Jejak Vol 12 (2) (2019): 466-481 DOI: https://doi.org/10.15294/jejak.v12i2.19229

JEJAK

Journal of Economics and Policy

http://journal.unnes.ac.id/nju/index.php/jejak

Triangle Analysis: Carbon Emissions, Economic Growth, And Poverty In Indonesia

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Permalink/DOI: https://doi.org/10.15294/jejak.v12i2.19229

Received: May 2019; Accepted: July 2019; Published: September 2019

Abstract

This research tried to investigate the correlation between carbon emissions on poverty levels and the economic growth effect toward the level of poverty. This study utilizes secondary data-set time series from 2010 to 2016 across 34 provinces in Indonesia. The source of the data is from the Central Statistics Agency (BPS) and German watch. The data estimation uses a panel regression by Fixed Effect Model and processed using E-views software version 8.0. The results of the study reveal that 1) effect of carbon emission is positive but not significant on poverty levels; 2) economic growth affects the poverty level positively significant. Thus, the economic development that results in pollution (i.e., industrialization, transportation) should more controlled and in line with sustainable development goals (SDGs). Therefore, there are needs for the government to put effort into designing and making policies related to decreasing emissions. Furthermore, the government should also involve all stakeholders to participate in contributing to economic-environmental friendly. They have to increase their awareness in carrying out the policies set by the government and paying more attention to the waste screening process.

Key words : economic growth, carbon emission level, poverty level, panel data

How to Cite: Suryanto, S., Radhianita, A., & Juwita, A. (2019). Triangle Analysis: Carbon Emissions, Economic Growth, And Poverty In Indonesia. JEJAK: Jurnal Ekonomi dan Kebijakan, 12(2). doi:https://doi.org/10.15294/jejak.v12i2.19229

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ISSN 1979-715X

INTRODUCTION

The increasing of Gross Domestic Regional Product (GRDP) does not always follow the community of livelihood. Improvement of livelihood can be measured by the index of environmental quality and economic growth. When the quality of economic growth have successfully achieved, it determines the improvement of livelihood. A study by Kuncoro (2010) believed that the problems that occurred in developing countries as the effect of growth such as unemployment, poverty, and inequality in income distribution could be reduced by increasing income per capita.

Economic growth is the percentage change in GDP over time (Madura: 2007). Economic growth is a measure of gross regional domestic growth per capita as a measure to see the development of people's welfare (Pangkiro: 2016). According to Schumpeter in Arsyad (2010), economic growth is the ability of the community to increase output due to the increasing number of production factors used in the production process, without any changes in the production technology itself. Thus, it can be concluded that economic growth is the development of economic activities in an exact area generated from the gross domestic product calculation process.

Statistical Bureau released the data on economic growth in Indonesia. Since 2015 until 2017 shows that economic growth Indonesia has raising. Economic growth of Indonesia in 2015 is 4.88 percent, 2016 is 5.07 percent, and 2017 is 5,17 percent.

Growth of economic is not always be followed by reducing the poverty. According to BPS (2018), poverty is the individual inability from the economic side to cover their basic needs measured by the expenditure. According to Bappenas (2002), in Arsyad (2010), poverty is defined as the inability of a person or group to carry out their life as a standard of living that as a human being. According to Ravallion (2001) in Arsyad (2010), poverty is a condition in which a person experiences hunger, does not have a place to live, and does not have money to afford a doctor or medical treatment. Every individual or institution has a different poverty definition because it depends on the living standards in an area.

There are 2 (two) types of poverty that are absolute and poverty. Absolute poverty is the inability of individuals to fulfill basic needs with the income they have. According to Todaro and Smith (2003), in Arsyad (2010), this concept is intended to determine the minimum level of income to meet the physical needs of food, drinks, clothing, and housing to survive. In relative poverty, it is seen by comparing a person to his population. If a person's income is still far lower than the income of the population, it can be said that the person is poor.

The results from Stevans and Sessions (2005) if GDP over time does not effect to poverty. The changes GDP do not indicate a change in poverty. This happened due to economic expansion in 1980 at U.S.

Based on Table 1, the number of poor people tends to decrease from 2015 until 2017. The number of poor people in East Java Province is the highest, which is 16,57 percent in 2017. Central Java Province also has a high number of poor people; in 2017, there was 15,79 percent.

Table 1. Percentage of the Number of Poor People in Indonesia

Province	2015	2016	2017
Aceh	3.01	3.03	3.12
Sumut	5.29	5.23	4.99
Sumbar	1.23	1.36	1.35
Riau	1.97	1.81	1.87
Jambi	1.09	1.05	1.05
Sumsel	3.90	3.95	4.09
Bengkulu	1.13	1.17	1.14
Lampung	3.86	4.11	4.08
Babel	0.23	0.26	0.29
Kep. Riau	0.40	0.43	0.48
DKI Jakarta	1.29	1.39	1.48
Jabar	15.73	15.01	14.20
Jateng	15.80	16.19	15.79
DIY	1.70	1.76	1.75
Jatim	16.75	16.71	16.57
Banten	2.42	2.37	2.63
Bali	0.77	0.63	0.66
NTB	2.81	2.83	2.81
NTT	4.07	4.14	4.27
Kalbar	1.42	1.41	1.46
Kalteng	0.52	0.50	0.52
Kalsel	0.66	0.66	0.73
Kaltim	0.74	0.76	0.82
Kalut	0.14	0.17	0.18
Sulut	0.76	0.72	0.73
Sulteng	1.43	1.49	1.59
Sulsel	3.03	2.87	3.11
Sultengg	1.21	1.18	1.18
Gorontalo	0.72	0.73	0.76
Sulbar	0.54	0.53	0.56
Maluku	1.15	1.20	1.21
Malut	0.25	0.28	0.29
Papua Barat	0.79	0.81	0.80
Papua	3.15	3.30	3.42
Indonesia	100.00	100.00	100.00

Source: Statistical Breau, 2018

The government usually relies on the amount of per capita income from the population that considered a benchmark in the assessment that it has advanced or previously increase the economy of a country. Income in a country can be referred to as the process of a country's economic success. The increasing Gross Domestic Product (GDP) is usually used as a reference to see economic growth in an area from time to time. The success of a country's economy can be seen through increasing output over time (Todaro: 2005 in Ma'ruf and Wihastuti: 2008).

Unfortunately, the impact in economic growth to reducing poverty depends on the Gini Index and the participation of people in economic growth. Some facts, although countries or regions have the same growth rate, and they have unequal distributions level would be a different result in reducing poverty (Herman, 2014). When there is high-income inequality in an area, the poor will become more miserable.

Saragih (2004) in Bangun and Hutagaol (2008) consider that the industrial sector is capable of coping with economic problems that are usually believed by developing countries. A large number of industries will also affect the number of labor absorption. Thus, the number of workers absorbed in the high industrial sector will have a positive relation to the declining unemployment rate. The existence of industrial estates is expected to absorb workers. Thus, it could provide income for the community. The existence of the industrial sector can strengthen national economic stability (Adisasmita 2013). Therefore, the industrial sector has an essential role in

economic growth in a country. The decreasing unemployment number has an impact on the decline in poverty because people can generate income. The increase in per capita income is one indicator of economic growth.

The industrial sector has not only many positive impacts on the economy but also negative impacts both directly and indirectly. Firms often ignore environmental problems when the production process takes place. It will lead to a decrease in environmental quality due to the high amount of exhaust emissions produced from the production process. According to Akhadi (2014), the application of modern technology in industrial activities would accelerate development. It will have an impact on the environment around industrial estates, where environmental quality has decreased due to the large number of pollutants that pollute the air.

Carbondioxide (CO_2) gas produced from the combustion of the production process in the industrial sector is poisonous to be inhaled. Even when the amount of CO_2 gas exceeds 10%, it can cause impaired vision, hearing, tremors, which will eventually faint (Supardi: 2003). CO_2 gas is also formed when carbon monoxide (CO) that exposed by sunlight due to the presence of carbon monoxide (CO) gas whose specific gravity is higher than air and reacts with its Oxygen (Setyono: 2015). Therefore, similar to CO gas, CO_2 gas is a colorless and odorless gas.

A prosperous society can be achieved by an integral and comprehensive social process, both in the form of economic growth and social change (Supardi: 2003). Most economic activity often ignores the performing of environmental sustainability. Project waste often pollutes and spread the environment. People should improve their standard of living in the community. However, the community can be infected by the disease due to the lack of attention to the management of the project waste. Supardi (2003) stated that the prosperity and welfare of the community could be achieved optimally in complex environmental management and economic development.

Carbon dioxide (CO_2) gas is a component contained in the air. CO_2 gas is naturally present in the air as a product of combustion and oxidation (Harrington: 2003). In the proper circumstances, carbon dioxide is used by plants to carry out photosynthetic activities. However, if the concentration of CO_2 in the air exceeds the safe level, it will have a negative impact on the environment.

