchange rate volatility are generally found to negatively affect trade flows (Alleyne & Lorde, 2014). Those reminding variables also a remarkable improvement approach of gravity model as the consequences of globalization for trade patterns in which location of economic activity are mattered (Anderson Boston College, 2016).

Indonesia's international trade with its major partner countries listed in Table 1 shows the dynamic pattern of trade surplus and deficit to nine countries. Based on the data, Indonesia recorded the surplus only with Netherland, Italy, Japan, and United States, meanwhile recorded deficit to other countries for 2014 – 2018 period. Interestingly, the data indicate that Indonesia recorded trade deficit with China despite having a free trade, whereas recorded trade surplus with United Sates despite the absence of such free trade agreement. This fact raises an important question whether the practice of free trade agreement supports the idea of trade surplus or not. Free trade makes international trade activities more integrated, which is why it is often referred to as international trade integration that eliminate tariffs, quotas and other barriers for number of goods (Kepaptsoglou et al., 2010). This implementation of free trade was later adopted by other countries, sparking debate over whether free trade is beneficial or detrimental, as the elimination of tariffs in free trade can threaten domestic industries if they are unable to compete (Paul R. Krugman et al., 2015).

**Table 1.**  
**Indonesia's Trade Balance with Major Export Destination Countries**

Description	Value: US\$ million				
	2014	2015	2016	2017	2018
Total Balance Sheet	-9758,5	-7471,2	-5896,9	-5336,8	-19167,7
1. Singapura	-8457,3	-5389,9	-2687,3	-4163,6	-8524,5
2. Malaysia	-1125,4	-899,8	-79,3	-417,1	668,7
3. Thailand	-3997,9	-2576,1	-3272,9	-2807,9	-4131,9
4. Germany	-1269,6	-807,5	-520,8	-869,9	-1264,7
5. Netherland	3076,3	2656,9	2531,3	3011,4	2657,3
6. Italy	564,0	504,7	184,9	362,3	80,6
7. Tiongkok	-13018,4	-14364,5	-14009,7	-12683,7	-18405,6
8. Japan	6109,9	4757,4	3113,8	2558,8	1488,8
9. United States	8360,0	8467,6	8843,0	9672,9	8263,5

Source: Trade Figures, Ministry of Trade of Indonesia, 2019.

International trade between Indonesia and United States is conducted under Trade and Investment Framework (TIFA) meanwhile between Indonesia and China is conducted under ASEAN-China Free Trade Agreement (ACFTA) (Urata & Okabe, 2014). These two significant different agreements resulted a different trade balance of Indonesia. The free trade agreement between ASEAN and China eliminates tariff barriers among the participating countries. This condition potentially contributes to the occurrence of a trade deficit between Indonesia and China. In contrast, international trade between Indonesia and United States is conducted without a free trade agreement and recorded the highest trade surplus during the observed period. This phenomenon suggests that the existence of a free trade agreement does not necessarily provide benefits for Indonesia. By this fact, the study employs dummy variable to classify trade agreement types of Indonesia namely dummy free trade agreement.

Along with the development of international trade studies, the determinants of international trade are no longer limited to GDP and distance. Modern international trade theory emphasizes the role of price competitiveness in influencing trade flows (Paul R. Krugman et al., 2015), Price competitiveness can be reflected by the Producer Price Index (PPI), which represents price changes at the producer level and serves as an indicator of production cost stability (Nakamura & Steinsson, 2013). Higher producer prices tend to reduce export competitiveness by increasing production costs, which may discourage international trade activities. Despite the extensive use of the gravity model, most empirical studies primarily focus on traditional variables such as GDP and distance, while the role of production-side variables, such as Producer Price Index, remains relatively underexplored. In addition, the effectiveness of free trade agreements in enhancing trade performance remains inconclusive, as previous studies report mixed findings regarding their impact on trade flows.

