The environmental Kuznets curve in Indonesia: Exploring the potential of renewable energy

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ABSTRACT

There is an increasing interest in investigating the environmental Kuznets curve (EKC) hypothesis because it suggests the existence of a turning point in the economy that will lead to a sustainable development path. Although many studies have focused on the EKC, only a few empirical studies have focused on analyzing the EKC with specific reference to Indonesia, and none of them have examined the potential of renewable energy sources within the EKC framework. This study attempts to estimate the EKC in the case of Indonesia for the period of 1971-2010 by considering the role of renewable energy in electricity production, using the autoregressive distributed lag (ARDL) approach to cointegration as the estimation method. We found an inverted U-shaped EKC relationship between economic growth and CO_2 emissions in the long run. The estimated turning point was found to be 7,729 USD per capita, which lies outside of our sample period. The beneficial impacts of renewable energy on CO_2 emission reduction are observable both in the short run and in the long run. Our work has important implications both for policymakers and for the future development of renewable energy in Indonesia.

Keywords: Renewable energy; environmental Kuznets curve; Cointegration

1. Introduction

The quest for higher economic growth cannot be detached from the issue of energy security and environmental deterioration. On the one hand, serves as an essential input for economic activity, but on the other hand, extensive use of energy exerts greater pressure on the environment, either due to by-product pollutants or depletion of natural resources. In the context of sustainability, economic development should be achieved while making efforts to preserve the environment so that its utility for future generations is maintained. The environmental Kuznets curve (EKC) hypothesizes that instead of being harmful to the environment, economic development is favorable for improving environmental indicators that will eventually lead to a sustainable development path. The EKC hypothesis posits that the relationship between economic growth and environmental degradation follows an inverted U-shaped curve. It suggests that after exceeding a certain level of gross domestic product (GDP) per capita, the increasing trend of environmental degradation reverses so that higher GDP per capita leads to environmental recovery that reverses the environmental damage incurred at the initial stages of economic development.

The strong links between economic development, energy consumption, and environmental quality render the empirical evidence of the EKC hypothesis largely significant, particularly for a developing country such as Indonesia, which is currently striving to boost its economy. Over the last decade, Indonesia's economy grew rapidly at an annual average rate of 5.4 percent per year. This was followed by an increasing amount of total energy supply to approximately 1,525 million barrel of oil equivalents (BOE) in 2013 from 1,111 million BOE in 2000, with an annual average growth rate of 2.5 percent. Accordingly, the total emissions of carbon dioxide (CO_2) from fossil fuel combustion also showed an upward trend with a slightly faster average growth rate of 3.9 percent per year, amounting to 424.6 million tons CO_2-equivalent in 2013 from 258.3 million tons

CO_2-equivalent in 2000. More than 38 percent of that combustion resulted from electricity generation (IEA, 2015). This has created serious environmental problems, including the threat of climate change. A series of energy- and environment-related policies have been introduced by the Government of Indonesia (GoI) as countermeasures to mitigate the environmental impacts of greenhouse gas (GHG) emissions. Therefore, the empirical evidence of the EKC will depict the efficacy of those policies in promoting green growth and harnessing a sustainable development path.

Numerous studies have been carried out to investigate the existence of the EKC hypothesis with respect to CO_2, both for developed and developing countries. However, most of them rely on cross-country panel data analysis, portraying only general inferences of the EKC hypothesis that tend to disregard both the distinctive complexity of economic environments and the historical experience of individual countries (Ang, 2008; Lindmark, 2002; Stern et al., 1996). These studies underline the need for a country-specific CO_2 EKC study that provides the in-depth analysis that is required for framing effective energy and environmental policies for each country. Therefore, this paper aims to find empirical evidence of the EKC hypothesis for CO_2 in the context of Indonesia by examining the relationship between economic growth and environmental degradation using the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). Additionally, the high correlation between economic development, energy consumption, and environmental quality encourage us to study the EKC within this framework. Therefore, we also seek to study the potential of renewable energy sources in improving environmental quality and initiating the EKC pattern.

The rest of this paper is organized as follows. Section 2 describes Indonesia's pattern of energy consumption. Section 3 briefly explains the literature related to the EKC hypothesis.

Section 4 outlines the research methodology and data. Section 5 presents the main findings and analysis of the results. Section 6 presents the conclusions and its policy implications.

3. Literature review

Although technological progress has led to new discoveries that prevent the exhaustion of nonrenewable resources, environmental issues remain a major problem (Kaika and Zervas, 2013a). This has caused a marked shift in global development issues, from limit to growth, which primarily focused on the scarcity of natural resources, to sustainable development issues, which are concerned about the environmental impact of economic development (Ekins, 1993). In the early 1990s, the concept of the EKC hypothesis has emerged as a promising theory that will lead to sustainability. It began with the study of Grossman and Krueger (1991) finding an inverted U-shaped relationship between pollutants and income per capita. The fundamental idea of the EKC can be found later in the study of Beckerman (1992), who claims that environmental problems are strongly associated with poverty and that the most feasible way to address them is to become rich. Panayotou (1993) argues that environmental degradation occurring in the initial stage of economic development is, without a doubt, inevitable. However, after reaching a certain level of income, further economic development will ameliorate the damage and eventually lead to improved environmental indicators. He also introduced the term EKC for the first time to differentiate this hypothesis from the famous Simon Kuznets hypothesis about the inverted U-shaped relationship between income inequality and economic development. These studies have laid noteworthy foundations for the development of the EKC hypothesis, which was followed by subsequent influential studies such as Grossman and Krueger (1994), Selden and Song (1994), List and Gallet (1999) and Dinda (2004).

The rationale of the EKC hypothesis is comprehensively explained by Grossman and Krueger (1991). They differentiate the impacts of economic growth on environmental quality into three effects: scale effect, composition effect, and technique effect. At the initial stage of development, the increasing level of pollution is inevitable because of the acceleration of economic development and the extensive extraction of natural resources that exceed those resources' regeneration rates (Panayotou, 1993). This process is marked by a structural change in the economy from agricultural to industrial. At this stage, economic growth undergoes a scale effect that has negative impacts on the environment and is responsible for the upward trend of the EKC. However, after reaching a certain level of income, this trend might reverse. As income increase, the economy undergoes a structural transformation from a resource-intensive economy to a service- and knowledge-based, technology-intensive economy (Dinda, 2004). This stage is referred to as the composition effect, leading to development of cleaner industries and having positive impacts on the environment. Finally, economic growth also has positive impacts on the environment through the technique effect. A significant improvement in environmental quality is achieved from technological progress and the adoption of new technologies that tend to be both cleaner and more efficient (Dinda, 2004). However, this process requires adequate R&D investments, which become affordable after a certain economic stage (Kaika and Zervas, 2013a). The combination of these three effects, which correspond to various stages of economic development, might result in an inverted U-shaped relationship between economic growth and environmental quality. The positive impact of the composition and technique effects on the environment will compensate for the damages caused by scale effect, resulting in a downward EKC trend (Dinda, 2004).

