

Economic Activity and Pollution: The Case of Indonesia 1967-2013

¹*Mohammad Rofiuddin, ²Tito Aditya Perdana, ³Nugroho SBM

¹Faculty of Economics and Business, Muhammadiyah University of Surakarta

²Agrocampus Ouest, Rennes- France

^{1,3} Faculty of Economics and Business, Diponegoro University, Indonesia

*Corresponding Author: r4f155@gmail.com

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Abstract

Increased economic activity accompanied with environmental pollution. The objective of the study was to analyze the effect of per capita GDP on CO₂ emissions and to prove the hypothesis of the Kuznets environment curve. Method for analyzing data by using multiple linear regression with quadratic equation. The results show that GDP per capita has a positive and significant influence on CO₂ emissions, as well as the square GDP per capita has a negative and significant influence on CO₂ emissions, so the Kuznets Environment Curve's hypothesis can be proven.

Keywords: CO₂ emission, GDP per capita, Kuznets Environment Curve

Jel Classification: F68, K32, O13

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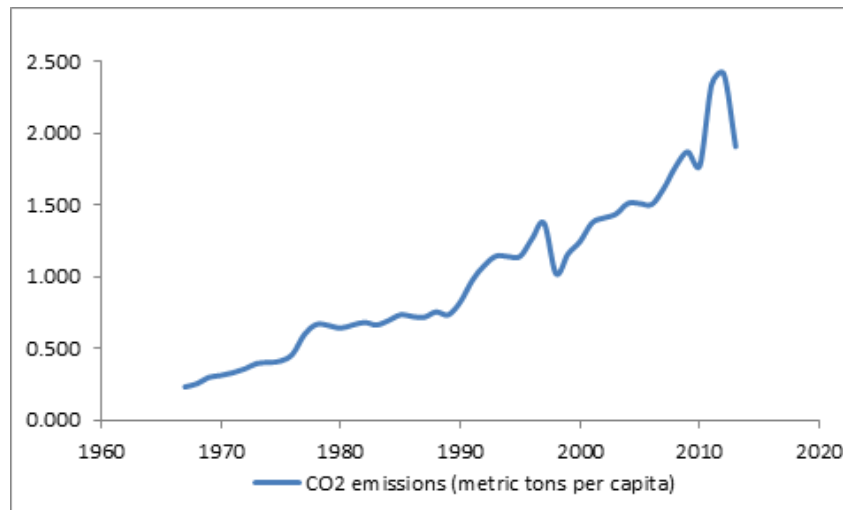
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1. Introduction

Economic development ultimately aims for the welfare of society which one of the parameters is economic growth. The increase in the economy shows or identifies the increase in welfare. But on the other hand in order to increase economic growth there are natural resources or environment that suffered damage and pollution. One of the negative impacts caused to the environment include air pollution, water pollution and soil contamination (Idris, 2016).

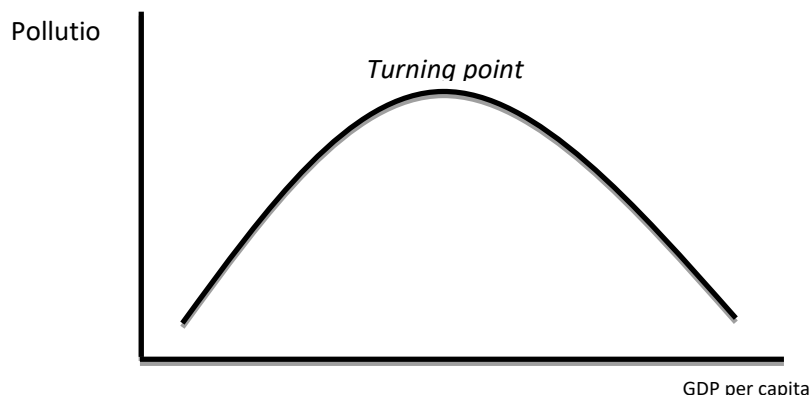
In fact, economic growth in every year both in developing and developed countries continue to be improved, even become a matter of the

great (*target goal*) in achieving it, so that all activities undertaken by the government and the private sector driven in the context of economic growth. Coinciding with the increase in economic growth, global warming and climate change are becoming something that has begun to be noticed. These conditions provide an illustration that economic development which is only intended to gain the maximum profit without regard to the sustainability of nature and the environment will bring the negative impact for nature and humans. Description of the damage can be seen from the condition of CO₂ emissions in Indonesia since 1967-2013 as shown in Figure 1.



Source: World Bank (2016)

Figure 1. Trend of CO2 Emission of Indonesia of 1967-2013



Source: Mir and Storm (2016)

Figure 2. *Environmental Kuznets Curve (EKC)*

Based on Figure 1 shows that the increasing of trend of CO2 emissions in each year. However there are certain years where CO2 emissions decrease. This condition gives an idea that CO2 emissions become obstacles in economic development that ultimately provide harm to humans.

