



ORIGINAL RESEARCH ARTICLE

Environmental quality and macroeconomic phenomenon

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ARTICLE INFO

Article History:

Received 14 September 2023

Revised 18 November 2023

Accepted 22 December 2023

Keywords:

Economic growth
Environmental quality
Environmental taxes
Government spending
Industrialization
Inflation
Unemployment

ABSTRACT

BACKGROUND AND OBJECTIVES: This study aimed to analyze the influence of economic growth, industrialization, government spending, and environmental taxes on environmental quality as well as the influence of environmental quality, unemployment, and inflation on Indonesia's economic growth. This condition is important to maintain environmentally friendly economic development to achieve sustainable development.

METHODS: The study was conducted using simultaneous equation model analysis considering classical assumption tests such as normality tests, granger causality and heteroscedasticity. This study data began in 2015 to 2021 in 34 provinces in Indonesia. In this study, the determinants of environmental quality used were industrialization, government spending and environmental taxes, whereas those of economic growth were unemployment and inflation.

FINDINGS: The results of the study indicate that economic growth, industrialization, government spending and environmental taxes have a significant effect on Indonesia's environmental quality. Collectively, these determinants account for 22.18 percent of the variance. However, environmental quality and unemployment do not have a significant effect on Indonesia's economic growth. Meanwhile, inflation has a significant effect on economic growth. Simultaneously, the influence of the determinants of economic growth is 33.52 percent.

CONCLUSION: Economic growth, industrialization, government spending and environmental taxes have a significant influence on Indonesia's environmental quality. On the other hand, environmental quality and unemployment do not have a significant effect on Indonesia's economic growth. Meanwhile, inflation has a significant effect on economic growth. The policies suggested, include the following 1) the government must be able to maintain environmental quality while still encouraging economic growth, implemented by creating an environmentally sound growth concept or applying the green economic concept to harmonize growth and the environment; 2) the industrialization process must be maintained so that it does not damage the environment, and pollution threshold rules created in the industrialization process must be applied.

DOI: [10.22035/gjesm.2024.02.23](https://doi.org/10.22035/gjesm.2024.02.23)

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NUMBER OF REFERENCES

51



NUMBER OF FIGURES

3



NUMBER OF TABLES

8

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Note: Discussion period for this manuscript open until July 1, 2024 on GJESM website at the "Show Article".

INTRODUCTION

Environmental problems have become a very serious topic of discussion and attention in the world (Umar *et al.*, 2020; Mohadesi *et al.*, 2023; Samimi, 2024). Widespread pollution poses a real threat to industrialized countries, whereas quality of life until recently was measured almost solely by the growth of material output alone (Anwar *et al.*, 2020; Samimi and Nouri, 2023). Natural resource management should refer to aspects of environmental conservation and preservation. Exploitation of natural resources that is only economically oriented has not only positive economic effects but also negative effects for the continuity of human life. Economic growth targets and environmental quality improvement have become the main focus in achieving sustainable development carried out by organizations, governments and international institutions. In terms of energy use which is closely associated with carbon and pollution, it must be correlated with the improvement of industrial infrastructure to avoid detrimental impacts on human health, this step will lead to the reduction of global warming and thus requires countries to provide funding so that this goal can be achieved. One of the efforts made is strengthening the policy base to anticipate the risk of high emissions and reduce fossil energy to renewable energy globally (Dube and Horvey, 2023; Moghadam and Samimi, 2022). Environmental quality has made people aware of the importance of renewable energy which is more environmentally friendly (Samimi and Moghadam, 2024). Fiscal space in a country must focus on the energy transition in the long term in order to maintain production nationally and globally with policy mechanisms that lead to economic development (Raihan and Tuspekova, 2022; Appiah and Korankye, 2021). The process of achieving environmental sustainability needs to be adopted using a technological approach in processing natural resources in carrying out the framework as a policy function developed with an endogenous growth model in the scope of economic development (Aydin and Bayrak, 2016; Huo *et al.*, 2023). Economic growth is a fundamental factor for analyzing a country's economic achievements. The composition of growth needs to be based on economic activities with the intensity of trade and industrialization both from within and outside the country. The opportunity to design economic activities based on the perspective of environmental sustainability is a challenge in itself for a country with a more innovative pattern. The development of a country that has

achieved industrialization is encouraged to transform toward stages of large-scale economic change by providing policy alternatives that support these stages (Dogan *et al.*, 2022; Tang *et al.*, 2022). Productivity is seen as a factor to improve the level of the economy starting from investment which has an impact on the availability of capital, technological progress, trade and market expansion. This is very important for the process and quality of growth which will ultimately provide greater opportunities in the production scale which is supported by increased manufacturing capacity in industrialization so that it is able to produce the required goods and services (Varvarigos, 2023; Salman and Hosny, 2021; Azimi, *et al.*, 2019). One measure of whether the environmental quality of an area is good or not can be seen from the Indonesian Environmental Quality Index (IEQI) built by the Ministry of Environment and Forestry. This index is calculated from composite values in the form of water, air, land, and sea water quality indices. The temporary environmental quality index for 2021 is in the good range. Based on the trend since 2015, the environmental quality index tended to increase although it decreased in 2016 and 2018. A sharp increase occurred from 66.55 points in 2019 to 70.72 points in 2020 (Fig. 1).

