Diputra, Eko Mahar; Baek, Jungho

Article

Is growth good or bad for the environment in Indonesia?

Reference: Diputra, Eko Mahar/Baek, Jungho (2018). Is growth good or bad for the environment in Indonesia?. In: International Journal of Energy Economics and Policy 8 (1), S. 1 - 4.

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(1), 1-4.

Is Growth Good or Bad for the Environment in Indonesia?

Eko Mahar Diputra[1], Jungho Baek[2]*

[1]Technology Management, Economics and Policy Program, College of Engineering, Seoul National University, Soutk Korea,
[2]Department of Economics, School of Management, University of Alaska Fairbanks, USA. *Email: jbaek3@alaska.edu

ABSTRACT

This paper attempts to contribute to the literature on the growth-environment nexus by asking: What is the effect of growth on Indonesia's CO_2 emissions, controlling for energy consumption and urbanization? To that end, an autogressive distributed lag approach to cointegration is applied to annual data for the period 1971–2013. Results show that income growth tends to increase CO_2 emissions monotonically in Indonesia. It is also found that there is strong evidence that energy consumption increases CO_2 emissions and little evidence that urbanization causes significant environmental degradation.

Keywords: Autogressive Distributed Lag, CO_2 Emissions, Environment, Growth, Indonesia
JEL Classifications: C2, Q4, Q5

I. INTRODUCTION

Since a range of economic reforms was implemented in the late 1980s, Indonesia has been one of the fast-growing emerging economies in Asia. During the period 1990–2016 (except for the Asian financial crisis in 1998–1999), for example, the Indonesian economy has recorded an average annual economic growth rate of approximately 6%. As a result, Indonesia has been ranked as the largest economy in Southeast Asia and the sixteenth largest economy in the world. However, Indonesia's fast-expanding economy over almost three decades has led to pollution and environmental degradation because of the rapid growth of industrial sector. During the period 1990–2016, for example, carbon dioxide (CO_2) emissions have increased by more than 150% in Indonesia. As a result, Indonesia currently ranks the world's eighth largest emitter of CO_2 emissions. Thus, one of interesting research questions to ask about Indonesia would be: What is the effect of growth on Indonesia's environment?

A large body of literature in empirical economics has attempted to assess the impact growth has on a country's environment in the environmental Kuznets curve (EKC) framework – an inverted U-shaped relationship between growth and certain types of pollutants. Early literature examines the growth-environment nexus using pure cross-sectional or cross-sectional time-series (panel) data. Examples include, but are not limited to, Shafik and Bandyopadhyay (1992), Panayotou (1993), Holtz-Eakin and Selden (1995), Moomaw and Unruh (1997), Roberts and Grimes (1997), Heil and Selden (2001), Harbaugh et al. (2002), Liu (2005), Frankel and Rose (2005), Shahbaz et al. (2015), Al-mulali and Ozturk (2015), Zambrano-Monserrate et al. (2016), (Gill et al., 2017; Anastacio; 2017). These authors have provided conflicting results for the growth impact on the environment. Moomaw and Unruh (1997), for example, report little evidence of the EKC for CO_2 emissions in 16 developed countries. Frankel and Rose (2005), on the other hand, confirm the EKC hypothesis for various air pollutants in 40 countries. Recently, however, a growing body of research contends that early studies may suffer from aggregated bias of data (e.g., Baek and Kim, 2011; Baek, 2015); that is, when cross-sectional and panel data models are adopted in examining the growth-environment nexus, a significant growth effect with one country is likely to be dominated by insignificant growth impacts with other countries, thereby providing little evidence of the EKC, or vice versa. The latest studies thus further argue that in order to deal with aggregation bias effectively, time series models would be deemed because they can be used to analyze data at the individual country level. Examples include, but are not limited to, Soytas and Sari (2009) for Turkey, Jalil and Mahmud (2009) for China, Halicioglu (2009) for Turkey, Iwata et al. (2010) for France, Baek and Kim (2011; 2013) for Korea, Shahbaz et al. (2013) for Romania, and Baek (2015) for seven Arctic countries (Canada, Finland, Denmark, Iceland, Norway, Sweden and the United

States). These authors generally provide supportive evidence of the EKC. Halicioglu (2009), for example, reports the existence of the EKC for CO_2 emissions in Turkey. Iwata et al. (2010) provide supportive evidence for the EKC hypothesis in France. Up until now, however, their attention of empirical analysis has been limited to individual countries in East Asia and Europe. There thus remains an additional room to contribute to the literature in the latest group by investigating the growth-environment nexus in countries other than East Asia and Europe. This observation has motivated the present study.