A large number of industries in urban areas induce high yield of exhaust gases resulting from the production process of the industrial sector. CO_2 gas from production processes in the industrial sector is poisonous to breathe. A 10% exceed in the amount of CO_2 gas can cause impaired vision, hearing, tremor, which eventually will faint (Supardi: 2003). In addition, CO_2 gas can also be formed when the density of carbon monoxide (CO) is higher than the air reacts with Oxygen and exposed by the sunlight (Setyono: 2015).

A discussion about the Environmental Kuznets Curve (EKC) stated that the discussion about economic growth and decreasing of quality environment is like the “u reverse” alphabet. It is mentioned that in the beginning, economic growth will increase environmental pollution, then the level of pollution is going to increase slowly, and finally, it is going to be declined.

Investigation in China conducted by Wang *et al.* (2016) concluded that the increasing of CO_2 is along with economic growth. By using granger causality and utilize panel data. By using granger causality and panel data, the correlation between economic growth and CO_2 emission is positive. CO_2 emission affects economic growth positively significant, when CO_2 increasing will be followed by increasing of

economic growth. China, as the largest developing country, can maintain economic growth for more than three decades. Wang *et al. (2013)* in Wang *et al.* (2016) stated that fast economic growth is achieved by energy consumption that yields high CO2 emission.

Meanwhile, the results of a study by Hassan et al. (2015) have different effects than Wang (2016). Based on cointegration testing and the Error Correction Model (ECM), it can be analyzed whether the relationship between economic growth and CO2 emissions as well as economic growth and poverty has a two-way relationship or not. It turns out, the increase in CO2 in the air and economic growth has a negative and significant correlation in the short term.

Some studies proved that there was a relationship between economic growth and poverty. The high level of economic growth will decrease the poverty level. A study by Jonaidi (2012) supports the statement by using panel data in Indonesia. Economic growth affects poverty negatively significant. While poverty affects economic growth negatively significant. The increase in capital access, education quality, and health degree. The increasing of capital access, education quality, and health degree are expected to boost human resources productivity. The increasing of human resources productivity can support the increase of investment through saving enhancement. Thus, it can accelerate economic growth.

A study by Alam (2016) revealed that the level of energy consumption has a negative effect on the environment in the short and long run. Meanwhile, economic growth also affects negatively. The relationship between CO2 and population growth affect four countries statistically significant. Environmental Kuznets Curves (EKC) hypothesis implies that CO2 will decline in Brazil, China, and Indonesia. Co2 emissions will decrease over time as income increases. In India, there is a positive relationship between CO2 emission and income.

Prishardoyo dan Sebayang (2013) relied on descriptive statistics to reveal that the majority that lives in an industrial district experience the impact of the production process. Some majority revealed that there is attention from the business makers in the production process in the industrial sector in order to maintain the environmental sustainability.

METHOD

The main purpose is to determine the effect of carbon emissions and economic growth on the poverty level. This research used a cross-section dataset from 34 provinces in Indonesia and also time series data from 2010 to 2016. This study relied on panel data regression methods to investigate the effect of these variables.

This study has conducted by a quantitative research approach. In this approach, the study started with a problem formulation, theoretical reviews, hypothetical formulation, and data analysis for an estimate of the relationship between variables. In this study, a quantitative method was utilized to describe the effect of economic growth and emission levels on poverty levels in Central Java Province.

This study relied on the secondary dataset, which was generated from relevant institutions or agencies through websites, libraries, etc. to support the study. The dataset was generated from the Central Bureau of Statistics C (BPS) and Germanwatch.

This study utilized economic growth, Carbon Emissions (CO2), and poverty as the variables. Economic growth is the economic development in an area obtained from the Gross Domestic Product (GDP) calculating process. This study relied on Gross Regional Domestic

Products in Constant Prices 2010 (ADHK 2010 GRDP) in units of billions of IDR. Carbon Emissions (CO_2) are exhaust gas left over from the production process of the industrial sector in the form of carbon dioxide gas that exceeds the threshold. CO_2 can pollute the air, which can affect the components of fresh air. In this study, CO_2 emissions were obtained by proxying the value of the Climate Change and Performance Index, Province GRDP, and GDP in Indonesia. Poverty is a person's inability to fulfill their basic needs due to the minimum amount of income they receive. In this study, we used the number of poor people in units.

This study employed a panel data regression method with Fixed Effect Model. Due to the limitation number of data, we regress by panel data techniques. This techiques is such as regression that combines time series and cross-sector data (cross-section). According to Rahayu (2012), by using a panel data model, the number of observations increases the degree of freedom and reduces collinearity between explanatory variables and then improves the efficiency of econometric estimation. In the Fixed Effect Model method, it is known that the variable level of CO_2 emissions and poverty levels significantly affect economic growth at 5% significance level.

RESULTS AND DISCUSSION

Before further discussion, first, the researcher tested the data to be used with the unit root test. The data processed had to be stationary data. Table 1 is the Probability of the results with 6 methods and 3 levels (level, 1st diff, 2nd diff).

Table 2. Root Unit Test Probability Results

Variable	Prob (PE, TE, TK)		
Method	**Level***	**1st diff****	**2nd diff***
Levin, Lin, Chu	0.995	0.000	1.000
Breitung t-stat	0,186	0,026	0,405
Im, pesaran, shin	0,000	0,000	0,000
Fisher-ADF Chi-Square	0,000	0,000	0,000
PP-Fisher Chi-Square	0,000	0,000	0,000

The results show that the data could be processed or said to be stationary with the levin, lin, Chun method on the 1st diff with a After having a unit root test done, a correlation test could be performed to see how strong the correlation between the three variables. If the results obtained more than 0.5, it could be said that the correlation between variables is strong.

The number of poor people variable had a weak correlation on the GRDP and the CO_2 Emissions index with the GRDP of 0.36 <0.5 and CO_2 Emission Index 0.1 <0.5.

Table 3. Correlation panel

	LOG(Pov)	LOG(GDRP)	CO_2
LOG(Pov)	1	0.36	0.18
LOG(GDRP)	0.36	1	0.78
CO_2	0.18	0.78	1

The correlation relationship between GRDP was strong by showing a figure of 0.36 <0.5, but the correlation on the CO_2 emission index was strong, with a result of 0.78> 0.5. The CO_2 Emission Index showed a strong correlation to GRDP (0.78 > 0.5), but not to the number of poor people.

The panel cointegration test used the Johansen test to see the long-term relationship between variables. Therefore, this test was to find out the relationship and cointegration of poor level variables, ADH PDH 2010, and CO_2 Emission Index.

The results showed that the probability was smaller than 0.05, so that the variables above had a relationship or cointegration at the 0.05 level. In the equation above, if there is a change in one variable, then together (simultaneously), other variables will also move up or down.

Table 4. Cointegration Johansen Panel

Hypothesized No. of CE(s)	Trace Stat.	Max Eigen Stat.	Prob**
None*	197.02	21.13	0.0001
At most 1*	48.16	14.26	0.0000
At most 2*	14.00	3.84	0.0002

*denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Determination of the best model was best used MacKinnon, White, and Davidson Test (MWD Test). The selection of empirical models were made to determine the best model used in an equation, both the linear model and the log-linear model. The best empirical model was done by comparing the values of Z1 and Z2 in the MWD test. The following are estimation results from the MWD test:

Table 5. MWD Test Estimation Results

Variable	Probability	Explanation
Z1	0,0121	Sig pada α=5%
Z2	0,0000	Sig pada α=5%

Source: processed data

Table 5 shows that the Probability value of Z1 added as an independent variable to the MWD linear model estimated at 0.01. The probability value of Z1 is smaller than the significance level of 5%, meaning that the value of Z1 is statistically significant. These results mean that Ho was rejected, which means the log-linear model was the best empirical model used in this study.

A probability value of Z2 was added as an independent variable in the MWD linear log model estimation of 0.00. The Z2 probability value is smaller than the 5% significance level, meaning that the Z2 value is statistically significant. These results indicate that Ho was accepted, which means the linear model was the best empirical model used in this study.

The probability values of Z1 and Z2 from the MWD test showed that both were statistically significant. It meant that both the linear model and the log-linear model were equally good or feasible in this study. Panel data regression estimation in this study used a log-linear model. The log-linear model made data in variables smoother.

There are three model estimation approaches for panel data regression analysis, namely: Pooled Least Square approach, Fixed Effect Model, and Random Effect Model.

The Pooled Least Square approach is the simplest approach in estimating panel data models. Panel data estimation used the Pooled Least Square approach (see appendix 5).

Table 6. Pooled Least Square

Variable	Coef.	Prob.
Cons.	27,364	0.000
Loggdrp	0,207	0.000
CO_2	3,813	0.000
R Squares	0,85	
F Stat	799.14	

Table 6 shows the results of the panel data estimation using the Pooled Least Square approach, and the coefficient of determination (R2) of 0.852 was obtained. Economic growth variables could be explained in the model of 85.23%. While the results of the F-statistic value of 799.14, where the F table value is 3.03. It means that the regression coefficient of the CO_2 emission level and poverty level has an F table value of 3.03, where it is smaller than the statistical F value of 799.14. In other words, the level of CO_2 emissions and the number of poor

people together have a significant effect on economic growth.

