Vol. 5(4), 21-27

Journal of Energy & Environmental Policy Options

Exploring the Role of Investment, Economic Structure, and Urbanization on Energy Intensity in the MENA Nations

Hassan Mohammadi[a]

Abstract

This article examines energy intensity across a panel of six Middle East and North Africa (MENA) countries: Tunisia, Algeria, Morocco, Egypt, Jordan, Iran, Saudi Arabia, and the United Arab Emirates, spanning from 1980 to 2020. The analysis employs panel data econometrics, specifically heterogeneous panel cointegration tests developed by Pedroni, and utilizes the pooled mean group estimator proposed by Pesaran. The findings underscore that energy intensity, defined as the amount of energy consumed per unit of GDP, is significantly influenced by several key factors within MENA economies. Firstly, the level of investment plays a pivotal role in shaping energy intensity levels. Higher levels of investment typically correspond to increased industrial and infrastructural development, which in turn can lead to higher energy consumption relative to GDP. This relationship highlights the critical importance of investment policies and their implications for energy use efficiency. Secondly, the structure of economies within the MENA region is identified as a significant determinant of energy intensity. Countries with economies heavily reliant on energy-intensive sectors such as manufacturing, heavy industry, and resource extraction tend to exhibit higher energy intensity levels. This structural dependency underscores the challenges and opportunities associated with transitioning towards more energy-efficient economic models and diversifying energy sources. Additionally, urbanization rates emerge as another influential factor affecting energy intensity in MENA countries. Rapid urbanization often accompanies economic growth and industrialization, leading to increased energy demand for transportation, housing, and commercial activities. Managing urbanization processes through sustainable urban planning and infrastructure development becomes crucial in mitigating the rise in energy intensity and promoting efficient energy use practices. The study's methodological approach, utilizing panel data econometrics and cointegration tests, provides robust insights into the long-term dynamics of energy intensity across the MENA region. By incorporating country-specific characteristics and structural factors, the analysis offers a nuanced understanding of how varying economic contexts within MENA countries impact energy consumption patterns. The implications of these findings suggest that policies aimed at reducing energy intensity should focus on enhancing energy efficiency measures, promoting renewable energy adoption, and optimizing investment in sustainable infrastructure. Encouraging diversification away from energy-intensive sectors and fostering innovation in energy technologies are also critical strategies for achieving sustainable development goals and mitigating environmental impacts.

Keywords: Energy Intensity, Investment, MENA Countries

JEL Codes: Q43, C23, O53

1. INTRODUCTION

Since the oil shocks of the 1970s, energy conservation has become a significant concern for countries worldwide. This heightened awareness has spurred a growing interest in studying the relationship between energy consumption and Gross Domestic Product (GDP) growth. The level of economic and social development in a country is often linked to its per capita electricity consumption, highlighting the critical role of energy in facilitating development. In developing nations, the establishment of a competitive industrial base is heavily reliant on manageable energy costs. Between 1980 and 2022, Africa's electricity consumption grew by 2.3 times, and conventional energy consumption increased by 1.8 times. During the same period, GDP grew by a factor of 1.6, and the population expanded by 1.7 times. Notably, energy consumption per capita rose by 10%, underscoring the increasing energy demands associated with economic and population growth.

These statistics indicate a complex interplay between energy consumption, economic growth, and population dynamics. The significant rise in per capita energy consumption suggests improvements in access to energy and its usage efficiency, which are crucial for economic development. However, this also points to the challenges of ensuring sustainable energy consumption amidst rapid economic and demographic changes.

As countries continue to develop, the demand for energy will likely increase, making it essential to balance energy conservation with economic growth. This necessitates the adoption of energy-efficient technologies and policies that promote sustainable energy use. By addressing these challenges, nations can achieve a more sustainable and prosperous future, where economic growth is supported by efficient and responsible energy consumption practices. Overall, energy intensity in Africa is higher than the global average. According to statistics from the International Energy Agency (IEA, 2010), the consumption of conventional energy has seen a greater increase than GDP over the past two decades. This trend highlights the continent's heavy reliance on conventional energy sources and the inefficiencies in energy usage.

