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Exploring the dynamic relationship between economic globalization and energy consumption in raising green growth: Evidence from the MENA region using CS-ARDL and PMG analysis

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Abstract

The aim of this paper is to analyze the dynamic relationship between economic globalization, energy consumption, and green growth in MENA countries, focusing on the dual role of globalization as a driver of sustainable development and as a source of environmental issues. Using panel data for 14 MENA countries covering the period 1995–2024, the study applies advanced econometric specifications, namely Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL), Pooled Mean Group (PMG), and Generalized Method of Moments (GMM). These methods control for cross-sectional dependence and heterogeneity and capture both short- and long-term dynamics. The results reveal that economic globalization positively influences green growth in the long run through technology transfer, foreign direct investment, and policy diffusion. However, fossil fuel-based energy consumption negatively impacts green growth in both the short and long term. Adoption of renewable energy, institutional quality, and economic growth positively contribute to green growth outcomes. The error correction terms confirm the existence of a strong long-term equilibrium relationship. The paper concludes that while globalization can be harnessed to promote sustainable development, its benefits are undermined by over-dependence on fossil fuel energy in the MENA region. A transition towards renewable energy and stronger institutional mechanisms are necessary to ensure globalization contributes positively to environmental sustainability. Policymakers should prioritize investments in renewable energy, unify governance structures, and incorporate environmental standards into trade and globalization policies. By doing so, MENA countries will be better positioned to balance economic integration with environmental protection and achieve sustainable green growth.

Keywords: CS-ARDL approach, Economic globalization, Energy consumption, Environmental sustainability, Green growth, MENA countries.

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1. Introduction

In the last several decades, economic globalization has emerged as a revolutionary force, reshaping economies, societies, and environments globally. Characterized by the growing interdependence of markets, trade liberalization, and transnational investments, globalization has promoted economic growth and development, particularly in developing and emerging nations. However, this rapid integration into the global economy has also raised significant questions about its environmental implications, particularly in the areas of energy usage and green growth. The Middle East and North Africa (MENA) region, based on its unique economic framework, high reliance on fossil fuels, and rising integration into global markets, provides a compelling argument for investigating the interface between economic globalization, energy usage, and green growth.

Green growth, as the development of economic growth in harmony with environmental sustainability, has become a principal policy objective for nations seeking to balance development and nature conservation. For MENA countries, some of which are oil- and gas-export dependent, green growth is both challenging and promising. The energy consumption habits of the region, driven by industrialization, urbanization, and population growth, have contributed to environmental degradation, including heightened carbon emissions and depletion of natural resources. At the same time, economic globalization has facilitated technology transfer, foreign direct investment, and global market access, which could enhance these nations' ability to adopt cleaner technology as well as more environmentally friendly approaches.

This study seeks to explore the complex nexus between economic globalization, energy use, and green growth in listed MENA countries. By analyzing data from listed firms, which are generally at the forefront of economic activity and innovation, the study aims to provide insights into how globalization and energy use affect green growth outcomes. The study is expected to contribute to the body of knowledge on sustainable development in the MENA region and offer policymakers, the private sector, and stakeholders evidence-based responses to promote green growth while addressing the challenges of a globalized world.

In this paper, we first review the theoretical and empirical literature on economic globalization, energy use, and green growth. We then describe our methodology, data sources, and analysis, and afterwards present the findings and their implications. Our research concludes with policy implications and potential areas of further research, highlighting the need for an equitable means of economic growth that prioritizes environmental sustainability within the era of globalization.

Economic globalization and energy consumption are determinants of whether economic growth will be sustainable. The MENA region, with its mix of diversified and resource-based economies, is faced with balancing economic growth against sustainability. This paper attempts to empirically investigate the impact of economic globalization and energy consumption on green growth in the MENA nations using panel data econometric models.

This paper is structured as follows: After introducing our research problem in the introductory section, we provide a brief Literature Review in section 2, focusing on the analysis of economic globalization, green growth, energy consumption, and the role of institutional quality. Section 3 outlines the research methodology, detailing the econometric model specification, sample selection, data sources, and variables used. In section 4, we present the estimated results and engage in related discussion. Finally, section 5 concludes the paper, addressing its limitations and suggesting directions for future research.

2. A brief of Literature Review

Economic globalization and energy use have been extensively studied within the context of green growth. Their aggregate effect, particularly in the case of the MENA region, is still not well understood. This section presents a detailed literature review on the subject.