Panayotou (1993) argues that the EKC pattern is not solely determined by advancement in technology; it is also induced by the increasing degree of environmental awareness and a higher share of environmental protection expenditures. He believes that as income grows, people's willingness to pay for environmental abatement will also increase, along with their growing awareness of the need to improve environmental quality. Kumar et al. (2012) and Managi and Okimoto (2013) find that people's attitude toward the environment can also be influenced by incidental events such as a surge in oil prices. They show a positive relationship between oil prices and clean energy firms' stock prices, suggesting that consumer preferences for clean energy and technology increase as oil prices increase. Additionally, Panayotou (1993) argues that higher income leads to more stringent environmental regulations, which are essential for improving environmental quality. Dasgupta et al. (2001) supports his argument by showing a positive correlation between per-capita income and the stringency of environmental regulations. Similarly, Yin et al. (2015) show the significant role of environmental regulation in initiating EKC patterns.

The EKC hypothesis is an enticing view that suggests the existence of a turning point, subsequent to which the environmental benefits of economic growth will be achieved. Thus, based on this hypothesis, economic growth will improve both living standards and environmental quality, eventually leading to sustainability. However, this hypothesis has limitations that are worth mentioning. First, the estimated turning point of the EKC might occur at a very high level of income. As a result, for some countries, the positive effects of economic growth on environmental quality are impossible to achieve (List and Gallet, 1999). EKC opponents further argue that this turning point may go even higher because industrial societies continuously create new pollutants that will prevent the curve from declining (Dasgupta et al., 2002). In contrast, EKC proponents are optimistic that the turning point is actually shifting to the left, resulting in a more reasonable turning point. They suggest that the level of pollution starts to decline earlier, at a lower income level, along with economic growth (Dasgupta et al., 2002). Second, the EKC hypothesis does not apply to all types of pollutants, which have varied environmental impacts. The EKC patterns are more likely to be observable for pollutants that have both a local impact on the environment and a perceptible impact in the short term (Dinda, 2004; Kaika and Zervas, 2013b; Stern, 2004; Tsurumi and Managi, 2010a). For instance, air and water quality has been found to have EKC patterns with varying turning points for different types of pollutants (Grossman and Krueger, 1994). Similarly, Selden and Song (1994) find an inverted U-shaped relationship between air pollution and economic development. Specifically, the evidence for the EKC hypothesis can also be found for air pollutants, such as SO_2 and NO_x (Kumar and Managi, 2010; List and Gallet, 1999), and pesticide use (Managi, 2006). Nevertheless, in the case of global pollutants such as CO_2, which is considered the major GHG emission that cause global climate change, the result remains inconclusive.

In most cases, the EKC pattern for CO_2 emissions is rarely observed (for a summary of previous empirical studies of the CO_2 EKC, see, for instance, Kaika and Zervas (2013a)). This is likely attributable to the high correlation between energy consumption, economic growth and CO_2 emissions. Higher economic growth requires higher energy consumption, leading to higher CO_2 emissions (Ang, 2007; Apergis et al., 2010). Furthermore, Sun (1999) argues that the CO_2 EKC does not reflect a turning point at which environmental quality will start to improve, but it is just showing the peak of energy intensity. Thus, the EKC pattern for CO_2 emissions can only be found in countries that have reached peak energy intensity. Additionally, Tsurumi and Managi (2010b) show that the reduction of CO_2 emissions intensity can only be achieved through a structural change in CO_2 emissions, i.e., reducing the share of coal in energy production. This implies that emissions reduction requires more than just a higher income level for improving environmental quality and initiating the EKC pattern for CO_2 emissions.

Two well-known approaches have been widely used for investigating the EKC. The first relies on cross-country panel data analysis (see, for instance, Arouri et al., 2012; Jaunky, 2011; Narayan and Narayan, 2010; Narayan et al., 2016; Richmond and Kaufmann, 2006; Tsurumi and Managi, 2010a; Yang et al., 2015), whereas the other one relies on a single region time-series analysis (see, for instance, Al-Mulali et al., 2015; Bölük and Mert, 2015; Iwata et al., 2010; Saboori and Sulaiman, 2013; Saboori et al., 2012a; Saboori et al., 2012b; Tutulmaz, 2015). In addition to the aforementioned methods, Halkos and Tsionas (2001) propose a cross-sectional data analysis by using the Markov chain Monte Carlo (MCMC) method to empirically find the existence of EKC by using switching regime models. However, this analysis is less preferable because it does not capture the dynamics of the income – environment relationship over a period of time. Cross-country panel data analysis indeed offers a more robust econometrical analysis. However, it portrays only the general inference of the EKC hypothesis, which might not be applicable to a specific region or country. For instance, Jaunky (2011) finds a positive correlation between income and CO_2 emissions both in the short and in the long run for panel of 36 high-income countries from 1980 to 2005, but based on a country-specific analysis, he provides evidence of an EKC only for 5 countries, including Greece, Malta, Oman, Portugal and the United Kingdom. Thus, to frame an effective energy- and environmental-related policy for a specific country, a time-series analysis approach is preferable. Such an analysis provides an in-depth examination based on the complexity of the economic environments and historical experiences of each country (Ang, 2008; Lindmark, 2002; Stern et al., 1996). However, it requires a reliable dataset for a relatively long time period, which might be difficult to obtain, particularly for developing countries.

From an empirical perspective, most of the EKC literature (see, for instance, Bölük and Mert, 2015; Iwata et al., 2010; Kaika and Zervas, 2013a; Saboori and Sulaiman, 2013; Saboori et al., 2012a; Saboori et al., 2012b; Tutulmaz, 2015) tests the validity of the EKC hypothesis by employing squared or cubic functional forms of income—environmental quality models to estimate the range of possible turning points of the EKC in the economy, beyond which the environmental benefits of economic growth are likely to be achieved. Some of the estimated turning points are implausible because they lie outside the sample and cannot be achieved. Bernard et al. (2015) further suggest a parametric inference method that corrects for potential weak-identification of the turning point. However, Narayan and Narayan (2010) argue that such models are prone to problems of collinearity or multicollinearity because the models contain both income and square of income as exogenous variables. To avoid these problems, they suggest an alternative approach to evaluate the environmental impacts of economic growth by comparing the short- and long-run income elasticities of a linear model of income—environmental quality. They argue that the benefits of economic growth for mitigating CO_2 emissions will be achieved if long-run income elasticity is smaller than short-run income elasticity. Furthermore, Jaunky (2011) and Al-Mulali et al. (2015) argue that lower long-run income elasticity is not a strong indication of the EKC. However, an EKC-type relationship appears if the long-run income elasticity is negative, indicating that higher economic growth leads to improved environmental quality.

This paper's first objective is to find empirical evidence of the EKC hypothesis for CO_2 with specific reference to Indonesia by employing the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). There are several compelling reasons for choosing Indonesia as the subject of our research. With one of the largest economies in Asia, Indonesia has experienced outstanding economic growth, followed by a significant increase in energy consumption and CO_2 emissions from fossil fuel combustion over the past decade. Additionally, despite its huge potential for renewable energy, Indonesia's energy mix remains dominated by fossil fuels. Therefore, our second objective is to study the role of renewable energy sources in improving environmental quality and initiating the EKC pattern. To the best of our knowledge, only a few empirical studies have focused on analyzing CO_2 EKC specifically for Indonesia, and none of them have examined the potential of renewable energy sources within the EKC framework. One such study is conducted by Saboori et al. (2012b), who analyze the CO_2 EKC for Indonesia from 1971-2007 by incorporating foreign trade and energy consumption. They find a U-shaped relationship between income and environmental degradation, denying the existence of the EKC hypothesis. However, their findings might be misleading because they are using the critical values (CVs) reported in Pesaran et al. (2001), which according to Narayan (2005), are not applicable for small sample size. To accommodate the relatively small sample size in this study (40 observations), we use the CVs reported in Narayan (2005) for testing the cointegration between variables.