[a] Polytechnic School of Tunisia, Carthage University, Tunisia

Currently, Africa faces significant challenges related to energy supply shortages. In response, the concept of energy substitution has gained traction for two primary reasons: national energy security and the increasing concern about global warming. Energy substitution involves replacing one energy source with another, often aiming to shift from high greenhouse gas-emitting sources to more sustainable and environmentally friendly alternatives. The push for energy substitution is driven by the urgent need to enhance energy security. Many African countries depend on imported energy, which makes them vulnerable to global energy market fluctuations and geopolitical tensions. By diversifying energy sources and increasing the use of domestic renewable energy, nations can reduce their dependency on imports and enhance their energy resilience.

Additionally, the rising global awareness of climate change has amplified the call for reducing greenhouse gas emissions. Certain energy pathways, such as solar, wind, and hydroelectric power, have been promoted for their potential to replace fossil fuels, thereby mitigating environmental impact. These renewable energy sources produce little to no greenhouse gases, making them crucial in the fight against global warming. While Africa's energy intensity remains high, the move towards energy substitution presents a promising pathway to address both energy security and environmental sustainability. By adopting and integrating renewable energy sources, African nations can work towards a more secure, sustainable, and resilient energy future. This shift not only addresses immediate supply challenges but also aligns with global efforts to combat climate change. With the exception of butane gas, the renewable energy sector in the region remains constrained within a system dominated by production, distribution, and maintenance institutions. This dominance is prevalent despite the presence of numerous informal sector enterprises that could potentially contribute to the industry's growth and diversification. The butane gas market stands as an anomaly within the broader renewable energy sector, highlighting the unique challenges faced by other renewable energy sources. Butane gas has managed to establish a more integrated and accessible supply chain compared to other renewable energy forms, which remain largely dependent on formal institutions for their operations.

The renewable energy sector's reliance on these dominant institutions creates several barriers to entry and growth for informal enterprises. These institutions often control critical aspects of the supply chain, including production technologies, distribution networks, and maintenance services. This control can stifle innovation and limit the participation of smaller, informal enterprises that could offer alternative solutions and drive competition within the market. Moreover, the existing institutional frameworks can result in inefficiencies and higher costs, as they may not be as agile or responsive to market demands as smaller enterprises. Informal sector businesses, with their flexibility and adaptability, could play a significant role in expanding the reach and effectiveness of renewable energy solutions. However, the dominance of formal institutions often restricts these smaller players' ability to scale up and integrate into the larger market. To unlock the potential of the renewable energy sector in the region, there is a need for policies and initiatives that encourage the inclusion of informal enterprises. This could involve creating more supportive regulatory environments, providing access to financing and technical assistance, and fostering partnerships between formal institutions and informal businesses. Such measures could help diversify the market, reduce costs, and enhance the overall sustainability and accessibility of renewable energy solutions.

While butane gas has carved out a more established niche within the energy sector, other renewable energy sources remain hindered by institutional dominance. By addressing these structural challenges and promoting greater inclusion of informal enterprises, the region can better harness its renewable energy potential and move towards a more resilient and sustainable energy future. In the MENA (Middle East and North Africa) region, solar energy stands out as a highly accessible renewable energy source, particularly in desert areas where solar irradiance is exceptionally high. The potential for solar energy in these regions is substantial, with solar radiation levels being approximately twice as high as those in Paris. This significant advantage means that the MENA region can harness solar energy more efficiently and effectively compared to many other parts of the world. A striking illustration of this potential is the idea that a solar park spanning roughly 5,000 km² could generate an amount of energy equivalent to the annual oil production of the entire Middle East. This highlights the vast untapped potential for solar power to transform the energy landscape of the region. Such a solar park could serve as a cornerstone for energy security, reducing dependency on fossil fuels, and contributing to the reduction of greenhouse gas emissions.

