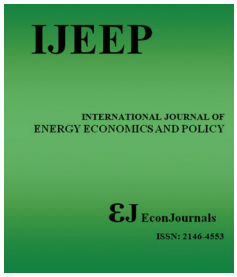

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Environmental Kuznets Curve: Economic Growth with Environmental Degradation in Indonesia

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ABSTRACT

Environmental Kuznets Curve (EKC) is a hypothesis of the influence of the relationship between environmental degradation and economic growth (GDP per capita) in the perspective of economic development. The purpose of this research is to prove that there is an economic growth influence on environmental degradation in the U-shaped EKC hypothesis and to determine the influence of primary energy consumption, income inequality, education level and Environmental degradation in the Sustainable development of Indonesia. The study used the Error Correction Model (ECM) Engel and Granger estimation techniques to determine the short-term and long-term impact of the 1994-2018 period in Indonesia. The results showed that the EKC was proven in the short term as well as in the long term. Economic growth variables and primary energy consumption have a positive and significant effect on environmental degradation. Income inequality is negatively influential but not significant in the short or long term, the level of education in the short term is insignificant but positive and significant in the long term. For the export variables in the short term, the effect is positive and significant but not with long term against environmental degradation.

Keywords: Carbondioxide Emissions, Environment Kuznets Curve, Error Correction Model, Economic growth, Sustainable Development
JEL Classifications: O44, Q56

1. INTRODUCTION

The debate on economic growth and environmental degradation (environmental preservation) at this time is one that may not have found an effective answer. There is an impact of externalities between economic growth and environmental degradation. The assumption that occurs is that the relationship between economic growth and environmental degradation is that when you want to increase economic growth it means increasing the level of environmental degradation, on the other hand when economic growth increases it will increase state income and domestic goods and services can be fulfilled which affects the welfare of the community that is fulfilled.

Rapid economic growth affects the depletion of natural resources which can cause environmental damage. Fulfilling the desires of the needs of the people who want to be fulfilled sufficiently makes a country required to provide goods and services that are increasing from year to year, the increase in goods and services also causes an increase in state income which can affect high economic growth.

On the other hand, economic growth causes a reduction in natural resources and causes environmental damage. Figure 1 shows that the components of economic growth fluctuate from year to year but tend to increase, for the use of CO_2 emissions from year to year has increased. It is seen that the increase in economic growth is also accompanied by an increase in emission of CO_2.

Carbon dioxide emissions in 2018 increased by 0.5% for every one-pin percentage increase in global economic output, compared with an average 0.3% increase since 2010. The Carbon Dioxide Status Report stated that energy-related carbon dioxide emissions rose 1.7% to a record 33 billion tonnes last year in compare with 2017. The figures represent unprecedented levels of carbon

pollution (International Energy Agency, 2019). According to Figure 2, Indonesia for carbon dioxide emissions has reached 542 Mt CO_2, which is ranked eleventh in the world rankings and first in Southeast Asian countries.

The increasing need for goods and services production causes air pollution intensity through production and mobility processes. The high level of air pollution is due partly to the economic structure of a country. Since the Industrial Revolution, human activities such as burning oil, coal and gas, and deforestation have greatly increased the concentration of CO_2 in the atmosphere. The most important sources of CO_2 worldwide are caused by the transportation of goods and services, emissions caused by people traveling by car, plane, train, etc. are examples of direct emissions. Emissions caused by transportation of goods are indirect emissions because consumers do not have direct control over the distance between factories and shops, because between producers and consumers there is growing pressure on the transportation industry to bridge and ultimately create indirect emissions.

