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**Article**

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# Institutional Quality and Economic Growth in the Energy Transition of MENA Countries

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**ABSTRACT**

This paper investigates the energy transition in MENA region countries, emphasizing the pivotal role of institutional quality and its impact on economic growth. It explores the interactions between institutional quality, energy transition initiatives, and economic growth, aiming to understand how strong institutions can facilitate a successful transition. The empirical analysis employs a simultaneous equations model to identify institutional factors that can either support or hinder the energy transition and its influence on economic growth. The findings provide valuable insights for policymakers and economic stakeholders, underscoring the critical importance of robust institutions in driving the energy transition process and stimulating economic growth in the MENA region from 2000 to 2022.

**Keywords:** Institutional Quality, Economic Growth, Energy Transition and Simultaneous Equation Model
**JEL Classifications:** B55, O40, A19, C33

## 1. INTRODUCTION

The general context of energy transition and sustainable development encompasses the Sustainable Development Goals (SDGs) established by the United Nations. These goals include clean energy, combating climate change, preserving biodiversity, ensuring access to clean water, and promoting gender equality. Energy transition is a crucial means of achieving these objectives in an integrated manner.

Recently, the prominence of environmental and institutional factors indicates a significant transformation in how economies navigate their diverse roles within sustainable development (Boulhaga et al., 2023; Busch and Schnippering, 2022; Raimo et al., 2020). However, energy transition must adhere to principles of social justice to ensure equitable distribution of its benefits and drawbacks. Human activities, particularly the intensive use of fossil fuels, have contributed to global climate change, concentrating these resources in specific regions and creating geopolitical imbalances and tensions. By diversifying energy sources, countries can reduce their dependence on fossil fuel imports and enhance their energy security.

Several fundamental factors related to environmental, economic, and institutional issues justify the energy transition, influencing sustainable development. Climate change is one of the most pressing challenges of our time, exacerbated by fossil fuels associated with polluting emissions, oil spills, destructive mining operations, and other environmental degradations. Transitioning to cleaner energy sources helps reduce air, water, and soil pollution, preserving biodiversity and quality of life. This transition also offers significant potential for job creation in renewable energy, energy efficiency, and research and development sectors. Moreover, it stimulates innovation, promotes economic growth, and enhances national economic competitiveness. However, the energy transition is not merely about changing energy sources; it also involves adopting technologies and practices that promote more efficient energy use (Mtiraoui, A., et al. 2024)..

Overall, energy transition and sustainable development aim to balance current societal needs, environmental imperatives, and long-term economic requirements. These transitions are essential for building a more resilient, sustainable, and equitable future (Mtiraoui, A., & Snoussi, A., 2024). The main objective of this work is to study the interaction between energy transition and sustainable development in MENA countries during the period from 1990 to 2020. MENA countries can design energy transition strategies that promote sustainable development, aligning national objectives with international commitments, where institutional qualities play a role in improving the quality of life of their populations inclusively and equitably.

These specific questions will provide a useful basis for formulating the conceptual model and hypotheses of our research, relying on a review of recent literature. Our work will be subdivided into five main sections: literature review, methodology, descriptive analyses, results, and conclusion.

## 2. LITERATURE REVIEW

### 2.1. Information and Communication Technology, Daily Energy Needs and Sustainability

Increasing energy consumption presents a significant challenge to sustainable development and the energy transition. To tackle this issue, it is essential to reduce overall consumption, promote sustainable practices, invest in exo-energy technologies, and encourage the adoption of renewable energy. Kammen. D., and Sunter.D., (2016) discuss integrating renewable energy into urban settings to enhance sustainability, while Sovacool. B., (2011) analyzes energy use in urban households and the role of policy interventions. Aklin. M., et al. (2015) examine the impact of digital technology adoption on energy access in India, highlighting public dissatisfaction with government policies. Balachandra. P., (2011) proposes a framework for improving rural energy access in India through public-private partnerships and innovative approaches, aiming at energy empowerment and climate change mitigation.

