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Nexus between socio-economic development, fiscal decentralization, and environmental quality: Evidence from Indonesia

Ardian Prasetianto[1,*], Iwan Kustiwan[2]
Institut Teknologi Bandung, Indonesia[1,2]
Corresponding e-mail: 24021003@mahasiswa.itb.ac.id[*]

ABSTRACT

Purpose — *The main objective of this study is to analyze the influence of socioeconomic development and fiscal decentralization on environmental quality in Indonesia, as well as to identify causal relationships between them.*

Method — *The data utilized in this study are secondary data collected over the period from 2010 to 2020. Data sources were obtained from the Ministry of Environment and Forestry, the Central Bureau of Statistics, the Ministry of Finance, and the World Bank. This study uses a quantitative approach in dynamic panel data analysis with a generalized method of moments (GMM) estimation analysis. The causal relationship between environmental quality and the research variables is analyzed using the Granger causality test.*

Result — *The study's findings indicate the presence of the reverse of an Environmental Kuznet Curve (EKC) relationship between Gross Regional Domestic Product (GRDP) per capita and environmental quality. Environmental quality is influenced positively and significantly by various factors, including human development, expenditure on environmental functions, poverty, and the manufacturing industry. On the other hand, fiscal transfers and urbanization have a negative and significant effect on environmental quality.*

Contribution — *A more comprehensive analysis of the impact of development achievements in Indonesia on environmental quality indicators is needed at the provincial government level, considering economic development, social development, and governance aspects. This study also classifies research results based on three regional classifications and includes GMM estimation analysis, which has not been widely done.*

Keywords: *development, EKC, environmental quality, fiscal decentralization, GMM*

INTRODUCTION

Based on the narrative of the 2020–2024 RPJMN, Indonesia's economic growth dependence on the commodity and natural resource sector faces obstacles, such as environmental degradation and natural resource depletion. High community quality will increase community activity and productivity, which will also lead to increased use of natural resources and an increase in pollution from the use of energy, ultimately reducing environmental quality (Li and Xu, 2021; Wiyekti, 2021).

Global environmental problems are significantly influenced by poverty, as acknowledged by experts. They assert that poverty is the primary driver of environmental degradation. Therefore, to effectively tackle environmental issues, governmental authorities, and policymakers must first address the underlying problem of poverty (Butarbutar, 2023).

Fiscal decentralization in Indonesia has resulted in differences in fiscal capacity in various regions, which are affected by the balancing funds provided by the central government to regional governments in the form of asymmetric transfers. One of the problems in environmental management on a regional scale is the limited ability of the region in terms of finance to achieve environmental goals (Halimatussadiah et al., 2021).

However, fiscal imbalances for ecological development exist in Indonesia because areas with rich ecological functions or greater forest cover receive fewer balancing funds than areas with minimal ecological functions or less forest cover. The implementation of regional autonomy related to environmental aspects is still experiencing some crucial problems, one of which is the very limited budget allocation.

Studies conducted in modern and developed countries indicate that sustainable economic and social development does not lead to environmental degradation (Ioan et al., 2020). Research conducted in developing countries has revealed the opposite phenomenon. The development carried out has led to extensive ecological damage. This environmental damage threatens the sustainability of civilization and has become a significant concern for the global community.

Analysis of the impact of development achievements in Indonesia on environmental quality indicators has indeed been carried out. However, a more comprehensive analysis is needed at the provincial regional government level, both from the aspect of economic development and social development, and from the aspect of governance. One of the interesting things that deserve to be used as material for analysis from the aspect of government is the effect of the implementation of decentralization on environmental quality. Therefore, the

objective of this study, based on the background and description of the problem, is to analyze the influence of socioeconomic development and fiscal decentralization on environmental quality in Indonesia.

METHOD

The quantitative research approach involves testing specific theories by analyzing the correlation between the dependent variable and the independent variables based on the research objective. The data used are secondary data for the period 2010-2020. Data sources were obtained from the Ministry of Environment and Forestry, the Central Bureau of Statistics, the Ministry of Finance, and the World Bank. Before running data on estimation analysis, data transformation can be performed to minimize the range of data that is too far or extreme, which may affect the estimation of the resulting regression coefficient. The data will be transformed into the form of natural logarithm (ln).