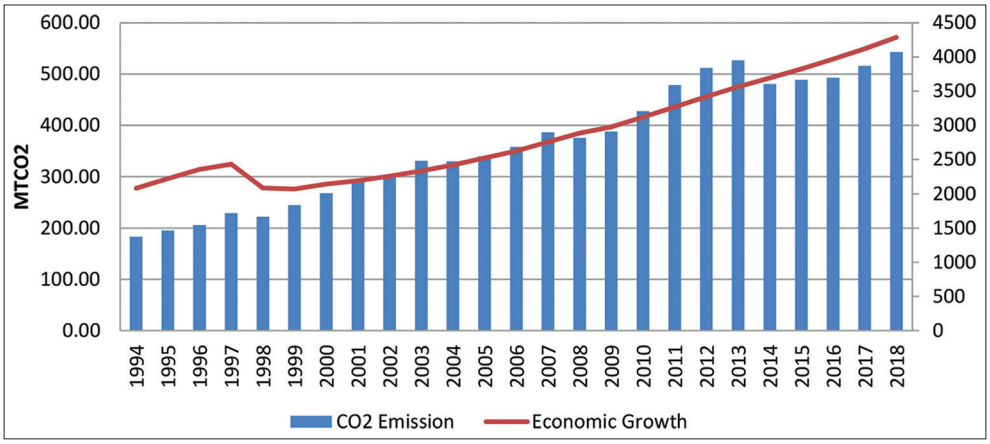
2. LITERATURE REVIEW

Grossman and Krueger (1995) in their research obtained the results that the relationship between economic growth and various environmental indicators, the results of this study revealed that initially economic growth will worsen the environment but in later conditions, environmental preservation will arrive at a turning point where later the environment can occur in a sustainable development. The hypothesis to examine whether there is a relationship between economic growth and environmental degradation is known as the Environmental Kuznet Curve (EKC) or the Kuznets environmental curve. Sustainable development is an integration between the economy and the environment as a human effort to improve the quality of life while still trying not to exceed the ecosystem that supports life (Kuncoro, 2010).

At the 67th annual meeting of The American Association in 1954, Simon Kuznet gave a speech to the President of the association with the title Economic Growth and Income Inequality. Kuznet suspects that with increasing per capita income, income inequality will also increase initially, but at a certain turning point, the inequality will begin to decrease (Kuznet, 1995).

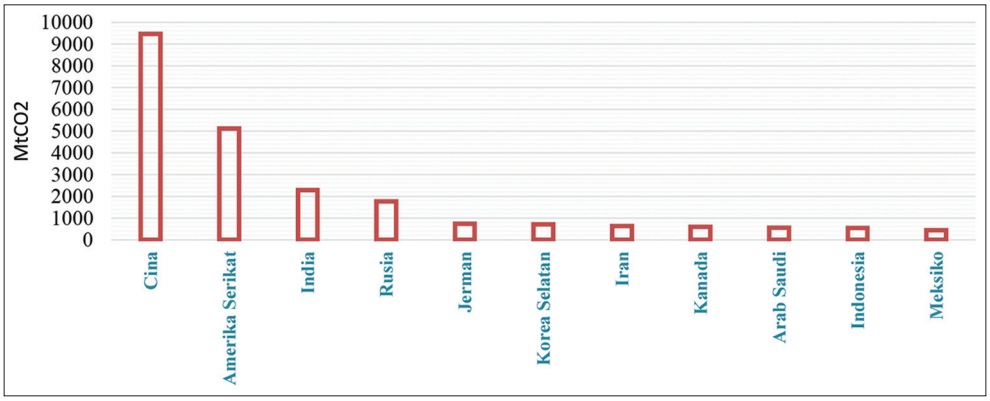
There is an interesting fact that happened in Indonesia, namely high economic growth was followed by an uneven distribution of income, causing another problem, namely income inequality. Environmental degradation appears to be a side effect of income inequality and the analysis shows that there is a negative correlation between inequality and environmental sustainability, the higher the income inequality will reduce the environment, such as the addition of production

Figure 1: Economic growth and environmental degradation



Source: World Bank and World Energy (Processed)

Figure 2: World carbon dioxide emissions ranking



Source: World Energy (2019), Processed

waste, water consumption, loss of biodiversity and environmental composite index (Andrich et al., 2010). With this it is also known that a high level of CO_2 emission can result in a decrease in a country's production capacity and will also affect climate change.

