

DOI <https://doi.org/10.30525/978-9934-26-597-6-4>

THE IMPACT OF AI, ENERGY USE, ECONOMIC GROWTH AND EXPORTS ON CARBON EMISSIONS IN JAPAN

Atif Yaseen^{1,*}, Lidija Kraujalienė², Inga Bilinskienė³

¹*Islamic University of Indonesia, Indonesia*

²*Kazimieras Simonavičius University (KSU), Business Innovation
and Communication School, Vilnius, Lithuania*

³*SMK University of Applied Social Sciences, Kaunas, Lithuania*

**Corresponding author's e-mail: atifyaseen441@gmail.com*

Abstract

In the past few decades, technology has played an important role in the development of countries, one of which is Artificial Intelligence. AI tools are used to help economic processes, resulting in a country's growth. However, these AI tools require more energy to process. While AI contributes to development, it also threatens environmental sustainability globally. Academic scholars have different opinions about AI tools. Some say AI helps with economic growth and environmental sustainability, while others argue that AI supports economic growth but harms the environment. This research aims to find out whether AI helps or harms the environment in Japan by using the econometric technique ARDL model to examine the short-run and long-run impacts from 1995 to 2024. The outcomes of the research indicated that artificial intelligence and energy use have a positive impact on carbon emissions in Japan, as a result of economic growth. Conversely, exports have a negative impact on carbon emissions. The novelty of the research lies in the interconnection between artificial intelligence, energy use, and carbon emissions. This research offers suggestions for stakeholders to help improve the environment. The contribution of this research is that it offers recommendations for formulating policies that can guide stakeholders in mitigating emissions while fostering artificial intelligence development.

Keywords: artificial intelligence, energy use, economic growth, carbon emissions, sustainability

1 Introduction

In the recent past, the role of technology has increased in the development of a country's growth. This role of technology depends on energy use. However, the growing use of artificial intelligence has a significant impact on

energy consumption and economic growth but, at the same time, increases carbon emission levels, creating a complex and interconnected relationship that needs to be carefully considered. Today, there is a major concern for future generations because emission levels are rising due to the development of artificial intelligence systems (Tomlinson et al., 2024). Total global carbon emissions increased between 2022 and 2023 (Crippa et al., 2023). At the same time, energy use per person increased from 2022 to 2023 (Our World in Data (OWID), 2024). These two reports highlight that both energy consumption and carbon emissions have increased in recent years. Similarly, AI tools can help create an eco-friendly environment. But how much energy do they consume, and is their environmental cost greater or smaller than their impact on fighting climate change? (Monica de Bolle, 2024).

Energy, ecology, and environmental issues are closely connected in human activities. The increased amount of carbon emissions is a global concern due to the energy required for further development in countries (Zhang et al., 2024). Energy is an important element for a country's development as it is needed for local requirements and business activities, and the growth of these sectors depends on energy levels (Pratiwi et al., 2020). The imbalance between economic growth and the increasing levels of emissions has become a serious global issue. In this regard, Brock and Taylor argue that sustainable economic growth involves not only fostering economic growth but also improving the environment (Brock et al., 2005). Moreover, since the 19th century, Reverend Thomas Malthus has been one of the first to discuss the impact of economic activities on environmental quality (Glass et al., 1976).

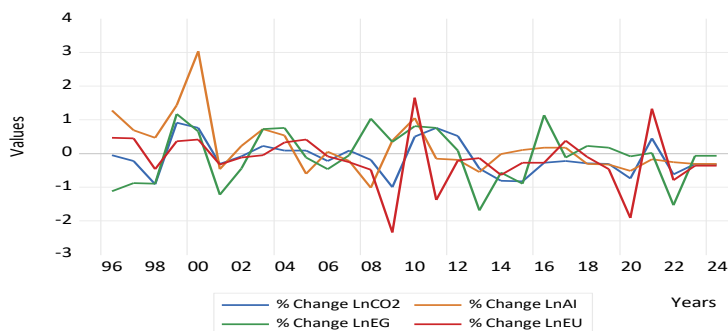


Fig. 1. Trend analysis of the study variables in Japan from 1995 to 2024 (i.e., economic growth, artificial intelligence, carbon emissions and energy use) (prepared by authors, 2025)

The impact of artificial intelligence on the environment remains a subject of ongoing debate, with differing views on whether it is more detrimental or less. However, with this economic growth comes the need for increased energy consumption, raising an important question: Does the energy used for artificial intelligence development contribute to economic development, or does it simultaneously result in increased emissions? This concern underscores a crucial debate about whether the development of artificial intelligence is ultimately beneficial or harmful to the environment in Japan. This research examines the short-run and long-run impacts of carbon emissions along with other variables between 1995 and 2024 in Japan using the econometric ARDL model.

