The Analysis of Indonesia's Coal Export Value Using the Gravity Model

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Abstract. This study aims to prove whether the variables of Indonesia's GDP, trading partner countries' GDP, distance, inflation, and the real exchange rate in the gravity model proved significant in explaining the value of Indonesia's coal exports in the long and short term. This study used the value of Indonesia's coal exports as the dependent variable, while the independent variables include Indonesia's GDP, Indonesia's trading partner countries' GDP, distance, inflation, and real exchange rate. The type of data used in this study is secondary data in the form of time series data, with a time period of 2010 Q4 – 2019 Q4. The analytical method used in this research is the Error Correction Model (ECM). The results of this study indicates that Indonesia's GDP, GDP of Indonesia's trading partner countries, distance, inflation, and the real exchange rate have a significant effect on the value of Indonesian coal exports.

Keywords: Coal exports, GDP, distance, inflation, real exchange rate, Error Correction Model (ECM).

1 Introduction

Export is the activity of shipping goods from the customs area as referred to in the provisions governing customs [1]. Exports can be said to be the locomotive or driving force in economic activity, so that increasing exports is very important for a country, where increasing exports will increase the economic growth.

As the driving force in economic activity in a country[2], based on the Central Statistics Agency' data, in Indonesia's trade balance, in this case the non-oil and gas sector, the data shows the largest contribution compared to the oil and gas sector. The graph below shows Indonesia's five main export commodities in 2010-2019.
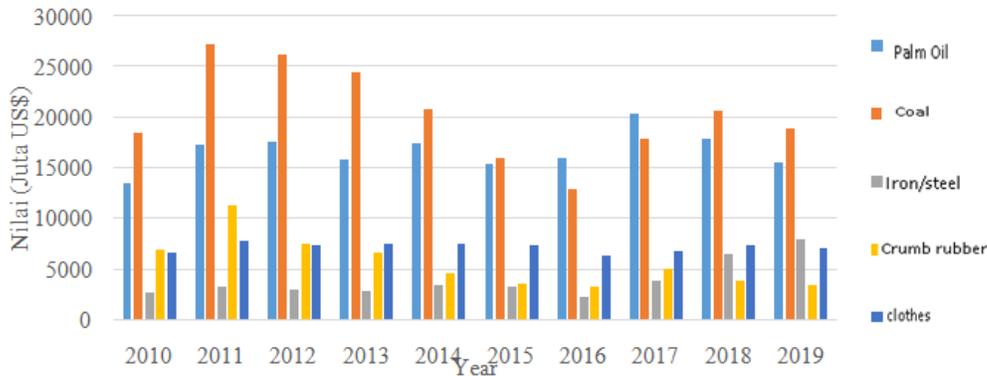
Fig. 1. Five Leading Commodities in Indonesia in 2010-2019.

Based on Figure 1 above, there are five leading Indonesian export commodities in the last ten years, and coal has been Indonesia's main export commodity for the last ten years. Then followed by palm oil, iron/steel, clothing, and crumb rubber.Coal is one of the mineral fuel commodities which is traded between countries. Coal is the fastest growing energy source in the world compared to oil, gas, water, nuclear, or other substitute resources. Coal has played a very important role for centuries, not only for generating electricity, but coal is also the main fuel in producing cement, and steel, as well as other industrial activities.Coal is an important source of energy for the world, where 40% of electricity worldwide comes from coal [3]. The following Table 1 presents data on the largest coal producing countries in the world.

Table 1. The Largest Coal Producer Country in the World (Million Tons)

Country	2016	2017	2018	2019	Contribution 2019 %
China	3410,6	3524,1	3683,1	3720,2	47,6
India	689,8	711,7	765,1	783,7	9,5
United States	660,8	702,7	685,4	640,4	8,5
Indonesia	456,2	461,2	548,6	616,2	6,9
Australia	502,6	484,1	485,5	550,1	6,1
TOTAL					78,6
World	7491,3	7704,4	8012,8	8034,5	100

In this research, distance is one of the important factors in Indonesia's international trade activities, especially in export activities. It implies that when the geographical distance between two trading countries is getting farther, then there will be less trade activities carried out by the two countries.

The gravity model was first introduced by Tinbergen which was formulated based on Isaac Newton's model of gravity. Tinbergen states that the interaction between two objects is proportional to their mass in this case Gross Domestic Product (GDP), and inversely proportional to the distance between the two countries [4].The results by Mdanat indicates that the Gross Domestic Product (GDP), and dummy trade agreements have a positive and significant effect on international trade, while distance has a negative and significant effect on international trade [6].

With the problems faced by Indonesia, in this case international trade, especially export activities, Indonesia has experienced a trade balance deficit, in the past two years. Or it can say that the value of Indonesia's imports is far greater than the value of exports. Although the condition is not so severe, if the condition continues, then the Indonesia's trade balance will experience a continuous deficit.