In Hassan et al. (2015), Boyce has proposed that the unequal distribution of state wealth and power causes greater environmental damage by undermining collective action necessary for environmental protection. Human life is always faced by economic problems, problems that arise on the economic side, namely the scarcity of resources to satisfy unlimited human desires. Therefore, human wants are limitless, making existing resources very insufficient to meet these human needs and desires. Meeting the needs of using scarce resources creates an ecological crisis or causes environmental degradation.

In 1991, the Kuznet Curve gained new existence, this concept became a new tool for explaining the relationship between per capita income and environmental quality. The results of empirical research by Grossman and Krueger (1991) in Stern (2004) specifically show that there are findings that the level of environmental degradation of some pollutants and per capita income has the same relationship with the Kuznet curve.

The hypothesis of Grossman and Krueger (1991), the hypothesis is to publish the results of research on the relationship of per capita income with CO_2 pollution, dark matter, and suspended particles (SPM) as a study of the environmental impact of the application of the North American Free Trade Agreement. Regression used panels from The Global Environmental Monitoring System in 52 cities and 32 countries during the 1977-1988 period. The result is an Inverse U-shaped curve with a per capita income turning point of $ 4,772- $ 5,965 for CO_2 and dark matter.

Stern (2004. P. 1419) states that the EKC hypothesis was popularized in the World Development Report 1992 published by the World Bank which views that greater economic activity will inevitably damage the environment. However, as income increases, demand and a better environment increase as the investment becomes available in the better developed environment and technology. The emergence of the literature on EKC has important implications for sustainable development thinking. In addition, several studies conducted empirical studies of the EKC hypothesis on cases in various countries. Alam et al. (2016), using the Autoregressive Distributed (ARDL) method that the emission of CO_2 increases significantly with increasing income and energy consumption in the four countries. The hypothesized Kuznets environmental curve (EKC) implies that in the case of Brazil, China, and Indonesia, emissions of CO_2 will decrease over time as income increases. Using the same approach Shahbaz et al. (2009) in Pakistan the EKC hypothesis is also proven.

WhileJun et al. (2011) use multiple linear regression in that their research is that there is a negative relationship between environmental causality and income inequality in China, an increase in capital can reduce the adverse effects of differences in income distribution. Andrich et al. (2010) also shows that income inequality is negatively correlated with environmental degradation with decreasing natural resources. Romuald(2012) uses panel data in 85 countries by applying the GMM-System estimate that education is not a major factor in the growth of carbon dioxide emissions but that education is found to be a factor in the growth of pollution, although the effect is overcome by the presence of political institutions. Research in Indonesia by Zuhri (2014) states that the level of education has no effect in Indonesia because the absence of education leads to an environmental perspective, but simultaneously education affects carbon dioxide emissions in Indonesia. Meanwhile, exports have an impact on environmental degradation. According to Rahman (2017) using the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods that exports can increase carbon dioxide emissions in Asian countries and in the short term has two directions.

3. METHODS

This research uses a qualitative approach. This research approach was chosen to test research by detailing specific hypotheses using a measurable data set. Technically, this study seeks to find the influence between one variable and another in this case economic growth with environmental degradation Emissions CO_2 and prove whether the EKC hypothesis is proven. In addition, primary energy consumption, income inequality, education level, and exports are used as variables. The type of data used in this study is secondary data in time series from World Energy, World Bank, and the Central Bureau of Statistics from 1994 to 2018 and this research was conducted in Indonesia. In brief, the operational and variable descriptions can be summarized in Table 1.

According to Widarjono (2016. p. 322), suggests that time series data are often not stationary so that the regression results are dubious or are called sharp regression, which is a situation where the regression results show statistically significant regression coefficients and high determination coefficient values but the relationship between variables in the model not related. An appropriate model for time series data that is not stationary is the error correction model (ECM). In addition, by using this method the aim is to identify short-term and long-term relationships that occur due to cointegration between variables in the study.