The estimated pooled least square approach shows that the partial regression coefficient of the CO2 emission level has a positive effect, as evidenced by the coefficient of the CO2 emission level of 3.81. The significance of t-statistics is seen from the t-statistic value of 35.53 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (35.53> 1.97), meaning that CO2 emission levels statistically significantly influence economic growth.

The poverty level variable shows that the regression coefficient of the CO2 emission level has a positive effect, evidenced by the the number of poor people coefficient value of 0.21. The significance of t-statistics is seen from the t-statistic value of 11.08 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (11.08> 1.97), meaning that the level of poverty statistically significantly influences economic growth.

Fixed Effect Model used the dummy approach or known as Least Squares dummy variables (LSDV). Panel data estimation results with the Fixed Effect Model approach.

The estimation results of the Fixed Effect Model approach show that the regression coefficient value of the CO2 emission level has a positive effect, evidenced by the coefficient value of the CO2 emission level of 2.58. The significance of t-statistics is seen from the t-statistic value of 16.73 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (16.73> 1.97), meaning that statistically, CO2 emission levels significantly influence economic growth.

The regression showed effect of the number of poor people variable to the CO2 emission level has a negative, evidenced by the level coefficient value is -0.18. The significance of t-statistics is seen from the t-statistic value of -5.34 and the t-table value of -1.97. It shows that the value of -t-statistics <-t-table (-5.34 <-1.97), means that statistically, the number of poor people (poverty) significantly influences economic growth.

The panel data estimation results using the Fixed Effect Model approach in Appendix 1 obtained the results of the coefficient of determination (R2) of 0.9708. These results indicate that the variable of economic growth can be explained in the model of 97.08%. The results of the F-statistic value of 224.40, where the F-table value is 3.03. It means that the regression coefficient of the CO2 emission level and the poverty level has an F table value of 3.03 smaller than the F-statistic value of 224.40. The level of CO2 emissions and the level of poverty together significantly influence economic growth.

Fixed effects assume that differences between individuals (cross sections) can be accomodated from differences in their intercepts. The test carried out to see the value of the dependent variable when the independent variable is considered constant from each cross section need to be assessed by the Intercept Cross Section of the LSDV. The results of the six highest intercept cross sections.

Table 7. Intercept Cross Section (model 1)

logpov.	Coef.	Prob.
Cons.	11.40	0.000
Loggdrp	-0.015	0.627
CO2	2.3701	0.011
29_Brebes reg.	1.34	0.001
05_Cilacap reg.	1.15	0.014
27_Tegal reg.	1.11	0.019
02_Banyumas reg.	1.05	0.006
15_Grobogan reg.	0.907	0.005
03_Purbalingga reg.	0.817	0.085

Based on the Table 7 constant value is 11.40, with the result that the intercept value of Brebes regency is equal to 11.41 - 1.34 = 10.07, Cilacap regency is equal to 11.40 - 1.15 = 10.26, Tegal regency is equal to 11.41 - 1.11 = 10.3, and Banyumas regency is equal 11.41 - 1.05 = 10.36, Grobogan regency is equal to 11.41 – 0.907 = 10.53. Purbalingga regency is equal to 11.41 – 0.817 = 10.59. The result of this intercept value is that when the independent variable is considered constant then the dependent value of Brebes regency is 10.07 and etc. Its means when the GDRP and carbon emission levels (CO_2) are contant, number of poor people in Brebes regency is 10.59%, Cilacap regency is 10,26%, Tegal regency is equal to 11.41 - 1.11 = 10.3, Banyumas regency is 10.36%, grobogan regency 10.53% and Purbalingga regency is 10.59%.

Table 8. Intercept Cross Section (model 2)

loggdrp.	Coef.	Prob.
Cons.	24.67	0.000
Logpov	-0.085	0.627
CO_2	2.446	0.335
02_Banyumas reg.	0.0135	
19_Kudus reg.	-0.134	
29_Brebes reg.	-0.212	
22_Semarang reg.	-0.339	
10_Klaten reg.	0.359	

Based on the Table 8, constant value is 24.67, with the result that the intercept value of Banyumas regency is equal to 24.67 – 0.0135 = 24.66, Kudus regency is equal to 24.67 – (-0.134) = 24.804, Brebes regency is equal to 24.67 – (-0.212) = 24.882, and Semarang regency is equal 24.67 – (-0.339) = 25.009, Klaten regency is equal to 24.67 – (-0.359) = 25.039.

With Y is GDRP shows the intercept value highest intercept cross sections Banyumas, Kudus, Brebes, Semarang, Klaten with independent variables considered constant. Then, the intercept value in 5 regency are resipro 24.7%, 24.8%, 24,9%, 25% dan 25% and the overall value of intercept cross section not statistically significant.

Random Effect Model was used to solve problems regarding the reduction of the degree of freedom, which would have an impact on the efficiency of the parameters to be estimated. The panel data estimation results using the Random Effect Model approach were obtained from the coefficient of determination (R2) of 0.5838. These results indicate that the variable of economic growth can be explained in the model of 58.38%. The results of the F-statistic value of 194.25, where the F value of the table is 3.03. It means that the regression coefficient of the CO_2 emission level and the poverty level has an F table value of 3.03, smaller than the calculated F value of 194.25. The level of CO_2 emissions and the level of poverty together significantly influence economic growth.

The estimation results of the random effect model approach in Table 8 indicates that the value of the partial regression coefficient of the CO_2 emission level has a positive effect, evidenced by the coefficient value of the CO_2 emission level of 2.96. While the significance of CO_2 variable is not significantly affect to economic growth. The value of probability is 0,458 upper the limit 0,05. It means that statistically, the level of CO_2 emissions not significantly influences economic growth.

Table 9. Random Effect Model

loggdrp.	Coef.	Prob.
Cons.	30,13	0.000
Logpov	-0,02	0.000
CO_2	2,96	0.458
R Squares	0.58	0.990
F Statistic	194.242	
02_Kudus reg.	0.45	
19_Banyumas reg.	0.38	
29_Pati reg.	0.27	
22_Brebes reg.	0.32	
10_Semarang reg.	0.33	

The number of poor people variable has negative affect to economic growth, evidenced by the number of poor people coefficient value is -0.02. The significance of t-statistics can be seen that the probability value is under 0,05. It indicates that the statistics t-value > t-table, means that the number of poor people statistically significantly influence economic growth.

The choice of the best approach in estimating panel data regression consisted of three tests, namely the chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The chow test was used to choose the most appropriate equation estimation used in the Pooled Least Square or Fixed Effect Model. The Hausman test was used to select the most appropriate equation estimation used in the Fixed Effect Model or Random Effect Model. While the LM test was used to select the estimated equation, which was most appropriate in the Pooled Least Square or Random Effect Model.

The selection of panel data regression estimation using the chow test method was by comparing the results of the Redundant Fixed Effect Tests estimation with the level of significance (α = 5%) used. The chow test estimation results are as follows:

Table 10. Chow Test

Effects Test	Statistic	Prob.
Cross Section F	29,00	0.000
Cross Secton Chi Square	453,88	0.000

The results of the Chow test (Table 10) give a chi-square probability number of 0.00, which indicates significance at the 5% real level, meaning that the pooled least square model is rejected, and the fixed effect model is accepted. The Fixed Effect Model approach was more appropriate to be used in this study in estimating panel data regression.

In the selection of panel data, regression estimation used the Lagrange Multiplier (LM) test method by comparing the calculated LM value with the chi-square critical value. The calculated LM value is higher than the critical value of chi-square, then Ho is rejected, which means accepting Ha where the best model used is the Random Effect Model. The calculated LM value is smaller than the critical value of the chi-square then Ho is accepted, which means rejecting Ha, where the best model used is the Pooled Least Square. The LM test estimation results are as follows:

$$\frac{35(8)}{2(8\text{-}1)}\left[\frac{8^2(1{,}40321)}{17{,}8436}-1\right]^2$$

The results of calculating the residual value of the multiplier Lagrange test in Table 4.6, it was obtained the final value of $LM_{calculate}$ as follows:

$LM_{calculate}$ = 325,289

The results of calculating the residual value of the LM test obtained the LM value of 325.2891. The critical value of chi-square at d.f 277 and the significance level of 0.05 or 5% shows the number 316.82, meaning that the LM count > the critical value of chi-square (325.29> 316.82). Ho is rejected, or in other words, the most appropriate model used in this study was the random effect model.

In the selection of panel data, regression estimates used the Haussman test method by comparing the Haussman Tests estimation results with the level of significance (α = 5%) used. The results of the Haussman test are as follows:

The Hausman test results give a probability number of 0.00, which indicates significance at the 5% level, meaning that the random effect model is rejected, and the fixed effect model is accepted. The test results could be concluded that the model that was more suitable for use in this study was the fixed effect model.

Table 1 showed the effect of Carbon Emission Levels (CO_2) on number of poor peoples. The t-statistic value is 0.57, where the t-table value is equal to 1.97. It means that the t-

statistic value is smaller than the t-table (0.57 <1.97). It means that the regression coefficient is not statistically significant. In other words, the level of CO2 emissions affects the level of poverty statistically significant.