Table 1. Variable operational definition

	Variable	**Description**	**Data Source**
Dependent Variable	*lniklh*	Log natural Environmental Quality Index	KLHK
	lniku	Log natural Air Quality Index	KLHK
Independent Variable	*lnprdbpk*	Gross Regional Domestic Product at Constant 2010 Prices (Thousand Rp)	BPS
	lnipm	Log natural Human Development Index	BPS
	lnprsnmiskin	Log natural Percentage of Poor Population (percent); Poverty rate.	BPS
	lnprsntransfer	Log natural Ratio of Transfer fund revenue from central government to Total Revenue	Ministry of Finance
Control Variabel	*lnbelanjalh*	Provincial Government Expenditure on Environmental Functions (Billion IDR)	Ministry of Finance and World Bank
	lnindmanuf	Log natural Percentage of Value Added of Manufacturing Industry to GDP	BPS
	lnprsnurban	Log natural Percentage of Population in Urban Areas (Urbanization Rate)	BPS

Source: authors' compilation (2023)

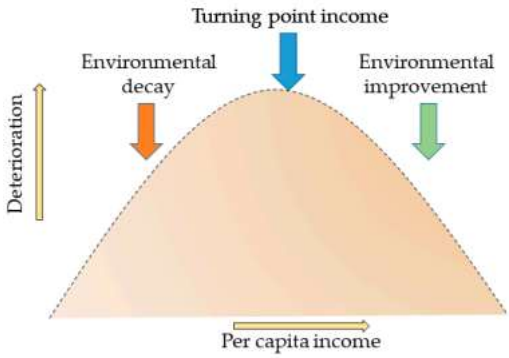
The quantitative analysis of this model will begin with a static panel model estimation analysis using the common effects (CE) or Ordinary Least Square (OLS) and fixed effects (FE) approaches. The output results of this analysis will be used as material for further analysis in the GMM method. In this study, the authors used several dynamic panel data analysis methods, such as Granger Causality tests (Juodis et al., 2021), and dynamic panel data tests, such as the Arellano-Bond test and Sargan test. Next, the authors perform an estimation

analysis of the dynamic panel model using GMM, which consists of the first difference GMM (FD-GMM) approach (Arellano & Bond, 1991) and the system GMM approach (Arellano & Bover, 1995; Blundell & Bond, 1998).

Hypothesis development

Economic growth and environmental quality

Figure 1. EKC Curve



Source: Mosconi et al. (2020)

The EKC curve proposed by Simon Kuznets has an inverted U shape, which illustrates that the level of environmental degradation will increase along with economic growth and a country's GDP per capita (Todaro & Smith, 2012). This theory suggests that during the initial phases of economic growth, there is a tendency for environmental degradation to rise. As GDP per capita increases, the level of environmental degradation then decreases and reaches a low point in the final phase of the EKC curve.

Several studies have supported the EKC growth hypothesis by examining the correlation between economic growth and the environment. The study by Rashid Khan et al. (2019) confirmed the Environmental Kuznets Curve (EKC) hypothesis of carbon emissions with respect to per capita income and public expenditure on education. The study by Sen & Abedin (2021) found evidence of Environmental Kuznets Curves in China and India at both individual and panel levels.

H1: GRDP per capita initially harms environmental quality, then a higher increase in GRDP per capita (squared) will make a positive impact on environmental quality

Human development and environment quality

Li & Xu (2021) conducted a study exploring the connection between human development and the environment in Chinese provinces from 2004 to 2017, as measured by industrial solid waste and air quality. The study's findings revealed a positive correlation between human development and both industrial solid waste and air quality.

Oktavilia et al. (2018) conducted research in 31 provinces in Indonesia from 2010 to 2015, and their study concluded that increasing human development has a positive effect on the Environmental Quality Index (EQI).

H2: Human development has a positive effect on environmental quality

Poverty and environmental quality

With a sample of 33 provinces in Indonesia from 2012 to 2017, Setyadharma et al. (2020) identified a trade-off between poverty and environmental degradation in their research. The study's results indicated a unique relationship between poverty and environmental quality.

