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Environmental Degradation, Trade Openness, and Economic Growth in Southeast Asian Countries

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ABSTRACT

The trade-off between economic growth and environmental quality has long been debated. The aim of this study was to find out if the hypothesis of the Environmental Kuznets Curve (EKC) in five Southeast Asian countries - Indonesia, Malaysia, the Philippines, Singapore, and Thailand – is supported. This study analysed the effect of GDP per-capita and the ratio of trade openness on CO_2 emissions. Using annual data from 1975 to 2014, this study employed the Error Correction Model (ECM) to test the EKC hypothesis for each country and applied the fixed effect panel data model to test the EKC hypothesis for all countries. The results showed that in the long run, the inverted U of the EKC hypothesis was supported in Singapore, without any turning point in Indonesia and in the Philippines, but no evidence was found for Malaysia and Thailand. Except for Singapore, trade liberalisation had positive effect on CO_2 emissions. The results of panel data analysis indicated that, in general, the inverted U of the EKC hypothesis was supported in Southeast Asian countries, while trade liberalisation positively affected the increase of CO_2 emissions.

Keywords: CO_2 emission, economic growth, environmental degradation, error correction model, EKC hypothesis, panel data, trade openness

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INTRODUCTION

Economic growth is the focus of many developing countries but it also leads to negative externalities such as environmental degradation. Todaro (2000) points out that this condition may be a result of

exploitation and depletion of the natural resources. For example, economic openness of economic stimulates the economic transformation from agriculture to industry and is suspected to be the cause of the environmental degradation (Huang & Labys, 2002). Moreover, industrialisation tends to increase the CO_2 emission as the use of energy increases (Ekbom & Dahlberg, 2008).

Several developing countries in Southeast Asia whose national development depend on the existence of their natural resources placeless attention on the environmental sustainability issues. The link between trade openness and economic growth in Southeast Asian Countries during 1980 – 2014 is shown in Figure 1.

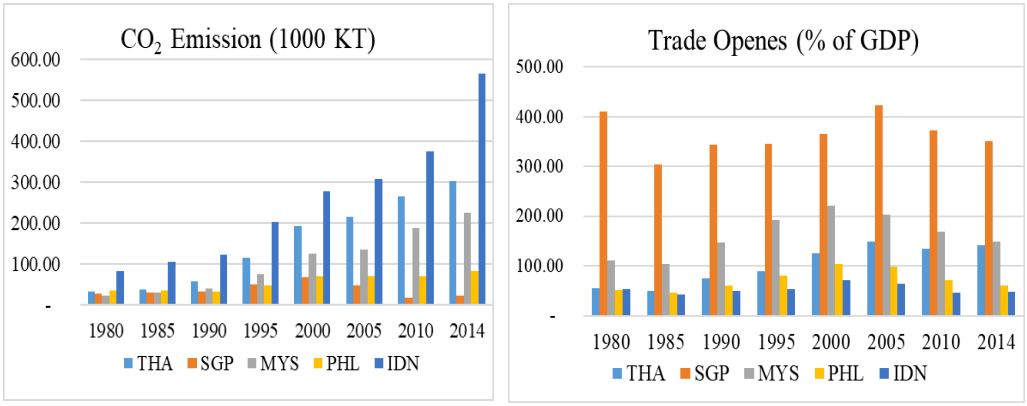

Figure 1. CO_2 Emissions and trade openness in five Southeast Asian countries 1980-2014
Note: THA = Thailand; SGP = Singapore; MYS = Malaysia; PHIL = the Philippines; IDN = Indonesia
Source: World Bank (2016)

The relationship between rate of economic growth and environmental degradation can be explained using Environmental Kuznets Curve hypothesis. This hypothesis explains that when a country's income remains relatively low, the attention of the government will be focused on how to increase the national income through economic growth. The long-run interaction between economic growth and environmental quality resembles an inverted U-curve (Grossman & Krueger, 1991), and this phenomenon is called Environmental Kuznets Curve -EKC.

In the developing countries, economic growth which leads an increase in population often ignores the environmental quality issues. Meanwhile, in the developed countries, the awareness of environment quality has increased as their income has improved in which the environmental degradation and the environmental pollution will be compensated. The demand of the people on environmental quality that

could be improved by improving social supervision and government regulation aims to achieve the prosperity of the people (Mason & Swanson, 2003).