The partial regression coefficient value of CO2 emissions is 0.10, which means that if the level of CO2 emissions in 35 regencies/municipalities in Central Java increase, the poverty rate will also increase. On the contrary, as the levels of CO2 emissions are declining, the poverty rate will also decrease. It means that 1 unit increases in CO2 emissions level will increase 10% of the poverty rate, whereas if the level of CO2 emissions decreases by 1 unit, it will decrease 0.10% of the poverty rate.

The equation of the fixed effect model is as follows:

$$LPov_{it} = \beta_1 + \beta_2 LGRDP_{it} + \beta_3 CO2_{it} + \varepsilon_{it}$$

Table 11. Fixed Effect Output

Var.	Coefficient	t-Statistic	Prob.
C	11.564	20.55	0.000
LGRDP	-0.015	-0.49	0.627
Co2	2.370	2.57	0.010

Source: Data processed

The interpretation from the fixed-effect model estimation are as follows:

$$LPov = 11.564 - 0.012\ LGDRP + 0.10\ CO2 + \varepsilon_{it}$$

Specification:

LPov = Log of number of poor people in regency or municipality

LGRDP = Log Gross Regional Domestic Regional Product in regency or municipality

CO2 = CO2 emission level in regency or municipality

Based on Table 5, the dependent variable is the number of poor people (data in logarithm format). The t-statistic value of LGDRP is -0,49 where the t-table value is 1.97. It means that the t-statistic value is greater than the t-table (-0,49<1.97). Thus, the regression coefficient is statistically not significant. Economic growth is statistically not be followed decreasing the number of poor people. This means the problem solving to poverty its not only focused on GDRP that give a trickle down effect but also another variable who can solve that problem. The trickle down effect is greater economic activity is expected to have an effect on smaller activities.

The coefficient of CO2 from the partial regression result is 2,37, which means that, when the Co2 in 35 regencies/municipalities in Central Java is increasing, the number of poor people will increase as well. The raising in level of carbon dioxide will decline the number of poor people. It means every grows 1 unit carbondioxide will decrease 2,36% of the number of poor people (poverty). On the contrary, if the carbondioxide slow down by 1 unit, it will lead the number of poor people raise up to 2,36 %.

The existence of these results prove the hypothesis that economic growth could decrease poverty. In Central Java, the number of poor people decreases with economic growth but not significantly in number.

By using different methods with our study, the impact of reducing poverty is not affected by the accelerating of economic growth. Economic growth in Brazil in the mid-1980s to mid-2000s was not proven to be a strong influence of poverty reduction by economic growth (Ferreira, et al. 2010).

However, some previous study reported that there are negative correlation between economic growth and reducing poverty. Suryahadi, et al. (2006) in their study concluded economic growth has negative impact on rural poverty (agricultural) and urban poverty (services).

Hassan *et al.* (2015) stated that income growth could decline the poverty number because it can increase job demand by an increase in production that boosts GDP value. Their research explained that the industrialization has a positive impact on decreasing unemployment because there is labor absorption in the industrial sector. Human resource ability to manage and exploit technology is expected to be able to increase personal skills. Thus, it will increase their productivity and income.

Industrialization accelerates economic growth often causes trade-off to environmental quality. Wang *et al.* (2013) in Wang *et al.* (2016) stated that economic growth is achieved through energy consumption that produces high CO_2 emission.

Furthermore, Wang *et al.* (2016) stated that rapid economic growth is achieved through energy consumption that produces a high level of carbon dioxide (CO_2). Industrialization acceleration will accelerate economic growth. A large number of industries induce a high level of emission produced in the industrial sector. The distribution and the increasing of environmental pollution are worse because there a small number of areas that absorb exhaust gas like carbon dioxide (CO_2).

In this research revealed that increasing of carbon dioxide significantly affect to the number of poor people. The efforts to reduce air pollution, especially carbon emissions, can turn out to be a strategy to reduce the number of poor people.

Besides, we run the first model to investigate the impact of economic growth and carbon dioxide (CO_2) to the level of poverty. We also conducted the investigation impact of the number of poor people and level carbon dioxide (CO_2) in the air to economic growth.

This second model constructed on the classical theory of economic growth, which is a function of population and capital. The variable population is believed to cause GDP to increase due to productive labor, while a lot of capital will cause growth also to grow because of its investment capability.

The result of testing the second model for

$$LGRDP_{it} = \beta_1 + \beta_2\, LPov_{it} + \beta_3\, CO2_{it} + \varepsilon_{it}$$

Table 12. Fixed Effect Output

Var.	Coefficient	t-Statistic	Prob.
C	24.07	11.99	0.00
LPov	-0.08	-0.49	0.62
Co2	2.45	0.97	0.57

Source: Data processed

The log of GRDP will be 24.07 when the variable of poverty and Co2 have been assumed not to influence significantly impact on dependent variables. Otherwise, the coefficient variable of LPov would have a negative impact on the GRDP variable (-0,08) but not significant. The coefficient of CO_2 is 2,45 and value of t statistic is 0,97 (lower than 1,97). This result give signal that economic growth in Central Java is driven by increasing of energy that produces carbon.

CONCLUSION

The levels of CO_2 emissions have significantly positive effect on number of poor peoples. Industrialization, as an application from the government's policy, has a negative impact on the environment and economic indicators. A large number of industries that cause energy absorption makes a high amount of CO_2 emissions. This as a result of the middle-income economic community, or those who work in the industrial sector become victims of high emission rates. The impact on workers from a poor work environment is that they will spend more money due to the declining quality of health. The wages that they should use to

fulfill their daily needs also contributed to the decline in the quality of their health care.

The level of economic growth has a negative but not significant effect on the level of poverty alleviation. Poverty in Central Java is declining but not proportional to the economic growth achieved by the province. Economic growth that occurs indicates that the increase in GDRP is dominated by sectors that require capital-intensive and do not need unskilled labor.

The middle to upper-class community dominates the economic development in Indonesia. So, the middle to lower classes only become a minority in economic growth process. When there is high-income inequality in an area, the poor will become more miserable.

The government should design and apply policies in industrial development. Environmental policy needs to be done to minimize fuel consumption in industrial processes. Thus, when economic growth increasing each year, it would not be followed by increasing of CO2. In addition, there is needs to be environmentally friendly development. Thus, increasing economic growth also pays attention to environmental sustainability.

The government should be just in order to motivate the middle class and above. Thus, they can also contribute to the development of the Indonesian economy to reduce the current income inequality in Indonesia.

Firms should participate in protecting the environment by paying more attention to the waste screening process. Thus, the emissions that produced do not have a negative impact on the environment. The government sets the contribution of the industrial sector to GDP along with maintaining the quality of the environment and the awareness of businesspeople or innovators in carrying out environmental policies.

For further researchers, it is expected to be able to research the two-way relationship between economic growth, CO2 emission levels, and number of poor peoples. Thus, it can be able to see in more detail the relationship between variables.

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APPENDIX

Panel data model 1

Fixed-effects (within) regression — Number of obs = 280
Group variable: kabkota — Number of groups = 36

R-sq: within	=	0.0270	Obs per group: min	=	1
between	=	0.0261	svg	=	7.8
overall	=	0.0292	max	=	8
corr(u_i, Xb)	=	-0.2278	F(2,242)	=	3.36
			Prob > F	=	0.0363

loggdrp	Coef.	Std. Err.	t	P>|t|	(95% Conf.	Interval)
loggdrp	-.0115124	.023676	-0.49	0.627	-.581497	.0351249
co2	2.370197	.9218233	2.57	0.011	-5543751	4.186018
_cons	11.58485	.5636685	20.55	0.000	10.47453	12.69517
sigma_u	.82107919					
sigma_e	.13301621					
rho	.97442662	(fraction of variance due to u_i)				

F test that all u_i = 0: F(35, 242) = 240.54 Prob > F = 0.0000

Panel data model 2

Fixed-effects (within) regression			Number of obs	=	280
Group variable: kabkota			Number of groups	=	36
R-sq: within	=	0.0043	Obs per group: min	=	1
between	=	0.6932	svg	=	7.8
overall	=	0.5141	max	=	8
corr(u_i, Xb)	=	0.4021	F(2,242)	=	0.52
			Prob > F	=	0.5934

loggdrp	Coef.	Std. Err.	t	P>|t|	(95% Conf.	Interval)
logpov	-.0847836	.1743624	-0.49	0.627	-.4282453	.258678
co2	2.446038	2.530674	0.97	0.335	-2.538923	7.43099
_cons	24.07073	2.00746	11.99	0.000	20.1164	28.0250
sigma_u	3386573					
sigma_e	.36097507					
rho	.46813314	(fraction of variance due to u_i)				

F test that all u_i = 0: F(35, 242) = 1.97 Prob > F = 0.0016

Jurnal JEJAK

by Suryanto Suryanto

Submission date: 12-Feb-2020 08:11PM (UTC+0700)
Submission ID: 1256090110
File name: 19229-57105-2-PB.pdf (516.7K)
Word count: 7783
Character count: 39093