The research results from Setyadharma et al. (2020) are in line with Duraiappah (1998), which concluded that initially, the poor are not the direct cause of environmental damage. However, institutional and market failures cause the poor to have a direct impact on environmental quality.

H3: Poverty harms environmental quality

Fiscal transfer and environment quality

The principle of the DBH SDA (Distribution Based on the Harvesting) is centered around the origin of the producing area and its distribution, determined by regional revenues. However, this approach can lead to inequality between regions abundant in natural resources and those with limited natural resources (Manurung, 2019). The fiscal transfer policy has been criticized for not adequately supporting environmental protection initiatives, as pointed out by Pradiptyo et al. (2019).

H4: Fiscal transfer harms environmental quality

RESULT AND DISCUSSION

Based on Table 2, the probability value indicates whether there is a causal relationship with the variable by comparing it to alpha. If the probability (p-value) of the statistical test is less than the predetermined alpha significance level, this indicates a significant causal relationship between the variables. The causality relationship is shown by the results of the HPJ test with a probability value of less than α (5%).

Table 2. Granger non-Causality Test

Dependent Variabel	Independent Variabel	HPJ Wald Test	p-value	Causality Result
lniklh	*lnpdrbpk*	33.2764	0.0000	*lniklh ↔ lnpdrbpk*
lnpdrbpk	*lniklh*	24.2005	0.0000	
lniklh	*sqlnpdrbpk*	134.0832	0.0000	*lniklh ↔ sqlnpdrbpk*
sqlnpdrbpk	*lniklh*	12.1887	0.0005	
lniklh	*lnipm*	18.9410	0.0000	*lniklh ↔ lnipm*
lnipm	*lniklh*	9.4551	0.0021	
lniklh	*lnprsnmiskin*	497.2392	0.0000	*lniklh ↔ lnprsnmiskin*
lnprsnmiskin	*lniklh*	46.0202	0.0000	
lniklh	*lnpersenpad*	0.9056	0.3413	*lniklh → lnpersenpad*
lnpersenpad	*lniklh*	6.8062	0.0091	
lniklh	*lnprsntransfer*	6.6160	0.0101	*lniklh ↔ lnprsntransfer*
lnprsntransfer	*lniklh*	11.2267	0.0008	
lniklh	*lnbelanjalh*	3.6217	0.0570	*lnbelanjalh → lniklh*
lnbelanjalh	*lniklh*	4.0724	0.2538	
lniklh	*lnindmanuf*	17.2218	0.0000	*lnindmanuf → lniklh*
lnindmanuf	*lniklh*	0.2389	0.6250	
lniklh	*lnprsnurban*	21.9465	0.0000	*lnprsnurban → lniklh*
lnprsnurban	*lniklh*	-	-	
lniku	*lnpdrbpk*	24.6691	0.0000	*lniku ↔ lnpdrbpk*
lnpdrbpk	*lniku*	9.4947	0.0021	
lniku	*sqlnpdrbpk*	48.5489	0.0000	*lniku ↔ sqlnpdrbpk*
sqlnpdrbpk	*lniku*	13.4431	0.0002	
lniku	*lnipm*	25.9403	0.0000	*lnipm → lniku*
lnipm	*lniku*	0.1749	0.6758	
lniku	*lnprsnmiskin*	28.9626	0.0000	*lnprsnmiskin → lniku*
lnprsnmiskin	*lniku*	1.1225	0.2894	
lniku	*lnpersenpad*	0.1299	0.7186	*lniku → lnpersenpad*
lnpersenpad	*lniku*	39.1616	0.0000	
lniku	*lnprsntransfer*	0.0012	0.9725	*lniku → lnprsntransfer*
lnprsntransfer	*lniku*	15.9974	0.0001	
lniku	*lnbelanjalh*	2.9191	0.0875	*lniku ↔ lnbelanjalh*
lnbelanjalh	*lniku*	24.6506	0.0000	
lniku	*lnindmanuf*	31.2527	0.0000	*lniku ↔ lnindmanuf*
lnindmanuf	*lniku*	7.4486	0.0063	
lniku	*lnprsnurban*	117.6127	0.0000	*lnprsnurban → lniku*
lnprsnurban	*lniku*	-	-	

Source: processed data (2023)

The quality of the environment shows indications of a causal relationship or two-way causality with the variables of GRDP per capita, GRDP per capita squared, human development, the percentage of poor people, and the percentage of fiscal transfers to regional income. Meanwhile, the environmental function of regional expenditure variables, the proportion of the manufacturing industry to GDP, and the percentage of the urban population have a one-way causal relationship with environmental quality.

