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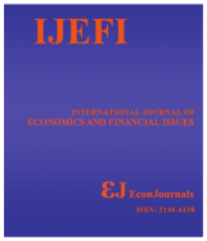

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The Relationships of Environmental Degradation and Trade Openness in Indonesia

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ABSTRACT

Economic development activity lowers the quality of the environment, mainly through production with the use of natural resources excessively, and the resulting residue. The impact of the environment is intensified with the increase of international trade. This study examines how the effect of trade liberalization (TL) on environmental quality and the existence of environmental Kuznets curve (EKC) in Indonesia. By employing the error correction model to annually data along 1976-2014, this study also analyses the dynamic relationship of the economic and environmental variables, in three equations, i.e., linear, quadratic and cubic. This study finds that in the long run, all equations statistically prove the effect of TL on environmental except in linear equation, and the EKC hypothesis proves on all equations. In the short run, the CO_2 emission is partially influenced TL in all types of equation, and the per capita income by the quadratic equation.

Keywords: Environmental Kuznets Curve, Per Capita Income, Trade Liberalization
JEL Classifications: F18, O13, Q56

1. INTRODUCTION

Economic development which primarily supported by the natural resources that neglecting the aspects of sustainability, in turn degrades the environment. Due to the limited carrying capacity of natural resources and the environment and the lack of attention to it, will cause problems to economic development in the future.

The relationship between economic growth, trade and environmental degradation (the increase CO_2 emissions) is interesting to be discussed in various economic areas. Regarding to that, at least, there are two main issues to be discussed, among other things: First, the trend of the increase of carbon emissions, in line with the agenda of the Kyoto protocol, which emphasizes the need for short-term environmental policies that reduce such emissions. In this regards, an understanding of the relationship between CO_2 emissions and gross domestic product (GDP) is very important as an input for effective public policy. Second, trade openness, which encourages economic growth but also increase pollution. Trade openness increases the volume of international trade, foreign demand, economic growth and environmental pollution (Huang and Labys, 2001).

The trade-off between economic growth and environmental degradation became an interesting issue to be discussed, since the issue of environment was an agenda at the 1972 United Nations (UN) Conference on the Environment in Stockholm, Sweden, and continue with the UN conference on the environment in Rio de Janeiro, Brazil in 1992, which preceded the UN conference on climate change in Montreal, Canada in 1990. Some of the conference affirmed that the human perceived environmental problems as a mutual problem, which demands the joint management also by countries in the world. Several studies have been conducted to analyze the effect of economic growth and trade liberalization (TL) on environmental quality, in some countries. This study aims to analyze the relationship between economic development, TL to environmental degradation which is represented by the CO_2 emissions in Indonesia. This study employs a dynamic econometric model, Engle-Granger (EG) two step procedure of error correction model (ECM) to demonstrate

the influence of the independent variables on the quality of the environment, both in the short and long term.

2. LITERATURE REVIEW

2.1. Economic Growth and Environmental Degradation

The relationship between economic activities and environment are complex and multi-dimensional. Although in the empirical level may still be difficult to obtain the convincing evidence of the form of economic activities and environmental relationships, the following is provided a starting point explanation of how the relationship between the two. As describes by Everett et al. (2010), that in general, the economic growth has three effects toward the environment (Figure 1). First, the effects of economies of scale - economic growth has a negative effect on the environment, where the increase of production and consumption cause the increase of the environment degradation. Second, the effect of the composition - the composition of production along the growth path, which initially leads to industrialization (and the shift from agriculture to industries that cause the increase of the environment degradation); then shifted the equilibrium of producing manufactured goods into producing services. Third, the technical effect - technological developments lead to the changes in the environmental impact of production, i.e. for example, improvements in energy efficiency, could also be represented by the technological advances that anticipate greater environmental damage.

The relationship between environmental degradation and economic growth described by EKC hypothesis. Initial studies that discuss EKC conducted by Everett et al. (2010), which analysed the relationship between environmental degradation and income per capita. Grossman and Krueger find that long-term relationship between economic growth and environmental quality is an inverted U-shaped curve (Figure 2).

Panayotou (1993) refers to the phenomenon as the environmental Kuznets curve (EKC). Explanation of the Kuznets inverted U curve is as follows: First, the occurrence of a shift in the transformation of the agricultural to the manufacturing sector because of the encouragement of foreign investment. Second, the demand for environmental quality will increase in line with the increase of income level. It begins when income is still low, it is difficult for developing country governments to make protection of the environment. When the income starts to rise, people begins to be able to pay for environmental damages resulting from economic activity. At this stage, people are willing to sacrifice the consumption of goods for the sake of protection of the environment (Andreoni and Levinson, 2001).