Jejak Vol 12 (2) (2019): 466-481 DOI: https://doi.org/10.15294/jejak.v12i2.19229

JEJAK

Journal of Economics and Policy

http://journal.unnes.ac.id/nju/index.php/jejak

Triangle Analysis: Carbon Emissions, Economic Growth, And Poverty In Indonesia

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Permalink/DOI: https://doi.org/10.15294/jejak.v12i2.19229

Received: May 2019; Accepted: July 2019; Published: September 2019

Abstract

This research tried to investigate the correlation between carbon emissions on poverty levels and the economic growth effect toward the level of poverty. This study utilizes secondary data-set time series from 2010 to 2016 across 34 provinces in Indonesia. The source of the data is from the Central Statistics Agency (BPS) and German watch. The data estimation uses a panel regression by Fixed Effect Model and processed using E-views software version 8.0. The results of the study reveal that 1) effect of carbon emission is positive but not significant on poverty levels; 2) economic growth affects the poverty level positively significant. Thus, the economic development that results in pollution (i.e., industrialization, transportation) should more controlled and in line with sustainable development goals (SDGs). Therefore, there are needs for the government to put effort into designing and making policies related to decreasing emissions. Furthermore, the government should also involve all stakeholders to participate in contributing to economic-environmental friendly. They have to increase their awareness in carrying out the policies set by the government and paying more attention to the waste screening process.

Key words : economic growth, carbon emission level, poverty level, panel data

How to Cite: Suryanto, S., Radhianita, A., & Juwita, A. (2019). Triangle Analysis: Carbon Emissions, Economic Growth, And Poverty In Indonesia. JEJAK: Jurnal Ekonomi dan Kebijakan, 12(2). doi:https://doi.org/10.15294/jejak.v12i2.19229

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ISSN 1979-715X

INTRODUCTION

The increasing of Gross Domestic Regional Product (GRDP) does not always follow the community of livelihood. Improvement of livelihood can be measured by the index of environmental quality and economic growth. When the quality of economic growth have successfully achieved, it determines the improvement of livelihood. A study by Kuncoro (2010) believed that the problems that occurred in developing countries as the effect of growth such as unemployment, poverty, and inequality in income distribution could be reduced by increasing income per capita.

Economic growth is the percentage change in GDP over time (Madura: 2007). Economic growth is a measure of gross regional domestic growth per capita as a measure to see the development of people's welfare (Pangkiro: 2016). According to Schumpeter in Arsyad (2010), economic growth is the ability of the community to increase output due to the increasing number of production factors used in the production process, without any changes in the production technology itself. Thus, it can be concluded that economic growth is the development of economic activities in an exact area generated from the gross domestic product calculation process.

Statistical Bureau released the data on economic growth in Indonesia. Since 2015 until 2017 shows that economic growth Indonesia has raising. Economic growth of Indonesia in 2015 is 4.88 percent, 2016 is 5.07 percent, and 2017 is 5,17 percent.

Growth of economic is not always be followed by reducing the poverty. According to BPS (2018), poverty is the individual inability from the economic side to cover their basic needs measured by the expenditure. According to Bappenas (2002), in Arsyad (2010), poverty is defined as the inability of a person or group to carry out their life as a standard of living that as a human being. According to Ravallion (2001) in Arsyad (2010), poverty is a condition in which a person experiences hunger, does not have a place to live, and does not have money to afford a doctor or medical treatment. Every individual or institution has a different poverty definition because it depends on the living standards in an area.

There are 2 (two) types of poverty that are absolute and poverty. Absolute poverty is the inability of individuals to fulfill basic needs with the income they have. According to Todaro and Smith (2003), in Arsyad (2010), this concept is intended to determine the minimum level of income to meet the physical needs of food, drinks, clothing, and housing to survive. In relative poverty, it is seen by comparing a person to his population. If a person's income is still far lower than the income of the population, it can be said that the person is poor.

The results from Stevans and Sessions (2005) if GDP over time does not effect to poverty. The changes GDP do not indicate a change in poverty. This happened due to economic expansion in 1980 at U.S.

Based on Table 1, the number of poor people tends to decrease from 2015 until 2017. The number of poor people in East Java Province is the highest, which is 16,57 percent in 2017. Central Java Province also has a high number of poor people; in 2017, there was 15,79 percent.

Table 1. Percentage of the Number of Poor People in Indonesia

Province	2015	2016	2017
Aceh	3.01	3.03	3.12
Sumut	5.29	5.23	4.99
Sumbar	1.23	1.36	1.35
Riau	1.97	1.81	1.87
Jambi	1.09	1.05	1.05
Sumsel	3.90	3.95	4.09
Bengkulu	1.13	1.17	1.14
Lampung	3.86	4.11	4.08
Babel	0.23	0.26	0.29
Kep. Riau	0.40	0.43	0.48
DKI Jakarta	1.29	1.39	1.48
Jabar	15.73	15.01	14.20
Jateng	15.80	16.19	15.79
DIY	1.70	1.76	1.75
Jatim	16.75	16.71	16.57
Banten	2.42	2.37	2.63
Bali	0.77	0.63	0.66
NTB	2.81	2.83	2.81
NTT	4.07	4.14	4.27
Kalbar	1.42	1.41	1.46
Kalteng	0.52	0.50	0.52
Kalsel	0.66	0.66	0.73
Kaltim	0.74	0.76	0.82
Kalut	0.14	0.17	0.18
Sulut	0.76	0.72	0.73
Sulteng	1.43	1.49	1.59
Sulsel	3.03	2.87	3.11
Sultengg	1.21	1.18	1.18
Gorontalo	0.72	0.73	0.76
Sulbar	0.54	0.53	0.56
Maluku	1.15	1.20	1.21
Malut	0.25	0.28	0.29
Papua Barat	0.79	0.81	0.80
Papua	3.15	3.30	3.42
Indonesia	100.00	100.00	100.00

Source: Statistical Breau, 2018

The government usually relies on the amount of per capita income from the population that considered a benchmark in the assessment that it has advanced or previously increase the economy of a country. Income in a country can be referred to as the process of a country's economic success. The increasing Gross Domestic Product (GDP) is usually used as a reference to see economic growth in an area from time to time. The success of a country's economy can be seen through increasing output over time (Todaro: 2005 in Ma'ruf and Wihastuti: 2008).

Unfortunately, the impact in economic growth to reducing poverty depends on the Gini Index and the participation of people in economic growth. Some facts, although countries or regions have the same growth rate, and they have unequal distributions level would be a different result in reducing poverty (Herman, 2014). When there is high-income inequality in an area, the poor will become more miserable.

Saragih (2004) in Bangun and Hutagaol (2008) consider that the industrial sector is capable of coping with economic problems that are usually believed by developing countries. A large number of industries will also affect the number of labor absorption. Thus, the number of workers absorbed in the high industrial sector will have a positive relation to the declining unemployment rate. The existence of industrial estates is expected to absorb workers. Thus, it could provide income for the community. The existence of the industrial sector can strengthen national economic stability (Adisasmita 2013). Therefore, the industrial sector has an essential role in

economic growth in a country. The decreasing unemployment number has an impact on the decline in poverty because people can generate income. The increase in per capita income is one indicator of economic growth.

The industrial sector has not only many positive impacts on the economy but also negative impacts both directly and indirectly. Firms often ignore environmental problems when the production process takes place. It will lead to a decrease in environmental quality due to the high amount of exhaust emissions produced from the production process. According to Akhadi (2014), the application of modern technology in industrial activities would accelerate development. It will have an impact on the environment around industrial estates, where environmental quality has decreased due to the large number of pollutants that pollute the air.

Carbondioxide (CO_2) gas produced from the combustion of the production process in the industrial sector is poisonous to be inhaled. Even when the amount of CO_2 gas exceeds 10%, it can cause impaired vision, hearing, tremors, which will eventually faint (Supardi: 2003). CO_2 gas is also formed when carbon monoxide (CO) that exposed by sunlight due to the presence of carbon monoxide (CO) gas whose specific gravity is higher than air and reacts with its Oxygen (Setyono: 2015). Therefore, similar to CO gas, CO_2 gas is a colorless and odorless gas.

A prosperous society can be achieved by an integral and comprehensive social process, both in the form of economic growth and social change (Supardi: 2003). Most economic activity often ignores the performing of environmental sustainability. Project waste often pollutes and spread the environment. People should improve their standard of living in the community. However, the community can be infected by the disease due to the lack of attention to the management of the project waste. Supardi (2003) stated that the prosperity and welfare of the community could be achieved optimally in complex environmental management and economic development.

Carbon dioxide (CO_2) gas is a component contained in the air. CO_2 gas is naturally present in the air as a product of combustion and oxidation (Harrington: 2003). In the proper circumstances, carbon dioxide is used by plants to carry out photosynthetic activities. However, if the concentration of CO_2 in the air exceeds the safe level, it will have a negative impact on the environment.

