IJEMD-SS, 5 (1) (2026) https://doi.org/10.54938/ijemdss.2026.05.1.779

International Journal of Emerging Multidisciplinaries: Social Science

Research Paper
Journal Homepage: www.ojs.ijemd.com
ISSN (Online): 2958-0277

Revisiting The Nexus Between Globalization, Energy Use, and Carbon Emissions: An Empirical Analysis for ASEAN Economies

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Abstract

This paper investigates the relationship between non-renewable energy consumption, globalization and carbon emissions under the Environmental Kuznets Curve (EKC) hypothesis, based on the observations of ASEAN economies between 1990 and 2023, which are unbalanced panel data. A panel cointegration analysis is used to explore the time-series dependence of the variables both in the short-term and in the long-term. The findings indicate the support of the Environmental Kuznets Curve (EKC) hypothesis which implies the energy consumption – carbon emission curve is inverted U-shaped. The results also confirm that the use of non-renewable energy sources also has a positive correlation with environmental pressure. Globalization, however, has not reached all countries similarly and appears to influence countries in different ways depending on the differences in countries' economic development, institutional environment, and environmental

policies. Therefore, this study proposes that the move towards Renewable Energy (RE) should be a priority in ASEAN economies and should be done in an environmentally sustainable way.

Keywords: Globalization, Non-renewable energy, EKC-Hypothesis, Environmental Degradation

1. Introduction

Although the international community has been making efforts to reach environmental sustainability, carbon dioxide (CO_2) emission has been on the rise. Climate change has emerged as one of the biggest challenges for the 21st century. Energy, and also the many fossil fuels consumed like coal, oil and natural gas, is one of the biggest sources of GHG emissions. The world is more conscious about sustainability concerns and yet fossil fuels make significant contribution to the energy use. These resources are still utilized in a great way and they have contributed significantly to environmental degradation and CO_2 emission. The continued use of them shows that there is a need to move towards more environmentally friendly and sustainable energy sources. Simultaneously, globalization has affected the structure of production and economies with greater trade liberalisation, capital mobility and technological dispersion. Globalization may on the one hand lead to efficiency and reduce the accessibility of clean technologies, but on the other hand, it is possible to increase energy consumption and industrial activity, which causes environmental deterioration, if there are no proper regulations (Kalaycı & Hayaloğlu, 2019).

Energy consumption is a crucial element of the economic development but its impact on the environment is greatly affected by the proportion of energy sources that are exploited. Indeed, CO_2 emissions are highly correlated with the nonrenewable energy consumption, and renewable energy resources can be alternative solutions on more sustainable development (Catık et al., 2024). There is consistently empirical evidence that use of fossil fuels exacerbates environmental pressures. The theoretical interpretation of the environmental impacts of globalization, on the other hand, is not obvious. On the other hand, it may be claimed that Globalization can lead to environmental degradation by the move of high resource consuming industries to less strict environmental regulations environments, the “pollution haven” hypothesis. The pollution halo hypothesis, conversely, offers a rationale for environmental quality gains through technology transfers and innovation, as well as through improved institutional practices, which are facilitated by

globalization. (Bhatti et al., 2020). The opposing opinions indicate that the impact of globalization on environmental degradation may differ among countries, depending on their situation.

The EKC model is used to understand the relationship between economic growth and environmental degradation in economics. The Environmental Kuznets Curve (EKC) theory states that environmental degradation deteriorates with the growth of a country but gets better once a country reaches some stage in its development. Empirical results on the EKC, however, are so far mixed, even after taking into account other factors like energy use pattern and globalization (Ansari, 2022). This implies that the determinants inherent in the usual EKC models might not be sufficient to explicitly reflect these determinants.

The Association of Southeast Asian Nations (ASEAN) is faced with a context where energy use, globalization and environmental degradation are all important issues. ASEAN countries' economies have experienced rapid growth, have become more globally integrated and demand for energy has risen over the past 30 years. This growth has been mainly attributed to the region's growing use of fossil fuel and a corresponding rise in CO_2 emissions in the region. Meanwhile, the same is true of the ASEAN countries in terms of economic development, institutional quality and energy transition. The energy-environmental-ASEAN linkages are crucial; with energy production contributing to emissions and energy consumption contributing to economic activity. This analysis can be useful to shape a sound energy and environmental policy on a regional and international level.