Lund (2007), in his work "*Renewable energy strategies for sustainable development*," explores the role of renewable energy sources like wind, solar, wave, and biomass in formulating sustainable development strategies. These strategies focus on three main technological shifts: reducing energy demand, increasing energy production efficiency, and replacing fossil fuels with renewable sources. For large-scale implementation, integrating these renewables into cohesive energy systems, supported by energy-saving and efficiency measures, is critical. Using Denmark as a case study, Lund. H., and Mathiesen, B. (2010) discusses the challenges and opportunities of transitioning current energy systems to a 100% renewable framework. He concludes that this goal is achievable, provided that the necessary renewable resources are available and further technological advancements are made. Converting the transport sector and adopting flexible energy system technologies are particularly vital for this transformation.

In a related context, Ishida. H., (2015) investigates the effects of ICT development on economic growth and energy consumption in Japan using an autoregressive distributed lag (ARDL) approach. By estimating two multivariate models—one for the production function and another for the energy demand function, both including ICT investment as an explanatory variable—over the period from 1980 to 2010, Ishida finds a stable long-term relationship for both functions. However, the long-term coefficient for ICT investment in the production function is statistically insignificant, unlike the significant coefficients for labor, capital, and energy. In contrast, in the energy demand function, the coefficients for GDP, energy price, and ICT investment are statistically significant, with ICT investment showing a long-term elasticity of -0.155 in relation to energy consumption. This suggests that while ICT investment may lead to a modest reduction in energy consumption, it does not significantly enhance GDP. Therefore, Ishida concludes that ICT investment impacts energy demand by lowering consumption, but its effect on the production function is less significant compared to other inputs like labor, capital, and energy.

Furthermore, Mtiraoui, A., and Obeid, H., (2023) conducted a comparative study analyzing the dynamics of Tunisia's public expenditure, energy consumption, and economic growth from 1990 to 2018, with a particular focus on the COVID-19 period. They used cartographic spatial distribution analysis and empirical validation to map the allocation of public expenditure across key sectors, such as social services and energy. Their findings highlighted the relationship between public spending patterns and economic performance, providing insights into how resource allocation influences long-term economic growth. With the ability to control energy flows being a crucial factor for industrial production and socioeconomic development (Cleveland et al., 1984 and Krausmann. F., et al., 2008), industrial societies are frequently characterized as 'high-energy civilizations' (Smil. V., 2000). Globally, per capita incomes are positively correlated with per capita energy use and economic growth can be identified as the most relevant factor behind increasing energy consumption in the last decades.

### 2.2. Challenges in Institutional Energy Standards and Transition

Incorporating institutional quality into energy transition planning and implementation offers the potential to enhance sustainability initiatives, optimize policy effectiveness, and foster inclusive economic, social, and environmental development in developing nations. Magdalena. A., et al. (2013) emphasize that energy transitions are vital for achieving developmental goals but also present significant challenges and opportunities. These challenges include the complexity and centralization of existing energy systems, which are often opaque to most users, creating coordination difficulties and requiring collective action to advance renewable energy technologies.

Since energy transitions rely heavily on both technological and social innovations, this discussion focuses on the role of institutional factors in overcoming these obstacles. The study aims to explore how a combination of institutional, biophysical, and social factors is essential for successful energy transitions, with the goal of identifying a set of "*design principles*" similar to the institutional design principles discussed in the article "*Institutional Factors That Determine Energy Transitions: A Comparative Case*

*Study Approach.*"

The work of Sovacool. B., et al. (2015) highlights the current landscape of energy studies and offers recommendations for better integrating social sciences into energy research. Achieving a future low-carbon and reliable energy system will require enhanced collaboration between the physical and social sciences. Schlosberg. D., (2013) introduces the concept of "energy justice," which builds on environmental justice and extends into climate and atmospheric justice, as also explored by Dawson. P., et al. (2010), Vanderheiden. S., (2008).