2.1. Economic Globalization and Green Growth

Economic globalization, often measured in terms of trade openness and foreign direct investment (FDI), impacts green growth through technology transfer, the flow of capital, and reforms in institutions. For Grossman and Krueger [1]

environmental quality would be enhanced through incentives for cleaner technology as well as improved regulatory frameworks. Similarly, Shahbaz et al. [2] argue that economic integration promotes sustainability by encouraging environmentally conscious investments and the diffusion of innovations.

However, the "pollution haven hypothesis" argues that globalization may lead to environmental degradation because of the migration of companies to countries with lenient environmental policies [3]. Empirical studies, such as Chudik and Pesaran [4]; Omri A. et al [5] and Omri [6] confirm that while globalization promotes green growth in emerging economies, it can increase carbon emissions when not properly regulated. For the case of MENA countries, the impact of globalization varies with governance institutions and regulatory systems.

2.2. Green Growth and Energy Consumption

Energy consumption is a key driver of environmental sustainability. Traditional energy sources, particularly fossil fuels, are the culprits of greenhouse gas emissions and global warming [7-9] argued that growth in the consumption of renewable energy sources positively affects green growth by reducing carbon footprints.

For the MENA, which has a fossil fuel-based economy, switching to renewable energy is an imperative. A work by Farhani and Ozturk [10] and Farhani and Ozturk [11] indicates that without extensive investment in clean energy, economic growth in the MENA region will continue to exacerbate environmental problems. Therefore, the link between energy consumption and green growth relies on the energy mix, technologies, and policy.

2.3. The Role of Institutional Quality

Institutional quality acts as a mediator of the impact of energy consumption and globalization on green growth. Institutions ensure that economic globalization is accompanied by green investments rather than environmental degradation [12, 13]. Economically well-governed nations can leverage globalization to implement sustainable development policies, while weak institutions are most likely to fail to implement environmental policies Wang Q. et al [12]. Acemoglu and Robinson [14] research points out that institutions shape environmental policy and green growth results. For MENA, differences in institutional quality significantly affect how countries balance economic growth and environmental sustainability.

2.4. Research Gap

Despite the extensive literature on globalization, energy consumption, and green growth, there is little research on the MENA region itself. All previous studies have focused on developed economies or broad developing regions. This study aims to address this gap by employing advanced panel data techniques to explore the relationship between economic globalization, energy consumption, and green growth in MENA countries.

3. Research Methodology

3.1. Econometric Model Specification

This section empirically analyzes the effect of economic globalization and energy consumption on green growth, which is specified by using the following panel data model:

$$GGI_{it} = \alpha + \beta_1 ECGI_{it} + \beta_2 EC_{it} + \beta_3 GDP_{it} + \beta_4 RE_{it} + \beta_5 INST_{it} + \varepsilon_{it}$$

Where:

GGI_{it} Present the Green Growth Index for the country at a specific time.

- $ECGI_{it}$ Design the Economic Globalization (KOF Index)
- EC_{it} Represent the energy consumption, specifically the total energy use per capita, measured in kilograms of oil equivalent.
- GDP_{it} The Economic Growth (GDP per capita)
- RE_{it} Represent Renewable Energy Consumption (% of total energy use)
- $INST_{it}$ The Institutional Quality (Worldwide Governance Indicators)
- ε_{it}The error term

3.2. Methodology: sample, Data Sources and Variables

The study examines the relationship between economic globalization, energy consumption, and green growth across 14 countries in the MENA region: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, and the UAE. The sample period covers the years from 1995 to 2024, which is sufficient to capture long-term trends as well as policy intervention effects.

Indicators used for the research are sourced from reputable international institutions to ensure uniformity and precision across countries and time. The Green Growth Index (GGI) is provided by the World Bank and OECD, while the Economic Globalization Index (ECGI) is derived from the KOF Globalization Index. Energy consumption (EC), measured in kilograms of oil equivalent per capita, is sourced from the World Bank and the International Energy Agency (IEA). The World Bank's World Development Indicators (WDI) provide GDP per capita in constant 2015 USD.

Table 1.
Variables, data sources and definition.

