Review Article

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Role of Rule of Law in the Renewal Energy Transition in Saudi Arabia: A Review and Analysis

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Abstract

The effectiveness of the rule of law and general institutional quality are critical for encouraging Renewable Energy Consumption (REC), which facilitates the Renewable Energy Transition (RET). This concept is empirically tested in Saudi Arabia, using data spanning 1996–2022. Our findings show that there are substantial long- and short-term correlations within the model, demonstrating a positive association between RET and all evaluated variables of institutional quality. The long-term favorable impact of the rule of law is also remarkable, implying that reforms in legal and regulatory frameworks could result in an instant boost in RET. Similarly, control of corruption, as well as voice and accountability, have positive long- and short-term impacts. However, our data shows that economic growth has no substantial impact on RET. As a result, we urge that the Saudi economy emphasize efforts to improve institutional quality as a means of advancing the Renewable Energy Transition agenda. Strengthening the rule of law, reducing corruption, and increasing voice and accountability procedures can all contribute to the development of renewable energy in Saudi Arabia, propelling the country toward a more sustainable energy future.

Keywords: *Renewable energy transition; rule of law, institutional quality, economic growth*

1. Introduction

The influence of the Rule of Law (ROL) extends far beyond conventional perceptions, encompassing a wide array of social, economic, political, and diplomatic dynamics within a nation. In the intricate fabric of a country's political and legal systems lie numerous factors that wield significant influence over economic trajectories on a grand scale. In the context of escalating global environmental discourse and mounting concerns surrounding climate change, it becomes imperative to discern how the ROL shapes a nation's energy landscape and affects its Renewable Energy Transition (RET). This study delves into the pivotal role of the ROL in determining the extent of RET in Saudi Arabia. We also add the effects of COC, income, and Voice and Accountability (VA) in the model to capture a holistic picture of the effect of the quality of institutions on RET in Saudi Arabia.

From a theoretical standpoint, the nexus between the ROL and RET is multifaceted. Mahmood et al. (2022a) examined South Asia, and their findings suggest that a robust governance framework correlates with reduced CO_2 emissions and improved environmental conditions, compared to the adverse impact of escalating energy consumption on the environment. Central to this dynamic is the notion that strong governance fosters trust in government institutions among citizens, thereby promoting greater adherence to legal norms and fostering a sense of civic responsibility and RET. This, in turn, engenders a tendency among individuals to adopt behaviors conducive to environmental preservation. When citizens trust in governmental initiatives and perceive them as beneficial, they are more inclined to actively participate in efforts aimed at enhancing the cleanliness and overall well-being of their country, including environmental stewardship.

Asongu and Odhiambo's (2022) thorough study delves into the complex dynamics of ROL, COC, VA, and RET. Their comprehensive analysis sheds insight into how these governance issues influenced the trajectory of RET adoption and its subsequent impact on economic development. Building on their landmark work, we want to broaden the model's application by investigating the association between RET deployment and growth in Saudi Arabia. Salman et al. (2019) emphasized the critical impact of a strong ROL on lowering pollution levels. In contrast, the negative association between the ROL and RET shows that certain regions, particularly in South Asia, may be slow to prioritize renewable energy within their legal systems. Furthermore, Mahmood et al. (2022b) posited that governance improvements, rather than the mere control of corruption, significantly reduce emissions in Pakistan in the short run. Viewed through an environmental lens, the short-run impact on the environment underscores the importance of bolstering governance structures. By prioritizing governance reforms and combating corruption, nations can cultivate an environment conducive to sustained economic growth, thereby fostering a virtuous cycle wherein economic prosperity coexists harmoniously with environmental sustainability.

Arminen and Menegaki (2019) found the negative impact of corruption on the efficient enforcement of environmental rules. Their research demonstrated how corruption weakens the integrity of regulatory systems, resulting in slack enforcement and compliance loopholes, notably in industries involving nonrenewable energy usage. In response, they stressed the urgent need to strengthen corruption control measures to mitigate the negative effects of corruption on environmental sustainability. Hassan et al. (2020) found a direct correlation between corruption and environmental deterioration in Pakistan, lending credence to this statement. Their empirical investigation revealed how corrupt practices worsen environmental damage by encouraging regulatory capture, bribery, and rent-seeking behavior, sustaining unsustainable practices in sectors that rely on nonrenewable energy sources. Galinato and Galinato (2012) argued that inadequate governance institutions are vulnerable to lobbying pressures, preventing effective renewable energy policy formulation. This highlights the necessity of strengthening the government's capacity to withstand such challenges and support renewable energy sources. Despite the hurdles, improving government effectiveness shows promise for increasing renewable energy consumption.

Galinato and Galinato (2012) gave useful insights into the difficulties posed by insufficient governance structures in developing effective renewable energy policies. Their research revealed how

these organizations, when weak or vulnerable to lobbying pressures, can reduce the formulation and implementation of comprehensive programs to boost renewable energy adoption. This highlights the important need to strengthen the government's capability to withstand external forces while prioritizing the long-term sustainability goals connected with renewable energy sources. These difficulties necessitate coordinated efforts to strengthen governance structures, increase transparency, and foster a legislative climate that encourages renewable energy investment and innovation. Policymakers can reduce the effect of entrenched interests by strengthening institutional frameworks, ensuring that renewable energy policies are guided by public interest and environmental sustainability.