Environmental justice, as Davies (2006) notes, emerged in the United States in the 1970s in response to the unequal distribution of environmental harms, such as pollution and waste treatment facilities. This movement is concerned with the "*fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, regarding the development, implementation, and enforcement of environmental laws, regulations, and policies.*" Moreover, Bo et al. (2020), in their work titled "Perspectives of Energy Transitions in East and Southeast Asia," demonstrate that East Asia has made significant initial progress in renewable energy development and improvements in energy efficiency. As the body of literature in this field continues to grow, future research will further illuminate the complex challenges faced by policymakers as they navigate the intersection of energy transition and sustainable development in developing countries. Although the economic benefits of this transition gradually ease the burden of pollution (Miraglia. S., et al., 2005), this goal is often overlooked in the formulation of energy policies within the region under consideration.

### 2.3. Energy Transition: Challenges and Future Directions

In recent years, the concept of energy transition has become a significant focus in both public discussions and academic research. However, Broggio (2014) observed that the understanding and implementation of energy transition are not uniform across contexts. They define energy transition as the process of replacing non-renewable resources with renewable ones, with the goal of reducing the distance between energy production and consumption.

Folchi. M., and Rubio. M., (2012) describe a recurring pattern in the energy history of nations, where a dominant energy source is gradually replaced by a new one over time. This "energy transition" involves the progressive substitution of one energy source with another, driven by the need to shift from conventional to more efficient and versatile renewable sources (Fouquet. R., 2015).

Lejoux. P., and Ortar. N., (2014) argue that changes in energy systems are motivated by two main factors: the anticipated scarcity of energy resources and the negative environmental impacts of current energy practices.

However, the first factor has diminished in importance due to advances in oil and shale gas extraction and the vast global coal reserves (IEA, 2014). The pressing global issue is not the ability to meet growing energy demands but rather the challenge of managing the environmental consequences of energy consumption, particularly the impact of greenhouse gases (GHGs) on the planet[1]. In this context, the goal of energy transition is to move away from centralized production systems controlled by large corporations toward a decentralized model of small production units, ideally owned by citizens, to ensure energy autonomy (Deshaies, M., 2014).

Environmental transition is also critical and is evaluated through indicators related to greenhouse gas emissions, such as carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). These indicators are essential for assessing the environmental impact of human activities. This study examines and analyzes these indicators within the framework of environmental transition, offering valuable insights to inform future decisions and actions for environmental protection (Mtiraoui, A., and Snoussi, A., 2024).

Furthermore, estimates for biofuels compared to gasoline and diesel vary widely due to factors such as land productivity, crop management practices, conversion processes, and the energy sources used in these processes. Uncertainty regarding $N_2O$ emissions from fertilization and methodological choices in life cycle assessment (LCA) also contribute to this variation (Williams. D., et al., 2009).

The shift to renewable energy encounters significant hurdles that must be addressed to ensure a successful transition from fossil fuels to sustainable energy sources (Figure 1). One major challenge is the substantial initial cost associated with renewable energy technologies. Solar panels, wind turbines, and other renewable infrastructure require considerable upfront investment, which can be a barrier for many governments and private entities.

To tackle these challenges, a coordinated effort from various stakeholders is essential. Governments need to take the lead by enacting and enforcing supportive policies, offering subsidies, and creating incentives for investments in renewable energy (IRENA, 2019). Businesses can play a role by investing in research and development to improve the efficiency and affordability of renewable technologies (IRENA, 2019). Additionally, communities and international organizations are crucial in raising public awareness and fostering participation (Sovacool. B., 2011).

Grassroots movements and global collaborations can drive demand for clean energy, creating a collective push towards a more sustainable future (Gunningham. N., 2019). Moreover, enhancing infrastructure, such as modernizing the electrical grid and developing advanced energy storage solutions, is vital for accommodating the variable nature of renewable energy sources (Lund. H., and Mathiesen, B., 2010). By addressing these barriers comprehensively, the transition to renewable energy can become both feasible and advantageous.

Carbon dioxide ($CO_2$) emissions per kilowatt-hour (kWh) produced are a key metric for evaluating the environmental

1 *"IEA, 2014"* refers to the International Energy Agency's publications or reports from the year 2014. The IEA regularly publishes reports on global energy trends, policy recommendations, and statistical data.

efficiency of electricity generation systems in different regions. This Figure 2 varies significantly from one area to another.

