Renewable and non-renewable energy consumption and economic growth: Evidence from MENA Net Oil Exporting Countries.

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Renewable and non-renewable energy consumption and economic growth: Evidence from MENA Net Oil Exporting Countries.

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Abstract: This study investigate the relationship between renewable and non-renewable energy consumption and economic growth in a sample of 13 MENA Net Oil Exporting Countries covering the period 1980–2012 within a multivariate panel framework. The Pedroni (1999, 2004), Kao (1999) as well as the Westerlund (2007) panel cointegration tests indicate that there is a long-run equilibrium relationship between real GDP, renewable energy consumption, non-renewable energy consumption, real gross fixed capital formation, and the labor force with elasticities estimated positive and statistically significant in the long-run. Results from panel error correction model show that there is unidirectional causality from economic growth to renewable energy consumption in the short-run and bidirectional causality in the long-run. Additionally, results prove bidirectional causality between non-renewable energy consumption and economic growth in both the short-run as well as the long-run. In fact, there are several initiatives and policies must be undertaken by Government so as to stimulate the introduction of renewable energy such as the development of several important regional based institutions and cooperation, renewable energy production tax credits, installation rebates for renewable energy systems and the creation of markets for renewable energy certificates.

Keyword: Renewable and non-renewable energy consumption, Growth, Panel cointegration, MENA Net Oil Exporting Countries.

JEL Classification: C33, Q43.

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1. INTRODUCTION :

Recently, contributions have exposed that the world is facing severe problems with energy depletion in consequence of the unbalanced availability between finite energy resources and population growth as well as industrial development. The available quantity of finite-based energy resources was expected to last between 30-150 years[2]. Additionally, According to the International Energy Agency (IEA, 2012), production from gas and oil reserves will drop to about 40-60% by 2030. Besides, Huntington (2009) exposed that this type of energy use was also vulnerable to disruptions caused by major events in the world, such as war, monopolistic behaviors (e.g. by OPEC[3]) and commonly more depending on the political stability of the net oil producing countries. These circumstances indeed slowed down the economic development in most countries in the world. Not only finite energy resources availability became the immediate concern, but also the environmental degradation whereas oil and coal exploitation ultimately led to forest destruction, biodiversity extinction as well as natural disasters.

To overcome these complexities, especially the scarcity problem of non-renewable energy resources, many countries have in progress to exploit energy which is produced from renewable resources. In order to meet the huge rising of energy future demand, different types of renewable energy sources, such as solar, wind, water, geothermal, and biomass have been used greatly by MENA[4] Net Oil Exporting Countries (NOEC), whereas non-renewable energy availability are anticipated to be scarce by 2050[5]. In fact, NOEC are concerned

[2] World Resource Institute, 2007.
[3] Organization of the Petroleum Exporting Countries
[4] Middle East and North Africa
[5] BP Statistical Review of world Energy 2012.

about the rapid growth in domestic fossil fuel consumption for electricity, water desalination, as well as transport, and recognize that this augmented consumption means a loss of export revenues. Recent estimates yet point out that if Saudi Arabia continues its growth in domestic fossil fuel consumption, it would lose the ability to export oil by 2020 and become a net oil importer by 2038, what has made significant influence among NOEC, particularly in the Gulf Cooperation Council (GCC) countries[6].

Consequently, Countries in the MENA NOEC region are increasingly and strongly implementing policies not only to facilitate the rapid uptake of renewable energy, but also to promote local economies along the renewables value chain, to offer more domestic employment opportunities and especially to provide more domestic fossil fuel consumption for electricity in the context of expanding populations.

Investigations that have explored the causal relationship between energy consumption and economic growth were clustered into three strands. The first strand in the literature studied the causality between energy consumption and economic growth (i.e Lee 2006, 2007; Mozumder and Marathe 2007; Apergis and Payne 2009a,b, 2010a,b). Besides, the following strand investigated the relationship between renewable energy consumption and economic growth (i.e Payne 2011; Apergis and Payne 2010c,d ; Fang 2011). Finally, the last strand consists of the researches, which looked at the effects of renewable and non-renewable energy consumption on economic growth (Apergis and Payne 2011b, 2012; Tugcu et al., 2012; U.Al-mulali et al., 2014).

[6] Glada Lahn and Paul Stevens (2011).

The present investigation is a contribution to the third strand of the literature, which aims to differentiate and to explore the relative impact of the two types of energy sources on economic growth for a panel of thirteen MENA Net Oil Exporting countries (NOEC) over the period 1980-2012 within a multivariate framework.

Although most previous studies lump different countries together in their analyses regardless of their state of development, our analysis economically extends previous research by allowing for heterogeneity amongst MENA countries. Consequently, the MENA countries were clustered into two sub-groups based on oil abundance (oil versus non-oil countries) and we initially undertake the case of MENA Net Exporting Countries[7].

The following section (Section 2) will disclose the renewable energy growth in the MENA Net Oil Exporting Countries. Additionally, Section 3 will expose data source, the empirical model and the panel methodology tests that will be developed in this analysis and will discuss the empirical results. Conclusion and policy implications will be reviewed in Section 4.

