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Impact of Economic Growth and FDI on Indonesia Environmental Degradation: EKC and Pollution Hypothesis Testing

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Abstract

This study examines the impact of economic growth and FDI on environmental degradation in Indonesia through a two-hypotheses model. Environmental degradation is a crucial matter that needs attention and is often associated with economic growth and the FDI required by developing countries. Based on the externality theory, this study uses the EKC hypothesis, followed by pollution haven vs. pollution halo. With time series data from 1980–2021, two hypothesis models were estimated using the error correction method. This study's results support the EKC and pollution haven hypotheses. First, for the EKC hypothesis model, this study found that economic growth at an early stage increases environmental degradation, but economic growth beyond the turning point would reduce ecological degradation. Besides testing the EKC hypothesis, renewable energy consumption can reduce environmental degradation caused by carbon emissions. Second, for the pollution hypothesis model, it's been found that increased FDI can increase ecological degradation, thereby supporting a pollution haven. This research suggests that policymakers should require foreign investors to apply the green economy concept supported by a green taxonomy and then provide fiscal incentives to those who do so.

INTRODUCTION

Economic growth is one of the goals that has been aimed for by various countries. Because the process of economic growth cannot be ignored, if ignored, of course, this will have a destructive impact on people's welfare in a country. Therefore, adequate economic growth is needed in an economy. According to Solow (1956), increasing economic growth requires capital accumulation, such as physical capital, which generally includes savings, investment, and labor supply from population growth. Physical capital is achieved through savings and investment, while employment is achieved through population growth. Investment activities in a country generally come from foreign direct investment (FDI) and domestic investment. Salvatore (2013) said that multinational companies typically carry out foreign direct investment, and there are spillover effects of technology and knowledge; of course, these two things become a medium for introducing advanced technology from foreign countries that invest in the host country; This indicates that the existence of foreign investment is significant in a country, especially

Indonesia as a developing country. However, economic growth is also effective in increasing the standard of living of people in a country.

However, on the other hand, activities that seek to increase economic growth often override environmental sustainability, resulting in ecological degradation; this is marked by an increase in the intensity of CO_2 emissions in Indonesia in the last 41 years (see Figure 1). In addition, FDI activity is often associated with environmental degradation. FDI fluctuations shown by Figure 1 in several kinds of literature (Duan & Jiang, 2021; Hitam & Borhan, 2012; Mert & Caglar, 2020; Nasir et al., 2019; Neequaye & Oladi, 2015; Neves et al., 2020; Shahbaz et al., 2015b; Wang et al., 2021; Zugravu-Soilita, 2017) explained that high or low environmental degradation as a result of CO_2 emissions triggered by FDI depends on whether or not a country's regulation of the environment is strict. In this case, FDI and CO_2, which are increasing simultaneously, indicate that environmental rules in Indonesia are not strict yet, and FDI activities are still spillover into technologies that are not environmentally friendly. Conversely, if FDI increases while CO_2 decreases, environmental regulations in Indonesia are said to be quite stringent, thus encouraging FDI to spill over into environmentally friendly technologies.

Figure 1. CO_2 Emission Contribution by GDP Per Capita & FDI

Sources: Our World in Data (2020), United Nations Conference on Trade and Development, & World Bank Group

In addition, the Global Carbon Atlas organization claims that, in 2021, Indonesia was positioned as the 9th largest carbon emitter from using fossil fuels in the world (see Figure 2 below). It can be seen that Indonesia still produces substantial emissions. CO2 amounts to about 619 metric tons of carbon dioxide. As urgent, Indonesia's energy transition must be carried out to reduce carbon emissions through renewable energy. To suppress environmental degradation due to carbon emissions, in the current era, there is global action through the sustainable development goals (SDGs) program, which is a continuation of the MDGs (millennium development goals) program.

