BADAN PENDIDIKAN DAN
PELATIHAN KEUANGAN
KEMENTERIAN KEUANGAN
REPUBLIK INDONESIA

JURNAL BPPK

ECONOMIC GROWTH AND CO2 EMISSIONS IN INDONESIA : INVESTIGATING THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS EXISTENCE

Azwar[a]
[a] Balai Diklat Keuangan Makassar, Indonesia. Email: azwar.iskandar@gmail.com

ARTICLE INFORMATION

ARTICLE HISTORY
Received
05 Maret 2019

Accepted to be published
28 Juni 2019

KEYWORDS:
growth,
co2,
emission,
Kuznets,
Environmental.

ABSTRACT

Peningkatan ancaman polusi udara dan pemanasan global telah dibahas secara luas dalam berbagai *event* internasional. *Environmental Kuznets Curve (EKC)* menjadi sebuah isu riset yang memotivasi banyak studi dalam mengklaim adanya hubungan antara pendapatan ekonomi dan emisi CO2 melalui pembuktian hipotesis *inverted U-shaped,* dimana hipotesis ini menjelaskan bahwa pada tahap awal pertumbuhan ekonomi, degragdasi lingkungan akan terjadi, tetapi pada tahap puncak pertumbuhannya justru akan mengurangi emisi CO2 bagi lingkungan. Penelitian ini bertujuan untuk menguji keberadaan *Environmental Kuznets Curve (EKC) Hypothesis* dalam hubungan antara pertumbuhan ekonomi dan emisi karbondioksida di Indonesia selama periode tahun 1981-2016. Penelitian ini menggunakan teknik analisis *Autoregressive Distributed Lag (ARDL) co-integration.* Data yang digunakan merupakan data sekunder yang berasal dari *World Bank Development Indicators.* Hasil penelitian mengindikasikan bahwa hipotesisEKC tidak terdapat di Indonesia. Selain itu, permodelan jangka panjang menunjukkan bahwa pertumbuhan ekonomi, khususnya pada sektor *electricity and heat production,* memberikan dampak positif dan signifikan terhadap emisi karbondioksida di Indonesia. Atas dasar temuan-temuan tersebut, penelitian ini mengisyaratkan adanya kebutuhan mendesak bagi Indonesia untuk menekankan perluasan *service intensive economy* daripada *resource intensive,* serta pengembangan sumber-sumber energi terbarukan dalam rangka memitigasi degradasi lingkungan seiring perkembangan dan pertumbuhan ekonomi.

The increasing threat of air pollution and global warming had been widely discussed in various international events. Environmental Kuznets Curve (EKC) become an interesting issue that motivated a lot of studies on the inverted U-shaped relationship between income and CO2 emission: in the early stage of development, environmental degradation occurs, but at a certain point, an increase in economic development will reduce CO2 emission. This study aims to investigate the existing of EKC hypothesis and the dynamic relationship between CO2 emission and economic growth in Indonesia for 1981-2016 using Autoregressive Distributed Lag (ARDL) co-integration framework. Data were retrieved from World Bank Development Indicators. The study shows that EKC Hypothesis does not exist. In addition, the long run model shows that economic growth appears to have a significant positive impact on CO2 emission, especially from electricity and heat production. These findings suggest the Indonesian government shift towards a service-intensive economy rather than resource-intensive and develop an alternative renewable energy source to mitigate environmental degradation as well as promote economic development.

1. INTRODUCTION

The increasing threat of air pollution and global warming had been widely discussed in various international events. According to the Intergovernmental Panel on Climate Change (IPCC), carbon dioxide emissions (CO2) are suspected as the major source of global warming. IPCC (2007) predicts an increase of global temperature and a rise in sea level from 1.1° to 6.4° and 16.5 to 53.8 cm respectively by 2100. As the main source of greenhouse gases, CO2 emissions related to fossil fuels energy consumption such as oil and gas. Unlike other gases, for example, SO2 and NOx, CO2 emission spreads beyond the borders to other countries and indirectly affect the health. Thus a country is likely less incentive in CO2 emission reducing especially during the rapid economic expansion period.

Environmental Kuznets Curve (EKC) become an interesting issue that motivated a lot of studies. EKC claims an inverted U-shaped relationship between income and CO2 that in the early stage of development, environmental degradation occurs, but at a certain point, an increase in economic development will decrease CO2 emission (Grossman and Helpman, 1991; Panayotou, 1993; Shafik and Bandyopadhyay, 1992). The application of the EKC hypothesis is important since no policy prevention is needed as the effect of economic progress on CO2 tends to become negative after the turning point.

The major explanations on the possibility of an inverted U-shaped relationship between economic growth and environmental pollution are based on three different channels: scale effect, composition effect and technique effect (Grossman and Krueger, 1991). Based on the scale effect, economic growth has a negative impact on the environment. All else being equal, an increase in production will increase pollution and environmental degradation. On the other hand, the composition effect shows a positive effect on the environment. During economic development, the structure of the economy changes, as in the earlier stages pollution increases with the changes in a country's economic structure from mainly agricultural production to more resource intensive heavy manufacturing industries and in later stages of development pollution decrease as the structure shifts towards service and light manufacturing industries. Finally, the technique effect suggests that dirty and obsolete technologies are replaced by new and cleaner technology which improves environmental quality. Based on EKC, the negative impacts of scale effects on the environment tend to dominate in the initial stages of economic growth but the positive impacts of composition and technique effects that tend to decrease emissions levels prevail at the declining stage (Stern, 2004).

Apart from other environmental indicators such as deforestation, carbon emission, sulfur dioxide, and municipal waste, the existence of the EKC hypothesis on the relationship between CO2 emission and economic development had been largely examined, yet the relationship is still inconclusive. Shafik and Bandyopadhyay (1992), Shafik (1994) and Azomahou et al. (2006) found a linear relationship between CO2 emission and income. While, Roberts and Grimes (1997), Cole et al. (1997), Schmalensee et al. (1998), Galeotti and Lanza (1999), and Saboori et al. (2012) confirmed the existence of the EKC hypothesis.

