

IS THE SINGLE-BUYER MODEL A BARRIER TO CLEAN ENERGY? EMPIRICAL EVIDENCE ON DECARBONIZATION AND RENEWABLE ENERGY SUPPLY IN DEVELOPING COUNTRIES

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Overview

This paper compares the energy transition performance of the Single-Buyer Model (SBM) and the Competitive Wholesale Electricity Market (WEM) in 63 emerging and developing countries. Using propensity score matching and panel data analysis, we analyze renewable energy share in supply and carbon emission performance of different market models between 2010 and 2022. Results reveal that the competitive electricity market model has not outperformed the single-buyer model in increasing renewable energy share in generation and reducing carbon emission intensity. Despite early criticisms labeling the single-buyer model as a “dangerous path” for developing countries, our results suggest that contextual factors, particularly the regulatory framework for renewable energy investments, significantly affect outcomes. The findings emphasize the need for tailored market designs and regulatory reforms to balance efficiency, equity, and sustainability in transitioning power systems.

Methods

We employ two major empirical analyses to investigate the impact of market type on renewable energy share and carbon intensity. First, we start analysis using Propensity Score Matching (PSM) methods. Matching methods are widely used in comparative analyses, especially within observational studies, as they enable researchers to construct comparable groups by aligning units with similar covariate profile. This alignment facilitates more accurate estimation of differences by mitigating potential confounding biases, thereby reducing model dependence and enhancing the robustness of causal inferences.

In addition, to account for unobserved heterogeneity across countries and over time, we apply a fixed-effects regression model that controls for time-invariant characteristics within each country that could also confound the relationship between market type and renewable energy supply/carbon intensity. We exploit the ratification of the Paris Agreement as an exogenous shock to mitigate issues associated with unobserved time-varying heterogeneity, and further isolate the impact of market structure on renewable energy adoption and carbon emissions.

The main variables of interest are renewable energy share and carbon intensity of the power sector. As for renewable energy technologies, we only include wind and solar technologies in the analysis, because these technologies are less dependent on geographical conditions (contrary to hydro and geothermal), and there is more investment flexibility due to small-scale investment options. Due to the lack of available data, we only compare carbon intensity and renewable energy supply performance, and we do not compare the economic performance (unit investment costs and system costs) of markets.

Results

Empirical analysis shows that there is no statistically significant performance difference, on average, between the single-buyer and competitive electricity market models in renewable energy supply and carbon intensity in developing countries. While these results seem counterintuitive to the earlier arguments presented literature, there are several critical factors that can explain these outcomes. Based on existing discussions and our findings, we can list some of these factors as follows:

- Small market size and limited capacity for investment
- Financial constraints and high-risk premiums for private investors
- Prevalence of mixed ownership:
- Available resources, technological lock-ins, and new technologies
- Transmission capacity and infrastructure limitations:
- Policy and regulatory frameworks

Besides, many countries with SBM have improved their regulatory framework to support renewable energy technologies, and the gap between countries with WEM in regulatory framework quality has decreased over time. This progress also shows that there is no "one-size-fits-all" approach in designing these policies. Regulatory and legal frameworks must align strategic policy targets (energy security and affordability) with sustainability goals (decarbonization) and ensure regulatory flexibility to respond to technological advancements and market disruptions.

Conclusions

The effectiveness of competitive electricity markets in developing countries in promoting operational efficiency has long been debated, and the literature has highlighted that electricity market reforms may not create better economic and operational performance due to the structural issues in these countries. Now, these countries are struggling with the growing financial burden of the energy transition, and the proposed market structure has shifted from fully competitive electricity market models to "hybrid market models", in which the government takes a more active approach by designing long-term generation mix in line with sustainability goals, whereas markets are used for short-term resource allocation.

In this paper, we compared the renewable energy supply and carbon emission performance between different market models in developing countries. Our analysis has shown that there was no statistical difference between competitive market model and the single-buyer model in renewable energy supply and carbon intensity between 2010 and 2022. The progress in decarbonization was mostly driven by the regulatory framework to support sustainable energy technologies, and countries in the latter group closed the gap in regulatory framework quality in recent years.

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