While a number of publications have dealt with the energy–environment linkage, they have either been centered on globalization or on energy consumption alone and have produced ambiguous and little conclusive results. Moreover, the literature does not provide consistent results and there is no evidence of whether the average temperature of the ASEAN region is increasing or decreasing. Part of the reason for these dsifference might be due to methodological constraints, including the absence of econometric analysis to adjust for cross sectional dependence and the different structure of the countries. Furthermore, some studies have small samples sizes and/or only some variables, therefore, their results are not reliable (Vo et al., 2019; Khan et al., 2022). Even recent papers, which apply the most up-to-date methodology do not combine energy consumption and globalization in a single analytical framework, particularly when taking into account the latest

available data (Ghoshray & Lorusso, 2025). Thus, there is a lack of evidence to offer clear and reliable policy guidance.

In view of this, this study empirically investigates the linkage of energy, globalization and CO_2 emissions within the economies of the ASEAN countries for the period 1990 to 2023. The study focuses on short and long effects of relationship of the variables by utilizing panel cointegration analysis. Therefore, the study takes one dimension: energy use and globalization, which would be a comprehensive view of the impact they have on the environment. Furthermore, the study is conducted under the Environmental Kuznets Curve (EKC) framework to see whether or not the income–environment relationship holds true in the case of these important aspects.

The current research has a few contributions to the existing literature. First, it provides a fresh empirical assessment of the effect of energy use and globalization on CO_2 emissions in the ASEAN countries, for the time period 1990-2023. Secondly, it brings together both variables in one empirical model, while this is not the case in previous studies where these have been studied separately. Third, it applies a complicated panel cointegration method which addresses the cross-sectional dependence and heterogeneity of the panel, further improving the reliability and robustness of the results. The results deepen understanding of the environmental impacts of economic integration and energy use and provide valuable policy lessons for sustainable development in emerging economies.

The intertwined relation between globalization, energy consumption and carbon emission is complex and intensively studied in the empirical field particularly focusing on the issue of environmental sustainability and the Environmental Kuznets Curve (EKC) hypothesis. Globalization, energy use, are two important sources of environmental change as you mentioned in your research but they affect different countries and regions in different ways. Globalization may stimulate the development and use of better technology and more efficient utilization of resources, but it may also lead to greater industrial activity and greater use of energy. Likewise, energy consumption, especially of non-renewable energy continues to be a significant contributor of CO_2.

2. Literature Review

There has been much written on the relationship between globalization and carbon emission, some studies showing a positive relationship and others a negative relationship. Empirical studies have been inconclusive, and have demonstrated the large differences in carbon emissions between countries and studies. In general, the more global an economy, the less carbon emissions are found in a range of high and middle-income economies, as found by Shahbaz et al. (2019), consistent with the EKC (environmental Kuznets curve) hypothesis. In a few countries, however, emissions were seen to have increased with globalization which indicated a non-linear relationship.

Similarly, Anser et al. (2021) and Sadiq et al. (2023) revealed that in the long-run, globalization has positive effects on CO_2 emission in the economies of South Asia. Economic growth in South Asian countries heavily depends on using fossil fuels, which ultimately contributes to environmental degradation. While globalization has had a differential impact, reducing emissions in India and increasing emissions in Pakistan, Nepal, and Bangladesh, Jun et al. (2021) have shown.

More details were provided by Jahanger (2022) who tried to divide globalization into dimensions. This research revealed that political globalization enables to enhance environment, but economic and social globalization causes to increase emission. This indicates a positive relationship between institutional quality and governance and the mitigation of impacts of globalization on environment.

Globalization has a negative impact on the environment in South Africa and other developing countries, and Oladipupo et al. (2022) confirmed this. Likewise, Aziz et al. (2021) reported that environmental quality can be worsened in MINT countries due to globalization's impact on an increase in energy consumption. Hanif et al. (2022) also revealed that globalisation contributes to the emission of CO_2 in ASEAN countries. There are other studies which give focus on the positive drawbacks of globalization. Fakher and Inglesi-Lotz (2022) argue that openness to trade may serve to help curb environmental degradation through technology diffusion and efficiencies. This is in line with the results obtained by Kalaycı and Hayaloğlu (2019) which found that adopting cleaner production techniques in NAFTA countries due to globalization results in lower emissions.