The government could have a dynamic and varied impact on a country's energy mix. While strategic and political variables surely influence energy decisions, COC, adherence to the ROL, and political stability all play important roles in deciding the use of renewable energy sources. Thus, achieving a balanced energy portfolio demands a comprehensive approach that combines governance principles with overarching strategic imperatives. While this present study makes substantial contributions to understanding the association between governance and RET, it is critical to widen the discussion to include other political and social drivers such as the COC and VA. A full examination must acknowledge the role of institutions and broader political circumstances in affecting energy sector dynamics. To summarize, we highlight the critical role of governance, such as ROL, COC, and VA, in determining energy transitions and renewable energy uptake. Addressing shortcomings in energy governance systems, improving governance frameworks at the regional level, and implementing transition management methods are critical steps toward achieving sustainable energy transitions and addressing energy scarcity. By focusing on good governance, policymakers can pave the way for a more sustainable and equitable energy future.

2. Literature Review

Numerous studies have shown the critical importance of governance in RET. Oberthur et al. (2021) conducted a thorough investigation of governance dynamics in the acceptance of renewable energy sources, focusing on energy-intensive sectors such as cement, chemicals, aluminum, and steel. Despite this, harnessing global governance mechanisms to accelerate decarbonization in these industries is largely unknown and underutilized. To close this gap, the authors recommend the creation of a centralized agency with the authority to enforce energy rules and aid industries in meeting predetermined carbon reduction targets. This emphasis on centralized governance in the energy sector sheds light on how various political dimensions, such as COC, governance quality, and adherence to the ROL, influence the use of energy across industries. Lu et al. (2021) discovered that political governance structures have a considerable impact on energy efficiency, with the corruption perception index also playing a role. Their findings, based on proxy measures of political governance, show a favorable relationship between governance quality and energy efficiency, suggesting additional investigation into the interaction between energy efficiency initiatives and renewable energy uptake.

Cabeca et al. (2021) emphasized the importance of the European Union improving its governance structures to boost regional energy efficiency. Effective governance not only promotes energy efficiency but also allows residents to have greater access to energy resources within their country. Komandantova et al. (2021) presented a strong argument for the implementation of governance frameworks, emphasizing their potential to improve public acceptance and perception of emerging energy technology. Polycentric governance techniques provide a more inclusive and participatory model for handling the complexity of the energy transition by decentralizing decision-making authority and encouraging cross-level collaboration among varied stakeholders. One of the primary advantages of polycentric governance is its ability to involve local communities and stakeholders in decision-making, hence increasing the transparency, accountability, and legitimacy of energy policies and programs. Polycentric frameworks, by allowing communities to actively shape

energy development policies, can help create trust, eliminate resistance, and improve public support for the adoption of new energy technology.

Muhammad and Long (2021) conducted a thorough investigation of the complex association between the ROL and emissions dynamics from 2000 to 2016. Their work shed light on the various paths by which COC, political stability, and the ROL either increase or decrease CO_2 emissions. Notably, their findings emphasized the critical significance of a strong ROL in reducing emissions and promoting environmental improvements, notably by facilitating tough environmental regulations on polluting firms. Furthermore, the study identified subtle effects of trade openness on emissions, indicating a paradox in which such openness was associated with decreased emissions in rich countries but showed an opposing trend in lower-middle-income countries. Lazaro et al. (2021) made substantial contributions to our understanding of the significance of governance institutions in establishing effective energy policies, particularly with their qualitative analysis of biofuel policy in Brazil. By digging into the complexities of policy design and execution, their research highlighted the important role of governance systems in achieving sustainable energy management goals. Brazil's experience with biofuel policy is an intriguing case study, revealing how governance institutions may help or hinder the creation and implementation of effective energy policies. This qualitative investigation revealed the complex interplay of government institutions, industry players, civil society, and other actors in creating biofuel policy results. They emphasized the role of regulatory frameworks, institutional arrangements, and decision-making procedures in shaping the trajectory. Putnam and Brown (2021) advocated innovative financial mechanisms and community-based governance initiatives to address environmental justice concerns, focusing on retrofit loans and fuel poverty programs. Their recommendations were to improve energy equity and promote a more inclusive renewable energy adoption framework.

Brisbois (2020) emphasized the importance of decentralized governance within electrical governance structures as a key driver for improving not just operational efficiency but also adaptation and resilience in the energy sector. This method, which is distinguished by the dispersion of decision-making authority across several levels of the electricity system, is a foundation for encouraging innovation, responsiveness, and community empowerment. By delegating decision-making authority to regional or local institutions, stakeholders can adjust strategies and solutions to specific challenges and opportunities in their respective contexts, maximizing resource allocation and reducing bottlenecks. Furthermore, decentralized governance frameworks provide more agile responses to changing market conditions, technical breakthroughs, and regulatory landscapes, allowing the electrical sector to successfully traverse uncertainties and capitalize on emerging trends. Furthermore, Tzankova (2020) recommended a collaborative approach to renewable energy governance and policymaking that included both public and private entities, highlighting the importance of well-monitored and regulated business activities.

