THE EFFECT OF THE IMPACT OF GROSS DOMESTIC PRODUCT AND ENERGY CONSUMPTION ON CARBONDIOXIDE EMISSIONS IN INDONESIA DURING 1985-2019 PERIOD

Putri Indah Lestari, Abdurrahman shaleh*, Syamsurijal A. Kadir, Abdul Bashir
Fakultas Ekonomi, Universitas Sriwijaya, Palembang, Indonesia

Abstract

Economic growth in Indonesia will have its own impact, both positive and negative. One of the negative impacts arising from this economic growth is environmental damage such as an increase in the amount of carbon dioxide emissions. The Indonesian economy itself is very dependent on energy consumption, which is still largely dominated by fossil fuels. This study aims to determine the impact of the Gross Domestic Product (GDP) and energy consumption on carbon dioxide emissions in Indonesia in the period 1985-2019. The data used are secondary data with annual quantitative type. The method used is multiple linear regression Ordinary Least Square (OLS). The conclusion from the results of this study is that GDP and energy consumption have a positive and significant effect on the level of carbon dioxide emissions.

Keywords: *GDP, Co2 Emission, Energy Consumption, Economic Growth.*

1. INTRODUCTION

Indonesia is a country that is formed from dozens of islands and provinces that have a diversity of ethnic cultures and an abundance of natural resources. Indonesia is a country with the second highest level of biodiversity in the world after Brazil. This fact shows the high diversity of biological natural resources owned by Indonesia and this will become the backbone of a sustainable economic development (green economy). The Nagoya Protocol itself formulates the granting of access and profit sharing fairly and evenly between the management and the countries owning the living natural resources, and contains an explanation of the mechanism for exploiting the wealth of natural resources. Indonesia is a country that is abundant in natural resources but for the management of these natural resources there is still a minimum of human resources and supporting technology, so that in managing it we still need assistance from a country that has the technology and competent human resources.

Currently, Indonesia is a country with the largest economy in the world, ranked 9th in the world based on GDP-PPP in 2015 (CIA World Factbook, 2016). The total population of 250 million people in 2015 (National Socio-Economic Survey, 2015) and total household consumption which reached 56.6% of total GDP or around 492 billion US Dollars (World Bank Data, 2016) in 2015 further illustrates the large share Indonesian market. This makes Indonesia have a real role in the world economy, which of course also has its own impact on the one hand. One of the issues that has surfaced is the economic impact on the environment, such as greenhouse gases. Among the 6 dominant gases in greenhouse gases, carbon dioxide (CO2) emissions are considered to have the greatest impact and also this CO2 concentration can persist in the earth's atmosphere for a long

*Coressponding author. *Email address:* shalehabdurrahman@yahoo.com

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time (UNFCCC, 2009). Judging from the percentage, CO2 represents 76 % of the total volume of greenhouse gases, is very large when compared to other gas components such as CH4 at 16% and N02 at 6% (IPCC, 2014). In a report presented by the UNFCCC, in 2009 total global CO2 emissions reached 31.3 billion tonnes, with an increase of 40% since 1990.

Indonesia's GDP is seen as a measure of economic progress, it continues to increase, seen from Indonesia's income from 1985 amounting to 228,786 billion rupiah until 2019 amounting to 1,204,479 trillion rupiah. However, it should be noted here that GDP also takes into account the contribution of companies and foreign citizens, so there is an assumption that most of the GDP is contributed by foreigners. This is certainly a bad thing, considering that there are several consequences. First, the GDP figure is considered large but is not felt in the form of an increase in welfare by the community. Second, economic progress that has its own impact on the environment, but the lack of reciprocal efforts from foreign parties in improving the environment. A real example is the natural damage to the Freeport mining area, as well as the damage to the Kalimantan forests due to oil palm plantations, which incidentally are owned by foreigners. It can be said that Indonesia has experienced two-fold losses, and raises the question of whether our economic progress must sacrifice the environment, especially if such economic progress is not felt directly and tends to be distributionally and regionally unequal.

According to Zarzoso, Morancho and Lage (2006) in their research on European Union member countries, the conclusion is that economic growth and technology intensity in energy use have a significant and positive effect on the volume of CO2 emissions. Even though they underline that the two countries that are actually the largest pollutants, namely Britain and Germany, have a negative correlation between economic growth and emission levels. Farhani (2015) in his research on Middle East and North Africa countries concluded that in the long term there was a positive correlation between energy consumption and economic growth on CO2 emissions. The same thing was also stated by Hubacek (2008), in his research on China from 1980 to 2002 using the VAR method and structural decomposition analysis, found that energy consumption and economic growth had a significant effect on CO2 emissions.

