ANALYSIS OF THE INFLUENCE OF GRDP, FOREIGN DIRECT INVESTMENT, AND POPULATION DENSITY ON ENVIRONMENTAL QUALITY IN JAVA IN ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS (SDGS)

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Abstract :

This study aims to analyze the effects of Gross Regional Domestic Product (GRDP), Foreign Direct Investment (FDI), and Population Density on environmental quality in Java Island during the period 2014–2024. The research method employed is panel data analysis with a regression approach, covering six provinces in Java as the units of observation. The dependent variable used is the Environmental Quality Index, while the independent variables consist of GRDP, realized FDI, and Population Density. The findings indicate that GRDP has a significant relationship with the Environmental Quality Index, following the pattern of the Environmental Kuznets Curve (EKC). Meanwhile, FDI shows a positive and significant effect on the Environmental Quality Index. Population Density is also proven to exert a negative and significant influence on the Environmental Quality Index. Therefore, synergy among various stakeholders is required to encourage the implementation of environmentally friendly economic concepts. The green economy approach can serve as a foundation for sustainable development, accompanied by population growth control, reduced dependence on fossil energy, and accelerated transition toward renewable energy, which have been incorporated into the SDGs agenda as a pillar supporting the balance between economic activities and environmental sustainability.

Keywords : *GRDP, FDI, Population Density, Environmental Quality Index*

INTRODUCTION

Economic growth is one of the key indicators for measuring the success of a country's development (Fafurida, et al, 2022). Economic development is carried out with the aim of improving public welfare from various aspects; however, all economic activities depend on natural or environmental resources, making the relationship between economic activity and the environment inseparable (Muhammad & Pahlevi, 2020).

Indonesia possesses abundant natural potential, both renewable and non-renewable resources. This natural wealth significantly contributes to the

country's economic growth. Nevertheless, if natural resources and economic growth are not accompanied by efforts toward environmental conservation and sustainable utilization, they may lead to various issues encompassing economic, environmental, social, and cultural dimensions (Yunitasari & Firdaus, 2022). The natural condition, daily human activities, and industrial operations all affect the environment of a region and contribute to environmental problems. Therefore, it is essential to understand how economic growth contributes to environmental quality in order to achieve a sustainable balance (Putri, et al, 2024).

The Organisation for Economic Co-operation and Development (OECD) has established ten key environmental indicators, one of which is greenhouse gas (GHG) emissions, currently a global concern regarding environmental degradation. Indonesia has integrated the Sustainable Development Goals (SDGs) into the National Medium-Term Development Plan (RPJMN), in line with the principle of integration among economic balance, social harmony, and environmental sustainability as the three pillars of sustainable development, which are also mandated by the constitution (Hakim, et al, 2021). Sustainable development is targeted to be achieved by 2030 with an orientation not only on quantitative aspects but also on quality. This is based on the core principle of sustainable development, namely meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (Rahayu & Handri, 2023).

Indonesia's economic growth to date is still supported by Java Island, which contributes the largest share to national economic growth and serves as the country's economic center, with an average contribution of 58.01 percent to Indonesia's income during 2014–2023, as shown in Figure 1. This figure demonstrates that Java Island dominates more than half of Indonesia's economy.
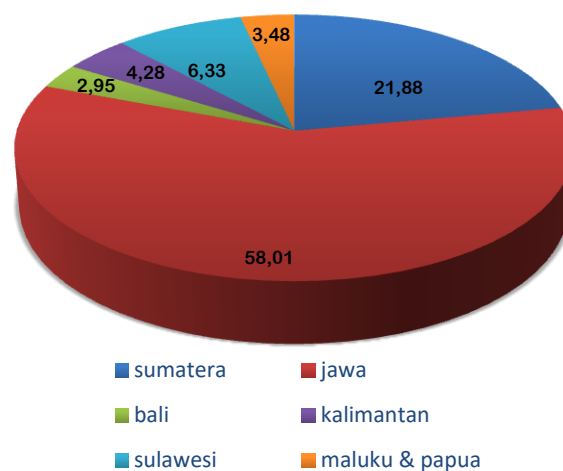
Source: Statistics Indonesia (BPS), processed data
Figure 1. Distribution of Indonesia's Income by Island (percent)