Some of the targets of the SDGs that help reduce environmental degradation include the 7th, 11th, 13th, and 15th targets. On the 7th target, the Sekretariat Nasional SDGs emphasizes that energy use must be carried out in efficient, sustainable, and renewable energy because several countries have taken significant initiatives to reduce the intensity of energy use so that by 2030, they can guarantee access to cleaner and environmentally friendly fuel. On the 11th target, the Sekretariat Nasional SDGs emphasize that air quality and waste management receive special attention to minimize environmental degradation in regulating an inclusive urban order. At the 13th target, the Sekretariat Nasional SDGs emphasize that public awareness in areas vulnerable to climate change must be increased through national policies and strategies, bearing in mind that emissions from the greenhouse effect have risen much higher than in 1990. At the 15th target, the Sekretariat Nasional SDGs emphasize that increased global support needs to be carried out to reduce environmental degradation by protecting and improving the use of terrestrial ecosystems. Thus, Indonesia needs international assistance through sustainable foreign investment, strategies, and well-established national policies so that the results of achieving the SDGs targets can be sustainable for future generations.

Figure 2. Indonesia CO2 Emission Rate 2021

Sources: Global Carbon Atlas

What's more, economic growth is significant for increasing the standard of living of people in a country even though it has the potential to cause environmental degradation. This potential is related to the externality theory (covering two characteristics, positive and negative), which was introduced by Arthur Cecil Pigou (Pressman, 2006). The approach generates various premises, such as the environmental Kuznets curve (EKC) and the pollution (halo vs. heaven) hypothesis. First, the phenomenon of environmental degradation due to economic growth is explained by the discovery of the EKC hypothesis, introduced by Simon Kuznets in 1955. Studies examining regions/countries, analysis techniques, indicators, and periods show further findings. The intention some studies support the EKC hypothesis (Fosten et al., 2012; Grossman & Krueger, 1995; Heil & Selden, 2001; Hitam & Borhan, 2012; Ilham, 2021; Nasir et al., 2019; Neequaye & Oladi, 2015; Shahbaz et al., 2015a; Sugiawan & Managi, 2016; Taskin & Zaim, 2000) and while some do not support it (Akbostancı et al., 2009; Azomahou et al., 2006; Iskandar, 2019; Soytas & Sari, 2009). Simultaneously, Dong et al. (2020) found that high and upper-middle-income countries do not support the EKC, while low-middle and low-income countries support the EKC hypothesis.

Second, in addition to economic growth, investment through FDI is also associated with environmental degradation. However, FDI as a catalyst for economic growth also has externalities to a country's environment. As stated by the Kementerian Investasi/BKPM (2022), an investment can be said to be sustainable if the investment creates positive externalities on the economy, environment, society, and governance. Externalities originating from FDI are explained by two opposite hypotheses, namely the pollution haven hypothesis, which demonstrates that FDI has a negative externality to the environment. Meanwhile, the pollution halo hypothesis explains that FDI creates positive environmental externalities. Various studies examining the effect of FDI on environmental degradation still produce controversial findings because various studies use multiple resources. Several studies support the pollution haven hypothesis (Duan & Jiang, 2021; Hitam & Borhan, 2012; Nasir et al., 2019; Wang et al., 2021). Meanwhile, research supports the pollution halo hypothesis (Mert & Caglar, 2020; Neequaye & Oladi, 2015; Neves et al., 2020). In addition, there is research that supports both hypotheses simultaneously (Shahbaz et al., 2015b; Zugravu-Soilita, 2017) which indicates that the support of the hypothesis depends on whether regulation is strict or lax in each country on the environment and also depends on the spillover effects of technology originating from FDI.

The research problem of this study is built based on previous empirical studies (see paragraphs 5 and 6 above), in which research on testing the EKC hypothesis in different contexts shows findings that are still controversial, as well as research that tested opposite hypotheses such as the pollution haven vs. pollution halo hypothesis. Then these two things trigger questions for this research. First, in the context of research in Indonesia using the 1980–2021 period, is the EKC hypothesis still valid? Second, between the points of view of the pollution haven and pollution halo hypotheses, which one fits the context of this research?

Then, as a research gap or the difference between this research and previous research, the advantages of this research that have not been done in previous studies are based on two things. First, use a research period based on different phenomena in the Indonesian context. Second, the authors built a separate model to generate valid findings in testing the EKC and pollution hypotheses. Because the EKC hypothesis and pollution have the same dependent variable, namely "environmental degradation," and different independent variables, where the EKC hypothesis analysis uses the variable "economic growth" as the independent variable and the pollution hypothesis uses "FDI" as the independent variable. Technically, testing both types of hypotheses in the same research model will produce biased results. Another reason is that in the "national income identity" equation in macroeconomic theory, FDI is a proxy for the investment variable, the independent variable or determinant of economic growth and output.