2. Renewable energy growth in the MENA net oil exporting countries:

A number of key factors that led to the marked expansion of renewable energy market in the MENA Net Oil Exporting Countries, as well as the diversity of countries currently participating in it such as energy security enhancement; major energy demand growth due to population increases, urbanization, and economic progress; as well as water scarcity. Renewable energy has become an increasingly attractive substitute to domestic oil and gas consumption. Additionally, it is also cited as a potential means of industrial diversification, new value-chain and employment activities, technology transfer, as well as improved environmental

[7] The further study will undertake the case of MENA Oil Importing Countries for the same topic and over the same period.

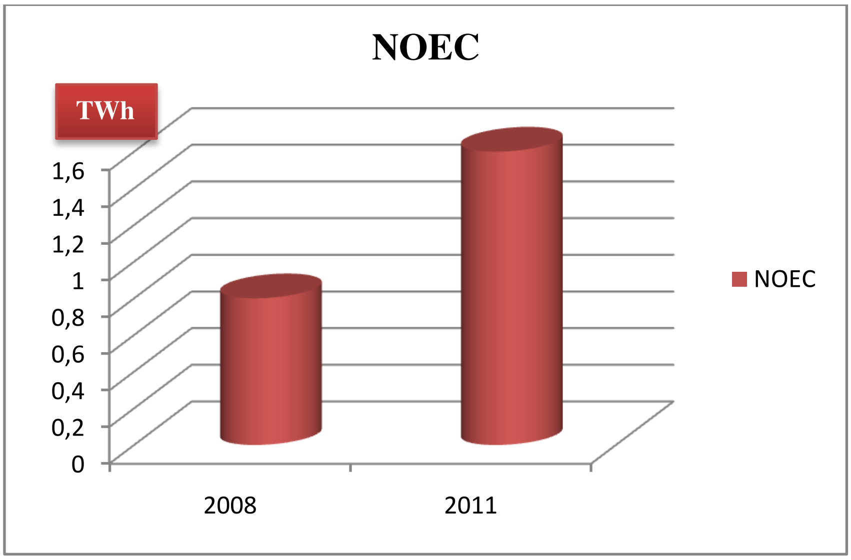
footprints. In fact, The MENA Net Oil Exporting Countries' Total Primary Energy Supply (TPES) was increased by 15.3% in 2010 compared to 2007 and, for an average annual growth of 4.7% over the period (IEA, 2012). Increased energy consumption in NOEC is due mainly to population growth, with related increases in demand for liquid fuels and electricity for domestic use and devices, heating, cooling, as well as desalination of water. It is motivating to note, however, that given the declining cost of modern renewable energy technologies and the increasing costs of fossil fuels, technologies such as wind and solar have been considered to meet growing energy needs in all Net Oil Exporting Countries of the region, and are likely to be the favored technologies in the foreseeable future.

In regard of absolute numbers, according to Renewable Energy Policy Network for the 21st Century (REN21, 2012) hydropower remains the primary renewable energy source for power generation in the NOEC region today. In fact, Iran and Egypt are the leaders in the region in installed capacity with 9.5 GW and 2.8 GW[8], respectively, followed jointly by Iraq, and Syria with over 1 GW of installed capacity. Besides, Hydropower generation proved a whole increase of almost 30% from 2008 to 2011 (or almost 9% average annual growth rate), 11 proportion points more than fossil fuel sources. This growth has been led essentially by Iran and Iraq, which commonly generated over 16.9 TWh[9] in 2011, more than 46% of the MENA hydropower production[10]. Actually, for different reasons, growth in renewable energy generation is taking place in the NOEC (notice Fig.1.). In the NOEC, there is increasing recognition of the opportunity cost of oil and gas used for domestic purposes, especially electricity production, desalination, as well as air conditioning,

[8] Gigawatt
[9] Terawatt-hour
[10] BP, Statistical Review of World Energy (2012)

all of which are experiencing speedy increases in demand, driven mainly by rising GDP, urbanization, and population growth in much of the exporting region.

Fig.1: Non-hydro Renewable Electricity Production in the MENA NOEC Region, 2008 and 2011



Sources: BP- Statistical Review of World Energy, 2012

Moreover, solar and wind energy play an important role in the exporting region because these two energy sources are the most common source of renewable electricity production in the region. Actually, Egypt is the leader in the exporting region with 550 MW[11] of installed wind power capacity, followed by Iran with 91 MW and Bahrain with 0.5 MW in 2012[12]. Unfortunately, Socio-political events linked to the Arab Spring in some parts of the MENA exporting region recently seem to have slowed down the promising and rather extensive development of wind[13]. Additionally, solar photovoltaic (PV) has an important role to play in the electrification of rural areas in the MENA exporting region. Indeed, the United Arab Emirates (UAE), which approximately doubled its installed capacity over the last two years, came in first, with 22.5 MW, up from about 11 MW in 2010 and 19.5

[11] Megawatt.
[12] Global Wind Statistics report (2012).
[13] World wind energy report (2012).