The difference between the units and the variable magnitudes causes the regression equation to be made logarithmic models. According to Ariefianto (2012. p. 59-60), regression equations can be specified in other functional forms such as certain transformations using logarithms. This is done to obtain better statistical features, reduce the disperse or distribution of variables, and reduce the symptoms of heteroscedasticity. Therefore, the short-term regression equation is as follows after the logarithmic transformation is carried out, namely:

$$\Delta \text{LogCO}_{2t} = \alpha_0 + \alpha_1 \Delta \text{LogPE}_t + \alpha_2 \Delta \ddot{u}\ddot{u}\ddot{u} \quad {}^{2}_{t} + \alpha_3 \Delta \quad {}_{t}$$
$$+\alpha_4 \Delta GINI_t + \alpha_5 \Delta EDU_t + \alpha_6 \Delta LogEX_t + \alpha_7 EC_{t-1} + \varepsilon_t$$

For the long-run regression equation as follows:

$$LogCO_2 = \beta_0 + \beta_1 LogPE_t + \beta_2 LogPE_t^2 + \beta_3 CE_t$$
$$+\beta_4 GINI_t + \beta_5 EDU_t + \beta_6 LogEX_t + \varepsilon_t$$

The coefficient expected to form an EKC curve in accordance with the Kuznets hypothesis is positive on PE_t and negative on PE_t^2 so an inverted U curve will be formed. The formula for finding a turning point is as follows:

- If α_2 dan $\beta_2 < 0$, there is an inverted U-shaped relationship
- If α_2 dan $\beta_2 > 0$, occurs shaped relationship U
- Turning point $= \frac{-\alpha_1}{2\alpha_2}$ and $\frac{-\beta_1}{2\beta_2}$.

Based on the results of the calculation of the ECM linear regression analysis above, it can be seen that it is characterized by the presence of elements Error Correction Term (ECT),are the residuals that arise in the ECM method, the variables that indicate balance. If the ECT coefficient is statistically significant, that is the coefficient ECT < 1 and significance on α= 5% then the model specification used is valid.

4. RESULTS AND DISCUSSION

4.1. Data Stationarity Test

The data stationarity test aims to verify that the data generation process is stationary to avoid false regressions. Before testing the ECM on short-term and long-term equations, data stationarity testing should be carried out. The data stationarity test uses the Augmented Dickey Fuller test (ADF test). If the ADF test value is greater than the 5% significance level, the data is stationary. The following are the results of the data stationarity test:

Based on Table 2, it can be seen that the variables above in the stationarity test at the level of the variables are not stationary. With this, it is necessary to continue the degree of integration test, namely by carrying out the root root test at the level of the first degree or 1st difference. In the 1st difference test, it is known that the variables are stationary which is indicated by a probability value of less than 5%.

Table 1: Variables, symbols, units, and data sources

Variables	Symbols	Units	Data sources
Carbon dioxide emissions	CO_2	Million Tonnes	World Energy
Economic growth	PE	GDP per capita US$ (Constant 2010)	World Bank
Primary energy consumption	CE	Gigajoule per kapita	World Energy
Income inequality	GINI	Indeks	BPS
Level of education	EDU	Persen	BPS
Export	EX	US$ (Constant 2010)	World Bank

Table 2: Data stationarity test results

Variable	Unit root test			
	Level		1st difference	
	ADF	Prob	ADF	Prob
LogPE	1.281385	0.9975	−3.31506	0.0208
$LogPE^2$	1.305091	0.9033	−3.406112	0.0219
CE	−1.253282	0.6337	−5.783414	0.0001
GINI	−1.492171	0.5203	−3.713595	0.0109
EDU	−0.831184	0.7910	−5.912979	0.0001
LogEX	−0.698383	0.8289	−6.475533	0.0000
$LogCO_2$	−1.989974	0.2889	−4.354130	0.0026