A large number of industries in urban areas induce high yield of exhaust gases resulting from the production process of the industrial sector. CO_2 gas from production processes in the industrial sector is poisonous to breathe. A 10% exceed in the amount of CO_2 gas can cause impaired vision, hearing, tremor, which eventually will faint (Supardi: 2003). In addition, CO_2 gas can also be formed when the density of carbon monoxide (CO) is higher than the air reacts with Oxygen and exposed by the sunlight (Setyono: 2015).

A discussion about the Environmental Kuznets Curve (EKC) stated that the discussion about economic growth and decreasing of quality environment is like the “u reverse” alphabet. It is mentioned that in the beginning, economic growth will increase environmental pollution, then the level of pollution is going to increase slowly, and finally, it is going to be declined.

Investigation in China conducted by Wang *et al.* (2016) concluded that the increasing of CO_2 is along with economic growth. By using granger causality and utilize panel data. By using granger causality and panel data, the correlation between economic growth and CO_2 emission is positive. CO_2 emission affects economic growth positively significant, when CO_2 increasing will be followed by increasing of

economic growth. China, as the largest developing country, can maintain economic growth for more than three decades. Wang *et al. (2013)* in Wang *et al.* (2016) stated that fast economic growth is achieved by energy consumption that yields high CO_2 emission.

Meanwhile, the results of a study by Hassan et al. (2015) have different effects than Wang (2016). Based on cointegration testing and the Error Correction Model (ECM), it can be analyzed whether the relationship between economic growth and CO_2 emissions as well as economic growth and poverty has a two-way relationship or not. It turns out, the increase in CO_2 in the air and economic growth has a negative and significant correlation in the short term.

Some studies proved that there was a relationship between economic growth and poverty. The high level of economic growth will decrease the poverty level. A study by Jonaidi (2012) supports the statement by using panel data in Indonesia. Economic growth affects poverty negatively significant. While poverty affects economic growth negatively significant. The increase in capital access, education quality, and health degree. The increasing of capital access, education quality, and health degree are expected to boost human resources productivity. The increasing of human resources productivity can support the increase of investment through saving enhancement. Thus, it can accelerate economic growth.

A study by Alam (2016) revealed that the level of energy consumption has a negative effect on the environment in the short and long run. Meanwhile, economic growth also affects negatively. The relationship between CO_2 and population growth affect four countries statistically significant. Environmental Kuznets Curves (EKC) hypothesis implies that CO_2 will decline in Brazil, China, and Indonesia. Co2 emissions will decrease over time as income increases. In India, there is a positive relationship between CO_2 emission and income.

Prishardoyo dan Sebayang (2013) relied on descriptive statistics to reveal that the majority that lives in an industrial district experience the impact of the production process. Some majority revealed that there is attention from the business makers in the production process in the industrial sector in order to maintain the environmental sustainability.

METHOD

The main purpose is to determine the effect of carbon emissions and economic growth on the poverty level. This research used a cross-section dataset from 34 provinces in Indonesia and also time series data from 2010 to 2016. This study relied on panel data regression methods to investigate the effect of these variables.

This study has conducted by a quantitative research approach. In this approach, the study started with a problem formulation, theoretical reviews, hypothetical formulation, and data analysis for an estimate of the relationship between variables. In this study, a quantitative method was utilized to describe the effect of economic growth and emission levels on poverty levels in Central Java Province.

This study relied on the secondary dataset, which was generated from relevant institutions or agencies through websites, libraries, etc. to support the study. The dataset was generated from the Central Bureau of Statistics C (BPS) and Germanwatch.

This study utilized economic growth, Carbon Emissions (CO_2), and poverty as the variables. Economic growth is the economic development in an area obtained from the Gross Domestic Product (GDP) calculating process. This study relied on Gross Regional Domestic

Products in Constant Prices 2010 (ADHK 2010 GRDP) in units of billions of IDR. Carbon Emissions (CO_2) are exhaust gas left over from the production process of the industrial sector in the form of carbon dioxide gas that exceeds the threshold. CO_2 can pollute the air, which can affect the components of fresh air. In this study, CO_2 emissions were obtained by proxying the value of the Climate Change and Performance Index, Province GRDP, and GDP in Indonesia. Poverty is a person's inability to fulfill their basic needs due to the minimum amount of income they receive. In this study, we used the number of poor people in units.

This study employed a panel data regression method with Fixed Effect Model. Due to the limitation number of data, we regress by panel data techniques. This techiques is such as regression that combines time series and cross-sector data (cross-section). According to Rahayu (2012), by using a panel data model, the number of observations increases the degree of freedom and reduces collinearity between explanatory variables and then improves the efficiency of econometric estimation. In the Fixed Effect Model method, it is known that the variable level of CO_2 emissions and poverty levels significantly affect economic growth at 5% significance level.

RESULTS AND DISCUSSION

Before further discussion, first, the researcher tested the data to be used with the unit root test. The data processed had to be stationary data. Table 1 is the Probability of the results with 6 methods and 3 levels (level, 1st diff, 2nd diff).

Table 2. Root Unit Test Probability Results

Variable	Prob (PE, TE, TK)		
Method	Level*	1st diff**	2nd diff*
Levin, Lin, Chu	0.995	0.000	1.000
Breitung t-stat	0,186	0,026	0,405
Im, pesaran, shin	0,000	0,000	0,000
Fisher-ADF Chi-Square	0,000	0,000	0,000
PP-Fisher Chi-Square	0,000	0,000	0,000

The results show that the data could be processed or said to be stationary with the levin, lin, Chun method on the 1st diff with a After having a unit root test done, a correlation test could be performed to see how strong the correlation between the three variables. If the results obtained more than 0.5, it could be said that the correlation between variables is strong.

The number of poor people variable had a weak correlation on the GRDP and the CO_2 Emissions index with the GRDP of 0.36 <0.5 and CO_2 Emission Index 0.1 <0.5.

Table 3. Correlation panel

	LOG(Pov)	LOG(GDRP)	CO_2
LOG(Pov)	1	0.36	0.18
LOG(GDRP)	0.36	1	0.78
CO_2	0.18	0.78	1

The correlation relationship between GRDP was strong by showing a figure of 0.36 <0.5, but the correlation on the CO_2 emission index was strong, with a result of 0.78> 0.5. The CO_2 Emission Index showed a strong correlation to GRDP (0.78 > 0.5), but not to the number of poor people.

The panel cointegration test used the Johansen test to see the long-term relationship between variables. Therefore, this test was to find out the relationship and cointegration of poor level variables, ADH PDH 2010, and CO_2 Emission Index.

The results showed that the probability was smaller than 0.05, so that the variables above had a relationship or cointegration at the 0.05 level. In the equation above, if there is a change in one variable, then together (simultaneously), other variables will also move up or down.

Table 4. Cointegration Johansen Panel

Hypothesized No. of CE(s)	Trace Stat.	Max Eigen Stat.	Prob**
None*	197.02	21.13	0.0001
At most 1*	48.16	14.26	0.0000
At most 2*	14.00	3.84	0.0002

*denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Determination of the best model was best used MacKinnon, White, and Davidson Test (MWD Test). The selection of empirical models were made to determine the best model used in an equation, both the linear model and the log-linear model. The best empirical model was done by comparing the values of Z1 and Z2 in the MWD test. The following are estimation results from the MWD test:

Table 5. MWD Test Estimation Results

Variable	Probability	Explanation
Z1	0,0121	Sig pada α=5%
Z2	0,0000	Sig pada α=5%

Source: processed data

Table 5 shows that the Probability value of Z1 added as an independent variable to the MWD linear model estimated at 0.01. The probability value of Z1 is smaller than the significance level of 5%, meaning that the value of Z1 is statistically significant. These results mean that Ho was rejected, which means the log-linear model was the best empirical model used in this study.

A probability value of Z2 was added as an independent variable in the MWD linear log model estimation of 0.00. The Z2 probability value is smaller than the 5% significance level, meaning that the Z2 value is statistically significant. These results indicate that Ho was accepted, which means the linear model was the best empirical model used in this study.

The probability values of Z1 and Z2 from the MWD test showed that both were statistically significant. It meant that both the linear model and the log-linear model were equally good or feasible in this study. Panel data regression estimation in this study used a log-linear model. The log-linear model made data in variables smoother.

There are three model estimation approaches for panel data regression analysis, namely: Pooled Least Square approach, Fixed Effect Model, and Random Effect Model.

The Pooled Least Square approach is the simplest approach in estimating panel data models. Panel data estimation used the Pooled Least Square approach (see appendix 5).

Table 6. Pooled Least Square

Variable	Coef.	Prob.
Cons.	27,364	0.000
Loggdrp	0,207	0.000
CO2	3,813	0.000
R Squares	0,85	
F Stat	799.14	

Table 6 shows the results of the panel data estimation using the Pooled Least Square approach, and the coefficient of determination (R2) of 0.852 was obtained. Economic growth variables could be explained in the model of 85.23%. While the results of the F-statistic value of 799.14, where the F table value is 3.03. It means that the regression coefficient of the CO2 emission level and poverty level has an F table value of 3.03, where it is smaller than the statistical F value of 799.14. In other words, the level of CO2 emissions and the number of poor

people together have a significant effect on economic growth.

