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# Fiscal Decentralization in Indonesia: Does It Curb the Quality of Environment?

Adam Hawari, Faisal Madjid Alyasa\*, Muhammad Reyhan Akbar, and Estro Dariatno Sihaloho



**AFFILIATION:**

Department of Economics, Faculty of Economics and Business, Universitas Padjadjaran, West Java, Indonesia

**\*CORRESPONDENCE:**

faisal20005@mail.unpad.ac.id

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**Abstract:** Local authorities have played an enormous role in maintaining the sustainability of the environment through decentralization. While decentralization could improve the quality of the environment as an attribute of public good provision, it could also harm the environment by setting low environmental standards to boost environment-related business. In addition, the Environmental Quality Index (IKLH) from various provinces has shown fluctuations in the past ten years. With this ambiguous effect of decentralization, this study aims to disentangle the effect of decentralization on the quality of the environment in Indonesia. This study utilizes Indonesia's provincial-level data in 33 provinces from 2010 to 2020. In order to solve the model's suffering endogeneity problem, the two-stage least square panel-instrumental variable method is performed. The main results demonstrate that fiscal decentralization and its square significantly affect environmental quality. Its square indicates a nonlinear U-shaped relationship, that in the low-level stage of decentralization tends to harm the environment until the turning point. In addition, this research also suggests the positive but weak effect of Intergovernmental Fiscal Transfer (IFT) on environmental quality. Considering all the results, this research infers that decentralization curbs the quality of the environment in Indonesia and, to some extent, contributes to maintain environmental quality. Therefore, local authorities have a significant role in promoting green regulation to enhance environmental quality and this also reaffirms the importance of green indicators in local budgeting.

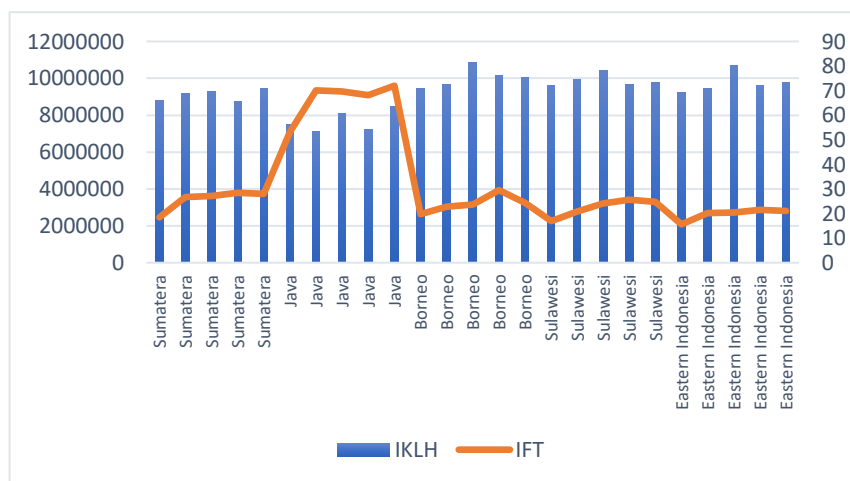
**Keywords:** Fiscal Decentralization; Environmental Quality; Intergovernmental Fiscal Transfer

**JEL Classification:** E62; H3; F64

## Introduction

Environmental quality has become a frequently debated issue in recent decades (Udeagha et al., 2022). Emissions from greenhouse gasses are an essential link between the economic sector and global warming. These hazards are categorized as transitional threats and economic costs for development (Xia et al., 2022; OECD, 2019). Otherwise, environmental quality needs special attention from central and local governments (Udeagha & Breitenbach, 2023). The central government regulates environmental issues in law number 32 of 2009. Meanwhile, local governments get the opportunity to improve environmental facilities through fiscal decentralization policies (Prawidya, 2018).