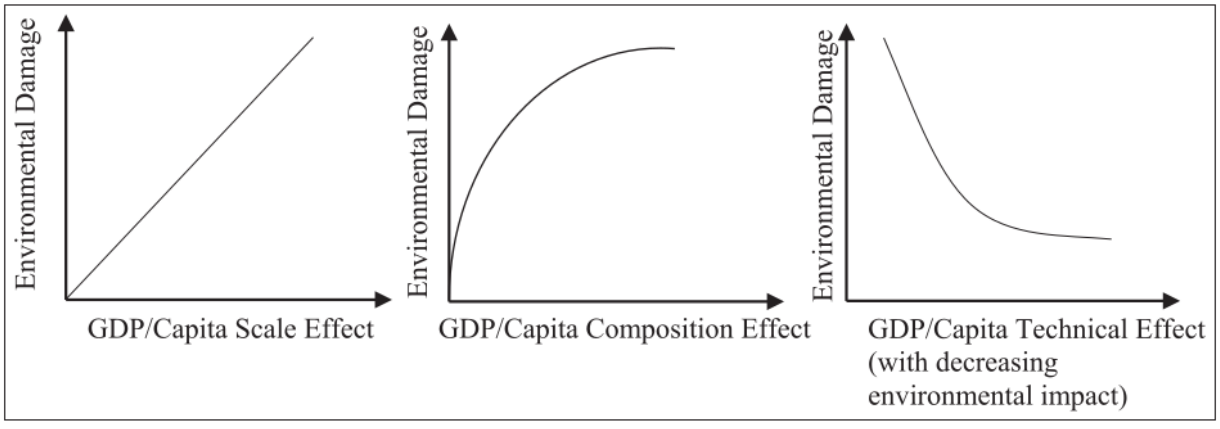
No clear conventions from the previous studies in choosing the best indicator used to approximate the environmental degradation. Some researchers use carbon dioxide emissions include Holtz-Eakin and Selden (1995); Roberts and Grimes (1997); Moomaw and Unruh (1997). Other researchers measure the environmental degradation with variable sulphur dioxide emissions (Grossman and Krueger, 1991).

2.2. Trade Openness and Environment

The first theoretical contributions on literature of the trade and environment using the perfect competitive model of the classics theory of trade (Baumol, 1971; Copeland and Taylor, 1994, 2004; Siebert, 1974; 1979). Several studies implement a variety of models, that is incorporate the emissions into the Heckscher-Ohlin trade model or Ricardian framework. A typical example is the standard model of the Heckscher-Ohlin with some goods and pollution factors that modeled as an additional production factor.

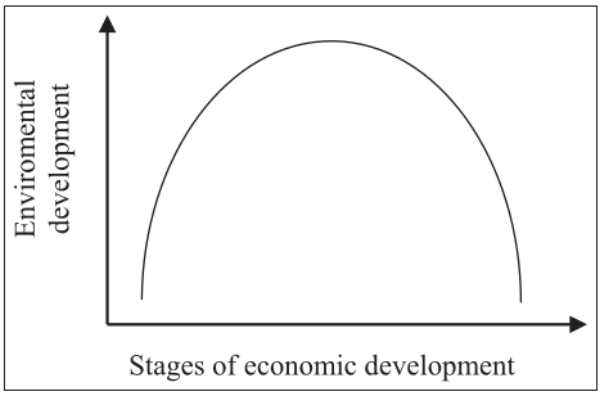
The economic theory shows that the liberalization of trade between countries with different environmental protection can cause pollution-intensive industry to concentrate in countries with lax environmental standards (Baumol and Oates, 1988). This effect is called the pollution haven effect, which is the most controversial point of debate on the topics of TL and the environment. There is no consensus in the economic literatures on the presence or absence of the pollution haven effect. If one country internalizes the social cost of the environment, and the environment do not

Figure 1: The Relationship between economic growth and environmental degradation



Source: Everett et al. (2010. p. 20)

Figure 2: Environmental Kuznets curve



Source: Everett et al. (2010, p. 17)

include in trade between countries, the last country presents a comparative advantage of commodities with high environmental costs (Copeland and Taylor, 1994).

The short run and long run analysis about the environmental impact on the trade model shows that less developed countries may specialize in pollution-intensive products in anticipation of the economic growth (Baumol, 1971; Baumol and Oates, 1988). Attempts to distort trade pollution on possible spillover effects that may exacerbate the other distortion, and hence it is needed to reform the policies comprehensively (Copeland and Taylor, 1994).

3. METHOD OF ANALYSIS

This study employs the dynamic econometric model namely EG procedure of ECM to analyse the dynamics of the short-run impact of independent variables on the dependent variable.

