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# The Role of Fossil Fuels and Renewable Energy as Production Inputs in Shaping Economic Growth: Evidence from BRICS Using a CS-ARDL Panel Approach

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## Abstract

This paper examines the contributions of fossil fuel and renewable energy production to economic growth in BRICS countries over 1996–2023, employing a Cross-sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) panel model as the core methodology to account for cross-sectional dependence, slope heterogeneity, and both short- and long-run dynamics, complemented by robustness checks including Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), panel quantile regression for distributional effects, and Granger causality tests. Empirical findings reveal that both energy types positively influence growth, with fossil fuels exerting stronger short-run impacts and renewables delivering sustained long-run benefits, consistently validated across methods and quantiles, alongside bidirectional causality that confirms a robust energy-growth nexus. These results underscore the need for balanced policy strategies in interconnected BRICS economies, leveraging fossil fuels for immediate expansion while prioritising renewable diversification to enhance long-term resilience and sustainability.

**Keywords:** Energy–growth nexus, BRICS economies, CS-ARDL panel model, Sustainable development