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Environmental Degradation in Indonesia 1969-2016

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ABSTRACT
The purpose of this study is look at the factors that influence environmental degradation, and test the existence of an inverted U-shaped environmental Kuznet curve in Indonesia. The findings of this study are per capita income, trade openness, energy consumption, and population have an effect on environmental degradation in Indonesia. Then the inverse U curve hypothesis Kuznet curve is not proven in Indonesia

Keywords: *EKC Curve, ARDL, High Income Country, Upper Middle Income*

1. INTRODUCTION

According to the Global Carbon Atlas [1], Indonesia is the world's 12th carbon producer of 487 Metric Tons of CO2, ranked 5th in carbon-producing countries at the Asian level and ranked 1 in Southeast Asia. The high level of CO2 carbon emissions is a negative externality, from Indonesia's rising GDP per capita to $ 3927 or around Rp. 56,000,000 per capita per year [2]. According to Lipsey [3] CO2 carbon emissions are pollution that arises because of the consequences of increasing the economies of scale of a country. Indonesia's high rating of CO2 carbon emissions has prompted the government to sign a paris agreement which was joined by 196 countries. The agreement contains NDC (nationally determined contribution) or emission reduction contribution set by the government. According to Indonesia Climate Watch [4], Indonesia has voluntarily committed to reduce 29% of unconditional greenhouse gas emissions by 2030. From these explanations, it is necessary to look at the factors that drive the increase in CO2 carbon emissions thereby causing environmental degradation in Indonesia. The relationship between economic activity and environmental degradation is explained according to Panayotou [5], that when a country's income is relatively low, the government will focus on how to increase national income through economic growth so that it affects the level of pollutants produced. In developing countries, economic growth that leads to increased income often ignores environmental quality issues. Meanwhile, in developed countries with high incomes, increased public awareness of environmental quality [6]. The interaction between income per capita and environmental quality in the long run will resemble an inverse U curve, and this phenomenon is called the EKC (Environmental Kuznet Curve) curve [7].

Many diverse studies related to the EKC curve in Indonesia. Kuswantoro [8] shows that there is EKC consistency that results from deforestation in Indonesia. Then Sugiawan & Managi [9] showed the existence of EKC curves in Indonesia due to the use of renewable energy outside of fossil energy sources. Apergis & Ozturk [10] using the variable GDP per capita, population density, area, and GDP of the industrial sector proves the existence of EKC in Indonesia. While the results of other studies use economic growth variables, and economic openness shows there is no EKC in the country of Indonesia [11]. Ali Nasir [12], in Indonesia, using the variable FDI, GDP, quadratic GDP and the financial sector showed insignificant results. Based on the differences in the results of these studies, the need for this study was carried out. Because there are still mixed results related to the existence of EKC curves in Indonesia.

2. LITERATURE REVIEW

According to Dinda [13] When per capita income rises, a person reaches a higher standard of living and cares more about the quality of the environment so that it demands a better occupied environment. Structural changes occur in the economy which tends to reduce environmental degradation. The explanation for the shape of the EKC curve is that when a country reaches a fairly high income standard, people increasingly care about the environment [14][15].
According to Aye & Edoja [16], there are four perspectives on the impact of financial development on carbon emissions, namely environmentally friendly technology, foreign direct investment (FDI), an increase in the manufacturing sector and

an increase in consumer credit. Then increasing the financial sector reduces carbon emissions when the financial markets provide financial / credit assistance to local companies to obtain environmentally friendly and clean technology for manufacturing or industrial purposes. This view is supported by Yu Xiang & Chen [17] that lending from the financial sector provides funds and technical assistance that enables companies to adopt new and sophisticated technologies that are environmentally friendly, Frankel & Rose [18] financial markets can effectively provide credit assistance to companies domestic to enable them to buy environmentally friendly technology. On the other hand more lending to consumers can increase the scale of purchases of goods such as household appliances and cars that consume a lot of energy [19].

Trade openness, according to Dinda [13], allows an increase in pollution and environmental quality due to the production of waste generated from production activities in line with expanding market access due to trade openness. Whereas on the other hand trade openness can improve environmental quality because it adopts cleaner production methods [20].

Energy consumption carried out in an economic activity both household or country, will produce energy changes from one form to another. The results of these energy changes produce a residue called pollution. Then in Indonesia the energy consumption is still dominated by fossil fuel oil [21], according to the burning of fossil fuels according to [22] quoted from [23] causing smoke, rain acids, and the greenhouse effect that causes global warming.

Population factors affect the quality of the environment because increasing population will reduce the carrying capacity of the environment [24]. Basyiran [25] that the influence of the population on emissions is greatest, because within the population there are households that carry out activities using electricity energy consumption.

