ECONOMIC GROWTH BETWEEN INSTITUTIONAL QUALITY AND ENERGY TRANSITION: CASE OF MENA COUNTRIES

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Abstract
This paper examines the energy transition in MENA region countries, with a focus on the crucial role of institutional quality and its impact on economic growth. It explores the interaction between institutional quality, energy transition initiatives, and economic growth, seeking to understand how institutional quality can facilitate a successful transition. The empirical analysis highlights institutional factors that can either facilitate or hinder the energy transition, as well as its influence on economic growth, using a simultaneous equations model. The findings of this research provide valuable insights for policymakers and economic actors, emphasizing the crucial importance of robust institutions in the energy transition process to stimulate economic growth in the MENA region during the specified period (1990-2020).
Keywords: *Energy Transition, Institutional Quality, Growth, Simultaneous Equation Model.*
Classification JEL: *A19, B55, O40, C33*

1. INTRODUCTION

The general context of energy transition and sustainable development truly encompasses the Sustainable Development Goals (SDGs) established by the United Nations, which encompass various objectives related to 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 goals in an integrated manner.

Recently, the dominance of environmental and institutional factors signifies a significant transformation in how economies navigate their diverse roles in the context of sustainable development (Boulhaga, M., & al., 2023 ; Busch, T. & Schnippering, M., 2022 ; Raimo, N. & al., 2020).

However, energy transition must be guided by principles of social justice to ensure an equitable distribution of benefits and drawbacks. Human activities have contributed to global climate change, particularly through the intensive use of fossil fuels, the majority of which are concentrated in certain regions of the world, 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 can justify energy transition, which influences sustainable development. On one hand, climate change has become one of the most pressing challenges of our time. However, fossil fuels are often associated with polluting emissions, oil spills, destructive mining operations, and other forms of environmental degradation. Transitioning to cleaner energy sources helps reduce air, water, and soil pollution, thereby preserving biodiversity and quality of life. It also offers significant potential for job creation in renewable energy, energy efficiency, and research and development sectors. Furthermore, it stimulates innovation, promotes economic growth, and enhances national economic competitiveness. Nevertheless, energy transition is not merely about changing energy sources; it also involves adopting technologies and practices that promote more efficient energy use. (Mtiraoui, A., 2024).

Overall, energy transition and sustainable development aim to strike a balance between 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. and Snoussi, A., 2024). The main objective of this work is to study the interaction between energy transition and sustainable development for the case of countries in the MENA region during the period from 1990 to 2020. This is why the countries MENA can design energy transition strategies that promote sustainable development, align national objectives with international commitments whose institutional qualities have the role of improving the quality of life of their populations in an inclusive and equitable manner. These specific questions will allow us to have a useful basis for formulating the conceptual model and the hypotheses of our research while relying on a review of recent literature. Our work will be subdivided into five main lines, namely: literature review, methodology adopted, descriptive analyses, results and conclusion.

2. LITERATURE PAPER

2.1. Energy Need, NICT and Sustainability

Currently, increasing energy consumption indeed represents one of the major challenges in the context of energy transition and sustainable development. To address these challenges, measures must be taken to reduce overall energy consumption, promote more sustainable consumption patterns, invest in exo-energy technologies and infrastructures, and encourage widespread adoption of renewable energy sources. This also requires active awareness and participation from governments, industries, communities, and individuals to foster a more sustainable energy transition and contribute to long-term sustainable development. (Lejoux, P., and Ortar, N., 2014)

Numerous academic contributions emphasize the importance of one of the themes addressing the relationship between energy transition and sustainable development. Kammen, D., and Sunter, D., (2016) in their contribution “City-integrated renewable energy for urban sustainability". The researchers examine how renewable energy can be integrated into urban areas to promote sustainability. It explores innovative solutions to meet the energy needs of urban areas while limiting the environmental impact. The authors explore options for establishing sustainable energy systems by reducing energy consumption, particularly in the buildings and transportation sectors, and providing robust, decentralized and renewable energy sources. With technical advances in power density, city-integrated renewables will be better suited to meet the high energy demands of growing urban areas. Several economic, technical, behavioral and political challenges must be overcome for innovation to improve urban sustainability.

Furthermore, Sovacool, B., (2011) proposes a conceptual approach to understanding energy use in urban households in his article titled; "Conceptualizing urban household energy use: Climbing the Energy Services Ladder." In this work, the author begins by defining energy services and identifying their differences across sectors, urban and rural areas, as well as direct and indirect uses.The study then examines household energy services divided into three categories: low income, middle income, and high income.