Despite the large number of literature that investigated the existence of EKC among income and CO2, only a few studies applied individual countries to explore the hypothesis. Consequently, lack of policy implications to each country arises, since pollution feature differs from country to another (Ang, 2008). Studies employed time series technique include De Bruyn et al. (1998) for Netherlands, West Germany, UK and USA; Roca et al. (2001) for Spain; Day and Grafton (2003) for Canada and Friedl and Getzner (2003) for Austria; Fodha and Zaghdoud (2010) for Tunisia; Saboori et al. (2012) for Malaysia; Shahbaz et al. (2013) for Turkey; Al-Mulali et al. (2015) for Vietnam. On the other hand, few studies found inclusive results include Ozturk and Acaravci (2010) for Turkey; Menyah and WoldeRufael (2010) for South Africa. Findings in exploring the EKC hypothesis between CO2 emission and economic growth for individual countries are likely to vary as a result of various econometrics techniques, time span, and different employed proxies.

Inconclusive results regarding the existence of EKC in studies on individual countries cannot be extrapolated as evidence of similar results for all countries. For example, the existence of the decoupling phase of the EKC between economic growth and CO2 emissions in Turkey is not yet apparent in testing when employing different econometric methodologies with different time periods and different additional variables. Soytas and Sari (2007) and Ozturk and Acaravci (2010) conclude that there is no inverted-U shaped relationship between income and CO2 emissions in Turkey. In other words, the empirical results are sensitive to the country/ countries chosen, the period considered, chosen estimation technique and the use of different control variables in the model.

This study aims to investigate the existing of the EKC hypothesis and the dynamic relationship between CO2 emission and economic growth in Indonesia case. The issue of environmental pollutants is in a progressive trend in developing countries as they require more energy consumption for higher economic development. Consequently, they suffer from more environmental problems. As a developing country, of course, Indonesia faces similar problems like other developing countries.

Indonesia is a useful case study for several reasons. First, Indonesia is the 4th largest greenhouse gas (GHG) emitter globally and is now leading the way to make a significant voluntary commitment to cut its national greenhouse gas emissions by 26% (unilaterally) and 41% (with support from the international community) by 2020. Second, Indonesia is playing a strategic role as part of the G20 and, as a middle-income country, it could be argued that it has an important responsibility in balancing development and emissions reductions priorities (EDC2020, 2019)[1]. Third, Indonesia which is an archipelagic state is vulnerable to climate change. If the current trend of global warming continues unabated, it is expected that 2000 of the 17000 islands in Indonesia will be submerged by 2030 (Lean & Smyth, 2010). Additionally, Imansyah et. al. (2013) found that the growth of CO2 emission during 1990-1995 is 92.82%, from 33,704.31 thousand tons to 64,987.37 thousand tons.

The acceleration of economic development to achieve higher GDP growth in order to increase the

[1] http://www.edc2020.eu/117.0.html

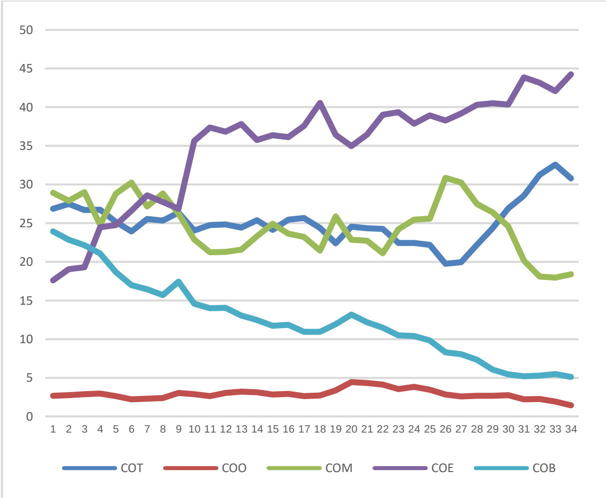
income of people can cause a higher CO2 emission. Previously, the Government of Indonesia devised a National Action Plan on Green House Gas Emission Reduction called the RAN-GRK and set up the greenhouse gas reduction to 26% in 2020 in each sector with national action of self-effort and to 41% reduction with international support. Under the Intended Nationally Determined Contribution (INDC), Indonesia agreed to reduce carbon emissions to 29% in 2030.

Increasing carbon emission in line with economic growth is triggered by fast-growing industrial and manufacturing activity. According to the Ministry of Environment (2006), the industry sector was the highest energy consumers since 2001, followed by the transportation sector. Manufacturing sectors contributed to 25% to Gross Domestic Product (GDP) in 2010. Ministry of Industry also has identified that there are eight manufacturing sectors as the highest contributors of CO2 emission to the greenhouse gas effect which are cement, steel, pulp and papers, petrochemical, fertilizer, ceramics, textiles, and food and beverage sectors in which these sectors use energy more than 6000 TOE (Giorgetti, 2007). The consequences of this contribution are the higher level of energy consumption and CO2 emission from the industry sector, withan average escalation of 146.87% in five years (1995-2000). However, higher energy consumption is caused not only by higher economic growth but also by low energy efficiency in Indonesia (Basri, 2009; Kusumawardhani, 2009). Based on Review of World Energy (2004), Indonesia requires more than 470 tons of energy to generate GDP of US$ 1 million and Thailand requires approximately 400 tons. Meanwhile, Japan needs only 92.3 tons and OECD countries around 200 tons.

Policy makers require comprehensive information on energy use and CO2 emission to make an appropriate policy, particularly for key sectors that show significant growth in Indonesia. Comprehensive information is needed for the key sectors in Indonesian economy, especially in the context of CO2 emission from the sectors, if the sectors are driven to be the key sectors in the acceleration of economic development. Should this happen, economic acceleration that relies on the key sectors would generate a higher CO2 emission as well. Therefore, a review is important to identify whether or not the key sectors generate high CO2.

Based on World Development Indicators's data, CO2 emission from energy such as electricity and heat production in Indonesia was about 17,59 million metric tons in 1981 and reaches 44,25 million metric tons in 2014. Figure 1 shows the gradual it increase as a source of CO2 emission. It is worthwhile to investigate the policies proven an effect on CO2 emission reduction in Indonesia.

Figure 1: Carbon dioxide (CO2) emission in Indonesia in 1981-2016; COT is CO2 emissions from transport; COO is CO2 emissions from other sectors, excluding residential buildings and commercial and public services; COM is CO2 emissions from manufacturing industries and construction; COE is CO2 emissions from electricity and heat production; COB is CO2 emissions from residential buildings and commercial and public services.