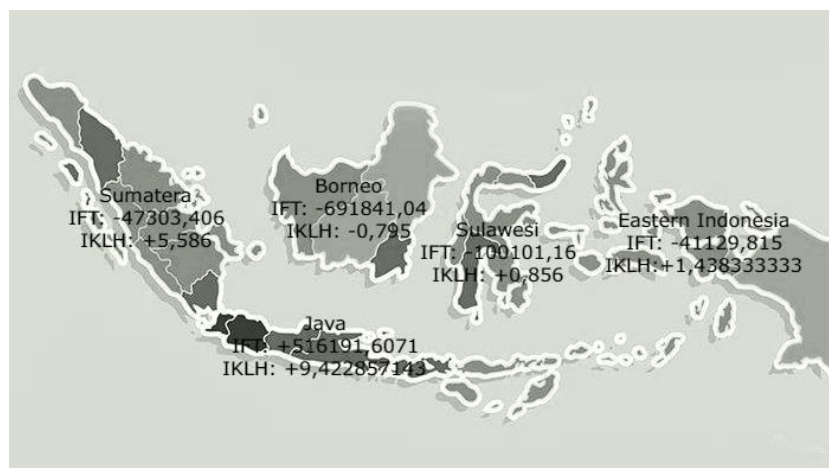
Implementing fiscal decentralization policies can well suppress environmental quality (Chen & Liu, 2020). Fiscal decentralization provides a new point of view on the economic system. The mechanism of this policy is the expansion of autonomy granted by the central government to regional governments to control economic activities in the regions (Hao et al., 2019; Fatoni, 2020). As a result, a positive stimulus can be felt through more equitable economic growth to adequate availability of public goods (Cahyadi, 2019; Talitha, et al., 2019).



**Figure 1** The Fluctuation of Environmental Quality Index (IKLH) and Intergovernmental Fiscal Transfer (IFT) in Indonesia 2016-2020  
 Source: BPS-Statistics Indonesia

The fiscal decentralization budget function in Indonesia implements as intergovernmental transfer funds. Intergovernmental transfer funds are divided into The General Allocation Fund (DAU), Special Allocation Funds (DAK), and Revenue Sharing Fund (DBH) (Ministry of Finance Republic of Indonesia, 2020). Masaki (2018); Ajefu and Ogebe (2022) found that intergovernmental transfer funds positively influence the income and quality of well-being of local communities in less developed countries. In addition, intergovernmental transfers 3 in Indonesia can cover the inequality of native income of less productive regions through the instrument of The General Allocation Fund (DAU).

Figure 1 shows the progression of the Environment Quality Index (IKLH) and Intergovernmental Fiscal Transfer (IFT) in 5 accumulation parts of Indonesia (Java, Sumatera, Borneo, Sulawesi, and Eastern Indonesia) in the 2016-2020 interval. In the last five years, Java Island has become the island with the most prominent regional revenue from intergovernmental fiscal transfers compared to 4 other regions. The significant growth in intergovernmental fiscal transfers in Java is quite inversely proportional to the lowest achievement of the IKLH value indicated by the blue line. This anomaly is reinforced by the eastern part of Indonesia having the highest IKLH, although their intergovernmental fiscal transfers are the lowest.



**Figure 2** Distribution of Environmental Quality (IKLH) and Intergovernmental Fiscal Transfer (IFT): Special Case 2018  
Source: BPS-Statistics Indonesia

Temporarily, Figure 2 shows that the empirical condition in 2018 is the most unique because there is a growth in the IKLH trend for every five parts of Indonesia without considering intergovernmental fiscal transfer fluctuations in various regions. The improvement in 2018 environmental quality is due to advances in water quality (water quality index) and calculation methods that consider rehabilitation and conservation aspects (land cover index) (Ministry of Forestry and Environment, 2019). Meanwhile, in 2020 improvements in environmental quality coincided with a comprehensive decrease in intergovernmental fiscal transfers. This decrease was caused by a decrease in the Revenue Sharing Fund (DBH) components sourced from regional revenues as one effect of the Covid-19 Pandemic (Ministry of Finance of the Republic of Indonesia, 2020; Financial Supervisory Agency, 2020).

According to the previous explanation, fiscal decentralization tends to have a relationship with environmental quality. Hence, the primary purpose of this paper is to scrutinize whether Indonesia's fiscal decentralization might curb the environmental quality or not.