Zhang et al. (2021) argued that the RET is influenced by governance and the ROL plays a critical role in creating the energy industry environment. Their study, which looked at 47 nations, produced intriguing results about the impact of corporate governance on RET. Notably, the study found that energy sector governance procedures have a considerable impact on RET. For example, board duality has been shown to hurt renewable energy uptake, especially in nations with a common legal framework. Hargrove et al. (2019) undertook a cross-national examination of CO_2 emissions in light of global governance and climate justice. Their findings emphasized the multidimensional character of emissions dynamics, namely the contributions of population size and manufacturing activity to increasing CO_2 emissions. Crucially, the study revealed the moderating effect of state governance on emission treaties, underlining the critical importance of regulatory frameworks in creating environmental results. Furthermore, the study highlighted the compounding effect of environmental treaties, pushing for a comprehensive approach in which states agree to several policies to strengthen governance processes and enhance CO_2 emissions laws. Finally, these findings highlight the importance of effective global governance institutions in addressing climate change and promoting environmental sustainability.

Caprotti et al. (2020) provided a strong case for a multiscale approach to energy governance, acknowledging the spatialized nature of energy transitions and the complex interplay between local, national, and global governance frameworks. Their study emphasizes the complexities of modern energy concerns, which transcend traditional jurisdictional borders and necessitate coordinated action at several levels of government. Similarly, Alkon and Wong (2020) emphasized the complex relationship between decentralization and environmental governance, pointing out potential conflicts between centralized and decentralized political systems. Their findings highlight the significance of managing intergovernmental relationships and socioeconomic structures in developing effective energy policies. Furthermore, recognizing the significance of social acceptance is critical for promoting renewable energy projects in the long term. Danish et al. (2019) conducted a comprehensive investigation of the complex relationship between emissions and governance. They discovered a correlation between strong governance practices and lower CO_2 emissions, contributing to improved environmental quality. Governance has a wide-ranging impact on the ROL indicators examined. A well-functioning governance framework denotes a coordinated alignment of institutions, corporations, and governmental agencies inside a country, acting under a defined legal framework to ensure order and compliance. Indeed, the consequences of better governance reach far beyond the economic and social worlds, expressing themselves in environmental protection as well.

Sanderink (2020) recognized a key gap in global energy governance structures, stressing a predominance of climate change mitigation and energy access, appropriately addressing the impending challenge of an energy shortage. By failing to emphasize concerns about energy scarcity, these organizations risk harming efforts to promote REC adoption and facilitate RET. To overcome this oversight, global energy governance organizations must aggressively detect and manage energy scarcity challenges, increasing the effectiveness of renewable energy adoption initiatives and reforming global energy policies. Adom et al. (2018) conducted an interesting study on the ecological effects of political indicators, shedding light on the complex interplay between democracy and the environment. Their results found that, while financial growth tended to reduce emissions, democracy had a greater influence on the transportation sector, demonstrating a sector-specific benefit.

Bellakhal et al. (2019) discuss how inadequate governance undermines renewable energy investment in the MENA region, slowing progress toward renewable energy transitions. Their findings highlight the importance of building well-structured and rigorous governance frameworks to encourage the use of renewable energy technology. A unified governance system is critical for negotiating the difficulties of renewable energy investment and creating a climate conducive to sustainable energy transitions. Furthermore, Nochta and Skelcher (2020) demonstrated the potential of transition management solutions to strengthen governance networks inside countries, allowing for simpler energy transitions. Using transition management concepts, countries can improve stakeholder coordination and collaboration, resulting in more effective governance structures capable of generating meaningful progress in energy transition programs.

Khan and Rana (2021) emphasized the importance of institutional quality in reducing emissions in Asia. They stressed the importance of strong institutional frameworks for moving forward with renewable energy ambitions. Furthermore, technical improvements play an important role in promoting the use of renewable energy sources by increasing efficiency and accessibility. Furthermore, investments in renewable energy infrastructure are critical to promoting market growth and sustainability. Shukla et al. (2017) emphasized the revolutionary potential of sophisticated technology and information systems for improving energy infrastructure and monitoring procedures. Countries can use these tools to construct more resilient and efficient energy systems, allowing for wider use of renewable energy options. Sarkodie and Adams (2020) highlighted the relationship between political systems and energy access. Their findings emphasized the significance of competent governance, institutional integrity, and respect for the rule of law in strengthening overall energy systems and increasing access to power for marginalized groups.

Liu et al. (2021) probed the influence of information and communication technology (ICT) in emissions reduction, using panel data analysis to uncover the complex dynamics at work. Their

research revealed a twofold effect in which both ICT and corruption were shown to increase CO_2 emissions, but an intriguing interaction between the two factors appeared, resulting in a moderating influence on pollution levels. Mahmood et al. (2021) analyzed the complex relationship between income and energy in Egypt. Their findings demonstrated a cubic effect of income on energy, highlighting the complex processes at work in the energy-economic nexus. Thus, the multidimensional nature of energy transitions and technological innovation improves RET. Policymakers can guide the energy future toward greater sustainability and resilience by tackling these interconnected problems and possibilities.