Source : World Development Indicators (WDI)

This paper attempts to test the hypothesis of; (1) The long-run co-integration among economic growth and CO2 emission. This hypothesis is investigated employing five CO2 resources; (2) EKC existence on the association between CO2 emission towards economic growth in Indonesia over the period of 1981-2016.

The rest of the paper is organized as follows: Section 2 describes the literature review, section 3 presents methodology including data and model, section 4 provides the empirical results and discussions, while section 5 concludes the paper.

2. LITERATURE REVIEW

The relationship between CO2 emissions and economic growth is of great interest in the economics literature in the last decades. An article on this topic was published by Coondoo & Dinda (2002). They examined the causality relationships between CO2 emissions and income using panel data representing 88 countries and the time period 1960–1990. However, their analysis does not provide much evidence for the existence of a causal relationship between income and carbon emissions.

Lise (2006) concluded that the relation between CO2 emissions and income in Turkey is linear rather than quadratic and it does not support the EKC hypothesis. Richmond and Kaufmann (2006), employing simple OLS in levels, found that there is no significant relationship between economic growth and CO2 emissions. In contrast, using a VAR approach for the EKC model, Ang (2008) found a long-run positive dependence between pollution and energy consumption.

Furthermore, Soytas and Sari (2009) investigated the long-run Granger causality relationship between economic growth, CO2 emissions, and energy consumption in Turkey. They found the existence of

Granger causality running from carbon emissions to energy consumption, but only for one direction.

Similarly, Akbostanci, Turut-As¸ Ik, and Tunc (2009) studied the relationship between income and environment in Turkey using time series for the period of 1968-2003 and panel data 3 and 1992–2001 for the period of 1992-2001. They indicated a positive relationship between CO2 emissions and income. On the other hand, Menyah and Rufael (2010) found a unidirectional relationship between energy consumption and economic growth in South Africa, where the causality runs from energy consumption to economic growth. Moreover, Apergis and Payne (2010) observed that energy consumption and economic growth causes CO2 emissions and at the same time they found causality between energy consumption and CO2 emissions and between energy consumption and economic growth.

Using time series data and cointegration analysis, Fodha and Zaghdoud (2010) investigated the relationship between economic growth and pollutant emissions degradation based on the EKC hypothesis for Tunisia during the period 1961–2004. The results provide support for a unique and robust long-run relationship between the per capita emissions of pollutants and per capita GDP, indicating a monotonically increasing linear relationship between per capita CO2 emissions and per capita GDP. Chang (2010) investigated the causal relationships between CO2 emissions, energy consumption and economic growth based on the panel data for 28 China provinces over the period 1995–2007. The study demonstrates bi-directional causality running: from GDP to CO2 emissions and the consumption of crude oil and coal; and from electricity consumption to GDP.

Furthermore, an increase in GDP growth or energy consumption stimulates CO2 emissions. Pao and Tsai (2011) and Zamula and Kireitseva (2013) found a strong positive bi-directional causal relationship between energy consumption, CO2 emission, foreign direct investment, and growth in the BRIC countries and Ukraine. Niu et al. (2011) revealed that there are long-term equilibrium relationships between energy consumption, GDP growth and CO2 emissions for the eight Asia-Pacific countries. Causality runs from energy consumption to CO2 emissions. GDP is responsible for the increase in energy consumption, and there is a strong causality between GDP and CO2 emissions over the long run in developed countries, in contrast, the relationship is not present in developing countries. Narayan and Popp (2012) tested the Environment Kuznets's Curve (EKC) hypothesis for 93 countries for the period from 1980 to 2004. They examined the long-run impact of energy consumption on real GDP and established a sign of the long-run causality effect.

3. RESEARCH METHODOLOGY

This study uses time series data from 1981-2016. CO2 emission is measured in metric tons and categorized into five types as follows: (1) CO2 emissions from transport; (2) CO2 emissions from other sectors, excluding residential buildings and commercial and public services; (3) CO2 emissions from manufacturing industries and construction; (4) CO2 emissions from electricity and heat production; and (5) CO2 emissions from residential buildings and commercial and public services were used. This study also uses GDP per capita (constant LCU), exports of goods and services (constant LCU), and Imports of goods and services (BoP, current US$). The data were retrieved from the World Development Indicators (WDI) online database.

Following Halicioglu (2009) and Kanjilal and Ghosh (2013), this study specifies the following linear logarithmic quadratic functional form for the long-run relationship among carbon emission, economic growth, and export-import for the country. Based on the EKC hypothesis, a non-linear quadratic association exists between pollution and income. Therefore EKC hypothesis may be formulated as follows:

$$E = \emptyset_0 + \alpha_1 Y_t + , \alpha_2 Y^2{}_t + \alpha_3 Z_t + \varepsilon_t$$

Where, E refers to environmental degradation, Y is growth, Y^2 is a square of growth, and Z represents other descriptive variables that may influence environmental degradation.

CO2 emission has been widely used as a dependent variable (Al-Mulali et al., 2014; Lau et al., 2014; Osabuohien et al., 2014; Pao and Tsai, 2011a; Pao and Tsai, 2011b; Tiwari et al., 2013). If the EKC hypothesis is valid, the expected sign of α_1 is positive and α_2 is negative. The statistical significance of α_2 implies that there is a monotonically increasing relationship between carbon emission and income. The author has converted all the series into a natural logarithm (Ln) for consistent and reliable results. The log-linear specification provides better results because the conversion of the series into logarithm reduces the sharpness in time series data (Shahbaz, 2012).

Economic growth is widely used as economic development and to incorporate the EKC hypothesis. Furthermore, several studies had employed import and export as an indicator to trade such as Al-Mulali et al. (2014), Du et al. (2012), Osabuohien et al. (2014) and Tiwari et al. (2013).

This study employs an Autoregressive Distributed Lag approach (ARDL) bounds testing approach, by Pesaran et al. (2001). This approach has several advantages over alternatives. For instance, it can be applied whether variables are stationary or integrated in a different order. Hence, it overcomes the problem of integration order related to Johansen & Juselius (1990). This approach fixes heterogeneity and mitigates serial correlation problems through accurate order augmentation of the repressor and appropriate lag selection.

First, this study test the unit root of all the variables using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. After checking for the unit root, this study employs either the Johansen & Juselius (1990) or the Engle-Granger co-integration test to check whether the series of each variable is integrated of the same order. If the author finds that the variables used in this study are not all integrated of the same order and hence, the author will employ the ARDL approach for co-integration test as Johansen method, co-integration test requires the variables to be integrated of the same order. Otherwise, the predictive power of the models tested would be affected.