Although Java Island plays a central role in supporting national economic growth, this is accompanied by potential threats to environmental sustainability. These threats arise from the transfer of pollution generated by various economic activities (Amparian, et al, 2022). The trade-off between achieving economic development and preserving the environment indicates that environmental sustainability in the provinces of Java Island is at risk, despite the region's strong economic performance (Ummah, 2021).

In addition to the high rate of economic growth supported by the annual increase in GRDP, Java being the island with the largest number of industries and intense economic activities has become an attractive destination for investors to channel their funds into Indonesia, particularly in Java. According to (Febrianto & Arifin, 2021), foreign investment or Foreign Direct Investment (FDI) is one of the main sources of economic growth in developing countries. The large inflows of FDI into the manufacturing and real estate sectors in Java accelerate regional development, but also exacerbate environmental pressures, such as the increase of industrial waste, land conversion, and air and water pollution, which ultimately affect environmental quality (Tutupoho, 2019).

Furthermore, high population density also plays a significant role in shaping environmental conditions. As the population increases, the demand for natural resources rises, further intensifying environmental pressure (Marlina & Usman, 2020). Uncontrolled urbanization can trigger various environmental problems, including air pollution, declining water quality, and unsustainable land use. Environmental quality thus becomes an important indicator for assessing the balance between economic growth and population density (Nufus & Husein, 2021).

This study employs relevant concepts and theories in its analysis. One such theory is the Environmental Kuznets Curve (EKC), which posits that at the early stages of economic growth, environmental quality tends to deteriorate, but once a certain income level is reached, society becomes more concerned with the environment and adopts more eco-friendly policies (Juni, et al, 2023). Additionally, the Carrying Capacity Theory is applied to understand the extent to which a region can support its population without compromising environmental quality (Ridho, et al, 2022).

Based on the phenomena described, the main research problem concerns how economic growth, foreign direct investment, and increasing population density influence environmental quality in Java Island. Does economic growth contribute positively to environmental quality through the adoption of innovative technologies and environmentally friendly policies, or does it negatively impact environmental conditions? Furthermore, how does increasing population density place additional pressure on environmental sustainability?

The primary objective of this study is to evaluate the relationship between economic growth and population density with environmental quality

in Indonesia. It also aims to examine the effects of each variable on the environment and formulate policy recommendations that support the realization of sustainable development (Ciptawaty, 2021). By understanding the interrelation between economic growth, population density, and environmental quality, the findings of this study are expected to serve as a reference for policymakers in designing development strategies oriented toward environmental conservation.

RESEARCH METHOD

This study employs a quantitative approach by applying panel data regression analysis to examine the relationship between economic growth, population density, and environmental quality in Java Island. The data analyzed are secondary data obtained from Statistics Indonesia (BPS), covering the period from 2014 to 2023.

In this research, two types of variables are used: independent and dependent variables. The independent variables include economic growth measured by Gross Regional Domestic Product (GRDP), Foreign Direct Investment (FDI), and population density per square kilometer. Meanwhile, the dependent variable is environmental quality, measured using the Environmental Quality Index (EQI), which encompasses water, air, and land quality aspects.

The data analysis techniques applied include classical assumption tests to ensure the validity of the regression model, as well as hypothesis testing through t-tests and F-tests to determine the significance of the independent variables on the dependent variable. In addition, the coefficient of determination (R^2) is used to assess the extent to which the independent variables explain variations in the dependent variable.

This study is also grounded in relevant theories, such as the Environmental Kuznets Curve (EKC), which posits that in the early stages of economic growth, environmental quality tends to deteriorate, but as welfare increases, environmental awareness improves. Furthermore, the concept of Carrying Capacity Theory is employed to understand the extent to which a region can support its population without causing environmental degradation (Hafifah & Suherty, 2023).

