Research article

From black to green: Quantifying the impact of economic growth, resource management, and green technologies on CO_2 emissions

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ABSTRACT

In an exploration of environmental concerns, this groundbreaking research delves into the relationship between GDP per capita, coal rents, forest rents, mineral rents, oil rents, natural gas rents, fossil fuels, renewables, environmental tax and environment-related technologies on CO_2 emissions in 30 highly emitting countries from 1995 to 2021 using instrumental-variables regression Two-Stage least squares (IV-2SLS) regression and two-step system generalized method of moments (GMM) estimates. Our results indicate a significant positive relationship between economic growth and CO_2 emissions across all quantiles, showcasing an EKC with diminishing marginal effects. Coal rents exhibit a statistically significant negative relationship with emissions, particularly in higher quantiles, and mineral rents show a negative association with CO_2 emissions in lower and middle quantiles, reinforcing the idea of resource management in emissions reduction. Fossil fuels exert a considerable adverse impact on emissions, with a rising effect in progressive quantiles. Conversely, renewable energy significantly curtails CO_2 emissions, with higher impacts in lower quantiles. Environmental tax also mitigates CO_2 emissions. Environment-related technologies play a pivotal role in emission reduction, particularly in lower and middle quantiles, emphasizing the need for innovative solutions. These findings provide valuable insights for policymakers, highlighting the importance of tailoring interventions to different emission levels and leveraging diverse strategies for sustainable development.

1. I. introduction

Carbon dioxide (CO_2) emissions have emerged as a substantial worldwide issue, directly contributing to climatic changes and its detrimental effects on environment and humankind. Coal undoubtedly presents an environmental concern due to its impact on CO_2 emissions, particularly in countries wealthy in coal assets. Coal is the single greatest source of overall CO_2 emissions, accounting for approximately 40% of all CO_2 emissions in 2021 (IEA, 2022). While coal has had significant historical and monetary significance, its utilization as an energy source certainly presents a sizeable barrier to reducing carbon emissions (Williams, 2023). Businesses focused on coal extraction in countries with abundant coal reserves significantly influence global CO_2 emissions because of the extremely high intensity of emissions (Weber et al., 2021). Income created from mining coal, also known as coal rents, could

hypothetically affect emissions levels (Nwani and Adams, 2021). Furthermore, coal usage and forest depletion are interconnected, with a unidirectional causality observed, where increased coal consumption leads to deforestation and, consequently, higher CO_2 emissions (Zaman et al., 2017). The global forest carbon stock is expected to be approximately 662 billion tons, which accounts for about two-thirds of the total atmospheric carbon (FAO, 2020). Hence, forest ecosystems are vital carbon sinks, crucial in mitigating climate change by absorbing CO_2 emissions (Kundzewicz et al., 2023). However, profit-driven forest management models can inadvertently lead to higher CO_2 emissions (Zhang et al., 2022). Preserving natural forests and preventing plantation expansion are crucial approaches for lowering CO_2 emissions, emphasizing the significance of sustainable forest management and expansion (Favero et al., 2023; Piabuo et al., 2023). Mineral rentals can decrease CO_2 emissions utilizing mineral carbonation, transforming CO_2

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