The association between economic growth and RET has received a lot of attention, especially in emerging countries where fast industrialization and urbanization coincide with rising energy consumption. Li et al. (2020) shed light on this issue in their research on China, where they discovered a cubic association between income and fossil fuels, specifically oil, coal, and gas. Similarly, Luzzati and Orsini (2009) conducted a large-scale panel analysis involving 113 countries and reported the same results. Aboagye's (2017) research in Ghana reinforced this pattern by revealing a positive association between income and energy intensity. This demonstrates that rising economies frequently exhibit higher energy consumption rates as they attempt to meet developmental demands and increase productivity. However, Mahmood et al. (2023) went deeper into this link, focusing on Middle Eastern countries where the oil and gas industries dominate, emphasizing the importance of economic growth in driving energy demand. Their findings revealed a quadratic effect, implying that while early stages of economic expansion promote nonrenewable energy use, further advancement leads to a gradual drop in dependency. This complex approach emphasizes the changing character of energy transitions in the context of economic development, with countries gradually shifting to cleaner, more sustainable energy sources as their economies mature.

The available literature has provided vital insights into the important roles that institutional frameworks and economic growth play in shaping pollution levels as well as RET. However, there is still a significant gap in understanding the specific dynamics of institutional and economic growth that drive the renewable energy transition in Saudi Arabia. This economy presents particular obstacles and opportunities in its pursuit of a renewable energy transition, given its prominent position in the global energy scene. While the Kingdom has traditionally relied significantly on fossil fuels for energy, there has been a growing realization in recent years of the importance of diversifying its energy mix and reducing reliance on finite, carbon-intensive resources. The present study investigates the effect of institutional quality and economic growth on RET in Saudi Arabia from 1996-2022.

3. Methods

To comprehensively explore the nuanced relationships between economic growth, ROL, COC, VA, and RET, we propose a multifaceted analytical model that integrates key variables and their interdependencies. Our model aims to elucidate the complex dynamics influencing the adoption of renewable energy sources within the context of governance frameworks and economic development in the following way:

$RET_t = f(GDPC_t, ROL_t, COC_t, VA_t)$

The variables in our model are defined as follows. RET_t indicates the REC percentage of total energy usage, and $GDPC_t$ implies GDP per capita. ROL_t, VA_t, and COC_t are institutional quality indicators, which range from -2.5 to +2.5. These quantitative values help to capture the qualitative effect (Iqbal et al., 2022). All data used in this analysis were obtained from the World Development Indicators by the World Bank (2023). The data was collected from 1996 to 2022. Before analysis, the data are tested using the Augmented Dickey and Fuller (1981) methodology, as described by the following equations:

$$\Delta x_t = a_1 x_{t-1} + \sum_{i=0}^{p} a_{2i} \Delta x_{t-i} + e_{1t} \quad (2)$$

$$\Delta x_t = b_0 + b_1 x_{t-1} + \sum_{i=0}^{p} b_{2i} \Delta x_{t-i} + e_{2t} \quad (3)$$

$$\Delta x_t = c_0 + c_1 T + c_2 x_{t-1} + \sum_{i=0}^{p} c_{2i} \Delta x_{t-i} + e_{3t} \quad (4)$$

Equation 2 shows the ADF specification without intercept and trend. However, the intercept is added to the ADF specification in Equation 3. Moreover, both intercept and trend are added to the ADF specification in Equation 4. After performing the Augmented Dickey-Fuller (ADF), we proceed to use the Autoregressive Distributed Lag (ARDL) strategy, as advocated by Pesaran et al. (2001), as our chosen modeling framework. The ARDL method has various advantages, most notably the ability to accommodate diverse integration orders and allow for both short- and long-term interactions among the variables in our model. Furthermore, the ARDL framework allows for the inclusion of lagged variables, error correction terms, and other important control variables, which improves the robustness and explanatory power of our model. By accounting for any confounding factors and lagged impacts, we want to give more precise and dependable assessments of the links between economic growth, governance quality, and renewable energy transition. The use of the ARDL approach proceeds:

$$\Delta RET_t = d_0 + d_1 RET_{t-1} + d_2 GDPC_{t-1} + d_3 ROL_{t-1} + d_4 COC_{t-1} + d_5 VA_{t-1} + \sum_{i=1}^{m} d_{6i} \Delta RET_{t-i} + \sum_{i=0}^{m} d_{7i} \Delta GDPC_{t-i} + \sum_{i=0}^{m} d_{8i} \Delta ROL_{t-i} + \sum_{i=0}^{m} d_{9i} \Delta COC_{t-i} + \sum_{i=0}^{m} d_{10i} \Delta VA_{t-i} + e_{4t} \quad (5)$$

$$\Delta RET_t = gECT_{t-1} \sum_{i=1}^{m} d_{6i} \Delta RET_{t-i} + \sum_{i=0}^{m} d_{7i} \Delta GDPC_{t-i} + \sum_{i=0}^{m} d_{8i} \Delta ROL_{t-i} + \sum_{i=0}^{m} d_{9i} \Delta COC_{t-i} + \sum_{i=0}^{m} d_{10i} \Delta VA_{t-i} + e_{5t} \quad (6)$$