Up to this point, several studies that have been described previously have generally found that economic growth and the level of energy consumption have a positive and significant impact on CO2 emissions, although there are some exceptions for certain conditions, for example in developed countries or in long-term situations. Even so, there are several results from previous studies that generally show contradictory results from the research results in the previous description.

Based on the description above, the researcher is interested in researching "The Effect of the Impact of Gross Domestic Product and Energy Consumption on Carbon Dioxide Emissions in Indonesia in the Period 1985-2019"

2. LITERATURE STUDY

Economic Growth

The first person to discuss systematic economic growth was Adam Smith (1723-1790). According to Smith, people are given the widest freedom possible in determining what economic activities they feel are the best to do. Because the free market economic system will create efficiency, bring the economy to a condition of full employment, and guarantee economic growth to a stationary position. The stationary position occurs when natural resources have been fully utilized. Even if there is unemployment, it is temporary. The government does not need to interfere too deeply in economic affairs. The government's task is to create conditions and provide facilities

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that encourage the private sector to play an optimal role in the economy. (Tarigan, 2012).

Robert Solow develops an economic growth model known as the Solow Growth Model. The model departs from the aggregate production function as follows (Dornbusch et al., 2004):

$$Y = A.F(K,L)$$

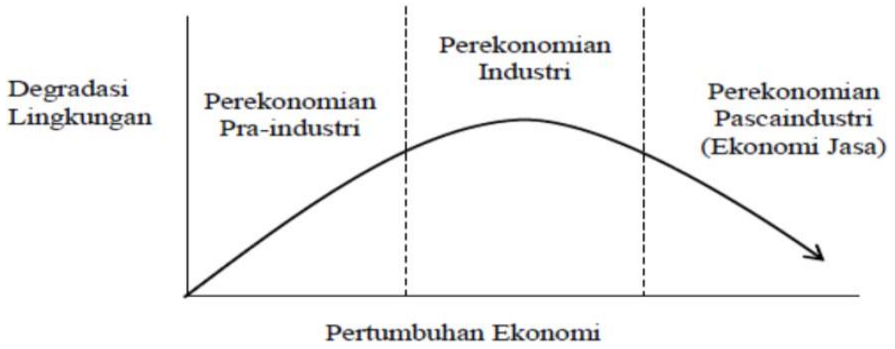
where Y is national (regional) output, K is physical capital (capital), L is labor, and A is technology. Y will increase as the input (K or L, or both) increases. An important factor affecting the provision of physical capital is investment. Y will also increase if there is a development in technological progress as indicated by an increase in A. Therefore, national economic growth can come from input growth and technological advancement — which is also known as total factor productivity growth. (Siregar and Wahyuniarti, 2007).

Economic growth reflects the development of a region's economic activity. The higher the economic growth of a region indicates the development of economic activities, both production, consumption, investment and trade activities in the area, which then has an impact on labor absorption (Widodo, 2006).

Enironmental Kuznet Curve

The Environmental Kuznets Curve (EKC) theory states that the case in developing countries over time, technological advances can destroy nature and the environment. Meanwhile, in developed countries over time technological advances can improve environmental sustainability. This theory is known as the first theory that describes the relationship between the rate of economic growth and environmental degradation. This theory states that when a country's income is still low, the country's attention - both in terms of production, is an investment that can encourage an increase in income by ignoring environmental problems. As a result, the income growth will be followed by the pollution level and then will decrease with the continued growth.

Gambar 1
Kurva Environmental Kuznet Curve



Sumber: Panayaotuo, 2003

The Environmental Kuznet Curve is divided into three stages, (Panayotou, 2003), among others; first, the beginning of the economic development process will be followed by environmental damage which is known as the pre-industrial economy; second, the industrial economic stage, and third, the post-industrial economic or post-industrial stage. Initially, industrialization started as a small industry and then developed into a large industry. This movement will increase natural resources and increase environmental degradation. After that, industrialization will expand its role

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in the formation of domestic national products. This occurs in the second stage, along with the investment that drives the economic transformation from the agricultural sector to the industrial sector.