This study has two objectives to answer research questions and fill in the limitations of previous research. First, examine the impact of economic growth on environmental degradation to prove the existence of the EKC hypothesis. Second, explore the effects of FDI on ecological degradation to confirm which pollution hypothesis is supported. Many studies are found in Indonesia to test the linkage between GDP growth and carbon dioxide emission. Still, no reliable studies have been found to test the FDI effect on carbon dioxide emission, specifically in Indonesia. Therefore, to achieve these research goals, this study uses time series data with a range of 1980–2021, which is estimated using the error correction model or ECM estimation technique and two research models (in detail, this information can be seen in the "research methods" section). The writers hope that the result of this research could be new knowledge for the readers about how GDP and FDI affect carbon emission in Indonesia, which in turn may be an insight for the government and the policymakers to implement a new policy or revise current policies in Indonesia to support the Sustainable Development Goals (SDGs) program.

RESEARCH METHODS

This study uses a quantitative approach of dependent and independent variables (accompanied by controls). The author, of course, carries out this type of variable to test two types of hypotheses (for more details, see sections 3.3 and 3.4). The authors use time series annual data for Indonesia's 1980-2021 period. Secondary data used as the dependent variable, namely CO_2 per capita resulting from the use of fossil fuels and industry (in metric tons), was obtained from Our World in Data (2020). Meanwhile, the secondary data used as the independent variable includes GDP per capita (constant local currency) accepted from the World Bank Group and foreign direct investment (million US$) obtained from United Nations Conference on Trade and Development. As an indicator or representation of other descriptive variables (control variable) that impact environmental degradation, namely renewable energy consumption (in %), obtained from the World Bank Group.

The authors use the error correction model (ECM) method to achieve the research objective, estimated by ordinary least squares (OLS). First, the author does stationarity and cointegration tests, then compiles long-term and short-term regressions. Granger and Weis (1983) said that ECM is intended to identify the characteristics of time series data based on lag structure when modeling economic theory based on statistical equilibrium.

Suppose the economic theory being modeled is convincing enough. In that case, they suggest including the error correction term (ECT) parameter in ECM (short-term) model, then comparing the ECT parameters with the previous long-term/equilibrium model. Next, to test cointegration between variables, Abu-Qarn and Abu-Bader (2004) in their research, recommend conducting a cointegration test using the Johansen Cointegration test when using multiple linear regression (regression involving more than one independent variable). By looking at trace statistics and Eigenvalue as a benchmark, this value determines whether there are long-term impacts on estimated data.

Another method suggested by Gujarati and Porter (2009) is Engle-Granger (EG) or augmented Engle-Granger (AEG), which is generally used to test the cointegration of simple linear regression (regression involving only one independent variable). Moreover, Gujarati and Porter (2009) said that to determine whether there is a unit root in time series data, the formal procedure uses a stationary test, and they recommend augmented Dickey-Fuller (ADF) as one of the tests. Then the writer employs two estimation models to test each hypothesis, arguing that if the writer tests the hypothesis in one equation, it will produce estimation results that tend to be biased.

To test the environmental Kuznets curve (EKC) hypothesis, the author models into equation (1) as follows (Halicioglu, 2009; Iskandar, 2019; Kanjilal & Ghosh, 2013):

$$E_t = \emptyset_0 + a_1 Y_t + a_2 Y_t^2 + a_3 Z_t + \varepsilon_t \quad \text{.......} (1)$$

Where E_t represents environmental degradation, Y_t Is the initial stage of economic growth, Y_t^2 is the beyond the initial stage of economic growth, Z_t Another variable can affect environmental degradation.

The authors transform the model specification from linear to log-linear, in which Shahbaz et al. (2015a) emphasized that the specification of the logarithmic model provides a precise and efficient interpretation of the elasticity between the variables tested. Based on equation (1), the writer reformulates it into equation (2) to show the long-term impact between variables, as follows:

$$lnE_t = \beta_0 + \beta_1 lnY_t + \beta_2(lnY_t^2) + \beta_3(lnREC_t) + \varepsilon_t \quad \text{.......} (2)$$

Where β_0 is constant, β_1 is coefficient of lnY_t, β_2 is the coefficient of (lnY_t^2), β_3 is the coefficient of $(lnREC_t)$ which is represented Z_t from equation (1), and ε_t The study's confounding variable is statistically stated as error term/disturbance term/white noise.

