

Income Disparities and Environmental Dynamics: Exploring Varied Impacts of Renewable Energy, Innovations, and Economic Growth on CO₂ Emissions

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ABSTRACT

The study explores the moderating effect of income on the long-run interrelationships between energy consumption, economic growth, and environmental degradation to test the environmental Kuznets curve (EKC) hypothesis. Data for 190 countries across 1990-2020 is divided into three panels (low-income, middle-income, and high-income) based on the World Bank classification. The study employs the second-generation augmented mean group (AMG) and common correlated effects mean group (CCEMG) estimators that account for cross-sectional dependence and slope heterogeneity among panels. Bidirectional associations among variables are analyzed via the panel Granger-causality test of Dumitrescu and Hurlin (2012). Findings suggest a linear association between economic growth and CO₂ emissions for LICs, providing evidence against the EKC hypothesis. Nevertheless, the EKC hypothesis is validated for MICs and HICs, indicating the decoupling of growth-environment associations at higher income levels. Consequently, HICs have reached their inflection point in 2014, whereas MICs are expected to reach their inflection point by 2053. Further, nuclear energy is negatively associated with CO₂ emissions for MICs and HICs, but not for LICs. In addition, innovations magnify the mitigating effects of renewable energy for all income classifications. The Granger-causality analysis depicts mixed causalities, indicating a differential effect of income on the energy-growth-environment nexus.

Keywords: CO₂ emissions, Nuclear energy, EKC hypothesis, Innovations, Panel cointegration, Granger-causality