As developed by Pesaran et al. (2001), the ARDL approach solves these problems as ARDL can be applied irrespective of whether the variables are stationary in level [I(0)] and/or in first difference level [I(1)]. More importantly, the Johansen approach is not suitable for co-integration analysis with short time series data. On the other hand, ARDL provides robust results even in small samples (Pesaran & Shin, 1999). Therefore, this approach is advantageous since income inequality data is only available annually and the data availability is also limited for many emerging economies like Indonesia. In addition, Another ARDL lets the optimal lag lengths of the variables to be vary, while the Johansen approach requires that all variables in the model have the same number of lags. This study uses AIC (Akaike Information Criterion) to determine the optimal lag lengths for the ARDL model. Even though Schwarz Bayesian Criterion (SBC) provides a small standard error for some of our models tested under the ARDL, the author found that, in some models, SBC ran the models with ARDL (0,0,0,0) such that no ECM statistical output was produced. This is due to the SBC's method of choosing the minimum lag possible and accordingly, the author finds that AIC is more suitable for our study.

The initial step in ARDL is to empirically investigate empirically the existence of long-run relationship among the variables. Then, the calculated F-statistic is compared against the upper and lower critical bound provided by Pesaran et al. (2001) which correspond to the assumptions that the variables are I(0) and I(1) respectively. If the calculated F-statistics exceeds the upper critical bound (UCB), then the series are cointegrated; if it is below the lower critical bound (LCB), there is no cointegration. If the calculated F-statistics lies between the UCB and the LCB, then cointegration is inconclusive.

The ARDL co-integration test analyzes the following hypotheses: H_0: δ1 = δ2 = δ3 = δ4 = 0 i.e there is no long-run relationship between the variables and H_a: δ1 ≠ δ2 ≠ δ3 ≠ δ4 ≠ 0 i.e there is cointegration or long-run relationship between the variables.

In the second step, once co-integration between the variables has been established, the long run coefficients and the error correction term (ECT) can be estimated. The ARDL co-integration procedure allows the co-integrating relationship to be estimated by OLS once the lag order is selected. The model can be identified as follows:

$$\Delta LnCOT_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOT_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDP_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGDP^2_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnEXP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnIMP_{t-1} + \beta_1 \Delta LnCOT_{t-1} + \beta_2 \Delta LnGDP_{t-1} + \beta_3 \Delta LnGDP^2_{t-1} + \beta_4 \Delta LnEXP_{t-1} + \beta_5 \Delta LnIMP_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta LnCOO_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOO_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDP_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGDP^2_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnEXP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnIMP_{t-1} + \beta_1 \Delta LnCOO_{t-1} + \beta_2 \Delta LnGDP_{t-1} + \beta_3 \Delta LnGDP^2_{t-1} + \beta_4 \Delta LnEXP_{t-1} + \beta_5 \Delta LnIMP_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta LnCOM_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOM_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDP_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGDP^2_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnEXP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnIMP_{t-1} + \beta_1 \Delta LnCOM_{t-1} + \beta_2 \Delta LnGDP_{t-1} + \beta_3 \Delta LnGDP^2_{t-1} + \beta_4 \Delta LnEXP_{t-1} + \beta_5 \Delta LnIMP_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta LnCOE_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOE_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDP_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGDP^2_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnEXP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnIMP_{t-1} + \beta_1 \Delta LnCOE_{t-1} + \beta_2 \Delta LnGDP_{t-1} + \beta_3 \Delta LnGDP^2_{t-1} + \beta_4 \Delta LnEXP_{t-1} + \beta_5 \Delta LnIMP_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta LnCOB_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOB_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDP_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGDP^2_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnEXP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnIMP_{t-1} + \beta_1 \Delta LnCOB_{t-1} + \beta_2 \Delta LnGDP_{t-1} + \beta_3 \Delta LnGDP^2_{t-1} + \beta_4 \Delta LnEXP_{t-1} + \beta_5 \Delta LnIMP_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (6)$$

Where COT represents CO2 emissions from transport; COO is CO2 emissions from other sectors, excluding residential buildings and commercial and public services; COM is CO2 emissions from manufacturing industries and construction; COE is CO2 emissions from electricity and heat production; COB is CO2 emissions from residential buildings and commercial and public services were used; GDP is GDP per capita ; EXP is exports of goods and services; and IMP is imports of goods and services, respectively.

From those equations, Δ is the first difference of the logged variables, t and ε_t stand for time period and white noise, respectively. θECT_{t-1} in equation (2 -6) corresponds to the error correction term (ECT). ECT indicates the speed of the adjustment and shows how quickly the variables return to the long-run equilibrium. a_i where i = 1, 2, 3, 4, are the corresponding short-run multipliers, while the parameters β_i, where i = 1, 2, 3, 4 are the long-run dynamic coefficitients of the underlying ARDL model. This equation is a standard vector autoregression (VAR) model in which a linear combination of lagged-level variables is added as a proxy for lagged error terms.

The dynamic error correction model (ECM) is derived from the ARDL model through a simple linear transformation where the ECM incorporates the short run dynamics along with long-run equilibrium, without losing the long run information. Through the t-statistic of the ECM, the causality in the earlier step will be tested and confirmed. Meanwhile, the coefficient of the ECM shows the speed of adjustment of the dependent variable towards its long-run equilibrium. The endogeneity or exogeneity of the variable is tested through the ECM, and the same equation is used with each proxy of corruption as well as poverty, in turn, being the dependent variable. The hypothesis is tested by the ECM as follows: H_0: The variable is Exogeneous; and H_a: The variable is Endogenous.

4. RESULT AND DISCUSSION

The descriptive statistics of sample data collected from World Development Indicators (WDI) as follows:

Table 1.Descriptive Statistics of Data

	Min	Max	Ave.	Std. Dev.
COT	19,7418	32,57181	25,17741	2,796438818
COO	1,434037	4,437569	2,886216	0,640011813
COM	17,95116	30,86108	24,63139	3,587644253
COE	17,59715	44,25125	34,81896	7,315094176
COB	5,11076	23,93268	12,4874	5,250756837
GDP	11786442	36125914	21030426	7016941,787
IMP	1,62E+10	2,13E+11	7,5E+10	61632277459
EXP	2,96E+14	2,05E+15	9,97E+14	5,84648E+14

Source : World Development Indicators (WDI)

The unit root test provides guide to ascertain whether ARDL is applicable or not since it is only applicable to the analysis of variables that are integrated of order zero [I(0)] or order one [I(1)], but not applicable when higher order of integration such as I(2) variable is involved. Stationary testing of the variables is important to avoid spurious regression. Thus, the Augmented Dickey-Fuller (ADF) of Dickey & Fuller (1981) and Phillips-Perron (PP) test by Phillips &Perron (1988) technique were used to investigate the variables stationary. of the variables. The ADF and PP test results with trend and intercept are shown in Table 2.