MW in 2011. Egypt, which has tripled its capacity over the last three years, has attained almost 15 MW of installed capacity. Saudi Arabia has 7MW of installed capacity; Bahrain and Libya have roughly 5 MW of installed capacity each (REN21,2012) Regrettably, this renewable energy technology suffer from making data monitoring of installed capacity rather challenging as well as the lack of up-to date data that can lead to an under-assessment of results.

Besides, concentrating solar (thermal) power (CSP) contributes considerably to the rising share of solar energy in the exporting region. In 2011, the majority of countries operating CSP plants were located in the MENA exporting region, specifically: Algeria, Egypt as well as Iran[14]. In 2013, these countries were joined by the UAE. The country became a major player in the CSP market while Shams 1, the world's largest CSP plant with an installed capacity of 100 MW, started operation in March 2013[15]. Modern biomass and geothermal for power are the least exploited energy sources in the exporting region. Qatar and the UAE are the only exporting countries presently producing electricity from modern biomass (REN21, 2012). Policymakers in the exporting region are more and more conscious of the wide range of benefits from renewable energy deployment, such as energy security, decrease of greenhouse gas emissions, improved health, job creation, manufacturing opportunities, rural development, as well as energy access. Consequently, these interests lead to greater adoption of renewable energy support policies in those countries. Besides, the opportunity to localize the renewable energy value chain and to build domestic industries and jobs is of considerable awareness in NOEC, and some countries, such as Egypt, Saudi Arabia as well as the UAE, are enacting policy provisions to capture these benefits. Targets and policies in the exporting region

[14] REN21, Renewables 2012 Global Status Report (Paris: 2012).
[15] Masdar, "Masdar Launches Shams 1, The World's Largest Concentrated Solar Power Plant in Operation," press release (Abu Dhabi: 17 March 2013).

place their priority on solar PV and CSP, reflecting the high quality solar energy resources in those countries, and the speedily declining costs of these technologies that especially caused by substantial technological advances as well as strong surplus manufacturing capacities in China and elsewhere.

The MENA exporting region saw significant developments in 2012 that are reflecting the rising momentum in the NOEC. Generally, The Egyptian Solar Plan, approved in July 2012, set a target for 2,800 MW of CSP and 700 MW of solar PV by 2027; Iraq announced a target of 400 MW of wind and solar capacity by 2016; Saudi Arabia set a target of 25 GW of CSP, 16 GW of PV, 9 GW of wind, 3 GW of waste-to-energy, and 1 GW of geothermal by 2032 (representing 20% of total electricity production); Qatar set a target of 2% renewable electricity by 2020 and launched a plan to add 640 MW of solar PV by 2020; Yemen added targets of 400 MW of wind and 6 MW of biomass capacity to its 2009 National Renewable Energy and Energy Efficiency Strategy, which intends to produce almost 10% to 15% power generation from renewables by 2025; Libya's 2012 plan comprises a continuing raise in its renewable electricity target from 3% by 2015 to 7% by 2020 and 10% by 2025; as well as both Kuwait and Oman announced targets for 10% of electricity generation from renewables, by 2030 and 2020, respectively (REN21,2012). Actually, NOEC have much more ambitious renewable energy targets, which suggest that those MENA exporting countries will rapidly become leaders in the region for new renewable energy investment, capacity, as well as production. This can due to the fact that NOEC are usually in a more favorable position to finance their renewable energy projects. Among NOEC, Saudi Arabia has by far the most ambitious target (54 GW by 2032), followed by Algeria (12 GW by 2030) and Egypt (10.7 GW by 2027)[16].

3. Data, methodology and empirical results

Annual data from 1980 to 2012 were obtained from the U.S. Energy Information Administration, the Penn World Table (PWT8.0)[17] as well as the World Bank Development Indicators on line data base. The MENA Net Oil Exporting Countries included in this analysis are Algeria, Bahrain, Egypt, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen[18].

Table 1 reports renewable energy (defined in million of kilowatt hours as net geothermal, solar, wind and biomass energy) annual percentage growth rates computed over the period 1980–2012 in MENA Net Oil Exporting Countries (NOEC). During the period 1980-2012, the main average annual growth rate of renewable energy consumption were recorded in Egypt (6.5% per year on average) and Algeria (6.5% per year on average). The higher renewable energy consumption growth rates in those exporting countries that became a major player reveal the momentum of renewable energy sector in addition to the rising interest in order to promote and to facilitate the deployment of renewable energy as well as to broaden the range of proposed energy solutions. Egypt has established several institutions to develop its local renewable energy industry: first in the early 1990s through the establishment of a Wind Energy Technology Centre (WETC) and a National Renewable Energy Development Organization (REDO), and then in 2000 through the creation of the Industrial Modernization Centre (IMC)[19]. These Egyptian institutions are committed to rising power generation from renewable sources and

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[16] REN21 (2012).
[17] http://www.ggdc.net/pwt.
[18] Sources: U.S. Energy Information Administration. MIDDLE EAST & NORTH AFRICA.
[19] Georgeta Vidican (2012).

developed a policy framework that incentivizes investment in renewable energy generation. According to the World Bank, Egypt has some of the world's best wind power resources, especially in the Gulf of Suez area where an estimated 7.2GW could be developed by 2022, with additional significant potential on the east and west banks of the River Nile. It is estimated that average wind speeds in the Gulf of Suez reach 10 meters per second. Egypt had an installed wind capacity of 430MW at the end of 2009. The country's largest wind project to date is a US$490 million (€352 million) development in the Gulf of el Zayt, commissioned in 2009 with a generating capacity of 200MW[20].