In addition, from the results of the analysis, air quality also shows indications of a causal relationship or two-way causality with the variables of GRDP per capita, GRDP per capita squared, regional spending on environmental functions, and manufacturing industry share to GDP. Air quality also has a one-way causal relationship with the percentage of PAD to regional income and the percentage of fiscal transfers to regional income, while human development, the percentage of poor people, and the percentage of urban residents have a one-way causality relationship with air quality.

Based on the results of the Granger causality test, we obtained the direction of the relationship between the variables in the study. The estimation model that corresponds to the direction of the relationship in the Granger causality test is shown by equations (1) and (2).

$$lniklh_{it} = \alpha + \beta_1 lnpdrbpk_{it} + \beta_2 lnpdrbpk_{it}^2 + \beta_3 lnipm_{it} + \beta_4 lnprsnmiskin + \beta_5 lnprsntransfer_{it} + \beta_6 lnbelanjalh_{it} + \beta_7 lnindmanuf_{it} + \beta_8 lnprsnurban_{it} + \beta_9 lniklh_{it-1} + e_{it} \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$lniku_{it} = \alpha + lnpdrbpk_{it} + \beta_2 lnpdrbpk_{it}^2 + \beta_3 lnipm_{it} + \beta_4 lnprsnmiskin_{it} + \beta_5 lnbelanjalh_{it} + \beta_6 lnindmanuf_{it} + \beta_7 lnprsnurban_{it} + \beta_8 lniku_{it-1} + e_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Information:

$lniklh_{it}$	: Environmental Quality Index (in index units);
$lniku_{it}$	: Air Quality Index (in index units);
$lnpdrbpk_{it}$	: GRDP per capita;
$lnpdrbpk_{it}^2$	: GRDP per capita squared;
$lnipm_{it}$	: Human Development Index (HDI);
$lnprsnmiskin_{it}$	: Percentage of Total Poor Population;
$lnprsntransfer_{it}$	: Percentage of Transfer Revenue to Total Revenue;

$lnbelanjalh_{it}$: Pemprov Expenditures for Environmental Functions;
$lnindmanuf_{it}$: Share of the manufacturing industry to GDP;
$lnprsnurban_{it}$: Percentage of Population in Urban Areas
α : constant (intercept);
β : coefficient of the slope of each independent variable;
e : error value (error);
i : entity i;
t : t-period

Before interpreting the estimation results, a feasibility test of the GMM model is first carried out. Based on the output in Table 3 and Table 4, the p-value of the AR test (1) in the first difference GMM model is mostly below the significance level of α = 5%. However, in the IKU model in Java, there is a p-value from the AR test (1) that is above the significance level of α = 10% (0.1121). Meanwhile, the p-value of the AR test (2) in the first difference GMM model is mostly above the significance level of α = 1%. This shows that there is not enough evidence to reject the null hypothesis, indicating that there is no serial correlation in the estimation model error.

