

ENVIRONMENTAL DETERIORATION OR ENVIRONMENTAL SUSTAINABILITY? EVIDENCE OF RENEWABLE AND NON-RENEWABLE ENERGY CONSUMPTION

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| **Dr. Muhammad Nadeem, Sadia Masood, Ruqia Shaheen,Farrah Nayab Jehangir,Sayyed Muhammad Bilal. Environmental Deterioration Or Environmental Sustainability? Evidence Of Renewable And Non-Renewable Energy Consumption -- Palarch’s Journal Of Archaeology Of Egypt/Egyptology 19(3), 1052-1062. ISSN 1567-214x****Keywords: Renewable Energy, Non-Renewable Energy, P-Ardl, Southeast Asia, South Asia, Central Asia.** |

**ABSTRACT**

The study analyzes the impact of renewable and non-renewable energy on the environmental conditions of developing nations in three Asian regions. To meet the objectives, the data is taken from 1990 to 2018. The Panel-ARDL outcomes for the long run illustrate that non-renewable forms of fossil fuels deteriorate the environment. At the same time, renewable energy and economic growth endorse environmental sustainability in all three Asian regions. However, capital formation and labor productivity follow the path of non-renewables by hurting the environmental conditions of Southeast Asian, South Asian, and Central Asian emerging economies. In discussing the effects in the short run, only renewable energy and labor productivity are the factors that significantly reduce carbon emissions and lead to environmental sustainability. However, it has been noticed that the error correction term has adjusted the error by about 56 percent. Therefore, the study recommends following the sustainable path of renewable energy to attain sustainable development goals.

**INTRODUCTION**

In this modern era, stable economic growth is the priority of developed and developing countries. Every country is trying to increase its growth level. In this regard, they are focusing on their rapid production process and adopting growth-friendly policies to sustain their economic well-being. For rapid growth and productivity, developing and developed countries are found to be relying on industrialization. By adopting modern techniques in modern societies, the demand for energy has increased. The reliance on energy consumption has developed its growth level to make industrial production more attractive and practical. Basically, energy is generated through two resources: renewable and non-renewable energy resources. So, developing and developed countries use renewable and non-renewable energy resources according to their need, demand, and supply, which considerably affects their economic growth (Gozgor *et al.,* 2018; Zafar *et al.,* 2019; Huang *et al.,* 2020).

With the increased production and growth, the sustainability of the environment is another task. A clean and healthy environment is also the demand of modern societies for their well-being. It has been found that the plentiful reliance on energy is promoting the economic growth of countries but hurting their environmental sustainability in the form of emissions of greenhouse gases like carbon emissions (Acheampong, 2018; Bekun *et al.,* 2019). According to the World Development Indicators, most countries are found to be indulged in fossil fuel energy use. The developing and developed countries have increased their growth level with more fossil fuel energy, which is evident from past research (Ahmad *et al.,* 2019; Hanif *et al.,* 2019). The reasons for more fossil fuel energy consumption are that it is less costly, more effective in the production and growth process, and has a high level of demand and supply. That’s why developing countries are following their growth productivity processes to enhance their growth level and for the sake of the status of the developed economy. But in modern times, the condition of a clean and healthy environment matters. Fossil fuel energy consumption causes a greenhouse effect on the environment of developed and developing countries.

On the other hand, renewable energy resources are a great source of enhanced economic growth. According to World Development Indicators, most developed and developing countries have adopted renewable energy resources for sustainable growth and economic well-being. As well as the sustainable environmental quality of modern societies is also a condition. Following this condition, most developing countries have adopted renewable energy resources, reducing carbon emissions (Ito, 2017). As we discussed before, economic growth and a clean environment is the demand of almost all developing economies, and they are struggling for this reason. Still, the sustainable environment and growth are questionable and not satisfied by past research. That’s why this research is conducted to measure the impact of renewable and fossil fuel energy consumption on the carbon emissions of developing countries.