Of the several factors that influence environmental degradation as mentioned above, the basic theory is the kuznet inequality curve that forms the inverse U curve. But in this study there are changes in the variables by including the quality of the environment so that it is known as the environmental kuznet curve (EKC). EKC theory explains that economic growth will initially increase environmental degradation. This is because the country will focus on increasing production without regard to environmental aspects [7]. The production process carried out continuously will then cause environmental damage such as pollution of both soil, water, and air. Economic growth at a certain point accompanied by increasing income makes people aware that the need for good environmental quality is very important. This point is called a turning point where economic growth will reduce environmental degradation [26].

3. Research Methodology

This study uses secondary data, with a span of 1969-2016 taken from WDI (world development index) [27] data of the world bank https://datacatalog.worldbank.org/, WRI (world resources index) [28], and Global Atlas Carbon [1]. The operational definition of variables used includes CO2 is the level of carbon emissions (metric tons) proxy to see environmental degradation, GDP is income per capita in a year (US $), FS is credit to the private sector (% of total GDP), TRADE is trade openness / the sum of exports and imports (% of total GDP), E is energy consumption (terra-watt / hours), and Pop is the population (Million). The letter Ln is the transformation of the variable into a natural logarithmic form.

The econemetry model used to analyze income per capita, credit to the private sector, trade openness, the industrial sector to GDP, and energy consumption to environmental degradation are as follows:

$$LnCO2 = \alpha_0 + \alpha_1 LnGDP + \alpha_2 LnFS + \alpha_3 LnTRADE + \alpha_4 LnE + \alpha_5 LnPop + \varepsilon \ldots\ldots \quad (1)$$

To find out the existence of EKC then added income per capita squared variable (GDP^2), so that the curve is formed shown in equation model (2) as follows:

$$LnCO2 = \alpha_0 + \alpha_1 LnGDP + \alpha_2 LnGDP^2 + \alpha_3 LnFS + \alpha_4 LnTRADE + \alpha_5 LnE + \alpha_6 LnPop + \varepsilon \ldots\ldots \quad (2)$$

The estimation method still depends on the stationarity of the data. If there is non-stationary data at the level, use ARDL (autoregressive distribution lag). ARDL is used to overcome models with different levels of stationarity [29]. The equation (3) of ARDL can be written as follows:

$$\begin{aligned}\Delta LnCO2 = \alpha &+ \sum_{i=1}^{n} \alpha 1 LnCO2t - i + \sum_{i=1}^{n} \alpha 2 LnGDPt - i \\ &+ \sum_{i=1}^{n} \alpha 3 LnFSt - i + \sum_{i=1}^{n} \alpha 4 LnTRADEt - i \\ &+ \sum_{i=1}^{n} \alpha 5 LnEt - i + \sum_{i=1}^{n} \alpha 6 LnPopt - i \\ &+ \theta 1\, LnCO2\, Yt - i + \theta 2\, LnGDPt - i \\ &+ \theta 3\, LnFSt - i + \theta 4\, LnTRADEt - i \\ &+ \theta 5\, LnEt - i + \theta 6\, LPopt - i \\ &+ \varepsilon t \ldots \ldots \quad (3)\end{aligned}$$

4. Result and Discussion

Equation 1 is used to measure the effect of income per capita, credit to the private sector, economic openness, energy consumption and population on environmental degradation. Estimation results of equation (1) using ARDL (2,0,0,2,0,2) are shown in table 1. Equation (2) is used to see the EKC curve shape by adding the GDP2 variable. ARDL estimation results (2,2,2,0,1,0,1) are shown in table 2.

Table 1.ARDL Regression Estimation Results (2,0,0,2,0,2) Equation (1)

	Long Run				Short Run		
	coefficient	**t-stat**	**Prob**		**Coefficient**	**t-stat**	**Prob**
LnGDP	0,2061	3,9520	0,0004***	D(LnCO2(-1))	0,3738	3,9468	0,0004***
LnFS	0,00003	0,0006	0,9996	D(LnTRADE)	-0,0813	-1,3081	0,1996
LnTRADE	-0,2045	-2,1761	0,0366**	D(LnTRADE(-1))	0,1824	2,8756	0,0069***
LnE	0,6492	0,1590	0,0003***	D(LnPop)	132,9832	3,3291	0,0021***
LnPop	-0,6287	-0,9233	0,3623	D(LnPop(-1))	-165,3030	-4,1076	0,0000***
C	13,0408	1,0217	0,3141				
				ECT(-1)	-0,9858	-9,4690	0,0000
R^2		0,995		R^2		0,735	
A (Global Atlas Carbon, 2017)*djust* R^2		0,993		*Adjust* R^2		0,701	
F-stat		664,5536	(0,0000)	*Sum Square Residu*		0,121	