Table 3. GMM Estimation results of IKLH

Variabel	Indonesia		Java		Outside Java	
	FD GMM	System GMM	FD GMM	System GMM	FD GMM	System GMM
L.lniklh	0.366***	0.562***	0.0496	0.0545	0.328***	0.369***
	-0.0425	-0.0276	-0.13	-0.117	-0.0539	-0.0494
lnpdrbpk	-1.480***	0.38	-0.676	0.666	-1.382***	-0.838**
	-0.461	-0.235	-0.692	-0.672	-0.318	-0.396
sqlnpdrbpk	0.223***	-0.0404	0.0536	-0.0575	0.196***	0.133**
	-0.067	-0.0297	-0.0537	-0.081	-0.0447	-0.0526
lnipm	0.79	1.239***	1.096	2.990***	0.909	0.672*
	-0.892	-0.387	-3.162	-0.827	-0.59	-0.388
lnprsnmiskin	0.428***	0.244***	0.617***	0.610***	0.219***	0.0544*
	-0.0357	-0.0392	-0.18	-0.11	-0.0392	-0.0299
lnprsntransfer	-0.0198	-0.0136	-0.135***	-0.114	0.0942***	0.0520**
	-0.0129	-0.0157	-0.0311	-0.0813	-0.0187	-0.0254
lnbelanjalh	0.00812***	0.00647***	0.00451	-0.00665	0.00860***	0.00813***
	-0.00228	-0.00216	-0.00464	-0.0108	-0.00216	-0.0027
lnindmanuf	-0.0325	0.015	-0.954***	0.502***	0.0378	0.0121
	-0.038	-0.0322	-0.198	-0.115	-0.0307	-0.0342
lnprsnurban	0.701	-0.230**	2.821***	0.112	0.301	-0.138
	-0.481	-0.0973	-1.076	-0.228	-0.368	-0.163
Constant	-1.786	-3.929***	-8.854	-13.66***	-0.72	1.228
	-2.266	-1.233	-7.028	-3.2	-1.383	-0.777
Observations	297	330	54	60	243	270
Number of prov	33	33	6	6	27	27
Sargan Test	0.9448	0.9938	0.2903	0.0086	0.9901	0.9998
A-B test AR(1)	0.0008	0.0009	0.0393	0.1618	0.0001	0.0002
A-B test AR(2)	0.1428	0.2511	0.1037	0.0623	0.2308	0.21
OLS - Lag lniklh	0.547		0.0285		0.44	
FE – Lag lniklh	0.115		0.0728		0.135	
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Source: processed data (2023)

In the GMM system model, most of the estimation models have a p-value from the AR test (1) below the significance level of α = 10%, indicating a serial correlation in these models. However, the two models in Java have p-values above the value of α = 10% (0.1618 and 0.1004).

The AR (2) value of the GMM system model mostly has a p-value above the value of α = 5%, which indicates that there is no serial autocorrelation in the error. If the p-value of the AR (2) test is not significant, it indicates that there is no second-order serial correlation in the residuals, making the estimator consistent.

Table 4. GMM estimation results for IKU

Variabel	Indonesia		Java		Outside Java	
	FD GMM	System GMM	FD GMM	System GMM	FD GMM	System GMM
L.lniku	0.321***	0.412***	0.182*	0.224*	0.398***	0.412***
	(0.00742)	(0.0115)	(0.109)	(0.117)	(0.0157)	(0.0175)
lnpdrbpk	-2.275***	-1.050***	-2.165***	-1.111	-1.034***	-1.258***
	(0.230)	(0.215)	(0.468)	(0.693)	(0.275)	(0.390)
sqlnpdrbpk	0.323***	0.111***	0.271***	0.159**	0.116***	0.136***
	(0.0277)	(0.0263)	(0.0437)	(0.0627)	(0.0355)	(0.0522)
lnipm	1.716***	3.360***	3.438*	5.302***	1.853***	2.372***
	(0.394)	(0.231)	(1.972)	(0.644)	(0.675)	(0.278)
lnprsnmiskin	0.0377**	0.0283***	0.0707	0.220***	-0.0480	0.158***
	(0.0165)	(0.0106)	(0.165)	(0.0751)	(0.0444)	(0.0434)
lnbelanjalh	0.0106***	0.00561**	0.0104	0.0105	0.00707***	0.00919***
	(0.00170)	(0.00235)	(0.00695)	(0.00824)	(0.00248)	(0.00305)
lnindmanuf	-0.0425***	0.0334*	-0.433	0.480**	0.0616***	0.00205
	(0.0125)	(0.0194)	(0.346)	(0.196)	(0.0224)	(0.0136)
lnprsnurban	-0.133	-0.609***	0.192	-1.293	-0.200	0.113
	(0.206)	(0.0529)	(0.837)	(0.964)	(0.267)	(0.107)
Constant	0.148	-7.215***	-6.672	-14.17***	-2.301	-5.530***
	(0.975)	(0.633)	(7.595)	(4.912)	(1.507)	(0.523)
Observations	297	330	54	60	243	270
Number of prov	33	33	6	6	27	27
Sargan Test	0.9090	0.9945	0.2699	0.3517	0.9867	0.9996
A-B test AR(1)	0.0021	0.0016	0.0991	0.1004	0.0003	0.0003
A-B test AR(2)	0.4960	0.7050	0.3835	0.3830	0.4467	0.3321
OLS - Lag lniku	0.608		0.213		0.562	
FE – Lag lniku	0.269		0.188		0.343	
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Source: processed data (2023)