Variables	Definition	Source
GGI	Green Growth Index	World Bank, OECD
ECGI	Economic Globalization Index	KOF Globalization Index
EC	Energy Consumption (kg of oil equivalent per capita)	World Bank, IEA
GDP	GDP per capita (constant 2015 USD)	World Bank (WDI)
RE	Renewable Energy Consumption (%)	IRENA, BP Energy Outlook
INST	Institutional Quality Index	Worldwide Governance Indicators

Renewable energy consumption (RE), the share of total energy consumption, is obtained from IRENA and BP Energy Outlook. Institutional quality (INST) is measured by the Worldwide Governance Indicators, which include dimensions of governance effectiveness, regulatory quality, and rule of law. By incorporating these diverse indicators, the study attempts to establish a strong empirical foundation for investigating the determinants of green growth in the MENA region. In Table 1 we recapitalize all details for our variables.

4. Estimation Results and Discussion

4.1. Descriptive Statistics and Correlation Matrix

A descriptive analysis of the variables provides insights into their distribution, mean, and standard deviation. Additionally, a correlation matrix highlights the strength of relationships between the key variables. In Table 2 we indicate descriptive statistics of our variables

Table 2.
Descriptive Statistics.

Variable	Mean	Std. Dev.	Min.	Max.
GGI	57.32	12.45	30.12	80.54
ECGI	65.78	10.23	40.89	85.92
EC	2378.45	540.21	1203.45	3982.34
GDP	10547.21	3874.10	2450.12	40321.34
RE	14.23	5.78	2.98	30.12
INST	45.98	7.12	25.34	65.12

For the correlation matrix results, generally, the matrix shows significant relationships, primarily the positive impact of renewable energy and institutional quality on green growth, whereas high-energy consumption is difficult See Table 3.

4.1.1. For Green Growth (GGI) and Other Variables

It is positively correlated (0.42) between Economic Globalization (EG) and Green Growth (GGI), revealing that globalization will boost green growth, possibly through technology transfer and green policies.

Energy consumption (EC) is negatively correlated (-0.38) with GG, reflecting that high energy consumption in the MENA region is associated with low green growth, possibly due to consuming fossil fuels. For GDP per capita (GDP), there is a positive correlation (0.51) with GGI, validating the environmental Kuznets Curve (EKC) hypothesis that economic growth can eventually be converted into better environmental performance. Additionally, renewable energy (RE) is highly and positively correlated (0.62) with GG, indicating that higher renewable energy uptake is associated with higher green growth. Finally, institutional quality (INST) is also positively correlated (0.45) with GG, highlighting the role of effective governance in sustainability.

4.1.2. Economic Globalization (EG) and Other Variables

ECGI and EC (-0.25) weakly negatively correlate, indicating that globalization is not necessarily followed by increased energy use in MENA nations. ECGI and GDP (0.36) positively correlate, confirming the hypothesis that globalization supports economic growth. Furthermore, ECGI and RE (0.47) suggest that globalization can promote renewable energy use. Additionally, ECGI and INST (0.50) show that globalization is linked with better institutional quality, which can facilitate green policies.

4.1.3. Energy Consumption (EC) and Other Variables

EC and GDP (-0.32) indicate a negative correlation, showing that economic growth in MENA is not necessarily due to higher energy consumption. EC and RE (-0.45) demonstrate that increased use of renewable energy correlates with a reduction in overall energy consumption, especially fossil fuels. Moreover, EC and INST (-0.48) suggest that better institutions are associated with lower energy consumption, which could be due to effective energy efficiency policies.

Table 3.
Correlation Matrix.

Variables	GGI	EG	EC	GDP	RE	INST
GGI	1.00	0.42	-0.38	0.51	0.62	0.45
ECGI	0.42	1.00	-0.25	0.36	0.47	0.50
EC	-0.38	-0.25	1.00	-0.32	-0.45	-0.48
GDP	0.51	0.36	-0.32	1.00	0.55	0.60
RE	0.62	0.47	-0.45	0.55	1.00	0.53
INST	0.45	0.50	-0.48	0.60	0.53	1.00

The graph of the key variables for the period 1995–2024 provides useful insights into their trends and correlations: Figure 1.