Through this method, the study is expected to provide a more comprehensive understanding of the interrelationship between economic growth, foreign direct investment, population density, and environmental quality in Java Island, as well as generate policy recommendations that support sustainable development (Hermansyah, et al, 2021).

FINDINGS AND DISCUSSION

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	7.866013	(5,51)	0.0000
Cross-section Chi-square	34.298682	5	0.0000

Source: Processed data using EViews 12

Figure 2. Chow Test

Based on the results of the Chow test shown above, the probability value is 0.0000 < 0.05, which indicates that this study employs the Fixed Effect Model (FEM). Thus, the Common Effect Model is not selected in the regression model of this study.

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	22.400877	3	0.0001

Source: Processed data using EViews 12

Figure 3. Hausman Test

In the Hausman test shown above, the probability value obtained is 0.0001 < 0.05. This indicates that the Random Effect Model is not applicable in this study; therefore, the Fixed Effect Model is selected.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-30.82483	20.20481	-1.525618	0.1333
PDRB	1.04E-05	3.26E-06	3.185629	0.0025
PMA	0.000729	0.000283	2.571118	0.0131
KEPADATAN_PENDUDUK	-0.020578	0.006064	-3.393356	0.0013

Source: Processed data using EViews 12

Figure 4. Regression Test Results

Based on the estimated model and regression results shown in Figure 4, the regression equation can be formulated as follows:

From the processed data using the Fixed Effect Model, the interpretation is as follows:

- The constant value of **30.8248** indicates that if the independent variables (GRDP, Foreign Direct Investment, and Population Density) are constant or equal to zero, then the Environmental Quality Index (EQI) is **30.8248 units**.
- The **GRDP variable** shows a positive influence on the EQI with a coefficient value of **0.0000104**. This finding implies that a 1% increase in GRDP potentially contributes to an improvement in environmental quality in Java by **0.0000104 units**, assuming other variables remain constant.
- The **FDI variable** exerts a positive effect on the EQI with a coefficient of

0.0007. This indicates that each 1% increase in foreign investment may contribute to an improvement in environmental quality in Java by **0.0007 units**, assuming other variables remain constant.
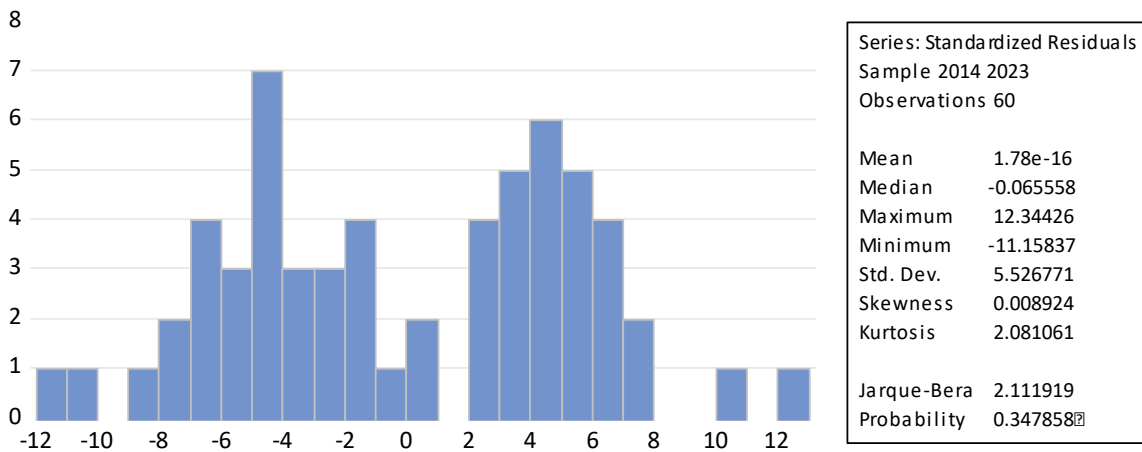
- The **Population Density variable** has a negative effect on the EQI with a coefficient of **-0.020**. This suggests that each 1% increase in population density potentially reduces environmental quality in Java by **0.020 units**, assuming other variables remain constant.