Therefore, this study aims to fill these gaps by incorporating both Producer Price Index and free trade agreements into an extended gravity model of Indonesia's international trade. This study contributes to the literature by providing empirical evidence on whether Production Price Index and trade agreements significantly influence Indonesia's trade performance. To address the research objectives, this study employs GDP, geographical distance, Producer Price Index (PPI), and free trade agreement (FTA) dummy variable as independent variables, while export value is used as the dependent variable. The research hypothesis proposes that GDP has a positive effect on export value, whereas distance and Producer Price Index (PPI) are expected to have negative effects on export value. In addition, dummy variable for free trade agreements is expected to indicate differences in export performance between trade with free trade agreement partners and non-free trade agreements partners.

## **METHODOLOGY**

The data used in this study consist of quantitative secondary data on export value, GDP, distance, and PPI. The dataset is structured as panel data, combining time-series and cross-sectional observations. The time period from 2014 to 2018, while the cross sectional includes 38 of Indonesia's trading partner countries. The data sources were obtained from the Ministry of Trade of Indonesia and the World Bank for the period 2014-2018.

The population of this study consists of Indonesia's non-oil and gas export and import partner countries during 2014-2018 period. The sampling technique applied in this study is purposive sampling with the criteria such as (1) Indonesia's non-oil and gas export and import partner countries, (2) partner countries that have bilateral free trade agreements with Indonesia, and (3) partner countries that do not have bilateral free trade agreements with Indonesia.

This study applies the gravity model of international trade by using panel data regression approach estimated by the Ordinary Least Square (OLS) method. The panel data regression is conducted in three stages: (1) regression using the full sample of trading partner countries, (2) regression using only countries that have free trade agreement with Indonesia, and (3) regression using countries that do not have free trade agreements with Indonesia. These three estimation stages are conducted to compare the regression coefficients in order to evaluate whether free trade agreements provide greater benefits to Indonesia's trade performance. These three stages of regression represent the novelty of this study and are intended to address the research gap identified in previous studies. The panel regression specification of the gravity model is adapted from Newton's law of gravity and transformed into a log-linear functional form as follows:

$$\text{Ln}X_{it} = \beta_0 + \beta_1 \text{LnGDP}_{it} + \beta_2 \text{LnDistance}_{it} + \beta_3 \text{LnPPI}_{it} + \beta_4 \text{FTD}_{it} + \varepsilon_{it}$$

Explanation:

- $\text{Ln}X_{it}$  : Dependent variable representing Indonesia's export value to trading partner countries (in USD)
- $\beta_0$  : Intercept coefficient (constant term).
- $\text{LnGDP}_{it}$  : Independent variable representing the Gross Domestic Product of partner countries (in USD).
- $\text{LnDistance}_{it}$  : Independent variable representing the geographical distance between Indonesia and partner countries (in kilometers).
- $\text{LnPPI}_{it}$  : Independent variable representing the Producer Price Index of partner countries (in percentage)
- $\text{FTD}_{it}$  : Dummy variable representing the existence of a free trade agreement between Indonesia and partner countries, 1 for free trade agreement, 0 for non-free trade agreement.

Panel data regression in this study focuses on two main estimation approaches, namely the Fixed Effect Model (FEM) and the Random Effect Model (REM), which are commonly used to account for unobserved heterogeneity across cross-sectional units. The selection of the appropriate model is based on the Hausman test, which examines whether individual effects are correlated with the explanatory variables. If the Hausman test indicates the presence of such correlation, the Fixed Effect Model is preferred, otherwise the Random Effect Model is considered more efficient. This approach ensures that the estimation results are both consistent and reliable. Although the Common Effect Model (CEM) may serve as a baseline specification, this study emphasizes FEM and REM as more appropriate approaches for panel data analysis (Agus Widarjono, 2018).

In addition, the OLS estimation method requires several classical assumptions to be satisfied. Therefore, diagnostic tests are performed, including the normality test, multicollinearity test, heteroscedasticity test, and autocorrelation test. The normality test is conducted to examine whether the residuals of the regression model are normally distributed. The validity of statistical inference particularly the t-test for individual regression coefficients, depends on the assumption that the residuals follow a normal distribution. In this study, the normality test is performed using the Jarque-Bera (J-B) test.