The main contribution of this paper is to incorporate the novelty of Indonesia's government fiscal decentralization policy into the analysis of local environmental quality in Indonesia's 33 provinces. In addition, this study also contributes to prove the existence of a non-linear correlation between fiscal decentralization and environmental quality. Finally, our findings provide new evidence of the intermediaries' relationship between fiscal decentralization, human capital as a mediating variable, and environmental quality.

#### Literatur Review

In recent years, institutional and governmental settings for environmental quality via decentralization have attracted scholars' attention. Decentralization often regards as the devolution of power from central to local government. Since residents represent their

preferences for the local public good by “voting their feet,” there is competition among local governments to provide efficient local public goods (Tiebout, 1956). On the other hand, environmental quality has been attributed to public goods; hence there is a considerable connection between decentralization with environmental quality.

There are two competing approaches regarding the impact of decentralization on environmental quality; the two approaches are: ‘race to the top’ and ‘race to the bottom’ (Cheng et al., 2020). The race to the top approach argues that decentralization positively affects environmental quality by providing appropriate environmental standards in their jurisdiction area. Contrary, the latter approach views local governments often setting aside environmental quality to boost their local economy. Therefore, there is still a lack of agreement and ambiguous evidence regarding the interconnection between decentralization and environmental quality.

Decentralization could also affect both directly and indirectly the environmental quality. Since decentralization has an impact on economic growth, the contribution of decentralization to environmental quality comes indirectly from its influence through economic growth (Tufail et al., 2021). In addition, decentralization is linked to environmental quality via human capital and institutional quality. Khan et al. (2021) found that human capital could accelerate the impact of decentralization through better environmental awareness and the development of environmentally friendly technology. Furthermore, Institutional quality complements decentralization by encouraging environmental legislation and a vibrant political sphere.

Moreover, fiscal decentralization will also affect the environment directly. Since local authorities have a better understanding of their localities, this would make the promotion of abating pollution more efficient through effective green investment. However, Chen et al. (2018) suggest that the real spirit of decentralization is to promote a high level of economic growth; hence local leaders tend to compensate for environmental quality with the acceleration of local economic activities. This argument aligns with Zhang et al. (2017) and Guo et al. (2020), who concluded from the green paradox perspective. They stated that decentralization becomes the institutional cause of the green paradox due to short-term benefits for local governments with violating the compliance of environmental regulations.

Recently, many scholars have suggested a non-linear relationship rather than a linear one between fiscal decentralization and environmental quality. Liu et al. (2017) developed a theoretical model based on endogenous growth theory that reveals non-linear U-shaped relation between decentralization with the quality of the environment. Cheng et al. (2020) empirically found evidence supporting non-linear U-shaped relations. They argue that in the early stage, the local government promotes sectors that give large portions of local growth, including high energy consumption sectors. Then, after the change in development mode, which incorporates the goal of achieving sustainable development, decentralization tends to enhance environmental quality.

## Research Method

### Data

This study uses 33-province panel data from 2010 to 2020 in Indonesia. The data were derived from Indonesia's Central Statistics Bureau (BPS) and the Ministry of Environment of Indonesia.

**Tabel 1** Variable and Data Source

Variable Name	Variable	Source
<b>Dependent Variable</b>		
IKLH	Index of environment quality.	Ministry of Environment of Indonesia
<b>Independent Variable</b>		
FD	Fiscal decentralization.	Central Statistics Bureau (BPS)
FDsq	Square of fiscal decentralization.	
IFT	Intergovernmental Fiscal Transfer.	
<b>Other Variable</b>		
extr_str	Extraction structure represents the contribution of extraction sectors in an economy.	Central Statistics Bureau (BPS)
ln_pdrb	Logarithmic form of Product Domestic Regional Bruto (PDRB) at constant price.	
gov_size	Government size denotes size of government spending relative to PDRB.	
HC	Human capital with expected years schooling as a proxy.	
IFTHC	Interaction variable between IFT and HC.	
IDI	Indonesia's Democracy Index.	
IFTIDI	Interaction variable between IFT and IDI.	

The Dependent variable for this study is *Indeks Kualitas Lingkungan Hidup (IKLH)*. The dependent variable is an index that proxies for environmental quality compiled by several indicators, including the water quality index, air quality index, soil quality index, and sea quality index (Ministry of Forestry and Environment, 2019).