In the third stage, there is a movement of economic transformation from the industrial sector to the service sector. This movement will be followed by a decrease in air pollution in line with an increase in income. Simultaneously, the demand for environmental quality goes hand in hand with an increase in income. The community began to be able to pay for environmental losses arising from economic activities.

Environment Externality

Environmental Damage and CO2 Emissions

In essence, environmental damage is a condition in which environmental quality decreases due to environmental components that are not functioning properly. Environmental damage can also be interpreted as direct and / or indirect changes to the physical, chemical and / or biological characteristics of the environment that exceed the standard criteria for environmental damage, as stated in Article 1 Number 17 (Law No.32 of 2009 concerning Protection and Environmental Management)

Based on the causative factors, environmental damage can be divided into two, namely:

1. Environmental damage caused by natural factors
   Natural disasters are natural factors that play a significant role in environmental damage. Some forms of natural events that have an impact on the environment are volcanic eruptions, earthquakes, tsunamis and hurricanes
2. Environmental damage caused by human factors
   Humans, as dominant living things in processing resources, often ignore the aspects of environmental sustainability and sustainability. This causes a loss of the balance of the ecosystem which results in disasters that could have been avoided.

Previous Research

The results of research conducted by (Dietz, 1997) entitled Effect of Technology and Affluence on CO2 Emissions show that an increase in economic growth will increase CO2 emissions while technology will reduce emissions. According to (Ghouali and Belmoka, 2015) it shows that energy consumption and economic growth have a significant positive effect on CO2 emissions, while FDI has a negative impact. Mesut's research (Bahbe, 2015) entitled Relationships among CO2 emissions, Economic Growth and Foreign Direct Investment and the Environmental Kuznets Curve Hypothesis in turkey using the VAR research method concluded that FDI economic growth has a significant impact on increasing carbon dioxide. Based on research (Danar, 2017) entitled Analysis of the impact of GDP and energy consumption on carbon dioxide emissions in Indonesia in the 1971-2013 period, it shows that GDP has a positive and significant impact on carbon dioxide emissions. As well as energy consumption is one indicator where the level of technology can be measured, where the widespread use of environmentally friendly technology can reduce energy consumption of fossil fuels. And research (Sweety & Mrutyuni, 2016) with the title CO2 emissions and economic growth of SAARC countries; evidence from a panel VAR analysis shows that economic growth has a positive impact on CO2 emission levels.

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3. RESEARCH METHODOLOGY

Data

The type of data used in this study is secondary data in the form of time series data. The data used includes data on CO2 emissions (metric tonnes), energy consumption data (per capita), and real GDP per capita. The data is sourced from the Central Statistics Agency (BPS) and related agencies.

Model Spesification

The analytical tool in this study uses multiple linear regression analysis based on Ordinary Least Square (OLS) with time series data along with statistical tests and classical assumption tests which aim to determine whether the data is worth estimating and to see the effect simultaneously on the dependent variable. The data processing tool used is eviews. The following regression equation model is used:

$$EMSt = \beta 0 + \beta_1 GDPt + \beta_2 ECON_t + et$$

Description:

EMS	= Co2 Emission
β0	= Intercept
β1, β2, β3	= Estimated Coefficient
GDP	= Gross Domestic Product (GDP)
ECO	= Energy Consumption
e	= error

4. RESULT AND DISCUSSION

Multiple Regression Test

Table 1. Multiple Regression Output

Dependent Variable: EMS
Method: Least Squares
Sample: 1985 2019
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-113.1010	7.178349	-15.75585	0.0000
GDP	2.04E-10	2.03E-11	10.04281	0.0000
ECON	14.86123	0.818412	18.15863	0.0000

R-squared	0.995123	Mean dependent var	313.5206
Adjusted R-squared	0.994818	S.D. dependent var	158.8977
S.E. of regression	11.43798	Akaike info criterion	7.793571

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Sum squared resid	4186.473	Schwarz criterion	7.926887
Log likelihood	-133.3875	Hannan-Quinn criter.	7.839592
F-statistic	3264.846	Durbin-Watson stat	0.519647
Prob(F-statistic)	0.000000		