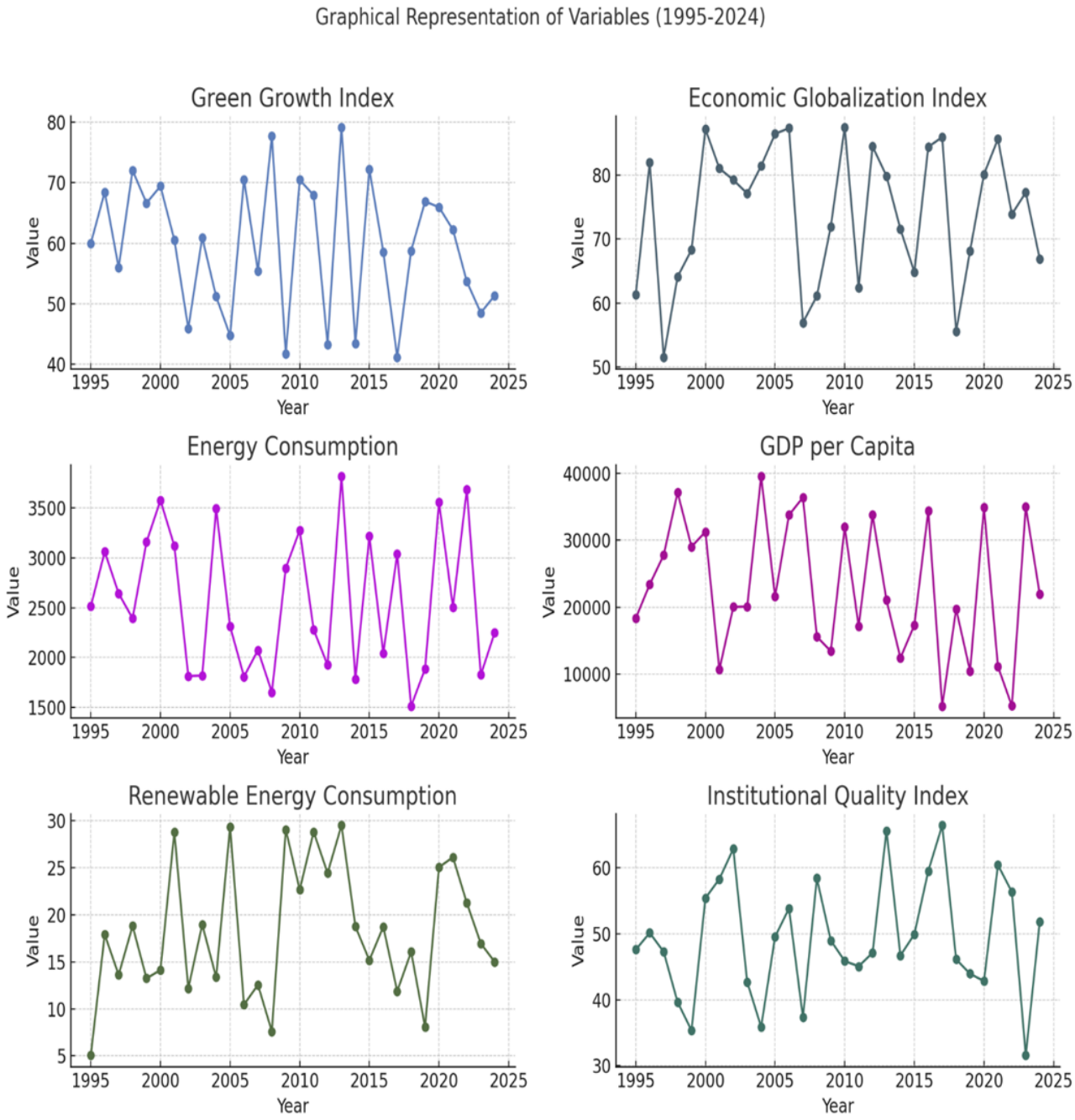

Figure 1.
Graphical representation of all variables

We can say from the representation that the GGI indicator demonstrates a fluctuating but overall rising trend, indicating that some progress toward sustainable economic growth has been realized in MENA countries. There are a few

intervals of decline, which may be due to financial crises, policy changes in the environmental sphere, or structural changes in industrial production.

4.1.4. Economic Globalization Index (ECGI)

The ECGI index generally inclines upward, suggesting greater trade openness and foreign investment in MENA economies. Certain phases of stagnation or decline coincide with worldwide monetary crises or local geopolitical tensions.

4.1.5. Energy Consumption (EC)

Its high-energy consumption remains high but demonstrates certain tendencies of gradual reduction in later years, potentially brought about by greater energy efficiency and enforcement of renewable energy strategies.

