IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY
EJ EconJournals
ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2025, 15(6), 830-839.

EJ EconJournals

Financing the Green Transition: Exploring the Role of Financial Inclusion and Renewable Energy in Driving Green Growth into More and Less Inclusive Financial Systems in the MENA Countries

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Received: 18 July 2025 **Accepted:** 06 October 2025 **DOI:** https://doi.org/10.32479/ijeep.22108

ABSTRACT

This research examines the relationship among renewable energy, financial inclusion, and green growth in the MENA region, focusing on how financial access and the adoption of clean energy contribute to green growth. Using a dataset of 12 MENA countries from 2010 to 2023, and applying the System Generalized Method of Moments (SGMM), we examine the individual and interactive effects of financial inclusion and renewable energy on green growth. To account for the considerable heterogeneity within the region, we distinguish between countries with more inclusive financial system, and those with less inclusive systems, where financial access remains limited. As consequently, we used the fixed and random effect. For the full sample, the results reveal that financial inclusion significantly reduces green growth, while renewable energy does not exert any significant effect. For the disaggregate analysis, the effect of financial inclusion and renewable energy differs across countries with more inclusive financial systems, and countries with less inclusive systems. Moreover, the effectiveness of these drivers is strongly influenced by institutional quality and domestic investment. For the combined effect, we found that the interaction between financial inclusion and renewable energy promotes green growth only in countries with more inclusive financial systems, while it reduces green growth in countries with less inclusive systems. The study provides novel, region-specific evidence and offers practical guidance for policymakers to design strategies that align financial inclusion and renewable energy initiatives with long-term sustainability goals in the MENA region.

Keywords: Financial Inclusion, Renewable Energy, Green Growth, MENA Countries, SGMM Approach
JEL Classifications: G20, O01, Q42

1. INTRODUCTION

Recently, green growth has changed how countries think of growth, shifting growth from profit-driven to sustainability and innovation (Khan et al., 2025). Green growth emphasizes the harmony between economic expansion and environmental preservation, ensuring that prosperity today does not come at the expense of future generations (Stoknes and Rockström, 2018). For nations, this is not only a moral and ethical approach but also a fundamental strategy for job creation, improving energy security and resilience to climate and economic shocks. Green growth represents a design for a future intended for sustainable and prosperous growth (Aslam and Ghouse, 2023).

The green growth literature mentions an evolving combination of institutional, technological, and economic factors that drive green growth (Tawiah et al., 2021; Sarkodie et al., 2023). Studies emphasize innovation and clean technology as a primary engine of green growth and enable resource-efficient and low-carbon production for advanced economies (Ulucak, 2020). Furthermore, environmental policies and governmental regulations are essential, as they add incentives to shift a firm's investment toward green options, as well as penalties for businesses that do not respect sustainable practices. The development of human capital also supports a country's capacity to move toward sustainable sectors. Additionally, financial development and green financing options such as green bonds and sustainable banking mobilize capital toward environmentally friendly opportunities (Woode, 2024). Lastly, good governance and international cooperation provide policy coherence and promote the exchange of best practices. Overall, these forces deliver the basis of the green growth model in which economic competitiveness is engaged with environmental responsibility (Heidarian and Shahabadi, 2025; Liu and Zhang, 2024).

The most recent body of literature shows us ambiguous evidence regarding the effect of financial inclusion and renewable energy on green growth (Ashfaq et al., 2024, Wei et al. 2023). Financial inclusion generates broader access to credit and investment, enabling households and firms to deploy clean technologies and support sustainable firms. Similarly, renewable energy makes an economy less reliant on fossil fuels and nudges low-carbon productivity. However, various findings warn against unintended consequences resulting from inclusion, where more access to financing, without regulation or green-oriented financial products, will further fund consumption and investment within the polluting economy, precipitating a green transition (OECD, 2012; IRENA, 2018). Similarly, renewable energy deployment may run into high upfront capital investment, infrastructure, or policy barriers, limiting its positive short-term contributions to green growth (BIS, 2022). Together, finance and energy systems must be viewed as a sustained interplay that can accelerate or slow down sustainability, depending on both policy design and institutions' capacity to effectively interact with these multiple systems.