Source: Eviews 10 (Processed), 2020

4.2. Cointegration Test

The cointegration test is a test of whether or not there is a long-term relationship between the independent variable and the dependent variable. The purpose of this cointegration test is used to determine whether the residuals are integrated or not. If the variables are integrated, there is a long-term stable relationship. So that before carrying out the cointegration test, regression must be carried out for the long-term equation in order to obtain the residual value. The results of the long-run regression estimation are as follows:

Cointegration testing is done by testing the augmented dickey fuller unit root test on the residual value. The results of the cointegration test in the equation are as follows:

The test results in Table 4 show that the probability value is 0.0024 which is less than the 0.05 significance. In addition, the ECT coefficient value is negative, which is equal to −4.433150, this shows that Ho is rejected, which states that there is no cointegration, so the equation being tested has a long-term equilibrium relationship. Then you can do the next Error Correction Model (ECM) test.

Table 3: Long-run estimation of regression

Variable	Coefficient	Std. Error	t-statistic	Prob
LOGPE	17.04146	7.589453	2.245414	0.0375
LOGPE2	−3.056973	1.363797	−2.241516	0.0378
CE	0.009133	0.000738	12.37089	0.0000
GINI	−0.082360	0.058093	−1.417724	0.1734
EDU	0.002952	0.000484	6.098706	0.0000
LOGEX	0.000141	0.000101	1.401502	0.1781
R-squared	0.996894			
Adjusted R-squared	0.995859			
F-statistic	962.9454			
Prob (F-statistic)	0.000000			

Source: Eviews 10 (Processed), 2020

Table 4: Cointegration test results

Variable	Coefficient	Prob.	Note
ECT	-4.433150		0.0024

Source: Eviews 10 (Processed), 2020

Table 5: Short-term regression estimation results

Variable	Coefficient	Std. Error	t-statistic	Prob
LOGPE	38.70349	9.584161	4.038276	0.0010*
LOGPE2	−7.007146	1.746185	−4.01283	0.0010*
CE	0.007745	0.000523	14.81864	0.0000*
GINI	−0.054896	0.026652	−2.059776	0.0561**
EDU	0.000662	0.000435	1.523886	0.1471
LOGEX	7.92E- 05	3.15E- 05	2.512889	0.0231*
ECT	−0.490353	0.169972	−2.884910	0.0108*
R-squared	0.959543			
Adjusted R-squared	0.941843			
F-statistic	54.21131			
Prob (F-statistic)	0.000000			

Source: Eviews 10 (Processed), 2020. *α = 5%, ** α= 10%

4.3. Empirical Results

Estimation results the independent variable on environmental degradation (carbon dioxide emissions) can be shown in the table as follows:

Table 5 shows that the regression results from the F statistic are 54.21131 with a probability of 0.000000. In this case, economic growth, consumption of primary energy, income inequality, education level, and exports together have an effect on environmental degradation. Meanwhile, the value of the Adjusted R-Squared is 0.941843, which means that economic growth, primary energy consumption, income inequality, education level, and exports affect the environmental degradation variable by 94.18% and the rest is influenced by other variables.

5. DISCUSSION

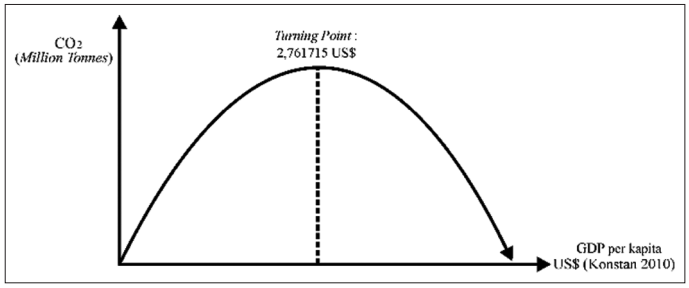
The short-term and long-term regression results show in Tables 3 and 5 that the coefficient value and economic growth are positive and squared economic growth is negative so that the EKC in Indonesia is proven both in the short and long term and shows an inverted U-shaped curve and has an influence on environmental degradation. this is consistent with the EKC hypothesis. Below is a graph of the EKC curve reaching a turning point in the short and long run (Figure 3 and 4).