The multicollinearity test is conducted to detect the presence of strong correlations among the independent variables in the regression model. Multicollinearity is examined using the Variance Inflation Factor (VIF). If the VIF value is greater than or equal to 10, it indicates the perfect multicollinearity among the explanatory variables. The heteroskedasticity test is conducted to ensure that the error terms have constant variance across observations. Heteroskedasticity may lead to inefficient parameter estimates and biased standard errors. In this study, heteroskedasticity is tested using the Breusch-Pagan test in order to ensure that the regression model fulfill the assumption of homokedastic residuals and has Best Linear Unbiased Estimators (BLUE). The autocorrelation test is conducted to ensure that the error terms are not correlated across observations. Autocorrelation can affect the efficiency of the regression estimates and the validity of hypothesis testing. In this study, autocorrelation is examined using the method of Breusch-Godfrey LM Test.

## DISCUSSION AND FINDINGS

### Descriptive Statistics

Descriptive statistics on Table 2 are used to provide an overview of the characteristics of the data employed in this study. The descriptive measures include the mean, minimum, maximum, standard deviation, as well as the distribution indicators such as skewness and kurtosis. This study uses export value as dependent variable, while the independent variables consist of GDP, geographical distance, the Producer Price Index (PPI), and a dummy variable for free trade agreements (FTA). The FTA dummy variable takes a value of 1 for countries that have free trade agreements with Indonesia and 0 otherwise. The descriptive statistics in Table 2 indicate substantial variation across variables, particularly for export values and GDP, which exhibit relatively high standard deviations, reflecting differences distance shows moderate variation, while PPI appears relatively stable over the observation period. Overall, the data exhibit sufficient variability, supporting their suitability for panel data regression analysis.

Table 2.  
Descriptive Statistics

	Export Value (USD)	GDP (USD)	Geographic Distance (KM)	PPI (%)
Mean	3.560.000.000	1.770.000.000.000	8335	122
Median	1.590.000.000	642.000.000.000	8294	104
Maximum	24.400.000.000	17.900.000.000.000	16741	950
Minimum	134.000.000	65.700.000.000	1268	71
Std. Dev	4.620.000.000	3.110.000.000.000	4209	88
Skewness	2	4	0	8
Kurtosis	7	17	2	70

Source. Data processed

### Classical Assumption Test

Based on Table 3, the Jarque-Bera normality test shows a probability value of 0.9856, which is greater than the five percent significance level. This indicates that the residuals are normally distributed, and thus the normality assumption of the regression model is satisfied. The fulfillment of the normality assumption implies that the statistical inference of the model, particularly the validity of t-tests and F-tests, can be considered reliable. In addition, normality distributed residuals indicate that the model does not suffer from specification bias related to non-normal error distribution. Therefore, the regression results can be interpreted with a higher degree of confidence, supporting the robustness of the estimated gravity model.

Table 3.  
Normality Test

Jarque-Bera	Probability	Conclusion
0.028996	0.985606	Residuals are normally distributed

Source. Data processed

Based on Table 4, the correlation values among the independent variables, namely GDP, geographical distance, the Producer Price Index, and the free trade agreement dummy variable, are below the critical threshold for multicollinearity. Therefore, it can be concluded that there is no multicollinearity problem among the independent variables in the regression model.

**Table 4.**  
**Multicollinearity Test**

	<b>LnGDP</b>	<b>LnDistance</b>	<b>LnPPI</b>	<b>FTD</b>
LnGDP	1.000000	0.353477	-0.165896	0.063331
LnDistance	0.353477	1.000000	0.207576	-0.361308
LnPPI	-0.165896	0.207576	1.000000	-0.204385
FTD	0.063331	-0.361308	-0.204385	1.000000

Source. Data processed

Based on Table 5 of heteroskedasticity test, the calculated Chi-square value (14.84356) is greater than the Chi-square critical value (9.49) at 4 degrees of freedom and a 5 percent significance level. This result leads to the rejection of the null hypothesis, indicating the presence of heteroscedasticity in the regression model. Therefore, the heteroscedasticity problem is addressed by applying the White cross-section method in the coefficient covariance estimation using EViews.