Environmental quality is closely related to economic growth as in the long term production must consider the environment so that it is not damaged due to excessive exploitation of natural resources in achieving development targets (Shahbaz *et al.*, 2019; Adu and Denkyirah, 2019).

As can be seen from Fig. 2, Indonesia's economic growth trend tends to improve from 2015 to 2021 before finally becoming -2.07 percent (%) in 2020. The rise and fall of the phenomenon of Indonesia's economic growth is caused by many factors, both economic and noneconomic factors. Of course, the phenomenon of economic growth has an impact on the quality of the environment itself. The phenomenon of environmental quality and economic growth has been investigated by many previous studies (Shahbaz *et al.*, 2019; Anwar *et al.*, 2020; Salman and Hosny, 2021). However, there are still very that examine the direct association between environmental quality and economic growth. This connection is important to see whether environmental quality and economic growth really influence each other or not, regardless of other factors that determine the focus of the two studies. Therefore, this study aimed to improve on previous studies by analyzing the association between environmental quality and

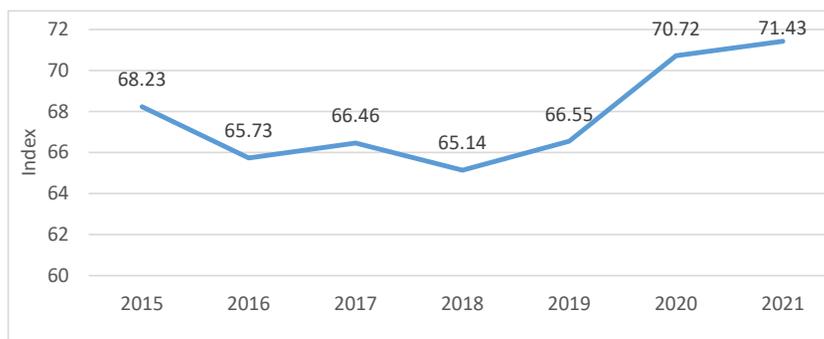


Fig. 1: Indonesian environmental quality index in 2015 to 2021 (Kementerian, 2022)



Fig. 2: Indonesia's economic growth in 2015 to 2021 (Badan Pusat Statistik, 2022)

economic growth and its determining factors. Based on the background above, this study analyzes the influence of industrialization, government spending and environmental taxes on environmental quality as well as the influence of unemployment and inflation on economic growth in Indonesia. This condition is important to analyze and maintain environmentally friendly economic development to achieve sustainable development. In general, the impact of economic growth on environmental quality varies in each country. Previous studies have demonstrated that there are positive and negative effects of economic growth on environmental quality. *Shahbaz et al. (2019)*; *Adu and Denkyirah, (2019)*; *Andrei et al. (2016)* reported the positive influence of economic growth on the environment. *Andrei et al. (2016)*; *Yazdi and Dariani, (2019)* showed that economic growth can be negatively related to certain types of pollutants but not affected by certain pollutants or positively related to certain pollutants. *Belaid and Youssef, (2017)*; *Siregar et al. (2024)*; *Rahman, (2020)* showed that economic growth worsens the quality of the environment. Based on the findings above, it can be concluded that economic growth

can exert a positive or negative effect on the quality of the environment. So what is the underlying positive and negative effect of economic growth on the quality of the environment? Theoretically, there are several aspects that underlie the positive and negative effects of economic growth. *Feng et al. (2022)*; *Peng et al. (2022)* reported that environmental taxes and government spending have a positive effect on environmental quality. An increase in environmental taxes can provide an impetus for improving environmental quality, although it does not necessarily change significantly. Furthermore, government spending is based more on high income so that a country's fiscal policy can be directed toward maintaining environmental quality. *Satrianto and Juniardi, (2023)*; *Yamen et al. (2018)* reported the importance of maintaining economic growth and industrialization in environmental sustainability. For decades, a country's development has focused on achieving high economic growth. However, this has a negative impact on the environment in the presence of strategic areas for economic development. In the long term, this risk will disrupt the sustainability of environmental quality as the higher levels of pollution