Source: processed data

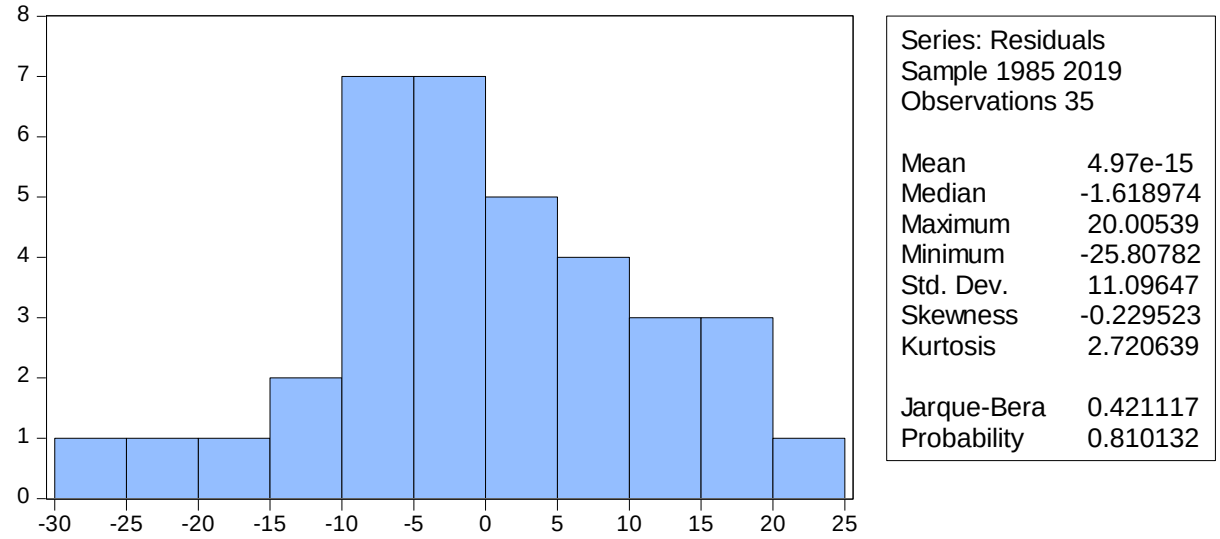
Based on the results of the statistical regression in Table 1, we conclude the results of multiple linear regression for the CO2 emission variable are as follows:

EMS = -113.1010 + 2.04E-10GDP + 14.86123ECON+ ei

The coefficient results show that the coefficient value for the Gross Domestic Product (GDP) variable is 2 billion and has a positive relationship, which means that when the GDP variable increases, it will increase Co2 emissions by Rp. 2M with a probability value of 0.000 <0.05 degree of error of 5% so that it is statistically significant to Co2 emission. The coefficient results for the variable Energy Consumption (ECON) 14.8612 which have a positive relationship, if the variable energy consumption increases, it will increase Energy Consumption by 14.8612, and if people's energy consumption decreases, the use of CO2 emissions will also decrease. The probability value of this variable is 0.0000 (ECO) with a degree of error of 5% (0.05), so that the energy consumption variable is statistically significant to CO2 emissions.

Normality Test

Figure 1. Normality Test



The normality test used in this study was the Jarque Bera Test. The results of the residual normality test in the attachment show that the jarque fallow value is 0.42111 with a p value of 0.8101 where> 0.05. so that H0 is accepted, which means that the data distribution residuals are normal.

Multicollinearity Test

Table 2. Multicollinearity Test Output

Variance Inflation Factors
Date: 05/20/21 Time: 20:41
Sample: 1985 2019
Included observations: 35

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	51.52870	13.78539	NA
GDP	4.14E-22	47.20787	8.446655
ECON	0.669798	84.28721	8.446655

Source : processed data

The data above shows that the value of Centered VIF for both Variable Gross Domestic Product (GDP), and energy consumption is below or less than 10, so it can be stated that there is no multicollinearity problem in the model.

Heteroscedasticity Test (Breusch-Pagan dan White)

Table 3. Heteroscedasticity Test Output

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.282401	Prob. F(2,32)	0.2912
Obs*R-squared	2.597095	Prob. Chi-Square(2)	0.2729
Scaled explained SS	1.867719	Prob. Chi-Square(2)	0.3930

Source : processed data

The heteroscedasticity test in this research model uses a test, namely the Breusch-Pagan test. In the heteroscedasticity test, namely the Breusch-Pagan test, it can be indicated by the Prob value. Chi square (2) at Obs * R-squared which is equal to 0.2729 or a p value of 0.2729> 0.05 then H0 is accepted or which means the regression model in the Breusch-pagan test is homocedasticity or in other words there is no problem with the assumption of non-heterocedasticity..