The research finds that primary energy technologies linked to low-income households involve a greater variety of fuels and carriers, ranging from manure and firewood to liquefied petroleum gas and coal, but provide fewer services. It highlights how focusing on energy services redirects the direction of energy policy interventions, emphasizes that energy services are neither uniform nor innate, and identifies exciting areas of potential research.

Enhancing the literature review, Aklin, M., and al. (2015) examine how the adoption of digital technologies in the retail sector influences business models and innovation, in their article titled "Digital servitization business models in ecosystems: A theory of the firm." In this study, the authors focus on the case of India, where access to energy is limited. The inquiry, in this regard, explores how the public reacts to the government’s inability to provide citizens with basic energy services such as electricity and clean cooking fuels.

Indeed, the authors address this inquiry by utilizing a survey conducted in two rural villages. Firstly, the researchers examine the association between a respondent's opinion on government intervention and policy failure. Specifically, they focus on whether individuals who believe in government intervention are likely to have lower levels of satisfaction with government energy access policies. Secondly, the researchers examine the link between policy failure and the likelihood of people considering political opinions on energy when voting. They find that people's preference for government intervention has a negative effect on satisfaction levels with government policies, and that individuals who hold the government accountable for policy failures are less likely to consider a policymaker's energy policies when voting.

However, the study by Balachandra, P., (2011) presents an implementation framework based on a public-private partnership that contained recommendations for adopting an integrated rural energy policy, developed by extracting relevant elements from existing energy policy documents and including new guidelines to facilitate the creation of new institutions and mechanisms, while enabling the implementation of the universal rural energy access program. In his contribution "Modern energy access to all in rural India: An integrated implementation strategy," the researcher sheds light on the inquiry into energy access for India's rural population, which represents a critical challenge for its government. He proposes an integrated implementation framework with recommendations for adopting business principles with innovative institutional, regulatory, financing, and distribution mechanisms, where energy service companies will function as intermediaries between these businesses and the global carbon market, both for carbon credit aggregation and trading under the Clean Development Mechanism (CDM). If such a program were implemented, it could address energy empowerment challenges by creating access to modern energy vectors and mitigating climate change. Within the framework of energy transition from fossil to renewable energy, Lund, H, (2007), in his contribution titled "Renewable energy strategies for sustainable development," discusses a perspective on renewable energies (wind, solar, wave, and biomass) in developing strategies for sustainable development. Such strategies generally involve three major technological changes: energy savings on the demand side, improvements in energy production efficiency, and the replacement of fossil fuels with various renewable energy sources. Consequently, large-scale implementation plans for renewable energies must include strategies for integrating renewable sources into coherent energy systems influenced by energy-saving and efficiency measures.

Based on the case of Denmark, there are obstacles and prospects for converting current energy systems into a 100% renewable energy system that remain to be discussed. The result obtained is that such development is possible if necessary renewable energy sources are available, and if additional technological improvements to the energy system are made, a renewable energy system can be created. Technologies for converting the transport sector and the introduction of flexible energy system technologies are particularly crucial. (Lund. H., and al, 2010)

In this context, the work done by Ishida, K., (2015), in an article titled "The effect of ICT development on economic growth and energy consumption in Japan," using a distributed autoregressive bounds test (ARDL) approach, the author estimates two different multivariate models corresponding to the production function and the energy demand function, both including investment in ICT as an explanatory variable, over the period 1980-2010. The results reveal the presence of a stable long-term relationship, not only for the production function but also for the energy demand function.

However, in the production function, the estimation of the long-term coefficient for investment in ICT is statistically insignificant, unlike the coefficients for labor, capital, and energy. In the case of the energy demand function, the coefficients for GDP, energy price, and investment in ICT are statistically significant. The results also indicate that the long-term elasticity of investment in ICT with respect to energy consumption is -0.155. Based on this, the author concluded that although investment in ICT may contribute to a moderate reduction in energy consumption, it was unfavorable for an increase in GDP.

Furthermore, the examination of the relationship between public expenditure, energy consumption, and economic growth during the COVID-19 period, while highlighting a comparative study between cartographic spatial distribution analysis and empirical validation (Mtiraoui, A., & Obeid, H. 2023).