Empirically, the trade-off between economic growth and environmental degradation has become academic issues. Researchers have analysed the relationship between environmental quality, economic growth, and liberalisation policies. Given this situation, Huang and Labys (2002) identify the argument focusing on two interrelated issues. The first is following the Kyoto Protocol Agenda of the trend in increasing carbon emission. In the future, one of the most important challenges for environmental policies is the effort to reduce CO_2 emission; it has been realized that formulating the relationship between CO_2 emission and economic growth for the benefit of the public policy is crucial. The second is the trade openness to accelerate the economic growth; yet, increase the pollution level. The international trade as a consequence of globalisation is characterised by economy growth; however, environmental pollution will also potentially increase.

This study examines the influence of growth and trade openness on the environmental quality in Southeast Asian countries by employing the error correction model (ECM), and using panel data regression. Data from 1975 to 2014 of five South East Asian countries, including Indonesia, Malaysia, Singapore, Thailand, and the Philippines was obtained and analysed.

LITERATURE REVIEW

Environmental Degradation and Income

The Environmental Kuznets Curve (EKC) due to its resemblance to Kuznets curve, which is an inverted U-shape curve, can be utilised to describe the relationship between inequality of income and economic growth (Huang & Labys, 2002; Panayotou, 2005). In pre-industrial development stage, as many countries experienced a low level of income per capita, the environment tended to be well preserved (Everett, Ishawaran, Ansaloni, & Rubin, 2010). The EKC describes the degradation of an environment as an inverted U-shape function to explain income per capita (Huang & Labys, 2002). In pre-industrial development stage, as many countries experienced a low level of income per capita, environment tended to be well preserved (Everett et al., 2010). However, the reverse happens when income per capita increases following the development of economic activities.

This situation could be explained using EKC hypothesis of Copeland and Taylor (2004) covering three important issues. First, the increase of negative impact on the environment in developing countries in line with pollution haven hypothesis, while the pollution haven hypothesis is only one of the evidences that affect trade and the environment. Second, revenue increase has a positive impact on the environment through changes in the economic structure. Third, national income grows in tandem with environmental awareness which is driven by

stringent environmental regulations and replacement of environmentally unfriendly technologies with clean and friendly ones.

These three important issues can be explained using the inverted U-shape curve of Panayotou (1993) as described below. First, foreign investment flows lead to structural transformation from agriculture to manufacturing. Second, rising income leads to demand for better environmental quality. In developing countries, low level of income per capita poses challenges for the government to protect the environment as a result of rapid industrialisation. However, rising income levels can compensate the environmental damage resulting from economic activities. At this stage, people are willing to sacrifice the consumption of goods for protecting the environment (Andreoni & Levinson, 2001).

There has been no standard environmental protection indicators. Some scholars such as Holtz-Eakin and Selden (1995); Roberts and Grimes (1997), use carbon dioxide emission as an indicator while Grossman and Krueger (1991); Panayotou (1997) use sulphur dioxide. The EKC hypothesis could be described using a linear, quadratic or cubic function (Panayotou, 1994).

Trade Openness and Environmental Degradation

The earliest work on trade and environment is the classical theory of trade which is based on the perfect competitive model (Baumol & Oates, 1993; Krutilla, 1991; Taylor & Copeland, 2004). Several studies apply Ricardian trade model or models that combine the emissions level into Heckscher – Ohlin (HO).

In economic theory, the relation between trade liberalisation and the environment, called the pollution haven effect, is the most controversial point of debate among scholars, as they are yet to reach a consensus on the presence or absence of the pollution haven effect. Baumol and Oates (1993) identify the pollution haven effect as the trade liberalisation among countries having different environmental protection standards and practices; Taylor and Copeland (2004) opine a country should be responsible forpaying the social cost of environmental protection. Trade between countries usually does not involve environmental issues and many developing countries pay a high environmental cost to gain commodity comparative advantage. Therefore, attempts to override the effects of the polluting impact of trade as a possible spill over effect may exacerbate other distortions, namely low production and income levels due to low technological mastery in developing countries, and hence, need comprehensive policy reforms (Antweiler, Copeland, & Taylor, 2001).

METHODS

This study employed time series data from 1975 to 2014 of five Southeast Asian countries, including Indonesia, Malaysia, Singapore, Thailand, and the Philippines. The CO_2 emissions representing

environmental degradation were used as the dependent variable. The economic condition represented by the real GDP per capita and the openness represented by trade ratio to GDP was the independent variables.