Algeria plays a key role in world energy markets as a principal producer and exporter of natural gas and liquefied natural gas. However, the country has enormous renewable energy potential, essentially solar, which the government is trying to exploit by launching an ambitious Renewable Energy and Energy Efficiency Program. The Program consists of generating almost 22,000 MW of power from renewable sources between 2011 and 2030, of which 12,000 MW will be meant for domestic consumption and the rest for export (Djalel Dibet al., 2012).

Besides, the Program is focused on developing and increasing the use of renewable resources, such as solar, wind, biomass, geothermal and hydropower, in order to expand energy sources and promote sustainable development of the country. Owing to its geographical location, Algeria holds one of the highest solar potentials in the world which is estimated at 13.9 TWh[21] per year. The country receives annual sunshine exposure equivalent to 2,500 KWh/m^2 [22]. Daily solar energy potential varies

[20] http://www.renewableenergyworld.com/rea/news/article/2010/12/quick-look-renewable-energy-development in-egypt.

[21] Terawatt-hour.
[22] Kilowatt-hour per square metre.

from 4.66 kWh/m^2, in the north to 7.26 kWh/m^2, in the south (UNEP[23], 2014). Approximately 60 solar photovoltaic plants, concentrating solar power plants, wind farms in addition to hybrid power plants are to be constructed during the next ten years. Additionally, Algeria has also joined the Desertec Industrial Initiative, which intends to use Sahara solar and wind power to supply 15 per cent of Europe's electricity needs by 2050 (UNEP, 2014).

Algeria has also good biomass energy potential in the form of solid wastes, crop wastes and forestry residues. Indeed, Solid waste is the best source of biomass potential in the country. According to the National Cadastre for Generation of Solid Waste in Algeria, annual generation of municipal wastes is more than 10 million tons[24]. Overall, despite being a hydrocarbon-rich nation, Algeria is building concerted efforts to harness its renewable energy potential. Algeria's renewable energy program is one of the most progressive in the MENA region and the government is making all-out efforts to secure investments and reliable technology partners for continuing and forthcoming projects. It is anticipated that the country will emerge as a major player in international renewable energy arena in the coming years. Moreover, it is interesting to note, however, that Yemen and the Gulf countries namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia as well as United Arab Emirates (UAE) have committed more recently[25] to developing renewable energy sector. This can be explained by the fact that those states are worried about the rapid growth in domestic fossil fuel consumption for electricity, water desalination, and transport, which are experiencing rapid increases in demand, driven especially by

[23] United Nations Environment Programme.
[24] http://www.ecomena.org/renewables-algeria/.
[25] The majority of projects are significantly started operation in 2012, which explain the absence of renewable energy annual percentage growth rates during 1980-2012(REN21, 2013).

urbanization, as well as population growth and recognize that this increased consumption means a loss of export revenues.

In addition, those countries suffer from barriers that negatively affect the development of the renewable energy sector such as the unskilled employment, financial uncertainty, policy risk, political instability as well as the lack of comprehensive renewable energy policy frameworks and incentive schemes. Practically, interest in renewable energy in the Gulf countries has been stimulated by the development of several important regional and regionally based institutions. These include: the International Renewable Energy Agency (IRENA), a 160-member country intergovernmental organization headquartered in Abu Dhabi; the Masdar initiative in Abu Dhabi; the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) in Saudi Arabia; and the Qatar Foundation as well as Qatar National Food Security Programme (QNFSP), which have programs on renewable energy (Rabia F. et al, 2013).

Table 2 reports real GDP percentage annual growth rates in MENA Net Oil Exporting Countries. Qatar is the leader in the MENA exporting region with the highest average annual growth rate over the sample period (6.01%), followed by Bahrain and United Arab Emirates (UAE) with 5.12% and 4.71%, respectively**.** Indeed, in terms of GDP growth those countries achieve relatively better than the whole MENA region. In fact, Qatar is currently one of the wealthiest countries in the world, which enjoys a high standard of living.

Additionally, for Qatar, it was noted that as the world’s largest Liquefied natural gas (LNG) exporter and possessing the third largest natural gas reserves. Qatar had capitalized on its hydrocarbon wealth and was investing in down-stream industries for diversification (The World Trade Organization (WTO), 2014).

Looney (2009) exposed that good performance in terms of growth in Bahrain is principally explained by good management of oil incomes, social cohesion, equitable distribution of oil resources, as well as political stability. Besides, Nyarko (2010) explained that the UAE succeeded to modernize its economy through an open importation of foreign skills and management and by converting its oil resources into sovereign wealth funds invested outside of the country. Because of their excellent communication, transport infrastructure, governance effectiveness, social policies as well as their economic freedom[26], Qatar, Bahrain, and the UAE become attractive for many prestigious international companies operating in the region and in the world.