**Table 5.**  
**Heteroskedasticity Test**

<b>Chi Square Value</b>	<b>Chi Square Critical Value</b>	<b>Conclusion</b>
14.84356	9.49	There is heteroskedasticity

Source. Data processed

Based on Table 6 of autocorrelation test, the calculated Chi-square value (9.29176) is greater than the Chi-square critical value (5.99) at lag length 2 and a 5 percent significance level. This result leads to the rejection of the null hypothesis, indicating the presence of autocorrelation in the regression model. Therefore, the heteroskedasticity problem is addressed by applying the White cross-section method in the coefficient covariance estimation using EViews.

**Table 6.**  
**Autocorrelation Test**

<b>Chi Square Value</b>	<b>Chi Square Critical Value</b>	<b>Conclusion</b>
9.29176	5.99	There is autocorrelation

Source. Data processed

In addition, based on the Chow test results, the probability value of 0.8974 is greater than the 5 percent significance level, indicating that the Common Effect Model is more appropriate than the Fixed Effect Model for panel data estimation. Furthermore, the Hausman test produces a probability value of 0.1180, which is also greater than the 5 percent significance level. This result suggests that the Random Effect Model is more appropriate than the Fixed Effect Model. In addition, since the number of cross-sectional observations is larger than the number of time-series observations, the Random Effect Model is considered more efficient and therefore more suitable for this study.

### **Random Effect Model Regression**

Panel data regression for the gravity model is conducted in three stages, namely (1) using a sample of all countries, (2) using a sample of countries that have free trade agreements with Indonesia, (3) using a sample of countries that do not have free trade agreements with Indonesia. The three stages of regression are conducted to see the highest coefficient of whether a free trade agreement is more profitable or not.

**Table 7.**  
**The Comparison Result of Random Effect Model**

<b>First Stage (All countries) df = 185</b>					
<b>Independent Variables</b>	<b>Coefficient</b>	<b>t-value</b>	<b>t-critical value</b>	<b>Probability</b>	<b>Conclusion</b>
LnGDP	0.731285	18.04701	1.97287	0.0000	H <sub>0</sub> rejected
LnDistance	-1.473442	-16.72059	-1.97287	0.0000	H <sub>0</sub> rejected
LnPPI	-0.057161	-0.359131	-1.97287	0.7189	H <sub>0</sub> accepted
FTD	-0.004373	-0.043892	-1.97287	0.9650	H <sub>0</sub> accepted

  

<b>Second Stage (Countries that have free trade agreement) df = 91</b>					
<b>Independent Variables</b>	<b>Coefficient</b>	<b>t-value</b>	<b>t-critical value</b>	<b>Probability</b>	<b>Conclusion</b>
LnGDP	0.649235	9.611838	1.98637	0.0000	H <sub>0</sub> rejected
LnDistance	-1.465306	-12.66994	-1.98637	0.0000	H <sub>0</sub> rejected
LnPPI	0.443766	0.728225	-1.98637	0.4683	H <sub>0</sub> accepted

  

<b>Third Stage (Countries that do not have free trade agreement) df = 91</b>					
<b>Independent Variables</b>	<b>Coefficient</b>	<b>t-value</b>	<b>t-critical value</b>	<b>Probability</b>	<b>Conclusion</b>
LnGDP	0.825060	15.80581	1.98637	0.0000	H <sub>0</sub> rejected
LnDistance	-1.438199	-9.934776	-1.98637	0.0000	H <sub>0</sub> rejected
LnPPI	-0.126903	-0.808281	-1.98637	0.4210	H <sub>0</sub> accepted

Source. Data processed

Based on the regression results of the estimated gravity model on Table 7, Indonesia's international trade is influenced by the GDP of partner countries and geographical distance between countries. The regression results from the first, second, and third estimation stages consistently show that GDP and distance significantly affect Indonesia's international trade, whereas the Producer Price Index does not have a significant effect.