Associated with the relationship between economic growth and environmental quality experts have tried to explain the relationship between growth and environmental contamination known as the Kuznets Environmental Curve (EKC). According to the EKC hypothesis that income growth in the early stages will have an

impact on increasing environmental damage, but at some point income growth will reduce environmental damage (Mercan and Karakaya, 2014). This is because with high income there is the ability to process waste better or in other words increased growth under certain conditions will affect the quality of the improved environment.

Economic growth is an increase in the ability of an economy to produce (potential GDP) over time. This increase occurs through an increase in the use of natural resources, human resources, or capital, or there is technological progress (Salvatore and Bartey, 2004). According to Adam Smith, the process of economic growth is

distinguished in two main aspects of total *output* growth and population growth (Arsyad, 2010). The basic elements of a country's production system are divided into three categories: 1) Availability of natural resources "land" is the most basic container of production activities, in which the amount of available natural resources has a "maximum limit" for the growth of an economy. 2) Human resources "population" holds a passive role in the process of output growth, means that the population will adjust to the needs of the workforce of a society. 3) The accumulation of capital owned by "capital stock" has the most important role in economic development identical as development fund.

Economy must always be developed, because it involves the livelihood of the people. However, the development of the economy finds a fairly complicated dilemma, namely economic development that is not in line with environmental preservation. Consequently, it will reduce the natural resources, pollution and land function. Economic development should not only be results-oriented, but also future-oriented with a focus on environmental sustainability (Jonny Purba, 2005).

The increase in high economic growth has to be paid at high prices as well as the increasing pollution and environmental damage. The worsening condition of the environment becomes an obstacle in creating sustainable economic development (Idris, 2016). This is not separated because of the pattern of relationships or between economic growth and environment.

The pattern of the relationship between economic growth and environmental pollution is implicit in the pattern of relationship of Environmental Kuznets Curve (EKC). The Kuznet curve concept explains the pattern of relationships between environmental quality measurements and per capita income. The higher per capita income at the outset is accompanied by increased environmental damage and at a certain point (*turning point*) with the increase in per capita incremental time accompanied with

declining of environmental degradation (Cuma and Yusuf, 2014).

Furthermore, the barometer of a successful development is the harmony between high economic growth and sustainable development, characterized by the absence of social destruction and natural destruction. Related to this matter, in development need to pay more attention to three way of view or pradiagma, development paradigm that is view by some side that environment is for economic development (*eco-developmentalism*), environment for human (*eco-humanism*), and environment for environment (*eco-environmentalism*) (Jonny Purba, 2005).

The empirical studies related to the *quznet curve environment* relationship as Arouri et al (2012), Annicchiarico et al (2014) and Mir and Storm (2016), which show that gross domestic product or per capita GDP is influential to CO2 emissions as well as to prove an inverted U. Meanwhile, studies conducted by Gupito and Kodoatie (2013), Khadaroo and Sultan (2012), Linh and Lin (2014), found no environmental curves inverted or unverified. In addition, other empirical studies conducted by Chebbi and Boujelbene (2008), Mercan and Karakaya (2014), found a correlation between economic growth and CO2 emissions, while Joo, Kim and Yoo (2015), found no causal relationship between economic growth and CO2 emissions. In summary from this empirical study, it can be argued that there are different phenomena associated with economic growth and CO2 emissions.

The subsequent systematic of this paper are organized by sub. Sub research method that discuss regarding the steps and tests in the research. Sub results & discussion is a sub, which presents the results and discussion based on test results. As well as the last sub, namely sub conclusion.

2. Research Method

Methods of data analysis in this study using multiple linear regression analysis model.

Regression analysis is a study of dependence of one dependent variable on one or more other variables (Gujarati and Porter, 2010). While the equation model in the study is based on the Kuznets Environmental Curve (*Environmental Kuznets Curve*) which discusses the relationship between increasing of welfare to environmental damage as follows:

$$CO2_t = \alpha + \beta_1 GDPp_t + \beta_2 GDPp_t^2 + ut_t$$

As for the conditions to form EKC, the variable must be significant and the parameter of income per capita is positive and the squares of income per capita is negative. Meanwhile, to find out on GDPp how much the maximum of CO2 emissions, then seek for the partial derivation of level 1 of the equation in the estimation and to be equaled to zero.

Data type used in this research is secondary data which is time series data of the year 1967-2013. These data include; 1) GDP per capita (GDPp) is the product of gross domestic product divided by the middle population of the year. Gross Domestic Product (GDP) is the sum of

gross added value by all residents in the economy plus product taxes and minus subsidies that are not included in the value of the product, in dollars. 2) CO2 emission (CO2) is carbon dioxide emissions from burning fossil fuels and cement making. They include carbon dioxide generated during solid, liquid, and fuel gas and gas burning consumption, with metric tons per capita. While source of data in this research is sourced from the World Bank.