Then formulate equation (3) which is usually called the ECM or short-term equation which d is the first difference, and ECT is a parameter to indicate the cointegration validity between variables in the long-term equation (see equation 2):

$$d(lnE_t) = \delta_0 + \delta_1 d(lnY_t) + \delta_2 d(lnY_t^2) + \delta_3 d(lnREC_t) + \lambda ECT_{t-1} + \varepsilon_t \ldots (3)$$

Where δ_0 is constant, δ_1 is coefficient of $d(lnY_t)$, δ_2 is coefficient of $d(lnY_t^2)$, δ_3 is coefficient of $d(lnREC_t)$, λ is the coefficient of ECT_{t-1}, and ε_t It is a confounding variable.

Pollution Hypothesis Estimation Model Specifications

To test the pollution hypothesis (pollution haven vs. pollution halo), the authors develop a methodology which is written in the form of equation (4) as follows:

$$lnE_t = \varphi_0 + \varphi_1 lnFDI_t + \varepsilon_t \quad \text{.......} (4)$$

Where lnE_t represents environmental degradation, $lnFDI_t$ is foreign direct investment, ε_t It is a confounding variable.

Then formulate equation (5) which is usually called ECM or short-term equation which d is the first difference, and ECT is a parameter to indicate the cointegration validity between variables in the long-term equation (see equation 4):

$$d(lnE_t) = \vartheta_0 + \vartheta_1 d(lnFDI_t) + \varphi ECT_{t-1} + \varepsilon_t \text{ ....} (5)$$

Where ϑ_0 is constant, ϑ_1 is a coefficient of $d(lnFDI_t)$, φ is the coefficient of ECT_{t-1}, and ε_t It is a confounding variable.

RESULT AND DISCUSSION

Stationary Test Result

This section will present the findings of the research. First, all data used in this study were subjected to static tests using augmented Dickey-Fuller (ADF). To qualify for using the error correction model (ECM), all data used must be stationary at integrated first difference. Table 1 simultaneously shows the results of the stationary data test at an integrated level and integrated first difference, using a significance level of 10% (or 0.10). The results show that all data is stationary at the combined first difference.

Table 1. Stationary Test Results of the Augmented Dickey-Fuller Test Equation

Variable	Integrated Level Probability	Results	Integrated First Difference Probability	Results
E_t	0.7119	Not Stationary	0.0000*	Stationary
Y_t	0.9065	Not Stationary	0.0002*	Stationary
(Y_t^2)	0.9245	Not Stationary	0.0002*	Stationary
FDI_t	0.9552	Not Stationary	0.0000*	Stationary
(REC_t)	0.9995	Not Stationary	0.0044*	Stationary

(*) significant at a 10% (or 0.1) level

Cointegration Test Result

After the stationarity test is done and it turns out that all data are stationary at the integrated first difference, a cointegration test needs to be done to show whether there is a long-term impact on the long-term estimation model (see equations 2 and 4). In Table 2, cointegration test results for the EKC hypothesis estimation model and pollution hypothesis estimation model indicate that at a 10% (or 0.1) significance level, there is cointegration (shown by the r symbol). The cointegration test was carried out using two methods, namely the Johansen method for the long-term EKC hypothesis estimation model. It augmented Engle-Granger for the long-term pollution hypothesis estimation model.

Table 2. Cointegration Test Results for Estimating EKC Hypothesis & Pollution Hypothesis

Johansen Cointegration Method: EKC Hypothesis Estimation Model
Variables: $E_t, Y_t, (Y_t^2), (REC_t)$
Lags interval (in first differences): 1 to 1
Trend assumption: Quadratic deterministic trend

Number of cointegrating vectors	Trace Test	0.1 Critical Value	Max-Eigen Statistics	0.1 Critical Value
r = 0	86.54183	51.64971*	38.56956	28.24065*
r ≤ 1	47.97227	32.06455*	29.38648	21.87330*
r ≤ 2	18.58580	16.16088*	18.33324	15.00128*
r ≤ 3	0.252552	2.705545	0.252552	2.705545

(*) Trace test and Max-Eigen value test indicates three cointegration equations at a significance level of 0.1