The GDP of partner countries has a positive and significant effect on Indonesia's international trade, while geographical distance has a negative and significant effect. These findings are consistent with the gravity model of international trade derived from Newton's law of gravity, which states that interaction between two objects is directly proportional to their mass and inversely proportional to the distance between them (Paul R. Krugman et al., 2015). Moreover The Producer Price Index variable does not have a significant effect on Indonesia's international trade. This indicates that changes in producer prices in partner countries do not directly influence Indonesia's exports to those countries. Furthermore, the free trade agreement dummy variable also does not have a significant effect on Indonesia's international trade. This suggests that there is no significant difference between Indonesia's trade with countries that have free trade agreements and those that do not.

Furthermore, the coefficient of determination ( $R^2$ ) measures the extent to which the independent variables explain the variation in the dependent variable within the regression model. In the first-stage regression, the  $R^2$  value is 0.758901, indicating that approximately 75.89 percent of the variation in Indonesia's export values can be explained by the independent variables included in the model, while the remaining 24.11 percent is explained by other variables outside the model. In the second-stage regression, the  $R^2$  value is 0.713283, suggesting that 71.33 percent of the variation in export values is explained by the independent variables, whereas 28.67 percent is

explained by factors not included in the model. In the third-stage regression, the  $R^2$  value is 0.777647, indicating that 77.76 percent of the variation in export values can be explained by the independent variables in the model, while the remaining 22.24 percent is influenced by other variables outside the model. Then the effect of each variables to export as the reflection of Indonesia's international trade is discussed as follow.

### **The Effect of GDP**

The regression results from the first, second, and third estimation stages indicate that the GDP of partner countries has a positive and significant effect on Indonesia's international trade. This finding is consistent with the gravity model of international trade derived from Newton's law of gravity, which suggests that trade interactions between countries increase as their economic size becomes larger. Therefore, countries with higher GDP tend to engage in greater trade activities with Indonesia. Based on the GDP data of Indonesia's major trading partners, the United States, China, and Japan represent the countries with the largest economic size. Countries with large economies tend to have higher production capacity and greater import demand to support domestic production activities. As a result, these countries dominate Indonesia's trade shares compared to other partner countries.

The United States and Indonesia strengthened their trade cooperation through the *Trade and Investment Framework Agreement* (TIFA) in 1996. Currently, Indonesia is one of the important suppliers of imported goods to the United States. Indonesia's major export commodities to the United States in 2018 included knitted apparel, woven apparel, rubber, footwear, and mineral fuels. Indonesia and China established closer trade relations through the *ASEAN–China Free Trade Area* (ACFTA), initiated in 2002 and fully implemented in 2010. Indonesia's main export commodities to China include palm oil, manufactured products, and other primary commodities. Until 2013, Indonesia recorded a trade surplus with China, although the surplus gradually declined afterward. Economic relations between Indonesia and Japan have existed since 1958 and were further strengthened through the *Indonesia–Japan Economic Partnership Agreement* (IJEPA) in 2008. The agreement included tariff reductions of approximately 80 percent for Indonesian export products. Following the implementation of this agreement, Indonesia's trade performance with Japan improved, particularly in agricultural products, apparel, footwear, and wood products. This result was supported as stated on (Chaney, 2011) (Alleyne & Lorde, 2014)

### **The Effect of Geographic Distance**

The regression results from the first, second, and third estimation stages consistently indicate that geographical distance has a negative and significant effect on Indonesia's international trade. This finding is consistent with the gravity model of international trade derived from Newton's law of gravity, which suggests that trade interactions between countries are inversely related to the geographical distance between them. Greater geographical distance increases transportation costs, leading countries to prefer trading with geographically closer partners in order to minimize logistics costs. Indonesia's trading partners that are relatively closer compared to the average bilateral distance include Australia, Russia, Hong Kong, India, Japan, South Korea, Malaysia, Myanmar, Oman, Pakistan, the Philippines, Saudi Arabia, Taiwan, China, the United Arab Emirates, and Vietnam.