Table 1: renewable energy growth rates in percent in MENA Net Oil Exporting Countries.

Country	**Algeria**	**Bahrain**	**Egypt, Arab Rep.**	**Iran, Islamic Re**	**Iraq**	**United Arab Emir**
Mean	6.5019	0.0625	6.5653	1.6017	1.62789	-1.3157
Max	192.1162	0.25	58.7114	20.6779	51.3778	1.0526
Min	-23.3585	0	-71.3237	-14.9045	-34.9599	-5
Std. Dev.	37.1939	0.125	26.7511	7.6701	16.5577	3.2337
Skewness	4.0859	1.1547	-0.3472	0.4260	0.8038	-0.6237
Kurtosis	20.84134	2.3333	3.7885	3.8014	5.0765	1.5
Median	0.1293	0	2.24401	1.6023	0,9917	0

Country	**Libya**	**Oman**	**Syrian Arab Repu**	**Saudi Arabia**	**Qatar**	**Kuwait**	**Yemen, Rep.**
Mean	-	-	2.1001	-	-	-	-
Max	-	-	51.3778	-	-	-	-
Min	-	-	-34.9599	-	-	-	-
Std.Dev.	-	-	16.6415	-	-	-	-
Skewness	-	-	0.7119	-	-	-	-
Kurtosis	-	-	4.8917	-	-	-	-
Median	-	-	0.2556	-	-	-	-

Source: Author's calculation using the U.S. EIA and The World Bank Development Indicators on line data base during 1980-2012.

[26] According to the Economic Freedom Foundation 2014, the three countries are considered as the mostly open and free in MENA region. Qatar, Bahrain, and the UAE are ranked 30, 13 and 28, respectively.

Table 2: GDP growth rates in percent in MENA Net Oil Exporting Countries.							
Country	**Algeria**	**Bahrain**	**Egypt, Arab Rep.**	**Iran, Islamic Re**	**Syrian Arab Repu**	**Kuwait**	
Mean	2.2843	5.1223	2.9860	3.8328	3.1902	3.3672	
Max	6.9000	20.8431	18.3279	13.6877	13.4703	30.1748	
Min	-2.1000	-6.8744	-14.9581	-9.1707	-18.7564	-21.4949	
Std. Dev.	2.2871	7.1378	6.1110	5.4400	6.1608	10.9622	
Skewness	-0.0681	0.7578	-0.3161	-0.2394	-1.5438	-0.0501	
Kurtosis	2.1508	2.7030	4.5670	2.9806	6.6252	3.1129	
Median	2.4	3.4522	3.3197	3.9603	5.0894	3.9241	
Country	**Libya**	**Oman**	**Qatar**	**Saudi Arabia**	**Iraq**	**United Arab Emir**	**Yemen, Rep.**
Mean	1.6787	2.5814	6.0114	4.702445	4.4027	4.7126	4.4712
Max	104.5	9.1037	17.0470	9.907171	49.6386	12.8700	14.6244
Min	-62.1	-11.0981	-3.4407	1.078838	-41.3	-4.7582	-10.4796
Std. Dev.	22.7383	5.0256	5.2546	1.905099	21.8225	3.5713	3.6015
Skewness	2.1927	-0.8083	0.6703	0.3827801	0.1312	-0.1463	-1.5870
Kurtosis	15.5227	3.2942	2.7678	3.21574	3.4401	3.6574	12.1381
Median	0.6	3.1091	5.4506	4.664294	1.3775	4.6950	4.1281

Source: Author's calculation using the World Bank Development Indicators on line data base and the Penn World Table (PWT8.0) during 1980-2012.

Following previous studies in this area, this investigation also use the production model of Chang and Lee (2008)[27] and we consider the simultaneous use of renewable and non renewable energy consumption[28] so as to differentiate the relative impact of

[27]A production function in economic theory shows the relationship between inputs of capital (K) and labor (L) and other technological factors (A) and the outputs of goods and services (Y). This relationship is extensively presented by the Cobb-Douglas functional form of production function, which is proposed by Cobb and Douglas (1928). Due to the biophysical approaches, including system models that give much attention to direct and indirect energy use (Giampietro et al., 2011),several economists revised the traditional growth model based exclusively on two factors of production (capital and labor) and integrated energy as an essential factor of production. Consequently, it can be directly utilized as an input (Stern 1993, 2000, 2011; Pokrovski, 2003; Ghali and El-Sakha, 2004; Thompson, 2006; Chang and Lee, 2008; Ayres et al., 2013; Shahbaz et al., 2012). Chang and Lee (2008) and Beaudreau (2005) confirm that the exclusion of the energy consumption of the production function is an unreasonable act. Additionally, Pokrovski (2003) and Shahbaz et al. (2012) supported that the production of output is determined by productive energy service, capital stock and labor. Recently, some studies have separated the energy input into renewable and non renewable energy input in an attempt to distinguish the relative impact of each input in the economic growth process and have extended The Chang and Lee(2008)production model(see Eq.(1); Payne, 2009; Apergis et al., 2010; Bowden and Payne, 2010; Apergis and Payne, 2011a, b, 2012).