Regarding this work, the authors attempted to present a mapping of spatial distribution for the case of Tunisia, showing the allocation and distribution of public expenditure among several necessary items such as basic social elements and energy consumption during the period from 1990 to 2018.

They closely examined, in this study, the correlation between public expenditure, energy consumption, and economic growth, with a particular emphasis on the COVID-19 period. We adopted a comparative approach that integrates both cartographic spatial distribution analysis and empirical validation, on one hand, and on the other hand, we used a cartographic methodology to visually represent the spatial distribution of public expenditure in Tunisia. This allowed us to observe how resources were allocated to different sectors, with a focus on basic social elements and energy consumption.

In parallel, they conducted empirical validation to verify the correlation between public expenditure, energy consumption, and economic growth. This involves using empirical data to confirm or refute trends observed in spatial distribution analysis. They extended our analysis over a significant period, from 1990 to 2018, to capture long-term developments and observe how the dynamics of public expenditure and energy consumption influenced economic growth.

2.2. Institutional energy quality and transition problems

In the perspective of integrating institutional quality into the design and implementation of energy transition, it is possible to enhance the sustainability of initiatives, improve policy efficiency, and foster inclusive economic, social, and environmental development in developing countries. Magdalena, A., K., & Anderies, J., M., (2013) consider energy transitions as important elements for achieving development goals. However, development and energy transitions pose both challenges and opportunities. Obstacles to transitions include an existing centralized and complex energy system whose function is opaque to most users. Thus, coordination issues and collective action depend on a path where difficulties evolve according to renewable energy technologies. Given that energy transitions rely on both technological and social innovations, we are interested in how institutional factors can be leveraged to overcome these obstacles. This work attempts to answer the question of what constellation of institutional, biophysical, and social factors is essential for an energy transition, aiming to deduce a set of "design principles" concerning the institutional drivers of energy transitions, analogous to institutional design principles from an article entitled "Institutional Factors That Determine Energy Transitions: A Comparative Case Study Approach."

The work of Sovacool, B. & al. (2015) reflects the state of the energy studies field while proposing recommendations for better integrating social sciences into energy research because achieving a future low-carbon and reliable energy system will require more comprehensive and meaningful collaboration between physical and social sciences. Moreover, Schlosberg, R. (2013) highlights the concept of "energy justice," which is based on environmental justice and, more recently, climate and atmospheric justice, also studied by Dawson and al. (2011) & -Vanderheiden, S. (2008).

Environmental justice emerged in America in the 1970s in response to the unequal distribution of environmental harms, such as pollution and waste treatment facilities, according to Davies, B. (2006). The movement represents a concern for "*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*[1]." Furthermore, Bo Li, Victor Nian & al. (2019), in their contribution titled "*Perspectives of energy transitions in East and Southeast Asia*" have shown that East Asia has experienced some initial success in renewable energy development accompanied by improvements in energy efficiency. Given the diversification of literature in this field, there will be further research published that provides a basis for understanding the complex challenges policymakers face when seeking to harness the impact of energy transition and sustainable development for developing countries, as the economic consequences of this transition gradually mitigate the scourge of pollution (Miraglia & al., 2005), yet this objective is practically not considered in defining energy policies in the region under consideration.

2.3. Energy transition: Challenges and perspectives

[1] *According to Bullard and Johnson (2000), unequal implementation of environmental civil rights and public health laws, [...] discriminatory zoning and land use practices, exclusionary practices that prevent certain individuals and groups to participate in decision-making*

Over the past years, energy transition has gained significant prominence both in public debates and academic research. However, Broggio & al. (2014) mentioned that the energy transition is far from uniform both conceptually and in its implementation. According to him, energy transition could be understood as a substitution of renewable resources for non-renewable ones, with a shortening of the circuit between energy production and consumption.

According to Folchi & Rubio (2006), all studies addressing the energy history of countries highlight a typical and recurring phenomenon. Throughout history, we can distinguish different periods during which a widely predominant energy source begins to gradually decline in the face of the advancement of a new source that eventually replaces it. This phenomenon, called "energy transition," can therefore be defined as the progressive substitution of one energy source by another over a given period. The logic behind this phenomenon, explained very succinctly, is the replacement of conventional energy sources by efficient renewable sources both in terms of yield and versatility (Fouquet, 2015).