The second model feasibility test is the Sargan test, which aims to evaluate whether the instrument used in the model is valid or not. The output results for the Sargan test in Table 3 and Table 4, using the first difference GMM, show that most of the models have a p-value above α = 1%. These results indicate that the instruments used in some of the FD-GMM models are valid. However, the GMM Sargan test system value shows that most of the models have a p-value above α = 1%, except for the IKLH model in Java, where the p-value is below the value of α = 1% (0.0086). It can be concluded that the results of the Sargan test show that

there are problems with over-identifying restrictions, indicating that the model has a problem with the validity of the instrument.

In analyzing the dynamic models of IKLH and IKU of provinces in Indonesia and provinces outside Java, it can be concluded that the FD-GMM model produces unbiased estimates. This is because the coefficient values of lag lniklh and lniku variables in the FD-GMM model are between the coefficient values of lag lniklh and lag lniku variables in the Ordinary Least Square (OLS) and fixed effect methods. On the other hand, the IKLH and IKU models of provinces in Java using FD-GMM produce estimates that are biased downward because the coefficient values of lag variables lniklh and lag lniku are smaller or close to the coefficient values of lag variables lniklh and lniku in the fixed effect method. The GMM system models that produce unbiased estimates include the IKLH model for provinces outside Java and the IKU model for provinces in Indonesia and outside Java since the lag coefficient value of the dependent variable is between the lag coefficient value of the dependent variable in the OLS and fixed effect methods.

After conducting the model feasibility test, the model is then interpreted. Models that meet the criteria of no serial autocorrelation in errors, have valid instruments, and are unbiased can be interpreted using the GMM approach. Interpretation of the estimation results is carried out on models that meet the best GMM criteria for variables that significantly affect environmental quality and air quality, complemented by an analysis of the impact or implications of supporting legislation.

Hypothesis testing

Table 5. Hypothesis testing

Relationship	Indonesia		Java		Outside Java		Decision
	Coef.	p-value	Coef.	p-value	Coef.	p-value	
lnpdrbpk -> lniklh	-1.480	0.001	0.666	0.322	-0.838	0.034	Accepted
sqlnpdrbpk -> lniklh	0.223	0.001	-0.057	0.478	0.133	0.011	
lnpdrbpk -> lniku	-1.050	0.000	-1.111	0.109	-1.258	0.001	
sqlnpdrbpk -> lniku	0.111	0.000	0.159	0.011	0.136	0.009	
lnipm -> lniklh	0.790	0.375	2.990	0.000	0.672	0.083	Accepted
lnipm -> lniku	3.360	0.000	5.302	0.000	2.372	0.000	
lnprsnmiskin -> lniklh	0.428	0.000	0.610	0.000	0.054	0.069	Declined

lnprsnmiskin -> lniku	0.028	0.007	0.220	0.003	0.158	0.000	
lnprsntransfer -> lniklh	0.020	0.124	-0.114	0.161	0.052	0.041	Declined

Source: processed data (2023)

Based on Table 5, the relationship of GRDP per capita in Indonesia and outside Java, and its square, have a significant negative and positive relationship following the hypothesis. Every 1 percent increase in GRDP per capita will reduce environmental quality and air quality in Indonesia by 1.480 points and 1.050 points, and environmental quality and air quality outside Java by 0.838 points and 1.258 points. Additionally, every 1 percent increase in GRDP per capita squared will increase environmental quality and air quality in Indonesia by 0.223 points and 0.111 points, and environmental quality and air quality outside Java by 0.133 points and 0.136 points (ceteris paribus). In addition, GRDP per capita ADHK 2010 squared has a positive and significant relationship with air quality in the provinces of Java Island.

Based on the estimation results, the proportion of the manufacturing industry has a significant positive effect on air quality in Indonesia and Java Island.