[28] Apergis and Payne (2012) tested the adequacy of the inclusion of both renewable and non renewable energy consumption in the model relative to a model without nonrenewable energy

each input in the economic growth process. The production modeling framework is given as follows in general notation:

$$Y_{it} = f\left(REC_{it}, NREC_{it}, K_{it}, LF_{it}\right) \qquad (1)$$

Where Y_{it} denotes real GDP in millions of constant 2005 U.S. dollars; REC_{it} is total renewable electricity consumption defined in million of kilowatt hours as net geothermal, solar, wind and biomass energy[29]; $NREC_{it}$ is total non-renewable electricity consumption related to coal, natural gas, and petroleum and defined in million of kilowatt hours[30]. K_{it} represents real gross fixed capital formation in millions of constant 2005 U.S. dollars[31]; and LF_{it} is total labor force in millions. These variables are converted into natural logarithms as to remove heteroskedasticity from the regression model.

To get robust results, it is therefore necessary to develop a number of preliminary statistical tests, which are exposed in Table-3 and Table-4, respectively. Indeed, we implement the following panel data unit root tests called the first generation unit root test such as Breitung(2000); Hadri (2000); Im, Pesaran and Shin(2003); Levin, Lin and Chu(2002) and Maddala and Wu (1999), who employ nonparametric methods in conducting panel unit root tests using the Fisher-ADF and Fisher-PP tests, which has the advantage of allowing for as much heterogeneity across units as possible . In fact, in the first generation unit root test model assuming a homogeneous autoregressive

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consumption using both the J-test of Davidson and MacKinnon (1982) and the JA-test of Doran (1993). Their findings prove both tests favor the inclusion of both renewable and non-renewable energy consumption against the omission of non renewable energy consumption at the 1% significance level.

[29] Sadorsky (2009a,b) and Apergis and Payne (2010a,b, 2011a,b, 2012) utilize the same measure for renewable energy consumption.

[30] Apergis and Payne (2011b, 2012) and Tugcu et al. (2012) utilize the same measure for non renewable energy consumption.

[31] The use of real gross fixed capital formation follows Soytas and Sari (2007) and Apergis and Payne (2009 a,b, 2010a,b,c,d, 2011a,b, 2012) in that under the perpetual inventory method with a constant depreciation rate, the variance in capital is closely related to the change in investment.

root[32], Levin et al. (2002; LLC) developed a panel unit root test based on ADF test and assumed the homogeneity in the dynamics of the autoregressive coefficients for all panel units with cross-sectional independence. They considered the following regression equation:

$$\Delta X_{it} = \alpha_i + \rho_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-j} + \varepsilon_{it} \qquad (2)$$

Where Δ is the first difference operator, X_{it} is the dependent variable, ε_{it} is a white-noise disturbance with a variance of σ^2, with i=1,2,..., N and t=1, 2,…, T respectively index country and time and $\alpha_i, \rho_i, \delta_i$ and γ_{ij} are parameters to be estimated. Since the lag order k is unknown, LLC (2002) assumed:

$\begin{cases} H_0 : \rho_i = 0 \\ H_1 : \rho_i < 0 \end{cases}$; Where the alternative that X_{it} is stationary.

The test basis is the statistic $t_{\rho_i} = \hat{\rho}_i / \sigma(\hat{\rho}_i)$. Since $\hat{\rho}_i$ is the OLS estimate of ρ_i in Eq.(2) and $\sigma(\hat{\rho}_i)$ is its standard error. Additionally, Levin et al. (2002) revealed that the panel approach considerably raises power in finite samples when compared with the single equation ADF test. They also developed a panel-based version of Eq. (3), which limits $\hat{\rho}_i$ by keeping it identical across cross-countries as follows:

$$\Delta X_{it} = \alpha_i + \rho X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-j} + \xi_{it} \qquad (3)$$

At this stage, Levin et al. (2002) additionally supposed:

$$\begin{cases} H_0 : \rho_1 = \rho_2 = ... = \rho = 0 \\ H_1 : \rho_1 = \rho_2 = ... = \rho < 0 \end{cases}$$

[32] The econometric literature has largely shown the importance of unit root tests, which are currently common practice among applied researchers and have become a fundamental part of econometric courses. Their applications in panel offer a significant way to improve the power of tests which is generally very low when they are applied to individual time series. A first generation of panel unit root test has thus emerged in the mid-1990s. Part of these proposed methodologies considers a homogeneous autoregressive root such as the test of Levin, Lin and Chu (2002; LLC), Breitung (2000) and Hadri (2000).

Where the test statistic is defined as $t_\rho = \hat{\rho}/\sigma(\hat{\rho})$. Since $\hat{\rho}$ is the OLS estimate of ρ in Eq. (3) and $\sigma(\hat{\rho})$ is its standard error.