Equation 5 attempts to test for cointegration by determining whether the coefficients d1, d2, d3, d4, and d5 are all equal to zero. This process will be used after deciding the optimal lag length through the Schwarz Information Criterion (SIC) for each differenced variable in Equation 5. This test determines the presence of a long-term equilibrium relationship between the variables under examination. Furthermore, to detect long-term effects more precisely, we normalize coefficients d2 through d5 in relation to d1 in equation 5. The addition of the error correction term (ECT_{t-1}) in Equation 6 enables us to examine short-run dynamics and determine how quickly deviations from the long-term equilibrium are repaired. A negative coefficient in the error correction term indicates the presence of short-run relationships, implying that departures from equilibrium are compensated for in subsequent periods. Moreover, the short-run effects will be captured by the coefficients of lagged differenced variables in equation 6.

4. Data Analyses

Table 1 presents ADF results, which provide useful information about the stationarity qualities of the variables under investigation. At the initial level, all variables display nonstationarity, with the exception of COC_t and ROL_t. This suggests that economic growth, ROL_t, VA_t, and RET_t follow stochastic trends and do not have stable mean and variance features. However, after differentiating the variables, they all become stationary. This transformation is critical for time series analysis because it stabilizes the variance and makes the data better suited to statistical modeling techniques like the ARDL approach. Thus, the ADF studies show a heterogeneous order of stationarity. Nonetheless, given this circumstance, we choose to use the ARDL approach, which is especially well-suited for mixed-order situations and ensures the efficiency of our research.

Table 1: ADF results

Series	C	C & T	None of C nor T
Level			
RET_t	0.3652	-0.6524	1.2541
$GDPC_t$	-0.7298	3.5436	3.1254
ROL_t	-2.6368	-5.3038***	0.3099
COC_t	-1.4729	-4.9388***	-1.1483
VA_t	-1.5928	-1.4546	-0.5177

Series	C	C & T	None of C nor T
Level			
ΔRET_t	-5.6387***	-5.1254***	-5.0964***
$\Delta GDPC_t$	-5.4772***	-5.2504***	-4.1922
ΔROL_t	-5.1939***	-5.1802***	-8.2576***
ΔCOC_t	-5.9793***	-5.8292***	-5.9853***
ΔVA_t	-5.6241***	-5.4129***	-5.6895***

Table 2 shows ARDL analysis results, which show the links between governance indicators and RET. In economic modeling, there is always the possibility of potential endogeneity in the model. However, the utilized ARDL framework removes endogeneity through its auto-regressive and distributed lag system (Pesaran et al., 2001). Thus, the estimates from ARDL are robust. Moreover, the time sample is limited from 1996 to 2022 because institutional quality data is not available before 1996. Notably, the F-value above the crucial threshold, shows that the variables are cointegrated. This discovery is crucial because it indicates the cointegration between the variables under study. Furthermore, the coefficient of ECT_{t-1} is negative, indicating a short convergence period of less than nine years. So, any deviations from the long-term equilibrium are adjusted in the following periods, and the system returns to its equilibrium condition relatively quickly. This quick adjustment emphasizes the dynamic character of the links between economic growth, governance quality, and renewable energy transition, as short-term errors are remedied over a relatively short time horizon. The demonstration of resilience through diagnostic testing increases the validity and reliability of the ARDL model used in our study. These diagnostic tests are used to determine the adequacy of the model specification, the presence of potential concerns such as autocorrelation, heteroscedasticity, or omitted variable bias, and the reliability of the coefficient estimates.

Table 2: Cointegration

Test	Statistic	P-value
Heteroscedasticity	4.5896	0.4679
Serial correlation	3.2242	0.1259
Normality	0.4996	0.3564
Functional form	0.2276	0.6987
Bound test-estimated	6.3521	
I(0)	4.28	
I(1)	5.84	

Our findings show that $GDPC_t$ has an insignificant effect on RET_t. This result suggests that income has an insignificant impact on the shift to RET. Thus, economic growth could not affect RET. However, Saudi Arabia launched the Saudi Green Initiative in 2021 to enhance RET for addressing climate change, improving quality of life, and safeguarding the environment for future generations. In this regard, Saudi Arabia has targeted achieving net zero emissions by 2060 by reducing emissions and promoting afforestation. For this purpose, 77 initiatives, with an investment of more than $186 billion, have been started (Saudi Green Initiative, 2021). These plans are expected to improve RET in the Kingdom. Furthermore, economic growth can spur investment in renewable energy infrastructure, technological innovation, and governmental support, all of which help accelerate the RET. This link is frequently mediated by legislative frameworks, technological breakthroughs, and market dynamics, which determine the incentives and opportunities for renewable energy adoption.