2. Indonesia's energy profile

Energy is an essential input for economic and social development. However, Indonesia's energy sector faces challenges in the context of sustainable development. First, despite its huge renewable-energy potential, Indonesia's energy sector is heavily dependent on fossil fuels. In 2014, Indonesia's total consumption of fossil fuels amounted to 1,358 million BOE, accounting for approximately 96 percent of total primary energy consumption (NEC, 2015). From Figure 1, we can see that oil was the main contributor of Indonesia’s energy mix by 48 percent, followed by coal and gas. Regardless of its dominance over other energy sources, the share of oil in the national energy mix shows a decreasing trend. With an average growth rate of 9.9 percent per year, coal has managed to gradually reduce the share of oil in the national energy mix, which has grown at a slower average rate of 1.9 percent per year in the past decade (BPPT, 2014). Similarly, a high dependency on fossil fuels is found in the electricity sector. In 2014, total electricity generation was approximately 288 TWh, 88 percent of which was generated from fossil fuels, with coal accounting for approximately 52.8 percent of the total figure (Figure 2) (NEC, 2015). To increase the electrification rate to 100 percent by 2020 and to ensure the security of the energy supply, which is required for supporting economic development, the GoI has launched the Electricity Fast Track program to boost the electricity generation capacity. Under that program, the GoI is accelerating the construction of new power plants with a total capacity of 20 GW. Whereas the first phase of the program relies completely on coal-fired power plant, the second phase of the program encourages the use of renewable energy for electricity generation (BPPT, 2014; NEC, 2015). Upon completion of the first phase of the program, the share of coal in the national energy mix is expected to increase further. Second, Indonesia’s energy sector is highly subsidized to ensure the availability and accessibility of energy for all levels of the community. In 2014, the government allocated more than 25 billion USD for energy subsidies, approximately 26 percent of which was allotted for electricity (NEC, 2015). This high subsidy level has imposed a great financial burden for Indonesia’s state budget (APBN). Additionally, it has caused inefficient consumption of energy and discouraged the development of new and renewable energy (NRE) (NEC, 2014). Third, Indonesia is currently experiencing a wide range of environmental problems including threats of climate change that are likely caused by rapid economic growth and the extensive use of natural resources, particularly fossil-fuel combustion. The World Bank predicted that the economic loss attributed to climate change in Indonesia is estimated to reach 2.5-7.0 percent of GDP by 2100. Meanwhile, the health impact of air pollution can cost more than $400 million per year (Leitmann, 2009).

<Figure 1>

<Figure 2>

Indonesia has huge potential for renewable energy, including geothermal, hydropower, biomass, wind, and solar. However, it is unlikely that renewable energy alone will displace the major contribution of fossil fuels in the national energy mix in the near future because their utilization remains far beyond their maximum capacity because of either technical or economic constraints. With a total estimated technical potential of more than 273 GW (excluding the potential of ocean energy), only approximately 4 percent of renewable energy technologies have been utilized. Hydropower is the highest potential source of renewable energy with an estimated capacity of 75 GW, but it is currently underutilized because it has a total installed capacity of only 11 percent of its total potential, amounting to some 8,111 MW (NEC, 2015). With an estimated potential capacity of approximately 32 GW, biomass has become the second-largest renewable energy resource available, only approximately 5 percent of which has been utilized for electricity generation (NEC, 2015). Due to its geographical position on the equator and located in the ring of fire, Indonesia is blessed with an enormous potential for geothermal and solar energy. The potential of geothermal energy is estimated to be more than 28 GW, accounting for 40 percent of the world's potential geothermal resource (Hasan et al., 2012), less than 5 percent of which has been utilized (NEC, 2015). Additionally, notwithstanding its geographical advantages as an equatorial country, Indonesia's utilization of solar energy in Indonesia is relatively small. With an average solar radiation of 4.8 kWh/m^2/day, only approximately 71 MW of solar energy systems have been installed (NEC, 2015). In contrast, the potential for wind energy in Indonesia is rather low, with low wind speeds ranging from 3-6 m/s (NEC, 2015).

The GoI's commitment to mitigating climate change is stipulated in Presidential Regulation 61/2011 regarding the National Action Plan for GHG Emission Reduction. By 2020, GHG emissions are expected to be reduced by at least 26 percent, through Indonesia's own effort, or by at least 41 percent, with international support. This is followed by amending the national energy policy, which is regulated in Government Regulation 79/2014, to endorse the diversification of energy sources and gradually reduce Indonesia's high dependency on fossil fuels by developing NRE technologies that are economically competitive. By 2025, the share of NRE is expected to reach at least 23 percent of the total energy mix. This is expected to make a contribution of approximately 50 percent of total GHG emission reduction in 2035 (BPPT, 2014). Additionally, a series of feed-in tariff policies have been introduced to support the development of NRE, including geothermal and hydropower. The GoI has also attempted to increase efficiency in the energy sector by gradually reducing the amount of its energy subsidy and reallocating funds to make new investments in energy infrastructure.

4. Methodology

4.1. Econometric model and data

This paper uses a reduced-form model as a baseline estimation model to test the validity of the EKC hypothesis. This model allows us to measure the direct and indirect relationship between income and environmental quality without being distracted by additional variables that would distort this study's primary objective and lessen its degree of analytical freedom (see List and

Gallet, 1999). We also seek to study the potential of renewable energy sources in improving environmental quality and initiating the EKC pattern. Renewable energy sources are a foreseeable vehicle for reducing high dependency on fossil fuels while mitigating the environmental effects of GHG emissions from fossil fuel combustion. Thus, the share of renewable energy sources acts as a proxy for composition effect that captures the structural change in energy production toward a less polluting technology. Our baseline estimation model can be written as follows:

$$\ln C_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln {Y_t}^2 + \gamma \ln ER_t + u_t \qquad (1)$$

$$\ln C_t = \beta_0 + \beta_1 \ln Y_t + \gamma \ln ER_t + u_t \qquad (2)$$

where *C* is per capita CO_2 emissions; *Y* is per capita GDP; *ER* is per capita electricity production from renewable sources; and *u* is the standard error term.

Equation (1) is the conventional model for estimating the EKC, employing both income and square of income as exogenous variables. This model provides us with several possible functional forms of income – environmental quality relationships. When $\beta_1 = \beta_2 = 0$, this indicates a level relationship, implying no relationship between income and environmental quality. A linear relationship occurs if $\beta_2 = 0$ and $\beta_1 > 0$ for a monotonically increasing relationship or $\beta_1 < 0$ for a monotonically decreasing relationship. A quadratic relationship exists if $\beta_2 < 0$ for an inverted U (EKC) relationship, or $\beta_2 > 0$ for a U-shaped relationship. A turning point on the EKC at which economic growth is harmless for the environment exists if there is an inverted U-shaped relationship between income and environmental quality. Equation (2), however, is the alternative approach to evaluate the EKC relationships, as suggested by Narayan and Narayan (2010). In this model, the EKC relationship is evaluated by comparing the short- and long-run income elasticities. The benefits of economic growth for mitigating CO_2 emissions will be achieved if long-run income elasticity is smaller than short-run income elasticity. Additionally, the expected sign of γ is negative because renewable energy sources produce less CO_2 emissions than fossil fuels.

