CHARTING THE ENERGY TRANSITION: RETHINKING GREEN POLICY STRATEGY AND SUSTAINABLE TECHNOLOGY INTEGRATION FOR ENERGY EFFICIENCY GAINS – SECTORAL EVIDENCE FROM EUROPE

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Overview

The European Union's goal of achieving carbon-neutrality is tied to the successful implementation of energy transition strategies. Traditionally, energy transition has focused on improving energy efficiency, but this view overlooks crucial factors such as the energy savings rate, which better reflects the decoupling of fossil fuel dependence. The paper investigates the impact of integrating sustainable technologies and climate action on energy efficiency gains within the European economy, industry, and services sectors. It examines the effectiveness of different green policy strategies and how sustainable technology integration responds to various policy frameworks, which is often underexplored in existing literature.

Methods

The analysis employs panel quantile regression within an instrumental variables (IV) framework. This methodology allows for a more robust analysis of energy efficiency gains across different performance tiers, addressing potential endogeneity issues that could arise from policy variables. The study uses a dataset spanning the EU-28 from 2010 to 2019, integrating multiple sources to create a comprehensive dataset. Besides the whole economy level, the industry, and services sectors are considered in this framework for the first time. The energy savings rate, derived from the energy efficiency index (which accounts for changes in energy consumption at the sector level), is central to the analysis. The study also uses policy data from EU directives and green fiscal policies to assess the impact of sustainable technologies and climate action.

Results

The analysis shows that the energy efficiency index, which measures energy savings, is a superior indicator for tracking energy efficiency gains compared to traditional energy intensities. It is particularly useful as it eliminates structural changes and factors unrelated to energy efficiency, providing a more accurate representation of energy transition progress. Econometric results indicate that both climate and energy taxes negatively affect energy efficiency gains across different performance tiers (low, medium, high). This negative impact suggests that such taxes may discourage investment in energy efficiency improvements, particularly in industries and sectors with lower energy performance. Investment in energy-related research and development (R&D) has a positive effect on energy efficiency gains, especially in countries at the low (Q25) and high (Q75) tier. This suggests that green technology innovation and knowledge dissemination through public investment can foster significant energy efficiency improvements. The use of an instruments' mix combining various green policies was found to be less effective in driving energy efficiency gains across the tiers considered (Q25, Q50, Q75). The evidence suggests that a more targeted policy approach, rather than a broad mix, may be more efficient in achieving energy efficiency goals. As regards, the sustainable technologies and green policy, the integration of green technologies (such as renewable energy and eco-innovation) shows a strong positive impact on energy efficiency across different policy regimes. Policies that promote renewable energy use and climate responsibility are particularly effective in supporting energy transition, underlining the importance of tailored green policies.

Conclusions

The study concludes that energy-related R&D plays a partial but significant role in driving energy efficiency gains, particularly for countries at the low and high performance tiers. However, the broader policy mix appears to be ineffective in driving substantial energy efficiency improvements, with evidence showing negative impacts across performance tiers. Sustainable technologies**,** especially renewable energy, eco-innovation, and climate action policies, emerge as key drivers in enhancing energy efficiency and supporting energy transition within the EU. The findings emphasize the importance of more targeted policy approaches and green technology integration to achieve the EU's climate-neutrality objectives.