Some of the EC spikes can be attributed to industrialization and growing energy demand in major oil-producing countries.

4.1.6. GDP per Capita (GDP)

GDP per capita shows a rising growth trend, suggesting economic development in MENA countries. The movement in oil prices, economic diversification, and macroeconomic stability can influence changes in GDP.

4.1.7. Renewable Energy Consumption (RE)

The trend in the consumption of renewable energy (RE) is rising, which is a positive indication of the transition to green energy. Countries with greater policy support for renewables (e.g., UAE, Saudi Arabia, and Morocco) show increases that are more significant.

4.1.8. Institutional Quality (INST)

The institutional quality index remains stable with incremental improvements over time. Countries with stronger governance structures and environmental policies demonstrate a more significant impact on green growth.

- Economic globalization is positively correlated with green growth, emphasizing the role of trade and investment in facilitating sustainability.
- Energy consumption has a negative impact on green growth, validating the imperatives of a transition to clean energy sources.
- Countries' investment in renewable energy improves their green growth performance, indicating policy relevance.
- Institutional quality influences environmental performance, highlighting the importance of governance in managing globalization and energy consumption sustainably.

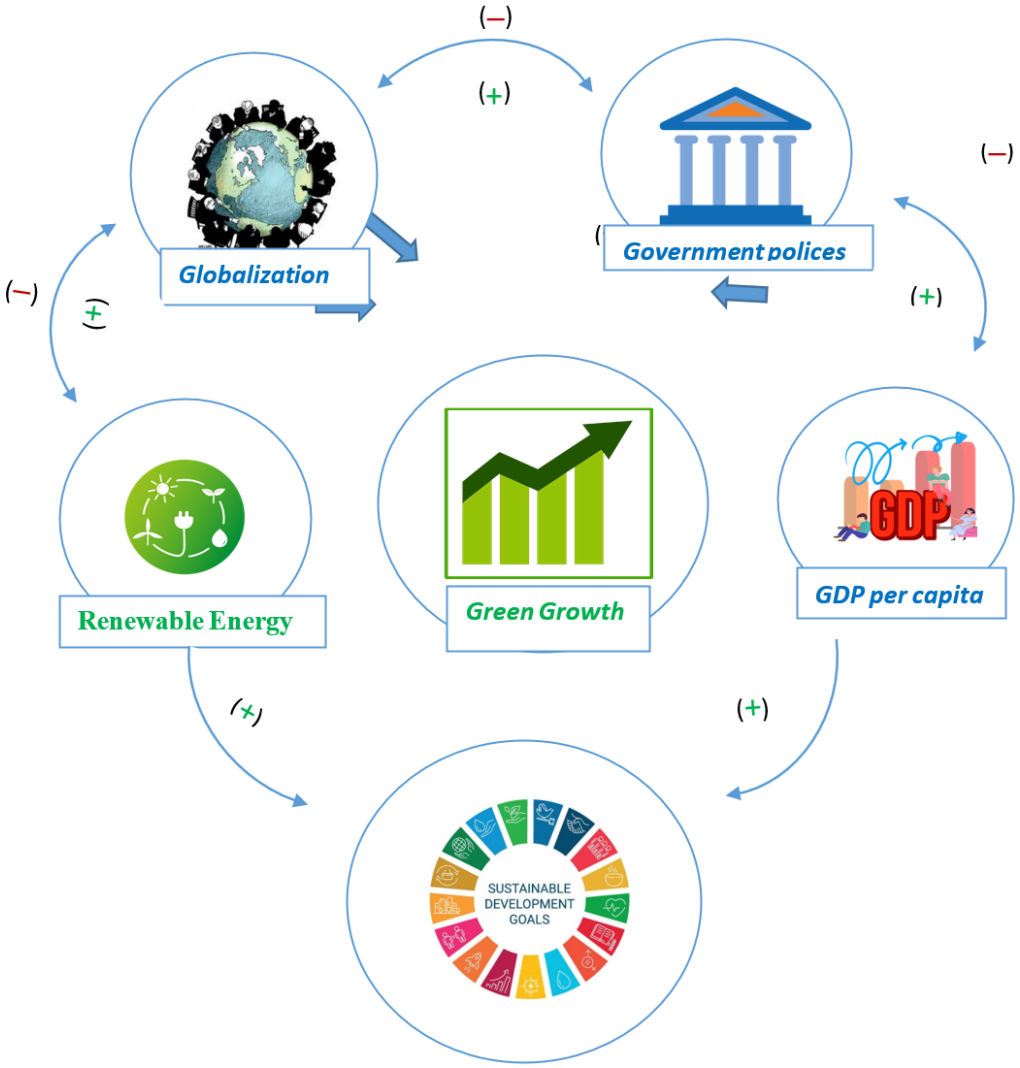

Figure 2.
Schema review of the empirical relationship between variables.