To avoid omitted variable bias, Equations (1) and (2) need to be expanded to include variables that capture scale effect and technique effect, and this paper uses the level of energy consumption and total factor productivity (TFP), respectively. Advancement in economy requires more energy as the main input in production. Consequently, a higher level of emissions will be generated as by-product of the process. Thus, energy consumption demonstrates the scale effect that has a negative impact on the environment. However, technical effect, which is indicated by technological progress and the adoption of new technologies, creates a positive impact on environment, either by increasing productivity and efficiency in production, or by reducing emissions per unit output (Stern, 2004). This paper uses TFP as a proxy for technical effect.

Annual data covering the period 1971-2010 are used in this study. CO_2 emissions (C) is measured in metric tons per capita. Per capita real GDP (Y) is in constant 2005 US dollars. Electricity production from renewable sources (ER) is measured in kWh per capita. Energy consumption is measured in kg of oil equivalent per capita. The abovementioned data are obtained from the World Bank, World Development Indicators 2015. In addition, we use the data on TFP, which are obtained from the Penn World Table (Feenstra et al., 2015).

4.2. ARDL bounds testing of cointegration

This paper utilizes the ARDL-bounds testing approach to cointegration developed by Pesaran et al. (2001) to examine the long-run relationship between income and environmental quality. This method has several advantages over other methods. First, the ARDL approach effectively corrects for the possible endogeneity of explanatory variables, thus providing unbiased estimates of the long-run model and valid t-statistics even when some of the regressors are endogenous. Second, the ARDL test is suitable even if the sample size is small, such as in our study, which uses 40 observations. Third, the ARDL method does not require all of the variables to be integrated in the same order. Therefore, it can be applied regardless of whether the underlying regressors are integrated in order one (*I(1)*), in order zero (*I(0)*) or fractionally. As a result, we can avoid the uncertainties created by unit root testing. Finally, this method can simultaneously estimate causal relationships both in the short-run and in the long-run.

The ARDL approach to cointegration estimates the following unrestricted error-correction (UREC) model:

$$\Delta \ln C_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln C_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{r} \beta_{3i} \Delta \ln (Y_{t-1})^2 + \sum_{i=0}^{s} \alpha_{4i} \Delta \ln ER_{t-i} \qquad (3)$$

$$+\lambda_1 \ln C_{t-1} + \lambda_2 \ln Y_{t-1} + \lambda_3 \Delta \ln (Y_{t-1})^2 + \lambda_4 \ln ER_{t-1} + \varepsilon_t$$

where β is the short-run coefficient and λ is the long-run multiplier of the underlying ARDL model. The tests for cointegration are carried out by computing the joint significance of the lagged levels of the variables using the F-test (or Wald statistic). The null hypothesis of no cointegration is defined by H_0: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ against the alternative hypothesis H_1: $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0$. The CVs for the F-statistic are non-standard under the null and were originally derived by Pesaran et al. (2001) and later modified by Narayan (2005) to accommodate small sample sizes. There are two sets of CVs. The first set assumes that all of the variables included in the ARDL model are *I(0)*, whereas the second set uses the assumption that the variables are *I(1)*. If the computed F-statistic exceeds the upper-bounds CVs, then the null hypothesis of no long-run relationship is rejected. If the computed F-statistic falls below the lower-bounds CVs, then the null hypothesis of no long-run relationship is not rejected. However, if the computed F-statistic falls between the lower- and upper-bound CVs, then no conclusion about long-run relationships can be drawn unless we know whether the series were *I(0)* or *I(1)* (Pesaran and Pesaran, 2010). In the presence of strong cointegration between variables, Neuhaus (2006) argues that the problems with multicollinearity can be disregarded.

Choosing the optimal lag order of the underlying UREC model is of primary importance. The lag order should be high enough to reduce the residual serial correlation problems. At the same time, however, it should be low enough that the conditional error-correction model is not subject to over-parameterization problems (Pesaran et al., 2001). This paper uses the Akaike Information Criterion (AIC) and Schwarz's Bayesian criterion (SBC) to select the optimal lag order of the model. The preferred model is the one that has the smallest value of AIC and SBC. However, these two methods might provide different lag structures for the ARDL model because AIC tends to select maximum relevant lag length, whereas SBC tends to select the smallest possible lag length, resulting in a somewhat parsimonious model. In such a case, we prefer to use the AIC information criteria to prevent the model from being under-fit, although there might be a risk of over-fitting the model.

Having found the evidence of cointegration, the long-run relationship between variables is then estimated using the following equation:

$$\ln C_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \ln C_{t-i} + \sum_{i=0}^{q} \beta_{2i} \ln Y_{t-i} + \sum_{i=0}^{r} \beta_{3i} \ln(Y_{t-1})^2 + \sum_{i=0}^{s} \beta_{4i} \ln ER_{t-i} + \varepsilon_t \qquad (4)$$

Next, the short-run interactions between variables are estimated by using the following error-correction model:

$$\Delta \ln C_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln C_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{r} \beta_{3i} \Delta \ln(Y_{t-1})^2 + \sum_{i=0}^{s} \beta_{4i} \Delta \ln ER_{t-i} \qquad (5)$$

$$+\pi \, ECT_{t-1} + \varepsilon_t$$

where π is the speed adjustment parameter and ECT_{t-1} is the error correction term with lag. The lagged error-correction term measures the speed of adjustment of the endogenous variable when there is a shock in equilibrium. The coefficient of the lagged error correction term is expected to be negative and statistically significant.

Post-estimation diagnostic tests such as serial correlation, normality, heteroskedasticity and functional form tests are conducted to ensure the robustness of the model. In addition, we also conduct the stability test, i.e., cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), to confirm the model's stability.

5. Results and discussion

Our evaluation starts with an examination of the integration properties of the variables by performing unit root tests. Although the bounds test approach does not require that all variables are *I(1)*, it is necessary to validate that none of the variables is integrated in order 2 (*I(2)*). This is because in the presence of the *I(2)* variable, the results of the F-test would be spurious. We use the augmented Dickey-Fuller (ADF), Kwiatkowski-Phillips-Schimdt-Shin (KPSS) and breakpoint unit root tests to test the stationarity of the data. In the ADF and breakpoint unit root tests, the null hypothesis of the series has a unit root that is tested against the alternative of stationarity. Conversely, the KPSS test has a null hypothesis of stationarity. The lag lengths of the ADF and breakpoint unit root test are selected based on the Schwarz Information Criterion. The bandwidth selection of the KPSS test is based on the Andrews method. The results of the unit root tests that are provided in Table 1 show that after taking the first difference, all of the variables were confirmed to be stationary. Therefore, we can conclude that all the variables used in this study are not *I(2)*.