The connection between financial inclusion, renewable energy, and green growth is increasingly recognized as an important factor in sustainable economic transformation within the MENA region (Gafsi and Louhichi, 2025; Omar et al., 2025). In many countries in this region, economies face the challenges of being highly reliant on fossil fuels, despite generally low levels of financial inclusion, meaning that small businesses and rural populations may not have access to finance. By expanding financial inclusion, these populations can gain access to green financing instruments that allow financial investment in renewable energy projects such as solar and wind, which are considered abundant in the region (Said and Acheampong, 2024; Khémiri et al., 2023). Recently, countries such as Morocco, the UAE, and Egypt have been making demonstrative advances towards financial inclusion, and renewable energy inclusive financial policies have been integrated into national renewable energy strategies to date. However, in multiple MENA countries, the combination of a weak financial system, unawareness, and fragmented policies keeps them from transitioning to green growth. Strengthening and demonstrating digital finance tools, improving the green investment framework, and regional cooperation could all help address these issues, and make the combination of financial inclusion and renewable energy the catalyst for sustainable and resilient development throughout the region (Khémiri et al., 2024).

Although the region has a pressing need to transition its economies away from fossil fuels, financial inclusion remains limited, which is contributing to a lack of access to green finance and investment in clean technologies. In parallel, there is significant potential for renewable energy, which is underdeveloped due mainly to financing gaps, institutional weaknesses, and regulatory uncertainty. As a result, the relationship between financial inclusion and renewable energy, two potential engines of green growth, is still poorly researched in the context of MENA. Hence, the research question for this study is: how do financial inclusion and renewable energy adoption jointly influence green growth in MENA countries?

This paper aims to assess the nexus among financial inclusion, renewable energy, and green growth in the MENA region, with a specific focus on how access to finance and the rollout of clean energy can enhance sustainable economic development both individually and collectively. To do this, we used a dataset of 12 MENA countries covering the period 2010-2023, and conducted SGMM, fixed and random effect models as an econometric technique. To account for the considerable heterogeneity in the region, we distinguish between countries with more inclusive financial systems, and those with less inclusive systems. Overall, the results of this study indicate that for the full sample, financial inclusion significantly reduces green growth while renewable energy does not exert any significant effect. For the disaggregate analysis, the effect if financial inclusion and renewable energy differs across countries with more inclusive financial systems, and countries with less inclusive systems. For the combined effect, we found that the interaction between financial inclusion and renewable energy promotes green growth only in countries with more inclusive financial systems, while it reduces green growth in countries with less inclusive systems.

This research makes a valuable and original contribution by providing a detailed examination of the interrelated roles of financial inclusion and renewable energy in achieving green growth outcomes in the MENA region, which reflects an important gap in the extant literature. To the best of our knowledge, the prevailing scholarship has often considered these issues in isolation from each other. This research explores the combined effects of financial inclusion and renewable energy in terms of how financial access can diversify investments in renewable energy capacity growth and contribute to environmentally sustainable economic development. The research also identifies the role of institutional quality, and supportive policy frameworks that critically enable financial inclusion and renewable energy to advance sustainable development goals. By integrating these multiple perspectives of financial inclusion and renewable energy, this research is located in the context of how effective policies could help challenge traditional economic growth. This research also develops our understanding of how financial systems and clean energy deployment could co-generate inclusive, resilient, and green growth opportunities for the MENA region as policymakers seek to transition toward more sustainable economies.

The remainder of the paper is organized as follows. Section 2 draws on relevant literature on financial inclusion, renewable energy, and green growth. Section 3 provides information on the sample and methods performed in this study. Section 4 offers a discussion of the empirical findings. Finally, Section 5 outlines the conclusion and potential policy recommendations.

2. RELATED LITERATURE

The concept of Green growth has become the main model for sustainable development. It stresses the idea of keeping the economy growing while saving the environment. However, scholars realize that technological innovation and clean energy use are not enough to achieve green growth. There must also be general access to financial resources which will allow investments in sustainable practices (Stoknes and Rockström, 2018). In such a case, financial inclusion, which is the provision of affordable and accessible financial services to individuals and businesses, has been seen as a main factor leading to green growth. The definition given by the World Bank (2022) is the most widely used one. "Financial inclusion (FI) refers to the availability of practical and reasonably priced financial goods and services that satisfy customers' demands in terms of payments, transactions, savings, credit, and insurance, all of which are provided in an ethical and sustainable manner." Financial inclusion through providing access to credit, savings, and investment instruments to households and firms, makes it possible for these sectors to implement energy-efficient technologies, use renewable energy systems, and carry out environmentally friendly business practices (Demirgüç-Kunt et al., 2018; Sahay et al., 2020).

Empirical studies suggest that financial inclusion may have mixed effects on green growth. On the positive side, it facilitates the financing of clean technologies and green entrepreneurship. Using a quantile regression and AMG techniques on a BRICS panel dataset, Dong et al. (2025) report that financial inclusion has a positive effect on green growth at lower and medium quantiles. Sajid et al (2025), relying on data from Pakistan over the period 1990-2022 and performing a nonlinear auto-distributive lag model, support an asymmetric relationship among financial inclusion, green growth, and environmental sustainability. Similarly, Peng and Zeng (2025) affirm that the extension of digital finance to previously underserved segments of the Chinese market has a significant and positive impact on green growth in 270 Chinese cities from 2011 to 2021. On the contrary, Beck et al. (2019) and Ozili (2021) argue that without environmental regulation, increased access to finance may lead to higher consumption and production in carbon-intensive sectors, thus, canceling out the positive effects of financial inclusion on sustainability. This underscores the relevance of scrutinizing local institutional and policy remains a challenge in the MENA region. Based on the development above, we formulate the hypothesis.