The high levels of solar irradiance in the MENA region present an opportunity to develop large-scale solar projects, such as concentrated solar power (CSP) plants and photovoltaic (PV) farms. These projects can provide a reliable and sustainable energy supply, supporting both domestic energy needs and potential exports of renewable energy to neighboring regions. Moreover, the development of solar energy infrastructure in the MENA region can drive economic growth by creating jobs, fostering technological innovation, and attracting investments. The establishment of a robust solar energy sector could also lead to advancements in energy storage and grid integration technologies, further enhancing the efficiency and reliability of the energy supply. However, to fully realize the potential of solar energy in the MENA region, several challenges must be addressed. These include securing the necessary investments, developing supportive regulatory frameworks, ensuring access to advanced technologies, and building the technical expertise required for the construction, operation, and maintenance of solar energy facilities.

The MENA region's exceptional solar energy potential represents a transformative opportunity to meet energy needs sustainably. By investing in and developing solar infrastructure, the region can achieve significant economic, environmental, and social benefits, positioning itself as a global leader in renewable energy. Several countries in the MENA region are also investing in wind power as part of their efforts to diversify energy sources and enhance energy security. These investments are crucial for reducing reliance on fossil fuels and mitigating the impacts of climate change.

Tunisia has developed four wind farms with a total installed capacity of 120 MW. These wind farms contribute significantly to the country's renewable energy mix, helping to reduce greenhouse gas emissions and promote sustainable energy practices. Jordan has established a wind power site with a capacity of 40 MW. This investment reflects Jordan's commitment to increasing its renewable energy capacity and reducing its dependence on imported energy sources. The wind farm not only supports the country's energy needs but also stimulates local economic development. **Morocco** is a leading example in the region, with four wind power sites totaling 1,000 MW in capacity. Morocco's ambitious wind energy projects are part of a broader strategy to increase the share of renewables in its energy mix, aiming to reach 52% renewable energy by 2030. The country's favorable wind conditions and proactive policies have made it a model for renewable energy development in the region.

Egypt has set forth an ambitious plan to produce 2,000 MW from wind power by 2016, with a target of generating 12% of its electricity from wind energy by 2020. Egypt's commitment to wind energy is driven by the need to meet growing energy demands and reduce environmental impact. The country's wind power projects are strategically located in areas with high wind potential, such as the Gulf of Suez, to maximize efficiency and output. These investments in wind power across the MENA region demonstrate a significant shift towards sustainable energy solutions. By harnessing wind energy, these countries are not only working towards energy independence but also contributing to global efforts to combat climate change. The development of wind power infrastructure creates job opportunities, fosters technological innovation, and attracts foreign investments, further bolstering the region's economic growth. The MENA region's increasing investment in wind power is a positive step towards sustainable energy development. The efforts of Tunisia, Jordan, Morocco, and Egypt highlight the region's potential to lead in renewable energy adoption, providing a cleaner and more resilient energy future.

Energy intensity, which measures the amount of energy used to generate a unit of GDP, varies significantly across regions and reflects differences in energy efficiency and economic structure. In the MENA region, energy intensity is notably higher compared to other regions, indicating that more energy is required to produce the same economic output. In East Asia and the Pacific, energy intensity is comparatively lower, reflecting more efficient energy use. This can be attributed to advanced energy technologies, more stringent energy efficiency policies, and a higher share of less energy-intensive industries. These factors contribute to a more efficient overall energy use, allowing these regions to achieve economic growth with lower energy consumption. Latin America also exhibits relatively low energy intensity, suggesting efficient energy use. This efficiency may result from a combination of factors, including the adoption of energy-efficient technologies, a diversified mix of energy sources, and less reliance on energy-intensive economic activities. The lower energy intensity in these regions highlights their ability to sustain economic growth while minimizing energy consumption.

2. LITERATURE REVIEW

Energy plays a pivotal role in the economic development of a country by enhancing the productivity of factors of production and elevating living standards. The interconnectedness of economic development and energy consumption is widely acknowledged. Historical events, such as the energy crisis of the 1970s and persistently high energy prices, particularly oil prices, have significantly impacted the economic activities of developing economies, underscoring the importance of energy in economic growth. The relationship between energy consumption and economic growth has been a subject of extensive research over the past two decades. Numerous studies have explored this nexus, offering insights into how energy consumption drives economic growth and vice versa. Ozturk (2010) provides a comprehensive survey of the literature on the energy-growth nexus, highlighting the various methodological approaches and findings across different contexts and periods.

