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Does Growth Clean Up After Itself? A Multi-Gas Test of the Environmental Kuznets Curve

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ABSTRACT

This study reexamines the Environmental Kuznets Curve (EKC) hypothesis in developing economies, identifying which greenhouse gas CO_2, CH_4, or N_2O most influences environmental degradation, and combining all three into a composite index via Principal Component Analysis. Using a cleaned panel of 51 developing economies, 2000–2024. The study estimates two-way fixed effects models, an Anderson–Hsiao dynamic-panel check, and a cross-sectional dependence robust CCEMG estimator. The inverted-U EKC holds only for N_2O under fixed effects (turning point ≈ US$6,000 GDP per capita, already crossed by 23% of the sample), though CCEMG motivated by a Pesaran CD test confirming strong cross-sectional dependence tempers this to a directional rather than significant result. Evidence for CO_2, CH_4, and the composite index remains weak throughout. Renewable energy consistently lowers CO_2 emissions; nonrenewable energy is the strongest, most robust driver of degradation across specifications; urbanization raises emissions significantly. These results show that EKC conclusions in developing economies depend heavily on which pollutant is used and which econometric technique is applied, with implications for energy and industrial policy.

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1. Introduction

Global warming and environmental degradation driven by greenhouse gas (GHG) emissions remain among the most consequential challenges facing the global economy. Since the industrial revolution, the pursuit of economic growth has been accompanied by a persistent rise in GHG emissions and particularly carbon dioxide (CO_2) contributing to ozone depletion, rising global mean temperatures, and increasingly visible physical effects such as accelerated sea-ice loss, rising sea levels, and more frequent extreme heat events. Carbon dioxide remains the single largest anthropogenic GHG by volume, but methane (CH_4) and nitrous oxide (N_2O) are also major contributors to radiative forcing and are disproportionately linked to agriculture, livestock, and industrial waste sectors that make up a larger share of economic activity in developing than in advanced economies. Developing economies, in aggregate, are now the fastest-growing source of global GHG emissions: fuel-related carbon emissions in developing countries rose sharply between

1990 and the early 2010s, and multiple international assessments have projected further increases without significant policy intervention (IEA, 2015; OECD projections cited in Sohag, Al Mamun, Uddin, & Ahmed, 2017).