The main objective of this study is to examine the effect of growth on the environment for Indonesia, Southeast Asia's biggest economy, controlling for other relevant factors such as energy consumption and urbanization. The widely used autoregressive distributed lag (ARDL) modeling approach to cointegration (referred to here as ARDL model) proposed by Pesaran et al. (2001) is employed to achieve the objective. For this purpose, in section II we present our empirical model along with an application of an ARDL model. In section III, we discuss the empirical results. Section IV provides our summary and conclusion. Discussion on data is presented in the Appendix.

2. THE MODELS AND METHODS

In examining the growth-environment nexus, the extant literature (e.g., Iwata et al., 2010; Baek, 2015) commonly relies on an empirical model in which a measure of environmental quality is related to a measure of gross domestic product (GDP) per capita (as a proxy for growth) and other relevant variables - energy consumption and such a demographic factor as urbanization. Since CO_2 is considered one of the primary greenhouse gases (GHG) (accounting for approximately 72% of the totally emitted GHG) causing global warming and has been the most widely used measure of environmental quality in the literature, our long-run model specifies CO_2 emissions (c_t) as function of GDP per capita (y_t), energy consumption (en_t) and urbanization (urb_t):

$$c_t = \beta_0 + \beta_1 y_t + \beta_2 y_t^2 + \beta_3 en_t + \beta_4 urb_t + u_t \tag{1}$$

Where, all variables are in natural logarithm. The coefficients of primary interest in the current study are β_1 and β_2. When $\beta_1>0$ and $\beta_2<0$, the quadratic has a parabolic shape, thereby providing supportive evidence for the EKC hypothesis: Growth has a diminishing effect on CO_2 emissions after a certain (per capita) income turning point. If a rise in energy consumption results in increasing CO_2 emissions, we would expect $\beta_3>0$. Finally, if an increase in the urbanization tends to reduce CO_2 emissions, we would expect $\beta_4<0$.

Equation (1) is clearly a long-run specification and Pesaran et al. (2001) recommend that in order to obtain stable long-run estimates, the short-run dynamic adjustment process among the variables be incorporated into the modeling process. Thus, Equation (1) is reformulated as an error-correction format as in Equation (2):

$$\begin{aligned}\Delta c_t = \beta'_0 + \sum_{k=1}^{p}\beta'_{k1}\Delta c_{t-k} + \sum_{k=0}^{p}\beta'_{k2}\Delta y_{t-k} + \sum_{k=0}^{p}\beta'_{k3}\Delta y_{t-k}^2 \\ + \sum_{k=0}^{p}\beta'_{k4}\Delta en_{t-k} + \sum_{k=0}^{p}\beta'_{k5}\Delta urb_{t-k}\sigma_0 c_{t-1} + \sigma_1 y_{t-1} \\ + \sigma_2 y_{t-1}^2 + \sigma_3 en_{t-1} + \sigma_4 urb_{t-1} + \xi_t\end{aligned} \tag{2}$$

Equation (2) follows Pesaran et al. (2001) who include the linear combination of lagged level variables (c_{t-1}, y_{t-1}, y_{t-1}^2, en_{t-1} ,and urb_{t-1}) rather than lagged error term from Equation (1). They then demonstrate that the standard F-test can be applied to establish joint significance of lagged level variables as evidence of a cointegration relationship among the variables. For this, they tabulate new two (upper and lower) critical values for the F-test that account for integrating properties of all variables such as integrated of order zero, I(0) and integrated of order one, I(1); hence, the pre-unit root testing is not necessary in the ARDL approach. For cointegration the calculated F-statistic must be above the upper critical value. Once cointegration is identified, the long-run coefficient estimates are derived by normalizing σ_0 and rearranging the estimates of σ_1–σ_4. The short-run effects are obtained by the estimates of coefficients attached to first-differenced variables.

