International Journal of Environment and Climate Change

Volume 14, Issue 7, Page 364-370, 2024; Article no.IJECC.119410
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Causality of Environmental Degradation and Economic Growth in Indonesia

Sri Rahayu Budi Hastuti [a*], Didit Welly Udjianto [a], Rini Dwi Astuti [a] and Ilyasin Aditya Rahman [a]

[a] UPN Veteran Yogyakarta, Jl. SWK 104, Condongcatur, Depok, Sleman, Yogyakarta, 55283, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijecc/2024/v14i74277

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/119410

Original Research Article

Received: 03/05/2024
Accepted: 05/07/2024
Published: 09/07/2024

ABSTRACT

Nowdays, the issue of global warming is being widely discussed in all countries, both developed and developing countries, because of its negative impact on the environment. This study aims to develop an integrated analytical framework of causality between energy consumption, carbon emissions, financial development, trade openness, and economic growth in Indonesia, 1990-2021. This study provides research benefits in the form of a set of empirical evidence to assist in developing a series of key strategies that can improve environmental quality through sustainable development. With granger causality analysis and vector autoregression model, this study provides results that high economic growth and energy consumption can cause environmental degradation through increased carbon gas emissions.

**Corresponding author: E-mail: srirahayubudihastuti@upnyk.ac.id;*

Cite as: *Hastuti, Sri Rahayu Budi, Didit Welly Udjianto, Rini Dwi Astuti, and Ilyasin Aditya Rahman. 2024. "Causality of Environmental Degradation and Economic Growth in Indonesia". International Journal of Environment and Climate Change 14 (7):364-70. https://doi.org/10.9734/ijecc/2024/v14i74277.*

Keywords: Environmental degradation; financial development; trade openness; economic growth.

1. INTRODUCTION

Global warming has become a global issue, because it impacts sustainable development. The problem of global warming began to be raised to the surface at the Earth Summit in Rio de Janerio, Brazil in 1992. Before the Earth Summit was held, the issue of global warming was not taken too seriously, and was considered a common occurrence in every life or interaction between humans. However, with various studies and marked by various signs and impacts, global warming is getting more attention internationally. The Earth Summit held in Kyoto, Japan in 1997, increasingly solidified the world that global warming is the main enemy of humanity inhabiting the earth, so efforts are needed to overcome it comprehensively, integrated and sustainably. Likewise at the G20 Summit held in Rome, Italy in 2021, the leaders of the G20 member countries agreed to reduce global warming to 1.5 degrees Celsius. The correlation between renewable energy and CO2 emissions in BRICS nations (excluding Russia) from 1999 to 2014 was examined in a research study, it was determined that there exists a comprehensive three-way association involving energy, emissions, and affairs. Renewable energy positively influences real affairs, and vice versa, as indicated by the empirical results attained. Moreover, Brazil exhibits a similar three-way relationship with the other BRICS countries when compared to other nations [1].

Energy use drives economic rise [2-4]. However, energy use and carbon emissions have increased along with rapid economic as an important source of global warming and environmental degradation [5-8]. Environmental quality is declining where humans depend on the environment to fulfill basic needs by consuming natural resources [9]. Likewise, the financial sector indirectly affects the environment through its role in channeling loanable funds for productive projects [10]. The financial sector is a driver of economic development, The impact of the financial sector's development on the environment, such as environmental degradation [11].

Fossil fuels like coal, petroleum, and natural gas are being increasingly utilized to meet the growing energy demands driven by sustainable economic growth, industrialization, and urbanization. Nonetheless, this usage is also contributing to the release of greenhouse gases, leading to environmental pollution and adverse impacts on human health [12]. Many scholarly articles analyze the impact of non-renewable and renewable energy, capital formation, and economic growth on CO2 emissions in developing countries involved in the China Economic Silk Road (SREB) initiative. The findings indicate that increased use of renewable energy and greater capital formation can significantly reduce both long-term and short-term CO2 emissions in SREB nations [13]. In a different study, it was discovered that the connection between per capita income, CO2 emissions, and financial development from 1976 to 2015 had an energy impact. The study found that per capita income's influence on carbon emissions is not significant in the short term but becomes positively significant in the long term. Conversely, the relationship between energy and financial development showed a negative coefficient but was not statistically significant. This implies that at lower income levels, energy consumption contributes to environmental pollution, while at higher income levels, its negative impact on carbon emissions weakens in certain regions [14].