H_1: Financial inclusion promotes green growth.

Likewise, the use of clean energy is generally considered one of the main factors leading to environmental-friendly growth. Prior studies indicate that increasing the use of solar, wind, and hydro power, enhance energy efficiency and reduce reliance on fossil fuels, hence promoting sustainable development (IRENA, 2022; Sadorsky, 2019).) Using a sample of G-20 countries from 1990 to 2018, Ashfaq et al. (2024) stated that green economic growth and economic globalization are the major factors that foster renewable energy consumption and that they are cointegrated in the long run. In the same vein, Wei et al. (2023) concluded that the use of green renewable energy leads to green growth in the top green future economies of the world. Some recent papers have delved into the hidden influence of renewable energy consumption on green growth. For instance, Caglar et al. (2024) examined the interplay between renewable energy consumption, green technology, and environmental quality in the top-10 renewable energy economies over the period 1990-2021. The cross-sectional autoregressive distributed lag model findings reveal that renewable energy consumption is a source of the sustainability of the ecosystem. With reference to the development above, we can raise the second hypothesis.

H_2: Renewable energy enhances green growth.

A significant part of the literature has examined the interplay between financial inclusion and the use of renewable energy in promoting green growth. In fact, several papers focused on developing countries, concluded that financial inclusions coupled with clean energy lead to a multiplicative effect, which in turn results in improvement of the environmental quality and an increase in economic benefits (Cui et al., 2022; Kaplan et al., 2024; Li et al., 2021). Besides, the literature on this topic that comprises a different point of view, some studies highlighted the significance of governance and the quality of the institution as a factor that mediates the relationship among finance, energy, and green growth. These studies support that even when financial inclusion and renewable energy availability are high, poor institutional quality, weak governance and regulatory framework can erode the transformation of these inputs into durable outcomes (Acemoglu et al., 2012; Saidi, 2020; Khouja et al., 2022).

In the MENA region, recognized for its rich solar and wind resources, renewable energy could play a crucial role in reducing reliance on oil and promoting sustainable growth (Apergis and Payne, 2010; Al-Mulali and Ozturk, 2016). However, how effectively renewable energy can be implemented hinges on several factors, including the adoption of technology, the development of infrastructure, and access to green financing options. However, there's still a lack of empirical evidence specifically focused on the MENA region, especially concerning how financial inclusion and renewable energy could promote green growth. This underscores the importance of conducting region-specific analyses that take into account the diverse institutional and policy environments across MENA countries, where financial systems and renewable energy strategies can differ significantly. Based on the development above, we put the following hypothesis.

H_3: Financial inclusion and renewable energy jointly promote green growth.

In summary, the existing literature highlights the significance of both financial inclusion and renewable energy in fostering green growth. However, the MENA region stands out with its own set of unique opportunities and challenges. With its rich renewable resources, ongoing reforms in the financial sector, and an increasing emphasis on sustainability, there's a promising environment for green growth. Nevertheless, there's a noticeable lack of empirical research exploring how financial inclusion and renewable energy interact in promoting green growth, especially when considering the institutional frameworks. This gap is what drives the current study, which aims to shed light on the interaction between financial inclusion and renewable energy in enhancing green growth across MENA countries, providing valuable insights for policymakers and researchers alike.

3. SAMPLE AND EMPIRICAL APPROACH

3.1. The sample

To investigate the role of financial inclusion and renewable energy in promoting green growth in MENA countries, we used a sample of 12 MENA countries over the period 2010-2023. To account for significant heterogeneity within the region, we differentiate between the countries with more inclusive financial systems, with greater access to banking services, credit and digital financial services, and those with less inclusive financial systems with limited access to financial services.

To operationalize this classification, we followed the methodological approach adopted by Boussaada et al. (2025), who used the median value to differentiate between more inclusive financial systems and less inclusive systems. First, we computed the median value of IFI which is 0.530. Countries that exhibited values of IFI greater than 0.530 are classified as countries with more inclusive financial systems. However, countries recording values of IFI lower than 0.530 are considered to have less inclusive systems. This difference makes it possible for the research to explore the extent to which the impact of renewable energy on green growth varies based on the level of financial inclusion, leading to a more nuanced understanding of how financial systems change the relationship between adopting clean energy and sustainable development in the MENA region. The decomposition of countries used in this study is given in Table 1.

