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Investigating the Relationships between Renewable Energy Consumption, Socio-Economic Factors and Health: A PVAR Analysis from MENA Net Oil Importing Countries

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Abstract: In this paper, we tried to contribute to the previous literature by analyzing the relationship between renewable energy consumption, socio-economic factors and health in the presence of a stringent environmental policy and lobbying power. Using a Panel Vector Auto-Regressive (PVAR) technique, we specifically examine the role of the government effectiveness and the lobbying pressure in moderating the impact of renewable energy consumption on CO_2 emissions, economic growth and health factor considering the case of Middle East and North Africa (MENA) Net Oil Importing Countries (NOICs) from 1996 to 2019. Our analysis shows that (i) environmental policy stringency and good governance will induce a rise in the level of renewable energy consumption; (ii) lobbying power and interest groups discourage the renewable energy sector's development since the add in economic growth of these economies is not oriented towards renewable energy projects; (iii) a rise in renewable energy consumption, perhaps generated by renewable energy policies, should favor the improvement of public health. Finally, the political implications of the findings are summarized and discussed.

Keywords: renewable energy consumption; economic growth; CO_2 emissions; health; environmental policy; lobbying power; PVAR; MENA NOICs

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1. Introduction

Today and as never before, the future of the planet is at stake and therefore the situation is currently serious. A growing commitment from policymakers, environmentalists, international organizations and scientific scholars has emerged regarding the adverse impacts of climatic deregulation on human health, human life and environment quality (see, e.g., [1–3]). Given that the main source of climate change is greenhouse gas emissions, it makes sense and is imperative according to several policymakers and scientific researchers to massively reduce it; a fact that was adopted at the Paris climate conference (COP21) and recently at the Glasgow climate conference (COP26). According to the recent Medical Society Consortium on Climate and Health (MSCCH) report, the level of the average temperature will rise by more than 2 °C if the greenhouse gas emissions continue to blaze which will unfortunately lead to threatening human health and life (see, e.g., [4–6]).

However, various studies on the environment and economic dimensions of sustainable development influencing human health have recently been developed (see, e.g., [7,8]), while works on the interactions between renewable energy consumption, economic as well as social determinants and health factor are quite few. One of the leading indicators of the collective well-being and economic development of any nation is health. With strong global population growth and environmental degradation, the health factor is on peril and can be tackled through the transition to renewable energies. Indeed, ref. [9] have concluded that the renewables allowed the reduction of fossil fuels use and CO_2 emissions, generating positive impacts on human health given by respiratory and cardiovascular diseases as two main examples. In the near past, the author of [10] analyzed energy/electricity use and diverse indicators of life quality according to a sample of high-income industrialized countries, already generating an increase in the energy use. In fact, he retained that "changes in per capita energy/electricity consumption are not associated with corresponding improvements in life quality and wellbeing". The authors of [11] showed that the "total human health impacts of nuclear and renewables are much below those of fossil technologies". They also confirmed that "climate change and human toxicity contribute most to total human health impacts and, the fossil fuel combustion and coal mining are the most polluting life cycle stages". Nevertheless, many studies have shown that environment improvement can reduce economic activity (see, e.g., [12,13]). Thus, the environmental policy rigor is crucial in the balancing between improving environmental quality and keeping acceptable levels of economic activity. That is to say that policymakers in many countries around the world have been challenged to solve this dilemma. Among these countries, the MENA region appears to be characterized by a high availability of natural resources deemed to be essential in encouraging the use of renewable energy. It is worth noting that this region considered as related to the major part of solar radiation when comparing it to other regions in the world [14], while only 1% of its primary energy mix used in energy consumption comes from renewable resources [15]. That said, the implementation of renewable energy policies could accelerate the energy transition in the MENA region, reduce unemployment, diversify energy mix, reinforce energy security, improve environmental quality, and combat the volatility of energy prices (see, e.g., [16–18]). Within this region, the present study tries the case of MENA Net Oil Importing Countries (NOICs) defined as a sample of countries believed to be most influenced primarily by rising energy price volatility. It is also an opportunity to minimize their dependence to other regions by reducing the quantities of imports plagued by economic and political uncertainty. Despite their many environmental and socio-economic benefits, investment in green and renewable energy projects continues to face major constraints in MENA NOICs. According to [14], two main consistent blocks to private investment in this area are detected and may also be explained by "difficulties for investors to access financing added to an insufficient positive cash flow to recover the high costs due to the long installation life of renewable energy projects". In addition, another major barrier, instead, is related to lobbying pressure, which is positively correlated to the traditional energy sources participations.