By applying the EKC hypothesis, this study estimated three regression equation as follows:

Linear: $Y_t=\beta_0+\beta_1 X_t+\varepsilon_{it}$ (1)

Quadratic: $Y_t=\beta_2+\beta_3 X_t+\beta_4 (X)_2+\beta_5 TL_t+\varepsilon_{2t}$ (2)

Cubic: $Y_t=\beta_6+\beta_7 X_t+\beta_8 (X)_2+\beta_9 (X)_3+\beta_{10} TL_t+\varepsilon_{3t}$ (3)

Where, Y_t is CO_2 gas emissions in year t (in kg/ton); X_g is real GDP per capita in year t (in US$), as an indicator of the performance of economic development in a given year t; TL_t is the TL in year t, i.e. the percentage of exports to GDP (in percent); β_0 is a constant; β_1, β_2, ... β_{10}, is the regression coefficient and ε_{it} is the error term for each equation i in year t.

Estimated long-run equilibrium relationship can be done simply by estimating the regression all of cointegrated variables (Thomas, 1997). Cointegration for two (or more) time series variable indicates that there is a long-run relationship or equilibrium between these variables. After a time series relationship between long run and mutually cointegrated, it can also be estimated short-run disequilibrium in the relationship between variables. The following are the brief derivation of ECM models using Equation 3, for Equation 1 and Equation 2 are described with the similar procedure:

Estimation of Equation 3 need to be reordered. First, add the lag of independent variables, then reorder the equation with reduced Y_{t-1} on both sides:

$$Y_t-Y_{t-1}=b_0+b_1X_t+b_2X_{t-1}+b_3(X_t)^2+b_4(X_{t-1})^2+b_5(X_t)^3+b_6(X_{t-1})^3+b_7TL_t+b_8TL_{t-1}+\mu Y_{t-1}-Y_{t-1}+\varepsilon_t \quad (4)$$

Perform addition and subtraction on the right side with:

b_1X_{t-1}, $b_3(X_{t-1})^2$, $b_5(X_{t-1})^3$, b_7TL_{t-1}, then (5)

$$Y_t-Y_{t-1}=b_0+b_1X_t-b_1X_{t-1}+b_1X_{t-1}+b_2X_{t-1}+b_3(X_t)_2-b_3(X_{t-1})^2+b_4(X_{t-1})^2+b_5(X_t)^3-b_5(X_{t-1})^3+b_5(X_{t-1})^3+b_6(X_{t-1})^3+b_7TL_t-b_7TL_{t-1}+b_7TL_{t-1}+b_8TL_{t-1}-(1-\mu)Y_{t-1}+\varepsilon_t \quad (6)$$

and can be written also as $\Delta Y_t=b_0+b_1\Delta X_t+(b_1+b_2)X_{t-1}+b_3\Delta(X_t)^2+(b_3+b_4)(X_{t-1})^2+b_5\Delta(X_t)_3+(b_5+b_6)(X_{t-1})^3+b_7\Delta TL_t+(b_7+b_8)TL_{t-1}-\lambda Y_{t-1}+\varepsilon_t$ (7)

where $\lambda=1-\mu$

From the above equation can be manipulated to form a new parameter, $\varnothing=\frac{b_1+b_2}{\lambda},\varnothing_2=\frac{b_3+b_4}{\lambda},\varnothing_3=\frac{b_5+b_6}{\lambda},\varnothing_4=\frac{b_7+b_8}{\lambda}$, namely so as

$$\Delta Y_t=b_0+b_1\Delta X_t+b_3\Delta(X_t)^2+b_5\Delta(X_{t-1})^2+b_7\Delta(X_t)^3-\lambda\left(Y_{t-1}-\alpha_0-\varnothing_1X_{t-1}-\varnothing_2(X_{t-1})^2-\varnothing_3(X_{t-1})^3-\varnothing_4TL_{t-1}\right)+\varepsilon_t \quad (8)$$

Where, α_0 is a long-run constant of the model. Equation 11can be referred to a first order modest ECM equation with $(Y_{t-1}-\alpha_0-\varnothing_1X_{t-1}-\varnothing_2(X_{t-1})^2-\varnothing_3(X_{t-1})^3-\varnothing_4TL_{t-1})$ as an error correction term.