Augmented Engle-Granger (AEG) Cointegration Method: Pollution Hypothesis Estimation Model
Variables: E_t, FDI_t

t -Statistics at 0.1 Critical Value	Probability
-1.610907*	0.0008*

(*) t-statistics and probability indicate that there is a cointegration equation at the 0.1 significance level

Long-Term Equation Estimation Result

Furthermore, to analyze the long-term impact between variables contained in the EKC hypothesis equation model and pollution hypothesis (see equations 2 and 4). Then the ordinary least squares (OLS) estimation method is used, which in this study shows the coefficients and probabilities obtained to analyze the impact between variables in each estimation model. Referring to table 3 shows that in the long run, per capita carbon emissions [lnE_t] are significantly influenced by three variables, namely per capita economic growth [lnY_t], per capita squared economic growth [$ln(Y_t^2)$], and the renewable energy consumption [$ln(REC_t)$]. Furthermore, to analyze the long-term impact between variables contained in the EKC hypothesis equation model and pollution hypothesis (see equations 2 and 4). Then ordinary least squares (OLS) estimation method is used, which in this study shows the coefficients and probabilities obtained to analyze the influence between variables in each estimation model.

Table 3. Long-Term Equation Regression Results

EKC: Long-Term Hypothesis Estimation Model Dependent Variables: lnE_t			
Independent & Control Variables	**Coefficient**	**Probability**	**Results**
Constant	-377.5961	0.0000*	Significant
lnY_t	46.52834	0.0000*	Significant
$ln(Y_t^2)$	-1.350728	0.0000*	Significant
$ln(REC_t)$	-0.898433	0.0001*	Significant
Pollution Hypothesis: Long-Term Estimation Model Dependent Variables: lnE_t			
Independent Variables	**Coefficient**	**Probability**	**Results**
Constant	16.75819	0.0000*	Significant
$lnFDI_t$	0.335035	0.0000*	Significant
(*) significant at a 10% (or 0.1) level			

Table 3 is based on long-term regression for the EKC hypothesis estimation model. In the long term, per capita economic growth in the initial stage (Y_t) has a positive and significant impact on environmental degradation due to carbon emissions (E_t), which indicates that as per capita economic growth in the initial stage in Indonesia increases, at the same time, it also increases the intensity of carbon emissions. At this point, Indonesia focuses on expanding the country's economic growth by paying less attention to environmental aspects, giving rise to negative externalities. Then, in the long run, economic growth beyond the initial stage (Y_t^2) has a negative and significant impact on environmental degradation due to carbon emissions (E_t), which indicates that increasing per capita economic growth beyond the initial stage in Indonesia can minimize environmental degradation; this happens when the implementation of pro-environmental care policies has been implemented as well as possible so that economic growth creates positive externalities for the environment. Regarding other variables (control) that affect environmental degradation. In the long term, the use of renewable energy (REC_t) has a negative and significant impact on environmental degradation due to carbon emissions (E_t); This indicates that increasing renewable energy consumption can help reduce the intensity of carbon emissions because renewable energy consumption creates positive externalities for the environment.

Based on the results of regression estimation for the pollution hypothesis model. In the long term, foreign investment (FDI_t) has a positive and significant effect on environmental degradation due to carbon emissions (E_t); This indicates that the increase in foreign direct investment can trigger environmental degradation caused by carbon emissions. This finding proves that ecological regulations in Indonesia can be said to be relatively lax so that FDI activities still carry out spillover of technologies that are not environmentally friendly.

Short-Term Equation Estimation Result

After analyzing the long-term impact, a short-term analysis or error correction model (ECM) is performed for each estimation model contained in equations (3) and (5). Table 4 shows an error correction term (ECT) parameter to indicate the validity estimation of two hypothesized models in the short term or ECM. The short-term findings show a significant dynamic impact between the estimated variables. This study also indicates that the use of both estimation models is stated to be valid; This is evidenced by the resulting coefficient, which is between -1 and 0, and the ECT_{t-1} probability is significant, indicating a stable short-term and long-term equilibrium adjustment process.