affect the quality of good production and services. Furthermore, [Opoku and Boachie, \(2020\)](#); [Lugina et al. \(2022\)](#); [D'agostino et al. \(2016\)](#) explained the positive influence of government spending and environmental taxes on environmental quality. Economic policies that support environmental quality are urgently needed at this time. The high participation of technology in a country's development is a new problem that arises achieving low levels of carbon emissions. Energy use in the industrial sector receives special attention in the management of existing resources that have been the biggest contributor to environmental damage, be it air pollution, increased carbon and lack of energy efficiency. [Kuo et al., \(2022\)](#); [Wang et al., \(2022\)](#) reported the importance of environmental tax levies aimed at the decarbonization process in a country. Environmental quality is reflected in the levels of carbon, pollution and CO₂ which emphasize the importance of achieving a green energy-based economy. To minimize environmental damage, economic activity actors are able to provide accountability by providing costs for environmental taxes while focusing their production sector on the renewable energy sector to avoid ongoing climate change. [Lu et al., \(2023\)](#); [Mandeya and Ho, \(2021\)](#) explained their findings that inflation has a negative effect on economic growth. The production process begins with the provision of raw materials from various commodities at stable prices. Thus, to achieve economic growth, stable inflation in maintaining production supply is considered more effective in maintaining economic activity. High inflation must be avoided with price intervention from a country's government to ensure that the economy remains a driver of economic growth. [Khan et al., \(2020\)](#); [Musibau et al., \(2021\)](#); [Ozokcu and Ozdemir, \(2017\)](#) aside from demonstrating the negative influence of economic growth on environmental quality, also reported the indirect influence of economic growth in the form of mitigation. Mitigation is a form of government policy to reduce pollution through pollution sources, so that economic growth is good for the environment. Based on this, it can be deduced that by increasing environmental regulations, economic growth can have a positive effect on environmental quality. The association between economic growth and environmental quality can be explained by the Environmental Kuznets Curve (EKC) hypothesis. The EKC hypothesis shows the association between economic growth and environmental degradation. The EKC hypothesis emerged in a study conducted [Ozokcu and Ozdemir, \(2017\)](#); [Abdouli and Hammami, \(2017\)](#) which

examined the association between pollution levels and economic growth in 42 countries. [Shahbaz et al., \(2018\)](#); [Yazdi and Dariani, \(2019\)](#); [Andrei et al., \(2016\)](#) reported that increasing income can increase environmental degradation, but an increase in income at a certain level will decrease environmental degradation. In graphical form, if environmental damage is the vertical axis (ordinate) and economic growth is the flat axis (abscissa), then the EKC will be shaped like an inverted_U ([Fig. 2](#)). The EKC pattern in the shape of an inverted U as seen in [Fig. 2](#) is used as the basis for the argument that economic growth can improve environmental quality. Economic growth will initially reduce environmental quality (increasing environmental degradation), but at a certain point increasing economic growth will improve environmental quality (decreasing environmental degradation).

The association between economic growth and environmental quality through EKC can be explained through three effects scale, composition and technical. Scale effects are changes in environmental quality due to changes in output scale, composition effects are changes in environmental quality due to changes in the composition of producers (environmentally friendly and unfriendly), whereas technical effects are changes in environmental quality due to changes in government policy and techniques in production ([Umar et al., 2020](#); [Shahbaz et al., 2018](#); [Belaid and Youssef, 2017](#); [Musibau et al., 2021](#)). The working mechanism of these three effects adopts the assumption that pollution per output is constant. Economic growth can increase production activities thus, it can be deduced that economic growth increases a country's output scale. The production process always produces pollution because the latter is a coefficient of economic activity ([Musibau et al., 2021](#); [Yazdi and Dariani, 2019](#); [Ssali et al., 2019](#)). Economic growth can increase the scale of output and pollution, the coefficient of economic activity indicates that reducing the quality of the environment from economic growth has a scale effect. The composition effect is shown from changes in the composition of producers (environmentally friendly and nonenvironmentally friendly). Economic growth promotes increased specialization of production in sectors with comparative advantages, so that it will increase producers in these sectors. Based on this, the composition effect can have a negative impact on a country with a comparative advantage in a sector that produces relatively large amounts of pollution. This statement is based on the shift of producers toward sectors that tend to be less

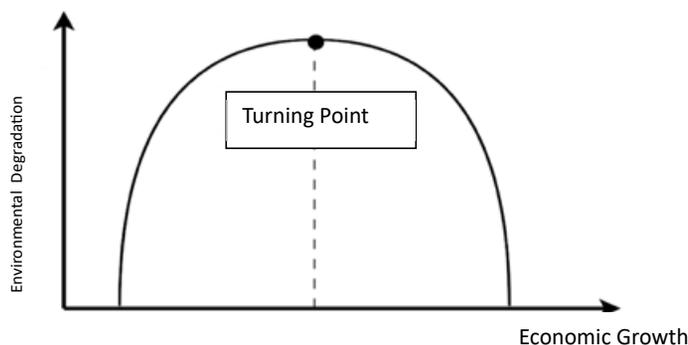


Fig. 3: Environmental Kuznet curve (Ozokcu and Ozdemir, 2017)