Wen et al. (2021) and Ahmed et al. (2020) highlighted that with the presence of innovation, development of ICTs and institutional strength, globalization can contribute to reduction of

emissions. Globalization also has the potential to create the "pollution haven hypothesis" if there is no strict environmental policy, however, and industries relocate to developing countries which have less strict environmental policy.

In general, globalization has a mixed (conditionally positive) effect on carbon emissions. The factors such as the economic state, policies, institutional quality, and the energy structure etc. have a certain influence on this impact.

It's widely recognised that energy use is a key contributor to carbon emissions. Studies reveal that the environmental effects associated with the use of non-renewable energy sources are quite comparable to the sustainability effects associated with the use of renewable energy sources. Non-renewable energy sources are an important determinant of CO_2 emission in the South Asian economies according to Anser et al. (2021). Similarly, Vo et al. (2019) and Ghoshray and Lorusso (2025) found energy consumption to be an important factor that contributes to emissions in the ASEAN economies.

Renewable energy contributes to better environmental conditions in China, India and Japan, whereas the use of non-renewable energy sources worsens it (Jena et al., 2022). Similarly, the more renewable energy is used, the less environmental degradation will occur and the more fossil fuels are used, the more emissions will be produced (Fakher & Inglesi-Lotz, 2022). Energy sources significantly affected the ecological pressure in the G-7 economies during the study with non-renewable energy showing negative impacts, and renewable energy showing positive impacts, on ecological pressure. Sarwat et al. (2022) discovered that green energy utilization in BRICS countries can cut emissions, with natural resources use and fossil fuels worsening environmental issues.

Hanif et al. (2022) revealed that non-renewable energy and its association to CO_2 emission play a significant role in the ASEAN economies and renewable energy can help mitigate environmental stress. Aziz et al. (2021) also showed that renewable energy plays an important role in the reduction of emissions, particularly for the high income groups.

The energy consumption is still one of the most important long-term factors contributing to carbon emissions in both developed and developing countries as stated by Çatık et al. (2024). These

studies highlight also the need for restructuring the energy structure to enable sustainable development.

3. Material and Method

This section presents the materials and methods which were employed to explore the relationship between carbon emissions, energy use and globalization, economic growth and population growth, consumption of renewable energy and regulatory quality in the selected countries of the Association of Southeast Asian Nations (ASEAN). Data for this study are annual panel data of CO_2, EU, GLOB, GDP, POPG, REC and RQ Data from the World Bank database of World Development Indicators (WDI) (1990-2023) and data on globalization measures from the KOF Globalization Index (KOF) (1990-2023). The variables and framework used in this study are similar to those used in the previous studies that examined the environmental and economic linkages in developing regions (Mazloomi & Sulaiman, 2012; Apergis & Ozturk, 2015). The model has a structural form of:

$$CO_2 = f(EU,GLOB,GDP,POPG,REC,RQ) \quad \ldots\ldots\ldots\ldots\ldots\ldots (i)$$

CO_2: Carbon emissions, EU: Energy use, GLOB: Globalization, GDP: Gross domestic product, POPG: Population growth, REC: Renewable energy use, RQ: Regulatory quality.

In the econometric form:

$$CO_{2it} = \beta_o + \beta_1 EU_{it} + \beta_2 GLOB_{it} + \beta_3 GDP_{it} + \beta_3 POPG_{it} + \beta_4 REC_{it} + \beta_2 RQ_{it} + \varepsilon_{it} \ldots.(2)$$

The stationarity of the variables was first checked by the Augmented Dickey–Fuller (ADF) test (Dickey & Fuller, 1979) before estimating the model. The order of integration was determined by the ADF test which has a crucial role in the validity of the econometric technique used. The following is herewith a rewritten version which has been cleaned-up academically, but with the same methodology and meaning:

The Autoregressive Distributed Lag (ARDL) model proposed by Pesaran and Shin (1995) and Pesaran et al. (2001) is appropriate for this study since none of the variables are integrated at level 2 I(2); they are only integrated at level 1 (I(0) or I(1) – first difference). Hence, bounds test is applied using the ARDL to check the existence of long run equilibrium relationship between the

variables. The ARDL model is used after the cointegration to estimate the long run coefficients and short run effects. The model is then represented in an error correction model (ECM), a model which is used to model the adjustment process which takes the economy off the equilibrium path as the result of some short-term shock but returns the economy to the equilibrium path after a while. It can also be used to investigate the impact of short run shifts in the explanatory variables in the framework on the response of CO_2 emissions.