The ECM model of EKC of five Southeast Asian countries

To examine the EKC hypothesis, this study computes the three of regression equation models as follows:

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

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

Cubic $$:Y_t = \beta_6 + \beta_7 X_t + \beta_8 (X_t)^2 + \beta_9 (X_t)^3 + \beta_{10} TL_t + \varepsilon_{3t} \quad (3)$$

Y_t is CO_2 emissions in year t (in kg/ton); X_{it} is the real GDP per capita in year t (in US$); and TL_t is the ratio of exports to GDP in year t (in percent) as the trade liberalisation indicator. The β_0, β_2, and β_3 are constants in equations (1), (2) and (3) successively; β_1, β_3, β_4, β_5, β_7, β_8, β_9, and β_{10}, are the regression coefficients and ε_{1t}, ε_{2t}, ε_{3t} are the error terms for equation (1), (2) and (3) successively in year t.

This study applied Engle-Granger (EG) procedure of Error Correction Model (ECM) to analyse the dynamics of the short-run effect of economic growth on environmental degradation, where the long-run relationships can be performed by estimating the regression of all co-integrated equations (Thomas, 1997). The co-integration of the two (or more) time series variables indicates there is a long-run nexus or equilibrium between the variables, then the short-run disequilibrium relationship between dependent and independent variables can be estimated.

EG test is conducted to test the cointegration of the residual ε_{3t}, using the Dicky-Fuller (DF) stationary test (Gujarati & Porter, 2009):

$$\Delta u_t = \Omega_1 \varepsilon_{3t-1} + v_t \quad (4)$$

The following equations are a brief derivation of ECM model based on equation (3); while, equation (1) and equation (2) are explained using similar procedures. To estimate the ECM model, equation (3) needs to be re-ordered by first adding the lag of independent variables, and the model is autoregressive distributed lag (ARDL) (1,1):

$$Y_t = b_0 + b_1 X_t + b_2 X_{t-1} + b_3 (X_t)^2 + b_4 (X_{t-1})^2 + b_5 (X_t)^3 + b_6 (X_{t-1})^3 + b_7 TL_t + b_8 TL_{t-1} + \mu Y_{t-1} + e_t \quad (5)$$

and the result is,

$$\Delta Y_t = b_1\Delta X_t + b_3\Delta X_t{}^2 + b_5\Delta X_t{}^3 - (1-\mu)\left(Y_{t-1} - \frac{b_0}{1-\mu} - \frac{(b_1+b_2)}{1-\mu}X_{t-1} - \frac{(b_3+b_4)}{1-\mu}(X_{t-1})^2 - \frac{(b_5+b_6)}{1-\mu}(X_{t-1})^3\right) + e_t \quad (6)$$

From the ADRL (1,1), it is noted that where $\beta_6 = \frac{b_0}{1-\mu}$, $\beta_7 = \frac{(b_1+b_2)}{1-\mu}$, $\beta_8 = \frac{(b_3+b_4)}{1-\mu}$, and $\beta_9 = \frac{(b_5+b_6)}{1-\mu}$. Equation (6) can be referred to a first order model ECM equation with $\left(Y_{t-1} - \frac{b_0}{1-\mu} - \frac{(b_1+b_2)}{1-\mu}X_{t-1} - \frac{(b_4+b_4)}{1-\mu}(X_{t-1})^2 - \frac{(b_5+b_6)}{1-\mu}(X_{t-1})^3\right)$ as an *Error Correction Term*.

Panel Data Regression Model of EKC in Southeast Asian Countries

Fixed Effects Model (FEM) and Random Effects Model (REM) are selected for the fit model used in this study. In this case, FEM assumes the intercept of each individual to have differences caused by special characteristics possessed by each individual. The terminology of the fixed effect shows that despite the fact the intercept varies among the individuals, for each individual, the intercept does not vary over time, called time invariant. It can also be stated that based on FEM models, it is assumed the slope coefficient of regressors does not vary between individuals and over time. The REM intercept is considered as the average of random variables. The intercept is not assumed to be constant, so the model is also popularly known as random error component model (Gujarati & Porter, 2009).