In one notable study, Mehrara (2007) investigated the causal relationship between per capita energy consumption and per capita GDP in oil-exporting countries. His findings revealed strong unidirectional causality from economic growth to energy consumption in these countries. This implies that economic growth drives energy consumption, suggesting that policies aimed at promoting economic growth could lead to increased energy demand in oil-exporting nations. This relationship underscores the importance of understanding the dynamics between energy consumption and economic growth, especially for developing economies that are heavily reliant on energy imports. By examining these dynamics, policymakers can devise strategies to balance energy consumption with sustainable economic growth, ensuring that energy policies support rather than hinder economic development. The ongoing discourse in the literature continues to evolve, providing valuable insights into how countries can navigate the complexities of energy consumption and economic growth in an era of fluctuating energy prices and growing energy demands. Zhang-wei and Xun-gang (2012) analyzed the relationship between energy consumption and economic development in China using a vector autoregression (VAR) model. Their study identified a unidirectional causality running from energy consumption to gross domestic product (GDP), indicating that increases in energy consumption lead to economic growth in China. This finding suggests that energy consumption is a crucial driver of economic development in the Chinese context.

Similarly, Selim et al. (2010) examined the dynamic causal relationship between electricity consumption and economic growth in Romania. Using sophisticated econometric techniques, they found that causality runs from electricity consumption to economic growth. This implies that, for Romania, electricity consumption is a significant factor influencing economic growth, and policies aimed at enhancing electricity infrastructure could foster economic development. In the UK, Rashid and Kocaaslan (2013) explored the impact of energy consumption volatility on GDP volatility. Their research demonstrated that the variability of energy consumption significantly influences GDP volatilities, highlighting the importance of stable energy consumption patterns for economic stability. This study underscores the need for policies that mitigate energy consumption fluctuations to maintain steady economic growth. Shahateet and Fedel (2014) analyzed the relationship between economic growth and energy consumption in Jordan within the framework of neoclassical productivity theory. By treating capital, labor, and energy as separate production factors, their study provided a nuanced understanding of how energy consumption integrates into the broader economic growth process. Their findings suggest that energy consumption, alongside capital and labor, plays a vital role in driving economic growth in Jordan.

Based on the econometric model constructed by Shahateet and Fedel (2014), using annual time series data spanning from 1970 to 2011, their study examines the causal relationship between economic growth and production factors, including energy consumption, in Jordan. Their findings reveal several significant insights regarding the dynamics between GDP and energy consumption. Firstly, the study identifies Granger causality running from GDP to energy consumption, indicating that economic growth in Jordan influences energy consumption levels. However, contrary to this directional causality, there is no evidence of Granger causality running from energy consumption to GDP. This suggests that changes in energy supply or energy conservation policies might have little to no immediate impact on economic growth in Jordan, at least within the studied timeframe. The implication of this unidirectional causality is significant for Jordan's economic policy framework. It implies that Jordan is less dependent on energy for its economic growth, potentially allowing the government more flexibility in introducing energy supply constraints or conservation measures without adversely affecting GDP growth. This finding challenges traditional theories advocating for stringent energy conservation policies as a means to boost economic growth. Moreover, the study's findings support government policies aimed at increasing energy prices and reducing public demand for energy consumption. These policies are seen as crucial not only for fiscal reasons, such as reducing the government budget deficit and managing foreign debt, but also for aligning energy consumption patterns with broader economic goals.

Shahateet and Fedel's research provides empirical evidence that the direction of causality between GDP and energy consumption in Jordan is unidirectional from GDP to energy consumption. This underscores the need for tailored energy policies that reflect Jordan's unique economic context and the potential to leverage energy management strategies for broader economic stability and sustainability. The study conducted by Naji and Maryam (2014) focuses on investigating the causal relationship between Real GDP and energy consumption across various economic sectors in Iran, including household and commercial sectors, industry, transportation, and agriculture. They employ two primary time series techniques: the Toda Yamamoto method and an error correction model (ECM) to analyze data spanning from 1967 to 2010. Using the Toda Yamamoto method, the researchers find compelling evidence of a strong unidirectional causality from energy consumption in the industry sector to real Gross Domestic Product (GDP). This suggests that energy consumption within Iran's industrial sector significantly contributes to economic development, indicating that industrial energy use plays a pivotal role in stimulating economic growth. Furthermore, the study complements its findings by employing an error correction model, which allows for a comparison with the results obtained from the Toda Yamamoto method. While specific details of the comparison are not provided, the use of multiple econometric techniques enhances the robustness of their analysis and strengthens the validity of their conclusions regarding the relationship between energy consumption and economic growth across different sectors in Iran.