Hence, the main aim of this research is to study the role that may be played by socio-economic and health factors in the transition to a renewables-based economy in the MENA NOICs over the period 1996–2019. More precisely, the contribution of the current study is to investigate, in the MENA NOICs, the relationships between renewable energy consumption, government effectiveness, economic activity, environment improvement, lobbying power, and health. We have investigated which roles can be played by government effectiveness and lobbying pressure in moderating the impact of renewable energy consumption on CO_2 emissions, economic growth and health factor. To our knowledge, there is no study in the empirical literature that has examined this research question in MENA region. It is also interesting to underline the use of the vector autoregressive (VAR) framework, the multivariate panel approach in [19], to explore the links between the above-mentioned components.

The remainder of the paper is organized as follows. The second section describes the data and explains the methodological approach. Section 3 presents and discusses the empirical results. The last section concludes by highlighting the main policy implications.

2. Data and Methodology

2.1. Data Description

This study uses annual frequency data of 10 MENA NOICs (Armenia, Cyprus, Georgia, Israel, Jordan, Lebanon, Malta, Morocco, Tunisia, and Turkey; sources: [16,20]; we exclude Mauritania due to lack of data on certain variables) from 1996 to 2019. Six variables were used in this study to investigate the above-stated main purpose. These variables include: (1) Renewable energy consumption as a percentage of total final energy consumption which proxies the degree of transition to a country based on renewable energy [21]; (2) The Government effectiveness index that essentially measures the quality of public policies, but also the government effective responsibility with regard to these public policies. In fact, it proxies the good governance and the environmental policy stringency; (3) The Gross Domestic Product (GDP) per capita as a main variable of economic growth to achieve sustainable development; (4) CO_2 emissions per capita used as a proxy for general public sensitization; (5) The electricity production from traditional energy sources related to lobbying power measured as the percentage contribution of these energy sources to total electricity generation. Lobbying pressure is surely correlated to the participations of traditional energy resources discouraging the development in the sector related to renewables; (6) The life expectancy at birth proxies the health factor. The datasets can be found in the World Development Indicators (WDI) as well as the World Governance Indicators (WGI). Indeed, Table 1 gives a recap of the descriptions with symbols, definitions and sources of variables, and Table 2a,b display the summary statistics, as well as the correlations between the investigated variables.

Table 1. Descriptions, definitions and sources of the used data.

Variables	Definitions	Sources
Renewable energy consumption (REC)	Renewable energy consumption (% of total final energy consumption)	WDI
Government effectiveness index (GEI)	Measures essentially the public services' quality and its policies, civil servants, and the degree of independence from political pressures	WGI
GDP per capita (GDP)	GDP per capita (PPP, current international $)	WDI
CO_2 emissions per capita (CO_2)	CO_2 emissions per capita (metric tons)	WDI
Electricity production (EP)	Electricity production from oil, gas, coal sources (% of total)	WDI
Life expectancy at birth (LEB)	Life expectancy at birth, total (years)	WDI

Source: Authors' tabulation.