Breitung (2000) studies the local power of LLC and IPS test statistics against a sequence of local alternatives. Breitung points out that the LLC and IPS tests suffer from a remarkable loss of power if individual-specific trends are incorporated. This is attributable to the bias correction that also removes the mean under the sequence of local alternative. Thus, Breitung (2000) proposes a test statistic that does not employ a bias adjustment whose power is substantially higher than that of LLC and IPS test using Monte Carlo experiments[33]. The simulation results indicate that the power of LLC and IPS test is very sensitive to the specification of the deterministic terms and those tests have size distortions as N gets large relative to T[34]. Breitung (2000) developed the following regression:

$$Y_{it} = \alpha_{it} + \sum_{j=1}^{k+1} \theta_{ij} \Delta X_{i,t-j} + \varphi_{it} \qquad (5)$$

Where Δ is the first difference operator, Y_{it} is the dependent variable, X_{it} is the independent variable, φ_{it} is a white-noise disturbance with a variance of σ^2, i=1,2,..., N specifies country, and t=1,2,..., T specifies time. In Eq. (5), the test statistic of Breitung (2000) supposes the following hypothesis: the null hypothesis is specified by $H_0 : \sum_{j=1}^{k+1} \theta_{ij} - 1 = 0$, while the alternative hypothesis is specified by $H_1 : \sum_{j=1}^{k+1} \theta_{ij} - 1 < 0$ for all i and supposes that Y_{it} is stationary.

[33] Hlouskova and Wagner (2006) find evidence that the Breitung (2000) panel unit root test has the highest power and smallest size distortion.
[34] Baltagi(2005), p.243.

Precisely, Breitung (2000) employs the transformed vectors $Y_i^* = AY_i = \left[Y_{i1}^*, Y_{i2}^*, ..., Y_{iT}^*\right]'$ and $X_i^* = AX_i = \left[X_{i1}^*, X_{i2}^*, ..., X_{iT}^*\right]'$ so as to make the following test statistic: $\psi_B = \sum_{i=1}^{N}\left(1/\sigma_i^2\right)Y_i^{*\prime}X_i^{*\prime} \Big/ \sqrt{\sum_{i=1}^{N}\left(1/\sigma_i^2\right)X_i^{*\prime}A'AX_i^*}$ (7)

Hadri (2000) develops a residual-based Lagrange multiplier (LM) test where the null hypothesis is that there is no unit root in any of the series in the panel against the alternative of a unit root in the panel. Particularly, Hadri (2000) considers the two models as follows:

$$Y_{it} = \theta_{it} + \varepsilon_{it} \qquad i = 1,...,N \qquad t = 1,...,T \tag{8}$$

$$Y_{it} = \theta_{it} + \delta_i t + \varepsilon_{it} \qquad i = 1,...,N \qquad t = 1,...,T \tag{9}$$

Where $\theta_{it} = \theta_{i,t-1} + \xi_{it}$ is a random walk. $\varepsilon_{it} \sim IIN\left(0, \sigma_\varepsilon^2\right)$ and $\xi_{it} \sim IIN\left(0, \sigma_\xi^2\right)$ are jointly independent normals that IID[35] across *i* and over *t* and δ_i is a deterministic trend. Using back substitution, Eq. (9) becomes as follows:

$$Y_{it} = \theta_{i0} + \delta_i t + \sum_{s=1}^{t}\xi_{is} + \varepsilon_{it} = \theta_{i0} + \delta_i t + \zeta_{it} \quad i = 1,...,N \qquad t = 1,...,T \tag{10}$$

Where $\zeta_{it} = \sum_{s=1}^{t}\xi_{is} + \varepsilon_{it}$, the stationary hypothesis is defined as $H_0 : \sigma_\xi^2 = 0$, wherein case $\zeta_{it} = \varepsilon_{it}$ .The LM statistic is defined by:

$$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N}\frac{1}{T^2}\sum_{t=1}^{T}S_{it}^2\right)\Big/\hat{\sigma}_\varepsilon^2 \tag{11}$$

Where $S_{it} = \sum_{s=1}^{t}\hat{\varepsilon}_{is}$ are partial sum of OLS residuals $\hat{\varepsilon}_{is}$ from Eq. (10) and $\hat{\sigma}_\varepsilon^2$ is a consistent estimate of σ_ε^2 under the null hypothesis H_0. A potential candidate is $\hat{\sigma}_\varepsilon^2 = \left(1/NT\right)\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\varepsilon}_{it}^2$. Moreover, Hadri (2000) assumed an alternative LM test that allows for Heteroskedasticity across *i*, defined as $\sigma_{\varepsilon i}^2$ .This is in actual fact

[35] Independently and identically distributed

$$LM_2 = 1/N \left(\sum_{i=1}^{N}\left(1/T^2\sum_{i=1}^{T} S_{it}^2/\hat{\sigma}_{\varepsilon i}^2\right)\right) \tag{12}$$

Precisely, the test statistic is specified by $Z = \sqrt{N}\,(LM - \rho)/\phi$ and is asymptotically distributed as N (0, 1), where $\rho = (1/6)$ and $\phi = (1/45)$ if the model only include a constant, and $\rho = (1/15)$ and $\phi = (11/6300)$, otherwise.

