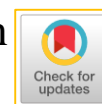


# Investigating the theory of environmental Kuznets curve on environmental quality index in Indonesia



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## ABSTRACT

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The relationship between economy, environment, and human capital has developed into a discourse that has attracted the attention of all parties, especially academics. The inconsistency of research results that occur in developing and developed countries is our basis for conducting research with the hypotheses that have been built. This research aimed to determine the effect of human capital and gross domestic product on environmental quality in Indonesia. This study used panel data during the 2015-2020 period. The ordinary least square analysis measures the effect of the independent variables on the dependent one in the model. The results of this study indicate that human capital has a positive and significant impact on improving the quality of the environment. There are several aspects on which human capital can positively affect the environment, one of which is education. On the other hand, an increase in GDP has an inverse effect on the environment. This is because the economy's orientation in developing countries still focuses on the industrialization sector, which negatively impacts the environment. Moreover, this is reinforced by the low level of supervision carried out by the regional or central government.

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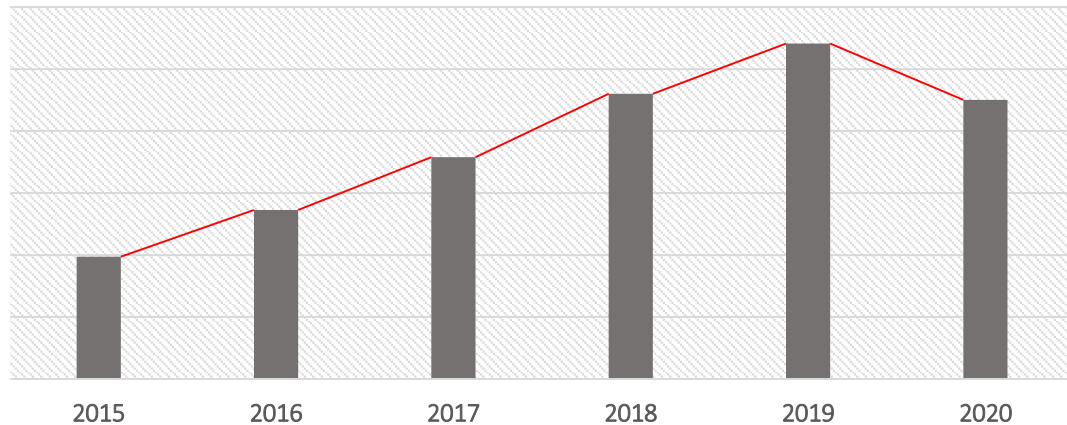


## 1. Introduction

Concerns about the current state of the earth are increasing due to its complex impacts on human life. One of the causes of environmental degradation, for example is the impact of economic activities on the environment. The potential for natural disasters is closely related to nature's response to destructive human activities. Therefore, prevention and renewal are needed to maintain the substantial value of the environment. Hence, it is necessary to investigate the relationship between economic growth and environmental damage. The Environmental Kuznets Curve (EKC) suggests a negative relationship between an increase in gross domestic product (GDP) and environmental quality. The EKC hypothesis explains that an increase in GDP will cause a decrease in environmental quality. However, over time income increase exceeding a specific limit can improve environmental quality (Stern et al., 1996). Quality improvement is caused by the birth of various innovations that can minimize environmental degradation and the existence of policies that emphasize ecological aspects so that environmental ecosystem stability and economic progress can be realized. This study aims to conduct an analysis related to environmental quality based on the Kuznets theory hypothesis.