2.2. PVAR Specification

Unlike quite few previous studies that have employed traditional econometric models, such as the vector error correction model (VECM) and/or the vector autoregressive (VAR) framework, the present analysis uses Panel Vector Auto-Regressive (PVAR) method, developed in [19], to study the interactions among renewable energy consumption, government effectiveness, GDP per capita, CO_2 emissions per capita, electricity production and life expectancy at birth by modeling the endogenous behavior between the degree of transition to a country based on renewable energy, the rigor of the environmental policy, economic growth, environmental degradation and general public sensitization, lobbying power and health factor, as well as determining the appropriate interpretations. Moreover, the PVAR model obtains its advantage from the traditional VAR model that considers all the used variables as endogenous in one system. Furthermore, this recent multivariate econometric tool also has an advantage from the panel data analysis that permits unseen individual heterogeneity for all the variables by including fixed effects, a fact that improves the estimation consistency. The PVAR model normally presents the following form:

$$Z_{it} = \alpha_i + \Gamma(L)Z_{it} + \mu_i + d_{c,t} + \varepsilon_{it} \quad (1)$$

where Z_{it} indicates the vector of dependent variables (REC, GEI, GDP, CO_2, EP, LEB). All the variables are transformed into natural logarithm to attain dependable results [22] and more stationary behavior [23], except for GEI.

α_i represents the individual-specific fixed effects for the country i.

i and t, respectively, indicate country and time.

$\Gamma(L)$ indicates the matrix of the lag operator polynomial, where $\Gamma(L) = \Gamma_1 L^1 + \Gamma_2 L^2 + \ldots + \Gamma_p L^p$.

μ_i denotes the country-specific effects vector.

$d_{c,t}$ is the dummy variable related to the country-specific time.

ε_{it} designates the residuals' vector.

Table 2. (**a**) Summary statistics (1996–2019). (**b**) Correlation matrix.

(**a**)

Variables	Mean	Std. Dev.	Min	Max
REC	11.58417	11.76239	0	56.758
GEI	0.340285	0.6126632	−0.8328025	1.563668
GDP	15,039.58	10,641.28	1990.583	46,766.77
CO_2	3.912125	2.441243	0.7439962	9.615068
EP	80.27406	28.93259	6.752101	100
LEB	75.40784	3.822807	67.175	82.80488

(**b**)

	REC	**GEI**	**GDP**	**CO_2**	**EP**	**LEB**
REC	1					
GEI	−0.4014	1				
GDP	−0.4295	0.8507	1			
CO_2	−0.5173	0.8313	0.8731	1		
EP	−0.7123	0.4518	0.4360	0.5536	1	
LEB	−0.5701	0.7302	0.8768	0.8334	0.5549	1

Source: Authors' calculation.

In addition, the Schwarz Information Criteria (SIC) is used to choose the optimal lag length in the PVAR model (the optimum lag length was set to 1.) In this context, the authors of [24] pointed out that Akaike Information Criterion (AIC) is regarded as being inconsistent in the sense that it does not select the model with maximum information where the probability tending to one. This problem seems to be overcome by SIC which is recommended for large samples in place of AIC. Moreover, the estimation of this model raises an issue given the presence of fixed effects. Following [19], the Helmert procedure is based on the forward mean-differencing to remove the fixed effects (could create biased coefficients) which are correlated with the exogenous variables, due to the lags of the endogenous variables is applied. This transformation removes the forward mean (for example, the mean of all the future observations that may be detected for each country-year [19]), which subsequently keeps the orthogonality between transformed variables and lagged regressors [19]. To give details about the Helmert procedure, the following reduced form of the PVAR model (see, e.g., [25]) is considered:

$$Z_{it} = \Gamma(L) Z_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

In fact, this method supposes that all the variables in the PVAR model are transformed into deviations from forward means to eliminate the fixed effects. Let $\overline{Z}_{it}^m = \sum_{s=t+1}^{T_i} Z_{is}^m / (T_i - t)$ refer to the means detected from the $\overline{Z}_{it}^m$ calculated values, which is a variable in the vector $Z_{it} = \left(Z_{it}^1, Z_{it}^2, \ldots, Z_{it}^M\right)'$, where T_i refers to the last date for the country i. Let $\overline{\varepsilon}_{it}^{m}$ indicate the same transformation of ε_{it}^{m}, where $\varepsilon_{it} = \left(\varepsilon_{it}^{1}, \varepsilon_{it}^{2}, \ldots, \varepsilon_{it}^{M}\right)'$. The transformed variable, as follows, is consequently obtained:

$$\widetilde{Z}_{it}^{m} = \phi_{it}\left(Z_{it}^{m} - \overline{Z}_{it}^{m}\right) \quad (3)$$

and

$$\widetilde{\varepsilon}_{it}^{m} = \phi_{it}(\varepsilon_{it}^{m} - \overline{\varepsilon}_{it}^{m}) \quad (4)$$

where $\phi_{it} = \sqrt{(T_i - t)/(T_i - t + 1)}$.

Since there are no future values for the last year data to construct the forward means, this transformation cannot be calculated ([25]). The final transformed specification is therefore given by:

$$\widetilde{Z}_{it} = \Gamma(L)\widetilde{Z}_{it} + \widetilde{\varepsilon}_{it} \quad (5)$$

where $\widetilde{Z}_{it} = \left(\widetilde{Z}_{it}^{1}, \widetilde{Z}_{it}^{2}, \ldots, \widetilde{Z}_{it}^{M}\right)'$ and $\widetilde{\varepsilon}_{it} = \left(\widetilde{\varepsilon}_{it}^{1}, \widetilde{\varepsilon}_{it}^{2}, \ldots, \widetilde{\varepsilon}_{it}^{M}\right)'$.

It is interesting to note that the forward mean-differencing presents a substitute to the first-difference operator, which has the weakness of magnifying gaps in unbalanced panels. This alternative transformation has an advantage in keeping sample size in the case of panel gaps [26]. In addition, this procedure shows an orthogonal deviation, where each observation indicates a deviation detected from the average future observations [25] and also needs to standardize the variance with a weighted variable. If the initial errors did not present an autocorrelation and also outlined the presence of a constant variance, the transformed errors would display identical properties. As a result, this deviation is characterized by the presence of homoscedasticity, and it will then not engender serial correlation [27]. Moreover, this technique makes it possible to employ the lagged values of the exogenous variables as a first tool before to estimate the coefficients by the Generalized Method of Moments (GMM) system.

Ultimately, the analysis of the model's dynamic inevitably passes through the impulse response functions (IRFs) and variance decomposition. Firstly, the IRFs express the reaction of a variable to the innovations in another one. Secondly, the variance decomposition provides the degree of the influence of shocks in one variable on the fluctuations in other variables. Using 1000 Monte Carlo simulations for 10 years, the forecast error variance decomposition was completed.

3. Results and Discussion

Before proceeding to the estimation of the PVAR model, we first test the stationarity. However, the choice of the panel unit root tests to be used, either first generation ([28–31], among others) or second generation ([32–35], among others), is respectively linked to the presence of cross-sectional independence or dependence. In order to examine the existence of a cross-sectional dependence (CD), the test performed in [36] is applied and its results are presented in Table 3. In fact, these results indicate the acceptance of the CD hypothesis with a high significance level. The findings also show that the MENA NOICs are cross-sectionally related. We will then suggest using panel unit root tests of the second generation, such as the test used in [35].

Table 3. CD test results.

Variables	***P* (*Lag Length*) = 1**	
REC	−2.14 **	(0.032)
GEI	2.48 **	(0.013)
GDP	30.96 ***	(0.000)
CO_2	−0.10 ***	(0.000)
EP	4.17 ***	(0.000)
LEB	31.94 ***	(0.000)

Notes: The values between (.) indicate probabilities. *** and ** denote the significance levels of 0.01 and 0.05 (1% and 5%), respectively.

The results of the panel unit root test included intercept and trend are reported in Table 4. The test used in [35] indicates that all the variables are integrated of order 1, i.e., I (1), which means that the first difference is applied for all series to be stationary.