Certain countries have made substantial investments in cleaner technologies and infrastructure for power generation. For instance, government policies may have promoted stricter emissions standards for power plants or offered financial incentives for adopting cleaner technologies. Additionally, geographical factors contribute significantly; regions with abundant natural resources, such as rivers for hydropower or extensive sunny areas for solar power, have distinct advantages for large-scale deployment of renewable energy (Osabuohien et al., 2014).

Overall, CO2 emissions per kWh produced differ widely between regions. There are still opportunities to further reduce these emissions and advance cleaner, more sustainable electricity generation. Achieving this will require continued focus on energy policies, investment in clean technologies, and international cooperation to tackle global climate challenges.

## 3. RESEARCH METHODOLOGY

### 3.1. Data

Our country sample includes 17 nations from the MENA (Middle East and North Africa) region, categorized into three groups: (06) African countries, (10) Gulf countries, and (01) Mediterranean country. Specifically, the countries under study are the United Arab Emirates, Qatar, Saudi Arabia, Tunisia, Turkey, Morocco, Egypt, Iran, Iraq, Algeria, Jordan, Bahrain, Kuwait, Yemen, Oman, Libya, and Sudan. The data for these countries, spanning from 2000 to 2022, is sourced from the World Bank, which publishes comprehensive annual reports on various economic and social indicators. This extensive dataset allows for a thorough analysis of regional trends and patterns across different MENA countries.

### 3.2. Assumptions

Hypothesis 1 (H1): In the MENA region, there is a positive relationship between Institutional Quality (IQ) and energy transition (ETI). Specifically, countries with higher institutional quality are more likely to experience favorable outcomes in their energy transition efforts.

Hypothesis 2 (H2): We propose that environmental transition (ETI) acts as a catalyst for economic growth. This suggests that advancements in environmental sustainability and energy efficiency have the potential to drive economic expansion and development.

Hypothesis 3 (H3): Institutional Quality (IQ) serves as a crucial mediator in the relationship between environmental transition (ETI) and economic growth (GDP/C). Higher institutional quality can enhance the effectiveness of environmental transition efforts, thereby promoting economic growth. This implies that strong institutions not only facilitate successful environmental policies but also ensure that these policies translate into tangible economic benefits.

### 3.3. Indicator's Presentation

The data for this study are drawn from secondary sources, including the World Development Indicators (WDI, 2017) and the Worldwide Governance Indicators (WGI, 2015), and cover variables such as GDP per capita, trade openness, population, and institutional quality. Institutional quality is assessed using indicators from Kaufmann. D., et al. (2010), including government effectiveness, regulatory quality, and control of corruption, while environmental transition is measured by per capita carbon dioxide emissions, methane, and nitrous oxide levels, following methodologies established by various authors like Grossman and Krueger (1995) and Panayotou (1997). According to ISO 50001, energy transition is quantified based on energy efficiency, usage, and consumption metrics in various systems and equipment, which organizations use to gauge their energy performance. The indicators used in our econometric contribution are:

- GDP/C: Annual growth rate of GDP per capita. (WB)
- HK/T: Tertiary education rate. (WB)
- INV/G: Gross fixed capital formation relative to GDP. (WB)
- FDI/G: Net inflow of foreign direct investment. (BM)
- TRAD/G: Sum of exports and imports relative to GDP. (BM)
- IQ: Institutional quality of governance synthesized based on Kaufman indicators (WGI)
- ETI: Environmental transition indicator. In many cases, energy efficiency projects can be financed through CEE premiums (Energy Savings Certificates). These premiums represent a range of economic, social, and environmental variables, serving as abbreviations for various related factors.

### 3.4. Simultaneous Equations Model

To address our core issue of examining the direct and indirect effects of institutional quality (IQ) and environmental transition (ETI) on economic growth (GDP/C) in the MENA region, we will apply simultaneous equations analysis over the period from 2000 to 2022. According to Biswas. H., et al. (2011), a substantial portion of pollution emissions is attributed to various informal activities.