Table 3: ARDL results

Series	Parameter	Standard error	t-value	P-value
$GDPC_t$	-0.1324	0.4068	-0.3253	0.7487

Series	Parameter	Standard error	t-value	P-value
ROL_t	0.21659	0.0381	5.6922	0.0000
COC_t	0.1129	0.2019	5.5904	0.0000
VA_t	0.1269	0.0197	6.4288	0.0000
Intercept	1.5332	4.1396	0.3703	0.7154
$\Delta GDPC_t$	-0.01175	0.029125	-0.40358	0.691552
ΔROL_t	0.019235	0.024326	0.790732	0.439993
ΔCOC_t	0.010029	0.010127	0.990242	0.335942
ΔVA_t	0.01127	0.013419	0.839905	0.412619
ECT_{t-1}	-0.08881	0.034843	-2.54883	0.0183

ROL_t has a positive effect on RET_t. A strong rule of law framework lays the groundwork for transparent, predictable, and accountable government, which is critical for fostering renewable energy investment and innovation. ROL builds investor and stakeholder confidence by maintaining legislative stability, regulatory clarity, and enforcement mechanisms, thereby lowering the risks and uncertainties associated with renewable energy projects. Furthermore, ROL improves regulatory efficiency and effectiveness by streamlining permitting processes, accelerating project approvals, and lowering bureaucratic hurdles to renewable energy deployment. This, in turn, encourages the timely development of renewable energy projects and speeds up RET to a cleaner system. Furthermore, ROL promotes trust and collaboration among various stakeholders, such as government agencies, commercial sector actors, civil society organizations, and local communities. ROL promotes inclusive decision-making processes, participatory governance structures, and redress procedures to guarantee that the benefits of renewable energy production are disbursed equitably and that marginalized groups' concerns are addressed.

COC_t has a positive effect on RET_t. Our study supports the claim that reducing corruption improves RET, which is consistent with larger empirical findings and theoretical frameworks in governance and sustainable development. Effective anti-corruption measures help to create an atmosphere that promotes renewable energy investment, innovation, and implementation. Corruption is a key barrier to renewable energy transition because it distorts market mechanisms, undermines regulatory frameworks, and erodes investor confidence. In contrast, strong anti-corruption measures serve to reduce these issues by encouraging transparency, accountability, and integrity in governance processes. Countries that have better control over corruption tend to have higher levels of renewable energy investment, capacity deployment, and policy effectiveness. By lowering the risk of corruption-related distortions, investors are more eager to participate in renewable energy projects, resulting in greater deployment and adoption of clean energy technology. Furthermore, successful corruption control promotes trust and cooperation among stakeholders. Controlling corruption promotes consensus and support for renewable energy programs by ensuring fair and equitable decision-making procedures and decreasing the influence of rent-seeking behavior.

VA_t has a positive effect on RET_t. The claim that enhancing VA improves the RET is consistent with democratic governance and participatory decision-making. Our findings corroborate this relationship, emphasizing the VA's critical role in promoting transparency, inclusivity, and public participation in energy planning and implementation processes. Enhanced VA enables citizens to actively engage in decision-making processes linked to renewable energy production by allowing them to express their preferences, concerns, and priorities. By encouraging communication, collaboration, and consensus-building among diverse stakeholders, VA ensures that renewable energy policies and initiatives are responsive to community needs and aspirations, increasing their effectiveness and legitimacy. Furthermore, VA promotes the spread of information, expertise, and awareness of renewable energy technology, advantages, and opportunities. VA promotes public awareness and education programs to assist in the renewable energy transition, leveraging public resources and grassroots activities to drive sustainable energy development at the local, regional, and national levels. Furthermore, VA increases accountability systems, holding policymakers and

decision-makers accountable for their actions and decisions regarding renewable energy policies and investments. By encouraging transparency, supervision, and accountability, VA helps to prevent corruption, mismanagement, and vested interests from harming renewable energy transition efforts, establishing trust and confidence among stakeholders.

5. Conclusion

This study examined the delicate connection between the ROL, economic growth, COC, and RET in Saudi Arabia from 1996 to 2022. We solved stationarity concerns in our model by using unit root and cointegration tests. The findings confirmed cointegration and indicated the presence of a short-run link. The results show that economic growth does not affect RET. However, ROL has a positive impact on RET by enabling transparent, accountable governance, which is crucial for promoting renewable energy investment and innovation. ROL increases investor and stakeholder confidence by maintaining legislative stability, regulatory clarity, and strong enforcement measures, thereby mitigating the risks associated with renewable energy projects. ROL also increases regulatory efficiency by reducing permitting processes and accelerating project approvals, allowing for the timely development of renewable energy projects and speeding up the transition to a cleaner system. Furthermore, ROL promotes stakeholder trust and collaboration, as well as inclusive decision-making and redress procedures, to ensure equitable benefit distribution and address marginalized groups' concerns.

Moreover, reducing corruption benefits RET by creating an atmosphere that encourages renewable energy investment, innovation, and implementation. Effective anti-corruption measures promote openness, accountability, and integrity in governance processes, thereby eliminating fundamental impediments to renewable energy transition, such as market distortions, regulatory flaws, and investor uncertainty. Countries with greater corruption control tend to see higher levels of renewable energy investment, capacity deployment, and policy effectiveness since decreased corruption-related distortions attract investor engagement and promote the adoption of clean energy technology. Furthermore, effective corruption control promotes trust and cooperation among stakeholders, boosting consensus-building and support for renewable energy initiatives through fair decision-making procedures and reducing the influence of rent-seeking behavior.