The independent variable can be classified into two variables. Using provincial-level data from BPS, we construct our measures for fiscal decentralization with an expenditure approach. This study adopted an expenditure approach to measure the degree of decentralization of certain local governments, which is often used in the empirical study (Martinez-Vazquez et al., 2016). Expenditure decentralization is used to measure fiscal decentralization as

$$FD = \frac{\text{Total province budgetary expenditure}}{\text{Total national budgetary expenditure}}$$

In general intergovernmental transfer refers to the flow of funds from one level of government to another within the country, from the national to the provincial level of

government. In Indonesia, the intergovernmental fiscal transfer is reflected as Dana Perimbangan (Equalization Fund). Dana Perimbangan is divided into three main components: General Allocation Fund (Dana Alokasi Umum), Equalization Grants (Dana Bagi Hasil), and Special Allocation Fund (Dana Alokasi Khusus) (Nasution, 2016).

#### Empirical Model

Fiscal decentralization might impact environmental quality by changing many factors like demographic factors and economic factors. This condition will result in the possibility of endogeneity problems in the model due to the endogenous fiscal decentralization variable, which is also in accord with the argument by He (2015). To solve the endogeneity problem in the fiscal decentralization variable, This study uses a two-stage panel least square regression model to estimate the relation between dependent and independent variables. That is, the fiscal decentralization variable needs to use instrument variables for the model.

Two-stage estimation models allow us to eliminate the potential of endogeneity of fiscal decentralization, which is very important for the validity of fiscal decentralization variable. This study uses two-stage panel linear regression approach with the fixed-effect method to estimate the model. Fixed-effect method is assuming there is correlation between independent variable and unobserved variable. In addition, this approach would also circumvent omitted variables problem by removing individual effects term through time-demeaning process (Wooldridge, 2015).

The first-stage least square regression we use to estimate the fiscal decentralization variable as instrument variable, with specification:

$$\widehat{FD}_{it} = \hat{\alpha}_0 + \hat{\alpha}_1 popden_{it} + \hat{\alpha}_2 trade_{op}_{it} + \hat{\alpha}_3 ind\_str_{it} + \hat{\alpha}_4 IPM_{it} + \hat{u}_{it}$$

Where  $FD$  denotes the fiscal decentralization,  $popden$  is population density for province  $i$  at period  $t$  this variable calculate by dividing total population with land size of each province.  $Trade_{op}$  denotes the trade openness variable.  $Ind\_str$  denotes industrial structure which is the total of regional domestic product from the manufacturing sector divided by total regional domestic product.  $IPM$  denotes for human development index province  $i$  at period  $t$ .

The second stage regression is represented as below. The second stage regression is the model that would mainly discuss in the result and discussion part.

$$\widehat{IKLH}_{it} = \hat{\beta}_0 + \hat{\beta}_1 FD_{it} + \hat{\beta}_2 FDSq_{it} + \hat{\beta}_3 IFT_{it} + \sum \hat{\delta}_i X_{it} + \hat{u}_{it}$$

Where  $FD$  denotes fiscal decentralization,  $FDSq$  denotes the square of fiscal decentralization,  $IFT$  denotes intergovernmental transfer, and  $X$  denotes the control variable with the  $FD$  as an instrument variable. The two-stage panel linear regression approach assumes the exogeneity of fiscal decentralization, which is vital for the validity of fiscal decentralization as the instrument.

## Result and Discussion

The relationship between fiscal decentralization, both in linear and nonlinear terms, with environmental quality is shown in Table 2. Table 2 also provides estimation of the relationship of variables of interest both in InstrumentalVariable (IV) and Ordinary Least Square (OLS) approach. The comparison between both methods applied to evaluate the consistency of the models and showthat the difference after the endogeneity problem has been solved.

### Fiscal Decentralization

In the first and second regressions in Table 2, we investigate the effect of fiscal decentralization without controlling the variable. The result shows that fiscal decentralization has non-significance in linear and nonlinear relationships to the IKLH.

Since we did not control the endogeneity problem, we used an instrumental variable method with fixed-effect regression to investigate the relationship between fiscal decentralization and environmental quality in linear and nonlinear relationships. The fifth and sixth regressions show that fiscal decentralization has non-significant, linear, and nonlinear relations with environmental quality even though we have controlled the variable.