environmentally friendly, so that the composition of producers in the country yields more output from sectors that are relatively unfriendly. The third effect is the technical effect. As previously explained, technical effects are changes in environmental quality resulting from changes in policies and techniques in the production process. Changes in policy regarding the environment can occur due to pressure for specialization or public demand for better environmental quality. The most effective application of green economic indicators is a combination of resource efficiency (environmentally friendly indicators), energy efficiency with resource efficiency (social environmental indicators), and energy efficiency (socioeconomic indicators). Based on this, economic growth can encourage countries with comparative advantages in relatively dirty sectors, which can encourage governments to make policies that tend to harm the environment on the grounds of supporting superior sectors, thus having an impact on reducing the quality of the environment. Based on the aforementioned empirical and theoretical studies, relatively few have studied the association between environmental quality and economic growth simultaneously. It is important to establish this connection to determine whether environmental quality and economic growth actually influence each other, in addition to the factors that determine these two variables. This study aimed to develop previous research by analyzing the association between environmental quality and economic growth and its determining factors. Furthermore, it aimed to analyze the influence of determinants on environmental quality and economic growth in a model. The first hypothesis in this study is that economic growth, industrialization, government spending and environmental taxes significantly influence environmental quality. The

second hypothesis is that environmental quality, unemployment and inflation significantly influence Indonesia's economic growth. This study was conducted in 34 provinces in Indonesia from 2015 to 2021.

MATERIALS AND METHODS

Method of the study

The data in this study are panel data sourced from the Indonesian Central Bureau of Statistics (BPS) and Indonesia Ministry of Environment and Forestry starting from 2015 to 2021 in 34 provinces in Indonesia. The amount of data in the study is $7 \times 34 = 238$.

Operational definition of the variables

Measurement of the data of each variable is presented in Table 1. The data was collected from the documentation, annual reports or records issued by the Indonesia BPS.

The equations in this study are as follows using Eqs. 1 and 2 (Shahbaz *et al.*, 2019; Anwar *et al.*, 2020; Salman and Hosny, 2021).

$$Y_{1t} = \alpha_0 + \alpha_1 Y_{2t} + \alpha_2 X_{1t} + \alpha_3 X_{2t} + \alpha_3 X_{3t} + \mu_{1t} \quad (1)$$

$$Y_{2t} = \beta_0 + \beta_1 Y_{1t} + \beta_2 X_{4t} + \beta_3 X_{5t} + \mu_{2t} \quad (2)$$

Meanwhile, the identification test with order conditions in this study is as follows using Eqs. 3 and 4 (Gujarati and Porter, 2009).

$$\text{Equation 1: } K - k = 5 - 3 > m - 1 = 2 - 1 \rightarrow 2 > 1 \quad (3)$$

(overidentified)

$$\text{Equation 2: } K - k = 5 - 2 > m - 1 = 2 - 1 \rightarrow 3 > 1 \quad (4)$$

(overidentified)

Table 1: Operational definition of the research variables

Variable	Measurement	Unit
Environmental quality (Y1)	Environmental Quality Index	Index/y
Economic growth (Y2)	GDP growth	%/y
Industrialization (X1)	GDP in Industry sector	Billion/y
Government expenditure (X2)	Total government expenditure	Billion /y
Environmental tax (X3)	Energy tax, transportation tax, pollution tax and resource tax	Billion /y
Unemployment (X4)	Number of unemployed people	%/y
Inflation (X5)	Changes in the prices of goods	%/y

Table 2: Normality test results for environmental quality equations

Notes	Score
Mean	8.430015
Median	0.792758
Maximum	22.70566
Minimum	-25.58398
S.D.	8.665549
Skewness	-0.354561
Kurtosis	3.021653
Jarque-Bera	4.278233
Probability	0.117759

Table 3: Normality test results for economic growth equation

Notes	Score
Mean	-4.700016
Median	0.482065
Maximum	21.95156
Minimum	-24.30739
S.D.	8.627782
Skewness	-0.324016
Kurtosis	2.943426
Jarque-Bera	3.596740
Probability	0.165569

RESULTS AND DISCUSSIONS

Results of classical assumption test

Based on data processing using the EViews 12 program, data processing results for various tests and analysis models were obtained as follows:

Normality test

The normality test is employed to determine whether the residuals of a situation are typically circulated. In the event that the residuals of a situation are not typically appropriated information fluctuation will be inhomogeneous. Thus, endeavors are expected to improve with the goal that the residuals are ordinarily dispersed. In view of the ordinariness test involving the Jarque_Bera technique on the equation for environmental quality and economic growth, it may

be seen very well that the Jarque_Bera likelihood of an incentive for every situation is > 0.05 . Based on the situation, environmental quality is 0.117759 and economic growth is 0.165569. Accordingly, it tends to be reasoned that the lingering condition for environmental quality and economic growth is typically circulated.

Granger causality test

This test can basically help determine whether a variable has a two-way relationship, or just a single course. In the event that the likelihood esteem is more modest than $\alpha = 0.05$, the two factors (endogenous factors) have a two-way relationship or impact one another. Then again, in the event that the likelihood esteem is more prominent than $\alpha = 0.05$, the two factors (endogenous factors) have a one-way relationship or do

not impact one another.

Based on the results of the Granger causality test in Table 4, the probability value between environmental quality and economic growth is $0.0000 < 0.05$ whereas that between economic growth and environmental quality is $0.0002 < 0.05$. In other words, environmental quality variables on economic growth and economic growth on environmental quality have a two-way relationship or influence each other.

