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Nexus Between Renewable Energy Policy, Consumption, and Economic Growth in Asian Countries

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This paper examines the nexus between renewable energy policies, consumption, and economic growth in Asian countries. Using a dynamic GMM model, the study finds that renewable energy policies positively impact both renewable energy consumption and economic growth, but renewable energy consumption hinders economic growth. The research emphasizes the need for well-designed policy frameworks that support renewable energy transitions and foster economic growth in the Asian countries.

I. Introduction

The shift toward renewable energy reduces dependence on fossil fuels while fostering new industries, jobs, and technologies that contribute to economic growth. However, existing research reveals an inconsistent relationship between renewable energy consumption and economic growth. Some studies suggest that renewable energy consumption can drive economic growth, particularly in countries with supportive policies for renewable energy transition (Guliyev & Tatoğlu, 2023; Inglesi-Lotz, 2016). Conversely, other research indicates that such consumption may actually hinder economic growth (Doytch & Narayan, 2021; El-Karimi & El-houjjaji, 2022; Lahrech et al., 2024), while some studies find no significant impact (Aslan et al., 2022; Doytch & Narayan, 2021).

Renewable energy policies are widely recognized for their crucial role in reducing greenhouse gas emissions, enhancing energy security, and promoting both renewable energy consumption and economic growth. These policies help drive economic progress by encouraging investment and innovation in renewable energy technologies (OECD, 2017), as well as by promoting sustainable energy management and conservation practices (Khalfaoui et al., 2024). Empirical evidence shows that such policies can spur investment, technological innovation, and job creation, reducing reliance on fossil fuels and supporting economic development (Jaraite-Kazukauske et al., 2015; Li & Leung, 2021). Additionally, various studies confirm that incentives like tax breaks and subsidies are effective in boosting renewable energy consumption, which in turn can lead to significant economic growth (Bui & Bui, 2023; Filimonova et al., 2021; Nguyen, 2022).

Despite extensive research, the relationship between renewable energy consumption and economic growth remains inconclusive. While some studies support a one-way or two-way causal relationship and the green growth hypothesis (Aslan et al., 2022; Doytch & Narayan, 2021; Guliyev & Tatoğlu, 2023; Inglesi-Lotz, 2016), others report negative or insignificant effects, often attributing these results to the high costs associated with energy transition (Brady & Magazzino, 2018; Lahrech et al., 2024). These mixed findings highlight the need for further investigation, especially in regions like Asia, where the context-specific factors play a significant role in shaping these dynamics.

This study examines how renewable energy policy and consumption influence economic growth. It aims to (i) assess both the direct and indirect effects of renewable energy policy on economic growth, and (ii) revisit the impact of renewable energy consumption on economic growth. Employing a dynamic GMM model with data from Asian countries between 2010 and 2021, the study finds that renewable energy policies have a positive impact on both renewable energy consumption and economic growth, whereas renewable energy consumption appears to hinder economic growth. The research contributes by (i) confirming the role of renewable energy policies in promoting economic growth through increased consumption, (ii) showing the negative effect of renewable energy consumption on economic growth once endogeneity is addressed, and (iii) focusing the analysis on Asian countries with diverse energy resources and policy frameworks.

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II. Data and Methodology

A. Theoretical framework

Renewable energy policies play a dual role in facilitating the transition from fossil fuels to renewable energy sources while promoting economic growth. The mechanisms through which renewable energy policies contribute to economic growth include: (i) fostering investment and innovation in energy technology and supporting the development of the renewable energy production industry (Jaraite-Kazukauske et al., 2015); (ii) establishing frameworks for efficient energy management, conservation, and utilization (Khalfaoui et al., 2024); and (iii) ensuring energy security and environmental protection (Li & Leung, 2021; OECD, 2017). In addition, policies promoting renewable energy consumption indirectly influence economic growth by stimulating renewable energy use, with renewable energy consumption affecting economic growth. While the evidence suggests that renewable energy policy positively impacts economic growth, the indirect effect remains unclear due to the inconsistency in the relationship between renewable energy consumption and economic growth.