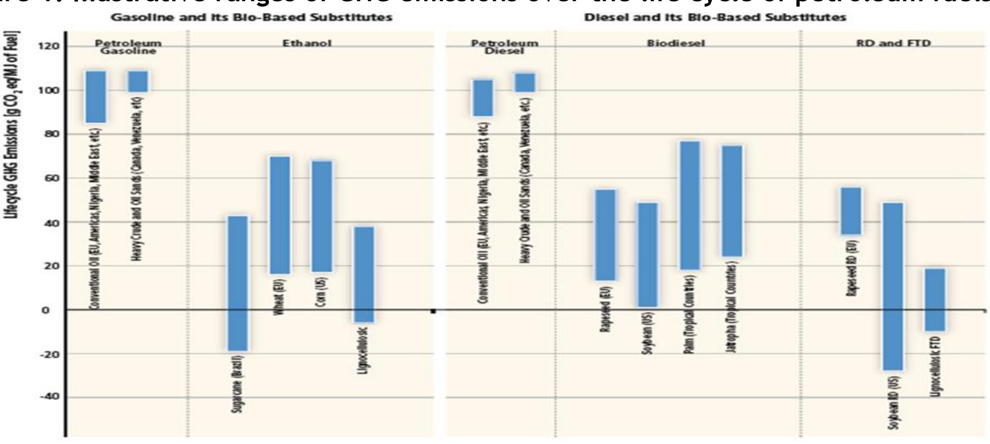
Moreover, Lejoux & Ortar (2014) show that "the change in the energy system is motivated by two elements: the foreseeable scarcity of energy resources and the negative impacts of our system on the environment." However, the first argument has lost importance due to the breakthroughs in oil and shale gas, and the abundant coal reserves that the world possesses (IEA, 2014). At the global level, the major issue does not primarily concern our ability to meet the growing energy needs in the coming decades but rather our ability to control the environmental consequences of our energy consumption, particularly the planetary impact of greenhouse gases (GHGs).

In this perspective, the objective of energy transition is to substitute centralized production structures controlled by large capitalist companies with a highly decentralized system of small production structures that ideally would belong to citizens, thus ensuring their energy autonomy (Deshaies, 2014).

Furthermore, environmental transition is a key variable examined through several crucial indicators related to greenhouse gas emissions. These gases, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), are essential for assessing the environmental impact of human activities. Thus, this study explores and analyzes these indicators in the context of environmental transition, providing valuable data to guide future decisions and actions in environmental protection.

In comparison, the range of estimates for biofuels is much wider than that for gasoline and diesel, such as variations in land productivity, crop management practices, conversion processes, and the energy source of the process; uncertainty regarding N2O emissions from fertilization; and methodological choices in LCA, for example, approaches to allocating co-products and defining system boundaries (Williams & al., 2009; Hoefnagels & al., 2010; Cherubini & Strømman, 2011).

Figure 1: Illustrative ranges of GHG emissions over the life cycle of petroleum fuels[2]