Different diagnostic tools are employed to verify the suitability and validity of the model estimated. The Breusch–Godfrey LM test (Breusch, 1978; Godfrey, 1978) is employed for checking the serial correlation of the residuals. Breusch–Pagan–Godfrey (BPG) test (Breusch & Pagan, 1979) and the Harvey test (Harvey, 1976) are used to examine heteroskedasticity. Additionally, the Akaike Information Criterion (AIC) is used to find the Lag structure of ARDL model. The methodological approach appears to be similar to the methodology adopted in empirical studies through which the environmental quality and macroeconomic variables in Asian economies are studied (Shahbaz et al. 2020; Dogan & Seker 2016).

Table 1: Variable description and Sources

Study Variable	**Variable Description**	**Data Sources**
CO_2	CO_2 (metric tons per capita)	WDI
EU	Energy use consumption (% of final consumption)	WDI
GLOB	KOF Globalization index	KOF swiss economic institute
GDP	Proxy for Economic Growth	WDI
REC	Renewable energy consumption (% of total final consumption)	WDI
RQ	Regulatory quality estimate	WDI
POPG	Annual Population Growth	WDI

Source: Author's compilation

4. Results and Discussion

This section reports and discusses the empirical results on the influence of carbon emissions, energy use, globalization, economic growth, population growth, renewable energy use and regulatory quality for the countries chosen for ASEAN.

Table 2 gives the descriptive statistics and shows that there is a lot of variation within the data. The descriptive statistics indicate that there is a wide range in CO_2 emissions per capita from 0.15 to 23.63 metric tons in average. Energy use averages 2058.66 kg per capita, with a high spread between 268.35 and 9699.30. The average value of globalization index is 59.16, and ranges from 22.46 to 84.18. The mean income is $10,635.93 and the median is $2,868.14; the difference is very great, suggesting great inequalities of income. Population growth is the average of 1.42 per cent (ranging from minus 4.17 per cent to plus 7.52 per cent). The range for renewable energy is somewhat wide, ranging from 0 to 85.80 percent and the average is 33.56 percent. The institutional strength in terms of regulatory quality varies from -2.35 to 2.25 with a mean value of -0.03. These differences indicate that there is a considerable economic and environmental difference between the countries examined.

Table 2: Descriptive Statistics

	CO_2	EU	GLOB	GDP	POPG	REC	RQ
Mean	4.6575	2058.66	59.16	10635.9	1.4152	33.56	-0.0305
Median	1.9572	702.47	61.45	2868.13	1.3810	30.10	-0.1125
Maximum	23.62	9699.30	84.18	67731.2	7.5230	85.80	2.2522
Minimum	0.1542	268.35	22.46	222.01	-4.1703	0.000	-2.3485
Std. Dev.	5.814	2527.5	14.880	16045.0	0.8896	27.56	1.0095
Observations	231	231	231	231	231	231	231

4.1. Stationarity Results

Table 3 reports the panel unit root results based on the ADF test. The results show that the variables are not stationary, as their p-values were insignificant at level. However, taking first differences makes all variables stationary at I(1). The findings suggest that the variables are stationary after differencing once, with a stationary relationship between the first differences of

the variables, indicating that they are integrated of order one, I(1), and hence can be tested for a possible long-run cointegrating relationship.

Table 3: Results of the Panel Unit Root Analysis

Variables	**ADF Test**	
	I(0)	**I(1)**
	T-Stat	**T-Stat**
LCO_2	-3.12883 (0.1013)	-18.24029 (0.0000)***
LEU	-1.27124 (0.6437)	-17.829 (0.0000)***
LGLOB	-3.73252 (0.44)	-19.46777 (0.0000)***
LREC	-1.4593 (0.5528)	-15.96136 (0.0000)***
LGDP	-2.88042 (0.487)	-18.24651 (0.0000)***
LPOPG	-1.84021 (0.3607)	-17.81808 (0.0000)***
RQ	-1.23328 (0.6601)	-15.05204 0.0000)***

*Note:**,*** indicates significance at 5% and 1% respectively.*

4.2. Lag Length Criteria

The lag selection criteria for AIC, SC, HQ, FPE and LR test are shown in Table 4. Most of the criteria (AIC, FPE and LR) suggest that lag 3 would be the most appropriate. Although SC indicates lag 1, lag 3 is the best overall. Hence, the lag of 3 is chosen for the long run estimation.