Table 4. Panel unit root test results.

Variables	CIPS (2007)	
REC	−1.146	(0.126)
D(REC)	−4.424 ***	(0.000)
GEI	−4.153	(0.114)
D(GEI)	−6.587 ***	(0.000)
GDP	1.117	(0.868)
D(GDP)	−4.457 ***	(0.000)
CO_2	0.355	(0.639)
D(CO_2)	−7.968 ***	(0.000)
EP	4.155	(1.000)
D(EP)	−3.545 ***	(0.000)
LEB	0.175	(0.569)
D(LEB)	−1.368 *	(0.086)

Note: The values between (.) indicate probabilities. *** and * denote the significance levels of 0.01 and 0.1 (1% and 10%), respectively. D(.) denotes the first difference.

According to the previous findings, it is essential to employ the [37] panel cointegration tests to check the possible existence of a long-run link among all the variables. The panel cointegration tests results are reported in Table 5.

Table 5. ECM panel cointegration tests results.

Statistics	Values	*p*-Values
Gt	−1.320	(0.113)
Ga	−6.231	(0.175)
Pt	−10.468	(0.263)
Pa	−5.987	(0.228)

Source: Authors' calculation.

The results indicated in Table 5 accept the null hypothesis of the cointegration's absence by all the four tests used. It is also noticed that the robust *p*-values are obtained through bootstrapping procedure with 400 replications, and that a constant and deterministic trend in the cointegration relationship have been allowed.

After having ensured the pre-estimation tests, the efficient way to explore and analyze the possible existence of a significant interaction between all the investigated variables is to estimate the PVAR model using one lag with Generalized Method of Moments (GMM), since it has been shown that all the variables can be used in the first difference. Indeed, the PVAR model's estimation results are reported in Table 6.

First, the findings on renewable energy consumption indicate that the first lag of this variable is negatively correlated with its current level. It can also be seen that the coefficient related to the first lag of renewable energy consumption is equal to −0.173 and significant at the rate of 5%. Additionally, the first lag of government effectiveness index positively impacts the effective level of renewable energy consumption at the 10% level, which indicates that the stringency of environmental policy and the good governance will induce an increase in the level of the renewable energy consumption. This result could be exploited by decision makers in the MENA NOICs to develop the studies of the nexus renewable energy-economy. Furthermore, when speaking of the means by which tools and legislative mechanisms should serve to improve the environment, "it is noteworthy the collective responsibility of producers, consumers, and central governments toward the environmental impacts of products, throughout their life cycle, including end-of-life management" [38]. Moreover, the lag of GDP per capita affects negatively the current level of renewable energy consumption at the rate of 1%. This result indicates that the fruits of economic growth in these countries are not oriented towards renewable energy projects. For the impact of the first lag of lobbying variable, the result is more interesting. This variable, which can be considered as a proxy of the electricity production, presents a negative and significant impact on the current renewable energy consumption. This finding shows that the lobbying power and the interest groups do not encourage the use of renewables, and these economies will then not be interested in this sector. Finally, the lag value of health factor, which is represented by life expectancy at birth, shows a strong positive impact on the current renewable energy consumption at the significance level of 10%. This means that the outreach operations could generate additional demand for renewables.

Table 6. PVAR model's estimation results.

