

# Impact of Gravity Model and Domestic Market Obligation (DMO) on Coal Indonesian Export

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## ABSTRACT

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This study aims to determine the effect of Indonesia's GDP per capita, GDP per capita destination country, real exchange rate, the population of the destination country, the distance between Indonesia and the country's objectives, and the variable of the Domestic Market Obligation (DMO) dummy for Indonesia's coal exports by using the gravity model. This study uses panel model regression with a research period of 2012-2022. The study results show that Indonesia's GDP per capita variable significantly negatively affects exports of Indonesian coal. GDP per capita of the destination country, the population of the destination country, the real exchange rate, and dummy DMO significantly positively affect Indonesia's coal exports. Whereas distance has no significant impact on Indonesia's coal exports

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## Introduction

The development of Indonesia's exports and imports in the non-oil and gas sector continues to increase from year to year, thus raising great expectations to contribute more to national income. Commodity non-oil and gas exports can be grouped into several commodities, namely primary and non-primary (Amrullah, 2020). Primary commodities are the result of the agricultural sector and mining. Meanwhile, non-primary commodities are in the industrial sector, such as coal, copper ore, and nickel which are export commodities major in the non-oil and gas mining sector (Dewi, 2018).

The mining sector produces various commodities, one of which is coal, which is the result of the sub-sector mining. Indonesian coal is included as the mainstay commodity in Indonesia's export activities because, in addition to this commodity, it has a comparative advantage (Yesa, et. Al. 2019). The same thing happened to the coal mining business. Indonesia has coal reserves of 0.5% of world reserves. Export amount of Indonesian coal is around 83% of its total production indicating that Indonesian coal mining orientation prioritizes market fulfillment even though the

actual demand for domestic coal is still very large (Siburian, 2012). Development of the mining sector seeks the development process of mineral and energy resources that can be utilized efficiently and optimally. Mineral resources is a non-renewable energy source updated (Fitriyanti, 2016). However on the other hand, there are many benefits from coal mining such as opening isolated areas, local sources of income, opening up employment opportunities, and as a source of foreign exchange income (Hakim, 2014).

Indonesian coal also has several advantages. In this study, international trade is specified in one commodity to measure Indonesia's determinants of exports. Indonesia is one of the largest coal producers and exporters in the world. Since 2005, when it surpassed Australian production, Indonesia has become a leading thermal coal exporter. This matter is supported by total domestic coal reserves relatively large compared to fossil resources, which amounted to 22.6 billion tons or 2.2% of the total global reserves (BP Statistical Review of World Energy, 2018). Indonesian coal in 2016 was recorded at 28,457.29 million tons which are estimated to have lasted for another 68 years. Besides coal, there are renewable energy sources with considerable potential, but resources the energy is still not optimal developed due to various constraints its application, such as high investment, efficiency relatively low technology, and geographical location and social factors of energy users ( Yudiartono. Et. Al, 2018).

Coal was originally used to power steam engines. It was still widely used as a train locomotive engine, marine ship, and various sectors, including iron and steel production and power plants, to generate nearly 40% worldwide. Asia's coal consumption is estimated to be around 65% of coal consumption world. Besides being influenced by domestic demand, coal production in Indonesia is influenced by world demand. Putra and Damanik (2017), explained that oil and gas exports, and non-oil and gas are the engine of the growth economy in Indonesia. Table 1 describes the contribution of coal and lignite mining subsector in the mining sector, and excavation is second only to the oil mining sub-sector, gas and geothermal in five years from 2014 to the year 2018.