*The Institutional Equation:

$$IQ_{i,t} = \alpha_0 + \alpha_1 GDP/C_{i,t} + \alpha_2 ETI_{i,t} + \sum_{i=3}^{3} \alpha_i P_{i,t} + \varepsilon_{i,t} \quad (A)$$

*The Economic Growth Equation:

$$GDP/C_{i,t} = \beta_0 + \beta_1 ETI_{i,t} + \beta_2 IQ_{i,t} + \sum_{i=3}^{4} \beta_i V_{i,t} + \mu_{i,t} \quad (B)$$

*The Energy Transition Equation:

$$ETI_{i,t} = \delta_0 + \delta_1 IQ_{i,t} + \delta_2 GDP/C_{i,t} + \sum_{i=3}^{4} \delta_i X_{i,t} + \omega_{i,t} \quad (C)$$

Hen ($i = 1... 17; T = 23$) and $X_{it} = GE_{i,t}$, $V_{i,t}$, = $INV/G_{i,t}$, $FDI/G_{i,t}$, $TRAD_{i,t}$ and $HK/T_{i,t}$; $P_{i,t} = CC_{i,t}$

$IQ_{i,t}$: The institutional quality index, which is a synthetic variable bringing together the six governance indicators from Kaufmann et al. (2010).

$\varepsilon_{i,t}$, $\mu_{i,t}$ and $\omega_{i,t}$ are the random variables of equations A, B and C respectively.

- *Method Used*[2]

Empirical studies have examined very simple models limited to a single equation, typically linear, where there is an endogenous variable or a variable to be explained. Estimation of model equations, the issue of endogeneity, REG3 methods (*Three-Stage Least Squares Regression*), and exclusion of restrictions have been considered (Mtiraoui, A.,2024).

In our model, the variable "IQ" appears in the first equation as an endogenous variable, and respectively, in the second and third equations as an exogenous variable. Similarly, the variables "GDP/G" and "IQ" appear in the last equation as exogenous variables, "GDP/C" appears in the second equation as an endogenous variable, and "ETI" appears in the last equation as an endogenous variable.

- Linear restrictions

There are two identification conditions: order conditions (necessary conditions) and rank conditions (sufficient conditions).

- Necessary conditions: Order conditions

In our case, we note that, for the model under study, all equations are over-identified. Indeed, we have three endogenous variables in the model (W = 3): "IQ", "GDP/C", and "ETI", and six exogenous variables: "TRADE/C", "GE", "INV/G", "HK/T", "CC", "FDI/G".

- First equation: Applying the identification conditions: W' = 1, K' = 3, and r = 0, where W' represents the number of endogenous variables appearing in an equation and K' the number of exogenous variables appearing in an equation. Therefore, we have W – W' + K – K' = 3 – 1 + 9 – 3 = 8 > W – 1 = 3 – 1 = 2, indicating that the first equation is overidentified.
- Second equation: We have: W = 3, K = 9, W' = 1, K' = 3, and r = 0, resulting in: W – W' + K – K' = 3 – 1 + 9 – 5 = 6 > W – 1 = 2, indicating that the second equation is over- identified.
- Third equation: We have: W = 3, K = 9, W' = 1, K' = 3, and r = 0, which implies W – W' + K – K' = 3 – 1 + 9 – 3 = 8 > W – 1 = 2, indicating that the third equation is over-identified. Since all equations in our model are over-identified, the model is therefore over-identified.

## 4. DESCRIPTIVE ANALYZES, PRESENTATIONS OF RESULTS AND COMMENTS

### 4.1. Descriptive Analytics

#### 4.1.1. Descriptive measures

First, our analysis will employ descriptive statistics to examine the characteristics of the explanatory variables, specifically focusing on measures of central tendency (Mean), dispersion (standard deviation), and variability (coefficient of variation). This approach helps us understand the distribution and degree of homogeneity within the data series Table 1.