**Table 2** Estimation Result

VARIABLES	2SLR				OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
Fiscal Decentralization	-4.71 (3.25)	-11.42 (8.65)	-5.64* (3.18)	-14.75** (6.01)	1.26 (1.33)	-4.78 (3.57)
Fiscal Decentralization <sup>2</sup>		0.28 (0.18)		0.38*** (0.13)		0.15* (0.086)
Intergovernmental Fiscal Transfers			0.37 (0.31)	0.48* (0.28)	0.67** (0.27)	0.62** (0.27)
Extraction Structure			-1.42 × 10 <sup>-5</sup> (3.47 × 10 <sup>-5</sup> )	- 0.0001*** (3.39 × 10 <sup>-5</sup> )	-5.47 × 10 <sup>-5</sup> (2.92 × 10 <sup>-5</sup> )	-7.71 × 10 <sup>-5**</sup> (3.16 × 10 <sup>-5</sup> )
ln. PDRB			5.99 (3.80)	7.62* (3.90)	2.21 (3.33)	4.14 (3.48)
Government Size			0.78 (0.56)	0.90 (0.55)	0.15 (0.48)	0.41 (0.49)
Constant	81.49*** (9.80)	94.28*** (21.18)	-38.72 (72.33)	-49.60 (70.86)	20.69 (65.39)	-3.46 (66.48)
Observations	363	363	363	363	363	363
R-squared					0.034	0.044
Number of id	33	33	33	33	33	33

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The result differs when we use a model that addresses the endogeneity problem and controls the fiscal decentralization variable. The third regression shows that fiscal decentralization has a negative and significant relationship with environmental quality. Our results show that a province with higher fiscal decentralization by one percentage point will decrease environmental quality by 5.65 points.

In the fourth regression, we include the square term of fiscal decentralization to evaluate whether a nonlinear significant relationship exists between fiscal decentralization and environmental quality. The result shows that the square of a term is positive and significant. This result implies a U-shaped relationship between fiscal decentralization and environmental quality.

The negative coefficient of fiscal decentralization in linear terms indicates the race-to-bottom hypothesis in Indonesia. This finding aligns with the previous studies by Zhang and Liu (2020) and Cheng et al. (2020). Several reasons explain this condition: the local authorities tend to pursue rapid local economic growth since their main objective is to improve their economic performances, even at the expense of the quality of the environment. Furthermore, since there is a lack of green indicators for evaluating economic performances, the local authorities have less ability to monitor and evaluate economic performances that promote environmental sustainability and tend to orient their policies on regional economic development rather than promoting sustainability of the environment. Wu (2014) argues that the competition among local governments also leads to the development of energy-oriented industries that compensate for environmental quality to increase the share of their economy. The development of energy-oriented industries from other regions also encourages local governments to imitate the mode of production from neighboring provinces which is inclined to harm the environment.

Table 2 also shows evidence of a U-shaped relationship between fiscal decentralization and environmental quality. The U-Shaped relationship indicates that decentralization tends to affect the quality of the environment from different phases. In the early stage, the local government promotes sectors that give large portions of local growth, including high energy consumption sectors. It is due to local governments pursuing several objectives that compensate for environmental standards, including rapid economic growth, attracting more investment, and competing with other local economies (Cheng et al., 2020; Xu et al., 2022).

Then, after local governments' changes in development mode, including the goals to achieve sustainable development and improve economic efficiency, decentralization gradually enhances environmental quality. Hence, this finding also confirms that the race to the top and the bottom occurred in Indonesia. In addition, this nonlinear result was also consistent with the studies by Liu et al. (2017), Chen et al. (2020), and Xu et al. (2022).



### Intergovernmental Transfer

The fourth regression shows that intergovernmental transfer has a positive and significant relationship with environmental quality. The result shows that provinces receiving higher intergovernmental transfers by one trillion are 0.481 points higher in environmental quality. However, the result will change if we add the intermediaries variable, as in Table 2. As a result, All regression results in Table 2 Show that the intergovernmental variable has non-significant relation with the environmental quality variable.