**LITERATURE REVIEW**

Environmental degradation hazards are the most concerning issue in almost all countries. The reliance on energy consumption for better growth turns them into the hazard of environmental pollution. According to previous studies, the increased level of consumed energy has enhanced the economic growth of examined countries as well a large amount of carbon dioxide is emitted in these countries (Alam *et al.,* 2007; Azlina and Mustapha, 2012; Zhang *et al.,* 2012; Saboori and Sulaiman, 2013; Hu *et al.,* 2014; Zeb *et al.,* 2014). The economy of Pakistan has gained constructive growth through more use of energy consumption which resultantly enhanced the emissions of carbon dioxide gas in Pakistan and became the cause of environmental pollution (Mudakkar *et al.,* 2013). Moreover, some more previous studies advocated the reduction in environmental sustainability because of the increased level of energy consumption and economic growth (Jammazi and Aloui, 2015; Wang *et al.,* 2015; Zhang and Gao, 2016). Raza *et al.* (2019) examined the increased energy consumption effect on the USA’s carbon dioxide emissions. Energy consumption and gross regional products push the carbon dioxide emissions positively, which resultantly reduces the environmental sustainability, which means ecological quality has deteriorated of more use of fossil fuel energy in China. At the provincial level, the carbon dioxide emissions are reduced by saving energy, resulting in reduced air pollution in twenty-six provinces of China (Zheng *et al.*, 2015). In the case of the Chinese agriculture sector, the negative influence of energy consumption on carbon dioxide emissions is found. In contrast, economic growth and carbon dioxide emissions have a bidirectional relationship in the Chinese agriculture sector (Zhang *et al.,* 2019).

Some past studies have proved the reduction in carbon emissions due to doubled economic growth (Shahbaz *et al.,* 2012; Nasreen *et al.,* 2017). Renewable energy consumption is firmly and effectively reduced carbon dioxide emissions in forty-two developing countries (Ito, 2017). Hanif *et al.* (2019) examined the short-long term effects of economic growth, foreign direct investment, and fossil fuel energy consumption of carbon dioxide emissions in fifteen developing countries in Asia. The long-run analysis showed that fossil fuel energy consumption, economic growth, and foreign direct investment positively affected the carbon dioxide emissions in all developing Asian countries, while squared economic growth has reduced the carbon dioxide emissions in the long run and developed the environmental Kuznets curve hypothesis. In the end, the strong and weak effect of renewable energy consumption is evidenced by past researchers. While, in MENA countries, renewable energy consumption weakens carbon dioxide emissions and contributes less to improving the quality of the environment of MENA countries (Charfeddine and Kahia, 2019).

**DATA, EMPIRICAL MODEL, AND METHODOLOGY**

***Data and Variables***

To examine the impact of energy consumption and economic growth on carbon emissions in panel countries, the data is sourced by “World Development Indicators,” covering the time period from 1990 to 2018. Fifteen counties are selected from South East Asia, South Asia, and Central Asia. The selected countries are Cambodia, China, Indonesia, Malaysia, Mongolia, Philippines, Vietnam, Bangladesh, India, Pakistan, Srilanka, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. Further, the variables such as Economic growth is measured in GDP per capita annual percent, Fossil fuel consumption as a percentage of the total, Renewable energy use as a percentage of total final energy consumption, Labor productivity as Total Labor Force, Capital Formation as a percentage of GDP and carbon emissions is measured in metric ton per capita.

***Empirical Model and Methodology***

The present study follows the Shahbaz *et al.* (2012) and Nasreen *et al.* (2017) studies to inspect the participation of energy consumption and economic growth in terms of carbon emissions in fifteen countries. This study is based on a linear function in which carbon emissions are functioned the energy consumption, economic growth, and their indicators to measure the environmental sustainability in selected economies. The function equation is given below:

*EDE = f (FOS, REW, EGP, CAF, LAP) (1)*

The above equation 1 shows the carbon emissions as EDE, while the FOS shows the fossil fuel consumption, REW as renewable energy use, EGP stands as per capita economic growth, CAF stands for capital formation, and labor productivity is denoted by LAP.

*EDEit =* α*0 +* α*1FOSit + β2REWit + β3EGPit +* γ*4CAFit +* γ*5LAPit + µi*  *(2)*

The above linear equation has coefficients in the form of *α*’*s*, *β’s,* andγ*’s,* while *it* shows the panel with respect to time, and *ui* is the error term. The above equation indicates the initial investigation stage to select the exact methodology for further investigation. The initial steps are a statistical summary, a test of multicollinearity, and stationarity to check the statistical strength of the model and to check the order of integration among variables.

After the initial steps, the bound test is a pre-analysis test of ARDL. It is actually the identification test of long run existence. The bound test equation is followed by past research by Nasreen *et al.* (2017).