3. THE RESULTS

In this section, we estimate the ARDL model outlined by Equation (2) using annual data for the period 1971–2013[1]. While descriptive statistics for our data is reported in Table 1, data sources from which we construct our variables are presented in the Appendix. To estimate Equation (2), we impose three as the maximum lag length on each of the first-differenced variables and using the Akaike information criterion, the ARDL (3, 2, 3, 2, 3) equation is determined as the optimal specification. We then report the long- and short-run results from the optimal model in Tables 2 and 3. Given that the environmental impacts of growth are generally regarded as a long-run phenomenon (Baek, 2015), our presentation in this section focuses on the results from the long-run analysis.

The long-run estimates reported in Table 2 reveal that the coefficient on the income is significantly positive and the quadratic term is significantly negative, implying that after the so-called turning point income, the income effect turns negative, and the quadratic shape means that the elasticity of CO_2 emissions with respect to income is decreasing as income increases. The estimated coefficients on the income and the quadratic term, for example, are +4.921 and −0.265, indicating that before (after) an income threshold, a 1% increase in income results in an increase (decrease) in CO_2 emissions by 4.921% (0.265%). Thus, this finding seems to be supportive of the EKC hypothesis for CO_2 emissions in Indonesia. When calculating the turning point income, however, it turns out to lie outside the sample period and hence the quadratic to the right of the value can be ignored[2]. In other

1 This time span is chosen due to availability of the data for all the variables in Equtaion (2).

2 While the calculated turning point of real income is found to be $12,840 in 2011 USD, the highest value in our sample is $9,452 in 2011 USD.

Table 1: Descriptive statistics

Variables	Mean±SD	Minimum	Maximum
CO_2 emissions (metric ton)	0.960±0.589	0.199	2.417
Income ($2011USD)	3,419.411±2,076.937	1,037.087	9,452.952
Energy consumption (kg)	571.461±198.583	297.201	877.878
Urbanization (%)	33.656±11.304	17.3	52.3

Table 2: Results of estimated long-run coefficients

Independent variables	Dependent variable: CO_2 emissions	
	Coefficient	t-statistic
Income	4.921	7.220**
$(\text{Income})^2$	−0.265	−6.754**
Energy consumption	0.719	3.609**
Urbanization	−0.078	−0.280
Constant	−26.413	−10.273**
F-statistic	11.435**	

All variables are in natural logarithms. **,* denote significance at the 5% and 10% levels, respectively. The upper critical bound value of the F-statistic at the 5% significance level is 4.532, which are computed by stochastic simulations using 20,000 replications

words, CO_2 emissions in fact have monotonically increased with growth in Indonesia.

The estimated effect of the energy consumption on CO_2 emissions is positive and highly significant, indicating that CO_2 emissions increase as energy consumption increases. When energy consumption increases by 1%, for example, CO_2 emissions increase by approximately 0.719%, holding income and urbanization fixed. The estimated coefficient on the urbanization is found to be negative, suggesting that CO_2 emissions decrease with high urbanization rates. Statistically, however, it is not significant. Notice that from the short-run estimates reported in Table 3 (Panel A), it is clear that there is at least one significant coefficient obtained for all the variables, indicating that income, energy consumption and urbanization have short-run impacts on CO_2 emissions in Indonesia.