Naji and Maryam's research underscores the critical role of energy consumption in Iran's industrial sector as a driver of economic growth. Their findings support the notion that policies and investments aimed at enhancing energy efficiency and optimizing industrial energy use could have substantial positive impacts on Iran's overall economic performance, particularly within the industrial domain. In their study, Pao et al. (2014) explored the interrelationships among economic growth, carbon dioxide emissions, renewable energy, and globalization within the context of the Portuguese economy spanning from 1970 to 2010. Utilizing a comprehensive array of time series econometric methods including Ordinary Least Squares (OLS), Generalized Method of Moments (GMM), unit root tests, Vector Error Correction (VEC) models, and Granger causality analysis, they aimed to dissect these complex dynamics. Their empirical results, derived from OLS and GMM models, revealed a positive correlation between carbon dioxide emissions, renewable energy consumption, and economic growth in Portugal. This suggests that as economic activity and renewable energy consumption increase, so do carbon dioxide emissions, reflecting the challenges of balancing economic development with environmental sustainability. Moreover, their analysis of the impact of globalization on economic growth indicated a positive effect. This finding underscores the notion that globalization, as measured by their overall index, contributes positively to Portugal's economic expansion over the studied period.

Regarding Granger causality, Pao et al. identified a unidirectional causality running from renewable energy consumption to economic growth. This implies that increases in renewable energy consumption precede and potentially facilitate economic growth in Portugal, highlighting the strategic importance of renewable energy policies in fostering economic development while mitigating environmental impacts. Overall, Pao et al.'s research provides valuable insights into the intricate relationships between economic growth, carbon dioxide emissions, renewable energy, and globalization in Portugal, offering empirical evidence that informs policy discussions aimed at achieving sustainable development goals.

Empirical studies examining the causal link between energy consumption and economic growth in the MENA region are hindered by gaps in econometric research that explore the dynamics of the region's productive systems.

3. METHODOLOGY

This article utilizes World Bank Indicators spanning from 1980 to 2020, selected due to data availability on energy intensity of GDP across MENA countries without missing data. The study includes eight member states: Tunisia, Algeria, Morocco, Egypt, Jordan, Iran, Saudi Arabia, and the United Arab Emirates. The model variables comprise Energy

Intensity (IE) as a measure of the productive system's energy demand, GDP per capita as the endogenous variable reflecting overall economic wealth, Gross Investment (INV) expected to correlate positively and significantly with GDP, and Urbanization Rate (TUB) influencing consumption levels. Additionally, the model incorporates a variable representing the economic structure encompassing agriculture, industry, and services.