*** α =1% ** α =5% * α =10%

Source: Results of Eviews

Table 2. ARDL Regression Estimation Results (2,2,2,0,1,0,1) Equation (2)

	Long Run				Short Run		
	Coefficient	**t-stat**	**Prob**		**coefficient**	**t-stat**	**Prob**
LnGDP	-0,5264	-3,8407	0,0006***	D(LnCO2(-1))	0,3914	4,6951	0,0001***
$LnGDP^2$	0,0602	5,8515	0,0000***	D(LnGDP)	0,5897	1,7084	0,0976*
LnFS	0,0001	0,0028	0,9978	D(LnGDP(-1))	-1,7964	-5,3246	0,0000***
LnTRADE	0,2360	2,8171	0,0084***	D($LnGDP^2$)	-0,0253	-0,9342	0,3574
LnE	0,6682	4,2696	0,0002***	D($LnGDP^2$(-1))	0,1411	5,3394	0,0000***
LnPop	-1,3276	-2,6408	0,0467***	D(LnTRADE)	0,0413	0,6767	0,5036
C	26,7965	2,2254	0,0335	D(LnPop)	-47,4186	-10,4052	0,0000
				ECT(-1)	-1,0642	-10,8874	0,0000
R^2		0,997		R^2		0,846	
Adjust R^2		0,996		*Adjust* R^2		0,818	
F-stat		822,5159	(0,0000)	*Sum Square Residu*		0,070	

*** α =1% ** α =5% * α =10%

Based on the results of calculations in table 1.4 and table 1.5 the coefficient of the variable credit to the private sector (LnFS) has a positive and not significant effect. According to Awaworyi Churchill, Inekwe, Ivanovski, & Russell [31] The coefficient on credit to the private sector can be positive or negative. The negative side of granting credit to the private sector is able to fund consumer activities to obtain goods, such as cars and other machines, which produce CO2 [6]. On the positive side, credit to the private sector provides technological innovation and facilitates access to new technologies that can increase efficiency in production and reduce carbon emissions [32]. Indonesia's credit to the private sector shows insignificant results. This happens because the provision of credit to the private sector is used for physical infrastructure development activities to support the acceleration of the current government infrastructure, which does not directly affect the level of emissions produced.
Based on the results of calculations in table 1.4 the coefficient of the variable trade openness (LnTRADE) has a negative and significant effect. Increasing trade openness by 1% will reduce the level of CO2 carbon emissions by 0.2045%. Table 1.5 shows that trade openness variables have positive and significant effects. Increasing trade openness by 1% will increase the level of CO2 carbon emissions by 0.2360%. Trade openness, according to Dinda [13], allows an increase in pollution and environmental quality due to the production of waste generated from production activities as market access expands. In line with Oktavilia, Sugiyanto, & Firmansyah [11] research in ASEAN countries, trade openness increases CO2 carbon emission levels. The results of this study are different, by showing positive and negative coefficients in the country of Indonesia. Another opinion explains that trade openness can reduce pollution and improve environmental quality. According to Reppelin-Hill [20] trade openness allows easy access to technologies that use cleaner production techniques and improve environmental quality. This is supported by the presence of gross industrial migration from developed countries to developing countries due to the openness of trade and the flow of foreign investment [33].
Based on the calculation results in table 1.4 and table 1.5. The coefficient of the variable energy consumption (LnE) has a positive and significant effect. Increasing energy consumption by 1% will increase the level of CO2 carbon emissions by 0, 6492% in model 1 and model 2 by 0.6682%. According to BPPT [21] Indonesia's energy consumption is still dominated by fossil fuel oil. Sugiawan & Managi's research [9] in Indonesia that to reduce the level of carbon dioxide emissions, it is necessary to use environmentally friendly renewable energy outside of fossil energy sources.

Based on the results of calculations in table 1.4 equation (1) the coefficient of the variable population (LnPop) has a negative and not significant effect, but equation (2) in table 1.5 has a negative and significant effect. Increasing the population by 1% will reduce the level of CO2 carbon emissions by 1.3276%. Increased growth in carbon dioxide emissions is associated with high energy consumption, as it occurs due to increased population growth [24]. The coefficient of the population has a negative effect on the level of carbon dioxide emissions, explaining that the population is aware of environmental problems. Residents or communities have attitudes and rational behavior and are responsible for protecting the environment.

5. CONCLUSION

Based on the results of this study the factors that influence environmental degradation in Indonesia are income per capita, trade openness, energy consumption, and population. The results show that there is a curve that forms the letter U, and does not show the existence of an ECC (environtmental kuznet curve) in the country of Indonesia.
Referring to the conclusions above, so that the condition of environmental quality is consistently maintained the need for enforcement of emissions tax both at the initial stage only applies to large industries that have not used environmentally friendly technology, gradually the medium industry to the imposition at the level of households that own motorized vehicles.

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