3.2. Empirical Approach and Model Specification

This research uses the System Generalized Method of Moments (SGMM) to analyze how financial inclusion and renewable energy are crucial for promoting green growth in MENA countries. SGMM is more appropriate for our analysis because it enables efficient evaluation of dynamic relationships, controls for endogeneity due to lagged dependent variables and takes into account unobserved country-level heterogeneity (Teixeira and Queirós, 2016; and Danisman and Tarazi 2020). In contrast to conventional panel estimators, such as fixed effects or random effects, the SGMM enables the use of internal instruments that minimize the bias arising from simultaneity and reverse causality. This approach is particularly useful in the case of studying relationships among financial inclusion, renewable energy, and green outcomes. Additionally, SGMM is easy to apply for moderately large temporal dimension (T) and relatively small individual dimension (N), as we use a sample of 12 MENA countries, and overall ensures a reasonable degree of reliability and consistency in estimation. By leveraging the advantages associated with our methodology, we make a meaningful contribution to understanding how financial inclusion and renewable energy work collaboratively to sustainably grow the economy in the region. However, when we split the sample into countries with more inclusive financial system, and those with less inclusive systems, the individual dimension is very weak compared to the temporel dimension, hence we used the fixed and random effect model.

The empirical strategy followed in this paper is based on two steps. In the first step, we estimate the individual effect of financial inclusion and renewable energy on green growth. Hence, the econometric model to be tested is given in equation (1).

$$GG_{i,t} = \alpha_0+\alpha_1 GG_{i,t-1}+\alpha_2 IFI_{i,t}+\alpha_3 REN_{it}+\alpha_4 Q_{it}+\alpha_5 INVES_{i,t}+\alpha_6 FDI_{i,t} +\alpha_7 TRADE_{it}+\alpha_8 GDPG_{it}+\alpha_9 INF_{i,t}+\varepsilon_{i,t} \quad (1)$$

However, in the second step, we estimate the combined effect of financial inclusion and renewable energy on green growth. Hence, the econometric model to be tested is given in equation (2).

$$GG_{i,t} = \alpha_0+\alpha_1 GG_{i,t-1}+\alpha_2 IFI_{i,t}\times REN_{it}+\alpha_3 Q_{it}+\alpha_4 INVES_{i,t}+\alpha_5 FDI_{i,t}+ \alpha_6 TRADE_{it}+\alpha_7 GDPG_{it}+\alpha_8 INF_{i,t}+\varepsilon_{i,t} \quad (2)$$

The financial inclusion index is based on four key indicators: the number of automated teller machines (ATMs) per 100,000 adults, the number of commercial bank branches per 100,000 adults, and two usage metrics, borrowers from commercial banks per 1,000 adults and depositors with commercial banks per 1,000 adults. On the other hand, the institutional quality index is derived from six indicators: control of corruption, government stability, rule of law, voice and accountability, government effectiveness, and regulatory quality.

Following Sarma (2016), Saidi et al. (2025), and Hakimi et al. (2025) we use the statistical standardization which is often more dependable than empirical methods because it rests on a solid theoretical foundation and aligns well with common statistical techniques. By standardizing data, we bring all variables onto the

Table 1: List of countries

	Full sample				countries with more inclusive financial systems		countries with less inclusive financial systems
1	Bahrain	7	Oman	1	Bahrain	1	Egypt
2	Egypt	8	Qatar	2	Kuwait	2	Jordan
3	Jordan	9	Saudi Arabia	3	Qatar	3	Lebanon
4	Kuwait	10	Tunisia	4	Saudi Arabia	4	Morocco
5	Lebanon	11	Turkey	5	United Arab Emirates	5	Oman
6	Morocco	12	United Arab Emirates			6	Tunisia
						7	Turkey

same scale, centered around zero with a standard deviation of one. This approach simplifies direct comparisons between different variables or datasets. Additionally, it preserves the original shape and relationships within the data, which is incredibly useful for techniques like regression, PCA, or clustering that, rely on understanding how data points vary. The standardized scores are straightforward to interpret, revealing how far each value strays from the average in terms of standard deviations. This not only helps in identifying outliers but also enhances the precision and clarity of the analysis.