Δ*(EDEit) =* α*0 +* α*1(EDEit-1) + β2(FOSit-1) + β3(REWit-1) +* γ*4(EGPit-1) +* γ*5(CAFit-1) +* γ*6(LAPit-1) + ∑ki=1α1*Δ*(EDEit-1) + ∑ki=0β2*Δ*(FOSit-1) + ∑ki=0β3*Δ*(REWit-1) + ∑ki=1*γ*4*Δ*(EGPit-1) + ∑ki=0*γ*5*Δ*(CAFit-1) + ∑ki=0*γ*6*Δ*(LAPit-1) + ui (3)*

After this, there are two steps of the ARDL model to measure the empirical relationship among the variables in the model. To find out the observed association in the model, it is necessary to measure its impact in the long and short run. Both the long and short run equations are based on previous research by Shahbaz *et al.* (2012) and Nasreen *et al.* (2017).

The long run Panel-ARDL equation is as follow:

*(EDEit) =* α*0 +* α*1(EDEit-1) + β2(FOSit-1) + β3(REWit-1) +* γ*4(EGPit-1) +* γ*5(CAFit-1) +* γ*6(LAPit-1) + µi (4)*

The short run Panel-ARDL equation is as follow:

Δ*(EDEit) = α0 + ∑ki=1α1*Δ*(EDEit-1) + ∑ki=0β2*Δ*(FOSit-1) + ∑ki=0β3*Δ*(REWit-1) + ∑ki=1*γ*4*Δ*(EGPit-1) + ∑ki=0*γ*5*Δ*(CAFit-1) + ∑ki=0*γ*6*Δ*(LAPit-1) + ui (5)*

In the end,the error correction model, the post-analysis of Panel ARDL, is used to stabilize the error arising from the short to the long run. The error correction equation is given below:

Δ*(EDEit) =* α*0 +* α*1(EDEit-1) + β2(FOSit-1) + β3(REWit-1) +* γ*4(EGPit-1) +* γ*5(CAFit-1) +* γ*6(LAPit-1) + ∑ki=1α1*Δ*(EDEit-1) + ∑ki=0β2*Δ*(FOSit-1) + ∑ki=0β3*Δ*(REWit-1) + ∑ki=1*γ*4*Δ*(EGPit-1) + ∑ki=0*γ*5*Δ*(CAFit-1) + ∑ki=0*γ*6*Δ*(LAPit-1) + ϴ(ECit-1)* + *ui (6)*

In equation 6 above, ECit-1 shows the error correction model with the *ϴ* sign, which indicates the speed of the adjustment term.

**RESULTS AND DISCUSSION:**

**Table 1** Descriptive Statistics

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **EDE** | **FOS** | **REW** | **EGP** | **CAF** | **LAP** |
| **Mean** |  7.201 |  69.180 |  19.880 |  4.100 |  11.001 |  22328031 |
| **Median** |  3.963 |  79.614 |  10.016 |  2.325 |  5.596 |  2685201 |
| **Maximum** |  68.644 |  984.000 |  89.710 |  95.369 |  2415.215 |  90275108 |
| **Minimum** |  0.0671 |  12.102 |  2.980 | -14.268 | -128.104 |  120658.0 |
| **Std. Dev.** |  8.562 |  28.304 |  19.219 |  4.020 |  56.107 |  4.5092 |

**Table 2** Correlation Matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **EDE** | **FOS** | **REW** | **EGP** | **CAF** | **LAP** |
| **EDE** | 1.000 |  |  |  |  |  |
| **FOS** | 0.325 | 1.000 |  |  |  |  |
| **REW** | -0.495 | -0.605 | 1.000 |  |  |  |
| **EGP** | -0.216 | -0.151 | 0.112 | 1.000 |  |  |
| **CAF** | 0.191 | -0.008 | -0.012 | 0.041 | 1.000 |  |
| **LAP** | 0.290 | 0.008 | 0.109 | 0.009 | -0.004 | 1.000 |