**Table 1. GDP of Mining and Quarrying Sector at Constant Prices By Field of Business (Billion Rupiah) 2014-2018**

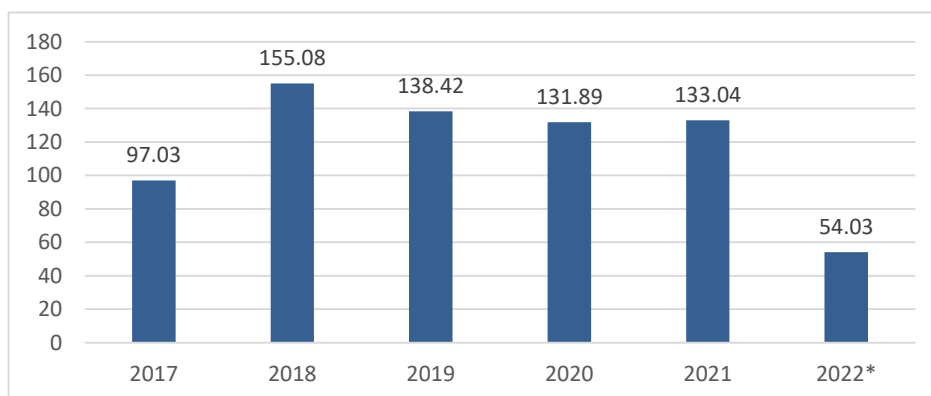
Sectors	2017	2018	2019	2020	2021
Mining and Quarrying	779.678,4	796.505,0	806.206,2	790.475,2	822.099,5
Oil Gas and Geothermal	302.653,0	298.420,1	289,980,1	272.583,2	260546,1
Coal and lignite	226.478,9	235.561,4	259.598,5	245.498,6	261.790,8
Metal Ore	95.150,4	103.719,4	88.003,4	105.829,4	129.999,6
Others	155.396,1	158.804,1	168.624,2	166.564,0	169.844,0

Source: Statistik Indonesia, 2022

Coal and lignite rank second as the mining sub-sector that contribute the most to Indonesia's gross domestic product. Based on data from British Petroleum (BP), coal production per year

country cannot be separated from domestic (domestic) demand and abroad (exports), which continues to increase. Several of the world's largest coal-producing countries can contribute to 89.26 of the total coal production in the world. The coal producer largest in the world is China, with a contribution in 2018 of 3,683 million tons or 45.96% of world production. While Indonesia ranked fourth after China, India, and the United States, which previously ranked fifth after Australia. Coal contribution to Indonesia in 2018 amounted to 548.5 million tons or 6.85% of world coal production.

Kim and Yoo (2016) did the test cause-and-effect relationship between the consumption of coal with economic growth in Indonesia for the period 1965-2010. Results estimation shows that there are two-way relationship (causality) of consumption coal to economic growth in Indonesia. The relationship implies that the increase in coal consumption directly stimulates economic growth. Korra (2017) in his research explains that based on the Granger causality test the causal relationship between coal consumption with GDP is one-way (unidirectional) namely from coal consumption to GDP. This matter because coal in Indonesia is the most consumed a lot for the electricity sector and industry. Electricity is a form of energy that is very important as one of the input production so that adequate supply can support economic activities to go well.



Source: Ministry of Energy and Mineral Resources, 2022

**Figure 1. Domestic Market Obligation (DMO) Realization 2017-2022  
2022\* : temporary data until Quartal 2**

The government has established a general policy regarding the utilization of mining products to encourage increased utilization of domestic mining for domestic needs following the mandate of Law Number 4 of 2009 concerning Mineral and Coal Mining. After the issuance of this regulation, the government followed up with Government Regulation Number 23 of 2010 concerning the Implementation of Mineral and Coal Mining Business Activities. The emergence of Government Regulation Number 96 of 2020 concerning the Implementation of Mineral and Coal Mining Business Activities states that entrepreneurs must ensure Prioritization of Domestic Interest, Production Control, and Control of Mineral and Coal Sales. This causes coal commodities to be required to comply with the Domestic Market Obligation (DMO) rules. Domestic Market

Obligation requires coal companies to prioritize domestic needs before exporting. Figure 1 show realization of Domestic Market Obligation from 2017-2022.

Arianti, Siahaan and Sihaloho (2017) in their research show that economic growth is influenced by various factors, one of which is export. High coal production also encourages Indonesia's exports of this commodity to be high. Table 2 shows Indonesia's export destinations for its main coal trading partners.

**Table 2. Destination Country of Coal Export 2017-2021**

<b>Destination</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
<b>Country</b>					
India	98,553.5	110,378.2	121,692.5	98,243.3	70,779.2
Tiongkok	48,167.4	48,135.7	65,670.5	62,492.5	108,487.2
Japan	31,421.4	28,722.9	28,436.4	26,965.1	22,978.4
South Korea	38,075.1	37,150.9	29,550.0	24,831.9	21,011.2
Taiwan	18,187.7	17,935.1	19,061.2	17,603.0	16,291.6
Malaysia	21,189.9	22,045.4	25,323.5	26,706.8	25,497.2
Philippines	18,977.9	22,595.0	27,450.8	28,060.9	30,085.8
Thailand	16,374.7	19,964.1	17,600.4	16,624.8	15,150.7
Hongkong	8,449.8	9,028.4	7,876.8	3,863.5	5,269.9
Spain	3,232.2	2,463.9	684.6	0.0	77.2
Others	16,468.8	24,704.7	31,589.1	36,155.8	29,824.8
<b>Amount</b>	<b>319,098.4</b>	<b>343,124.3</b>	<b>374,935.8</b>	<b>341,547.6</b>	<b>345,453.2</b>