One important question remaining now is whether the long-run estimates are statistically meaningful. In other words, is there a long-run/cointegration relationship among the variables? This question can be answered by comparing the calculated F-statistic with the upper critical value tabulated by Pesaran et al. (2001). The result shows that the calculated F-statistic is 11.435 (Table 2), which far exceeds the 5% upper critical value of 4.532, thereby supporting cointegration. To further check for cointegration, we conduct an alternative test. In this alternative test, we use the normalized long-run estimates and Equation (1) to generate an error term, EC_{t-1}. We then replace the linear combination of lagged level variables in Equation (2) by EC_{t-1} and estimate this new specification after imposing the same optimum lags. A significantly negative coefficient obtained for EC_{t-1} will support cointegration. Note that the t-statistic used to judge significance of EC_{t-1} has a non-standard distribution for which Banerjee et al. (1989) tabulate critical values based on the number of observations and the number

Table 3: Results of estimated short-run coefficients

Independent variables	Dependent variable: CO_2 emissions			
	Lag order			
	0	1	2	3
Panel A: Short-run coefficient estimates				
$\Delta(CO_2$ emissions)		0.784	0.533	
		(3.204)**	(2.726)**	
Δ(Income)	−2.794	−5.565		
	(−0.975)	(−2.271)**		
$\Delta(\text{Income})^2$	0.186	0.321	−0.069	
	(1.060)	(2.082)**	(−4.696)**	
Δ(Energy consumption)	0.246	−0.543		
	(1.091)	(−2.375)**		
Δ(Urbanization)	−4.371	−0.636	−12.042	
	(−0.863)	(−1.165)	(−2.513)*	
Panel B: Diagnostic statistics				
EC_{t-1}	LM	RESET	CUS (CUS^2)	Adj R^2
−1.315	0.013	1.242	Stable	0.668
(−5.340)**				

All variables are in natural logarithms. Numbers inside the parentheses are t-statistics. LM and RESET are the Lagrange multiplier test of serial correlation and Ramsey's test for functional form, which has a χ^2 distribution with one degree of freedom. The critical values at the 5% and 10% significance levels are 3.84 and 2.71, respectively. CUS and CUS^2 represent the cumulative sum and cumulative sum of squares tests. EC_{t-1} represents an error-correction term. ** and * denote significance at the 5% and 10% levels, respectively

of independent variables. Given the critical value of −4.05 at the 5% level, the t-statistic on EC_{t-1} of −5.34 in our model is highly significant, thereby confirming cointegration (Panel B in Table 3).

We finally report additional diagnostic statistics (Panel B in Table 3). First, in order to test for serial correlation, we utilize the Lagrange Multiplier test that has a χ^2 distribution with one degree of freedom. This statistic is found to be insignificant, indicating that there is no evidence of serial correlation in the CO_2 emissions model. Second, we also report the Ramsey's regression specification error test result that also has χ^2 distribution with one degree of freedom. This statistic is found to be insignificant, supporting a correctly specified optimum model. Finally, in order to test for stability of short-run and long-run coefficient estimates, the cumulative sum and cumulative sum of squares tests are applied to the residual of our optimum model. Apparently, all estimates are stable.

4. SUMMARY AND CONCLUDING REMARKS

In this short paper, the effects of growth on CO_2 emissions, controlling for energy consumption and urbanization, in Indonesia are investigated using the ARDL cointegration framework. Our results spanning 43 years over 1971–2013 show that income growth appears to increase CO_2 emissions monotonically. The same is true of energy consumption, suggesting that higher energy consumption has an adverse effect on reducing CO_2 emissions. Urbanization, on the other hand, does not seem to have a significant effect on CO_2 emissions.

One of important policy implications that can be derived from our finding is that, given the monotonous increase in CO_2 emissions with income growth, government policies to move towards a low-carbon economy through a more use of renewable energy and energy efficiency improvements could lead to mitigate CO_2 emissions while growing GDP in Indonesia. Another important implication is that, considering income growth generally hand in hand with increasing energy consumption, any policy decision made by the Indonesian government directed at promoting economic growth tends to accelerate growth of CO_2 emissions.

REFERENCES

Al-Mulali, U., Ozturk, I. (2015), The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. Energy, 84, 382-389.

Anastacio, J.A.R. (2017), Economic growth, CO_2 emissions and electric consumption: Is there an Environmental Kuznets Curve? An empirical study for North America Countries. International Journal of Energy Economics and Policy, 7(2), 65-71.