VA improves RET by encouraging democratic governance and participatory decision-making. VA promotes transparency, inclusion, and public involvement in energy planning and implementation processes, allowing citizens to actively participate in renewable energy production decisions. By fostering communication, collaboration, and consensus-building among diverse stakeholders, VAt ensures that renewable energy policies are responsive to community needs and aspirations, increasing their effectiveness and legitimacy. Furthermore, VA raises awareness and educates people about renewable energy technologies, fostering support for the shift to sustainable energy through public outreach and grassroots efforts. Furthermore, VA increases accountability systems, making lawmakers accountable for their decisions concerning renewable energy policies and investments, thus avoiding corruption and mismanagement and fostering confidence among stakeholders.

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References

Aboagye, S. (2017). The policy implications of the relationship between energy consumption, energy intensity and economic growth in Ghana. OPEC Energy Review, 41(4), 344–363. https://doi.org/10.1111/opec.12114

Adom, P. K., Kwakwa, P. A., & Amankwaa, A. (2018). The long-run effects of economic, demographic, and political indices on actual and potential CO2 emissions. Journal of Environmental Management, 218, 516–526. https://doi.org/10.1016/j.jenvman.2018.04.090

Alkon, M., & Wong, A. (2020). Authoritarian energy transitions undermined? Environmental governance cycles in China's power sector. Energy Research & Social Science, 68, 101531. https://doi.org/10.1016/j.erss.2020.101531

Arminen, H., & Menegaki, A. N. (2019). Corruption, climate and the energy-environment-growth nexus. Energy Economics, 80, 621–634. https://doi.org/10.1016/j.eneco.2019.02.009

Asongu, S., & Odhiambo, N. (2021). Governance and renewable energy consumption in sub-Saharan Africa. International Journal of Energy Sector Management, 16, 209-223. https://doi.org/10.1108/IJESM-10-2020-0009

Bellakhal, R., Ben Kheder, S., & Haffoudhi, H. (2019). Governance and renewable energy investment in MENA countries: How does trade matter? Energy Economics, 84, 104541. https://doi.org/10.1016/j.eneco.2019.104541

Brisbois, M. C. (2020). Decentralised energy, decentralised accountability? Lessons on how to govern decentralised electricity transitions from multi-level natural resource governance. Global Transitions, 2, 16–25. https://doi.org/10.1016/j.glt.2020.01.001

Cabeça, A. S., Henriques, C. O., Figueira, J. R., & Silva, C. S. (2021). A multicriteria classification approach for assessing the current governance capacities on energy efficiency in the European Union. Energy Policy, 148, 111946. https://doi.org/10.1016/j.enpol.2020.111946

Caprotti, F., Essex, S., Phillips, J., de Groot, J., & Baker, L. (2020). Scales of governance: Translating multiscalar transitional pathways in South Africa's energy landscape. Energy Research & Social Science, 70, 101700. https://doi.org/10.1016/j.erss.2020.101700

Danish, Baloch, M. A., & Wang, B. (2019). Analyzing the role of governance in CO2 emissions mitigation: The BRICS experience. Structural Change and Economic Dynamics, 51, 119–125. https://doi.org/10.1016/j.strueco.2019.08.007

Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. Econometrica, 49(4), 1057. https://doi.org/10.2307/1912517

Galinato, G. I., & Galinato, S. P. (2011). The effects of corruption control, political stability and economic growth on deforestation-induced carbon dioxide emissions. Environment and Development Economics, 17(1), 67–90. https://doi.org/10.1017/s135577ox11000222

Saudi Green Initiative (2021). Vision 2030. https://www.vision2030.gov.sa/en/projects/saudi-green-initiative/

Hargrove, A., Qandeel, M., & Sommer, J. M. (2019). Global governance for climate justice: A cross-national analysis of CO_2 emissions. Global Transitions, 1, 190–199. https://doi.org/10.1016/j.glt.2019.11.001

Hassan, S. T., Danish, Khan, S. U. D., Xia, E., & Fatima, H. (2020). Role of institutions in correcting environmental pollution: An empirical investigation. Sustainable Cities and Society, 53, 101901. https://doi.org/10.1016/j.scs.2019.101901

Iqbal, A., Hassan, S., Mahmood, H., & Tanveer. M. (2022). Gender Equality and Religious Tensions Nexus in Developing Countries: A Spatial Analysis Approach. Heliyon, 8(11), e11394. https://doi.org/10.1016/j.heliyon.2022.e11394

Khan, M., & Rana, A. T. (2021). Institutional quality and CO2 emission–output relations: The case of Asian countries. Journal of Environmental Management, 279, 111569. https://doi.org/10.1016/j.jenvman.2020.111569

Komendantova, N., Neumueller, S., & Nkoana, E. (2021). Public attitudes, co-production and polycentric governance in energy policy. Energy Policy, 153, 112241. https://doi.org/10.1016/j.enpol.2021.112241

Lazaro, L. L. B., Giatti, L. L., Bermann, C., Giarolla, A., & Ometto, J. (2021). Policy and governance dynamics in the water-energy-food-land nexus of biofuels: Proposing a qualitative analysis model. Renewable and Sustainable Energy Reviews, 149, 111384. https://doi.org/10.1016/j.rser.2021.111384