Table 4. Short-Term Equation Regression Results (ECM)

EKC: Short-Term Hypothesis Estimation Model (ECM) Dependent Variables: $d(lnE_t)$			
Independent & Control Variables	**Coefficient**	**Probability**	**Results**
Constant	-0.001534	0.9188	Not significant
$d(lnY_t)$	47.04364	0.0121*	Significant
$d(lnY_t^2)$	-1.351376	0.0148*	Significant
$d(lnREC_t)$	-0.550987	0.0136*	Significant
ECT_{t-1}	-0.470193	0.0056*	Significant
Pollution Hypothesis: Short-Term Estimation Model (ECM) Dependent Variables: $d(lnE_t)$			
Independent Variables	**Coefficient**	**Probability**	**Results**
Constant	0.038255	0.0008*	Significant
$d(lnFDI_t)$	0.032569	0.0920*	Significant
ECT_{t-1}	-0.154001	0.0076*	Significant
(*) significant at a 10% (or 0.1) level			

Source: Eviews 10 processing results

The Impact of Economic Growth on Indonesia's Environmental Degradation

Based on the EKC long-term estimation model results (see Table 3), the positive coefficient of initial stage economic growth (Y_t) is 46.52834, and the negative coefficient of -1.350728 of economic growth beyond the initial stage (Y_t^2). These results indicate that economic growth in the initial stages positively and significantly impacts environmental degradation. So, the increase in economic growth in the initial stages triggers an increase in ecological degradation (E_t). Then, economic growth that goes beyond the initial stage has a negative and significant impact on environmental degradation (E_t); This indicates that when economic growth goes beyond the initial stage, it helps reduce environmental degradation. In addition, the results of the EKC short-term estimation model (ECM) also prove the same direction of the coefficients as the results of the long-term regression (for details, see the results of these variable coefficients in Tables 3 and 4).

Based on the regression results for the models (the EKC long- and short-term hypothesis estimation models), these findings support the EKC hypothesis, similar to the effects of previous studies (Dong et al., 2020; Fosten et al., 2012; Grossman & Krueger, 1995; Heil & Selden, 2001; Hitam & Borhan, 2012; Ilham, 2021; Nasir et al., 2019; Neequaye & Oladi, 2015; Shahbaz et al., 2015a; Sugiawan & Managi, 2016; Taskin & Zaim, 2000). Their findings also prove that economic growth (Y) at the initial stage causes environmental degradation, which is triggered by increased carbon emissions. In this case, economic growth efforts create negative externalities for the environment. However, if economic growth beyond the initial stage (Y^2), then environmental degradation triggered by carbon emissions can be minimized. In this case, economic growth efforts generate positive externalities for the environment.

To suppress environmental degradation due to carbon emissions, Grossman and Krueger (1995) said that awareness of environmental sustainability needs to be increased, and environmentally friendly technologies need to be developed. Then Heil and Selden (2001) explained that the state significantly prevents global climate change due to environmental degradation. Any country trying to reduce environmental degradation needs to avoid "business as usual" (BAU) practices that have contributed to increased carbon emissions. From a governance perspective, Shahbaz et al. (2015a) argue that carbon emissions can be minimized when changes in the economic structure are triggered by industrialization, improved information services, and adequate technology. To realize this, clear policies are needed to regulate the provision of environmentally friendly technology, forestry management, and increasing the rate of urbanization.

Renewable Energy as a Solution for Indonesia's Environmental Degradation

According to the regression results for the long-term EKC testing models (see Table 3), renewable energy consumption (REC_t) as a control variable has a negative coefficient which is -0.898433. It means that an increase of 1% in renewable energy consumption could reduce the 0.89 environmental degradations caused by metric tons of CO_2. So, renewable energy consumption could reduce CO_2 that has caused environmental degradation in Indonesia (the same results were also shown in the short-term regression results for EKC, see Table 4).

The interpretation above also suggests that increasing renewable energy consumption is one of many ways to reduce carbon emissions in Indonesia. Dong et al. (2020) argue that renewable energy consumption could reduce carbon emissions because its technology produces an environmentally friendly clean technology. Increasing renewable energy consumption will not only reduce carbon emissions but could also increase economic growth sustainably (Apergis & Danuletiu, 2014; Ocal & Aslan, 2013; Pao & Fu, 2013; Nasir et al., 2019) emphasized that it is necessary to allocate resources to sectors that are environmentally friendly to encourage sustainable and inclusive economic growth. One is through the manifestation of an active policy response in supporting renewable energy development.