The panel regression equations of the hypothesis of EKC are formulated as follows (in the form of logarithm *Ln* quadratic models):

$$LnCO2_{it} = \beta_0 + \beta_1 LnGDPCAP_{it} + \beta_2(LnGDPCAP_{it})^2 + \beta_3 LnTL_{it} + u_{it} \quad (9)$$

To estimate the EKC hypothesis, the CO_2 emissions is used as a representation of environmental degradation, the Gross Domestic Product per Capita (*GDPCAP*) and the ratio of exports to gross domestic product (TL) are used to represent the macroeconomic condition and trade liberalisation. The subscript i indicate countries.

The fixed-effect model treats the β0 and β_t as regression parameters as they helped capture the countries' specific time invariant factors affecting pollution intensity. The random-effect model treats β_0 and β_t as components of random disturbances. If the correlation between β_0, β_t and the explanatory variables exist, the random-effect model cannot be estimated consistently (Hsiao,

2007). Only the fixed-effect model can be estimated consistently. The Hausman test will be used to determine whether the fixed effect or random effect model is preferred.

RESULTS AND DISCUSSION

For the long run models (Table 1), R^2 values explain the variation of CO_2 emissions more than 90 percent in each of estimation models of Indonesia, Malaysia, Thailand, and the Philippines, except Singapore (the R^2 is 56.4). The figure of the calculated F was found greater than critical F, which pointed to the overall independent variables affecting CO_2 emissions in each country (Table 1).

The long run estimation results indicate the models of EKC inverted U-shaped were empirically proven in Singapore, indicated by the coefficient $\beta_1 > 0$ and $\beta_2 < 0$. Meanwhile, in Indonesia, the model generated $\beta_1 > 0$ and $\beta_2 > 0$ exhibiting an increase in emissions CO_2 along with the increase of its economic growth; although, its per capita income does not statistically significant affect the CO_2 at 10 percent level of confidence (α). Moreover, the estimation model of Malaysia, Thailand, and the Philippines are $\beta_1 < 0$ and $\beta_2 > 0$ meaning that CO_2 emissions decrease when per capita income increases, despite at a certain point, the per capita income increases CO_2 emissions.

Table 1
Estimation result of long run EKC model: Dependent variable Y

Variable	Coefficient and (t-stat)				
	Indonesia	Malaysia	Thailand	Philippines	Singapore
Constant	3.102	34.843	9.050	51.009	-105.567
	(0.552)	(2.978)***	(1.502)*	(1.521)	(-5.938)***
LnX	0.707	-8.118	-1.387	-13.781	23.494
	(0.413)	(-2.767)***	(-0.850)	(-1.453)	(6.650)***
LnX^2	0.062	0.596	0.163	1.076	-0.120
	(0.497)	(3.424)***	(1.435)*	(1.610)	(0.524)***
LnTL	0.298	0.509	0.826	0.829	0.229
	(2.193)**	(3.118)***	(1.502)***	(14.020)***	(0.524)
R^2	0.971	0.985	0.979	0.933	0.563
Adj. R^2	0.969	0.984	0.977	0.927	0.527
F-stat	405.672	787.6747	549.756	165.891	15.501

Note: *** significant at α = 0.01; ** significant at α = 0.05; * significant at α = 0.10

The estimations of the long run model showed trade liberalisation had a positive and significant effect on CO_2 emissions, except in Singapore. Statistically, trade liberalisation in the island state did not significantly affect CO_2 emissions but it pointed to a positive relationship. This finding proves that Singapore economy as a developed country, places great concern on the quality of its environment.

According to ECM estimation (Table 2), the short run model is consistent with the long run one. For Indonesia, the variable of trade liberalisation do not statistically significant affect environmental degradation. For all countries, except the Philippines, the quadratic per capita income significantly affected CO_2 emissions. Based on the estimated coefficients of each country, the EKC hypothesis had only been occurred in Singapore, where $\beta_1 > 0$ and $\beta_2 < 0$. In the short run, the trade liberalisation variable had significant effect ($\alpha = 0.01$ and $\alpha = 0.05$) on the Philippines and Malaysia estimation models while the Thai model showed a significant effect at $\alpha = 0.1$. The negative sign of ECT explains the discrepancy between the long-run and the short-run estimated CO_2 emissions was corrected by the magnitude of the ECT coefficient within one period.