In terms of coal exports, the number of demands for coal from Indonesia's main export destination countries is unstable from year to year, and the value fluctuates. So that this condition is felt to be not optimal considering that Indonesia still has a very large opportunity to become a coal exporter in the world.Therefore, this study aims to analyze the value of Indonesia's coal exports with Indonesia's trading partner countries in 2010 Q4-2019 Q4 using the gravity model, as well as examine what factors affect Indonesia's coal exports with these trading partner countries.

2 Literature Review

Indonesia's export activities with Indonesia's trading partner countries are the result of an agreement made by the two countries to meet each other's needs, and benefit from the trade. To strengthen this research, the writer presents the theories used in the research, such as mercantilism theory, absolute advantage theory, comparative advantage theory, and Hecksher-ohlin theory.From the theory of international trade, such as, the theory of mercantilism explains that in international trade there are needs for government intervention to control economic activity [5]. While the theory of comparative advantage in international trade can occur by specializing products between the two countries, then the Hecksher-Ohlin theory appears to refine the classical theory which states that there is an endowment factor (abundance of labor or abundance of capital) in specialization [5].

International trade occurs in a condition where a country has an excess of production, while there are other countries that have a shortage of production or it can be said that the country cannot meet domestic demand, so this will create trade between the two countries [8]. Therefore, a model was developed that can answer these conditions. The gravity model was first developed by Tinbergen, according to which the relationship between two objects is proportional to their mass (GDP), and inversely proportional to the distance between each country [4]. So in this study, gravity model was used to measure the value of Indonesia's coal exports with trading partner countries.

3 Methodology and Data Analysis

The data that were used in this study are Gross Domestic Product (GDP), distance, inflation, the real exchange rate and the value of Indonesian coal exports, in which the data is secondary and quantitative data. In this study, secondary data is in the form of time series, started from 2010 Q4-2019 Q4. Data processing carried out in this study using the E-Views application program, and the analysis used in this study using the Error Correction Model (ECM) . Based on the law of gravity, we can use the law of gravity to measure the economic interactions between regions. The following is the equation of the economic interaction [7].

$$X_{ij} = G \frac{y_i y_j}{D_{ij}} \qquad (1)$$

The above equation explains that, X_ij as an economic interaction between one region and another. While G is a gravitational constant, y_is the Gross Domestic Product of region i, and y_j is the Gross Domestic Product of region j, and D_ij is the distance between one region (i) and region (j). In this case, to make it easier for this research, the equation will be changed in the form of an econometric model, as follows:

$$X_{ij} = G + y_i + y_j + D_{ij} \qquad (2)$$

So in this case the general form of the gravity model in the econometric equation can be formulated as follows:

$$\text{LogEKS(India)}_{it} = \beta_0 + \beta_1 \text{LogPDB}_{it} + \beta_2 \text{LogPDB}_{jt} + \beta_3 \text{LogDIS}_{ijt} + \beta_4 \text{LogINF}_{it} + \beta_5 \text{LogREER}_{jt} + \varepsilon_{ijt}$$
$$(3)$$

$$\text{LogEX(Amerika)}_{it} = \beta_0 + \beta_1 \text{LogGDP}_{it} + \beta_2 \text{LogGDP}_{jt} + \beta_3 \text{LogDIS}_{ijt} + \beta_4 \text{LogINF}_{it} + \beta_5 \text{LogREER}_{jt} + \varepsilon_{ijt}$$
$$(4)$$

In this case, the EKS symbol describes the value of Indonesia's coal exports to each trading partner country. GDPi explains Indonesia's Gross Domestic Product, GDPj Gross Domestic Product of each trading partner country (India and America), Next DISj, explains the distance between Indonesia and each trading partner country, INFi, explains the inflation rate in Indonesia. Then REERj, explains the real exchange rate of each trading partner country

4 Research Result and Discussion

This study used the cointegration test with the Engle-Granger (EG) cointegration test method. The long-term and short-term equations are the value of Indonesia's coal exports as the dependent variable and Indonesia's GDP, GDP of Indonesia's trading partner countries, distance, inflation, and the real exchange rate as independent variables.

Table 2. Long-Term ECM Regression Estimation Results for India

Variable	Coefficient	Std. Eror	t-statistik	Prob.	R^2	Adjusted R^2	F-statistic
C	-269,115	21,200	-12,693	0,0000	0,953	0,945	127,038
Log(GDPi)	7,3990	0,5457	13,558	0,0000			
Log(GDPj)	-2,1961	0,4123	-5,3262	0,0000			
Log(DIS)	12,057	0,9508	12,680	0,0000			
Log(INF)	0,8357	0,2692	3,1044	0,0041			
Log(REER)	7,3527	0,9781	7,5169	0,0000			

Based on Table 2 above, it can be seen that the estimation results of the long-term ECM regression showed by the value of t-statistics, in which all variables (GDPi) of Indonesia, (GDPj) of trading partner countries, distance, inflation, and the real exchange rate, are used in this study has a significant effect or in the sense that the probability value is $< = 0.05$ or with a 95% confidence level.