Response to	Response of					
	$D(REC_{(t)})$	$D(GEI_{(t)})$	$D(GDP_{(t)})$	$D(CO_{2(t)})$	$D(EP_{(t)})$	$D(LEB_{(t)})$
$D(REC_{(t-1)})$	−0.173 (−2.288) **	−0.018 (−0.427)	−0.044 (−2.136) **	0.035 (1.026)	0.007 (0.201)	0.004 (1.874) *
$D(GEI_{(t-1)})$	0.133 (1.736) *	−0.165 (−1.364)	−0.037 (−1.105)	−0.092 (−1.657) *	0.045 (0.310)	−0.0008 (−1.028)
$D(GDP_{(t-1)})$	−1.603 (−2.699) ***	0.615 (1.823) *	0.364 (2.756) ***	0.455 (2.117) **	0.647 (1.119)	0.008 (1.680) *
$D(CO_{2(t-1)})$	0.146 (0.412)	0.027 (0.130)	0.085 (1.134)	−0.006 (−0.046)	−0.327 (−0.684)	−0.009 (−2.077) **
$D(EP_{(t-1)})$	−0.138 (−1.731) *	0.081 (0.860)	0.036 (1.400)	0.101 (1.446)	−0.059 (−0.233)	−0.0005 (−0.681)
$D(LEB_{(t-1)})$	19.151 (1.810) *	1.399 (0.358)	3.863 (2.164) **	3.007 (0.936)	2.737 (0.565)	0.379 (2.564) **

Note: Heteroskedasticity adjusted *t*-statistics are shown in (.).***, ** and * denote the significance levels of 0.01, 0.05 and 0.1 (1%, 5% and 10%), respectively. D(.) denotes the first difference.

Second, the findings on the government effectiveness index indicate that only the first lag of GDP per capita positively affects the current level of the government effectiveness. This means that the previous economic growth strengthens the quality of public services and policies.

Third, for the GDP per capita equation, the findings indicate that the first lag of this variable is positively correlated with its current level at the rate of 1%. This result largely confirms the theory of economic growth. The estimated coefficient associated with the first lag of renewable energy consumption is negative at the rate of 5%. This corroborates the result found by [39], highlighting a negative relationship between renewable energy consumption and GDP per capita. In this vein, other extensive studies have shown that the implementation of renewable energy policies positively stimulates economic growth and can lead to improved environmental quality ([12,13,40]). Additionally, the first lag of life expectancy at birth positively and strongly affects the effective level of GDP per capita at the 5% level, which indicates that human health and its correlation with human development positively stimulate economic growth.

Fourth, regarding the CO_2 emissions equation, the first lagged value of government effectiveness index is significant at 10% level with a negative coefficient. This finding is very important because it shows that good governance and rigor environmental policy may reduce CO_2 emissions by stimulating the sustainable use of natural energy resources. In other words, the countries which pay attention to governance quality may improve the environmental quality by mitigating CO_2 emissions (see, e.g., [41,42]). Then it is possible to improve the environmental quality in the NOICs by promoting the renewable energy sector. This outcome is in accordance with some previous empirical findings (see, e.g., [43,44]). This may also ensure the ecological environment protection, for instance, by managing and planning sustainable urban spatial development (see, e.g., [45]). Additionally, the first lag of GDP per capita positively impacts the effective level of CO_2 emissions at the significance level of 5%. This means that the benefits of economic growth used in the MENA NOICs are not environmentally friendly.

Fifth, for the electricity production equation, the findings indicate that none of the lagged variables of the model are significant.

Finally, regarding life expectancy at birth, the findings are more interesting. Indeed, the coefficients of the one lag of renewable energy consumption and GDP per capita are positive at the significance level of 10%. This clearly indicates that an increase in renewable energy consumption, perhaps generated by renewable energy policies, should take care of public health. As expected, the coefficient of the one lag of CO_2 emissions is negatively correlated with life expectancy at birth at the significance level of 5%. It is to note that the first lag of life expectancy at birth variable is positively correlated with its current level at the significance level of 5%.

The results of variance decomposition and IRFs are reported in Table 7 and Figure 1, respectively. Precisely, the approach is based on the two principal variables of interest cited as renewable energy consumption and life expectancy at birth. The second role of this approach is to study the interactions between these two main variables and others.

Table 7. Variance decomposition results.