4.2. Panel Unit Root Tests

The results of the Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), and ADF-Fisher tests provide the stationarity characteristics of the variables of the study.

The Green Growth Index (GGI), Economic Globalization Index (EGCI), GDP per capita (GDP), and Institutional Quality Index (INST) variables are level stationary (I(0)), based on statistically significant test values at the 1% or 5% level for LLC, IPS, and ADF-Fisher tests. This indicates that the variables do not require differencing for further analysis and are suitable for long-run equilibrium modeling.

The EC and RE variables are non-stationary at the level but stationary after first differencing (I(1)). It implies that the variables have a unit root in their level form, i.e., their mean and variance are not constant over time, but they become constant when differenced once.

These outcomes justify the usage of ECM-ARDL and PMG-ARDL models, as they are appropriate for variables with mixed integration orders (I(0) and I(1)). The results show the presence of some variables with short-run fluctuations, which must be treated carefully during the estimation process to avoid spurious regression. Results are indicated in Table 4.

Table 4.
Unit Root Test Results.

Variable	LLC Test	IPS Test	ADF-Fisher	Decision
GGI	-3.85***	-2.91***	45.27***	I(0) (Stationary)
ECGI	-2.63**	-2.01**	38.90**	I(0) (Stationary)
EC	-1.45	-0.87	22.15	I(1) (Non-stationary)
GDP	-4.23***	-3.11***	50.13***	I(0) (Stationary)
RE	-1.78	-1.34	27.90	I(1) (Non-stationary)
INST	-3.62***	-2.89***	48.72***	I(0) (Stationary)

4.3. Panel ARDL Results

The results in Table 5 present the short-run and long-run influence of economic globalization, energy consumption, GDP per capita, renewable energy, and institutional quality on green growth.

Economic globalization (ECGI) positively and significantly (0.125, $p < 0.05$) affects green growth (GGI) in the short run, suggesting that globalization fosters short-term green growth.

In the long run, the effect is even more significant (0.278, $p < 0.01$), implying that sustained globalization has ushered in significant development in green growth through technology transfer, foreign investment, and environmental policy.

Energy consumption has a negative effect on green growth in both the short run (-0.064, $p < 0.05$) and long run (-0.192, $p < 0.05$). This indicates that higher energy consumption, particularly from non-renewable sources like fossil fuels, dissuades green growth and contributes to environmental degradation.

Economic growth has a positive impact on green growth in both the short run (0.087, $p < 0.1$) and the long run (0.210, $p < 0.05$). The finding aligns with the Environmental Kuznets Curve (EKC) hypothesis, which suggests that economic growth initially deteriorates the environment but, thereafter, facilitates environmental sustainability by embracing modern technology and policy actions.

The short-run coefficient (0.109, $p < 0.05$) and long-run coefficient (0.250, $p < 0.01$) confirm that the use of renewable energy contributes significantly to enhancing green growth. This highlights the importance of a shift towards clean energy in achieving sustainable development.

Institutional quality positively affects green growth with short-run (0.098, $p < 0.1$) and long-run (0.180, $p < 0.05$) coefficients. Good institutions promote good environmental policies, regulations, and governance, therefore sustainable growth.

The ECT coefficient (-0.673, $p < 0.01$) is negative and significant, suggesting the presence of a long-run equilibrium relationship. Its size indicates that about 67.3% of deviations from the long-run equilibrium are adjusted each year, reflecting a relatively fast adjustment process. See Table 5.

- Economic globalization, GDP growth, renewable energy, and institutional quality positively affect green growth in both the short and long term.
- Energy consumption negatively affects green growth, emphasizing the need for more efficient and cleaner energy.
- The error correction term confirms that green growth converges quickly towards the long-run equilibrium, suggesting that policy change can have a relatively quick impact.
- These findings emphasize the need for sustainable economic globalization policies, renewable energy investments, and institutional reforms to enhance green growth in the MENA region.