Heteroscedasticity

The heteroscedasticity test is used to determine whether the leftover change starting with one perception then onto the next is unique or the equivalent. Homoscedasticity is described as the event in which the leftover differences are very similar. The heteroscedasticity test in this exploration was conducted using the Glejser test strategy. In the event that the likelihood of an incentive for every variable is $> \alpha = 0.05$, the condition does not contain heteroscedasticity problems. Contrarily, in the event that the likelihood of an incentive for every variable is $< \alpha = 0.05$, the condition contains heteroscedasticity issues.

As can be seen from Tables 5 and 6, the probability value for each variable in each equation is $> \alpha = 0.05$. Therefore, all equations in this study do not contain heteroscedasticity problems. In other words, in each equation there is the same variance of the residuals for all observations in each equation.

*Estimation results of simultaneous equations
Environmental quality equation model*

Table 7 presents the results of estimating the environmental quality equation. From the estimates that have been conducted, an environmental quality equation model is obtained as shown in Eq. 5 (Shahbaz et al., 2019; Anwar et al., 2020; Salman and Hosny, 2021).

$$Y_1 = 77.73 - 1.77 Y_2 - 4.69 X_1 - 8.56 X_2 + 9.42 X_3 \quad (5)$$

In view of the assessment consequences of the natural quality condition shown above, with the assumption that financial development, industrialization, government spending and environmental taxes were missing, the environmental quality worth would be 77.73598 units. The R-squared worth of the natural quality condition is 0.221811. This indicates that the commitment of the factors financial development, industrialization, government spending and environmental taxes to environmental quality is 22.18%, and the excess of 77.82% is affected by different factors excluded from the environmental quality equation model. The direction of the influence of economic growth on environmental quality is negative with an estimated coefficient of -1.770236. This means that if economic growth increases by 1 unit, environmental quality will decrease by -1.770236 units assuming that other variables are constant (ceteris paribus). The direction of the influence of industrialization on environmental quality is negative with an estimated coefficient of -4.69E-05. This means that if industrialization increases by 1 unit, environmental quality will decrease by -4.69E-05 units (ceteris paribus). The direction of the influence

Table 4: Granger causality test results

Null Hypothesis	F-Statistic	Probabilities
Y2 does not Granger Cause Y1	12.84392	0.0000
Y1 does not Granger Cause Y2	9.79996	0.0002

Table 5: Heteroscedasticity test results for environmental quality equations

Variable	Probability	Description
Y2	0.9645	There is no heteroscedasticity
X1	0.4332	There is no heteroscedasticity
X2	0.5463	There is no heteroscedasticity
X3	0.3169	There is no heteroscedasticity

Table 6: Heteroscedasticity test results for economic growth equations

Variable	Probability	Description
Y1	0.1317	No heteroscedasticity occurs
X4	0.3151	No heteroscedasticity occurs
X5	0.7821	No heteroscedasticity occurs

Table 7: Estimated results of the effect of economic growth, industrialization and government spending on environmental quality in Indonesia

Variable	Coefficient	S.E.	t-Statistic	Prob.	R-squared	F-Statistic	Prob.(F-stat)
C	77.73598	7.172577	10.83794	0.0000			
Y2	-1.770236	0.427848	-4.13754	0.0009			
X1	-4.69E-05	1.16E-05	-4.05124	0.0001	0.221811	17.00507	0.000000
X2	-8.56E-10	2.54E-10	-3.37337	0.0022			
X3	9.42E-13	2.77E-13	3.40001	0.0016			

Table 8: Estimated results of the effect of environmental quality, unemployment and inflation on economic growth in Indonesia

Variable	Coefficient	S.E.	t-Statistic	Prob.	R-squared	F-Statistic	Prob.(F-stat)
C	1.690987	0.821589	2.058191	0.0409			
Y1	-0.068832	0.060659	-1.134737	0.2578	0.335165	13.86880	0.000000
X4	-1.43E-06	8.40E-07	-1.705618	0.0896			
X5	-0.164006	0.041188	-3.981842	0.0074			

of government spending on environmental quality is negative with an estimated coefficient of -8.56E-10. This means that if government spending increases by 1 unit, environmental quality will decrease by -8.56E-10 units (ceteris paribus). The direction of the influence of environmental taxes on environmental quality is positive with an estimated coefficient of 9.42E-13. This means that if environmental taxes increase by 1 unit, environmental quality will increase by 9.42E-13 units (ceteris paribus).

Economic growth equation model

Table 8 presents the results of simultaneous equation estimation of the economic growth equation. From the estimates that have been performed, an economic growth equation model is obtained as presented in Eq. 6 (Shahbaz et al., 2019; Anwar et al., 2020; Salman and Hosny, 2021).

$$Y_2 = 1.690987 - 0.068832 Y_1 - 1.43E-06 X_4 - 0.164006 X_5 \quad (6)$$

In view of the assessment consequences of the monetary development condition presented above, with the assumption that environmental quality, unemployment and inflation were missing, the value of economic growth would be 1.690987 units. The R-squared value of the economic growth equation is 0.335165. This shows that the contribution of environmental quality, unemployment and inflation variables to economic growth is 33.5165%, and the remaining 66.4635% is influenced by other variables not included in the economic growth equation model.