Table 4: Lag selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-300.7631	NA	1.75e-07	4.304378	4.449413	4.363313
1	1351.349	3119.372	3.20e-17	-18.11677	-16.95649*	-17.64529*
2	1409.937	104.8851	2.81e-17	-18.25087	-16.07535	-17.36684

3	1460.750	85.99088*	2.77e-17*	-18.27622*	-15.08547	-16.97965
4	1497.274	58.23412	3.38e-17	-18.10173	-13.89574	-16.39262

Note: indicates lag order selected by the criterion.*

4.3. Cointegration Test

The ARDL bounds testing approach was used to test for the stable long-run relationship between the variables in the study. Based on the results obtained in table 5, the F value (4.91) is higher than F upper critical value at given F significance level meaning that the mean values are significantly different. This provides some indication of a long-run relationship between the variables being studied.

Table 5: ARDL Bound Test

Test-Stat	Value	Significance Level	I(0)	I(1)
F-Statistic	4.910145	10%	1.99	2.94
		5%	2.27	3.28
		2.50%	2.55	3.61
		1%	2.88	3.99

4.4. ARDL-Based Long-Run Results

Once it is established that there is a cointegrating relationship between the variables, it goes on to estimate the long-run and short-run effects. Table 6 reports the long-run ARDL estimates which also support the presence of a stable equilibrium relationship, as was found in the bounds test results. The result is in line with the previous studies that analyzed the environmental and economic relations between developing and ASEAN countries. (Apergis & Ozturk, 2015; Shahbaz et al., 2013).

Table 6: Long run results of ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEU	0.868269	0.70514	1.231346	0.022
LGLOB	-1.71432	2.16357	-0.79236	0.0429
LGDP	1.895209	1.13695	1.66693	0.0972
LPOPG	0.966088	0.52227	1.849795	0.0659
LREC	1.00722	0.57535	1.750616	0.0816
RQ	-0.43159	0.47654	-0.90568	0.0366
C	-16.5352	5.67053	-2.91598	0.004

There is a positive and significant relationship between energy consumption (LEU) and CO_2 emission. An increase in energy use of 1% corresponds to an increase in carbon emissions of approximately 0.87%, indicating that there are environmental costs to an increase in energy use. This result is in line with the previous research which revealed that the more energy that is consumed the more environmental harm is caused, particularly for non-renewable energy sources (Ang 2007; Shahbaz et al 2013).

The relationship is on the contrary, negative and statistically significant between globalization (LGLOB) and CO_2 emissions. Increased integration with the global economy as found in this study by Shahbaz et al. (2017) may be one of the ways to mitigate the environmental impact by improving technologies, cleaner production processes and environmental consciousness.

The coefficient of GDP per capita (LGDP) is positive but not statistically significant in terms of CO_2 emissions. This suggests that there was an upward trend in carbon emissions with economic growth, however, the evidence is insufficient to conclude there is a significant long run effect. The findings are similar to the initial stages of the Environmental Kuznets Curve (EKC) proposed by Grossman and Krueger (1995) that indicates that economic growth could create environmental pressures in the early development stages.

Population growth (LPOP) also has a positive, but not statistically significant, coefficient. The estimated relationship between population growth and energy use does not appear to be statistically significant, but a larger population may result in increased environmental stress. This outcome is similar to that of Shahbaz et al. (2016) overall.

Consumption of renewable energy (LREC) is positively correlated with CO_2 emissions, although the correlation is not statistically significant. This result might look surprising, but it could be due to the transition energy structure of ASEAN countries where the growth of renewable energy has been happening in parallel to fossil fuels. Therefore, environmental gains from the use of renewable energy might not yet be big enough to reduce emissions from traditional energy sources (Nathaniel & Khan, 2020).

Lastly, the results show that the coefficient of the regulatory quality (RQ) is negative and statistically significant with CO_2 emissions. This fact underlines the potential gains to be realised from more effective implementation and enforcement of good environmental policies through the

creation of more effective regulatory institutions and governance. Overall, the findings align with the larger body of literature on the role of institutional quality on better environmental outcomes.