	D(REC)	**D(GEI)**	**D(GDP)**	**D(CO_2)**	**D(EP)**	**D(LEB)**
D(REC)	0.87013	0.00499	0.07243	0.00672	0.00630	0.03940
D(GEI)	0.01871	0.88201	0.08141	0.00183	0.01088	0.00514
D(GDP)	0.08413	0.00303	0.83749	0.01539	0.01447	0.04545
D(CO_2)	0.08029	0.01105	0.24318	0.60334	0.03775	0.02437
D(EP)	0.06575	0.00806	0.03809	0.07772	0.80694	0.00340
D(LEB)	0.09973	0.00764	0.04105	0.04868	0.00208	0.80079

Note: The orthogonalized impulse-responses are the original form of the finding results. The forecast error variance decomposition was applied through the use of 1000 Monte Carlo simulations for 10 periods.

Indeed, Table 7 shows the variance decomposition results, which specify the magnitude and the degree of the shocks' impact viewed in one variable on the detected fluctuations of the other variables. Obtained from the orthogonalized impulse response coefficient matrices as suggested by [46,47], the results of the variance decomposition also show that each variable is largely influenced by its lag. Specifically, renewable energy consumption explains (after 10 years) approximately 7.25% of the fluctuations in economic growth and 4% of the fluctuations in life expectancy at birth, while life expectancy at birth, which proxies health, explains approximately 10% of the fluctuations in renewable energy consumption, 4.9% of the fluctuations in CO_2 emissions and 4.1% of the fluctuations in economic growth.

Figure 1 reports the IRFs through Monte Carlo simulations with a thousand repetitions and five-percent errors bands. More specifically, we focus on the reaction of renewable energy consumption and life expectancy at birth to one shock in government effectiveness index, GDP per capita, CO_2 emissions and electricity production. Based on the Cholesky decomposition, we can confirm through the analysis of the model dynamics, and more precisely that of the IRFs, the conclusions of the estimation results and the variance decomposition drawn previously.