**Table 3** Panel Unit Root Test

|  |  |  |  |
| --- | --- | --- | --- |
|  | **I (0)** | **I (1)**  |  |
| **Variables** | **Intercept** | **Intercept & Trend** | **Intercept** | **Intercept & Trend** | **Decision** |
| **EDE** | **LLC** | - | - | -12.12 (0.00) | -9.72 (0.00) | **I(1)** |
| **IPS** | - | - | -11.91 (0.00) | -9.98 (0.00) |
| **FOS** | **LLC** | - | - | -10.52 (0.00) | -9.50 (0.00) |
| **IPS** | - | - | -11.58 (0.00) | -10.10 (0.00) |
| **REW** | **LLC** | - | - | -9.92 (0.00) | -8.59 (0.00) |
| **IPS** | - | - | -13.01 (0.00) | -10.20 (0.00) |
| **EGP** | **LLC** | -20.85 (0.00) | -16.90 (0.00) | - | - | **I(0)** |
| **IPS** | -11.54 (0.00) | -8.92 (0.00) | - | - |
| **CAF** | **LLC** | -13.15 (0.00) | -9.91 (0.00) | - | - |
| **IPS** | -11.09 (0.00) | -7.52 (0.00) | - | - |
| **LAP** | **LLC** | - | - | -5.87 (0.00) | -3.93 (0.00) | **I(1)** |
| **IPS** | - | - | -7.99 (0.00) | -5.76 (0.00) |

**Table 4** ARDL Bound Testing Model

|  |
| --- |
| **EDE \ FOS; REW; EGP; CAF; LAP** |
| **F-statistic** | **95% Lower Bound** | **95% Upper Bound** |
| 6.401 | 2.600 | 3.815 |

**Table 5** Long Run, Short Run, and Error Correction Representation for the Selected ARDL Model

|  |
| --- |
| **Dependent variable is dEDE** |
| **Regressor** | **Coefficient** | **Standard Error** | **T-Ratio**  |
| **FOS** | 0.506 | 0.409 | 1.851 |
| **REW** | -0.329 | 0.083 | -3.211 |
| **EGP** | -0.398 | 0.197 | -2.101 |
| **CAF** | 0.156 | 0.0716 | 2.342 |
| **LAP** | 0.197 | 0.136 | 2.091 |
| **dFOS** | -0.066 | 0.006 | -0.860 |
| **dREW** | -0.150 | 0.021 | -10.560 |
| **dEGP** | -0.092 | 0.029 | -0.595 |
| **dCAF** | -0.085 | 0.007 | -0.096 |
| **dLAP** | -0.007 | 0.005 | -3.095 |
| **EC (-1)** | -0.563 | 0.067 | -7.291 |

In the first step of statistical measurement, Table 1 describes the summary of the descriptive statistics. The statistical summary indicates that all the concerned indicators have a difference from their mean. At the same time, summery is showing a solid impression of the empirical model for further empirical analysis. In the second step of statistical measurement, Table 2 shows the correlation among variables in which the situation of arising multicollinearity is a great concern. The table shows that the FOS has moderate and positive relationships, while REW has average and antagonistic relationships with EDE. However, EGP has a negative and CAF has a positive correlation with EDE, while their relationship strength is weak because their values of -0.216 and 0.191 are less than the critical value of 0.300. Further, LAP indicates a positive and moderate association with EDE. However, it is found that the variables have moderate and weak associations with EDE and do not indicate multicollinearity among them. Furthermore, the statistical description of variables and correlation matrix have evidenced that the empirical model is suitable for further analysis.

The next step in table 3 is based on the order of integration among variables by applying LLC and IPS tests. Both tests have intercept, intercept, and trend values at the level, and the first difference to check the order of integration. The results of the panel unit root test integrated the EDE, FOS, REW, and LAP are integrated at the first difference I (1). In contrast, EGP and CAP are integrated at a level I (0). However, the mixed level I (0) and I (1) of stationarity among variables directed to apply of Panel-ARDL to the statistical model for further investigation. Before moving to ARDL analysis, the necessary step of bound testing is mandatory for the existence of long run interactions among variables. There should be the condition that the F-statistics value should be greater than the lower and upper bound values to reject the null hypothesis of no level effect. Here in table 4, the value of F-statistics is 6.401 is greater than the lower bound value of 2.600 and upper bound value of 3.815. The more outstanding value of F-statistics has rejected the null hypothesis of no level effect and accepted the alternative condition of the existence of long run interaction among variables.