Determination Coefficient Test (R^2)

From the results of the calculation of multiple linear regression analysis, it can be seen that the value of the R2 coefficient is 0.99 which is almost close to 1.Thus, it means that CO2 emissions in Indonesia during the period 1985-2019 can be explained around 99% by the Gross Domestic Product variable and Energy Consumption. . While the remaining 1% is explained by other variables not included in this research model.

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F Statistic Test

The F test aims to determine the effect of all independent variables together (simultaneously)on the dependent variable.

Table 5. F-Statistic Output

F-statistic	3264.846	Durbin-Watson stat	0.519647
Prob(F-statistic)	0.000000		

Source: processed data

In the results of the table above, it is found that the F-count value with a significance level of 5% or 0.05 is 3264.846> F-table (0.343) and the F-count Probability value is 0.000 <0.05, so it can be concluded that H1 is accepted, that the independent variable is simultaneously (together) affect the dependent variable

GDP (*Gross Domestic Product)*

Based on the regression results shown in Table 1, it is concluded that during the 1985-2019 period, GDP and energy consumption influenced the level of CO2 emissions. If you look at the GDP variable coefficient of 2.04 with a positive sign, then the interpretation will be as follows, when GDP changes by 1%, it will cause an increase in the emission level of 2.04%.

These results are consistent with the research of Zarzoso, Morancho and Lage (2006) in their research on European Union member countries which concluded that economic growth and technology intensity in energy use have a significant and positive effect on the volume of CO2 emissions. Other results are also consistent with research conducted by Dietz & Rosa (1997) in 111 countries, where they concluded that economic growth will have an impact on increasing CO2 emissions.

In Indonesia itself, if we look at representing the conditions of other developing countries, a high GDP level does not determine if it is followed by environmental damage. This is because GDP also takes into account the production produced by foreign nationals / foreign companies so that most of the GDP is contributed not only from national production. This raises that the prosperity of the community cannot be said to be perfect or even. Because the community has not felt the impact directly. If the community is not in a state of prosperity yet, environmental sustainability is not yet a very important issue. This can be exacerbated by the environmental damage that occurred during the pre-industrial period to industry, where most of it was caused by efforts to increase production which incidentally was foreign production, and the country had little or no profit at all. It could be that the state has actually experienced a double loss, namely the environmental damage is getting worse, but the community has not felt the economic improvement (Danar, 2017)

Energy Consumption

The next variable is energy consumption. One component that affects economic development is the amount of energy use nationally. The increasing use of energy encourages the industrialization process. The energy demand in the manufacturing industry to run machines is indeed very high. On the other hand, energy contribution support, especially in export revenue and government revenue, is a means of accumulating development capital. By realizing that energy consumption is closely related to GDP, it can be estimated how much increase is needed to get a certain level of output.

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In general, Indonesia's energy consumption continued to increase constantly in the 1985-2019 period. Meanwhile, the energy consumption coefficient is 14,861, which means a change in energy consumption of 1% will cause an increase in the emission level of 14.86%.

The same thing was stated by Hubacek (2008), in his research on China from 1980 to 2002 using the VAR method and structural decomposition analysis, found that energy consumption and economic growth had a significant positive impact on CO2 emissions. Although there were several variables that were classified as having a significant impact on CO2, such as capital investment and export levels, economic growth and energy consumption were at the top of the list as causes of CO2 emissions. They also highlighted the absence of environmentally friendly technology in China's production and electricity systems, as two things that are closely related to economic growth and energy consumption.

5. CONCLUSION

Based on the results of the above research, it can be concluded that the condition of GDP, energy consumption and carbon dioxide emissions in Indonesia during the period 1985-2019 continued to increase. There are some decreases when there is a crisis or the implementation of new policies, but this decrease tends to be insignificant when compared to an overall increase. fluctuation.

GDP has a positive and significant impact on carbon dioxide emissions. This means that in Indonesia, when GDP increases, carbon dioxide emissions will also increase. Evidenced by the estimation results where GDP has a positive coefficient.

Energy consumption has a positive and significant impact on carbon dioxide emissions. This means that in Indonesia, when energy consumption increases, carbon dioxide emissions will also increase. Evidenced by the estimation results, where the energy consumption coefficient has a positive result. In addition, energy consumption is one indicator by which the level of technology can be measured, in which the widespread use of environmentally friendly technology can reduce energy consumption of fossil fuels. However, it can also lead to an increase in energy consumption through increased levels of efficiency, increased income and human nature which tends to be wasteful and ineffective.

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