Using renewable energy is a win-win solution for a country, its citizens, and the world. Even though today's clean technologies have an expensive upfront investment, it's worth it for Indonesia to invest in the renewable energy sector as it could reduce carbon emissions and sustain economic growth. Also, the implementation should be done correctly to use the renewable energy potential fully.

The Impact of FDI on Indonesia's Environmental Degradation

Based on the pollution hypothesis long-term estimation model result (see Table 3), the positive coefficient of foreign direct investment (FDI_t) is 0.335035. These results indicate that foreign direct investment positively and significantly impacts environmental degradation. So, the increase in foreign direct investment triggers an increase in ecological degradation (E_t). In addition, the result of the pollution hypothesis short-term estimation model (ECM) also proves the same direction of coefficients as the results of the pollution hypothesis long-term estimation (for detail, see the result in tables 3 and 4).

Based on the regression results for the models (the pollution hypothesis extended - and short-term estimation models), these findings support the pollution haven hypothesis, the same as previous research (Duan & Jiang, 2021; Hitam & Borhan, 2012; Nasir et al., 2019; Shahbaz et al., 2015b; Wang et al., 2021; Zugravu-Soilita, 2017). Their findings prove that an increase in foreign direct investment (FDI_t) can increase a country's environmental degradation because environmental regulations are not strict enough. On the one hand, foreign direct investment activities still carry spillovers of technologies that are not environmentally friendly. In this case, foreign direct investment efforts generate negative environmental externalities.

In terms of policy effectiveness, Hitam and Borhan (2012) said that policies regarding fines for those who trigger pollution are not sufficient to reduce environmental degradation; This is because there are still many parties that operate using non-environmentally friendly technology, preferring to pay sanctions for ecological damage rather than choosing to use environmentally friendly technology, which is relatively expensive. Regarding market-based environmental regulation, Wang et al. (2021) suggest that policymakers need to support business actors to develop environmentally friendly technological breakthroughs to stop dependence on the use of fossil energy. For this reason, policymakers need to promote the emission trading system (ETS) to a broader industry as one of the basic steps to minimize carbon emissions.

CONCLUSION

This research aims to test the existence of the EKC hypothesis in Indonesia for 1980-2021, then try the opposing hypotheses, namely the pollution haven hypothesis and pollution halo hypothesis, so that this study produces two findings. First, it was found that the EKC hypothesis exists in Indonesia, and there is a scale effect that indicates that economic growth at the initial stages creates negative externalities to the environment. However, when Indonesia's economic growth is beyond the initial stage, a composition effect creates positive externalities by reducing environmental degradation. Besides testing the EKC hypothesis, this study also proves that increased renewable energy consumption in Indonesia can reduce environmental degradation caused by CO_2 emissions. Second, it was found that this research supports the pollution haven hypothesis, which indicates that ecological regulations in Indonesia can be said to be less stringent so that FDI still spillovers technologies that are not environmentally friendly. Investments made through foreign investment can be unsustainable because they are not what the Kementerian Investasi/BKPM (2022).

Focusing on the investment side, this research suggests that policymakers emphasize foreign investment from Indonesia to be pro-environmental. This policy can be reviewed through the guidelines designed by green taxonomy so that Indonesia can meet the definition of sustainable investment. The green taxonomy supports the green economy, an economic activity that considers environmental sustainability concerns. It is also done by financial service institutions such as financing institutions for the real sector that implement green financing. By considering loans by classifying sector/group/business activity criteria determined by green taxonomy including green, yellow, and red. The standard red sector is a business activity that financial service institutions highly avoid because this business activity has the potential to produce large amounts of carbon emissions (CO_2).

As we know, Indonesia is currently the ninth largest country in the world that produces carbon emissions from fossil energy, based on observations of the Global Carbon Atlas. As found in this study, increasing renewable energy consumption can be a solution to reduce the growth rate of carbon emissions. Thus, policymakers also need to transition in Indonesia from energy derived from fossils to clean and renewable energy; This can be done by providing fiscal incentives in the form of tax reductions and ease of financing for foreign and domestic companies that have successfully implemented the green economy concept. Indeed, this incentive could encourage companies in Indonesia to research and develop green technology to reduce the use of fossil energy, which has been the main contributor to increasing carbon emissions. As a result, it can also indirectly support the achievement of the SDGs' targets.

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