This research investigates the impact of artificial intelligence, energy use, economic growth, and exports on CO₂ emissions in Japan from 1995 to 2024. The study aims to examine how these factors affect environmental sustainability in Japan.

Research Objectives

This research focuses on addressing the following research objectives:

- To analyze the effect of artificial intelligence, energy use, economic growth, and exports on carbon emissions in Japan.
- To develop a model and estimate the long-run and short-run relationships between artificial intelligence, energy use, economic growth, and exports on carbon emissions in Japan.
- To assess the environmental impact – whether beneficial or harmful – of artificial intelligence, energy use, and carbon emissions on Japan's economic growth.

Research Methods

The main purpose of this research is to examine the connection between artificial intelligence, energy use, economic growth, exports, and carbon emissions. This research also investigates the short-run and long-run impacts of artificial intelligence, energy use, economic growth, and exports on carbon emissions in Japan. To achieve the research objectives, this study uses the Autoregressive Distributed Lag (ARDL) econometric technique. This technique is suitable for examining both the short-run and long-run relationships between the variables and provides insights into the outcomes in both the long run and short run. Additionally, this research employs various diagnostic tests to improve the accuracy of the research outcomes.

Conclusion

This research examines the relationship between artificial intelligence, energy use, economic growth, and carbon emissions in Japan from 1995 to 2024 using the ARDL econometric model. The findings highlight that while

AI contributes to economic growth, it also increases energy consumption and carbon emissions, raising concerns about environmental sustainability. The results indicate that AI's impact on the environment is complex, with both short-run and long-run implications. Policymakers must balance economic benefits with environmental responsibility by implementing strategies that mitigate emissions while supporting AI-driven development.

The study's findings provide a strong foundation for formulating policies that guide stakeholders in mitigating emissions while fostering artificial intelligence development. These policy implications have the potential to promote environmental sustainability, not only in Japan but globally (South Asian Association for Regional Cooperation (SAARC) and the Asia-Pacific region), especially in other countries advancing their artificial intelligence sectors.

References

- [1] Brock, W. A., & Taylor, M. S. (2005). Chapter 28 Economic Growth and the Environment: A Review of Theory and Empirics. In *Handbook of Economic Growth* (Vol. 1, Issue SUPPL. PART B). [https://doi.org/10.1016/S1574-0684\(05\)01028-2](https://doi.org/10.1016/S1574-0684(05)01028-2)
- [2] Crippa, M., Guizzardi, D., Pagani, F., Banja, M., Muntean, M., Schaaf, E., Becker, WE., Monforti-Ferrario, F., Quadrelli, R., Risquez Martin, A., Taghavi-Moharamli, P., Köykkä, J., Grassi, G., Rossi, S., Melo, J., Oom, D., Branco, A., San-Miguel, J., & Vignati, E. (2023). GHG emissions of all world countries. In *Publications Office of the European Union* (Issue KJ-NA-31-658-EN-N (online), KJ-NA-31-658-EN-C (print)). <https://doi.org/https://edgar.jrc.ec.europa.eu/>
- [3] Glass, D. V., & Appleman, P. (1976). Thomas Robert Malthus: An Essay on the Principle of Population. *Population Studies*, 30(2). <https://doi.org/10.2307/2173616>
- [4] Monica de Bolle. (2024). *AI's carbon footprint appears likely to be alarming*. <https://doi.org/https://www.piie.com/blogs/realtime-economics/2024/ais-carbon-footprint-appears-likely-be-alarming>
- [5] Our World in Data (OWID). (2024). *Our World in Data*. <https://ourworldindata.org/>
- [6] Pratiwi, S., & Juerges, N. (2020). Review of the impact of renewable energy development on the environment and nature conservation in Southeast Asia. In *Energy, Ecology and Environment* (Vol. 5, Issue 4). <https://doi.org/10.1007/s40974-020-00166-2>

[7] Tomlinson, B., Black, R. W., Patterson, D. J., & Torrance, A. W. (2024). The carbon emissions of writing and illustrating are lower for AI than for humans. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-54271-x>

[8] Zhang, Y. Q., Li, L., Sadiq, M., & Chien, F. S. (2024). The impact of non-renewable energy production and energy usage on carbon emissions: Evidence from China. *Energy and Environment*, 35(4).