<Table 1>

The next step is to examine the existence of a long-run relationship between variables by using Equation (3). We conduct the cointegration analysis for both linear and quadratic forms. In the first and second cases, we assume a linear form of the long-run relationship between environmental quality and income by controlling energy consumption and both energy consumption and TFP, respectively. In the third and fourth cases, we assume a quadratic relationship between those variables by controlling energy consumption and both energy consumption and TFP, respectively. Before we carry on with cointegration analysis, we need to determine the optimal lag length to be used in the ARDL model. For this purpose, we are using the AIC and SBC information criteria. Table 2 provides the top 5 models that minimize the AIC and SBC values by setting the maximum lag order at 4. From Table 2, we can see that the AIC and SBC suggest different model specifications, but we prefer to use the model that is suggested by AIC to avoid oversimplifying the model. Thus, we have ARDL (2,4,0,0) for Case I, ARDL (2,4,2,0,0) for Case II, ARDL (2,4,3,0,0) for Case III, and ARDL (2,0,4,2,0,0) for Case IV.

<Table 2>

By using the aforementioned ARDL model specifications, we calculate the joint significance of the long-run coefficient of the ARDL model in Equation (3). The results of the F-test are given in Table 3. From Table 3, we can see that for case I, the F-statistic exceeds the 10% upper bounds CVs, whereas for cases II, III and IV, the F-statistics exceed the 5% upper bounds CVs. Thus, we can reject the null hypothesis of no long-run relationship. After conforming that there is no evidence against cointegration, we estimate the long- and short-run interactions between variables by using Equations (4) and (5). The results of the long- and short-run estimations in the error correction representations are provided in Tables 4 and 5, respectively.

<Table 3>

<Table 4>

<Table 5>

For the linear model (case I and II), as seen in Tables 4 and 5, all of the variables are statistically significant and have the correct signs as expected, both in the long run and in the short run. The coefficients of ln Y and Δln Y are positive, implying that both in the long run and in the short run, higher income levels lead to higher CO_2 emissions. However, we find that in both cases, income leads to less carbon dioxide emission. In the long run, income elasticity decreased from 1.47 to 0.87 for case I and from 1.70 to 1.04 for case II. Our finding suggests that over time, economic growth contributes less to carbon dioxide emissions, implying that the environmental benefits of economic growth are likely to be achieved. Although Narayan and Narayan (2010) argue that the cutback in income elasticity over time, similar to the findings in our linear model, is consistent with the EKC hypothesis, Jaunky (2011) and Al-Mulali et al. (2015) argue that this argument is insufficient to support the EKC hypothesis. Our finding contradicts the earlier result from Narayan and Narayan (2010) showing higher long-run income elasticity for the case of Indonesia. This contradiction likely arose because Narayan and Narayan (2010) use a smaller sample size and a somewhat parsimonious model of income level and CO_2 emissions, disregarding the possible impacts of energy consumption and renewable energy sources on CO_2 emissions.

Another important finding from our model in case I is that the impact of electricity production from renewables on CO_2 emissions is negative both in the short run and in the long run, implying that the level of CO_2 emissions declines as the share of renewable energy increases.

This in line with the findings of Sulaiman et al. (2013) for the case of Malaysia and the findings of Bölük and Mert (2015) for the case of Turkey. The beneficial effects of renewable energy sources on environmental quality are likely to be achieved in the long run because its long-run coefficient is higher than its short-run coefficient. However, the long-run elasticity of renewable energy is considerably lower than that of energy consumption and economic growth. Thus, the beneficial effects of renewable energy sources might be obscured by the increasing level of CO_2 emissions caused by increasing economic activities and higher energy consumption. Chiu and Chang (2009) suggest a threshold point that must be attained for renewable energy to begin to have a favorable impact on environment. They argue that to make a noteworthy contribution to CO_2 emissions reduction, the share of renewable energy should be at least 8.4 percent of total energy supply. Currently, the share of renewable energy is only approximately 3.8 percent of Indonesia's total energy mix. However, if we only consider the electricity sector, which is responsible for more than 38 percent of CO_2 emissions, the share of renewable energy is more than 11 percent of total electricity generation, which is higher than the suggested threshold point of 8.4 percent. Therefore, the effect of electricity production from renewable energy sources on CO_2 emissions reduction should be observed, as explained by our model.

The positive coefficient of $\ln EC$ and $\Delta\ln EC$ imply that energy consumption positively influences the level of CO_2 emissions both in the long run and in the short run. This is not a surprising result: Indonesia's energy sector relies heavily on fossil fuels, accounting for approximately 96 percent of total primary energy consumption (NEC, 2015). This finding is consistent with that of Ang (2007) for the case of France and Saboori et al. (2012b) for the case of Indonesia. We also find that the elasticity of energy consumption in the long run is greater than elasticity in the short run, implying inefficiency in energy consumption. For case II, however, taking TFP into account in our model, we find only a slight increase in the elasticity of energy consumption in the long run. The negative and significant coefficient of TFP indicates that adopting a more efficient technology has beneficial effects on the environment, either by directly reducing the level of emissions or by increasing the efficiency of energy consumption. This finding supports Stern's (2004) argument, which proposes that a general increase in TFP has beneficial side effects for the environment through decreased emissions per unit of output.

We also attempt to evaluate the EKC-type relationship by using the traditional quadratic model (case III and IV). From Tables 4 and 5, we can see that, in general, the quadratic model provides similar results, particularly for the impacts of energy consumption, electricity production from renewables and TFP. Nevertheless, our findings on the impact of income level on level of CO_2 emissions show an interesting result. For case III, both in the short run and in the long run, the coefficients of ln Y and ln Y^2 are statistically not significant. There is a possibility that these variables fail to attain statistical significance because of the presence of multicollinearity, as advised by Narayan and Narayan (2010). However, by introducing variable *TFP* into our model (case IV) we find significant impacts of income level on CO_2 emissions in the long run. The negative and significant coefficient of ln Y^2 suggests an inverted U-shaped relationship between income level and CO_2 emissions, which is consistent with the EKC hypothesis. From the long-run estimates, the turning point is estimated to be $exp(\beta_1/|2\,\beta_2|) \cong 7{,}729$ USD per capita. The estimated turning point is relatively plausible, although it lies outside of the sample period (the highest value of GDP per capita in our sample is 1,570 USD). Several previous studies, such as Saboori and Sulaiman (2013) for the case of Malaysia and Bölük and Mert (2015) for the case of Turkey, have also reported EKC turning points that lie outside the observed sample period.

Additionally, Iwata et al. (2010) argue that for developing countries, there is a higher possibility that the EKC turning point will be found outside of the observed sample period.

From the short-run estimates in Table 5, we can see that the coefficients of the lagged error-correction term (ECT_{t-1}) in all cases are negative and statistically significant, as they should be. These results further establish the cointegration between variables. In addition, their absolute values are quite high, indicating a relatively high speed of adjustment in the presence of any shock to the equilibrium.