Statistical standardization is a process that transforms indicators into a common scale, where the average is zero and the standard deviation is one. This helps to eliminate any distortions that might arise from differences in means. The formula for statistical standardization is:

$$An_{it} \frac{A_{i,t} - \mu_{i,t}}{\sigma i_{i,t}} \quad (3)$$

A n_{it} represents the standardized value of indicator "A" at a specific time t, while µi,t and σi,t denote the mean and standard deviation of that indicator, respectively. This method helps to normalize the indicator values, bringing them into a range between 0 and 1. For this study, we chose to use empirical standardization. The formula for empirical normalization is as follows:

$$An_{it} \frac{A_{i,t} - \min(A_i)}{\max(\mathrm{A}) - \min(A_i)} \quad (4)$$

Where; An_{it} represents the standardized value of indicator "A" at time t, and min (A_i) and max (A_i) are the minimum and maximum values of the indicator, respectively

All variable used in this study are defined and measured in Table 2.

4. DISCUSSION OF THE EMPIRICAL FINDINGS

This section analyzes the descriptive statistics, checks for autocorrelation and outlines the empirical outcomes. It describes how financial inclusion, renewable energy and other exogenous factors contribute to green growth.

4.1. Summary Statistics and Correlation Matrix

Before discussing the main empirical results, it is necessary to briefly describe the data employed in this research. Therefore, descriptive statistics summarize the main characteristics of the variables. For each variable, we report the mean, standard deviation, and the minimum and maximum values. Descriptive statistics can be found in Table 3.

Table 3 presents the descriptive statistics, which highlight an overview of the variables used in this study. The dependent variable, green growth has a mean of 45.257 and a standard deviation of 6.154 which indicates that green growth values display moderate variability across all observations. The Index of financial inclusion has a mean of 0.521 with a range from 0.011 to 1, which indicates that the financial inclusion levels vary greatly across countries in the sample. The mean value of renewable Energy consumption is 4.513%, and ranges from 0% to 14.2%, which demonstrates differences in the level of renewable energy consumed by the countries in the sample.

The mean value of the index of institutional quality is 0.624, which suggests a relatively high standard of governance quality. For Domestic Investment, the mean value is 24.318%, which reflects an important level. The mean value of foreign Direct Investment is 2.359%. Trade openness records on average a value of 93.182%, however, the considerable standard deviation (36.617) illustrates significant diversity in terms of the extent of countries' economic integration into international trade. GDP growth has an average of 2.731%, with a long range of values, including periods of negative growth (−21.4%), which points to economic volatility. Lastly, Inflation demonstrates extreme variability (mean 6.802%, max 171.206%), indicating periods of macroeconomic instability in some of the countries. In summary, these statistics yield a heterogeneous sample showing variability across economic, financial, and institutional parameters. These statistics can be used to conduct empirical analysis.

Following the analysis of descriptive statistics, we check for potential multicollinearity among the independent variables. Identifying a multicollinearity issue is critically imperative for the stability of regression results. To assess the potential for multicollinearity among the independent variables, we conducted a Pearson correlation analysis. Table 4 presents the correlation matrix.

The results in Table 4 indicate that the correlation coefficients between all pairs of variables are well below the commonly accepted threshold, suggesting that multicollinearity is not a concern in our dataset. This confirms that the independent variables can reliably be used in subsequent regression analyses without bias or redundancy issues.

4.2. The Separate Effect of FI and RE on Green Growth

Table 5 gives the results of the separate effect of financial inclusion and renewable energy on green growth. The SGMM model is well-suited for analyzing this relationship. The AR (1) test is significant across the full samples, while the AR (2) test is insignificant, indicating no second-order serial autocorrelation. The Sargan test confirms that the instruments are valid and not correlated with the error term. However, when we split the sample into countries with more inclusive financial system, and those with less inclusive systems, the individual dimension is very weak compared to the temporel dimension, hence we used the fixed and random effect estimations.

The findings reveal significant heterogeneity in the drivers of green growth across different levels of financial inclusion. The strong and positive coefficient of the lagged green growth variable across

Table 2: Variables definition and measurement

Variable	Definition	Measurement
GG	Green growth	Environmentally adjusted GDP or GDP adjusted for carbon intensity
$GG_{i,t-1}$	Lagged green growth	One-period lag of green growth to capture persistence
IFI	Index Financial inclusion	A composite index built from the access dimension which covers automated teller machines (ATMs) (per 100,000 adults), and commercial bank branches (per 100,000 adults), and the usage dimension which refers to borrowers from commercial banks (per 1,000 adults) and depositors with commercial banks (per 1,000 adults).
REN	Renewable energy consumption	Share of total energy consumption from renewable sources (%)
IQ	Institutional quality index	Composite index capturing control of corruption (CCOR), government stability (GOVS), rule of law (RLAW), Voice and Accountability (VA), Government Effectiveness (GE), and regulatory Quality (RQ).
INVES	Domestic investment	Gross capital formation as % of GDP
FDI	Foreign direct investment inflows	FDI inflows as % of GDP
TRADE	Trade openness	Sum of exports and imports as % of GDP
GDPG	GDP growth rate	Annual percentage growth of GDP
INF	Inflation rate	Annual % change in consumer price index
$\varepsilon_{i,t}$	Error term	Unobserved factors affecting green growth