Among these countries, Singapore, Malaysia, and the Philippines are the closest trading partners to Indonesia. Indonesia recorded trade surpluses with Malaysia and the Philippines, indicating the potential presence of trade creation effects, where high-cost domestic production is replaced by lower-cost imports from partner countries within regional trade agreements. Meanwhile, Indonesia's trade relationship with Singapore also reflects the possibility of trade diversion effects,

where import sources shift from more efficient non-member countries to partner countries within trade agreements. The negative and significant effect of distance confirms that greater geographical distance reduces trade intensity between countries. However, distance is not the only determinant of international trade flows. Advances in transportation technology, logistics infrastructure development, economies of scale, and the implementation of free trade agreements have reduced the role of geographical distance as a barrier to international trade. This result was supported as stated on (Chaney, 2011) (Mdanat et al., 2018)

### **The Effect of Producer Price Index**

The Producer Price Index (PPI) reflects the average change in prices received by producers for the goods they produce. Theoretically, price stability at the producer level is expected to encourage international trade activities. Therefore, an increase in the Producer Price Index is expected to have a negative effect on international trade, as rising producer prices indicate higher production costs that may reduce export competitiveness.

However, the regression results from the first, second, and third estimation stages consistently indicate that the Producer Price Index does not have a significant effect on Indonesia's international trade. This finding may be explained by the data of producer price index on study period that show there were no substantial fluctuations in the Producer Price Index among Indonesia's trading partner countries. The relatively stable movement of producer prices during the observation period may explain why the Producer Price Index does not significantly affect Indonesia's international trade flows.

### **Free Trade Dummy**

The free trade agreement dummy variable is constructed to classify Indonesia's trading partner countries based on whether they have free trade agreements with Indonesia. A value of 1 is assigned to 19 countries that have free trade agreements with Indonesia, while a value of 0 is assigned to the remaining 19 countries without such agreements. Based on the regression results, the free trade agreement dummy variable does not show a significant difference between Indonesia's trade with partner countries that have free trade agreements and those that do not. This finding suggests that the existence of free trade agreements does not directly improve Indonesia's international trade performance during the observation period.

Nevertheless, free trade agreements still provide potential benefits for Indonesia's international trade. They may serve as a strategy to expand trade with geographically distant partner countries. Although transportation costs tend to be higher for distant markets, the elimination of trade barriers such as tariffs can enhance the competitiveness of Indonesia's export products in international markets. Furthermore, free trade agreements may support improvements in domestic production efficiency, particularly when domestic industries face limitations in economies of scale or production efficiency. Through the reduction of trade barriers, domestic producers can gain greater access to international markets and improve their export competitiveness.

### **The comparison between free trade and non-free trade countries**

The regression results present the estimated intercepts and coefficients for each variable across the three stages of gravity model estimation. The comparison across estimation stages is used to identify differences in Indonesia's trade performance between free trade agreement partner countries and non-free trade agreement partner countries. The regression constants and coefficients are reported in Table 8.

**Table 8.**  
**Constant and Coefficient of Each Stage Regression**

	<b>All trade countries</b>	<b>Countries that have free trade</b>	<b>Countries that do not have free trade</b>
Constant	0,819716	0,657980	-1,724283
LnGDP	0,731285	0,649235	0,825060
LnDistance	-1,473442	-1,465306	-1,438199
LnPPI	-0,057161	0,443766	-0,157003
FTD	-0,004373		

Source. Data Processed

Based on Table 6, the intercept value in the first-stage regression for all trading partner countries is 0.819716. In log-linear gravity models, the intercept primarily represents the baseline level of trade when other explanatory variables are held constant, while the main interpretation focuses on the magnitude and direction of the explanatory variables' coefficients.