The post-diagnostic tests of our models are reported in Table 4. We find no evidence of serial correlation, non-normality and heteroskedasticity in all cases. However, we cannot reject the null hypothesis of no miss-specification of functional form in case II. This result suggests that the quadratic form of the EKC-type relationship given in case IV is preferable to that of the linear form, although the model is likely to suffer from the problems with multicollinearity. However, Asteriou and Hall (2015) argue that even in the presence of imperfect multicollinearity, the estimated coefficients remain unbiased. In addition, to test the stability of the estimated models, the CUSUM and CUSUMSQ tests were employed. The plots of both CUSUM and CUSUMSQ tests, which are given in Figure 3, are within the 5% critical bounds, indicating that the estimated parameters in all cases are stable over the periods.

<Figure 3>

6. Conclusions and policy implications

The objective of this paper was to estimate the EKC for the case of Indonesia by considering electricity production from renewable energy sources for the period of 1971-2010. To avoid omitted variable bias, we considered the level of energy consumption and TFP in our model to capture the scale and technique effect. We used both the linear and traditional quadratic model to test the EKC hypothesis. For this purpose, we applied the Autoregressive Distributed Lag (ARDL) bounds testing approach proposed by Pesaran et al. (2001). Given the relatively small sample size in our current study (40 observations), we adopted the critical values reported in Narayan (2005) for testing the cointegration between variables.

From the estimation results, we found evidence supporting the EKC hypothesis for the case of Indonesia. Although our linear form of the model showed a positive relationship between CO_2 emissions and income level, we found that long-run income elasticity has decreased over time, implying that environmental benefits of economic growth are likely to be achieved. However, this finding is not considered as a significant support for the EKC hypothesis. Our quadratic form of the model, on the other hand, showed strong evidence of the EKC hypothesis. The estimated turning point was found to be $exp(\beta_1/|2\,\beta_2|) \cong 7{,}729$ USD per capita, which lies outside our sample period. Electricity generation from renewable energy sources was found to have a significant and favorable impact on CO_2 emissions reduction both in the short run and in the long run. In contrast, energy consumption was associated with higher levels of CO_2 emissions both in the short run and in the long run. Finally, we also found that an increase in TFP leads to a decrease in CO_2 emissions both in the short run and in the long run.

Although suggesting new policies is beyond the scope of this paper, our findings highlight some important policy implications. First, evidence of the EKC hypothesis does not necessarily imply that environmental benefits from economic growth can be achieved without any policy enactment. The huge gap between current economic level and the estimated turning point indicate that the GoI should evaluate the efficacy of current energy and environmental policies to obtain an EKC that is lower and flatter than our estimated turning point would suggest.

Second, we found that the long-run impact of energy consumption on CO_2 emissions level is considerably higher than its short-run effect. Our finding indicates an inefficiency in energy consumption that leads to further environmental deterioration. Therefore, current energy and environmental policies must be accompanied by other possible strategies that will encourage more efficient energy use. For instance, the GoI's attempts to gradually decrease subsidies on fossil fuels and electricity should be maintained, though this might not be a popular policy. In exchange, the GoI should make new investments in energy infrastructures that will be beneficial not only for improving energy efficiency but also for stimulating economic development. Additionally, the GoI should provide incentives for encouraging the adoption of new technologies that are both cleaner and more efficient. Our finding showed that increasing productivity provides beneficial impacts for CO_2 emissions reduction, which in turn leads to the initiation of the EKC pattern.

Third, the favorable impacts of electricity production via renewable energies on CO_2 emissions reduction indicate that environmental sustainability might be achieved by increasing the share of renewable energies in the electricity generation mix. Our findings further emphasize the significant roles of NRE sources in promoting a sustainable development path, particularly in the context of the 2015 Paris agreement on climate change. Encouraging the development of NRE sources will be very beneficial not only for ensuring the security of the energy supply and reducing the high dependency on fossil fuels but also for supporting the GoI's commitment to reduce CO_2 emissions. This in turn will lead to a lower and flatter EKC than our estimated turning point would suggest. Therefore, instead of relying heavily on coal-fired power plants to boost Indonesia's current electricity generation capacity, the GoI should exert greater effort to explore the potential of NRE sources. However, there are some technical barriers, such as the intermittent nature of the output, that make it difficult for renewable energy sources alone to replace the dominant role of fossil fuels. Therefore, the GoI should consider backing up its renewable energy system with a reliable low-carbon technology, such as nuclear power, to form a tight energy coupling system that can produce renewable electricity on a large scale in a sustainable manner (Soentono and Aziz, 2008). However, the implementation of nuclear energy-related policies should be carried out cautiously. The decision-making process should be based on a comprehensive analysis highlighting not only the beneficial impacts of nuclear energy on CO_2 emissions reduction and energy security but also the potential risks that can arise from the utilization of nuclear energy.