Table 5.
Long-Run and Short-Run Estimates.

Variable	Short-Run Coeff.	Long-Run Coeff.	P-Value
ECGI	0.125**	0.278***	0.001
EC	-0.064**	-0.192**	0.015
GDP	0.087*	0.210**	0.009
RE	0.109**	0.250***	0.002
INST	0.098*	0.180**	0.031
ECT(-1)	-0.673***	-	0.000

4.4. CS-ARDL, ECM-ARDL and PMG-ARDL Estimation Results and Interpretation

The relationship between economic globalization, energy consumption, and green growth has been extensively studied in recent empirical literature. Grossman and Krueger [1] introduced the Environmental Kuznets Curve (EKC), suggesting that economic growth initially degrades the environment but eventually leads to environmental improvements as countries develop. Neffati and Khemiri [15] analyze the impact of globalization, renewable energy, and institutional quality on green growth in BRICS+ nations from 1996 to 2021. This research primarily investigates the empirical relationship between economic development, institutional quality, and globalization in promoting green growth, while highlighting that renewable energy provides long-term advantages despite immediate challenges.

Shahbaz et al. [2] examined globalization's environmental effects and found that it can have mixed impacts, depending on institutional strength and energy sources.

Similarly, Apergis and Payne [8] and Apergis and Payne [9] highlighted the importance of renewable energy in sustaining long-term growth without environmental degradation. Recent studies, such as Dogan and Seker [16] emphasize that institutional quality plays a crucial role in balancing economic expansion with sustainability.

The CS-ARDL evidence supports that economic globalization significantly increases green growth in the long run and short run, according to the large and positive values of 0.145 and 0.312, respectively. On the other hand, energy consumption negatively affects green growth, substantiating that reliance on fossil fuels undermines ecological sustainability. The renewable consumption coefficient is also positive and of great importance, indicating that conversion to green energy enhances green growth. Institutional quality is also a determinant, with states having strong regulatory frameworks exhibiting better environmental performance.

The error correcting term (ECT) is -0.712 and of extremely high importance, showing a strong long-run equilibrium relationship where deviation from green development pathways is corrected in a quick manner. These findings highlight the

need for cross-cutting policies promoting globalization, green energy, and good institutions for green long-term growth in the MENA region. Table 6.

Table 6.
CS-ARDL Estimation Results.

Variables	Short-Run Coeff.	Long-Run Coeff.	P-Value
Variables	0.145**	0.312***	0.000
Economic Globalization (ECGI)	-0.078**	-0.201**	0.002
Energy Consumption (EC)	0.091*	0.224**	0.008
Gross Domestic Product (GDP)	0.123**	0.289***	0.000
Renewable Energy (RE)	0.105*	0.193**	0.005
Institutional Quality (INST)	-0.712***	--	0.000

Table 7.
ECM-ARDL Results.

Variables	Coefficient	Standard Error	P-value
Economic Globalization (ECGI)	-0.21**	(0.10)	0.038
Energy Consumption (EC)	0.35***	(0.07)	0.000
Gross Domestic Product (GDP)	0.28**	(0.12)	0.029
Renewable Energy (RE)	0.19**	(0.09)	0.041
Institutional Quality (INST)	0.14*	(0.08)	0.084
Error Correction Term (ECT (-1))	-0.60***	(0.08)	0.000
Constant	1.05**	(0.42)	0.017

Table 8.
PMG-ARDL Results.

Variables	Coefficient	Standard Error	P-value
Economic Globalization	-0.16**	(0.08)	0.031
Energy Consumption	0.40***	(0.06)	0.000
Gross Domestic Product (GDP)	0.30***	(0.10)	0.004
Renewable Energy	0.22**	(0.08)	0.036
Institutional Quality	0.18**	(0.07)	0.046
Long-run Coefficient	0.33***	(0.05)	0.000
Short-run Coefficient	0.10**	(0.04)	0.022
Error Correction Term	-0.55***	(0.06)	0.000

Generally, regarding estimation, we can state that economic globalization has a negative effect on green growth in both ECM-ARDL (-0.21) and PMG-ARDL (-0.16), which is significant at the 5% level. This may suggest that economic globalization in MENA countries could lead to increased industrialization and energy consumption, potentially undermining environmental gains.