EKC in Indonesia in the short and long term is proven because Indonesia is still a developing country which has early and late stages of development, initially carbon dioxide emissions will increase with an increase in economic growth, but at the end of development when it reaches a turning point Indonesia will reduce emissions. carbon dioxide in the presence of increased economic growth.

This study is in line with Alum et al. (2016) in his research results that imply that in Brazil, China, and Indonesia carbon dioxide emissions will decrease as income increases, with this proven EKC in these countries. The empirical results show that the EKC theory for carbon dioxide emissions must indeed take place in Indonesia both in the short and long term. This suggests that the level of carbon dioxide emissions will initially increase but eventually decrease with the rise of GDP per capita over time. The reason why Indonesia is able to experience a turning point on the EKC curve is that Indonesia has undergone a period of transition and transformation in the development structure with changes in the economy in general leading from the primary sector (agriculture, fisheries and mining) to the secondary sector (manufacturing, construction, services, and trade). The Minister of Industry said that the Indonesian state was already included in the category of industrialized countries as evidenced by the fact that Indonesia's manufacturing industry was included in the top 10 in the world and in 2017 it managed to rise to the ninth place with the added value of the world's largest manufacturing industry, besides the increase in added value to the industry from 2014 to 2017 amounting to 8.58% or to USD 225.67 billion in 2017 (Ministry of Industry, 2017).

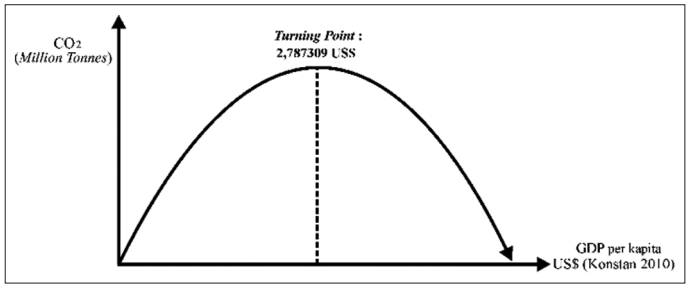
In addition, the government is serious about reducing GHG emissions. Indonesia has stated its commitment to the

Figure 3: Short term EKC



Source: Data Processed, 2020

Figure 4: Long term EKC



Source: Data Processed, 2020

15th Conference of Parties (COP) in 2009 to reduce greenhouse gas (GHG) emissions by 26% (by own efforts) and by 41% (if received international assistance) by 2020. Indonesia's commitment is strengthened through The Republic of Indonesia's first Nationally Determined Contribution (NDC) document in November 2016 with the stipulation of an unconditional target of 29% and a conditional target of up to 41% compared to the business as usual (BAU) scenario in 2030. Indonesia's serious efforts in supporting GHG emission control are followed up by the Republic of Indonesia Law Number 16 of 2016 concerning the ratification of the Paris Agreement to the United Framework Convention on Climate Change. Environmental control is also regulated in Law of the Republic of Indonesia Number 32 of 2009 in Article 13.

In addition, economic growth has a positive and significant effect both in the short and long term on environmental degradation with a coefficient value of 38.70349 in the short term and 17.04146 in the long term. In this finding that an increase in economic growth will increase carbon dioxide which causes increased degradation. The results of this study are in line with Wilson (2015) that his research in Indonesia also found that CO_2 emissions are positively influenced by economic growth, this indicates that the development technology used in Indonesia is not environmentally friendly. The development process still has a negative impact on environmental degradation, which is indicated by the results of research that have a positive relationship between the variable economic growth and the emission of CO_2. This research is also the same in Izyan et al. (2013), that the results of their research reveal that both the short and long term in Indonesia show a unidirectional causality between economic growth and CO_2 emissions, this proves that in Indonesia industrialization and economic activities have an impact. for economic growth both in the short and long term but on the other hand it causes environmental degradation and Indonesia needs to maintain economic growth without causing environmental degradation.