The effect of environmental quality on economic

growth is negative with an estimated coefficient of -0.068832. This means that if environmental quality increases by 1 unit, economic growth will decrease by -0.068832 units (ceteris paribus).

The effect of unemployment on economic growth is negative with an estimated coefficient of -1.43E-06. This means that if unemployment increases by 1 unit, economic growth will decrease by -1.43E-06 units (ceteris paribus). The effect of inflation on economic growth is negative with an estimated coefficient of -0.164006. This means that if inflation increases by 1 unit, economic growth will decrease by -0.164006 units (ceteris paribus).

Partial test

Partial tests are conducted to examine the influence of exogenous variables on endogenous variables in the partial regression equation by assuming that other variables are considered constant. It is also known as a probability test, this partial test. Rejecting H0 and accepting Ha indicate that there is a significant influence between the exogenous and endogenous variables if the probability value of the exogenous variable is less than $\alpha = 0.05$ (t-statistic \geq t-table or - t-statistic $<$ - t-table) on the endogenous variable. As opposed to this, Ha is rejected and H0 is accepted if the probability value of the exogenous variable on the endogenous variable is greater than $\alpha = 0.05$ (t-statistic \geq - t-table or t-statistic $<$ t-table). This suggests that there is no discernible association between the exogenous and endogenous variables. The probability value of every variable is visible based on the estimation results presented in Table 7. Environmental quality is affected

by economic growth.. This is indicated by the probability value of economic growth on environmental quality of $0.0009 < \alpha = 0.05$. Therefore, partially, economic growth has a significant effect on environmental quality in Indonesia. On the other hand, industrialization has a significant effect on environmental quality in Indonesia with the probability value of 0.0001 or less than 0.05. Furthermore, government spending has a significant effect on environmental quality in Indonesia. This is indicated by the probability value of 0.0022 or less than 0.05. In addition, environmental taxes have a significant effect on environmental quality in Indonesia. This is indicated by the probability value 0.0016 or less than 0.05. Based on the estimation results in Table 8, the probability value of each variable can be seen. Environmental quality does not significantly influence economic growth in Indonesia. This is indicated by the probability value $0.2578 > \alpha = 0.05$. Also, unemployment does not have a significant effect on economic growth in Indonesia, indicated by the probability value of $0.0896 > \alpha = 0.05$. Then, inflation has a significant effect on economic growth in Indonesia. This is indicated by the probability value of inflation on economic growth of 0.0074 or less than 0.05. Therefore, inflation partially affects economic growth in Indonesia.

F test result

The effects of the exogenous variables on the endogenous ones are determined using the F test. According to the first hypothesis of the study, Indonesia's environmental quality is significantly impacted by government spending, industrialization, economic growth, and environmental taxation. The environmental quality equation's estimation findings yield an F-statistic probability value of 0.00000. Given that the environmental quality equation's probability value (F-statistic) is less than $\alpha = 0.05$, it can be deduced that Indonesia's environmental quality is significantly impacted by government spending, industrialization, economic growth, and environmental taxes combined. This proves the alternative hypothesis in the first equation in this study. Thus, Indonesia's environmental quality is impacted by government spending, industrialization, economic growth, and environmental taxation. In Indonesia, there is a notable correlation between economic growth and environmental quality. The presence of a substantial association between economic growth and environmental quality suggests that economic expansion has an impact on environmental quality. Because of this, rising economic

growth suggests higher levels of output of products and services. The increase in the production of goods and services has increased the demand for production inputs, one of which is an increase in demand for inputs from natural resources. Increasing input from natural resources without paying attention to the effects on the environment such as exploitation of mining products, deforestation, and water waste resulting in water pollution, will result in environmental damage. Attention needs to be paid to these effects so that in the future the desired growth does not damage the environment. However, this does not indicate that to maintain environmental quality, the economy does not need to grow, produce goods, and services. The economy needs to grow while of paying attention to environmental quality. The findings of the study support the hypothesis that there is a direct correlation between environmental quality and economic growth (Shahbaz *et al.*, 2018; Anwar *et al.*, 2020; Shahbaz *et al.*, 2019; Siregar *et al.*, 2024). In other words, increasing economic growth will have an impact on worsening environmental quality. Partially, industrialization also has a significant negative effect on environmental quality in Indonesia. The existence of a significant influence between environmental quality and industrialization indicates that the former is influenced by industrialization. Industrialization improves the processing of raw materials into semifinished and finished goods. This will accelerate the production of goods and increase waste. Uncontrolled waste will worsen the quality of soil, water, and air. In the end, the accumulation of waste will create more problems in environmental quality. The results of this study are consistent with the theory stating that there is an inverse association between industrialization and environmental quality. The uncontrolled acceleration of industrialization has an impact on the deterioration of environmental quality. The results of this study are also consistent with those of previous research (Nasrollahi *et al.*, 2020). Furthermore, government spending shows a significant negative influence on environmental quality in Indonesia, partially. The fact that there is a significant correlation between government spending and environmental quality suggests that government spending has an impact on environmental quality. This requirement stems from the fact that higher government spending will promote higher levels of production capacity for both products and services. These improvements can be in the form of building roads, bridges, irrigation, electricity, networks, ports, and airports. This increase in