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Figures

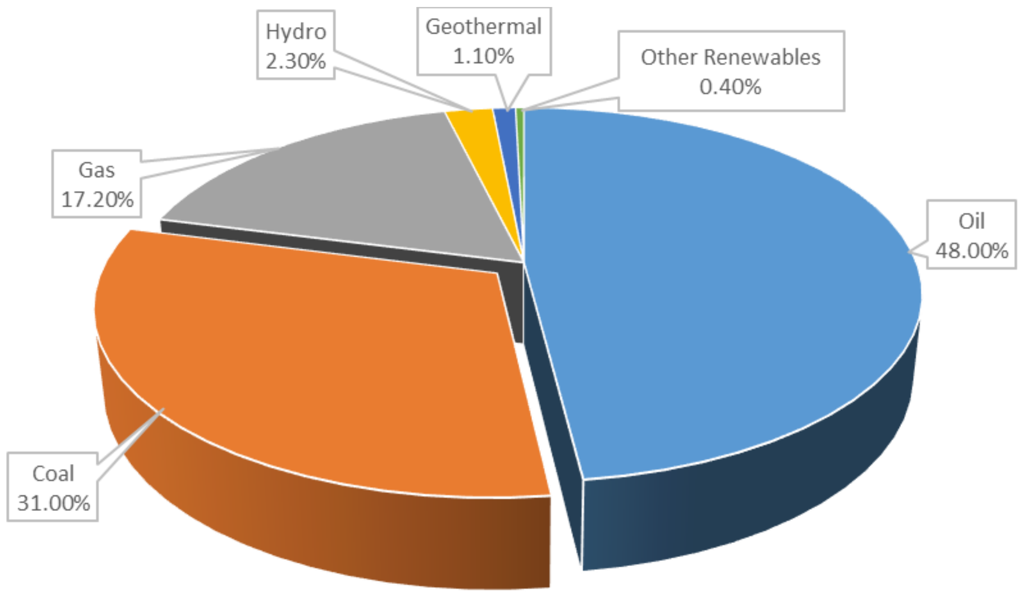

Figure 1. Indonesia's primary energy mix 2014

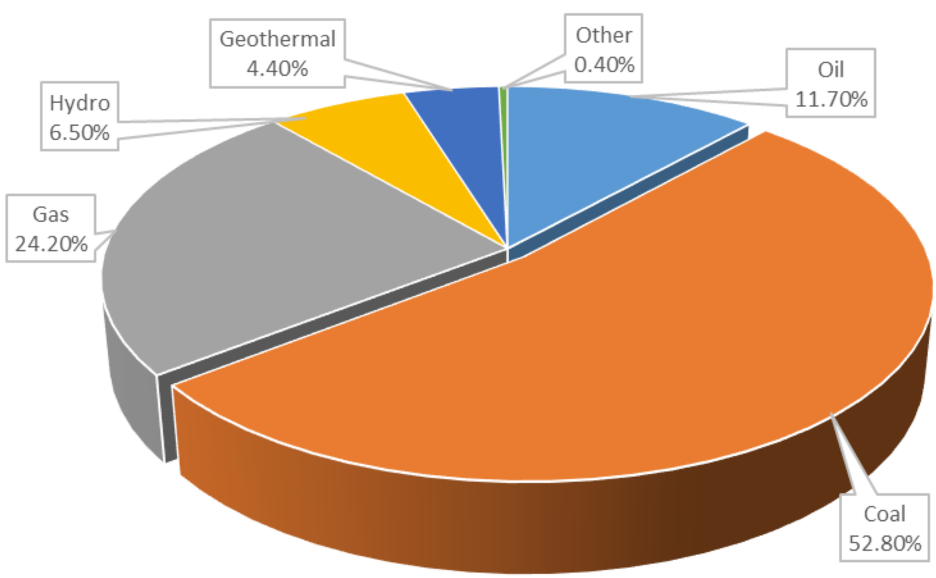

Figure 2. Indonesia's electricity generation mix 2014

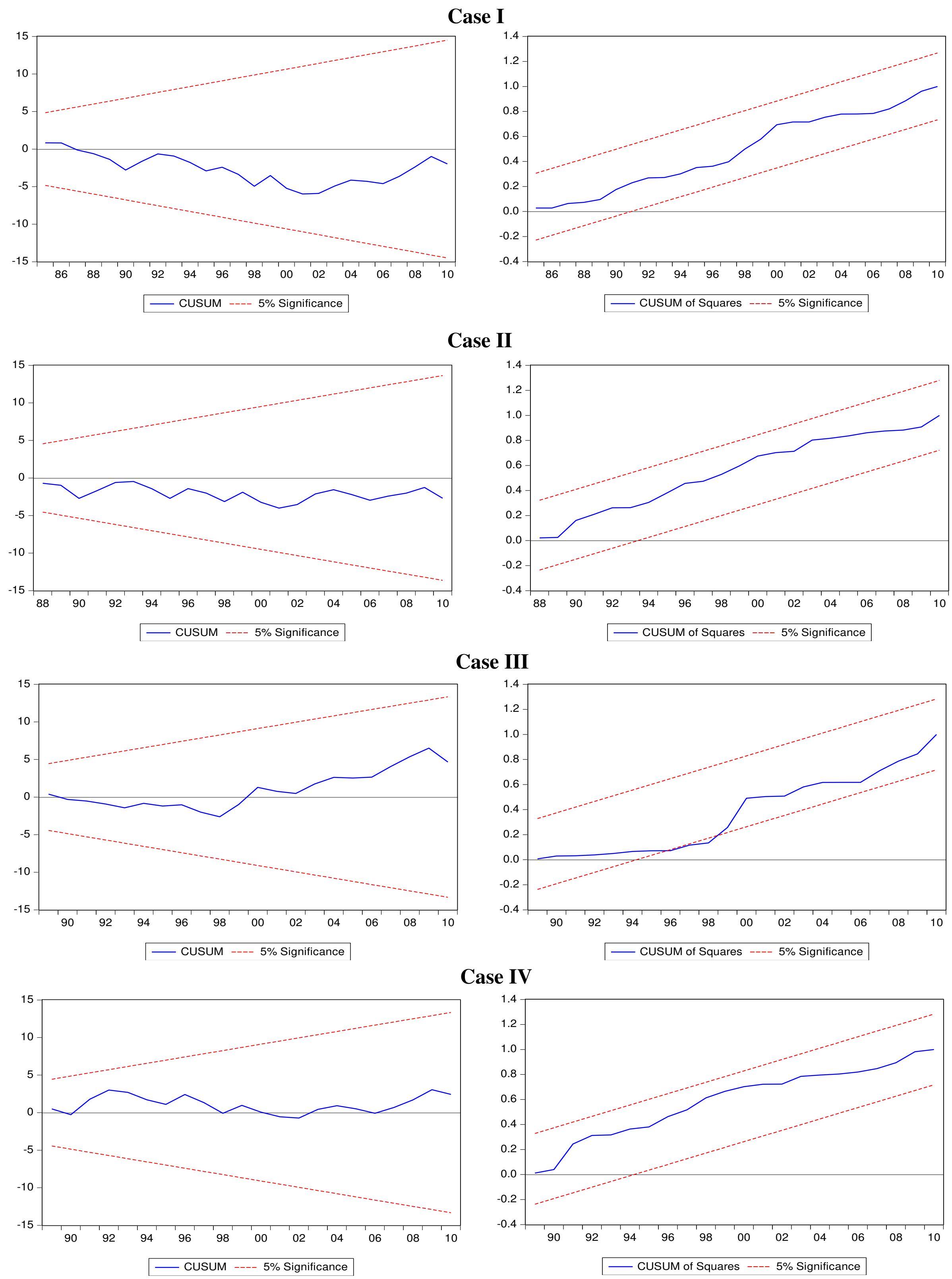

Figure 3. Stability of the models based on the plot of CUSUM and CUSUMSQ of recursive residual

Tables

Table 1. Unit root test results

Variables	ADF		Breakpoint unit root test		KPPS	
	No Trend	Trend	No Trend	Trend	No Trend	Trend
Levels						
ln *C*	-1.612036	-2.906569	-2.874843	-3.760061	0.773246[a]	0.104321[a]
ln *Y*	-1.583793	-2.062575	-2.049436	-7.608414	0.580830[b]	0.151892[b]
ln Y^2	-1.095478	-2.195491	-1.803745	-7.772209	0.687917[b]	0.146254[b]
ln *ER*	-0.821178	-2.172115	-3.471982	-6.143338[a]	0.519907[b]	0.120563[c]
ln *EC*	-0.606822	-1.694119	-5.509523[a]	-5.442050[a]	0.881272[a]	0.111969
ln *TFP*	-1.737774	-2.439344	-5.409033[a]	-8.424761[a]	0.263024	0.165459
First Differences						
ln *C*	-5.740083[a]	-5.784033[a]	-7.106165[a]	-7.040115[a]	0.132253	0.041451
ln *Y*	-4.518360[a]	-4.585807[a]	-9.945942[a]	-9.692768[a]	0.192859	0.060720
ln Y^2	-4.583948[a]	-4.570627[a]	-10.33277[a]	-10.28274[a]	0.121298	0.060339
ln *ER*	-8.151052[a]	-8.158039[a]	-9.406657[a]	-9.191273[a]	0.099847	0.082047
ln *EC*	-6.146892[a]	-6.093122[a]	-8.178754[a]	-7.967713[a]	0.100151	0.084858
ln *TFP*	-4.073000[a]	-4.187022 [b]	-6.833788[a]	-6.828087[a]	0.274802	0.086479

Notes: [a] , [b] and [c], denotes statistical significance at 1 percent, 5 percent and 10 percent levels, respectively.