It was found that HDI has a positive and significant influence on the environmental quality of provinces outside Java, as well as on the air quality estimation model in the three classification areas, following the hypothesis. The estimation results show that every 1-point increase in HDI will increase the air quality of provinces in Indonesia and provinces in Java by 3.360 points and 5.302 points, as well as environmental quality and air quality of provinces outside Java by 0.672 and 2.372 points (ceteris paribus).

There is a positive and significant influence between poverty and environmental quality in provinces in Indonesia and outside Java, and air quality in all three classification areas, which is not in line with the hypothesis. Every 1 percent increase in the number of poor people relative to the total population will increase the environmental quality and air quality of provinces in Indonesia by 0.428 points and 0.028 points, as well as increase environmental quality and air quality outside Java by 0.0544 points and 0.158 points (ceteris paribus).

It was found that fiscal transfers have a positive and significant effect on environmental quality in provinces outside Java, which is not in line with the hypothesis. The estimation results show that for every 1 percent increase in transfer income to total regional income (1 billion transfers to 100 billion regional income), the environmental quality of provinces outside Java increases by 0.0520 (ceteris paribus).

Discussion

The effect of economic development on environmental quality

The results show that the relationship between GRDP per capita and its square with the environmental quality model and the air quality model in Indonesia and outside Java is U-shaped or the opposite of the Environmental Kuznets Curve (EKC). However, this relationship is consistent with the EKC hypothesis due to differences in environmental variables. This study uses environmental quality, while the EKC hypothesis uses the level of environmental degradation. The conformity of the analysis with the EKC hypothesis is shown by the fact that environmental quality and air quality will gradually decrease and eventually reach a low point and then increase with economic growth. The EKC hypothesis shows that although initially, GDP growth can reduce environmental quality, after the turning point, environmental quality will eventually improve along with GDP growth (Rany et al., 2020). During this stage, individuals prioritize enhancing the quality of the natural environment over consumption patterns that disregard externalities.

This study reinforces the results of various earlier research that highlight a trade-off between economic and social development when it comes to the environment. The conflicting relationship between economic growth and environmental sustainability poses a challenging dilemma for developing countries, including Indonesia. The result of GRDP per capita squared significantly positive influence on air quality in provinces in Java Island shows that the characteristics of economic development in Java Island initially improve air quality. Then at this time, economic development in Java Island developed along with improved air quality; in other words, economic development is at the post-industrial stage of the EKC, where the industry began to shift to service-oriented industries.

As stated in the Coase theorem, the role of government can lead to efficiency in dealing with negative externalities. In the context of the Indonesian government's commitment to changing the development paradigm towards high-quality development through low-carbon methods and environmentally friendly development, the issuance of Government Regulation (PP) Number 59 of 2017 aims to carry out the achievement of the Sustainable Development Goals. All parties, including local government, are committed to participating in achieving sustainable development goals. Therefore, the current development focus is environmentally friendly development and inclusive growth following the goals of sustainable development (Butarbutar, 2023).

The fact that the total energy intensity of the Indonesian manufacturing sector has experienced a significant and sustainable decline over a period of 35 years (1980-2015), with a decrease of 65%, is supported by limited changes in the industrial structure toward lower intensity (Maulidiyah & Auwalin, 2021). With the change in energy policy through Presidential Decree No. 5 of 2006, PP No. 79 of 2014 concerning the National Energy Policy, and Presidential Regulation regarding the national energy plan since 22 December 2017, the Indonesian government has made several revisions in energy policymaking.

The effect of social development on environmental quality

The results of this study, that HDI has a positive and significant impact on environmental quality, are generally in line with previous studies (Bano et al., 2018; Shanty et al., 2018; Li & Xu, 2021). The calculation of HDI has internalized external costs that consider the value of depletion or loss of natural resources and degradation of environmental functions. Law No. 23/2014 on Regional Government also emphasizes local governments to increase PAD. Increased PAD will improve the quality of health services and infrastructure, which can affect the increase and stability of community life expectancy. The correlation between IKLH and life expectancy can be influenced by revenue-oriented regional policies.