Source: Central Bureau of Statistics, 2022

Based on the gas export data from 2017 to 2021 from the Central Statistics Agency above, it can be seen that Indonesia's main trading partners for coal commodities are India, China, Japan, South Korea, Taiwan, Malaysia, Philippines, Thailand, Hong Kong and Spain with three Indonesia's largest trading partners are India, China and Japan. In trading activities, they know the theory of gravity model, where the theory is taken and modified from Newton's theory of gravity. The gravity model is a model for measuring trade flows between regions or countries on a macro basis. The gravity model contains GDP as a trade pull factor, and distance in the gravity model is a proxy for transportation costs. It can be seen that the distances between the three main trading partners, although close together, have their respective distances, and the one with the farthest distance in India.

With the various backgrounds that have been explained, this research chooses the coal sector because this sector has a fairly high impact on Indonesia's economic growth and international trade. The selection of the research year was carried out with the consideration that there was an increase from year to year during that period.

## Method

The approach used in this research is quantitative. The focal point of this study is to test the established hypothesis, namely that it is suspected that there is an influence from the variables of Indonesia's GDP per capita, GDP per capita of the destination country (India, China, Japan, South Korea, Taiwan, Malaysia, Philippines, Thailand, Hong Kong and Spain), population, the value of real exchange rate, distance, and dummy monthly DMO to Indonesia's coal's exports in 2017-2022.

The method used in this research is using panel data regression analysis using panel data and processed using the Stata program. The data that has been collected is then carried out transformation into the natural logarithm of each variable which aims to equalize units into percentages. The general equation for panel data estimation is as follows:

$$\begin{aligned} \text{LnXij}_{it} = \alpha_0 + \beta_1 \text{LnGDP}_{it} + \beta_2 \text{LnGDPP}_{it} + \beta_3 \text{LnPopulation}_{it} + \beta_4 \text{LnNTR}_{it} \\ + \beta_5 \text{LnDistance}_{it} + \beta_6 \text{DDMO}_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

Where LnXij : Natural logarithm of FOB value for Coal exports (HS 271111) for Indonesia and destination countries in 2000-2017; lnGDP : Natural logarithm of Indonesia's total GDP per capita in 2000-2017; lnGDPP : Natural logarithm of the total GDP per capita of the destination country in 2000-2017; lnNTR : Natural logarithm of the real exchange rate of Indonesia and the country of destination in the year 2000-2017; lnPopulation : Natural logarithm of the destination country's population level in 2000-2017; DDMO : Domestic Market Obligation dummy variable 2000-2004 = 0 ; 2005 – 2017 = 1; X6 = process; X7 = physical evidence;  $\alpha_0$  = Constant or Intercept;  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$  = Regression coefficient; i for cross-section; t for time-series and  $\varepsilon$  = Error Term.

A significance test is a procedure used to test for error or truth from the results of the null hypothesis of the sample. The significance test used is the Coefficient of Determination (R<sup>2</sup>) which essentially measures how far the model's ability to explain the variation of variables is dependent, the value of the coefficient of determination is between zero and one. A small R<sup>2</sup> value means the ability of independent variables in explaining the variation of the dependent variable is very limited. Values close to one mean that the independent variables give almost all the information needed to predict the variation of the dependent variable the coefficient of determination for cross-sectional data is relatively low due to large variations between each observation, while for time series data (time series) usually have a high coefficient of determination. The statistical hypothesis test consists of two tests; t statistical test and a statistical test F. t statistic test show how far the influence of one explanatory/independent variable is individual in explaining the variation of the dependent variable. F statistic test indicates whether all the independent variables included in the model have a joint effect on the dependent variable with a 95% confidence level ( $\alpha = 0.05$ ). The results of the F statistical test can be seen in the ANOVA table.