Table 2. Model selection summary

Linear Model							
Case I				Case II			
AIC		SBC		AIC		SBC	
Value	ARDL	Value	ARDL	Value	ARDL	Value	ARDL
-2.939205	2,4,0,0	-2.523032	1,1,0,0	-3.014144	2,4,2,0,0	-2.526268	2,1,0,0,2
-2.923381	2,4,2,0	-2.499339	2,4,0,0	-2.987955	2,4,3,0,0	-2.508123	2,1,0,0,0
-2.907610	2,4,1,0	-2.487009	2,2,0,0	-2.985024	2,4,2,0,2	-2.499095	2,2,0,0,0
-2.897030	2,4,3,0	-2.478187	2,1,0,0	-2.983663	2,4,2,0,4	-2.497702	2,0,0,0,2
-2.895722	3,4,2,0	-2.431032	1,2,0,0	-2.980141	2,4,0,0,0	-2.496335	1,1,0,0,0

Quadratic Model							
Case III				Case IV			
AIC		SBC		AIC		SBC	
Value	ARDL	Value	ARDL	Value	ARDL	Value	ARDL
-3.014755	2,4,3,0,0	-2.438107	1,0,1,0,0	-3.157073	2,0,4,2,0,0	-3.150493	2,0,3,2,0,0
-3.010064	2,3,4,0,0	-2.432490	1,1,0,0,0	-3.150493	2,0,3,2,0,0	-3.135855	2,3,0,2,0,0
-3.004513	3,4,3,0,0	-2.418595	2,0,4,0,0	-3.143731	2,4,0,2,0,0	-3.157073	2,0,4,2,0,0
-3.001501	3,3,4,0,0	-2.407066	2,0,2,0,0	-3.142016	2,4,3,0,0,0	-3.060562	3,0,1,2,0,0
-2.978169	2,4,4,0,0	-2.404817	2,4,0,0,0	-3.141281	2,3,4,0,0,0	-3.058395	3,1,2,0,0,0

Table 3. Bound test for cointegration

	Linear Model				Quadratic Model			
	Case I		Case II		Case III		Case IV	
	Value	**k**	**Value**	**k**	**Value**	**k**	**Value**	**k**
F-statistic	4.570496	3	5.545779	4	4.585547	4	5.332040	5
Critical Values Bounds*	I_0	I_1	I_0	I_1	I_0	I_1	I_0	I_1
10%	2.933	4.020	2.660	3.838	2.660	3.838	2.483	3.708
5%	3.548	4.803	3.202	4.544	3.202	4.544	2.962	4.338
1%	5.018	6.610	4.428	6.250	4.428	6.250	4.045	5.898

Notes: * Based on Narayan's critical values (Narayan, 2005), for the case of unrestricted intercept and no trend.

Table 4. Long-run estimates based on ARDL model

Variables	Linear Model		Quadratic Model	
	Case I: ARDL (2,4,0,0)	**Case II: ARDL (2,4,2,0,0)**	**Case III: ARDL (2,4,3,0,0)**	**Case IV: ARDL (2,0,4,2,0,0)**
ln *Y*	0.87243 (0.26785)[a]	1.03806 (0.23162)[a]	-0.15389 (1.53462)	4.71954 (1.44783)[a]
ln Y^2	-	-	0.05150 (0.11063)	-0.26358 (0.10351)[a]
ln *ER*	-0.20348 (0.05695)[a]	-0.22232 (0.05170)[a]	-0.18612 (0.05606)[a]	-0.27757 (0.04477)[a]
ln *EC*	0.67124 (0.29423)[b]	0.49938 (0.28942)[c]	0.79649 (0.33321)[b]	0.43628 (0.21826)[c]
ln *TFP*	-	-0.19052 (0.08940)[b]	-	-0.38593 (0.09883)[a]
C	-9.41814 (0.65742)[a]	-9.56622 (0.68880)[a]	-5.66175 (5.35130)	-21.95706 (4.89835)[a]
R-squared	0.98872	0.99114	0.99162	0.99273
Adjusted R-squared	0.98482	0.98652	0.98668	0.98844
SE of regression	0.04960	0.04674	0.04646	0.04327
F-statistic	253.2984[a]	214.5052[a]	200.4357[a]	231.3499[a]
AIC	-2.93920	-3.01414	-3.01475	-3.15707
D-W statistic	1.85638	1.89591	1.85166	2.04092
Diagnostic tests				
Serial correlation	$\chi^2_{(1)}$= 0.05777 (P = 0.81)	$\chi^2_{(1)}$= 0.23135 (P = 0.63)	$\chi^2_{(1)}$= 0.00150 (P = 0.97)	$\chi^2_{(1)}$= 0.21811 (P = 0.64)
Functional form	$\chi^2_{(1)}$ = 0.00404 (P = 0.95)	$\chi^2_{(1)}$ = 5.94874 (P = 0.02)	$\chi^2_{(1)}$ = 2.06983 (P = 0.17)	$\chi^2_{(1)}$ = 1.79716 (P = 0.19)
Normality	$\chi^2_{(1)}$= 0.80972 (P = 0.67)	$\chi^2_{(1)}$= 0.52438 (P = 0.77)	$\chi^2_{(1)}$= 0.64434 (P = 0.72)	$\chi^2_{(1)}$= 0.10241 (P = 0.95)
Heteroscedasticity	$\chi^2_{(1)}$ = 2.85938 (P = 0.97)	$\chi^2_{(1)}$ = 4.75136 (P = 0.97)	$\chi^2_{(1)}$ = 4.01572 (P = 0.99)	$\chi^2_{(1)}$ = 4.38389 (P = 0.99)

Notes:

1. [a] and [b], denotes statistical significance at 1 percent and 5 percent levels, respectively.
2. The numbers in parentheses are standard errors.

Table 5. Short-run estimates based on ARDL model

Variables	Linear Model		Quadratic Model	
	Case I: ARDL (2,4,0,0)	**Case II: ARDL (2,4,2,0,0)**	**Case III: ARDL (2,4,3,0,0)**	**Case IV: ARDL (2,0,4,2,0,0)**
$\Delta\ln C_{t-1}$	0.39469 (0.14831)[b]	0.46932 (0.13566)[a]	0.51511 (0.15043)[a]	0.60922 (0.13579)[a]
$\Delta\ln Y$	1.46985 (0.27051)[a]	1.70191 (0.32813)[a]	-11.50687 (7.70250)	4.08808 (2.75265)
$\Delta\ln Y^2$	-	-	0.92997 (0.54977)	-0.15540 (0.19863)
$\Delta\ln ER$	-0.13220 (0.03939)[a]	-0.15842 (0.04558)[a]	-0.12191 (0.03925)[b]	-0.19161 (0.04311)[b]
$\Delta\ln EC$	0.43610 (0.18534)[b]	0.40899 (0.22109)[c]	0.52170 (0.20920)[b]	0.45462 (0.20561)[b]
$\Delta\ln TFP$	-	-0.23774 (0.19390)	-	-0.41390 (0.17729)[b]
ECT_{t-1}	-0.64969 (0.11766)[a]	-0.75155 (0.12663)[a]	-0.65500 (0.11102)[a]	-0.94820 (0.14237)[a]

Notes:

1. [a] , [b] and [c], denotes statistical significance at 1 percent, 5 percent and 10 percent levels, respectively.
2. The numbers in parentheses are standard errors.