The positive and significant relation between IFT (danper) with environmental quality, as shown in Table 2, reveals important implication regarding the nature of fiscal transfer from central government to local governments. As pointed out by Oates (1999) the main purpose of IFT is to promote equalization of public services among local governments. Hence, IFT may improve environmental quality as the improvement for provision of public services in environmental area. However, the model's result should be faced with precautions, as IFT also has a double-edged sword nature to the environment. Zhang and Liu (2020) argues that IFT may increase local government's physical expenditure that would harm environment, hence there should be appropriate allocation of IFT in local expenditure that would balance between economic and environment purposes.

### Human Capital & Institutional Quality

Table 3 presents the result for analyzing the role of institutional and human capital aspects when interacting with fiscal decentralization. This analysis is similar to a study by Khan et al. (2021). Since the data for comprehensive measurement of institutional quality is not available at a provincial level in Indonesia, we use IDI (Indeks Demokrasi Indonesia) as a proxy. For human capital, the proxy is expected years of schooling retrieved from BPS.

The eighth regression shows that human capital negatively relates to environmental quality. In addition, this regression shows statistically insignificant relation between human capital and environmental quality. Regression eighth also shows that the interaction variable between fiscal decentralization and education quality positively relates to environmental quality. This result shows the importance of fiscal decentralization in the education sector. The result in Regression tenth shows that institutional quality has a non-significant relationship with environmental quality. Regression tenth also shows that the interaction variable between fiscal decentralization and institution quality positively relates to environmental quality.

**Table 3** Estimation Result

VARIABLES	2SLR				
	(1)	(2)	(3)	(4)	(5)
Fiscal Decentralization	-18.93** (8.23)	-31.30** (13.07)	-16.64*** (6.412)	-17.28*** (6.66)	-34.30** (13.88)
Fiscal Decentralization <sup>2</sup>	0.47** (0.18)	0.45** (0.17)	0.42*** (0.14)	0.40*** (0.14)	0.49*** (0.19)
Intergovernmental Fiscal Transfers	0.46 (0.29)	0.13 (0.36)	0.43 (0.29)	0.44 (0.29)	0.008 (0.39)
Human Capital	-1.92 (1.98)	-4.25 (2.73)			-4.31 (2.78)
Indonesia Democracy Index			-0.12 (0.08)	-0.16 (0.11)	-0.13 (0.11)
Interaction Between Human Capital and Fiscal Decentralization		0.93** (0.46)			1.04** (0.5)
Interaction Between Indonesia Democracy Index and Fiscal Decentralization				0.011 (0.01)	-0.008 (0.01)
Extraction Structure	- 0.0001*** (3.93 × 10 <sup>-5</sup> )	- 0.0001*** (6.05 × 10 <sup>-5</sup> )	-9.93 × 10 <sup>-5</sup> *** (3.40 × 10 <sup>-5</sup> )	- 0.0001*** (3.91 × 10 <sup>-5</sup> )	- 0.0001*** (6.11e × 10 <sup>-5</sup> )
In. PDRB	16.64 (10.57)	21.29* (12.00)	10.68** (4.640)	11.00** (4.72)	24.41* (12.73)
Government Size	1.36* (0.78)	1.45* (0.81)	0.987* (0.568)	0.97* (0.57)	1.51* (0.82)
Constant	-189.2 (167.0)	-241.2 (182.5)	-93.99 (79.53)	-96.80 (80.20)	-284.6 (192.2)
Observations	363	363	363	363	363
Number of id	33	33	33	33	33

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In addition, Table 3 represents the positive impact of the interaction between institutional quality and human capital with decentralization to the quality of the environment. The findings confirmed that the interaction between fiscal decentralization and institutional quality complements a sustainable environment. Institutional quality plays a pivoting role in guaranteeing a comprehensive legislation process on improving environmental law, which is also related to the contribution of public awareness through the democratic process. With greater political rights for the citizen in a democratic regime, it is possible to form certain interest groups that have the same interests in advocating environmental quality. Through this group, the soundness of environmental protection and the legislation process of environmental law is ascertained, contributing to improving the environment (Khan et al., 2021). However, the linear term of democracy was found to be negative and statistically insignificant. The negative effect of democracy is also found by