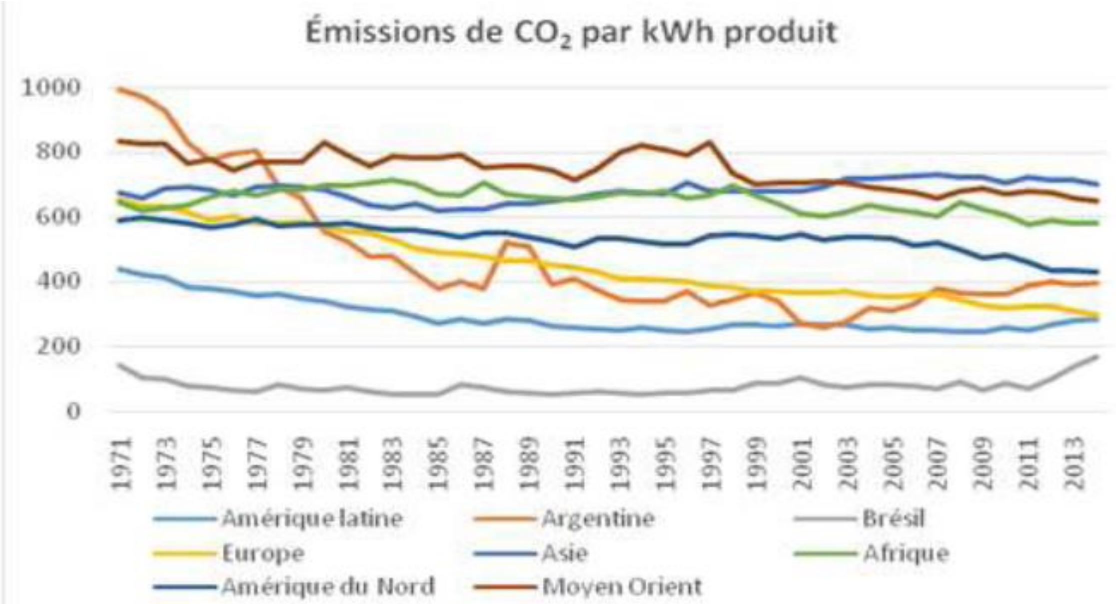


Source: Renewable Energy in the Context of Sustainable Development; Chapter 9.

[2] *Sources of plotted estimates: Wu et al., 2005; Fleming et al., 2006; Hill et al., 2006, 2009; Beer et al., 2007; Wang et al., 2007; CONCAWE, 2008; Macedo and Seabra., 2008*

The transition to renewable energy is not without challenges. Barriers such as high initial costs, technological limitations, policy and regulatory barriers, and resistance from vested interests can hinder the widespread adoption of renewable energy technologies. Overcoming these obstacles requires a concerted effort from governments, businesses, communities, and international organizations to invest in research and development, improve infrastructure, enact supportive policies, and promote public awareness and participation.

Figure 2: The evolution of electricity carbon intensity[3]



Source: Bersalli. G; ET Simon. J; (2017)

Carbon dioxide (CO2) emissions per kilowatt-hour (kWh) produced are a crucial indicator for assessing the environmental efficiency of electricity generation systems in a given region. This value is significantly lower than in other regions of the world.

Indeed, some countries have invested in cleaner technologies and infrastructure for their electricity production. For example, government policies may have encouraged the adoption of stricter emissions standards for power plants or provided financial incentives for investment in cleaner technologies. Geographically, any region can also play an important role in creating natural resources, such as rivers for hydropower or vast expanses of sunny land for solar power, providing unique opportunities for the deployment of renewable energy to large scale.

In total, CO2 emissions per kWh produced differ from one region to another, there remain opportunities to continue to reduce these emissions and promote cleaner and more sustainable electricity production across the region. This will require continued efforts in energy policy, investment in clean technologies and international collaboration to address global climate challenges.

3. METHODOLOGY

3.1. Data and Period

Our country sample is made up of 17 countries from the MENA region, namely: 06 African countries, 10 Gulf countries and 01 Mediterranean country. In fact, this study region is made up of 17 countries, namely: United Arab Emirates, Qatar, Saudi Arabia, Tunisia, Turkey, Morocco, Egypt, Iran, Iraq, Algeria, Jordan, Bahrain, Kuwait, Yemen, Oman, Libya and Sudan. All this data has an annual publication frequency (2000-2022) from the World Bank.

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[3] *Bersalli, G., and Simon, J., (2017), "Towards an energy transition in emerging countries: what incentive policies for renewable energies in the electricity sector in Argentina and Brazil? », Sustainable development and territories, Vol. 8, n°2.Pages 1-21*

3.2. Assumptions

H1: The link between Institutional Quality **(IQ)** and energy transition **(TEN)** is favorable in one for countries in the MENA region.
H2: Let us assume that the environmental transition **(TEN)** is a catalyst for Economic growth.
H3: Institutional Quality **(IQ)** plays an important role as a mediator between environmental Transition (TEN) which promotes economic growth **(GDP)**.

3.3. Presentation of data

The data used in this study are sourced from secondary sources, extracted from the World Development Indicators (WDI, 2017) and the Worldwide Governance Indicators (WGI, 2015). The variables studied include GDP per capita, the degree of trade openness, population, and institutional quality. The numerous institutional indicators from Kaufmann, D., and al. (2007) represent these variables, namely government effectiveness (GE), regulatory quality (RQ), and control of corruption (CC). The contributions of Kaufmann, D. and al. (2010) construct these indicators through surveys conducted among households, businesses, non-governmental organizations, and public sector organizations. The environmental transition, which represents the variable to be explained in this study, is captured in turn by the level of carbon dioxide emissions per capita (CO2) measured in "kilograms/tonne," methane (CH4), and nitrous oxide (N2O) measured in CO2 equivalent. These are the main greenhouse gases. Several authors have been used in the literature to measure environmental degradation such as Grossman and Krueger (1995), Panayotou (1997), Boyce and al. (1998), Akpan and al. (2012), Cho and al. (2014). According to the definition of the International Organization for Standardization (ISO), responsible for ISO 50001, TEN is a value or measure that quantifies results related to energy efficiency, usage, and consumption in installations, systems, processes, and equipment. Organizations use PEIs as a measure of their energy performance. The indicators used in our econometric contribution are:

- GDP: Annual growth rate of GDP per capita. (WB)
- HK: Tertiary education rate. (WB);
- INV: Gross fixed capital formation relative to GDP. (WB);
- FDI: Net inflow of foreign direct investment. (BM);
- TRAD: Sum of exports and imports relative to GDP. (BM);
- IQ: Institutional quality of governance synthesized based on Kaufman indicators (WGI);
- TEN: Environmental transition indicator, when TEN indicator is In most cases, these energy efficiency works can be funded by CEE premiums (Energy Savings Certificates). These terms are abbreviations for various economic, social, and environmental variables.(WB)

3. 4. Model Specification: Simultaneous Equations Model[4]

To answer our basic problem that exposes the direct and indirect effects of institutional reality (IQ) and environmental transition (TENV) on economic growth (GDP) in the MENA region while applying the simultaneous equations during the period: (2000-2022). A significant part of polluting emissions comes from numerous informal activities according to Biswas & al. (2011).

<u>The Institutional Equation</u>: $IQ_{i,t} = \alpha_0 + \alpha_1 GDP_{i,t} + \alpha_2 TEN_{i,t} + \sum_{i=3}^{3} \alpha_i P_{i,t} + \varepsilon_{i,t}$
(A)

<u>The Economic Growth Equation:</u> $GDP_{i,t} = \beta_0 + \beta_1 TEN_{i,t} + \beta_2 IQ_{i,t} + \sum_{i=3}^{4} \beta_i V_{i,t} + \mu_{i,t}$
(B)

<u>The Energy Transition Equation:</u> $TEN_{i,t} = \delta_0 + \delta_1 IQ_{i,t} + \delta_2 GDP_{i,t} + \sum_{i=3}^{4} \delta_i X_{i,t} + \omega_{i,t}$
(C)

<u>When (i = 1... 17; T = 23.), and</u> $X_{i,t}$=$GE_{i,t}$, $V_{i,t}$=$INV_{i,t}$,$FDI_{i,t}$,$TRAD_{i,t}$ **and** $HK_{i,t}$; $P_{i,t}$= $CC_{i,t}$

[4] *Mtiraoui, A. and Snoussi, A., (2024). Analysing the nexus between economic growth, institutional dynamics and environmental sustainability in the MENA region post-covid-19. RUSSIAN LAW JOURNAL. Vol. 12 No. 1 (2024), pp.1195-2205*

$IQ_{i,t}$ is the institutional quality index which is a synthetic variable grouping the six governance indicators of Kaufman et al.

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

- *Method used: Simultaneous equations in panel data*[5]

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" and "IQ" appear in the last equation as exogenous variables, "GDP" appears in the second equation as an endogenous variable, and "TEN" 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", and "TEN", and six exogenous variables: "TRADE", "GE", "INV", "HK", "CC", "FDI".

- 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 over-identified.
- 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. PRESENTATION AND DISCUSSION OF RESULTS

4.1. Descriptive Analysis:

- *Descriptive Measures* [6]

First, our analysis will focus on descriptive measures, in this case the characteristics of position (Mean), dispersion (Standard Deviation) and coefficients of variation of the explanatory variables. This is to allow us to have an idea of the distribution and the degree of homogeneity of the series.

**The average*: The average is a position measure which makes it possible to identify the value around which the observations are distributed.

* *Standard deviation*: The standard deviation is a measure of dispersion which makes it possible to evaluate the variability of a series. In other words, it makes it possible to determine the fluctuations of observations around the arithmetic Mean.

* *The coefficient of variation:* The coefficient of variation is a composite measure made up of the mean and the standard deviation. It makes it possible to gauge what the average is worth in relation to all the observations.