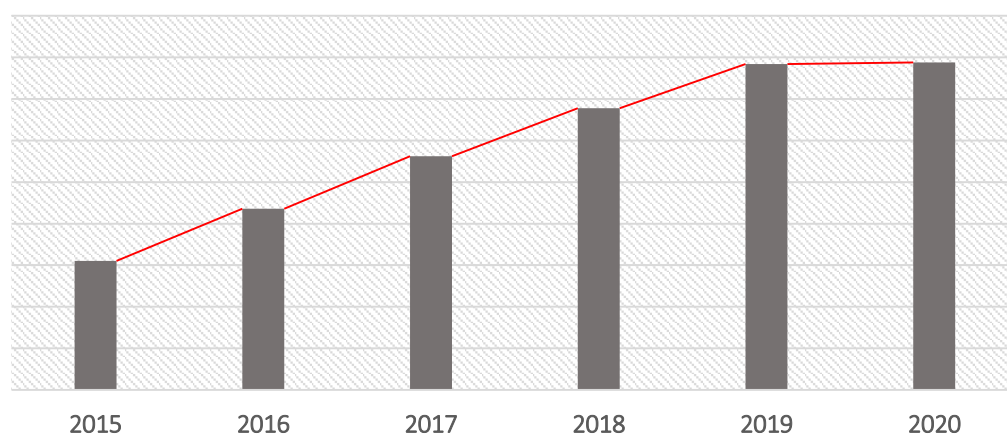
Empirically, the EKC is a hypothesis widely used for various studies discussing the correlation between economic and environmental aspects (Cole et al., 1997). The EKC focuses on the impact of changes in the economic sector that will affect the environmental balance. In a more profound study, the EKC emphasizes environmental protection. In other words, the EKC hypothesis explains the

relationship between economic aspects (GDP) and environmental quality, explaining that various economic activities will cause a decrease in environmental quality (Dinda, 2004). However, the concept of sustainable development, the EKC hypothesis has received various oppositions. This opposition is because many other factors can affect environmental quality. Therefore, this study aims to include social aspects measured through human capital as an analysis variable.



**Figure 1.** Economic growth of ASEAN emerging market countries 2010-2023.

In this modern era, GDP measures a country's economic level. Previous studies on GDP and the quality of environment have received attention from various sides (Bakirtas & Cetin, 2017). Figure 1 shows there was an increase in growth in Indonesia's GDP from 2015 to 2020. There was a positive development trend during this period, although there was a decline in the last year of analysis. The decrease in Indonesia's accumulated GDP in 2020 occurred due to the virus (COVID-19) outbreak, which caused multidimensional damage (economic, social, and health). An increase in GDP provides a good perspective for developing countries because an increase in GDP will cause a multiplier effect for other sectors. However, according to the EKC hypothesis, an increase in GDP will cause a decrease in environmental quality (paradox of growth). Grossman and Krueger (1995) founds hat there was a decrease in environmental quality along with the growth rate of GDP, and this finding is in line with several other findings such as Abbasi et al (2022); Brooks (2011); Wang et al (2016); Xepapadeas (2005). However, this condition depends on the condition of the country concerned, Narayan (2010) found varied results related to the EKC hypothesis based on the group of countries that were the object. Economic conditions, measured through an increase in GDP, provide a good perspective for a country, especially developing countries, and means an increase in GDP can cause a multiplier effect for other aspects.



**Figure 2.** Human Development Index (HDI) in Indonesia.

The EKC hypothesis has received much opposition from various parties. This debate is not only the economy that affects environmental quality, there are other factors and in this study including a human capital. Figure 2 shows that HDI in Indonesia increasing over time but a not-so-significant increase occurred from 2019 to 2020. Balaguer and Cantavella (2018) argue that human capital will

be crucial in balancing the economy and the environment. Furthermore, high human capital can give birth to various innovations and technologies that can minimize various risks that can impact the environment (Lan et al., 2012). The practical and efficient utilization of natural resources depends on humans as the central role.

Integrated economic growth is not only measured by how fast the increase in GDP is each period but there are supporting factors, namely human capital (Fauziyah & Trisnawati, 2022). Pambudi (2020) hypothesizes that increasing human capital will improve an area's environmental quality. This hypothesis is further supported by Marshall (2017) that argued good environmental quality reflects high-quality of human capital, as humans actively influence the environment (Hidayati & Zakianis, 2022). Because a clean environment is viewed as a luxury good (Ross, 2019). Several studies, there is a debate regarding the role of human capital in the environment. Martinez (2003) states that education has increased emissions, which aligns with other research such as Hill et al (1955) and Williamson (2017). However, Balaguer and Cantavella (2018) found that a high education level can improve environmental quality. The phenomenon can explain that in low-income countries, an increase in education can give poor people greater access to polluting technologies, such as cars, motorcycles, air conditioners, etc. The debate on human capital and the environment is like two sides of a coin that cannot meet a transparent meeting point, so this is what encourages us to further study the validity of the affect of human capital on the environment in Indonesia.