other studies such as Jahanger et al. (2021) and Akalin and Erdogan (2020). They argue that in developing countries, democratic regimes tend to pursue short-term goals that would underscore the sustainability of the environment. This condition is rooted from the lack of determination for formulating development in sustainable sense. Furthermore, the detrimental effect of democracy could also stem from the condition of democratic practice that is still interrupted by the lobbying groups that pressure the government to pursue economic goals rather than ecological issues Akalin and Erdogan (2020). In contrast with our finding, a study by Farzanegan and Markwadt (2018) found positive relation between democracy and environment in 17 MENA countries. They argue that public participation in democratic regimes would give the benefit to the environment, as citizens would more aware and involved in the attempt to preserve environment.

Moreover, similar positive interaction between human capital and decentralization indicates the complementarity between human capital and the environment's decentralization. In the region with better education, environmental protection awareness is more sounding; this could happen because educated citizens are more aware of the impact of environmental degradation. The awareness among educated citizens would tend to encourage the local government to promote environmental protection (Khan et al., 2021). Therefore, institutions and human capital have a significant role in transmitting the benefits of fiscal decentralization to the environmental quality.

## **Conclusion**

Several previous studies have found some negative relationship between fiscal decentralization and the environmental quality index (IKLH), which means that increasing fiscal decentralization can decrease environmental quality indirectly. We Use panel data from 33 provinces from 2011-2020; this research probably analyzes the impact of fiscal decentralization on the environmental quality index (IKLH).

We used the two-stage panel least square regression with instrumental variable method to avoid endogeneity problems in the model. The results indicate that fiscal decentralization has a negative and significant linear relationship with environmental quality. Our results show that a province with higher fiscal decentralization by one percentage point will decrease environmental quality by 5.65 points. In this sense, It implies that fiscal decentralization in Indonesia tends to be less concerned about environmental quality, hence supporting the race to bottom hypothesis.

However, the square term of fiscal decentralization has a negative and significant relationship with environmental quality. Those results imply a U-shaped relationship between fiscal decentralization and environmental quality in Indonesia. The U-Shaped relationship indicates that the different phases of decentralization impact the quality of the environment. In the early stage, the development will focus more on economic growth with high energy consumption until the economy reaches its efficiency point. The turning point implies the goals start to shift to enhancing environmental quality. It designs a need for green indicators for evaluating economic performances and tighter regional environment economy policy. Therefore, this study confirms the double-edged sword

nature between fiscal decentralization with environmental quality.

Interaction variables such as institutional quality and education level positively affect fiscal decentralization concerning the environmental quality index (IKLH). Institutional quality plays a vital role in guaranteeing better laws of environmental quality. Besides higher education, people have more awareness about their environmental quality. That indicator of human capital proves that the quality and ability of humans itself can help to improve better environmental quality in Indonesia.

### Recommendations

Based on the results presented from this study, several recommendations need to be considered by policymakers. First, this study suggests the need to increase the roles of local government in environmental protection, including local government authorities supervising and monitoring economic activities to align with the sustainability of the environment. Second, local governments should be more active in realizing environmental issues in arranging development and budgetary planning to achieve sustainable development. Third, local governments should develop essential environmental indicators to monitor economic activities in their localities and evaluate the regional development process. Eventually, Interregional cooperation in coping with environmental-related issues should be strengthened to optimize decentralization's role in preserving environmental quality.

### Further research

Further research will need to solve some research limitations as follows. Interacting variables in this model, such as years of schooling, might not provide a good proxy for human capital that describe the relationship between human capital with the dependent-independent variables. Moreover, Khan, et al (2021) find human capital index might be a better proxy if the data is available on a local government level. From the time period, it can use a more extended time series of data. The limitations for using one decade of data have been done because of evading the change of base year in the actual multidimensional index, especially the human development index as instrumental variables for fiscal decentralization. Thus, adding a series before the attendance of fiscal decentralization could explain more the before and after effects the fiscal decentralization on environmental quality. The novelty of methods might be interesting, while recent research focuses more on the two-stage panel least square model with instrumental variables methods. Then, The U-shaped relationship hypothesis needs more understanding to figure out the relevant implication from the model with empirical condition.

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