[5] *Mtiraoui, A. and al. (2019): ''Islamic Financial Development between Policy Stability and Economic Growth in the MENA region: Estimate a Model of Simultaneous Equations''. SSRN Electronic Journal.*

[6] *Mtiraoui, A. (2021). Corruption, Human Capital and Economic Development in the Mean Region: Empirical Test. J. Econ. Managem. Res. Volume 2(1), pp 1-8*

Table N°1: Descriptive Statistics.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
GDP	**391**	**11.2054**	**0.1676**	**-10.4797**	**41.5278**
IQ	**391**	**4.3676**	**0.5446**	**-2.2469**	**7.38329**
TEN	**391**	**3.7639**	**0.1295**	**-2.3352**	**9.78329**
GE	**391**	**9.6042**	**0.2567**	**1.6589**	**20.3578**
CC	**391**	**10.6625**	**0.8864**	**10.1204**	**31.2315**

Source: *Stata15.1 output made by the Authors*

- *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. In other words, it allows us to detect the presence of relationships between variables.

Table N°2: Correlation matrix between variables

	GDP	IQ	TEN	GE	INV	TRAD	HK	CC	FDI
GDP	1.000								
IQ	0.401	1.000							
TEN	0.148	0.102	1.000						
GE	0.032	0.019	0.037	1.000					
CC	0.598	0.743	0.446	0.701	-0.421	-0.014	0.233	1.000	

Source: *Stata15.1 output made by the Authors*

- *Analyse multivariée*

At this level, we will seek to specify the model. Unlike linear regression models where we can specify a one-dimensional model on the basis of economic theories and then carry out model validation tests, in the case of panel models, the analysis concerns two dimensions.

We analyze the characteristics of a set of countries over a defined period of time, we carry out different tests in order to define the form of the model studied. In other words, we seek to detect whether it is a stacked model, a fixed effect model (country/time) or a random effect model, from the tests. It is in this vein that we are led to carry out the Breusch-Pagan & Hausman test[7] pour la spécification du modèle. In addition to conducting tests to determine the structure of the model, we delve into further analysis to glean insights into the specific characteristics of each type of model. This entails examining the strengths and limitations of pooled models, fixed effects models, and random effects models in capturing the dynamics of the data under study.

4.2. Presentation of results

The results of the simultaneous equation estimation by the double least squares method of the direct and indirect effects of institutional quality (IQ) and economic growth (GDP) on Energy Transition (TEN) are presented in Table 3.

Table N°2: The Interaction of Institutional Quality (IQ), Economic Growth (GDP) and the Energy Transition for the MENA Region With REG3

[7] *Goaied, M. and al. (2004).The Value Relevance of Accounting and Financial Information: Panel Data Evidence. Applied Financial Economics, Vol.14; pp.1219-1224.*

Variables	IQ	GDP	TEN
Cons. ***	4.5826) (9.09)	0.5618*** (70.27)	0.21970* (1.84)
TEN	-0.6513* (-1.79)	1.1211** (2.06)	----------
IQ	-----------	0.9164* (1.87)	-1.4121** (-1.99)
GDP	1.6829*** (3.09)	-------	0.8921* (1.91)
GE	--------	--------	-0.9329* (-1.89)
INV	--------	0.2082* (1.79)	--------
TRADE	--------	-0.1140 * (-1.81)	---------
HK	--------	0.11723 (0.74)	---------
FDI	--------	0.51046* --- (1.76)	-------
CC	2.8217*** (3.98)	----	--------
Obs.	391	391	391
R^2	0. 13	0. 24	0.31

Source: The work done by the authors

Note: The terms in parentheses correspond to **t-Student** and *******, ******, *****: significant at a threshold of **1%, 5% and 10%** respectively.

4.3. Discussion des résultats

To demonstrate the interaction between institutional quality (IQ), economic growth (GDP), and environmental transition (TEN), it is important to revisit the findings that explore the direct and indirect effects of the institutional indicator on the energy indicator through the growth indicator, using a simultaneous equations model for the MENA region during the period (2000-2022).

The results found in Table 3 indicate that the energy transition (TEN) has a direct negative effect (-0.6513) on institutional quality (IQ), which is significant at the 10% threshold in the first regression, and conversely for the third regression where there is a negative and significant indirect impact (-1.4121) of institutional quality (IQ) on the energy transition (TEN) at the 5% significance level.

It is necessary to consider several aspects to interpret this result adequately. An increase of 10% in the quality index thus translates into a decrease of almost twice the level of carbon dioxide emissions per capita (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) measured in CO_2 equivalent (Energy Transition).