4. ANALYSIS OF ESTIMATION RESULTS

The first stage of the analysis is to estimate the long-term model of EKC. Table 1 presents the results of long run model for the estimation of EKC hypothesis with linear, quadratic and cubic equations. All of the regressions model have been checked with diagnostic check to generate the robust estimation. The estimation results of linear equation indicate that the per capita income has a negative significant effect on the degradation of the environment in Indonesia, while the variable TL has not. In quadratic equations, per capita income has significantly negative effect on CO_2 emissions, while the TL variable has the positive effect. On the cubic equation, it is proved that the TL has significantly positive effect on CO_2 emissions, while per capita income has not. From the results of the EKC model, it is stated that the increases the growth of per capita income generally has negative effect on the environment, which means that the increase in per capita income

lower CO_2 emissions, and low income per capita CO_2 emissions increase, which means the environmental degradation also increase. In the long run, the model with quadratic model is able to show an inverted U-shaped of EKC hypothesis for Indonesia.

In the EKC linear equation, the coefficient of per capita income is 313.681. It means that when per capita income increases by US$ 1, the CO_2 emissions increase by 313.681 kg/ton, while other variables remain constant. In EKC quadratic equation, the coefficient of the square of per capita income is 0.1264. The TL significantly affects the environment quality by 1230.780, which shows that when the ratio of trade to GDP rises by 1%, the CO_2 emissions increase by 1230.780 kg/ton. The effect of TL was also described by the cubic equation, with the coefficient value is 1241.791.

To explain the long run relationship or long run equilibrium between the independent variables and the environment degradation, cointegration by using EG test has been applied to each equation. From the cointegration results, the study find that all of the equations has cointegrated.

Table 1: Estimation result of long run EKC model

Variable	Coefficient and (t-stat)		
	Linear	Quadratic	Cubic
Constant	117530.2	−41627.36	−67745.79
	(−4.354696)*	(−1.554089)	(−0.881874)
X	313.6807	36.43216	121.5489
	(25.76765)*	(0.614443)	(0.502678)
X^2	-	0.126354	0.042484
	-	(4.739552)*	(0.182825)
X^3	-	-	2.51E-05
	-	-	0.363383
TL	191.6915	1230.780	1241.791
	(0.387006)	(2.729442)*	(2.714487)*
R^2	0.949689	0.969020	0.969136
Adjusted R^2	0.946969	0.966438	0.965609
F-stat	349.2123	375.34582	274.7553

*Significant at α=1%. EKC: Environmental Kuznets curve, TL: Trade liberalization

Table 2: Estimation result of short run EKC model

Variable	Coefficient and (t-stat)		
	Linear	Quadratic	Cubic
Constant	6882.209	7116.077	6165.424
	(1.211829)	(1.436148)	(1.135415)
X1	15389.8915	−348.9126	9.154829
	(1.399757)	(−1.291327)	(0.011093)
X2	-	0.219690	−0.094355
	-	(2.243457)**	(−0.139320)
X3	-	-	8.75E-05
	-	-	(0.477356)
TL	−81.04664	136.8036	109.9901
	(−0.172902)	(0.349433)	(0.274038)
Res1(−1)	−0.355241	−0.590632	−0.570676
	(−2.219037)**	(−3.745212)*	(−3.489540)*
R^2	0.167026	0.429690	0.439197
Adjusted R^2	0.095628	0.362595	0.354227
F-stat	2.339375	6.404180	5.168835

*Significant at α=1%; **significant at α=5%. EKC: Environmental Kuznets curve, TL: Trade liberalization

The second estimations are the short run EKC model. The estimations of regression are summarized in Table 2. From the results, it is known that only the quadratic model which is able to demonstrate the significant effect of the per capita income to CO_2 emissions, while in others model, the per capita income as well as TL have no effect to CO_2 emissions. From negatively significant of ECT, it can be explained that all of short run models, the ECT coefficient indicates that the discrepancy between long-term and short-term CO_2 emissions is corrected by the magnitude of the ECT coefficient in one period.

5. CONCLUSION

This study employs a set of static econometric model and cointegration test to estimate how long-term relationship of TL towards variable quality of the environment in Indonesia. In this model also proved hypothesis of existence of EKC. In this study also examined how the dynamic relationship of TL and income per capita with the quality of the environment in the short term, using ECM. The effect of TL on environmental degradation empirically evidence in the long run model, while in the short run, and there is no evidence of existence the effect on the sort run. Meanwhile, the EKC hypothesis are indicated in long-term model, and only quadratic models that indicate the existence of the effect of income per capita to environmental quality.

The significant effect of TL on environmental quality in Indonesia in the long term indicating that environmental and economic policies have ne coordinated in order to decrease the negative impact on the environment as a result of trades that occurred. EKC hypothesis can be proven that is occurred in Indonesia. Increasing per capita income of the people will increase environmental degradation. But after turning-point increase in the Indonesian economy will reduce environmental degradation.

This study may have some limitations such as the data Availability of long period. This model will be broadened with include more explanatory variables, and needs to have further in depth studies on the TL's impacts on the environment.

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