Evidence from many studies is that increases in carbon emissions are associated with increases in economic activity. This research fills the gap by involving energy consumption, as in [15] Sekrafi, et al., 2018; [16,17] establishes a reciprocal relationship between economic growth and carbon emissions. Emission reduction activities also have an impact on reducing economic growth. This research enriches literature studies on carbon emissions and environmental management by examining the relationship between energy consumption, carbon emissions, financial development, trade openness and economic growth in Indonesia, 1990-2021. Many developed countries have implemented various institutional changes to shift their economies to environmentally friendly energy sources while encouraging sustainable economic growth [18].

This study aims to create a framework for examining the combined influence of energy usage, carbon emissions, progress in the financial sector, trade liberalization, and economic expansion in Indonesia using causality analysis. The goal of this research is to offer empirical evidence that can aid in the formulation

of key strategies to enhance environmental quality through sustainable development. Furthermore, this study delves into the relationship between energy consumption trends, carbon emissions, financial sector advancement, trade openness, and economic growth. Such findings can assist policymakers in creating lasting strategies. Moreover, this study provides a thorough framework for policies aimed at maximizing the advantages of economic progress while ensuring environmental sustainability.

2. METHODOLOGY

This examine used Vector Autoregressive (VAR) which is a variation or mixture of multivariatse regression in time series analysis [19]. The principle difference among multivariate regression and multivariate time collection is advanced trying out within or between variables. In principle VAR analysis can be compared to simultaneous equation fashions, because it appears at several endogenous (related/structured) variables in one model. Every variable isn't best defined via it's past value, however is also motivated by way of the past of all other endogenous variables in the version underneath consideration. Further, VAR analyses normally do now not consist of exogenous (independent) variables in the model. The general VAR model with lag 1 is as follows [20].

$$Y_t = \alpha_{1i} + \sum \beta_{1i}\, Y_{t-1} + \sum \gamma_{1i}\, X_{t-1} + \varepsilon_t$$
$$X_t = \alpha_{1i} + \sum \beta_{1i}\, Y_{t-1} + \sum \gamma_{1i}\, X_{t-1} + \varepsilon_t$$

Variables Y and X reflect all variables in this study: carbon emissions (emission) is the amount of carbon emissions (thousands of tons); energy consumption (kons) is percentage of renewable energy intake (%); economic growth (pe) is real GDP increase (%); financial sector (keu) is broad money (M2) to GDP ratio (%); and trade openness (xm) is exports plus imports to GDP ratio (%).

3. RESULTS AND DISCUSSION

3.1 Unit Root Test

The data stationarity test is used to find out whether the data used is static or not. Stationary data shows that the data moves around the mean all the time. Analyzing time series data requires robust data. If the data is not stationary at zero or level, then it is necessary to test the level of integration to find out the extent of stationary data. The stationary test in Table 1 shows that all analysis data are stationary level so there is no need for integration level tests.

Table 1. Unit root test, I(0)

Variable	Prob I(0)	Conclusion
EMISSION	0.0076*	stationary
KONS	0.0762**	stationary
PE	0.0209*	stationary
KEU	0.0999**	stationary
XM	0.0228*	stationary

Note: * α = 5%, ** α = 10%

3.2 Granger Causality Analysis

The study included the creation of three distinct causality models. The initial model delves into the relationship between carbon emissions, energy usage, and economic expansion. The second model explores the causal links among carbon emissions, energy consumption, and the financial industry, while the third model focuses on the correlation between carbon emissions, energy usage, and global trade [21,22]. Analysis of the first model indicates a unidirectional causality between energy consumption and carbon emissions (Table 2). Specifically, an increase in energy consumption leads to higher carbon emissions, but not the other way around.

Table 2. Granger causality: Model 1

Null Hypothesis	F-Statistics	Prob.
KONS is not granger to cause EMISSIONS	3.92733	0.0487*
EMISSIONS are not granger cause KONS	0.43018	0.6600
PE is not granger to cause EMISSIONS	4.61030	0.0307*
EMISSIONS are not granger cause PE	0.17796	0.8390
PE is not granger causes CONS	1.77692	0.2079
KONS no granger causes PE	0.93591	0.4171

*Note: * significant at α=5%*

The relationship between economic growth and carbon emissions is such that economic growth leads to increased carbon gas emissions, but the opposite does not occur. Adebayo et al. [23-25] found that there is a positive correlation between economic growth and carbon emissions in Thailand. In South Asia, we see similar outcomes where economic growth initially leads to increased carbon emissions, and over time, higher carbon emissions result in further economic growth [26-29] analyzed Indian data using the NARDL model and discovered that over the long term, the rise in India's GDP per capita is correlated with an increase in carbon emission levels.