Table 2
Estimation result of short run EKC model: Dependent variable ΔLnY

Variable	Coefficient and (t-stat)				
	Indonesia	Malaysia	Thailand	Philippines	Singapore
Constant	0.046	0.067	0.070	0.023	0.029
	(2.35)**	(4.279)***	(5.164)***	(2.202)	(0.596)
ΔLnX	1.385	-8.816	-0.873	-9.696	14.553
	(0.291)	(-1.838)*	(-0.312)	(-0.864)	(1.356)
ΔLnX^2	-0.067	0.522	0.045	0.709	-0.789
	(-0.193)	(1.794)*	(0.240)	(0.885)	(-1.457)
ΔLnTL	-0.006	0.635	0.209	0.194	0.743
	(-0.062)	(3.194)**	(1.605)*	(1.503)***	(-3.132)
ECT	-0.370	-0.0535	-0.284	-0.422	-0.406
	(-3.224)***	(5.058)***	(-3.806)***	(-4.450)***	(-3.132)***
R^2	0.256	0.481	0.305	0.387	0.268
Adj. R^2	0.169	0.420	0.223	0.315	0.181
F-stat	2.930	7.874	3.732	5.370	3.106

Note: *** significant at $\alpha = 0.01$; ** significant at $\alpha = 0.05$; * significant at $\alpha = 0.10$

To find out how environmental issues affect Southeast Asian economies, this study applies panel data regression model, which is FEM - which is resulted by the Hausman model selection. The estimation results indicate that coefficient of GDP per capita (in linear and quadratic forms) affect CO_2 emissions in Southeast Asian countries. The coefficient of per capita income and quadratic per capita income are statistically significant affecting CO_2 emissions at level of confidence $\alpha = 0.01$ (Table 3). The coefficient per capita income of 4.830 points to the fact in the early stages of Southeast Asian economic development, 1 percent increase in per capita income increases CO_2 emissions by 4.830 percent.

The estimation of FEM model proves that a priori positive sign of the coefficient per capita income (β_1) and the negative sign of quadratic per capita income (β_2), form the inverted U curve of EKC hypothesis (indicated by $\beta_2 \neq 0$, and if $\beta_1 > 0$ and $\beta_2 < 0$). This finding means that panel data estimation was able to explain the behaviour of CO_2 emissions in the five Southeast Asian countries.

Table 3
Estimation results of the data panel – FEM

Variable	Coefficient	t-Statistic
Constant	-14.907	-12.396***
LnGDPCAP	4.830	15.419***
$LnGDPCAP^2$	-0.236	-12.758***
LnTL	0.638	7.868***
R-squared	0.922	
Adjusted R-squared	0.920	
F-statistic	326.172	

Note: *** significant at $\alpha = 0.01$

CONCLUSION

This study utilised the dynamic econometric model and the cointegration test to estimate the long-run relationship of trade liberalisation on environmental degradation to prove the EKC hypothesis in the five Southeast Asian countries. In the long run, the estimations indicated that a priori model of EKC was supported in Singapore, and the trade liberalisation had positive significant effect on CO_2 emissions, except in Singapore. In the short run, the estimation results proved the estimated parameters supported the EKC hypothesis, though the effect of income per capita and trade liberalisation on environmental degradation was not statistically significant.

The result shows the differences of national income per capita and trade liberalisation in relation to environmental degradation in developed country i.e. Singapore and in developing countries such as Indonesia, Malaysia, Thailand, and the Philippines in Southeast Asia. This could be due to the dependence of the latter countries on natural resources, the increase in the economies of scale, and the shift of the economic structure from agriculture to manufacture in four Southeast Asian countries, except Singapore.

The estimation of panel data regression of Southeast Asian countries indicated per capita income and trade liberalisation had significant effect on CO_2 emissions. Therefore, it can be concluded that the environmental policies were crucial and must be coordinated in order to reduce their negative impacts on the environment due to

rapid development and expansion of trade. Meanwhile, the EKC hypothesis was proven in Southeast Asian countries. The increase in per capita income aggravate environmental degradation in Southeast Asian countries, but the turning point is the increase in income that would reduce environmental degradation due to awareness and the cost of the environmental damages.

Although the findings, to some extent, are conclusive, this study has several limitations including lack of data in a long-time series and the use of environmental indicators, which were limited to CO_2 emissions. This study can be developed using other environmental indicators.

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