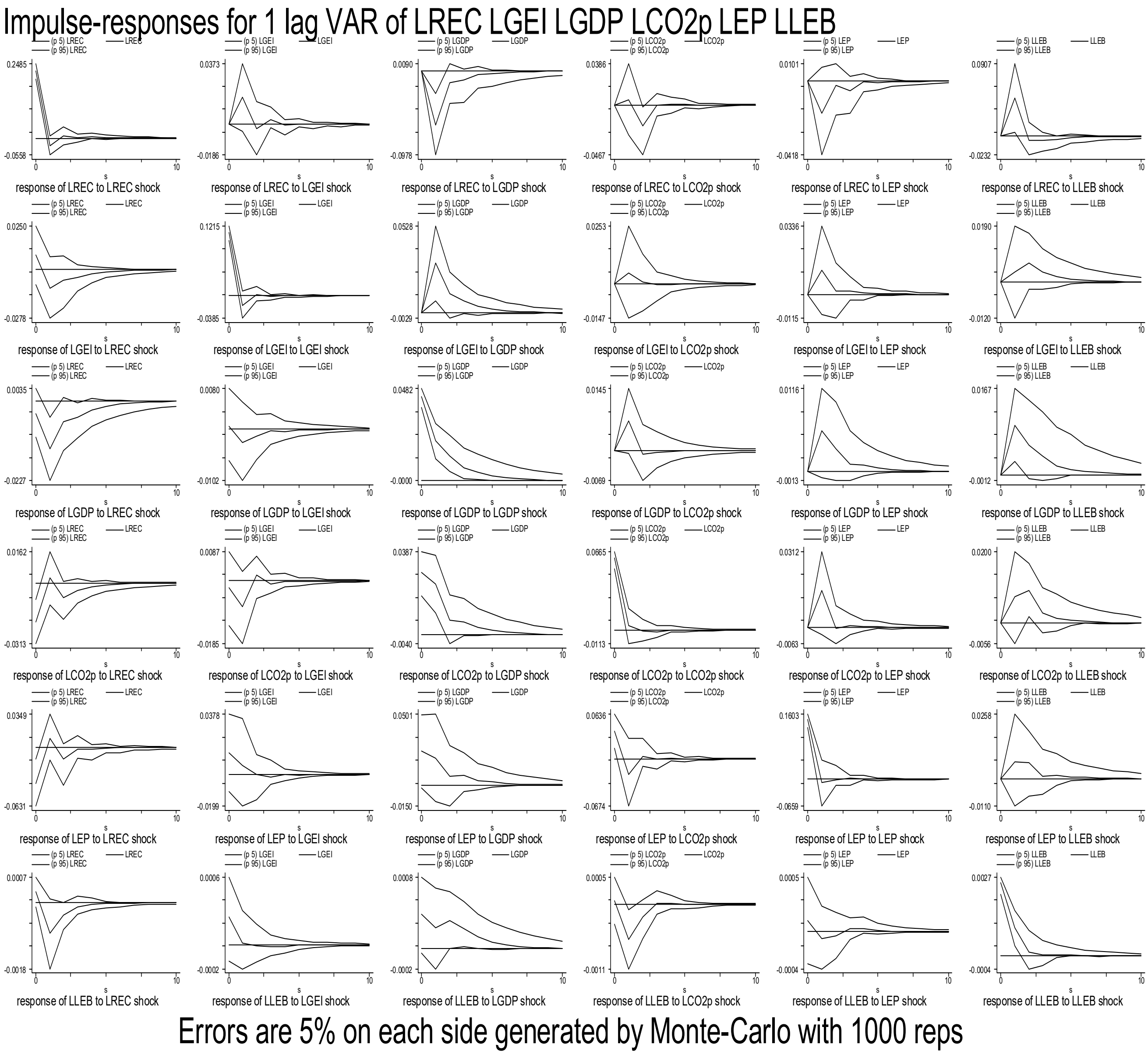

Figure 1. The impulse response functions (IRFs).

4. Conclusions, Policy Implications and Possible Extension

The principal aim of the present work is to study the relationships between the degree of transition to a renewable-energy economy, health, environmental degradation and economic growth, in the presence of a rigorous environmental policy and lobbying power. In the same vein, different proxies are included in this analysis such as renewable energy consumption, life expectancy at birth, CO_2 emissions per capita, GDP per capita, government effectiveness, and electricity production from oil, gas and coal sources. Using the Panel VAR approach in the case of MENA NOICs over the period 1996–2019, the empirical findings show that (1) good governance and stringency of environmental policy will induce an increase in the degree of transition to a country based on renewable energy consumption; (2) renewable energy may play a fundamental role in reducing CO_2 emissions and in enhancing the environment quality; (3) the benefits of economic growth, which are used in the activities of MENA NOICs, are not environment friendly. This can be explained in part by the lobbying pressure, which discourages the use of renewables and the development of this field; (4) an increase in renewable energy consumption should favor the improvement of public health.

Based on these results, the quality of public policies can ensure the transition to a renewable-energy economy in the MENA NOICs and contain the lobbying pressure. On the other hand, the government is considered as the first responsible for these public policies and the first element that can improve the governance quality. Furthermore, the policy makers should apply some policy tools that pay more attention to sustainable development through the individual well-being and awareness raising operations which could encourage the use of renewables, and then developing of the renewable energy sector in the MENA NOICs, as well as improving the environment quality and the public health. Moreover, implementing applicable environmental laws is recommended to improve and protect the environment. Overall, good coordination among several stakeholders such research institutes, a different government ministries, as well as industry and universities is widely required to implement a successful mitigation strategies.

The main limit of this study includes ignoring the discussion of results by chronological, geographical, energy, and socio-economic approaches. The PVAR analysis does not allow, technically, to discuss these allocations. Thus, a possible extension of this investigation may be to use a robust analytical framework, suggesting that the following domains of argumentation have to be better approached (see, e.g., [48]).

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Conflicts of Interest: The authors declare no conflict of interest.

Code Availability: EViews12.0 & Stata16.0 softwares.

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