B. Empirical model

Renewable energy consumption is an important aspect of overall consumption, reflecting the usage patterns of households and businesses and thus influencing both consumption and investment levels. The extent of renewable energy consumption is largely determined by policy measures that encourage investment in renewable energy production, infrastructure, and technology. Consequently, both renewable energy policy and consumption play significant roles in shaping economic growth.

Institutional theory highlights how the structure and quality of institutions influence economic outcomes. Within this framework, a country's output is determined not only by capital and labor but also by relevant policies and institutional arrangements. The empirical model therefore includes renewable energy policy and consumption as key determinants of economic growth, and is specified as follows:

$$\begin{aligned} LnY_{it} = \ & \alpha + \beta_1 LnK_{it} + \beta_2 LnL_{it} \\ & + \beta_3 REP_{it} + \beta_4 REC_{it} + Z_{it}\theta + \varepsilon_{it} \end{aligned} \quad (1)$$

$$REC_{it} = \gamma_0 + \gamma_1 REP_{it} + \vartheta_{it} \quad (2)$$

Here, Y denotes output, \$K\ \$represents capital, and L stands for labor—these are the traditional factors of production in mainstream economic growth models. REP refers to the renewable energy policy index, REC indicates renewable energy consumption, Z is a vector of country-level control variables, and ε and ϑ represent random error terms. The subscripts i and t denote country and time, respectively.

To address the potential endogeneity between renewable energy policy, renewable energy consumption, and economic growth, the study employs a dynamic GMM model. This approach uses lagged differences of the variables as instrumental variables, helping to resolve endogeneity issues. As a result, the estimated coefficients from this model are expected to be unbiased and consistent.

C. Data

The data are drawn from three databases. The World Development Indicators database provides information on economic growth, capital accumulation, labor, renewable energy consumption as a percentage of GDP, and country-level control variables such as population and urbanization rate. Data on renewable energy policy are sourced from the Regulatory Indicators for Sustainable Energy database, developed by the World Bank, which assesses renewable energy policies at the country level using a scale from 0 to 100. To capture institutional differences across countries, the study incorporates the Control of Corruption Index from the Worldwide Governance Indicators, which ranges from -2.5 to +2.5. The sample comprises 432 observations from 36 Asian countries spanning the years 2010 to 2021. Summary statistics for the main variables are presented in Table 1.

III. Estimated Findings

The study examines how renewable energy policy and consumption influence economic growth, using a dynamic GMM approach. To ensure the robustness of the results, FEM and GSEM models are also applied. Models 1 and 2 correspond to the Equations (1) and (2) described in Section II, with detailed empirical findings presented in Table 2.

The dynamic GMM model results reveal that renewable energy policies have a positive effect on economic growth in Asian countries, and this finding is consistent across all three estimation methods. Such policies stimulate investment, infrastructure development, and the emergence of new energy sectors, while also enhancing energy security, improving resource efficiency, and supporting environmental protection. By facilitating the shift toward renewable energy and advancing Net-Zero commitments, renewable energy policies contribute substantially to economic growth, as also documented in studies of the European Union, low-income, and South Asian countries (Jaraite-Kazukauske et al., 2015; Khalfaoui et al., 2024; Li & Leung, 2021).

Furthermore, renewable energy policies indirectly impact economic growth by encouraging renewable energy consumption. The results indicate that these policies significantly boost renewable energy consumption in Asian countries (1.921, statistically significant at the 1 percent level). Both theoretical and empirical research confirm that increased renewable energy consumption tends to promote economic growth (Filimonova et al., 2021; Guliyev & Tatoğlu, 2023; Inglesi-Lotz, 2016). However, this study identifies a slight negative effect of renewable energy consumption on economic growth (-0.0015, also statistically significant at the 1 percent level). As a result, the indirect effect of renewable energy policy on growth is negative. This outcome may be due to the high and inefficient costs associated with transitioning from traditional to renewable energy sources—especially in fossil fuel-rich regions like

Table 1. Descriptive statistics

	Average	Standard deviation	Min	Max
Log GDP per capita	8.643	1.302	6.370	11.594
Log capital	7.366	1.370	3.920	10.324
Log of labor	16.179	1.673	13.426	20.476
Renewable energy consumption (% GDP)	18.945	22.885	0.000	87.300
Renewable energy policy index	31.797	23.701	0.000	89.000
Control of corruption	-0.377	0.924	-1.974	2.884
Urbanization rate	58.886	25.308	16.768	100.00
Log of Population	17.010	1.685	13.994	21.070

Note: This table report descriptive statistics of all variables used in this study.