R-squared	0.700832	Mean dependent var	56.57717
Adjusted R-squared	0.653904	S.D. dependent var	8.956580
S.E. of regression	5.269149	Akaike info criterion	6.299096
Sum squared resid	1415.961	Schwarz criterion	6.613248
Log likelihood	-179.9729	Hannan-Quinn criter.	6.421978
F-statistic	14.93412	Durbin-Watson stat	1.240849
Prob(F-statistic)	0.000000		

Source: Processed data using EViews 12

Figure 5. F-Test Results

The F-statistic value along with its probability is 14.934. Since the probability (F-statistic) is 0.00000 (<0.05), it can be concluded that GRDP and population density jointly influence environmental quality in Java Island during the period 2014–2023.

Series: Standardized Residuals
Sample 2014 2023
Observations 60

Mean	1.78e-16
Median	-0.065558
Maximum	12.34426
Minimum	-11.15837
Std. Dev.	5.526771
Skewness	0.008924
Kurtosis	2.081061
Jarque-Bera	2.111919
Probability	0.347858

Source: Processed data using EViews 12

Figure 6. Normality Test Results

The figure above shows a probability value of 0.347 (>0.05), which indicates that the study passes the normality test.

	KEPADATA...	PDRB	PMA
KEPAD...	1	-0.4210728...	-0.1858843...
PDRB	-0.4210728...	1	-0.1137186...
PMA	-0.1858843...	-0.1137186...	1

Source: Processed data using EViews 12

Figure 7. Multicollinearity Test Results

Based on the multicollinearity test results, the value of each independent variable is ≥ 0.85, indicating that there is no multicollinearity

among the independent variables in this study.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.20421	7.608095	1.866986	0.0677
PDRB	1.08E-07	1.23E-06	0.088299	0.9300
PMA	-0.000109	0.000107	-1.025278	0.3101
KEPADATAN_PENDUDUK	0.002798	0.002284	1.225403	0.2261

Source: Processed data using EViews 12

Figure 8. Heteroskedasticity Test Results

The test results above show that none of the independent variables have a probability value ≤ α = 0.05. This leads to the conclusion that heteroskedasticity does not occur among the independent variables in this study.

R-squared	0.700832	Mean dependent var	56.57717
Adjusted R-squared	0.653904	S.D. dependent var	8.956580
S.E. of regression	5.269149	Akaike info criterion	6.299096
Sum squared resid	1415.961	Schwarz criterion	6.613248
Log likelihood	-179.9729	Hannan-Quinn criter.	6.421978
F-statistic	14.93412	Durbin-Watson stat	1.240849
Prob(F-statistic)	0.000000		

Source: Processed data using EViews 12

Figure 9. Coefficient of Determination Test

The coefficient of determination measures the proportion or percentage of the total variation in the dependent variable that can be explained by the regression model. In this study, the Adjusted R-squared value is 0.6539, indicating that GRDP, FDI, and Population Density explain 65.39% of the variation in environmental quality in Java Island, while the remaining 35.71% is explained by other variables outside this study.

The Effect of GRDP on Environmental Quality

The test results for the GRDP variable can be seen in Figure 4, showing that GRDP has a significant positive effect on environmental quality. This indicates that the increase in economic activity in a region does not always have a negative impact on the environment. In fact, when regional income rises, governments and communities have greater resources to invest in environmentally friendly technologies, improved waste management, and sustainable development policies.

Furthermore, economic growth often encourages greater public awareness of the importance of environmental preservation and quality of life. With increased fiscal capacity, local governments are also more likely to provide green infrastructure and public services that support environmental sustainability, such as eco-friendly transportation, clean water management, and green open spaces (Kustanto, 2020).