Provincial data in Indonesia shows that areas with high economic growth are not necessarily followed by a reduction in the poverty rate (Shanty et al., 2018). Observing the phenomenon that occurred in several provinces where income from the manufacturing sector was already high, it was not followed by a decrease in the poverty rate. Several studies have found trade-offs between poverty, HDI, and environmental quality. The results of this study support Setyadharma et al. (2020) research, which concluded that there is a unique relationship between poverty and environmental quality. When government budgets are limited, it's difficult to both reduce poverty and improve the environment at the same time. Strict environmental regulations can lead to more poverty as people might have limited access to natural resources.

The results of this study are consistent with the research of Duan & Tan (2019), where all developing countries that have high urbanization rates tend to experience land or forest transitions. Increasing urbanization causes an increase in CO2 emissions in line with the growth of the urban population and increased use of infrastructure, transportation, and energy. The shift in economic structure from agrarian to industrial, accompanied by urbanization, tends to contribute to an increase in environmental damage.

The effect of fiscal decentralization on environmental quality

The research results are in line with the government's efforts to reduce excessive exploitation in connection with the collection of DBH-SDA taxes. Since 2015, there has been a decrease in the value of natural resource utilization (DBH-SDA), while the value of tax revenue from the industrial sector (tax DBH) has increased (Wiyekti & Qibthiyyah, 2021). The central government acknowledges that with the change in revenue from DBHSDA to other tax revenues, natural resources are no longer the main source of state revenue. The research findings are consistent with studies by Droste et al. (2015) showing that earmark transfers play a larger role in the provision of conservation areas. Earmark transfers are considered more efficient than revenue sharing in the form of DBH or coordination funds. The provision of conservation areas that show positive spillover effects can be financed by earmark transfer (IFT) allocations (Kumar & Managi, 2009). The research results are also in line with a study by Wiyekti & Qibthiyyah (2021) which found that funding from the Special Allocation Fund (DAK) has a significant and positive impact on expanding forest protection in Indonesia down to the district level.

The results of the study, which show that environmental function local expenditure has a significant positive influence/relationship on environmental quality and provincial air quality in Indonesia and outside Java, are in line with the research hypothesis that environmental function budgets are important for improving environmental quality. The results are in line with several previous studies (He et al., 2017; Basoglu & Uzar, 2019; Oktavilia et al., 2021). The success of environmental management cannot be separated from government intervention. Local government intervention through policies on revenue from environmental and forestry management and spending on environmental and forestry functions can affect environmental quality. Increased government spending indicates that the spending is related to development and environmental sustainability.

CONCLUSION

Based on the results of the Granger causality test, the relationship between the independent variable and the dependent variable, it was found that there was an EKC relationship between GRDP per capita and environmental quality outside Java and air quality in Indonesia. In addition, HDI has a significant positive effect on environmental quality in Java and outside Java, as well as a positive effect on air quality in the three area classifications. The percentage of poor people also has a significant positive effect on the quality of the environment in Indonesia as

a whole, as well as on the quality of the environment and air quality in Java and outside Java. Fiscal transfers have a significant positive effect on the quality of the environment outside Java, as well as a significant negative effect on air quality in Indonesia. Provincial government spending on environmental functions has a significant positive effect on environmental quality and air quality in Indonesia and outside Java. Finally, urbanization has a significant negative effect on air quality in Indonesia and outside Java.

The central government and local governments need to formulate a GDP that considers the value of environmental depletion and supports sustainable development (Green GDP) and the application of Environmental Economic Instruments. Local governments must prepare new policy tools to guarantee the best service for people's lives from an environmental perspective. Local governments need to increase regulations and law enforcement for business actors who pollute the environment and increase technological innovation. By implementing an ecology-based fiscal transfer scheme, the government can provide incentives to regions that are performing well in environmental protection and management and help finance programs related to environmental preservation. In the field of expenditure monitoring, the government must improve the quality of spending on environmental and forestry functions so that they are right on target, effective, and efficient. The government should continue to maintain a national energy mix policy that focuses on domestic energy supply.

Future research can expand the scope of research by increasing the period and using data at the district government scale, using more specific variables of social development aspects and fiscal decentralization, using methods that can reflect the spatial influence of the areas around the research subject, and analyzing the relationship between environmental quality and development aspects in a bidirectional or reciprocal manner.

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