- Mean: The mean is a measure of central tendency that identifies the value around which observations are distributed.
- Standard Deviation: The standard deviation is a measure of dispersion that evaluates the variability of a series, indicating how observations fluctuate around the mean.
- Coefficient of Variation: The coefficient of variation combines the mean and standard deviation into a single measure, allowing us to assess the relative size of the mean in relation to the variability of all observations.

#### 4.1.2. Correlation matrix

We present, secondly, the correlation matrix table, also the analysis of the graphs which will allow us to appreciate the nature and type of relationship existing between the endogenous variable and the exogenous variables taken (Table 2). In other words, it allows us to detect the presence of relationships between variables.

#### 4.1.3. Analyse multivariée

At this stage, we aim to specify the model. Unlike linear regression models, where we can define a unidimensional model based on economic theories and then conduct validation tests, panel models involve analyzing data across two dimensions.

We examine a set of countries over a specified time period and perform various tests to determine the appropriate model structure. Specifically, we seek to identify whether the model is a pooled model, a fixed effects model (country/time), or a random effects model based on these tests.

To achieve this, we will conduct the Breusch and Pagan (1980) tests for model specification. Additionally, we will explore the specific characteristics of each model type, evaluating the advantages and limitations of pooled models, fixed effects models, and random effects models in capturing the dynamics of the data.

### 4.2. Analysis of Model Results

The results of the simultaneous equation estimation, using the two-stage least squares method to examine the direct and indirect effects of institutional quality (IQ) and economic growth (GDP/C) on energy transition (ETI), are shown in Table 3.

### 4.3. Discussions of the Results

To understand the interplay between institutional quality (IQ), economic growth (GDP/C), and environmental transition (ETI), it is crucial to revisit the findings that examine the direct and indirect effects of institutional indicators on energy transition through economic growth. This analysis uses a simultaneous equations model for the MENA region from 2000 to 2022.

The results in Table 3 reveal that energy transition (ETI) has a significant direct negative effect (−0.6513) on institutional

2 Mtiraoui, A. (2024). Interaction between Migration and Economic Growth through Unemployment in the Context of Political Instability in the MENA Region. *International Journal of Economics and Financial Issues*, 14(1), 204–215

**Table 1: Descriptive statistics**

| Variables | Obs. | Mean | Standard Deviation | Min. | Max. |
|---|---|---|---|---|---|
| GDP/C | 391 | 11.2054 | 0.1676 | −10.4797 | 41.5278 |
| IQ | 391 | 4.3676 | 0.5446 | −2.2469 | 7.38329 |
| ETI | 391 | 3.7639 | 0.1295 | −2.3352 | 9.78329 |
| GE | 391 | 9.6042 | 0.2567 | 1.6589 | 20.3578 |
| INV/G | 391 | 8.3651 | 0.5446 | −2.2469 | 18.3833 |
| TRADE/G | 391 | 12.5813 | 0.8284 | 32.4618 | 57.9957 |
| HK/T | 391 | 28.7927 | 0.4652 | 2.09751 | 60.6836 |
| CC | 391 | 10.6625 | 0.8864 | 10.1204 | 31.2315 |
| FDI/G | 391 | 6.6041 | 0.4568 | 3.8975 | 17.3578 |

Source: Stata15.1 output made by the Authors

**Table 2: Correlation matrix between variables**

| | GDP/C | IQ | ETI | GE | INV/G | TRAD/G | HK/T | CC | FDI/G |
|---|---|---|---|---|---|---|---|---|---|
| GDP/C | 1.000 | | | | | | | | |
| IQ | 0.401 | 1.000 | | | | | | | |
| ETI | 0.148 | 0.102 | 1.000 | | | | | | |
| GE | 0.032 | 0.019 | 0.037 | 1.000 | | | | | |
| INV/G | 0.082 | −0.077 | 0.138 | −0.167 | 1.000 | | | | |
| TRADE/G | −0.317 | −0.256 | −0.143 | −0.035 | −0.495 | 1.000 | | | |
| HK/T | −0.076 | −0.256 | 0.333 | 0.131 | 0.292 | 0.176 | 1.000 | | |
| CC | 0.598 | 0.743 | 0.446 | 0.701 | −0.421 | −0.014 | 0.233 | 1.000 | |
| FDI/G | 0.573 | 0.562 | 0.631 | 0.507 | 0.493 | 0.413 | 0.161 | 0.491 | 1.000 |