The estimated pooled least square approach shows that the partial regression coefficient of the CO2 emission level has a positive effect, as evidenced by the coefficient of the CO2 emission level of 3.81. The significance of t-statistics is seen from the t-statistic value of 35.53 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (35.53> 1.97), meaning that CO2 emission levels statistically significantly influence economic growth.

The poverty level variable shows that the regression coefficient of the CO2 emission level has a positive effect, evidenced by the the number of poor people coefficient value of 0.[illegible]. The significance of t-statistics is seen from the t-statistic value of 11.08 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (11.08> 1.97), meaning that the level of poverty statistically significantly influences economic growth.

Fixed Effect Model used the dummy approach or known as Least Squares dummy variables (LSDV). Panel data estimation results with the Fixed Effect Model approach.

The estimation results of the Fixed Effect Model approach show that the regression coefficient value of the CO2 emission level has a positive effect, evidenced by the coefficient value of the CO2 emission level of 2.58. The significance of t-statistics is seen from the t-statistic value of 16.73 and the t-table value of 1.97. It shows that the t-statistic value is higher than the t-table value (16.73> 1.97), meaning that statistically, CO2 emission levels significantly influence economic growth.

The regression showed effect of the number of poor people variable to the CO2 emission level has a negative, evidenced by the level coefficient value is -0.18. The significance of t-statistics is seen from the t-statistic value of -5.34 and the t-table value of -1.97. It shows that the value of -t-statistics <-t-table (-5.34 <-1.97), means that statistically, the number of poor people (poverty) significantly influences economic growth.

The panel data estimation results using the Fixed Effect Model approach in Appendix 1 obtained the results of the coefficient of determination (R2) of 0.9708. These results indicate that the variable of economic growth can be explained in the model of 97.08%. The results of the F-statistic value of 224.40, while the F-table value is 3.03. It means that the regression coefficient of the CO2 emission level and the poverty level has an F table value of 3.03 smaller than the F-statistic value of 224.40. The level of CO2 emissions and the level of poverty together significantly influence economic growth.

Fixed effects assume that differences between individuals (cross sections) can be accomodated from differences in the intercepts. The test carried out to see the value of the dependent variable when the independent variable is considered constant from each cross section need to be assessed by the Intercept Cross Section of the LSDV. The results of the six highest intercept cross sections.

Table 7. Intercept Cross Section (model 1)

logpov.	Coef.	Prob.
Cons.	11.40	0.000
Loggdrp	-0.015	0.627
CO2	2.3701	0.011
29_Brebes reg.	1.34	0.001
05_Cilacap reg.	1.15	0.014
27_Tegal reg.	1.11	0.019
02_Banyumas reg.	1.05	0.006
15_Grobogan reg.	0.907	0.005
03_Purbalingga reg.	0.817	0.085

Based on the Table 7 constant value is 11.40, with the result that the intercept value of Brebes regency is equal to 11.41 - 1.34 = 10.07, Cilacap regency is equal to 11.40 - 1.15 = 10.26, Tegal regency is equal to 11.41 - 1.11 = 10.3, and Banyumas regency is equal 11.41 - 1.05 = 10.36, Grobogan regency is equal to 11.41 – 0.907 = 10.53. Purbalingga regency is equal to 11.41 – 0.817 = 10.59. The result of this intercept value is that when the independent variable is considered constant then the dependent value of Brebes regency is 10.07 and etc. Its means when the GDRP and carbon emission levels (CO_2) are contant, number of poor people in Brebes regency is 10.59%, Cilacap regency is 10,26%, Tegal regency is equal to 11.41 - 1.11 = 10.3, Banyumas regency is 10.36%, grobogan regency 10.53% and Purbalingga regency is 10.59%.

Table 8. Intercept Cross Section (model 2)

loggdrp.	Coef.	Prob.
Cons.	24.67	0.000
Logpov	-0.085	0.627
CO_2	2.446	0.335
02_Banyumas reg.	0.0135	
19_Kudus reg.	-0.134	
29_Brebes reg.	-0.212	
22_Semarang reg.	-0.339	
10_Klaten reg.	0.359	

Based on the Table 8, constant value is 24.67, with the result that the intercept value of Banyumas regency is equal to 24.67 – 0.0135 = 24.66, Kudus regency is equal to 24.67 – (-0.134) = 24.804, Brebes regency is equal to 24.67 – (-0.212) = 24.882, and Semarang regency is equal 24.67 – (-0.339) = 25.009, Klaten regency is equal to 24.67 – (-0.359) = 25.039.

With Y is GDRP shows the intercept value highest intercept cross sections Banyumas, Kudus, Brebes, Semarang, Klaten with independent variables considered constant. Then, the intercept value in 5 regency are resipro 24.7%, 24.8%, 24,9%, 25% dan 25% and the overall value of intercept cross section not statistically significant.

Random Effect Model was used to solve problems regarding the reduction of the degree of freedom, which would have an impact on the efficiency of the parameters to be estimated. The panel data estimation results using the Random Effect Model approach were obtained from the coefficient of determination (R2) of 0.5838. These results indicate that the variable of economic growth can be explained in the model of 58.38%. The results of the F-statistic value of 194.25, while the F value of the table is 3.03. It means that the regression coefficient of the CO_2 emission level and the poverty level has an F table value of 3.03, smaller than the calculated F value of 194.25. The level of CO_2 emissions and the level of poverty together significantly influence economic growth.

The estimation results of the random effect model approach in Table 8 indicates that the value of the partial regression coefficient of the CO_2 emission level has a positive effect, evidenced by the coefficient value of the CO_2 emission level of 2.96. While the significance of CO_2 variable is not significantly affect to economic growth. The value of probability is 0,458 upper the limit 0,05. It means that statistically, the level of CO_2 emissions not significantly influences economic growth.

Table 9. Random Effect Model

loggdrp.	Coef.	Prob.
Cons.	30,13	0.000
Logpov	-0,02	0.000
CO_2	2,96	0.458
R Squares	0.58	0.990
F Statistic	194.242	
02_Kudus reg.	0.45	
19_Banyumas reg.	0.38	
29_Pati reg.	0.27	
22_Brebes reg.	0.32	
10_Semarang reg.	0.33	

The number of poor people variable has negative effect to economic growth, evidenced by the number of poor people coefficient value is -0.02. The significance of t-statistics can be seen that the probability value is under 0,05. It indicates that the statistics t-value > t-table, means that the number of poor people statistically significantly influence economic growth.

The choice of the best approach in estimating panel data regression consisted of three tests, namely the chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The chow test was used to choose the most appropriate equation estimation used in the Pooled Least Square or Fixed Effect Model. The Hausman test was used to select the most appropriate equation estimation used in the Fixed Effect Model or Random Effect Model. While the LM test was used to select the estimated equation, which was most appropriate in the Pooled Least Square or Random Effect Model.

The selection of panel data regression estimation using the chow test method was by comparing the results of the Redundant Fixed Effect Tests estimation with the level of significance (α = 5%) used. The chow test estimation results are as follows:

Table 10. Chow Test

Effects Test	Statistic	Prob.
Cross Section F	29,00	0.000
Cross Secton Chi Square	453,88	0.000

The results of the Chow test (Table 10) give a chi-square probability number of 0.00, which indicates significance at the 5% real level, meaning that the pooled least square model is rejected, and the fixed effect model is accepted. The Fixed Effect Model approach was more appropriate to be used in this study in estimating panel data regression.

In the selection of panel data, regression estimation used the Lagrange Multiplier (LM) test method by comparing the calculated LM value with the chi-square critical value. The calculated LM value is higher than the critical value of chi-square, then Ho is rejected, which means accepting Ha where the best model used is the Random Effect Model. The calculated LM value is smaller than the critical value of the chi-square then Ho is accepted, which means rejecting Ha, where the best model used is the Pooled Least Square. The LM test estimation results are as follows:

$$\frac{35(8)}{2(8\text{-}1)}\left[\frac{8^2(1{,}40321)}{17{,}8436}-1\right]^2$$

The results of calculating the residual value of the multiplier Lagrange test in Table 4.6, it was obtained the final value of $LM_{calculate}$ as follows:

$LM_{calculate}$ = 325,289

The results of calculating the residual value of the LM test obtained the LM value of 325.2891. The critical value of chi-square at d.f 277 and the significance level of 0.05 or 5% shows the number 316.82, meaning that the LM count > the critical value of chi-square (325.29> 316.82). Ho is rejected, or in other words, the most appropriate model used in this study was the random effect model.

In the selection of panel data, regression estimates used the Haussman test method by comparing the Haussman Tests estimation results with the level of significance (α = 5%) used. The results of the Haussman test are as follows:

The Hausman test results give a probability number of 0.00, which indicates significance at the 5% level, meaning that the random effect model is rejected, and the fixed effect model is accepted. The test results could be concluded that the model that was more suitable for use in this study was the fixed effect model.