Table 2. Impacts of renewable energy policy and consumption on economic growth

	Fixed effects model		GSEM Model		Dynamic GMM model	
	Renewable energy consumption (Model 2)	GDP per capita (Model 1)	Renewable energy consumption (Model 2)	GDP per capita (Model 1)	Renewable energy consumption (Model 2)	GDP per capita (Model 1)
Renewable Energy Policy	1,092***	0.0336***	1,730*	0.0353***	1,921***	0.0380***
	(0.2360)	(0.0120)	(1.0450)	(0.0132)	(0.1260)	(0.0055)
Log of Capital		0.402***		0.591***		0.587***
		(0.0295)		(0.0219)		(0.0096)
Labor log		0.847***		0.322***		0.478***
		(0.2040)		(0.0614)		(0.0283)
Renewable Energy Consumption		-0.0074***		-0.0032***		-0.0015***
		(0.0022)		(0.0009)		(0.0004)
Control corruption		0.0939***		0.159***		0.148***
		(0.0260)		(0.0228)		(0.0099)
Urbanization rate		0.0238***		0.0109***		0.0124***
		(0.0055)		(0.0012)		(0.0005)
Log of population		-1,742***		-0.333***		-0.479***
		(0.2450)		(0.0618)		(0.0286)
Contants	22.33***	20.28***	13.59***	4,209***	12.99***	4,215***
	(0.7500)	(1,8450)	(3,4190)	(0.2520)	(0.3990)	(0.1110)
Number of observations	432	432	432	432	432	432
R-squared	0.051	0.542				

Note: Standard deviations are presented in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

the Middle East and Central Asia, where significant infrastructure investments are necessary (Brady & Magazzino, 2018; Lahrech et al., 2024). High initial investment costs, disruptions in traditional industries, and unstable energy supplies can negatively affect economic growth during the early stages of renewable energy transformation.

The findings are consistent across the FEM, GSEM, and dynamic GMM estimation methods. The dynamic GMM approach addresses endogeneity issues, resulting in unbiased estimates. The results show a stronger direct effect of renewable energy policy and a negative effect of renewable energy consumption on economic growth. Capital and labor remain positive and significant drivers of growth, as predicted by mainstream economic theories. The influence of corruption supports the "sand the wheels" hypothesis and aligns with new institutional theory. Altogether, these empirical results validate the estimated model.

IV. Conclusion

Renewable energy policies have a positive impact on economic growth. However, Asian countries rich in fossil fuels face significant challenges during the transition due to high costs and slow progress, which can hinder economic growth in the short term. In contrast, Asian countries with technological advantages may experience temporary setbacks but are expected to realize long-term benefits as renewable infrastructure is developed.

This study offers several theoretical and managerial recommendations. First, from a theoretical perspective, research on the impact of renewable energy policy on economic growth should consider both direct and indirect effects. Renewable energy policy influences renewable energy consumption and, consequently, economic growth through both channels. Overlooking these indirect effects may lead to an underestimation of the true impact of such policies on economic growth.

Second, governments should prioritize investment in renewable energy infrastructure, with particular emphasis on reducing initial costs and enhancing energy storage systems and smart grids. Third, support for industrial transitions and job creation is essential. Training programs can help workers move from traditional energy sectors to renewable ones, reducing employment losses and fostering the creation of new green job opportunities. Finally, the stability of renewable energy pricing should be a key focus. Countries in the sample should implement mechanisms—such as long-term power purchase agreements or price support schemes—to stabilize prices and ensure affordable access, thereby reducing financial risks for renewable energy projects.

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