Source: Stata15.1 output made by the Authors

**Table 3: The interaction between Institutional Quality (IQ), Economic Growth (GDP), and Energy Transition in the MENA Region Using REG3 analysis**

| Variables IQ | GDP/C ETI |
|---|---|
| Cons. 4.5826) *** | 0.5618*** 0.21970* |
| (9.09) | (70.27) (1.84) |
| ETI−0.6513* | 1.1211** |
| (−1.79) | (2.06) |
| IQ | 0.9164* −1.4121** |
| | (1.87) (−1.99) |
| GDP/C 1.6829*** | 0.8921* |
| (3.09) | (1.91) |
| GE | −0.9329* |
| | (−1.89) |
| INV/G | 0.2082* |
| | (1.79) |
| TRADE/G | −0.1140* |
| | (−1.81) |
| HK/T | 0.11723 |
| | (0.74) |
| FDI/G | 0.51046* |
| | (1.76) |
| CC 2.8217*** | - |
| (3.98) | |
| Obs. 391 | 391 |
| $R^2$ 0.13 | 0.24, 0.31 |

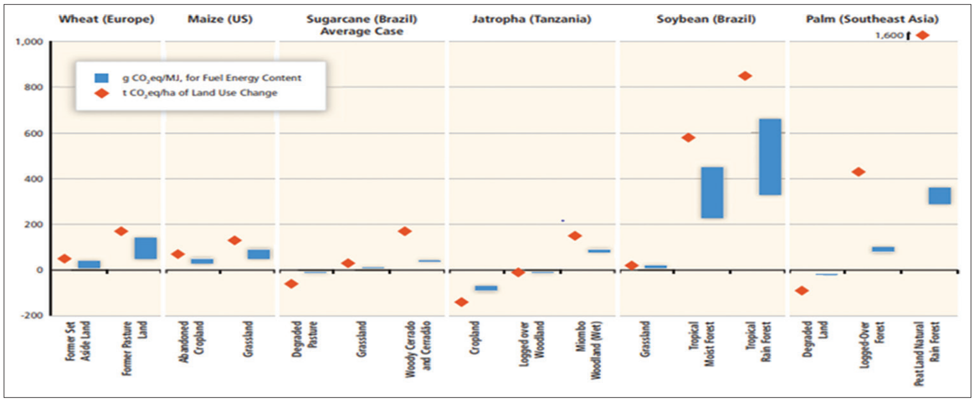
Source: The work done by the authors
Terms in parentheses correspond to t-Student and *, **, ***: significant at 10%, 5% and 1% level respectively

quality (IQ) at the 10% significance level in the first regression. Conversely, in the third regression, institutional quality (IQ) exerts a negative and significant indirect impact (−1.4121) on energy transition (ETI) at the 5% significance level.

To interpret these results accurately, several factors must be considered. A 10% improvement in the institutional quality index corresponds to a nearly twofold reduction in per capita carbon dioxide emissions ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$) measured in $CO_2$ equivalent. The analytical frameworks developed by Acemoglu et al. (2001) can provide insights into how institutions respond to environmental changes, including energy transitions. Additionally, Ostrom's (1990) work on common-pool resource management and Rodrik's (2000) research on institutions and economic growth offer valuable theoretical perspectives. Further analysis could strengthen the results, including examining the evolving relationship between energy transition and institutional quality, as discussed by Besley and Persson (2009).