Table 7: Dynamic results of ARDL model

Variables	Coefficient Use	T-Value	Prob.*
LCO_2 (-1)	0.966416	56.2918	0.000***
LEU	0.819745	9.904656	0.000***
LEU(-1)	-0.559481	-4.865208	0.000***
LEU(-2)	-0.231104	-2.968208	0.0034***
LGLOB	-0.057573	-1.140538	0.0555*
LGDP	0.063648	3.121094	0.0021***
LPOP	0.032445	2.589966	0.0103**
LREC	-0.272885	-4.031884	0.0001***
LREC(-1)	-0.306711	4.389153	0.000***
RQ	-0.014494	-0.898186	0.037**
CointEq(-1)*	-0.033584	-6.380696	0.0000***
C	-0.555313	-1.565091	0.0192**

*Note: *,**,*** indicates significance at 10%, 5% and 1% respectively.*

The results of ARDL in Table 7 reveal that in the short run most variables are significant in the short run). The current energy use has a positive significant impact (0.82) while the lagged values of energy use have significant negative impacts which show short-run adjustment as reported by Shahbaz et al. (2013). In the short run, globalization has a negative effect on CO_2 emissions, albeit not statistically significant. The results are consistent with Zafar et al. (2019) who concluded that globalization can improve the environmental quality by reducing the carbon emission. At the same time, the result is consistent with the recent research showing that globalization–environment relationship is complex and context-dependent, depending on the aspects of globalization and the context being analyzed. For instance, Abbas et al. (2012) discovered contrasting environmental outcomes in South Asia of various forms of globalization. What they were discovering was that economic globalization consisted of an increase in carbon emissions, social and political globalization consisted of an improvement of the environment. Similarly, Mirziyoyeva and Salahodjaev (2023).

The relatively small short run impact of globalization, which this study is documenting, may be a counterbalancing impact of the three dimensions of globalization (economic, social and political) on the short term. Carbon emissions are also negatively affected, though to a much lesser extent

and in a statistically significant way (see below), which reinforces Dinda (2004) who argues that improved institutional quality can lead to improved environmental outcomes. The error correction term (ECT) is negative and significant and equals to −0.033, which is in line with the model reverting to its long run equilibrium after any short run disturbances. The coefficient estimated is about 3.3% per period to correct the deviation from the equilibrium level.

Table 8: Diagnostic Tests

Diagnostic Test	Null Hypothesis	Test statistics and probability
Breusch–Godfrey LM Test for Serial Correlation	No evidence of serial correlation was detected up to lag 2.	0.730975 (0.4828)
Test for Heteroskedasticity: Breusch-Pagan-Godfrey	Homoskedasticity	2.461311 (0.33)
Heteroskedasticity Test: Harvey	Homoskedasticity	1.273803 (0.1772)

The results of the validation of 'ARDL model is presented in Table 8. The Breusch-Godfrey test both the F-statistic and Obs*R-squared are insignificant, indicating that there is no serial correlation. Similarly, the Breusch-Pagan-Godfrey test and the Harvey test do not show any heteroskedasticity among the residuals, implying that errors in the model are homoskedastic and stable. In conclusion, the results indicated that there were no significant specification errors and that the model is statistically reliable.

5. Conclusion

The ARDL method is used to examine the short- and long-run determinants of CO_2 emissions in this study. The analysis takes into account some of the factors which are determinant for the environmental quality, including energy consumption, globalization, economic growth, population growth, renewable energy consumption, and quality of regulations. The results are used to confirm the long-run relationship between variables. More energy use leads to more CO_2 emission and more globalization or better regulation quality leads to less CO_2 emission. Population growth and GDP growth exert a positive effect on emissions, and there are relatively small estimates for the

impact of both. The uptake of renewable energy does not result in the anticipated emission reductions; this may be due to the fact that the developing world is still transitioning to cleaner energy systems, whilst still relying on traditional energy sources. The validity of the ARDL estimates was confirmed by the model diagnostics and no evidence of serial correlation and heteroskedasticity was found.

The research indicates that government and policy makers need to further invest in renewable energy to further accelerate the shift away from fossil fuels. Furthermore, the regulatory framework and regulatory capacities have to be strengthened to make the environmental standards effective. Transfer of technology and trade for an environmentally responsible globalization can also lower emissions. Finally, the challenge of integrating population and economic growth strategy with sustainability is crucial to ensure environmental and economic sustainability over the long-term.

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