This finding is consistent with research by (Mulyasari, 2018), which showed that GRDP has a significant positive effect on environmental quality alongside economic growth. However, it contrasts with the findings of (Putri,

2022), who argued that GRDP can harm the environment and reduce environmental quality. It is therefore important to note that these positive effects depend on how economic growth is managed. Without proper environmental policies, rising GRDP may instead risk lowering environmental quality.

The Effect of Foreign Direct Investment (FDI) on Environmental Quality

The test results for the FDI variable can also be seen in Figure 4, showing that FDI has a significant positive effect on environmental quality. Foreign Direct Investment can contribute positively to improving environmental quality in Java if directed toward environmentally friendly sectors and technologies. FDI not only brings financial capital but also advanced technologies and operational standards that typically follow international best practices. Many multinational companies are committed to corporate social responsibility (CSR) principles, implementing better waste management systems, energy efficiency, and cleaner production technologies. In Java, as Indonesia's industrial and trade hub, FDI plays an important role in driving industrial waste management innovation, renewable energy development, and more modern and efficient environmental infrastructure (Anser et al., 2022).

Similar findings are presented by (Ar'rida & Sopiana, 2023), who explained that foreign investment flowing into developing countries can enhance energy efficiency and reduce emissions when directed to appropriate sectors and supported by adequate regulations and monitoring. Likewise, a study by (Nihayah & Diastuti, 2023) demonstrated that FDI has the potential to support environmental sustainability in China through the transfer of clean technologies, increased use of renewable energy, and improved environmental management practices. However, it should be emphasized that these positive impacts are not automatic. The government must continue to monitor and ensure that every incoming foreign investment does not overlook environmental sustainability.

The Effect of Population Density on Environmental Quality

The test results for the Population Density variable, shown in Figure 4, indicate that population density has a significant negative effect on the Environmental Quality Index, as evidenced by the regression analysis. This is in line with the growth limits theory, which states that as population increases, pollution levels rise and environmental quality declines (Sapkota & Bastola, 2017).

This finding, however, contrasts with the research of (Chunxia, et al, 2022) and (Shaheen et al., 2022), which showed that population density has a small but beneficial impact on environmental quality. Population density is a significant factor in predicting greenhouse gas and carbon emissions, suggesting that land reform policies should be developed to reduce population pressure on fertile land and allocate most of it for agricultural production. Both measures would ultimately improve the quality of life for local communities (Yasmeen, et al, 2022).

CONCLUSION

Based on the results of this study, it can be concluded that economic growth, as measured by GRDP, has a positive and significant effect on environmental quality. This indicates that an increase in economic activity can encourage improvements in environmental quality, particularly when supported by policies that promote investment in environmentally friendly technologies and greater public awareness of environmental issues. Foreign Direct Investment (FDI) is also found to have a significant and positive impact on improving environmental quality. This finding aligns with the *pollution halo* theory, which suggests that foreign investment can bring cleaner technologies and more sustainable industrial practices to host countries.

Meanwhile, population density shows a negative and significant influence on environmental quality. This pressure arises from the growing demand for land, energy, and natural resources that exceeds the environment's capacity, thereby potentially leading to pollution, ecosystem degradation, and a decline in community well-being. These findings highlight the importance of sustainable development strategies that not only focus on economic growth but also take into account the environmental carrying capacity in addressing demographic pressures and economic activities.

A region must therefore design land reform programs aimed at allocating a substantial portion of fertile land for agricultural production. Such measures are expected to improve environmental quality while reducing population pressure on land use. Furthermore, to enhance the Environmental Quality Index (EQI) in Java, both the government and the community must cultivate strong concern for nature conservation and environmental cleanliness.

In addition, synergy between the government, the private sector, and the community is required to promote the adoption of environmentally friendly economic concepts such as the *green economy* and *green growth*. These approaches can serve as the foundation for sustainable development. Thus, the implementation of the SDGs agenda as a framework for balancing economic activity and environmental sustainability can be optimized to achieve global development goals.

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