Table 2. Results of the ADF and PP test

Level				
	ADF Test		PP Test	
Variables	**t-statistic**	**Prob.***	**t-statistic**	**Prob.***
COT	-4.778233	0.0028*	-4.793426	0.0027*
COO	-5.359587	0.0006*	-6.375888	0.0000*
COM	-6.666660	0.0000*	-7.535745	0.0000*
COE	-5.800627	0.0002*	-6.732671	0.0000*
COB	-3.761470	0.0319**	-3.859408	0.0256**
GDP	-6.350535	0.0000*	-9.077954	0.0000*
GDP^2	-1.876046	0.6441	-6.702182	0.0000*
IMP	-1.959277	0.6025	-1.965290	0.5993
EXP	-7.514236	0.0000*	-7.648015	0.0000*
1st Difference				
COT	-5.449346	0.0006*	-22.93968	0.0000*
COO	-8.291489	0.0000*	-27.34769	0.0000*
COM	-3.976184	0.0222**	-33.59441	0.0000*
COE	-5.596048	0.0004*	-18.25378	0.0000*
COB	-10.36708	0.0000*	-9.599753	0.0000*
GDP	-6.345131	0.0001*	-22.88543	0.0000*
GDP^2	-10.96602	0.0000*	-16.96170	0.0000*
IMP	-5.979901	0.0001*	-5.986402	0.0001*
EXP	-4.843189	0.0033*	-26.73632	0.0000*

* Significance at 1 % level, ** Significance at 5 % level.
\# MacKinnon (1996) one-sided p values.

Source : Author's Calculation

The null hypothesis of the unit root problem is rejected at the first difference. This shows that most variables are found to be stationary at level implying that variables are integrated at I(0) and the variables used in this study are not all integrated of the same order, hence the author may employ the ARDL approach to test for cointegration.

After confirmed the variables stationarity, the next step of the analysis was to do a co-integration test among the variables. Therefore, the ARDL bounds testing approach is employed to test for the existence of a long-run relationship. However, in order to do this, it is important to identify an appropriate lag length to calculate the F-statistics. The ARDL model is sensitive to the lag order. In addition, an optimum lag order would be helpful in a reliable and consistent result in the analysis. Thus, the Akaike Information Criterion (AIC) is considered to obtain the optimum lag length. The choice of this criterion is based on the stricter penalties imposed by AIC (see Table 3). This AIC provides better and consistent results compared to other lag length criteria (Uddin et al., 2013).

Table 3. Model Selection Criteria

Model	Equation	Optimal Lag
1	COT=f(GDP, GDP^2, IMP,EXP)	(2,0,2,0,0)
2	COO=f(GDP, GDP^2, IMP,EXP)	(3,0,2,0,0)
3	COM=f(GDP, GDP^2, IMP,EXP)	(4,0,4,4,0)
4	COE=f(GDP, GDP^2, IMP,EXP)	(2,3,3,4,4)
5	COB=f(GDP, GDP^2, IMP,EXP)	(1,0,3,0,0)

Source : Author's Calculation

After that, the variables were tested for co-integration by applying ARDL bound testing approach for testing the Null that there is no long-run (LR) relationship among the variables. The computed F-statistic is compared with the upper and lower critical bounds to test the existence of co-integration Pesaran et al. (2001). The null hypothesis is $H_0 : \lambda_j = 0$, (where j = 1, 2, …, 4) in equation (4). This implies no long-run relationship among the variables, against the alternative hypothesis, $H_1: \lambda_j \neq 0$, implying the existence of long-run relationship among the variables.

The results in Table 4 showed that not all the computed F-statistic in the models are greater than the upper bound (5.06) at several levels of significance. Only Model 2 and Model 4 show evidence to reject the null hypothesis of no long-run relationship among the variables. Hence, the alternative hypothesis is accepted that there is long-run equilibrium relationship among CO2 emission, growth, import, and export in Model 2 and Model 4. **So, the first hypothesis of this study is cannot be rejected.**

Table 4. Result of Bounds Testing

Estimation	F-statistic	Result
Model 1 FLnCOT [LnCOT|LnY, LnY², LnZ]	3.466220	No co-integration
Model 2 FLnCOO [LnCOO| LnY, LnY², LnZ]	3.738737***	co-integration
Model 3 FLnCOM [LnCOM| LnY, LnY², LnZ]	3.197562	No co-integration
Model 4 FLnCOE [LnCOE| LnY, LnY², LnZ]	5.627878*	co-integration
Model 5 FLnCOB [LnCOB| LnY, LnY², LnZ]	1.892255	No co-integration
Critical values for F-statistics (%)	Lower I(0)	Upper I(1)
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

* Significance at 1 % level, *** Significance at 10 % level

Source : Author's Calculation

The existence of a long-run relationship between CO2 emission and its determinants based on the bound testing approach permits us to estimate the long and short run models of environmental degradation in Indonesia. In order to examine the existence of the EKC hypothesis, long-run and short-run models were compared (Narayan and Narayan, 2010). Tables 5 and 6 report short-run and long-run estimated models, respectively.

The Error Correction Model (ECM) associated with ARDL was estimated to show the short and long run effect of growth on the CO2 emission level. In addition to the fact that ECM comprises the short run transitory effects and the long run relationships, the speed of adjustment of the dependent variable to changes in the independent variables is also determined within the framework.