Fundamentally, environmental degradation is a phenomenon that occurs due to an imbalance that causes environmental degeneration through a decrease in the quality or quantity of the asset. The phenomenon related to environmental degradation have received much attention from all parties, including the United Nations (UN). The UN has determined that 2013-2024 is the green period (SE4ALL, 2013). Indonesia, as a member, supports this idea by setting several short and long-term goals related to the economy and the environment based on sustainable development (Lestari et al., 2020). Thus, this study aims to analyze the correlation of factors that "might" affect the decline in environmental quality. In the study discussed this time, GDP and human capital are used as parameters that affect the balance of environmental quality and to measure environmental quality, because those variables are suspected of having a high correlation (Schultz, 1988).

## 2. Method

Study focuses on various factors that affect the quality of the environment in Indonesia during 2015-2020. The data used is based on 34 provinces in Indonesia. Panel data results from a combination of time series and cross-section data. One of the factors in choosing panel data as research material is that panel data can minimize bias and overcome heterogeneities (Gujarati & Porter, 2012). The data used is of the secondary data type during the 2015-2020 period, which was obtained indirectly through the publication of related parties, which parties have high credibility in terms of data publication, such as the Badan Pusat Statistik Indonesia (BPS), and the Ministry of Environment and Forestry. The research carried out this time uses the human development index and gross regional domestic product variables as the dependent variable and the Environmental Quality Index as the independent variable.

**Table 1.** Variable List

Name	Notation	Measurement	Source
Quality of Environment	QE	Index = 100	menlhk.go.id
Human Capital	HC	Index = 100	BPS.go.id
Gross Domestic Product	GDP	Rupiah	BPS.go.id
Population	P	People	BPS.go.id
Gini Ratio	GR	Index	BPS.go.id

Source: World Bank, IMF and CEIC data.

The equation of the panel model based on Hayat et al (2023) as follows:

$$QE_{it} = \beta_0 + \beta_1 HC_{it} + \beta_2 GDP_{it} + \beta_3 P_{it} + \beta_4 GR_{it} + \varepsilon_{it} \quad (1)$$

Where  $QE$  is the index of quality of environment;  $HC$  is the human development index;  $GDP$  is gross domestic product;  $P$  is the total of population;  $GR$  is the gini ratio;  $\beta_0$  is the constant;  $\beta_1 - \beta_4$  is the coefficient of independent variables;  $it$  is the notation,  $i$  for cross-section and  $t$  for time-series and  $\varepsilon$  is the error term. Panel data regression has three approaches are used as reference in estimating

models, such as the common least square model (CEM), fixed effect model (FEM), and random effect model (REM). These three approaches are used to find the best model. However, several statistical test techniques, such as the Chow Test, Hausman Test, and Lagrange Multiplier, must be carried out before determining the best model. Then, after getting the best model, other statistical test are carried out, which include the classic assumption test and the significance test.

### 3. Results and Discussion

The first step is to estimate the panel regression model, from common least square model (CEM), fixed effect model (FEM), and random effect model (REM). These three approaches are used to find the best model based on Chow test and Hausman test. In this study, to find best model has to apply the classical assumption for panel data as the diagnostic tools.

**Table 2.** Result of Diagnostic Tools

Test Summary	Statistics	Prob
Cross Section Chi-Square (Chow test)	168.626	0.000***
Cross-section Random (Hausman test)	17.325	0.001***
Classical Assumption for FEM		
Normality Test	1.535	0.464
Multicollinearity Test	None of variables have a correlation value above 0.70	
Heteroskedasticity Test	All models have coefficient values above 10 percent	

Source: data processed

Table 2 shows the probability value of cross-section Chi-square  $< 0.05$ , the result can be determined that the FEM should be applied and for hausman test the probability value is less than  $< 0.05$  and means that the best model for panel data is FEM, to get the best results from FEM, research applying the classical assumption test on the model. Table 2 shows the probability value of Jarque-Bera is at  $0.464 > 0.05$ , conclude the residual of panel data is normally distributed. The term multicollinearity refers to the existence of an ideal or perfect linear relationship among some or all of the independent variables contained in the regression model and all variables used in the study none have a correlation value above 0.70, it means that model does not multicollinearity problem. The heteroscedasticity test uses the Glesjer approach where the residual value of the FEM is used as the dependent variable and the the probability value of the independent variable is  $> 0.10$ . The high probability value indicates that the variables included in the model are entirely free from the problem of heteroscedasticity.