Baek, J. (2015), Environmental Kuznets curve for CO_2 Emissions: The case of arctic countries. Energy Economics, 50, 13-17.

Baek, J., Kim, H.S. (2011), Trade liberalization, economic growth, energy consumption and the environment: Time series evidence from G-20 countries. Journal of East Asian Economic Integration, 15, 3-32.

Baek, J., Kim, H.S. (2013), Is economic growth good or bad for the environment? Empirical evidence from Korea. Energy Economics, 36, 744-749.

Banerjee, A., Dolado, J.J., Mestre, R. (1998), Error-correction mechanism tests for cointegration in a single-equation framework. Journal of Time Series Analysis, 19, 267-284.

Frankel, J.A., Rose, A.K. (2005), Is trade good or bad for the environment? Sorting out the causality. Review of Economics and Statistic, 87, 85-91.

Gill, A.R., Viswanathan, K.K., Hassan, S. (2017), Is environmental Kuznets curve (EKC) still relevant?. International Journal of Energy Economics and Policy, 7(1), 156-165.

Halicioglu, F. (2009), An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37(3), 1156-1164.

Harbaugh, W.T., Levinson, A., Wilson, D.M. (2002), Reexamining the empirical evidence for an environmental Kuznets curve. Review of Economics and Statistic, 84, 541-551.

Heil, M.T., Selden, T.M. (2001), Carbon emissions and economic development: Future trajectories based on historical experience. Environment and Development Economics, 6(1), 63-83.

Holtz-Eakin, D., Selden, T.M. (1995), Stoking the Fires? CO_2 emissions and economic growth. Journal of Public Economics, 57, 85-101.

Iwata, H., Okada, K., Samreth, S. (2010), Empirical study on the environmental Kuznets curve for CO_2 in France: The role of nuclear energy. Energy Policy, 38, 4057-4063.

Jalil, A., Mahmud, S.F. (2009), Environment Kuznets curve for CO_2 emissions: A cointegration analysis for China. Energy Policy, 37, 5167-5172.

Liu, X. (2005), Explaining the relationship between CO_2 Emissions and national income: The role of energy consumption. Economics Letters, 87, 325-328.

Moomaw, W.R., Unruh, G.C. (1997), Are environmental Kuznets curve misleading us? The case of CO_2 emissions. Environment and Development Economics, 2, 451-463.

Panayotou, T. (1993), Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. Geneva: ILO.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16, 289-326.

Roberts, J., Grimes, P. (1997), Carbon intensity and economic development 1962-1991: A brief exploration of the environmental Kuznets curve. World Development, 25, 191-198.

Shafik, N., Bandyopadhyay, S. (1992), Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence. NBER Working Paper No. 904.

Shahbaz, M., Mutascu, M., Azim, P. (2013), Environmental Kuznets curve in Romania and the role of energy consumption. Energy Economics, 18, 165-173.

Shahbaz, M., Dube, S., Ozturk, I., Jalil, A. (2015), Testing the environmental Kuznets curve hypothesis in Portugal. International Journal of Energy Economics and Policy, 5(2), 475-781.

Soytas, U., Sari, R. (2009), Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecological Economics, 68, 1667-1675.

Zambrano-Monserrate, M. A., Valverde-Bajana, I., Aguilar-Bohorquez, J., Mendoza-Jimenez, M.J. (2016), Relationship between economic growth and environmental degradation: Is there evidence of an environmental Kuznets curve for brazil?. International Journal of Energy Economics and Policy, 6(2), 208-216.

APPENDIX

Appendix: Data Definition and Sources

Annual data during the period 1971–2013 are used d to conduct the empirical analysis. The data sources are as follows:

a. World Development Indicators of the World Bank (www.worldbank.org).
b. Penn World Tables (http://cid.econ.ucdavis.edu/pwt.html).

Variables

c=CO_2 emissions per capita measured in metric ton (source a).
y=Real GDP per capita measured in 2011 U.S. dollar (source b).
en=Energy consumption measured in kg of oil equivalent per capita (source a).
urb=Percentage of urban population (source a).