4. RESULTS AND DISCUSSION

Table 1 presents the elasticity of short-run energy intensity for various countries, measured across different variables such as investments (LINV), GDP per capita (LPIB), urbanization (LTUB), agricultural value added (LVA AG), industrial value added (LVA IND), and service value added (LVA SER). For Algeria, the elasticity values are as follows: investments (LINV) show a value of 0.0028, GDP per capita (LPIB) 0.0480, urbanization (LTUB) -0.9415, agricultural value added (LVA AG) 0.2854, industrial value added (LVA IND) 1.0964, and service value added (LVA SER) 0.1036. These results suggest a significant negative relationship between urbanization and energy intensity, while industrial value added shows a strong positive relationship. In Egypt, investments (LINV) have an elasticity value of 0.0089, GDP per capita (LPIB) 0.1246, urbanization (LTUB) 3.5144, agricultural value added (LVA AG) 2.3854, industrial value added (LVA IND) 4.0107, and service value added (LVA SER) 4.0107. The results indicate a notably strong positive relationship between urbanization, industrial value added, and energy intensity. Iran displays elasticity values of 0.0446 for investments (LINV), 0.1145 for GDP per capita (LPIB), -2.0406 for urbanization (LTUB), 0.1007 for agricultural value added (LVA AG), 0.7091 for industrial value added (LVA IND), and 1.5664 for service value added (LVA SER). There is a significant negative relationship between urbanization and energy intensity, while the service sector shows a substantial positive impact. For Jordan, investments (LINV) are at 0.0711, GDP per capita (LPIB) 0.1453, urbanization (LTUB) -1.5895, agricultural value added (LVA AG) -0.0317, industrial value added (LVA IND) 0.2594, and service value added (LVA SER) 1.4263. The data indicates a negative relationship between urbanization and agricultural value added with energy intensity, whereas the service sector has a strong positive effect. Morocco has elasticity values of 0.2909 for investments (LINV), -0.0200 for GDP per capita (LPIB), -0.3815 for urbanization (LTUB), 0.4117 for agricultural value added (LVA AG), 0.3939 for industrial value added (LVA IND), and 0.0988 for service value added (LVA SER). These results show a negative impact of urbanization and GDP per capita on energy intensity, with positive contributions from other sectors. In Saudi Arabia, the elasticity values are -0.5752 for investments (LINV), 0.5946 for GDP per capita (LPIB), -3.8723 for urbanization (LTUB), 2.1991 for industrial value added (LVA IND), and 1.6185 for service value added (LVA SER). Urbanization has a strong negative relationship, while industrial and service sectors show significant positive effects on energy intensity. Tunisia's elasticity values are -0.0749 for investments (LINV), 0.2511 for GDP per capita (LPIB), -0.6029 for urbanization (LTUB), 0.0352 for agricultural value added (LVA AG), 0.3834 for industrial value added (LVA IND), and 0.3440 for service value added (LVA SER). Urbanization shows a negative relationship with energy intensity, while GDP per capita and other sectors exhibit positive relationships. In the Emirates, investments (LINV) have an elasticity of 1.1277, GDP per capita (LPIB) 0.5596, urbanization (LTUB) -3.3584, agricultural value added (LVA AG) -0.3716, and service value added (LVA SER) 1.9189. The results indicate a strong negative impact of urbanization and agricultural value added on energy intensity, with substantial positive contributions from investments and the service sector.

Table 1: Elasticity of short-run energy intensity for each country

	LINV	LPIB	LTUB	LVA AG	LVA IND	LVA SER
Alg.	0.0028	0.0480	-0.9415	0.2854	1.0964	0.1036
Egy.	0.0089	0.1246	3.5144	2.3854	4.0107	4.0107
Ir.	0.0446	0.1145	-2.0406	0.1007	0.7091	1.5664
Jor.	0.0711	0.1453	-1.5895	-0.0317	0.2594	1.4263
Mor..	0.2909	-0.0200	-0.3815	0.4117	0.3939	0.0988
A.S	-0.5752	0.5946	-3.8723	-	1.6185	2.1991
Tun.	-0.0749	0.2511	-0.6029	0.0352	0.3834	0.3440
Emirt.	1.1277	0.5596	-3.3584	-0.3716	-	1.9189

Table 2 presents the elasticity of long-run energy intensity for various countries across different variables, including investments (LINV), GDP per capita (LPIB), urbanization (LTUB), agricultural value added (LVA AG), industrial value added (LVA IND), and service value added (LVA SER). In Algeria, the elasticity of investments (LINV) is 0.3303 with a standard error of 0.240. GDP per capita (LPIB) shows a negative elasticity of -0.083 with a standard error of 0.07. Agricultural value added (LVA AG) also shows a negative elasticity of -0.1179 with a standard error of 0.406. Industrial value added (LVA IND) has a significant negative elasticity of -5.4056 with a standard error of 2.228, while service value added (LVA SER) also shows a negative elasticity of -5.3000 with a standard error of 1.826. For Egypt, the elasticity of investments (LINV) is -0.0459 with a standard error of 0.008, and GDP per capita (LPIB) has a negative elasticity of -0.044 with a standard error of 0.014. Urbanization (LTUB) shows a positive elasticity of 0.01444 with a standard error of 0.61. Agricultural value added (LVA AG) has a positive elasticity of 1.9402 with a standard error of 0.168, industrial value added (LVA IND) shows a positive elasticity of 2.6605 with a standard error of 0.250, and service value added