Table 5. Results of the Error Correction Model (ECM) for Short Run

Variable	Model 2	Model 4
D(LnGDP)	-0.035513	-0.489068
	[0.9338]	[0.1619]
D(LnGDP²)	-0.366968	-0.263981
	[0.0308]	[0.0511]
D(LnIMP)	-0.032196	-0.026402
	[0.7928]	[0.7885]
D(LnEXP)	0.107741	0.492839
	[0.8567]	[0.3081]
ECM(-1)	-0.205797	0.004549
	[0.6658]	[0.9905]

* Significance at 1 % level

Source : Author's Calculation

The results of the ECM in Table 5 showed the short effect of growth on CO2 emission. From the p-value (Prob.) of error correction (ECM(-1)) in table (where 1% as significance level), the author conclude that in the short-run both growth and CO2 emission are not endogenous for all models. That is all these variables are not dependent on other variables, which helps the author to argue that there is no dynamic relationship among growth, import, export and CO2 emission from other sectors, excluding residential buildings and commercial and public services; and from electricity and heat production in short-run. The lagged ECM terms for the model have the expected negative sign. Moreover, the coefficient of the ECM (-1) in Table 4 shows the speed of adjustment of the CO2 level to shocks in exogenous variables in the model. The negative and statistically significant of the coefficient of the Error Correction (ECM) indicates a stable process of adjustment to the long run equilibrium.

In long-run, see models (Table 6), growth (α_1) and square of growth (α_2) appear to have a significantly positive effect on CO2 emission from electricity and heat production, that is, an increase of 1% in GDP per capita leads to 1.5% increase in CO2 emission; while, import and export seem to have a negative effect. In Model 4, CO2 emission from electricity and heat production appears to be negatively affected through the export of goods and services, where a decrease by 1% in export leads to a 1.23% increase in CO2 emission from electricity and heat production.

Table 6. Results of ARDL Estimation Based on AIC for Long Run

Variable	Model 2	Model 4
LnGDP	0.078138	1.505**
	[0.8194]	[0.0407]
LnGDP²	-0.088502	0.908**
	[0.7798]	[0.0124]
LnIMP	0.020333	-0.0840
	[0.6798]	[0.1371]
LnEXP	-0.340195	-1.23***
	[0.3888]	[0.0564]

* Significance at 1 % level,** Significance at 5 % level, *** Significance at 10 % level

Source : Author's Calculation

According to short-run and long-run computed models, there is no evidence of the EKC hypothesis in all models. Moreover, regardless of CO2 emission sources, whether from transport; other sectors, excluding residential buildings and commercial and public services; manufacturing industries and construction; and electricity and heat production (Model 1,2,3, 4, and 5), EKC hypothesis is unproven. **So, the second hypothesis of this study is rejected.**

The estimated results are in line with other studies such as Jalil and Mahmud (2009), and Saboori et al. (2012). A possible explanation of non-existence of EKC hypothesis in Indonesia for all resources CO2 emission is that the Indonesia economy is still resource-intensive rather than services-intensive; in which services donate 45.9% of total GDP per capita in 2017, while agriculture and industry sectors contribute 13.9% and 40.3% respectively (Index Mundi, 2018)[2]. Agriculture includes farming, fishing, and forestry. Industry includes mining, manufacturing, energy production, and construction. Services cover government activities, communications, transportation, finance, and all other private economic activities that do not produce material goods.

Economic expansion and development is a key target for most emerging countries to be fully developed nations. At the same time, economic expansion usually causes environmental degradation. Hence, the implementation of appropriate policies regarding halt environmental degradation without harming economic development in the country is crucial for policymakers. Long-run findings suggest that CO2 emission from electricity and heat production are significantly associated with economic development in Indonesia. While, CO2 emission from other sectors, excluding residential buildings and commercial and public services, is statistically unrelated to the economic growth in the country. Obviously, any reduction in CO2 emission from electricity and heat production will harm economic expansion. Thus, any control towards CO2 emission must suitably be implied, and appropriate policies may be favored to efficient energy consumption. Moreover, a reduction in CO2 emission from electricity and heat production may reduce pollution as well as it does not harm economic growth in Indonesia. The oil and gas sector remains the driving force of the Indonesia economy.

The energy supply in Indonesia is mainly based on fossil fuels like oil, gas, and carbon. In 2015, 41% of Indonesian energy consumption was based on oil, 24% on natural gas and, 29% on coal. Renewable energy, particularly hydro and geothermal have a share of 6%, but statistics do not cover the traditional use of biomass as energy for cooking, lighting and process heat in rural areas, which is estimated to comprise 21% up to 29% of the total energy demand. In the past, the prolonged price subsidies and the availability of oil resulted in low oil prices in Indonesia. Currently, the gasoline market has been opened for private players and the gasoline price for transportation is fluctuates adapting to changes in oil prices. Additionally, Indonesia has a hard time to produce 1 million barrels/month. Indonesia, the founding member of OPEC has left the organization in 2009 and is now importing larger quantities of oil. However, on the other hand, Indonesia is still a net exporter of natural gas. That is why the national utility State Electricity Enterprise or Perusahaan Listrik Negara (PLN) is switching power generation from expensive oil to gas and coal of which Indonesia has large reserves.

The total power generation in Indonesia is around 55 GW. Around 30 GW has been installed by the utility PLN. The remaining consists largely of captive power for the manufacturing industry. Diesel generators account for approximately 60 % of captive power capacity, while cogeneration plants provide approximately 25%. The share of 80% from the 30GW is coming from oil, gas, and coal, 18% from hydropower, and 2% from geothermal. However, hydro and geothermal power plants generate a higher share of the electricity as the capacity of the other plants is not fully used. Electricity makes around 10% of the total energy consumption. About 80% of the electricity is consumed in Java and Bali alone. In recent years the consumption of electricity has increased by 7 percent annually. It is calculated that for every 1 percent increase in GDP the energy demand increases by 1.6 percent until the year 2020. Indonesia has failed to meet this demand growth with adequate system investments which has resulted in increased frequency and duration of power outages which prove costly to local industries. These factors have sharply put the need for diversification of supplies into focus and Indonesia has an ambitious plan for renewable energy and in parallel are advancing plans for the use of nuclear energy (Energypedia, 2018)[3].

Indonesia has a comparatively low overall rate of electrification among the middle-income country. Figures and interpretations diverge, but as much as 20% of the population representing 50 million people does not have access to electricity. Around 50% of un-electrified people in Indonesia are actually living in (already) electrified areas and would need grid densification programs. The costs are estimated to be US$ 290 per connection. The other half is living in non-electrified villages, which are mostly found in remote rural areas. Such areas can either be targeted through grid extension or dedicated off-grid solutions.