spending can increase the use of production inputs such as river dredging, deforestation, and gas disposal. If this cannot be properly controlled, productive government spending to encourage the real sector will have a negative impact on the environment. On the other hand, if government spending can be controlled by paying attention to environmental quality, this condition can have a positive impact on the environment. The findings of this study support the hypothesis that expenditure by the government degrades the quality of the environment. Research findings also corroborate the results of the studies by [Baz et al., \(2020\)](#); [Andrei et al., \(2016\)](#); [Abdouli and Hammami, \(2017\)](#) which conclude that uncontrolled government spending can damage the environment. Notably, there is a positive correlation between environmental taxes and the quality of the environment in Indonesia, albeit indirect. It can be deduced that environmental taxation has an impact on environmental quality because there is a considerable correlation between the two variables. This is because firms are required to pay environmental taxes, which are mandatory contributions. Environmental taxes will cause additional costs by companies or producers in producing goods and services. Companies will consider their behavior if they want to pollute the environment because environmental taxes will increase if there are actions that can pollute the environment. Certainly, this situation will be able to protect the environment from damage. On the other hand, if environmental taxes are not properly implemented, companies will be free to pollute the environment. In the end, this condition can damage environmental quality. The results of this study are consistent with the theory that environmental taxes can change the behavior of agents to damage the environment. Effective implementation of environmental taxes can help improve environmental quality. This result is also supported by studies conducted by [Andrei et al., \(2016\)](#); [Khan et al., \(2020\)](#); [Shahbaz et al., \(2019\)](#); [Adu and Denkyirah, \(2019\)](#) which conclude that environmental taxes contribute to the improvement of the environment. Environmental taxes can discourage agents' desire to pollute the environment. As reported by [Oryani et al., \(2022\)](#) efforts to improve environmental quality include reducing emissions from energy consumption, creating policies to manage energy consumption by increasing public awareness of the environment, diversifying the energy mix, and implementing laws regarding subsidies. The second hypothesis in this study states that environmental

quality, unemployment and inflation have a significant effect on economic growth in Indonesia. From the estimation results of the economic growth equation, a probability value (F-statistic) of 0.00000 is obtained. Because the probability value (F-statistic) in the economic growth equation is $< \alpha = 0.05$, it can be said that environmental quality, unemployment, and inflation have a significant effect on economic growth in Indonesia. The existence of the alternative hypothesis in the second equation in this study has been partially proven. Thus, environmental quality, unemployment, and inflation affect economic growth in Indonesia. Furthermore, environmental quality does not have a significant effect on economic growth in Indonesia. The lack of a significant correlation between environmental quality and economic growth suggests that environmental quality has a negligible effect on economic growth. This requirement from the fact that environmental quality influences economic activity as a result of environmental quality rather than being a cause of economic system. Good environmental quality has little effect on promoting rapid economic growth. Despite the fact that economic growth is still measured in association with the environment. Thus, even while environmental quality is improving, it will not have an effect on economic growth. Findings of this study are consistent with theory and research findings indicating that environmental quality cannot affect or have an influence on economic growth ([Adu and Denkyirah, 2019](#); [Ozokcu and Ozdemir, 2017](#); [Rahman, 2020](#)). Partially, unemployment does not significantly affect economic growth in Indonesia. The lack of a substantial correlation between unemployment and economic growth suggests that unemployment has a negligible effect on growth. This is because unemployed individuals represent the portion of the labor force that is not employed and hence not productive. Because unemployment does not result in the production of goods and services, it does not support economic expansion. In actuality, economic welfare is decreased by the presence of unemployment. Consequently, there is no association between the unemployment rate and economic growth indeed, labor plays a role in the process of economic output production. The findings of this study support Solow's theory in another way, which holds that labor, not unemployment, is what drives economic expansion. The findings of this study also support previous research suggesting that unemployment has no bearing on economic growth ([Adelowokan et al., 2019](#); [Louail and Riache, 2019](#)).

Furthermore, Indonesia's economic growth is severely hampered by inflation. The fact that there is a substantial correlation between inflation and economic growth suggests that inflation affects economic growth. The purchasing power of people may decrease when inflation increases. Weakening purchasing power will result in a decline in public consumption. Consumption as a factor in the demand for goods and services will reduce the production of the goods and services themselves. This transmission effect will ultimately result in a decline in economic growth. Although inflation is also required to spur growth, uncontrolled inflation can suppress the rate of growth itself. Conversely, low and relatively stable inflation can maintain people's purchasing power so that people's consumption remains sustainable. Certainly, this situation will be able to maintain Indonesia's economic growth in a better direction. The findings of this study are consistent with earlier hypotheses and investigations into the impact of inflation on economic growth. These findings suggest that inflation hinders economic expansion. Growing inflation will impede economic expansion (Azam and Khan, 2022; Sanga *et al.*, 2022; Satrianto and Juniardi, 2023).