(LVA SER) has a positive elasticity of 4.1888 with a standard error of 0.349. In Iran, the elasticity of investments (LINV) is 0.1232 with a standard error of 0.074. GDP per capita (LPIB) has a negative elasticity of -0.5760 with a standard error of 0.053. Urbanization (LTUB) shows a negative elasticity of -1.7853 with a standard error of 0.34. Agricultural value added (LVA AG) has a positive elasticity of 0.8664 with a standard error of 0.087. Industrial value added (LVA IND) shows a significant positive elasticity of 4.7673 with a standard error of 0.509, and service value added (LVA SER) has a significant positive elasticity of 12.967 with a standard error of 1.525. In Jordan, investments (LINV) have an elasticity of 0.1232 with a standard error of 0.025, and GDP per capita (LPIB) shows a negative elasticity of -0.5760 with a standard error of 0.576. Urbanization (LTUB) has a negative elasticity of -1.7853 with a standard error of 0.34. Agricultural value added (LVA AG) shows a positive elasticity of 0.8664 with a standard error of 0.087. Industrial value added (LVA IND) has a positive elasticity of 4.7673 with a standard error of 3.767, and service value added (LVA SER) has a positive elasticity of 12.967 with a standard error of 1.525. In Morocco, the elasticity of investments (LINV) is -0.4626 with a standard error of 0.074, while GDP per capita (LPIB) shows a positive elasticity of 0.0028 with a standard error of 0.043. Agricultural value added (LVA AG) has a positive elasticity of 1.0378 with a standard error of 0.960, industrial value added (LVA IND) shows a positive elasticity of 3.1833 with a standard error of 1.667, and service value added (LVA SER) has a positive elasticity of 4.8849 with a standard error of 2.847. In Saudi Arabia, investments (LINV) have a positive elasticity of 0.5753 with a standard error of 0.218, and GDP per capita (LPIB) shows a significant negative elasticity of -6.6818 with a standard error of 1.978. Urbanization (LTUB) shows a substantial positive elasticity of 83.129 with a standard error of 23.1. Agricultural value added (LVA AG) has a negative elasticity of -7.5882 with a standard error of 2.239, industrial value added (LVA IND) has a positive elasticity of 3.9708 with a standard error of 1.0326, and service value added (LVA SER) has a positive elasticity of 7.1579 with a standard error of 1.8474. In Tunisia, investments (LINV) show a positive elasticity of 0.1059 with a standard error of 0.003, and GDP per capita (LPIB) has a negative elasticity of -0.2827 with a standard error of 0.005. Urbanization (LTUB) shows a positive elasticity of 1.4609 with a standard error of 0.03. Agricultural value added (LVA AG) has a positive elasticity of 1.29984 with a standard error of 0.0610, industrial value added (LVA IND) shows a positive elasticity of 2.75675 with a standard error of 0.139, and service value added (LVA SER) has a positive elasticity of 4.65415 with a standard error of 0.240. In the Emirates, investments (LINV) have a negative elasticity of -0.8401 with a standard error of 0.385, and GDP per capita (LPIB) shows a negative elasticity of -0.9381 with a standard error of 0.501. Urbanization (LTUB) shows a substantial positive elasticity of 285.76 with a standard error of 285. Agricultural value added (LVA AG) has a significant positive elasticity of 8.45443 with a standard error of 3.6283, industrial value added (LVA IND) shows a positive elasticity of 26.9490 with a standard error of 9.5437, and service value added (LVA SER) has a positive elasticity of 9.86394 with a standard error of 2.6949.