Meanwhile, primary energy consumption has a positive and significant effect both in the short and long term on environmental degradation with a coefficient value of 0.0009133 in the short term and 0.007745 in the long term. These results are in line with research conducted by Shahbaz et al. (2009) in this study that in both the short and long term there is a relationship and influence between energy consumption and carbon dioxide. In addition, it is also in line with the research of Sasana and Aminata (2019), in his research that the use of primary energy has a positive and significant effect on carbon dioxide emissions.

Income inequality has a negative and insignificant effect both in the short and long term on environmental degradation at a significance level of 5%, but it will be significant at a significance level of 10% in the short term with a coefficient value of −0.054896. This research is in line with Jun et al. (2011) revealed that there is a significant negative relationship between environmental quality and income inequality in China, this is because an increase in human capital can reduce the negative impact of differences in income inequality, in Indonesia in the long run there is no influence between income inequality and environmental degradation. This is one of the efforts to increase the number of jobs that can absorb unemployment so that people will get income. In addition, the government can build infrastructure to facilitate mobility so that it will make it easier to distribute the productivity of goods and services, this will have an impact on accelerating economic growth.

In addition, the level of education has a positive and insignificant effect in the short term but significant in the long term with a coefficient of 0.002952 on environmental degradation. This is in line with research conducted by Zuhri (2014), which states that the level of education is not significant for air emissions in Indonesia, this is because in Indonesia there is no special education for environmental awareness. In Shaista (2010), Torras and Boyce (1998), and Klick (2002) say that pollution has a relationship with the level of education in a country where education is a control variable, therefore higher education is one of the prerequisites for a higher demand for environmental preservation. In addition, because education is a proxy for economic development and is also an input for education in environmental conservation efforts.

For the latter, exports in Indonesia in the short term have a positive and significant effect on environmental degradation with a coefficient of 7.915410, while in the long run it has a positive but insignificant effect. This is because the export sector in Indonesia is dominated by the goods sector from natural resources, this is one of the reasons that in the short term exports have an effect on environmental degradation, while the manufacturing and industrial sectors are still low (Badan Pusat Statistik, 2020). This means that exports in Indonesia contribute to low CO_2 emissions, so that in the long run, exports do not significantly affect environmental degradation. In the long term, exports in Indonesia do not significantly affect environmental degradation because the trade ratio in Indonesia is still below 100% and is classified as low. In contrast to developed countries whose trade ratios have exceeded 100%. This research is also in line with Tajul and Affandi (2019), in their research that the diversification of exports has no effect on the resulting CO_2 emissions, this is because export diversification in Indonesia is still not developing.

6. CONCLUSION

Based on the analysis results of the research and discussion, the Environmental Kuznets Curve (EKC) hypothesis is proven on economic growth and environmental degradation in Indonesia in the short and long term. This is evident because the relationship between economic growth and land degradation forms an inverted U-curve. Economic growth has had a significant positive effect on environmental degradation in the short and long term in Indonesia in 1994-2018. Primary energy consumption has a significant positive effect in the short term and in the long term has a significant positive effect on environmental degradation in Indonesia in 1994-2018. Income inequality has a negative and insignificant effect on environmental degradation in the short term and long term income inequality has no significant positive effect on environmental degradation in Indonesia in 1994-2018. Education level has no significant positive effect on environmental degradation in the short term but has a significant positive effect on the long term in Indonesia in 1994-2018. Exports have a significant positive effect on environmental degradation in the short term, but in the long run, they have a positive and insignificant effect in Indonesia in 1994-2018. Economic Growth, Square Economic Growth, Primary Energy Consumption, Income Inequality, Education Level, and Exports together have a significant influence on degradation in Indonesia in 1994-2018.This indicates that the increase in Economic Growth, Square Economic Growth, Consumption Primary Energy, Income Inequality, Education Level, and Exports are followed by changes in environmental degradation.

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