**Table 3.** Result of Partial Test

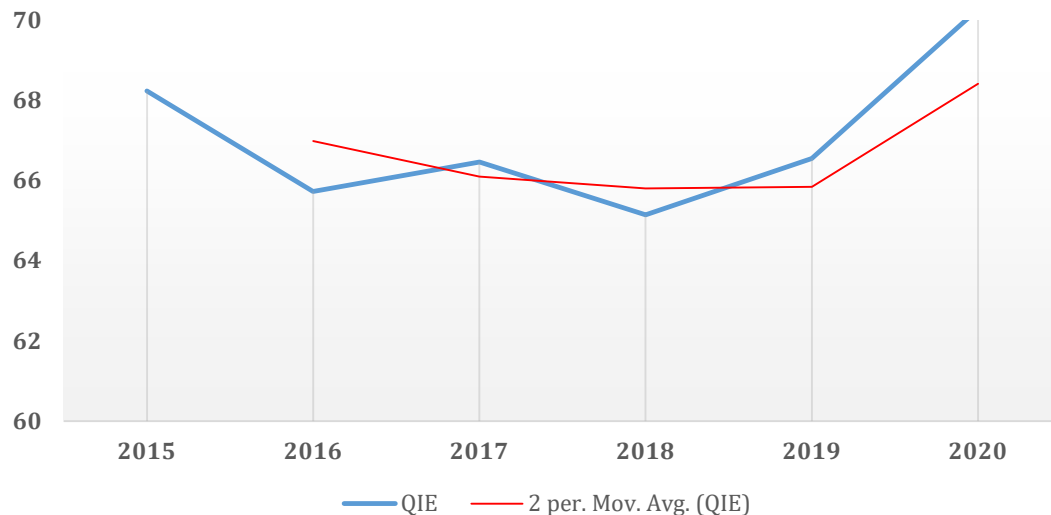
Variables	T-Statistics	Prob
HC	2.767	0.006
GDP	-2.390	0.018

Source: data processed

Table 3 shows the probability value of the HC is 0.006 and the GDP variable is 0.018. The probability value, is lower than alpha ( $\alpha$ , 5%) or 0.05, it means that the HC and GDP significantly affect on the QE. Furthermore, the partial test output results show the significance level of the independent variable to the dependent variable. Many authors have attempted to validate the Environmental Kuznets Curve (EKC) hypothesis, which is inverted U-shaped. In this modern era, a country's economy is measured based on its total cumulative income, and GDP is one of its parameters. Based on the estimation results, the relationship between GDP and environmental quality aligns with the EKC hypothesis. It is known that an increase in GDP can cause a decrease in environmental quality. If the EKC hypothesis is linked with the inverted U-shaped curve of the EKC hypothesis, it can be concluded that Indonesia is in the early stages of growth. It can be seen that during the analysis period, Indonesia's GDP experienced an increasing trend, while in Figure 3 shows it is known that the environmental quality remains stagnant at a moderate stage with an average of 67% (moving average line).

The rationale is that the increase in GDP occurs due to the increasing industrialization activities. The industrialization sector often exploits resources. The correlation between industrialization and

exploitation usually utilizes infrastructure facilities to accelerate growth. This growth frequently adopts dirty practices (Abbasi et al., 2022). Therefore, in this case, the government should implement a series of efficient and effective policies to maximize the industrial structure (Wang et al., 2016). In the context of developing countries such as Indonesia, the portion related to the role of the government in designing policies becomes an essential aspect in minimizing community environmental degradation (Xepapadeas, 2005; Zilio & Recalde, 2011), especially the economy of developing countries, more focused on the industrialization sector (He et al., 2020).



**Figure 3.** Indonesia Statistics of Environmental Quality

The analysis examining the relationship between the economy and environmental quality has become a study widely discussed and debated by many parties. In the 1970s, it was said that consumption activities (resources) experienced growth at the same point as the economy. However, at the beginning of the period, a view emerged stating that the limitations on the availability of resources would hinder economic growth. In the last 30 years, environmental aspects have received attention from all parties, as evidenced by the application of new environmentally based technologies and the existence of consumption orientation, with many institutions or agreements formed. Therefore, at this time, individual awareness of environmental problems is much higher compared to the 1970s period (Meadows et al., 2006).