Table 2: Elasticity of long-run energy intensity for each country

	LINV	LPIB	LTUB	LVA AG	LVA IND	LVA SER
Alg.	0.3303	-0.083	-	-0.1179	-5.4056	-5.3000
	(0.240)	(0.07)	-	(0.406)	(2.228)	(1.826)
Egy.	-0.0459	-0.044	0.01444	1.9402	2.6605	4.1888
	(0.008)	(0.014)	(0.61)	(0.168)	(0.250)	(0.349)
Ir.	0.1232	-0.5760	-1.7853	0.8664	4.7673	12.967
	(0.074)	(0.053)	(0.34)	(0.087)	(0.509)	(1.525)
Jor.	0.1232	-0.5760	-1.7853	0.8664	4.7673	12.967
	(0.025)	(0.576)	(0.34)	(0.087)	(3.767)	(1.525)
Mor.	-0.4626	0.0028	-	1.0378	3.1833	4.8849
	(0.074)	(0.043)	-	(0.960)	(1.667)	(2.847)
A.S	0.5753	-6.6818	83.129	-7.5882	3.9708	7.1579
	(0.218)	(1.978)	(23.1)	(2.239)	(1.0326)	(1.8474)
Tun.	0.1059	-0.2827	1.4609	1.29984	2.75675	4.65415
	(0.003)	(0.005)	(0.03)	(0.0610)	(0.139)	(0.240)
Emit.	-0.8401	-0.9381	285.76	8.45443	26.9490	9.86394
	(0.385)	(0.501)	(285)	(3.6283)	(9.5437)	(2.6949)

5. CONCLUSIONS

The study's findings underscore the complex dynamics between energy production, economic sectors like agriculture, and urbanization in the MENA region. Despite agriculture employing a significant portion of the population, its direct impact on the energy production system remains limited. This suggests that while modernization efforts in agriculture, such as increased mechanization, could potentially boost energy efficiency and productivity, their overall influence on energy intensity in GDP is modest. In contrast, urbanization trends in the MENA region pose challenges to energy efficiency improvements. The rapid urbanization observed across many countries in the area often leads to increased energy consumption per capita. This is primarily driven by the higher demand for residential and commercial energy use in urban settings, coupled with infrastructure demands. Therefore, while urbanization is crucial for economic growth and development, its unchecked expansion could hinder efforts to improve energy efficiency and sustainability. These insights highlight the nuanced interplay between economic structure, urban development, and energy policies in shaping energy intensity and economic outcomes in the MENA region. Future research and policy initiatives may need to address these complexities to foster sustainable economic growth while managing energy resources effectively.

The phenomenon of increased energy demand in large cities not only drives significant energy consumption but also contributes to higher energy intensity in GDP. Addressing these challenges effectively requires well-crafted policies and strategic planning by authorities. Implementing policies that decentralize governance and promote renewable energy sources can help mitigate these impacts. Structurally, the industry sector exerts a more pronounced influence on energy intensity compared to the agricultural and services sectors combined. This reflects the industrial sector's higher energy requirements and its role in driving economic production and growth. Managing and optimizing energy use in industrial activities thus becomes crucial for improving overall energy efficiency and reducing energy intensity in GDP. These insights underline the importance of tailored policies that balance economic development with sustainable energy practices across different sectors. By prioritizing renewable energy adoption, decentralization of governance, and targeted industrial energy efficiency measures, policymakers can work towards achieving more balanced and sustainable economic growth in urban and rural areas alike. The structural influence on the energy consumption per unit of GDP within the West African Economic and Monetary Union (WAEMU) region is primarily driven by the industrial sector.

This underscores the importance for authorities to encourage investments in energy-efficient practices and promote the adoption of renewable energy sources within industrial production processes. By shifting towards cleaner and more sustainable energy practices, countries in the WAEMU region can reduce their overall energy intensity and contribute to environmental sustainability goals. Interestingly, the average income per capita emerges as a significant factor in only two countries within the region, namely Tunisia and Egypt. However, when considered across the entire region using the Panel Mean Group (PMG) approach, income per capita does not show significant explanatory power for energy consumption per unit of GDP. This suggests that while income per capita may be a relevant indicator for analyzing energy intensities in industrialized countries, its impact is less pronounced and varied across MENA countries due to lower income levels and uneven distribution. Given the positive influence of energy consumption on economic growth, there is a compelling case for policies aimed at enhancing income per capita to stimulate economic dynamics through increased energy consumption. This approach could potentially spur economic growth while carefully managing energy efficiency measures to ensure sustainable development outcomes across the MENA region. Balancing economic advancement with environmental sustainability remains crucial for achieving long-term prosperity and resilience in the face of global energy challenges.

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