3. Result and Discussion

Descriptive gives an overview of data and dissemination of data used in this study. The depiction of the data includes the average (*mean*), the highest value (*maximum*), the lowest (*minimum*) value and the standard deviation value that describes the dissemination of this research data.

Based on Table 1, shows that the lowest value of CO2 emissions reached 0.23 metric tons per capita, while the highest reached 2.42 metric tons per capita. The lowest per capita GDP of 56.47 dollars and the highest reached 3700.52 dollars. As for the figure in time series is as shown below.

Table 1. Descriptive Statistic of Data Research

Variable	Minimum	Maximum	Mean	Std. Deviation
CO2 Emission	0.23	2.42	1.0048	.55687
GDP Per Capita	56.47	3700.52	934.0845	949.23276

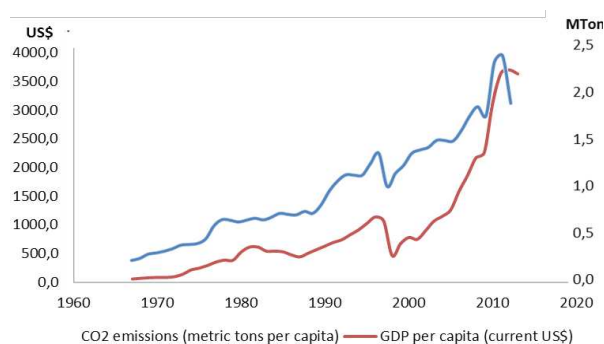


Figure 3. Trend of CO2 Emission and GDP Per Capita of the Year 1967-2013 in Indonesia

Table 2. Result of Research Model Estimation

$$\text{CO}_2 = 0.230 + 0.001\text{GDP}_t - 1.768\text{E-}07 \text{GDP}_t^2$$
$$(4.690)^* \quad (13.383)^* \quad (-7.552)^*$$

$$\text{R-squared} = 0,924; \text{F-statistic} = 266,217; \text{sig. F} = 0,000^*$$

Note: * Significant at $\alpha = 0,01$; ** Significant at $\alpha = 0,05$; *** Significant at $\alpha = 0,10$

The results of model estimation used in this study by using linear regression in summary as Table 2.

The results showed that sig. F of the regression model used in the study that is $0.000 < 0.01$. These results indicate that the regression model used in this study is feasible to be used as a regression model for hypothesis testing.

GDP per capita variables have t value $13.383 > 2.012$, which shows the influence of variable GDP per capita on CO₂ emissions occurred in Indonesia, with a sign of positive coefficient. As for quadratic variables GDP per capita has a value of t arithmetic $7.552 > 2.012$, which shows the influence of variable per capita GDP square to CO₂ emissions occurred in Indonesia, with a sign of negative coefficient. These results also show the formation of EKC, as the condition are fulfilled and in accordance with the Kuznets hypothesis which states that an increase in per capita income will initially lead to high CO₂ emissions or decreased environmental quality, but at a certain point (time) increasing of per capita will decrease CO₂ emissions or improve environmental quality.

The *turning point* can be obtained by calculating the first derivative of the main equation $\text{CO}_2 = 0.230 + 0.001 \text{GDP}_t - 1.768\text{E-}07 \text{GDP}_t^2$, being $\text{CO}_2 = 0.001 - 3.536\text{E-}07 \text{GDP}_t$ or so the GDP per capita value of 1489.9 US \$ *turning point*, and this condition has been achieved in 2005-2006. Obtaining the turning point in accordance with the hypothesis of Kuznets indicates that the condition of air pollution (CO₂ emissions) in Indonesia is improving. However, the curve occurring in this study is the increase in per capita income in line with the increase in CO₂ emissions, although turning points have

been achieved, so the shape of the curve will not be like EKC. This can certainly be clearly seen from the *turning point*.

The empirical results of this study are in line with the results of studies conducted by Arouri et al (2012), Annicchiarico, et al (2014), and Mir and Storm (2016), which shows the influence of per capita GDP on pollution and Kuznets curve can be proven. However, the results of this study are not in line with the research of Gupito and Kodoatie (2013), Khadaroo and Sultan (2012), Linh and Lin (2014), that found no U-inverse of EKC. This means that based on these results indicates that increasing output will have implications for increased emissions as a result of economic activities that can be worsen environmental quality. However, at certain times the increase in output is accompanied by declining emissions as an implication of improvement of economic activity.

4. Conclusion

Based on the results of the study on *economic activity accompanied with pollution*, it can be concluded that GDP per capita has a positive and significant influence on CO₂ emissions occurred in Indonesia. GDP square per capita has a negative and significant impact on the CO₂ emissions occurred in Indonesia. The hypothesis of the curves of Kuznets is can be proven.

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