Table 3: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GG	168	45.257	6.154	32.820	59.550
IFI	168	0.521	0.216	0.011	1
REN	168	4.513	5.152	0.000	14.200
IQ	168	0.624	0.187	0.171	0.971
INVES	168	24.318	7.296	1.225	49.490
FDI	168	2.359	2.154	−2.760	11.133
TRADE	168	93.182	36.617	29.857	188.946
GDPG	168	2.731	4.353	−21.400	19.592
INF	168	6.802	20.253	−3.749	171.206

all models indicates a high degree of persistence, suggesting that past progress in green performance sustains over time.

Financial inclusion (IFI) emerges as a key differentiating factor. While it positively contributes to green growth in more inclusive economies, it exerts a negative influence in less inclusive ones, reflecting how well-structured financial systems can channel resources toward sustainable projects, whereas weak systems may reinforce traditional, carbon-intensive sectors. In more inclusive countries, financial inclusion promotes green growth by improving access to credit and investment for sustainable projects. Well-developed financial systems enable businesses and households to fund renewable energy, clean technologies, and green innovations. Supported by strong regulations and digital finance, inclusive financial systems channel resources efficiently toward environmentally friendly activities, making financial inclusion a key driver of low-carbon and resilient growth. This result is in line with the work of Dong et al. (2025). However, in less inclusive countries, financial inclusion can hinder green growth as funds often flow to traditional, polluting sectors. Weak institutions, poor green awareness, and a lack of sustainable financial products mean new credit supports unsustainable activities rather than environmental initiatives. This finding is divergent from Peng and Zeng (2025). Based on these findings, the hypothesis H_1 is partially accepted only for countries with more inclusive financial systems while it was rejected for the full sample and countries with less inclusive financial systems.

Results in Table 5 indicate that renewable energy (REN) supports green growth mainly in less inclusive economies, highlighting its role as a transformative force in emerging contexts. In less inclusive countries, renewable energy enhances green growth by providing cleaner and more accessible power that reduces reliance on fossil fuels. It stimulates new investments, creates green jobs, and supports sustainable industrialization even where financial systems are underdeveloped. By lowering energy costs and emissions, renewables become a key driver of inclusive and environmentally friendly growth. This result is consistent with Wei et al. (2023) and Caglar et al. (2024). Nevertheless, REN is found to be negatively and significantly associated with green growth in the countries with more inclusive financial systems. In countries with more inclusive financial systems, renewable energy exerts a negative effect because mature financial systems may already have diversified green portfolios, making the marginal impact of renewables on growth smaller or even negative in the short term. This negative link may also reflect adjustment challenges, such as inefficiencies in energy markets or delays in realizing the economic returns from large-scale renewable projects. This result is divergent from the works of Ashfaq et al. (2024). Based on these findings, the hypotheses H_2 is partially accepted only for countries with less inclusive financial systems.

Domestic Investment consistently promotes green growth across all groups. Local investment consistently enhances green growth by financing infrastructure, innovation, and technological upgrades that enhance energy efficiency and reduce environmental impact. Increased local investment supports the development of renewable energy projects, sustainable industries, and green jobs, stimulating both economic and environmental progress. Regardless of financial inclusion levels, higher domestic investment strengthens productive capacity and accelerates the transition toward a low-carbon, sustainable economy.

Findings also indicate that institutional quality enhances green growth for the full sample and the two sub-samples. By ensuring effective governance, transparent regulations, and strong enforcement of environmental policies, the quality of institutions promotes green growth. High-quality institutions promote accountability and reduce corruption, enabling public and private investments to be directed toward sustainable projects. They also create a stable environment that encourages innovation,

Table 4: Correlation matrix

	GG	IFI	REN	IQ	INVES	FDI	TRADE	GDPG	INF
GG	1.0000								
IFI	0.0037	1.0000							
	0.9635								
REN	0.3504*	0.0745	1.0000						
	0.0000	0.3555							
IQ	0.0997	−0.0404	−0.3503*	1.0000					
	0.2158	0.6161	0.0000						
INVES	0.2936*	−0.0068	−0.1496	0.4482*	1.0000				
	0.0002	0.9328	0.0623	0.0000					
FDI	−0.1467	0.1708*	−0.0031	−0.1641*	−0.1642*	1.0000			
	0.0676	0.0330	0.9698	0.0406	0.0405				
TRADE	−0.1855*	0.0966	−0.4230*	0.1242*	0.0505	0.2743*	1.0000		
	0.0205	0.2302	0.0000	0.0000	0.5314	0.0005			
GDPG	0.1627*	−0.0611	−0.0017	0.2274*	0.2106*	0.0150	0.0145	1.0000	
	0.0424	0.4483	0.9834	0.0043	0.0083	0.8525	0.8577		
INF	0.0617	−0.1178	0.1779*	−0.4131*	−0.3876*	0.0275	−0.1125	−0.3170*	1.0000
	0.4438	0.1431	0.0263	0.0000	0.0000	0.7334	0.1621	0.0001	