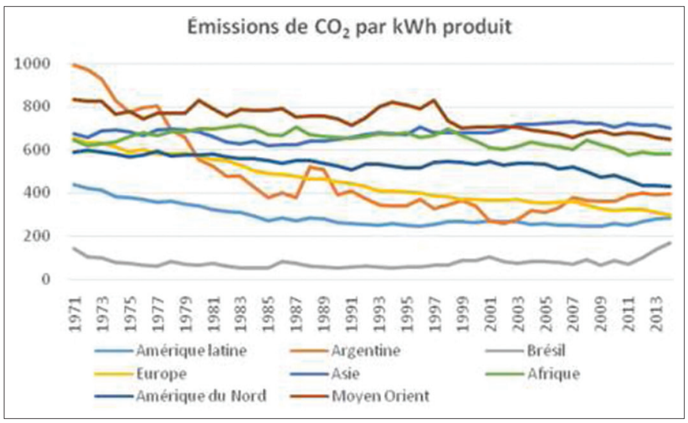
Furthermore, the economic growth indicator (GDP/C) in Equation 1 of the model shows a positive and significant correlation (1.6829) with institutional quality (IQ) at the 1% significance level. In contrast, Equation 2 of the model shows a positive indirect effect (0.9164) of institutional quality (IQ) on itself at the 10% significance level. This correlation does not imply a direct relationship, and other factors may also influence both GDP/C and institutional quality. A 1% increase in economic growth (GDP/C) results in a twofold increase in the institutional quality index. It is essential to control for omitted variables that could bias the results, such as education quality, infrastructure, monetary policy, and fiscal policies, which can impact both GDP and institutional quality. Barro (1997) identified various determinants of economic growth that should be considered to enhance the analysis accuracy. Acemoglu et al. (2001) also provide a framework explaining how economic development influences the formation and evolution of institutions. Kaufmann et al. (2010) offer methodologies for assessing institutional quality globally, which could improve the measurement of this indicator.

**Figure 1:** Illustrative ranges of GHG emissions over the life cycle of petroleum fuels




Source: Renewable Energy in the Context of Sustainable Development; Chapter 9

**Figure 2:** The evolution of electricity carbon intensity




Source: Bersalli and Simon (2017)

The Public governance effectiveness (GE) has a direct negative effect (−0.9329) on energy transition (ETI), significant at the 10% threshold. This indicates that a 10% increase in the public efficiency index results in a corresponding reduction in the energy transition indicator, highlighting the challenges faced by public policies in promoting sustainable energy sources.

Moreover, a negative indirect effect is observed between the quality index, as measured by the control of corruption (CC), and energy transition (ETI). The corruption control index (CC) is positively correlated (2.8217) with the institutional indicator and statistically significant at the 1% level. The combined negative effect (2.82* −1.4121) between the corruption index (CC) and the energy indicator (ETI) is significant at the 5% level.

In this context, Nordhaus (2013) offers important insights into the challenges of designing and implementing effective environmental policies, including institutional barriers that may obstruct government action. Sachs (2015) provides an in-depth analysis of global sustainable development challenges, emphasizing the need for coordinated global action to address energy transition and climate change.

## 5. CONCLUSION

The analysis of our central question examines the direct and indirect effects of institutional quality and economic growth on environmental transition in the MENA region from 2000 to 2022 using simultaneous equations. The empirical findings underscore how institutional factors can either facilitate or obstruct energy transition and their impact on economic growth. Understanding how institutional quality influences energy transition through economic growth is vital for advancing environmental sustainability.

However, energy transition is critical for achieving environmental sustainability. Strong, well-functioning institutions are essential for implementing and enforcing effective environmental and energy policies, such as reducing greenhouse gas emissions, promoting renewable energy sources, and enhancing energy efficiency. These institutions also play a key role in ensuring transparency, accountability, and public engagement in energy transition decisions.

The results reveal that while institutional quality is significant for driving economic growth, it does not automatically lead to a successful energy transition. The inefficacy of public action against corruption and the lack of effective policies to promote cleaner energy sources are major obstacles to energy transition in the MENA region.

For a successful energy transition, it is crucial to improve institutional quality by enhancing transparency, combating corruption, and implementing coherent and effective energy policies. Without these improvements, the MENA region is unlikely to meet its energy transition objectives, potentially resulting in negative economic and environmental outcomes.

Overall, for the MENA region to achieve a successful energy transition, public authorities must address institutional quality issues, especially those related to corruption. Only through effective and transparent governance can a favorable environment for adopting sustainable energy technologies and reducing greenhouse gas emissions be created.

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