[2] https://www.indexmundi.com/indonesia/gdp_composition_by_sector.html

[3] https://energypedia.info/wiki/Indonesia_Energy_Situation#Electricity_Situation

On January 31st, 2012 the Government of Indonesia (GoI) issued a Renewable Energy Feed-in Tariff (FiT) for biomass, biogas and municipal solid waste. The FiT guarantees access to the grid for renewable energy generators and obligation for national state utility company (PT. PLN) to purchase the renewable energy generated until capacity 10 MW. This policy expected to boost-up renewable energy development and further private sector involvement in the renewable energy sector in Indonesia. However, the new FiT not clearly mentioning the time period of the standard Power Purchase Agreement (PPA).

Indonesia government made a voluntary commitment to reduce the GHGs and pledges to reduce around 26 percent of Business as Usual emission in the year 2020 by unilateral finance and it could be increased to 41 percent with international finance supports. To reach this target, the energy sector must play a role at least by reducing greenhouse gasses emissions by 6% of the total emission reduction target.

The Indonesian Ministry of Energy and Mineral Resources (MEMR) has published an ESDM's law No. 38/2016. This regulation includes information on how a business can provide electricity to currently un-electrified regions through business area concessions and how it can receive electricity subsidies from the government. It, however, does not define how one can become an electricity provider.

Furthermore, about the Renewable energy power generation tariff, there are next MEMR decree No. 19/2015 (issued in July 2015), which set the FiT for renewable energy from mini-hydropower generation. Then the GoI issued a new decree in January 2017, MEMR decree No. 12/2017, which on this decree the tariff for new and renewable energy is not in the FiT form but based on 85 percent of the BPP (issued by PLN verified by MEMR), the new tariffs applied for electricity generated from solar energy, wind, hydropower, biomass, biogas, waste, and geothermal energy. Seem that with the new tariff there is still rejection but now arise from the private sector and investors who consider it an unattractive tariff. While instead, the GoI via MEMR believes that the new tariff still attractive to renewable energy investors, particularly in the 13 priority areas which having local BPP higher than the nation's.

GoI mentioned that the potential of renewable energy in those priority areas was very large, about 210 gigawatts will attract investment. Those areas namely, Aceh, North Sumatra, Riau, Bangka Belitung, West Kalimantan, South Kalimantan, East Kalimantan, North Sulawesi, South Sulawesi, West Nusa Tenggara, East Nusa Tenggara, Maluku, and Papua. The main challenge in those areas actually most sites are remote and have an underdeveloped PLN grid which raises additional project risk. GoI optimism that with the role and participation of the private sector/investors the targets of 23% energy mix in 2025 will be realistically achieved, this is the very ambitious renewable energy targets.

V. CONCLUSION

This paper examines whether the EKC hypothesis holds in the case of Indonesia or not. The CO2 emission from different sources, such as from transport; other sectors, excluding residential buildings and commercial and public services; manufacturing industries and construction; electricity and heat production; and residential buildings and commercial and public services, are separately used to show robust evidence. The study adopts a time series analysis for the period from 1981 to 2016. The ARDL bound test approach is employed since it is more appropriate for small sample size and applicable if there are some variables I(0) and others are I(1). The results reveal that CO2 emission from all sources implemented in this study fails to show any evidence of the EKC hypothesis. These findings indicate that the hypothesis of EKC does not exist in the case of Indonesia. However, the long-run models show that economic growth appears to have a positive significant impact on CO2 emission, especially from electricity and heat production.

The findings draw some serious policy implications, especially on energy consumption, that need to be addressed by the government of the country. Applicable policies that aim to efficient energy consumption, control CO2 emission and reduce environmental degradation must immediately be implemented. In addition, clean energies include wind and solar energy to reduce CO2 emission from electricity and heat production can be considered as alternative sources of energy in the country. The ongoing policy of the pollution treatment of Indonesia is working, but the question is how it is working? Perhaps to slow.

REFERENCE

Akbostanci, E., Turut-As¸ ik, S., & Tunc, G. I. (2009). The relationship between income and environment in Turkey: Is there an environmental Kuznets curve? *Energy Policy*, 37, 861–867.

Al-Mulali, U., Saboori, B., Ozturk, I. (2015). Investigating the environmental Kuznets curve hypothesis in Vietnam. *Energy Policy*, 76, 123-131.

Ang, J.B. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling*, 30(2), 271-278.

Apergis, N., Payne, J. E. (2010). The emissions, energy consumption, and growth nexus: Evidence from the commonwealth of independent states. *Energy Policy*, 38, 650–655.

Azomahou, T., Laisney, F., & Van, P.N. (2006). Economic development and CO2 emissions: A nonparametric panel approach. *Journal of Public Economics*, 90(6), 1347-1363.

Basri F, Munandar, H. (2009). *Lanskap Ekonomi Indonesia: Kajian dan Renungan terhadap Masalah-Masalah Struktural, Transformasi Baru,* *dan prospek Perekonomian Indonesia*. Jakarta: Kencana.

Chang, C. (2010). A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. *Applied Energy*, 87, 3533–3537.

Cole, M.A., Rayner, A.J., & Bates, J.M. (1997). The environmental Kuznets curve: An empirical analysis. *Environment and Development Economics*, 2(4), 401-416.

Coondoo, D., Dinda, S. (2002). Causality between income and emission: A country Group specifi c econometric analysis. *Ecological Economics*, 40, 351–367.

Day, K.M., Grafton, R.Q. (2003). Growth and the environment in Canada: An empirical analysis. *Canadian Journal of Agricultural Economics/ Revue Canadienne d'Agroeconomie*, 51(2), 197-216.

De Bruyn, S.M., van den Bergh, J.C.J., & Opschoor, J.B. (1998). Economic growth and emissions: Reconsidering the empirical basis of environmental Kuznets curves. *Ecological Economics*, 25(2), 161-175.

Dickey, D. A., Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49, 1057–1072.

Du, L., Wei, C., Cai, S. (2012). Economic development and carbon dioxide emissions in China: Provincial panel data analysis. *China Economic Review*, 23(2), 371-384.

Fodha, M., Zaghdoud, O. (2010). Economic growth and environmental degradation in Tunisia: An empirical analysis of the environmental Kuznets curve. *Energy Policy*, 38, 1150–1156.

Friedl, B., Getzner, M. (2003). Determinants of CO2 emissions in a small open economy. *Ecological Economics*, 45(1), 133-148.