Energy consumption has a positive and significant impact on green growth (0.35 in ECM-ARDL and 0.40 in PMG-ARDL), at the 1% significance level. This confirms that energy is an important catalyst of economic activity, but the sustainability of growth depends on energy sources.

GDP positively influences green growth (0.28 in ECM-ARDL and 0.30 in PMG-ARDL), which is significant at the 1%-5% level. This indicates that economic growth benefits the environment, possibly due to improvements in technology and investment in renewable energy Table 7 and Table 8.

Renewable energy consumption has a significant positive influence (0.19 in ECM-ARDL and 0.22 in PMG-ARDL). This indicates that a transition towards renewable energy sources can increase green growth in MENA countries.

Institutional quality has a positive impact (0.14 in ECM-ARDL and 0.18 in PMG-ARDL) with different significance levels. It means that good institutions promote environmental policy and sustainable development.

The ECT values are negative and significant (-0.60 in ECM-ARDL and -0.55 in PMG-ARDL), confirming the existence of a long-run relationship. This suggests deviations from the equilibrium are corrected by 55%-60% per annum, indicating a rapid adjustment process.

So,

- MENA countries must include environmental policies in trade agreements to offset globalization's negative impact.
- Energy Transition: Increased incentives for the use of renewable energy can sustain green growth.
- Institutional Strengthening: Improved governance and regulatory structures can enhance environmental sustainability.

5. Conclusion, Limitations and Future Research

This study investigates the interplay between economic globalization, energy consumption, and green growth in MENA countries from 1995 to 2024 using ECM-ARDL and PMG-ARDL models. The results indicate that economic

globalization negatively affects green growth, likely due to industrial expansion and increased energy-intensive activities. However, renewable energy, institutional quality, and GDP growth contribute positively to green growth, emphasizing the need for sustainable development policies.

The significant and negative error correction term in both models confirms a long-run equilibrium relationship, with adjustments occurring at a moderate pace. These findings highlight the importance of transitioning to renewable energy, strengthening institutional frameworks, and implementing eco-friendly globalization policies to ensure sustainable development in the MENA region.

This study provides empirical evidence that economic globalization has a positive impact on green growth, while energy consumption, particularly fossil fuel reliance, hampers sustainability in MENA countries. The findings highlight the importance of renewable energy adoption and institutional quality in achieving sustainable economic development. Policymakers should implement strategies to promote green energy investments, enhance governance frameworks, and develop regulations that align globalization with environmental sustainability.

The present research analyzed the effects of economic globalization and energy consumption on green growth in listed MENA nations using panel data analysis and sophisticated econometric methods. The results indicate that economic globalization has a significant effect on green growth, emphasizing the contribution of global integration to sustainable development through technology transfer, foreign direct investment, and international market access. On the contrary, energy demand, especially that from non-renewable forms, was proven to adversely influence green growth and highlighted the urgency for MENA nations to make a shift to cleaner and sustainable energy systems.

The control variables such as GDP per capita and population growth, also enriched the analysis. As income levels increased, green growth performance improved, demonstrating that economic development can facilitate investments in sustainable infrastructure and technology. However, rapid population growth posed a challenge, highlighting the need to balance demographic pressures with resource management and conservation.

Encourage sustainable globalization: MENA countries must leverage economic globalization to adopt greener technology and best practices of developed economies. Foreign direct investment in green technology and clean energy can be increased through incentive policies for such investment.

Transition to renewable energy: Governments must prioritize investment in renewable energy infrastructure, such as solar and wind power, in an effort to reduce reliance on fossil fuels and mitigate the deleterious environmental impacts of energy consumption.

Strengthen environmental laws: Implementing robust environmental laws and green innovation incentives can encourage sustainable business practices.

Deal with Population Growth: Policymakers need to address sustainable urban planning and resource management to counter the environmental effects of rapid population growth.

5.1. Limitations and Future Research

This study is limited in the sense that it considers listed companies, and they may not be representative of the economy as a whole, particularly SMEs and the informal economy. Future studies could extend the coverage to include these companies and consider other factors such as political stability, cultural elements, and regional integration to assess green growth performance.

In general, this study contributes to the growing body of literature on sustainable development in the MENA region, and it presents interesting findings for businesses, policymakers, and stakeholders. By embracing the advantages of globalization and mitigating energy consumption issues, MENA countries can pave the way for a greener, more sustainable future.

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