### **Countries that have free trade agreement**

Furthermore, the intercept value for the regression involving free trade agreement partner countries (0.657980) is higher than that for non-free trade agreement partner countries (-1.724283), indicating differences in trade characteristics between the two groups of partner countries. Based on the observed trade data, Indonesia recorded trade surpluses with 10 out of the 19 free trade agreement partner countries, including Malaysia, Myanmar, the Philippines, the Netherlands, Italy, Pakistan, Poland, Spain, Turkey, and Vietnam, while trade deficits were recorded with the remaining nine countries.

The coefficient of GDP in the regression for free trade agreement partner countries is 0.649235, which is lower than that obtained from the regression using the full sample of trading partners. This suggests that free trade agreement partner countries are not necessarily those with the largest economic size among Indonesia's trading partners. In addition, several geographically closer free trade agreement partner countries, such as Singapore, Australia, Japan, South Korea, and China, still recorded trade deficits with Indonesia.

### **Countries that have free trade agreement**

The intercept in the regression for non-free trade agreement partner countries is negative. In a log-linear gravity model, the intercept represents the baseline level of trade when other explanatory variables are held constant rather than the actual value of trade. The negative intercept indicates differences in trade characteristics between non-free trade agreement partner countries and free trade agreement partner countries.

The coefficient of LnGDP in the third-stage regression for non-free trade agreement partner countries is 0.825060, which is higher than the corresponding coefficients in the first and second regression stages. This suggests that the economic size of partner countries has a stronger influence on Indonesia's trade with non-free trade agreement partner countries. For example, the United States, which is one of the non-free trade agreement partner countries, has the largest GDP and represents one of Indonesia's major export destinations compared to several free trade agreement partner countries. This indicates that economic size remains an important determinant of Indonesia's trade even in the absence of formal trade agreements.

The coefficient of LnDistance in the third-stage regression for non-free trade agreement partner

countries is  $-1.438199$ , which is larger in absolute value than those obtained in the previous regression stages. This finding suggests that geographical distance has a stronger effect on Indonesia's trade with non-free trade agreement partner countries. This condition may be explained by the fact that several geographically closer non-free trade agreement partner countries, such as India, Pakistan, Taiwan, and the United Arab Emirates, contribute positively to Indonesia's trade balance.

## CONCLUSION

Based on empirical results, it can be concluded that the gravity model remains relevant in explaining Indonesia's international trade, proxied by export values. The findings confirm that the GDP of partner countries has a positive and statistically significant effect on Indonesia's exports, supporting the fundamental assumptions of the gravity model. However, this study also provides additional insights by showing that the Producer Price Indeks (PPI) does not have a statistically significant effect on trade flows. This suggests that production-side price competitiveness may not be a dominant determinant of Indonesia's bilateral trade compared to economic size and geographical factors. Furthermore, the insignificant effect of the free trade agreement dummy indicates that the presence of trade agreements alone does not necessarily enhance export performance, highlighting the importance of other structural factors such as competitiveness and trade composition. These findings contribute to the literature by emphasizing that, in the context of Indonesia, traditional gravity variables remain more influential than extended variables such as price indicators and institutional trade arrangements.

Based on the findings of this study, several policy recommendations can be proposed. First, future studies applying the gravity model of international trade are encouraged to incorporate additional explanatory variables related to trade facilitation, such as the logistics technology and transportation infrastructure. Second, the Indonesian government should strengthen trade information dissemination through the role of trade attaches in partner countries in order to identify potential export markets and strategic commodities that can enhance Indonesia's export performance. Third, export supporting facilities should be improved through the optimization of trade agreements with partner countries and through policies aimed at increasing domestic production efficiency to enhance export competitiveness. Finally, Indonesia should adopt a more selective and strategic approach in engaging in free trade agreements with partner countries that provide greater potential for generating trade surpluses.

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