## Results and Discussion

### Hausman Test

Hausman test aims to determine whether the Fixed Effect Model (FEM) or Random Effect Model (REM) is selected. If the probability of Chi-Square obtained is less than 0.05 then H0 is rejected, so the model which is more suitable to use is the Fixed Effect Model (FEM). On the other hand, if H1 is rejected, the model that should be used is the Random Effect Model (REM). From the result regression values were obtained as follows:

**Table 3. Hausman Test Result**

Test Summary	Prob
Prob>chi2	0.9217

Source : Author's Calculation

The Hausman test shows (Table 3) that the chi-square probability value is 0.9515 with a significance level =5%, then accept H0 and reject H1 (H0 = REM H1 = FEM). So that the right panel data model for data estimation is the Random Effect Method (REM) rather than Fixed Effect Method (FEM).

### Panel Data Regression Test

Based on the results of the Hausman test, it was found that the Random Effect Method (REM) model is the best model for estimating the regression equation of this study. This matter because in the panel data regression process, dummy variables are included to represent the ignorance of the actual model. Coding is done in the analysis before and after the Domestic Market Obligation (DMO) policy. However, as a consequence, the degree of freedom is reduced thereby reducing the efficiency of the parameter. To overcome this problem, error terms can be used which are called Random Effect Models (Gujarati and Porter, 2009). In addition, the reason for choosing the best random effect model used in this study is because there are several variables in this study which are in the estimation process linear log method is used to form rigid data, then the intercept formed is the average intercept of the cross sectional data and the error component which in the end represents the random deviation of individual intercepts from the mean intercept value. More supporters are the fulfillment of the requirements through the amount of cross-section data that is greater than the number of research variables (Gujarati and Porter, 2009). The random effects model approach uses a generalized least square so that the data used can be free from multicollinearity, and the characteristics of the data are constant so that the nature of the data is homoscedastic. Therefore, in this model classical assumption test was not performed. It can be seen in Table 4 that the independent variables used in this study simultaneously significant effect on the dependent variable. This can be seen from the size the probability value of the F statistic is 0.000 ( $< = 0.05$ ). In addition, it is known that the R2 value is 0.8979 which shows that the independent variable can explain the dependent variable by 89.79% and the rest is explained by

other variables outside the model. The partial significance test based on Table 4 shows the level of significance of each independent variable with a significance level of 1%, 5%, and 10%. The result explained that all the independent variables, namely the GDP per capita of the country exporters and importers, the population of exporting countries, real exchange rates of importing and exporting countries, the distance between the exporting country and the importer, and the dummy of the export policy of the exporting country significantly influence the total coal exports of the Indonesian state with trading partners main with a significance level (error rate) of 1%, 5%, and 10%.

**Table 4. Result of FEM Panel Data**

Variable	T-Stat
LnGDP	-7.724 (0.001)***
LnGDPP	6.016 (0.000)***
LnPopulation	7.565 (0.004)***
LnNTR	3.072 (0.085)*
LnDistance	0.837 (0.133)
DDMO	1.737 (0.001)
Diagnostic Tools	
R-Squared	0.898
Prob F-Stat	0.000***

Note: \*\*\*, \*\*, \* Significant for 1%, 5% and 10% respectively

The results of the research on the GDPit variable have a significant negative effect, An increase in the GDP per capita of the Indonesian population by 1% will cause a decrease in the average export value is 7.72364% by considering other factors outside the model is constant. The GDPPjt variable had a significant effect on coal exports with an average coefficient of 6.015586. This means that if the GDP per capita of the population of the destination country increases by 1%, exports will increase on average by 6.015586% by assuming other factors outside the model are constant. Population reflects the total population of the exporting country where if the population increases by 1%, exports will increase on average by 7.564882% by assuming the factors others outside the model are constant. NTR in this study has a positive coefficient value and has a significant effect on total exports. This can be explained statistically if there is an increase in NTR exporting and importing countries by 1% will cause an average increase in exports of 3.07233%, where other factors outside the model are fixed or *ceteris paribus*. The results of the research above show that distance is not significant for coal exports in Indonesia, Kabir et al., (2017) stated that not all the country will pay attention to the distance if the country (importer) requires a

commodity that is concerned. Statistically, it can be seen that the DMO dummy variable has a positive effect on Indonesia's total coal exports. With a significance level (error rate) of 1% and with a coefficient value of 1.736991. meaning, that the Domestic Market Bond (DMO) policy makes the probability of export value increase by 1.736991%.