Galeotti, M., Lanza, A. (1999). Richer and cleaner? A study on carbon dioxide emissions in developing countries. *Energy Policy*, 27(10), 565-573.

Giorgetti, Annabelle. (2007). *A Discussion on Cecoupling Economic Growth from the Emissions of Carbon Dioxide* (Environment Waikato Technical Report 2007/02). Retrieved from: http://www.waikatoregion.govt.nz/PageFiles/6131/tr07-02.pdf, 2007).

Grossman, G.M., Helpman, E. (1991), Trade, knowledge spillovers, and growth. European Economic Review, 35(2-3), 517-526. Retrieved from: http://www.dx.doi.org/10.1016/0014-2921(91)90153-A

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumtion, income and foreign trade in Turkey. Energy Policy, 37, 1156-1164. Retrieved from : https://doi.org/10.1016/j.enpol.2008.11.012

Imansyah, M. Handry et. al. (2013). The Key Sectors in CO2 Emission in Indonesia: Input Output Analysis. *Jurnal Ilmu Administrasi dan Organisasi*, January 2013. Retrieved from : http://journal.ui.ac.id/index.php/jbb/article/viewFile/1867/1462.

Jalil, A., Mahmud, S.F. (2009). Environment Kuznets curve for CO2 emissions: A cointegration analysis for China. *Energy Policy*, 37(12), 5167-5172.

Johansen, S., Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration - with applications to the demand for money, *Oxford Bulletin Economics Statistics*, 52(2), 169-210. DOI: 10.1111/j.1468-0084.1990.mp52002003.x.

Kanjilal, K., Ghosh, S. (2013). Environmental Kuznet's curve for India: Evidence from tests for cointegration with unknown structural breaks. *Energy Policy*, 56, 509-515. Retrieved from : https://doi.org/10.1016/j.enpol.2013.01.015

Kusumawardani, D. (2009). Emisi CO2 dari Penggunaan Energi di Indonesia: Perbandingan Antar Sektor. *Jurnal Ekonomi dan Bisnis*, Vol. 8, No. 3 (Desember).

Lau, L., Choong, C., Eng, Y. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: Do foreign direct investment and trade matter? *Energy Policy*, 68, 490-497.

Lise, W. (2006). Decomposition of CO2 emissions over 1980–2003 in Turkey. *Energy Policy*, 34, 1841–1852.

Menyah, K., Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. *Energy Economics*, 32, 1374–1382.

Narayan, P. K., Popp, S. (2012). The energy consumption-real GDP nexus revisited: Empirical evidence from 93 countries. *Economic Modeling*, 29, 303–308.

Niu, S., Ding, Y., Niu, Y., Li, Y., & Luo, G. (2011). Economic growth, energy conservation and emissions reduction: A comparative analysis based on panel data for 8 Asian-Pacific countries. *Energy Policy*, 39, 2121–2131.

Osabuohien, E.S., Efobi, U.R., Gitau, C.M.W. (2014). Beyond the environmental Kuznets curve in Africa: Evidence from panel cointegration. *Journal of Environmental Policy & Planning*, 16(4), 517-538.

Ozturk, I., Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. *Renewable and Sustainable Energy Reviews*, 14(9), 3220-3225.

Ozturk, I., Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. *Renewable and Sustainable Energy Reviews*, 14(9), 3220-3225.

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

Pao, H., Tsai, C. (2011). Modeling and forecasting the CO2emissions, energy consumption, and economic growth in Brazil. *Energy*, 36, 2450–2458.

Pesaran, M. H., Shin, Y. (1999).An autoregressive distributed lag modelling approach to cointegration analysis, in Strom, S. (Ed.), paper presented at *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium,* Cambridge University Press, Cambridge.

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.

Phillips, P. C. B., Perron, P. (1988). Testing for a unit root in time series regression. *Biometrica*, 75, 335–446.

Richmond, A. K., & Kaufmann, R. K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Ecological Economics*, 56, 176–189.

Roberts, J.T., Grimes, P.E. (1997). Carbon intensity and economic development 1962-1991: A brief exploration of the environmental Kuznets curve. *World Development*, 25(2), 191-198.

Roca, J., Padilla, E., Farré, M., & Galletto, V. (2001). Economic growth and atmospheric pollution in Spain: Discussing the environmental Kuznets curve hypothesis. *Ecological Economics*, 39(1), 85-99.

Saboori, B., Sulaiman, J., & Mohammed, S. (2012). Economic growth and CO2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve. *Energy Policy*, 51, 184-191.

Schmalensee, et al. (1998). An interim evaluation of sulfur dioxide emissions trading. *The Journal of Economic Perspectives*, 12, 53-68.

Shafik, N. (1994). Economic development and environmental quality: An econometric analysis. *Oxford Economic Papers*. p757-773.

Shafik, N., Bandyopadhyay, S. (1992). Economic Growth and Environmental Quality: Time-Series and Cross-Country Evidence. Washington, D.C: World Bank Publications.

Shahbaz, M., (2012). *Multivariate–based Granger causality between financial deepening and poverty: The case of Pakistan.* Paper presented, 13th Annual Research Conference on “Population Wellbeing: A Development Imperative” was held at Institute of Business Administration (IBA), Karachi (Pakistan).

Shahbaz, M., Ozturk, I., Afza, T., Ali, A. (2013). Revisiting the environmental Kuznets curve in a global economy. *Renewable and Sustainable Energy Reviews*, 25(2013), 494-502.

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

Stern, D.I., Common, M.S., Barbier, E.B. (1996). Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development. *World Development*, 24(7), 1151-1160.

Tiwari, A.K., Shahbaz, M., Hye, Q.M.A. (2013). The environmental Kuznets curve and the role of coal consumption in India: Cointegration and causality analysis in an open economy. *Renewable and Sustainable Energy Reviews*, 18, 519-527.

Uddin, G. S., Shahbaz, M., Arouri, M. E., & Teulon, F. (2013). Financial Development and poverty Reduction Nexus: A Cointegration and Causality Analysis in Bangladesh. *MPRA Paper No. 49264.*

Zamula, I., Kireitseva, A. (2013). Environmental Liabilities Arising from the Transactions with Atmospheric Air as an Accounting Object, Economics and Sociology, Vol. 6, No 2, pp. 190-200. DOI: 10.14254/2071-789X.2013/6- 2/17.