Table 1 showed the effect of Carbon Emission Levels (CO_2) on number of poor peoples. The t-statistic value is 0.57, where the t-table value is equal to 1.97. It means that the t-

statistic value is smaller than the t-table (0.57 <1.97). It means that the regression coefficient is not statistically significant. In other words, the level of CO2 emissions affects the level of poverty statistically significant.

The partial regression coefficient value of CO2 emissions is 0.10, which means that if the level of CO2 emissions in 35 regencies/municipalities in Central Java increase, the poverty rate will also increase. On the contrary, as the levels of CO2 emissions are declining, the poverty rate will also decrease. It means that 1 unit increases in CO2 emissions level will increase 10% of the poverty rate, whereas if the level of CO2 emissions decreases by 1 unit, it will decrease 0.10% of the poverty rate.

The equation of the fixed effect model is as follows:

$$LPov_{it} = \beta_1 + \beta_2 LGRDP_{it} + \beta_3 CO2_{it} + \varepsilon_{it}$$

Table 11. Fixed Effect Output

Var.	Coefficient	t-Statistic	Prob.
C	11.564	20.55	0.000
LGRDP	-0.015	-0.49	0.627
Co2	2.370	2.57	0.010

Source: Data processed

The interpretation from the fixed-effect model estimation are as follows:

$$LPov = 11.564 - 0.012\ LGDRP + 0.10\ CO2 + \varepsilon_{it}$$

Specification:

LPov = Log of number of poor people in regency or municipality

LGRDP = Log Gross Regional Domestic Regional Product in regency or municipality

CO2 = CO2 emission level in regency or municipality

Based on Table 5, the dependent variable is the number of poor people (data in logarithm format). The t-statistic value of LGDRP is -0,49 where the t-table value is 1.97. It means that the t-statistic value is greater than the t-table (-0,49<1.97). Thus, the regression coefficient is statistically not significant. Economic growth is statistically not be followed decreasing the number of poor people. This means the problem solving to poverty its not only focused on GDRP that give a trickle down effect but also another variable who can solve that problem. The trickle down effect is greater economic activity is expected to have an effect on smaller activities.

The coefficient of CO2 from the partial regression result is 2,37, which means that, when the Co2 in 35 regencies/municipalities in Central Java is increasing, the number of poor people will increase as well. The raising in level of carbon dioxide will decline the number of poor people. It means every grows 1 unit carbondioxide will decrease 2,36% of the number of poor people (poverty). On the contrary, if the carbondioxide slow down by 1 unit, it will lead the number of poor people raise up to 2,36 %.

The existence of these results prove the hypothesis that economic growth could decrease poverty. In Central Java, the number of poor people decreases with economic growth but not significantly in number.

By using different methods with our study, the impact of reducing poverty is not affected by the accelerating of economic growth. Economic growth in Brazil in the mid-1980s to mid-2000s was not proven to be a strong influence of poverty reduction by economic growth (Ferreira, et al. 2010).

However, some previous study reported that there are negative correlation between economic growth and reducing poverty. Suryahadi, et al. (2006) in their study concluded economic growth has negative impact on rural poverty (agricultural) and urban poverty (services).

Hassan *et al.* (2015) stated that income growth could decline the poverty number because it can increase job demand by an increase in production that boosts GDP value. Their research explained that the industrialization has a positive impact on decreasing unemployment because there is labor absorption in the industrial sector. Human resource ability to manage and exploit technology is expected to be able to increase personal skills. Thus, it will increase their productivity and income.

Industrialization accelerates economic growth often causes trade-off to environmental quality. Wang *et al.* (2013) in Wang *et al.* (2016) stated that economic growth is achieved through energy consumption that produces high CO_2 emission.

Furthermore, Wang *et al.* (2016) stated that rapid economic growth is achieved through energy consumption that produces a high level of carbon dioxide (CO_2). Industrialization acceleration will accelerate economic growth. A large number of industries induce a high level of emission produced in the industrial sector. The distribution and the increasing of environmental pollution are worse because there a small number of areas that absorb exhaust gas like carbon dioxide (CO_2).

In this research revealed that increasing of carbon dioxide significantly affect to the number of poor people. The efforts to reduce air pollution, especially carbon emissions, can turn out to be a strategy to reduce the number of poor people.

Besides, we run the first model to investigate the impact of economic growth and carbon dioxide (CO_2) to the level of poverty. We also conducted the investigation impact of the number of poor people and level carbon dioxide (CO_2) in the air to economic growth.

This second model constructed on the classical theory of economic growth, which is a function of population and capital. The variable population is believed to cause GDP to increase due to productive labor, while a lot of capital will cause growth also to grow because of its investment capability.

The result of testing the second model for

$$LGRDP_{it} = \beta_1 + \beta_2 LPov_{it} + \beta_3 CO2_{it} + \varepsilon_{it}$$

Table 12. Fixed Effect Output

Var.	Coefficient	t-Statistic	Prob.
C	24.07	11.99	0.00
LPov	-0.08	-0.49	0.62
Co2	2.45	0.97	0.57

Source: Data processed

The log of GRDP will be 24.07 when the variable of poverty and Co2 have been assumed not to influence significantly impact on dependent variables. Otherwise, the coefficient variable of LPov would have a negative impact on the GRDP variable (-0,08) but not significant. The coefficient of CO_2 is 2,45 and value of t statistic is 0,97 (lower than 1,97). This result give signal that economic growth in Central Java is driven by increasing of energy that produces carbon.

CONCLUSION

The levels of CO_2 emissions have significantly positive effect on number of poor peoples. Industrialization, as an application from the government's policy, has a negative impact on the environment and economic indicators. A large number of industries that cause energy absorption makes a high amount of CO_2 emissions. This as a result of the middle-income economic community, or those who work in the industrial sector become victims of high emission rates. The impact on workers from a poor work environment is that they will spend more money due to the declining quality of health. The wages that they should use to

fulfill their daily needs also contributed to the decline in the quality of their health care.

The level of economic growth has a negative but not significant effect on the level of poverty alleviation. Poverty in Central Java is declining but not proportional to the economic growth achieved by the province. Economic growth that occurs indicates that the increase in GDRP is dominated by sectors that require capital-intensive and do not need unskilled labor.

The middle to upper-class community dominates the economic development in Indonesia. So, the middle to lower classes only become a minority in economic growth process. When there is high-income inequality in an area, the poor will become more miserable.

The government should design and apply policies in industrial development. Environmental policy needs to be done to minimize fuel consumption in industrial processes. Thus, when economic growth increasing each year, it would not be followed by increasing of CO_2. In addition, there is needs to be environmentally friendly development. Thus, increasing economic growth also pays attention to environmental sustainability.

The government should be just in order to motivate the middle class and above. Thus, they can also contribute to the development of the Indonesian economy to reduce the current income inequality in Indonesia.

Firms should participate in protecting the environment by paying more attention to the waste screening process. Thus, the emissions that produced do not have a negative impact on the environment. The government sets the contribution of the industrial sector to GDP along with maintaining the quality of the environment and the awareness of businesspeople or innovators in carrying out environmental policies.

For further researchers, it is expected to be able to research the two-way relationship between economic growth, CO_2 emission levels, and number of poor peoples. Thus, it can be able to see in more detail the relationship between variables.

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APPENDIX

Panel data model 1

Fixed-effects (within) regression — Number of obs = 280
Group variable: kabkota — Number of groups = 36

R-sq: within = 0.0270 — Obs per group: min = 1
between = 0.0261 — svg = 7.8
overall = 0.0292 — max = 8

corr(u_i, Xb) = -0.2278 — F(2,242) = 3.36
Prob > F = 0.0363

loggdrp	Coef.	Std. Err.	t	P>|t|	(95% Conf.	Interval)
loggdrp	-.0115124	.023676	-0.49	0.627	-.581497	.0351249
t02	2.370197	.9218233	2.57	0.011	-5543751	4.186018
_cons	11.58485	.5636685	20.55	0.000	10.47453	12.69517

sigma_u	.82107919
sigma_e	.13301621
rho	.97442662 (fraction of variance due to u_i)

F test that all u_i = 0: F(35, 242) = 240.54 Prob > F = 0.0000

Panel data model 2

Fixed-effects (within) regression — Number of obs = 280

Group variable: kabkota — Number of groups = 36

R-sq: within = 0.0043 — Obs per group: min = 1

between = 0.6932 — svg = 7.8

overall = 0.5141 — max = 8

corr(u_i, Xb) = 0.4021 — F(2,242) = 0.52

Prob > F = 0.5934

loggdrp	Coef.	Std. Err.	t	P>|t|	(95% Conf.	Interval)
logpov	-.0847836	.1743624	-0.49	0.627	-.4282453	.258678
co2	2.446038	2.530674	0.97	0.335	-2.538923	7.43099
_cons	24.07073	2.00746	11.99	0.000	20.1164	28.0250
sigma_u	3386573					
sigma_e	.36097507					
rho	.46813314	(fraction of variance due to u_i)				

F test that all u_i = 0: F(35, 242) = 1.97 Prob > F = 0.0016

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