Li, S., Shi, J., & Wu, Q. (2020). Environmental Kuznets Curve: Empirical Relationship between Energy Consumption and Economic Growth in Upper-Middle-Income Regions of China. International Journal of Environmental Research and Public Health, 17(19), 6971. https://doi.org/10.3390/ijerph17196971

Liu, X., Latif, Z., Danish, Latif, S., & Mahmood, N. (2021). The corruption-emissions nexus: Do information and communication technologies make a difference? Utilities Policy, 72, 101244. https://doi.org/10.1016/j.jup.2021.101244

Lu, W. M., Kweh, Q. L., Nourani, M., & Lin, C. Y. (2021). Political governance, corruption perceptions index, and national dynamic energy efficiency. Journal of Cleaner Production, 295, 126505. https://doi.org/10.1016/j.jclepro.2021.126505

Luzzati, T., & Orsini, M. (2009). Investigating the energy-environmental Kuznets curve. Energy, 34(3), 291–300. https://doi.org/10.1016/j.energy.2008.07.006

Mahmood, H., Alkhateeb, T. T. Y., Tanveer, M., & Mahmoud, D. H. I. (2021). Testing the Energy-Environmental Kuznets Curve Hypothesis in the Renewable and Nonrenewable Energy Consumption Models in Egypt. International Journal of Environmental Research and Public Health, 18(14), 7334. https://doi.org/10.3390/ijerph18147334

Mahmood, H., Hassan, S., Tanveer, M., & Ahmad, A. R. (2022a). The Effects of Rule of Law, Regulatory Quality, and Renewable Energy on CO2 Emissions in South Asia. International Journal of Energy Economics and Policy, 12(6), 16–21. https://doi.org/10.32479/ijeep.13468

Mahmood, H., Hassan, S., Tanveer, M., & Furqan, M. (2022b). Rule of Law, Control of Corruption and CO2 Emissions in Pakistan. International Journal of Energy Economics and Policy, 12(4), 72–77. https://doi.org/10.32479/ijeep.13098

Muhammad, S., & Long, X. (2021). Rule of law and CO2 emissions: A comparative analysis across 65 Belt and Road Initiative(BRI) countries. Journal of Cleaner Production, 279, 123539. https://doi.org/10.1016/j.jclepro.2020.123539

Nochta, T., & Skelcher, C. (2020). Network governance in low-carbon energy transitions in European cities: A comparative analysis. Energy Policy, 138, 111298. https://doi.org/10.1016/j.enpol.2020.111298

Oberthür, S., Khandekar, G., & Wyns, T. (2021). Global governance for the decarbonization of energy-intensive industries: Great potential underexploited. Earth System Governance, 8, 100072. https://doi.org/10.1016/j.esg.2020.100072

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326. https://doi.org/10.1002/jae.616

Putnam, T., & Brown, D. (2021). Grassroots retrofit: Community governance and residential energy transitions in the United Kingdom. Energy Research & Social Science, 78, 102102. https://doi.org/10.1016/j.erss.2021.102102

Salman, M., Long, X., Dauda, L., & Mensah, C. N. (2019). The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand. Journal of Cleaner Production, 241, 118331. https://doi.org/10.1016/j.jclepro.2019.118331

Sanderink, L. (2020). Shattered frames in global energy governance: Exploring fragmented interpretations among renewable energy institutions. Energy Research & Social Science, 61, 101355. https://doi.org/10.1016/j.erss.2019.101355

Sarkodie, S. A., & Adams, S. (2020). Electricity access, human development index, governance and income inequality in Sub-Saharan Africa. Energy Reports, 6, 455–466. https://doi.org/10.1016/j.egyr.2020.02.009

Stritzke, S., Trotter, P. A., & Twesigye, P. (2021). Towards responsive energy governance: Lessons from a holistic analysis of energy access in Uganda and Zambia. Energy Policy, 148, 111934. https://doi.org/10.1016/j.enpol.2020.111934

Sudhakar, K., Shukla, A. K., & Baredar, P. (2017). Renewable energy resources in South Asian countries: Challenges, policy and recommendations. Resource-Efficient Technologies, (3), 342–346. https://doi.org/10.18799/24056529/2017/3/140

Tzankova, Z. (2020). Public policy spillovers from private energy governance: New opportunities for the political acceleration of renewable energy transitions. Energy Research & Social Science, 67, 101504. https://doi.org/10.1016/j.erss.2020.101504

World Bank (2023) World Development Indicators. Washington, D.C.: The World Bank. https://databank.worldbank.org/source/world-development-indicators (November 12, 2023)

Yang, Q., Huo, J., Saqib, N., & Mahmood, H. (2022). Modelling the effects of Renewable Energy and Public-Private Partnership in testing EKC Hypothesis: Evidence from Methods Moment of Quantile Regression. Renewable Energy, 192, 485-494. https://doi.org/10.1016/j.renene.2022.03.123

Zhang, D., Zhang, Z., Ji, Q., Lucey, B. M., & Liu, J. (2021). Board Characteristics, External Governance and the Use of Renewable Energy: International Evidence from Public Firms. Journal of International Financial Markets, Institutions and Money, 72, 101317. https://doi.org/10.1016/j.intfin.2021.101317