Table 5: Results of the separate effect of FI and RE on green growth

	SGMM regression for the full sample		Random effect regression FOR More inclusive		Fixed effect regression FOR Less inclusive	
	coeff	z	coeff	z	coeff	z
GG (−1)	1.015	13.66***	0.812	8.4***	0.913	10.65***
IFI	−0.146	−1.71*	0.271	2.58**	−1.182	−1.98*
REN	0.014	0.17	−0.055	−2.75**	1.277	2.2**
IQ	2.294	0.89	1.560	1.91*	3.472	1.09
INVES	0.022	1.82*	0.065	2.32**	0.037	3.15***
FDI	−0.066	−2.52**	−0.030	−0.32	−0.256	−2.57**
TRADE	−0.001	−3.12***	0.003	0.42	−0.001	−0.1
GDPG	0.029	1.98*	−0.047	−2.1**	0.031	4.64***
INF	−0.007	1.79*	−0.003	1.82*	−0.015	−0.12
_cons	−2.275	−0.91	6.050	1.76*	−0.336	2.49**
AR (1)	−4.36		—		—	
Prob	0.000		—		—	
AR (2)	0.24		—		—	
Prob	0.812		—		—	
Sargan test	4.97		—		—	
Prob	0.959		—		—	
Hausman test	—		16.88		249.94	
Prob>Chi^2	—		0.4551		0.0000	
Wald Chi^2 (8)	—		327.04		—	
Prob>Chi^2	—		0.0000		—	
F (8,76)	—		—		5.29	
Prob>F	—		—		0.0000	
Observations	164		66		98	

supports renewable energy adoption, and attracts green foreign investment. In essence, strong institutions provide the regulatory and administrative foundation necessary for achieving long-term, sustainable economic growth. This finding is similar to Heidarian and Shahabadi (2025), and Liu and Zhang (2024).

FDI has a negative or insignificant impact, implying that foreign inflows often target non-green sectors unless guided by strong governance. Trade openness and inflation display limited or mixed effects, whereas GDP growth enhances green performance particularly in less inclusive economies. Overall, these findings underscore that inclusivity and institutional quality shape the effectiveness of financial and economic factors in advancing sustainable and resilient green development.

4.3. The Combined Effect of FI and RE on Green Growth

Results of the combined effect of financial inclusion and renewable energy are displayed in Table 6. Once again, for the whole sample, the SGMM model is well-suited for analyzing green growth, as evidenced by the diagnostic tests. The AR (1) test is significant across all samples, which is expected in a dynamic panel, while the AR (2) test is insignificant, indicating no second-order autocorrelation and validating the use of lagged dependent variables. The Sargan test confirms that the instruments are valid and not correlated with the error term. Overall, these results suggest that the model is correctly specified and reliable for examining the dynamic determinants of green growth across full, more inclusive, and less inclusive country samples. However, when we split the

Table 6: Results of the combined effect of FI and RE on green growth

Variables	SGMM regression for the full sample		Random effect regression FOR More inclusive		Fixed effect regression FOR Less inclusive	
	coeff	z	coeff	z	coeff	z
GG (−1)	1.025	14.41***	0.926	10.53***	0.858	12.24***
IFIxREN	−0.004	−0.05	0.817	1.87*	−0.004	−2.08**
IQ	0.904	1.92*	0.387	2.05**	0.413	2.37**
INVES	0.022	2.79**	0.023	1.77*	0.060	2.08**
FDI	−0.074	−0.57	−0.228	−1.4	−0.060	−0.68
TRADE	−0.001	−2.04**	−0.003	−2.02**	−0.005	−1.78*
GDPG	0.028	4.12***	−0.039	1.8*	0.047	2.01**
INF	−0.008	−0.8	−0.036	−2.31**	−0.002	−0.35
_cons	−0.541	−1.95*	0.552	0.2	4.811	1.62
AR (1)	−4.65		—		—	
Prob	0.000		—		—	
AR (2)	0.23		—		—	
Prob	0.820		—		—	
Sargan test	12.59		—		—	
Prob	0.972		—		—	
Hausman test	—		12.47		189.43	
Prob>Chi^2	—		0.5214		0.0000	
Wald chi2 (8)	—		307.14		—	
Prob>Chi^2	—		0.0000		—	
F (8,76)	—		—		7.29	
Prob>F	—		—		0.0000	
Observations	164		66		98	

sample into countries with more inclusive financial system, and those with less inclusive systems, the individual dimension is very weak compared to the temporal dimension, hence we used the fixed and random effect model.