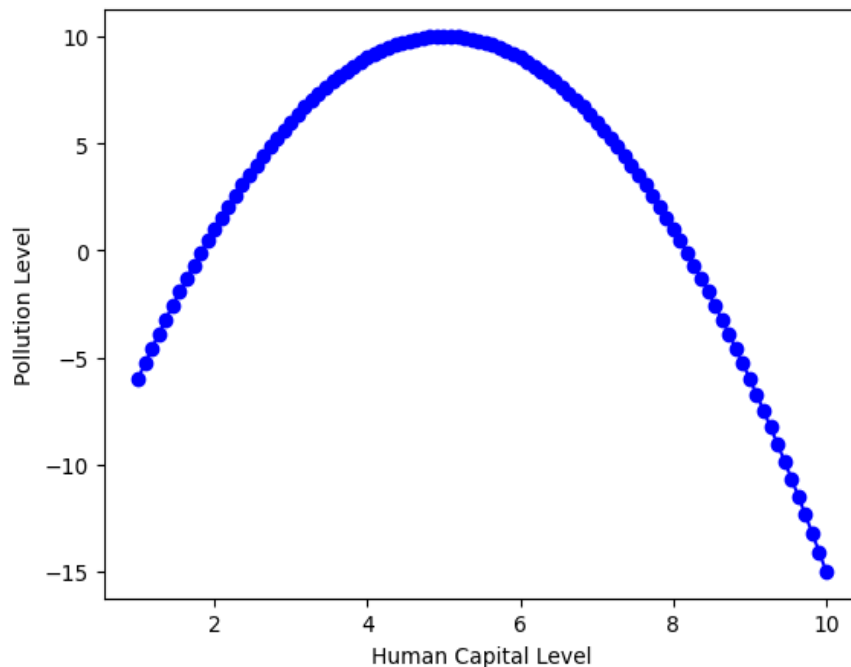
**Table 4.** Result of Fixed Effect Model (FEM)

Variables	Coefficient
C	203.574 (0.020)**
HC	1.837 (0.006)***
GDP	-0.0006 (0.018)**
P	-27.960 (0.028)**
GR	-29.711 (0.314)
Another Result of FEM	
F-Stat	17.372***
Adj R-Squared	0.751

Source: data processed

Table 4 shows The effect of HC on QE has a positive and significant impact, which is in line with studies on the same basis (Balaguer & Cantavella, 2018; Sapkota, 2017). High-income countries like Indonesia will continue to strive to improve environmental quality through various things, such as formulating policies (short- and long-term). Some of the Indonesian government's environmental targets before reaching 2060 include reducing emission intensity by almost 68%, carrying out

environmental restoration, increasing mangroves on the coast, and increasing the coverage of green open spaces (Lestari et al., 2020). Figure 4 shows the relationship between pollution and HC is explained. If examined more deeply, this curve is an extension of the EKC that has been modernized by adding social aspects. Simply put, the increase in human capital is underpinned by advancements in education. Increased HC will be oriented towards applying more environmentally friendly technology, which can undoubtedly reduce emission levels.



**Figure 4.** The Relationship of Emission and Human Capital

The coefficient of determination (adjusted R-squared) is a measure to explain the effect of independent variables used in the model rather than out of a model in regression based on the dataset. Table 4 shows that the independent variables included in the model can explain the variation of the dependent variable by 75%. The model is ideal for interpreting the research result when the adjusted R-squared value is close to 1 (one).

#### 4. Conclusion

One of the causes of environmental degradation, for example is the impact of economic activities on the environment. The potential for natural disasters is closely related to nature's response to destructive human activities. Therefore, prevention and renewal are needed to maintain the substantial value of the environment. The study's results have the opposite effects from the theories of EKC. The first impact explains that the increase in HC through education can improve the quality of the environment. This increase arises because of social and environmental awareness that can help improve environmental quality. The second impact is that increased HC will increase the GDP rate. However, this GDP increase depends on the advanced industrial sector, which needs to prioritize environmental elements.

The second effect fits the conditions in developing countries. Furthermore, the results of this study successfully confirm the suitability of the theory and hypothesis that have been built. These findings also provide validity that strengthens previous research. There are differences in conditions and situations between developing countries and developed countries. This difference is seen in the role and policies of the government towards the relationship between the economic sector and the environment, so the government must prioritize various environmental management programs. Through the Environmental Kuznets Curve hypothesis, this study only proves the relationship of HC and GDP to the environment, and this is our limitation in this study. Future research examines the causality relationship between economic, social, and other aspects of life.



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