CONCLUSION

Based on the results of the study and discussion in the previous section, this research concludes that economic growth, industrialization, government spending and environmental taxes significantly influence on the quality of the environment in Indonesia. The contribution of the influence of economic growth, industrialization, government spending, and environmental taxes on environmental quality is 22.18%. Partially, the influence of economic growth on environmental quality -1.770236 per unit; industrialization -4.69E-05 per unit; government spending -8.56E-10; and environmental taxes 9.42E-13 per unit. Economic growth, industrialization, and government spending have a negative effect on environmental quality. This means that increasing economic growth, industrialization, and government spending have an impact on the reduction of environmental quality. On the other hand, environmental quality and unemployment do not have a significant effect on economic growth in Indonesia. Fluctuations in environmental quality and unemployment do not influence the ups and downs of economic growth. Meanwhile, inflation has a significant and negative influence on economic growth. This indicates that an increase in inflation will reduce

economic growth by -0.164006 units. This implies that fluctuations in unemployment and environmental quality have no bearing on changes in Indonesia's rate of economic growth. Meanwhile, economic growth is significantly impacted by inflation. A rise in inflation will lead to a decline in economic growth. On the other hand, sloping and declining inflation will encourage increased economic growth in Indonesia. The policies that can be suggested from the results of this study are as follows: the government must be able to maintain environmental quality while still encouraging economic growth. This policy can be implemented by creating an environmentally sound growth concept. This concerns efforts to utilize natural resources while maintaining aspects of environmental maintenance and preservation. This environmentally friendly development prioritizes sustainable development that optimizes the benefits of natural resources and human resources by harmonizing human activities with the ability of natural resources to support them. This condition can be realized by implementing binding laws or regulations in each region in Indonesia. The government must be able to maintain the industrialization process to avoid damaging the environment. This can be done by applying the pollution threshold rules created by the industrialization process. The government can continue to maintain productive spending, particularly on spending that can improve environmental quality. Environmental taxes are an effective instrument in maintaining environmental quality during the study period. Therefore, the implementation of environmental tax policies can continue to be improved in the future to ensure improvement in environmental quality. Furthermore, the government must be able to ensure stable inflation so that it does not have a negative impact on economic growth. Management of the supply and demand sides of goods and services needs to be controlled so that prolonged inflation does not occur, which negatively affects Indonesia's economic growth.

AUTHOR CONTRIBUTIONS

S. Amar has roles in Conception and design, Critical revision of the manuscript for important intellectual content, Obtaining funding and Supervision. A. Satrianto has roles in Conception and design, Analysis and interpretation of data, Drafting of the manuscript, Critical revision of the manuscript for important intellectual content, Statistical analysis, Obtaining funding and Supervision. Ariusni has a role in Drafting of the manuscript, and Critical revision of the manuscript

for important intellectual content. A. Ikhsan has a role in Analysis and interpretation of data, Statistical analysis, and Administrative, technical, or material support. E.S Siregar has a role in acquisition of data, statistical analysis, and administrative, technical, or material support.

ACKNOWLEDGMENT

The authors would like to thank Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Padang for funding this work with a contract number [492/UN35.13/LT/2023].

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication, and/or falsification, double publication and/or submission, and redundancy, have been completely observed by the authors.

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ABBREVIATIONS

%	Percent
+	Plus sign

=	Equal sign
≥	greater than or equal to
-	Minus sign
/	Per
A	Alpha
BPS	Central Bureau of Statistics
E	Error term
EKC	Environmental Kuznets Curve
Eq	Equation
et al.	Et alia
F-test	A statistical test that is used in hypothesis testing to check whether the variances of two populations or two samples are equal or not
F-Statistic	A ratio of two variances
Fig.	Figure
GDP	Gross domestic product
i	Cross-section
IEQI	Indonesian environmental quality index
Prob.	Probability
Prob.(F-stat)	Probability F Statistic
R-squared	The coefficient of determination
S.D.	Standard deviation
S.E.	Standard error
t	Time series
t-Statistic	Hypothesis test statistic
X1	Industrialization
X2	Government expenditure
X3	Environmental tax
X4	Unemployment
X5	Inflation
y	Year
Y	Endogenous variable
Y1	Environmental quality
Y2	Economic growth

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HOW TO CITE THIS ARTICLE

Amar, S.; Satrianto A.; Ariusni.; Ikhsan, A.; Siregar, E.S., (2024). Environmental quality and macroeconomic phenomenon. Global J. Environ. Sci. Manage., 10(2): 791-804.

DOI: 10.22035/gjesm.2024.02.23

URL: https://www.gjesm.net/article_709464.html