Authors such as Acemoglu, D., Simon, J., and Robinson, J., (2001) have developed relevant analytical frameworks for understanding the relationships between institutions and economic development. Their work could help shed light on how institutions react to environmental changes, including those related to energy transition. Additionally, studies by Ostrom, E. (1990) on common-pool resource management or by Rodrik, D. (2000) on institutions and economic growth could provide useful theoretical perspectives in this regard. To strengthen the validity of the results, further analyses could be conducted, including an examination of the evolving relationship between energy transition and institutional quality. Besley, T. & Persson, T. (2009) addressed these questions by studying the interactions between institutions and economic development through comparative analysis.

Furthermore, the indicator of economic growth (GDP) in Equation N° 1 of the model is positively and significantly correlated (1.6829) with institutional quality (IQ) at the 1% threshold, and conversely for the estimation of Equation N°. 2 of the model where institutional quality (IQ) has a positive indirect effect (0.9164) on itself at the 10% significance level. This correlation does not necessarily guarantee a direct relationship, and other factors may also influence both GDP and institutional quality, as a 1% increase in economic growth GDP translates to a twofold increase in the institutional quality index.

Indeed, it is important to control for omitted variables that could bias the results, such as the quality of education, infrastructure, monetary policy, and fiscal policies, which can influence both GDP and institutional quality.

Barro, R., J. (1997) identified various determinants of economic growth that could be considered to improve the accuracy of the analysis. However, Acemoglu, D., Simon, J., and Robinson, J. (2001) developed a framework to explain how economic development can influence the formation and evolution of institutions.

Moreover, numerous authors like - Kaufmann, D., Kraay, A., and Mastruzzi, M., (2010) have proposed methodologies for assessing institutional quality on a global scale, which could be useful for improving the measurement of this indicator.

Furthermore, the effectiveness of public power (GE) has a direct negative effect (-0.9329) that is statistically significant at the 10% threshold on the energy transition (TEN). That is, when the public efficiency index grows by 10%, it translates to a reduction of only one time. This effect is an important finding that highlights the challenges faced by public policies aiming to promote the transition to more sustainable energy sources.

Moreover, a negative indirect effect persists between the index of quality through the fight against corruption (CC) and the energy transition (TEN), as the index (CC) is positively correlated (2.8217) and statistically significant at the 1% threshold with the institutional indicator. Thus, the negative effect (2.82 * -1.4121) between the corruption index (CC) and the energy indicator (TEN) is significant at the threshold (1% * 5%).

In this context, Nordhaus, W. (2013) provides an important perspective. The author, in his studies of environmental policies, emphasizes the inherent challenges in designing and implementing effective policies to mitigate the effects of climate change, including institutional barriers that may hinder government action.

Furthermore, Sachs, J. (2015) offers an in-depth analysis of global challenges related to sustainable development, including energy transition. The author underscores the importance of coordinated action on a global scale to address the challenges of energy transition and climate change.

5. CONCLUSION

The response to our central question delineates the direct and indirect effects of institutional quality and economic growth on environmental transition in the MENA region, employing simultaneous equations during the period (2000-2022).

Empirical analysis highlights institutional factors that can either facilitate or impede energy transition, as well as its influence on economic growth. The effects of institutional quality via economic growth on energy transition are crucial aspects to study in the context of environmental sustainability.

However, energy transition plays an essential role in energy transition. Effective and well-established institutions are necessary to implement and enforce efficient environmental and energy policies. This includes implementing regulations to reduce greenhouse gas emissions, promoting renewable energies, and encouraging energy efficiency. Strong institutions are also important to ensure transparency, accountability, and public participation in the decision-making process related to energy transition.

Results indicate that despite the importance of institutional quality in driving economic growth, this relationship does not necessarily translate into successful energy transition. Indeed, the inefficiency of public action in combating corruption and implementing effective policies to promote cleaner and sustainable energy sources appears to be a crucial factor hindering energy transition in the MENA region.

To achieve successful energy transition, it is imperative to enhance institutional quality by strengthening transparency, combating corruption, and implementing coherent and effective energy policies. Without these measures, it is unlikely that the MENA region will achieve its energy transition goals, which could have detrimental consequences both economically and environmentally.

Overall, to foster successful energy transition in the MENA region, it is essential for public authorities to decisively address institutional quality issues, particularly concerning the fight against corruption. Only effective and transparent government action can create an environment conducive to the adoption of more sustainable energy technologies and the reduction of greenhouse gas emissions.

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