The findings of Panel-ARDL are given in table 5, which includes long run, short run, and error correction outcomes. In the long-run P-ARDL estimates, fossil fuel consumption (FOS) is recorded at 0.506, which is significant at 10 percent. This indicates that fossil fuels have a slight effect on carbon emissions, and 10 units of fossil fuels are increasing environmental deterioration by about 0.506 units. The reason is that these developing countries rely much on fossil fuel energy resources to enhance their economic growth. By applying this method, per capita economic growth of selected economies is increasing but deteriorating the environment of concerned economies. It is stated that fossil fuel energy is consumed in the transport and industrial sectors of developing countries and is causing air pollution. Fossil fuels are burned for electricity production, while electricity is mainly generated through coal and natural gases. Further, fossil fuels are burned in industries for energy to produce industrial products, and due to burned fossil fuels and chemical reactions, greenhouse gases release and make the environment degraded. Raza *et al.* (2019) said fossil fuel consumption pushes carbon emissions, reducing environmental sustainability and deteriorating ecological quality. Hanif *et al.* (2019), Chunyu *et al.* (2021), and Ahmed *et al.* (2022) have also proved the long run positive effect of fossil fuels on carbon releases in developing countries.

The other form of energy is renewable energy. The value of REW is -0.329, which is significant and shows that more use of renewable energy reduces carbon dioxide emissions and promotes the environmental sustainability of selected countries. Nowadays, the demand for wind, solar, and biomass energy technologies is increasing. Most countries are now focusing on renewable resources like wind, solar, and biomass to produce energy. In this way, the demand for energy is fulfilled in each sector, while in the second, the emissions of greenhouse gases are reducing, which were emitted by burning fossil fuels. Ito (2017) evidenced renewable energy consumption's strong negative effect on forty-two developing countries' carbon emissions. While Charfeddine and Kahia (2019) also evidenced the negative impact of renewable energy consumption on carbon emissions in MENA countries. Further, some more evidence is in line with our findings (Tugcu and Topcu, 2018; Carfora *et al.,* 2019; Ridzuan *et al.,* 2020; Saidi and Omri, 2020; Batool *et al.,* 2022; Jiang *et al.,* 2022; Raza *et al.,* 2022).

Economic growth (EGP) value of -0.398 shows an adverse effect on carbon emissions, but this effect is limited in scale. However, with a limited scale effect, economic growth succeeds in mitigating greenhouse gases and stabilizing environmental sustainability in emerging countries. The reason is that the selected countries now rely on renewable energy resources rather than fossil fuels or other non-renewable energy resources. This regards their productivity in terms of economic growth, while environmental sustainability is achieved due to more sustainable production. The findings are in line with Ahmad *et al.* (2019). Furthermore, capital formation (CAF) and labor productivity (LAP) are on different tracks, and their enhanced effect is deteriorating the environment of Southeast Asian, South Asian, and Central Asian economies, which is in line with previous outcomes (Sibt e Ali *et al.,* 2018; Sibt e Ali *et al.,* 2021). According to the short run effect, dFOS, dEGP, and dCAF have an insignificant short run effect. In contrast, dREW and dLAP significantly and negatively affect EDE and align with Weimin *et al.* (2022). This indicates that renewable energy and labor productivity are helpful indicators in reducing carbon emissions and promoting environmental sustainability in a short period. Moreover, the value of EC (-1) is -0.563, which shows that 56 percent of error is adjusted from short to long-run in all fifteen developing countries.

**CONCLUSION:**

This panel study of fifteen Southeast Asian, South Asian, and Central Asian countries is conducted to measure the consequences of renewable and non-renewable energy use on environmental sustainability. The findings have proved the attributes of the empirical model in a statistical term. First, the panel unit root has shown a mixed level of stationarity, and evident the panel ARDL is to be applied to the empirical model. The bound testing procedure has rejected the no-level effect and evidenced the existence of a long run in the model. In the long run, panel ARDL has shown that non-renewables have failed to mitigate carbon emissions, while renewable energy use efficiently reduces carbon emissions and promotes environmental sustainability. However, economic growth is a constructive indicator of controlling greenhouse gas emissions and promoting environmental cleanliness. On the other hand, capital formation and labor productivity are failed to coordinate with environmental protection and became a cause of environmental degradation in the developing countries of Southeast Asian, South Asian, and Central Asian regions. In discussing the short-term effects, only renewable energy and labor productivity significantly reduce carbon secretions and promote environmental sustainability. Moreover, the error correction term succeeds in lowering the error by about 56 percent from the short to the long run. In the end, the study recommends that the policymakers should promote the renewable form of panels and electrification at the industrial level and move towards innovative technology of low carbon to meet sustainable development goals of green growth and a green environment.

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