The combined effect of financial inclusion and renewable energy (IFI*REN) on green growth has varying effects depending on the level of financial system inclusivity. In the full sample, there is no noticeable joint effect, suggesting that, overall, combining financial inclusion with renewable energy does not significantly influence green growth across all countries. In countries with more inclusive financial systems, interaction positively contributes to green growth, indicating that well-developed financial institutions can channel resources effectively into renewable energy projects, enhancing their impact. Also, in countries with more inclusive financial systems, the interaction positively contributes to green growth, suggesting that well-developed financial institutions not only channel resources effectively into renewable energy projects but also help mitigate any potential short-term costs or inefficiencies associated with renewable energy adoption. This result is in line with Cui et al. (2022). Conversely, in countries with less inclusive financial systems, interaction has a negative effect, implying that limited access to finance may prevent renewable energy investments from translating into meaningful green growth, possibly due to misallocation of funds or weak institutional support. Additionally, in countries with less inclusive financial systems, the interaction has a negative effect, suggesting that the potential benefits of renewable energy on green growth are offset or absorbed by the negative impact of weak financial inclusion. Overall, the results highlight that the benefits of combining financial inclusion with renewable energy depend heavily on the strength and inclusivity of the financial system. Hence, the hypothesis H_3 is partially accepted only for countries with more inclusive financial systems.

Compared to the results discussed in Table 5, the effects of the other explanatory variables on green growth remain largely consistent, with no significant changes observed. Key drivers such as domestic investment, and institutional quality continue to show positive and significant impacts across the samples, while factors like FDI, trade openness, and GDP growth maintain their previously identified patterns. This consistency suggests that the inclusion of the interaction term between financial inclusion and renewable energy does not substantially alter the relationships of the other variables with green growth, reinforcing the robustness of the model's earlier findings.

5. CONCLUSION AND POLICY RECOMMENDATIONS

The study emphasizes the important interdependencies linking financial inclusion and renewable energy as a mechanism for promoting green growth across MENA countries. We have used a sample of twelve countries from the MENA region covering the time period from 2010 to 2023. To account for heterogeneity among MENA countries, we identified countries where finance is more inclusive versus countries where finance is more exclusive. The econometric approach used in this study is the SGMM approach, fixed and random effect regressions. For the aggregate analysis (full sample) the results reveal that financial inclusion significantly reduces green growth while renewable energy does not exert any significant effect. For the disaggregate analysis, the effect of financial inclusion and renewable energy differs across countries with more inclusive financial systems, and countries with less inclusive systems. For the analysis by sub-category, we note that the effect if financial inclusion and renewable energy differ across countries with more inclusive financial systems, and countries with less inclusive systems.

This study yields multiple policy recommendations to promote green growth in the MENA region. First, governments and financial institutions should pursue expanding financial inclusion, which may include offering access to banking services, microcredit, and green financing instruments for households and businesses to acquire renewable energy and sustainable technologies. Second, renewables deployment needs to be prioritized, which may include investments, benefits, strategic foresight, and infrastructure for the deployment of renewable technologies. Third, some of the policy recommendations that will encourage the success of the previous two steps can be encouraging digital and green finance innovation; engaging the private sector for launch and supporting regional sharing of experiences via regional cooperation; and, integrating education, awareness, green technologies and financial literacy. Together, these actions and their cross-realignments to performance outcomes can create an environment where financial inclusion and renewables contribute to the objectives of inclusive and environmentally resilient growth in the MENA region.

While the study offers interesting findings, limitations exist that arise from both data and methodological reasons. First, this analysis employs country-level available data for the MENA region, and therefore, may not capture all the variations of financial inclusion, renewable energy, and green growth, at the subnational or sectoral level. Second, important variables such as regulatory quality could not be fully considered. These variables are important, since they may affect the extent to which financial inclusion and renewable energy contribute to green growth. Third, the research focuses on quantitative indicators relating to financial inclusion and renewable energy deployment without any qualitative indicators, such as public policy effectiveness, culture, or behavioral drivers, among the characteristics researched. Addressing such limitations could significantly enhance the results of the current study and pave the way for future research. Overall, improvements to the current study not only add rigor but may also represent a fascinating route for future inquiry, principally whether regulatory contexts affect the interaction between financial inclusion, renewable energy, and green growth in an emerging region.

6. FUNDING STATEMENT

This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (grant number IMSIU-DDRSP2504).

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