In addition, the unit root test on ECT shows the ADF t-statistic value which is -3.097 smaller than the critical value or critical value, and the probability value is less than 5%, then the residual or ECT from the estimated regression equation is stationer. This shows that the equations in Table 2 are cointegrated. So it can be concluded that there is a long-term relationship between the independent variables (GDP) of Indonesia, (GDP) of trading partner countries, distance, inflation, and the real exchange rate on the dependent variable of Indonesia's coal export value [10].

Table 3. Short-Term ECM Regression Estimation Results for India

Variable	Coefficient	Std. Eror	t-statistik	Prob.	R^2	Adjusted R^2	F-statistic
C	-245,14	13,224	-18,537	0,0000	0,980	0,975	238,133
Log(GDPi)	6,7464	0,3823	17,645	0,0000			
Log(GDPj)	-1,9033	0,2810	-6,7732	0,0000			
Log(DIS)	10,992	0,5896	18,642	0,0000			
Log(INF)	0,7047	0,1716	4,1071	0,0003			
Log(REER)	6,4011	0,6262	10,221	0,0000			
ECT (-1)	0,8575	0,1055	8,1251	0,0000			

Furthermore, based on Table 3 above, For India, it states that in the short term the ECM regression estimation results state that all variables (GDP) of Indonesia, (GDP) of trading partner countries, distance, inflation, and the real exchange rate, which are used in this study have a significant effect on the export value to Indonesian coal, with a 95% confidence level, in the short term.

Based on Table 4 below, it is stated that the estimation results of the ECM regression can be seen from the t-statistic value, where all Indonesian variables (GDP), distance, inflation, and real

exchange rates, used in this study have a significant effect or in terms of probability values. $< = 0.05$ or with a 95% confidence level. Meanwhile, the variable (GDP) of trading partner countries has a significant effect or in the sense that the probability value is $< = 0.010$ or with a 90% confidence level.

Table 3. Long-Term ECM Regression Estimation Results for United States

Variable	Coefficient	Std. Eror	t-statistik	Prob.	R^2	Adjusted R^2	F-Statistic
C	-773,70	163,07	-4,7443	0,0000	0,571	0,502	8,2674
Log(GDPi)	32,625	10,708	3,0466	0,0047			
Log(GDPj)	-24,326	12,717	-1,9128	0,0650	***		
Log(DIS)	54,843	14,664	3,7399	0,0007			
Log(INF)	-9,939	3,4345	-2,893	0,0069			
Log(REER)	33,010	10,7162	3,0803	0,0043			

Note: *** signifikan 10%

Then, in the unit root test, the ECT shows the ADF t-statistic value which is -3.025 smaller than the critical value and the probability value is less than 5%. Then the residual or ECT from the estimated regression equation is stationer, this is shows that the equations in Table 4 are cointegrated. So it can be concluded that there is a long-term relationship between the independent variables (GDP) of Indonesia, (GDP) of trading partner countries, distance, inflation, and the real exchange rate on the dependent variable of Indonesia's coal export value [11].

Table 5. Short-Term ECM Regression Estimation Results for United States

Variable	Coefficient	Std. Eror	t-statistik	Prob.	R^2	Adjusted R^2	F-statistic
C	-657,01	127,432	-5,1557	0,0000	0,777	0,731	16,915
Log(GDPi)	24,384	7,8534	3,1049	0,0042			
Log(GDPj)	-15,801	9,3726	-1,6859	0,1025			
Log(DIS)	42,757	10,812	3,9543	0,0005			
Log(INF)	-8.931	2,9519	-3,025	0,0052			
Log(REER)	24,522	7,9373	3,0894	0,0044			
ECT (-1)	0,7296	0,1343	5,4295	0,0000			

Based on Table 5 above, it is stated that in the short term the ECM regression estimation results state that the Indonesian variable (GDP), distance, inflation, and the real exchange rate, which are used in this study significantly influence the value of Indonesia's coal exports in the short term [12]. Meanwhile, the variable (GDP) of trading partner countries has no significant effect on the value of Indonesia's coal exports in the short term to the United States.

5 Implication and Suggestion for Future Research

Based on the results of the analysis on the research and discussion that has been described, conclusions can be drawn. That Indonesia's Gross Domestic Product (GDP) has a positive and significant effect on the value of Indonesia's coal exports, this shows that the greater Indonesia's Gross Domestic Product (GDP), the greater the ability of the average population of a country to produce high yields.So that the country's ability to export coal will increase. Similarly, the distance between Indonesia and Indonesia's trading partners has a positive and significant effect on Indonesia's coal exports. This explains that the farther the distance from the trading partner countries, the greater the export of coal will be, this is in oeder to cover the very large fixed costs of the effect of distance.

Furthermore, the inflation variable has a negative and significant effect on Indonesia's coal exports. This shows that an increase in Indonesia's inflation will lead to a decrease in Indonesia's coal productivity. Thus, from the decline in productivity, it causes a decrease in Indonesia's coal exports. Then the real exchange rate variable has a positive and significant effect on Indonesia's coal exports. This indicates that an increase in the real exchange rate will lead to an increase in Indonesia's coal exports.

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