The effect of the exporting country's GDP per capita on the export value of Indonesia's coal sector with the main trading partner has a negative effect with a significant level (error rate) of 1% and with a coefficient value of -7.72364. From these results, it can be concluded that if the GDP per capita of the exporting country increases by 1% then the effect on change in total exports with major trading partner countries decreased by 7.72364%, so on the other hand, if the GDP of the exporting country decreases by 1%, then the total exports carried out by exporting countries with major trading partners will increase by 7.72364%. Indonesia's GDP per capita has a negative effect on the export value of the sector coal with major trading partners. GDP per capita of an exporting country reflects the level of economic development in that country, where the greater the GDP per capita owned by the country, it will encourage economic development that will increase domestic production so that the capacity of the country's production increases.

The GDP per capita of the importing country has an influence on the export value of the agricultural sector in Indonesia, with a coefficient value of 6.015586. From these results, it can be concluded that if the GDP per capita of the importing country increases by 1%, the total exports will increase by 6.015586%. The GDP per capita of the importing country has an influence on the total exports of the coal sector in the country Indonesia with its main trading partners in accordance with the research that has been carried out by Alim's (2019) where GDP per capita is an instrument to measure the power buy a country if the country experiences an increase in GDP per capita it will increase also state spending. This result also follows Khayat (2019) The study concluded that GDP per capita for source and population for source and destination countries were significant and signed correctly.

The country's population is an indication of the development of Indonesia's coal exports. Based on the results of the study obtained a coefficient of 7.564882 and has a positive effect significant with an error rate of 5% of the total coal exports in Indonesia. Population variables indicate that countries with large populations have a volume high trade and vice versa. Wardani dan Mulatsih (2017) found countries with lower populations tend to have lower trading volumes. Increasing population in the destination country exports will shift the demand curve to the real exchange rate between the destination country's currency and Rupiah has a positive effect significant with a coefficient value of 3.07233. This means that if there is an increase in the exchange rate by 1% it will increase coal exports by 3.07233%. Exchange rate appreciation causes the price of domestic



goods (in the destination country) to tend to be relatively more expensive compared to the price of imported goods, so the demand for imported goods increases.

In theory, the greater the distance, the less trade between countries that happened. However, the study by Kabir et al., (2017) stated that not all the country will pay attention to the distance if the country (importer) requires a commodity that is concerned. From the results of the statistical test of panel data, it is obtained distance results have a positive and insignificant effect with a coefficient of 0.8372287. From the results of the above research can be concluded that the distance between the exporting country and the importers has no influence on the total exports of coal commodities. The results in this study indicate that the distance is not significant so it can be it is said that the gravity model theory is not applicable or irrelevant in the Indonesian coal trade with the main trading partners. DMO is an illustration of the trade influence of Indonesia's coal sector with its main trading partner from the results of panel data statistical tests, the results obtained that there is a positive influence between Dummy DMO on total exports of the Indonesian coal sector with significance level (an error rate of 1% and with a coefficient value of 1.736991. That is, the Domestic Market Obligation (DMO) policy makes the probability of export value increase by 1.736991%. From the results above, it can be concluded that after the enactment of a trade DMO policy on the coal sector in Indonesia with partner countries major trades increased. Although regardless of the enactment of pricing for the DMO policy is below the market price, but does not create interest in the exploitation of coal has decreased and has no impact on coal exports in Indonesia. The DMO dummy in the panel data test has a positive effect on exports is an illustration of the effect of the implementation of government policies on trade in the Indonesian coal sector by the major trading partner. This result follow Alims (2019) which the Domestic Market Obligation (DMO) policy has negative impact on coal's export.

## **Conclusion**

Variables of the importing country's GDP per capita, Population, Real Exchange Rate, Distance, and Dummy DMO, have a significant positive effect on coal exports in Indonesia. Variable GDP per capita of the exporting country has a significant negative effect on coal commodity exports while the distance variable as a proxy for the theory of gravity does not significantly affect Indonesian coal exports. From the research results it can be implied that trade liberalization between Indonesia with coal's trading partner represented by the proven Openness variable effective influence on Indonesian exports and export trading partners. This can considered for Indonesia when wanting to increase trade cooperation with trading partners. Indonesia with Trading Partners can improve broader trade cooperation because it can trigger an increase exports for both Indonesia and trading partners. But this is just one indicators that can be used as a reference.

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