The relationship between economic growth and energy consumption is not causal (Table 2). Economic growth has no impact on raising energy consumption, and similarly, higher energy consumption cannot prompt an increase in economic growth [30,31]. Consequently, the combination of increased energy consumption and economic growth will result in heightened environmental pollution due to the greenhouse gas effect. So it needs to be a serious concern so that economic growth does not only pursue output growth, but must also pay attention to the problem of environmental degradation. Increasing income will not be meaningful if in the end it is only to finance a decline in the quality of life due to deteriorating health. An unhealthy workforce will certainly have an impact on productivity and ultimately reduce economic growth.

In Model 2, the data indicates that energy consumption unilaterally leads to an increase in carbon emissions (Table 3). Higher energy consumption results in elevated carbon emissions, while the reverse does not hold true. There is no established causal connection between the financial development and carbon emissions, or between the financial development and carbon gas emissions [32]. Similarly, Model 3 does not demonstrate any causality between international trade and carbon emissions, or between trade openness and carbon gas emissions (Table 4). This implies that the expansion of Indonesia's financial development and trade opennes is environmentally sustainable, thereby helping to alleviate the adverse effects of carbon emissions on the environment.

Climate change in supporting sustainable development is an interesting global issue, especially related to planning, management, and utilization of renewable energy resources and consumption [33]. Several research papers have found that higher energy consumption leads to faster economic growth, but it also serves as the primary driver of environmental degradation [34-36].

Table 3. Granger causality: Model 2

Null Hypothesis	F-Statistics	Prob.
KONS is not granger to cause EMISSIONS	3.92733	0.0487*
EMISSIONS are not granger cause KONS	0.43018	0.6600
KEU does not granger cause EMISSIONS	0.88524	0.4361
EMISSIONS are not granger Causes KEU	1.10457	0.3605
KEU no granger causes KONS	0.24755	0.7843
KONS no granger causes KEU	0.90376	0.4290

*Note: * significant at α=5%*

Table 4. Granger causality: Model 3

Null Hypothesis	F-Statistics	Prob.
KONS is not granger to cause EMISSIONS	3.92733	0.0487*
EMISSIONS are not granger cause KONS	0.43018	0.6600
XM does not granger cause EMISSIONS	2.67534	0.1225
EMISSIONS no granger cause XM	0.69567	0.5237
XM no granger causes KONS	0.56375	0.5879
KONS no granger causes XM	1.05140	0.3887

*Note: * significant at α=5%*

4. CONCLUSION

The correlation between energy consumption and economic growth has been demonstrated in various studies, and the findings are crucial for developing policies and strategies aligned with economic growth patterns in addressing energy consumption. Increased energy consumption and economic growth will cause increased environmental pollution through the greenhouse gas effect. Environmental degradation can occur along with high economic growth.

Environmentally friendly economic policies are a prerequisite for sustainable economic growth. Ways to address and overcome the problem of global warming can be through conserving the environment involves planting trees and restoring land with severe conditions. Plants survive through photosynthesis, a process that allows them to produce oxygen. Increasing the oxygen production by plants will result in a reduction of carbon gases in the atmosphere. Then using alternative energy, it has the potential to decrease our reliance on fossil fuels such as petroleum and coal. The combustion of fossil fuels leads to significant carbon gas emissions. Bio-energy, wind energy, geothermal energy, solar energy, and other forms of alternative energy can serve as replacements for non-renewable energy sources. It is also important for recycling and energy efficiency. Human activities often produce carbon-containing gases, for example the use of kerosene stoves. The air is filled with smoke containing carbon gas when using kerosene stoves. Hence, it is advisable to substitute kerosene stoves with biogas, which can serve as a heat energy source derived from repurposed organic waste. Finally, education about environmental issues in the public sphere is crucial. The global community must be informed and knowledgeable about environmental issues in order to collaborate effectively in addressing these challenges. It is essential to comprehend human thought processes and behaviors that affect the environment. This understanding will help raise awareness within society and cultivate an appreciation for the environment. In addition, society needs to enforce laws regarding environmental protection and preservation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ACKNOWLEDGEMENTS

I am thankful to the Institute for Research and Community Service at Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia for providing grant to this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119410