However, Hurlin and Mignon (2005) pointed out that the concept of heterogeneity is an extremely important problem in econometrics. Consequently, we cannot admit the existence of dynamic properties for all series of the same variable, independently of the country concerned. In economics, this evidently represents a too restrictive assumption, which can lead to spurious results. Thus, the first generation of tests was quickly dealt with the possibility of extending the heterogeneity to the autoregressive root[36]. The Im et al. (2003; IPS) test is based on the conventional ADF test for the following regression:

$$\Delta Y_{it} = \alpha_i + \lambda_i Y_{i,t-1} + \eta_i t + \sum_{j=1}^{k} \mu_{ij} \Delta Y_{i,t-j} + \varepsilon_{it} \tag{13}$$

Where Δ is the first difference operator, Y_{it} is the dependent variable, ε_{it} is a white-noise disturbance with a variance of σ^2, with i=1,…,N and t=1, 2,…, T respectively index country and time and $\alpha_i, \lambda_i, \eta_i$ and μ_{ij} are parameters to be estimated. Since the lag order k is unknown. The IPS (2003) test considers the null hypothesis $H_0 : \lambda_i = 0$ against the alternative $H_1 : \lambda_i < 0$ for each individual i. The test is based on the test statistic $t_{\lambda_i} = \hat{\lambda}_i / \sigma(\hat{\lambda}_i)$. Since $\hat{\lambda}$ is the OLS estimate of λ in Eq. (13) and $\sigma(\hat{\lambda})$ is its standard error. The $\overline{T}$ test, which was developed by Im et al. (2003), supposes that all

[36] The first unit root tests in heterogeneous panels were then proposed by Im, Pesaran and Shin (2003; IPS) and Maddala and Wu (1999).

countries converge towards the equilibrium value at different speeds under the alternative hypothesis. There are two steps in making the $\overline{T}$ test statistic.

The first one is to compute the average of the individual ADF t_{λ_i} statistics of Eq. (13) for each of the countries in the sample. The second step is to perform the following standardized $\overline{T}$ statistic: $\overline{T} = \sqrt{N}\left[\bar{z} - E\left(\bar{z}\right)\right] / \sqrt{V\left(\bar{z}\right)}$ (14)

Where N represents the panel, $\bar{z} = \left(1/N\right)\sum_{i=1}^{N} t_{\lambda_i}$ is the average of the individual ADF t_{λ_i} statistics for each of the countries, with and without a trend. Additionally, $E\left(\bar{z}\right)$ and $V\left(\bar{z}\right)$ denote, respectively, the mean and the variance of each t_{λ_i} statistic. Im et al. (2003) generated Monte Carlo simulations of $E\left(\bar{z}\right)$ and $V\left(\bar{z}\right)$ and tabulated exact critical values for different combinations of N and T. A probable difficulty with the $\overline{T}$ test is that in the existence of cross-sectional dependence in the disturbances, the test is no longer applicable. However Im et al. (2003) recommended that in the presence of cross-sectional dependence, the data is able to be adjusted by demeaning and that the standardized demeaned $\overline{T}$ statistic converges to the standard normal in the limit. Maddala and Wu (1999) disapproved of the Im et al. (2003; IPS) test on the basis that in many real world applications, cross correlations are doubtful to utilize the simple form developed by Im et al. (2003) that can be effectively eliminated by demeaning the data. Additionally, Maddala and Wu (1999) proposed a panel ADF unit root test based on Fisher (1932). The Fisher ADF test basically combines the p-values of the test statistic for a unit root in each residual cross-sectional unit. The test is non-parametric and has a chi square distribution with 2N degrees of freedom, where N is the number of cross sectional units or countries. Using the additive property of the chi-squared variable, the test statistic can be defined as follows:

$$\eta = -2\sum_{i=1}^{N} \log_e \pi_i \quad (15)$$

Since π_i is the p-value of the test statistic for unit *i*. The Maddala and Wu (1999) test has the advantage over the Im et al. (2003) test that it does not rely on different lag lengths in the individual ADF regressions. Maddala and Wu (1999) computed Monte Carlo simulations proving that their test is better to that supposed by Im et al. (2003).

Note that we do not only apply the popular first generation panel unit root tests mentioned above, but also we recently introduced the second generation panel unit root tests: the CIPS (cross-sectionally augmented IPS) panel unit root tests by Pesaran (2007), which account for possible cross-sectional dependencies among the units included in the panel (Table 4). The difference between first and second generation tests is that the latter (Pesaran (2007)) take into account cross-sectional dependencies, whereas the former do not.

In fact, Pesaran (2007) considers the following simple dynamic linear heterogeneous model: $\Delta Y_{it} = \alpha_i + (1-\theta_i) Y_{i,t-1} + \lambda_i f_t + \varepsilon_{it}$ (16)

Where Δ is the first difference operator, Y_{it} is the dependent variable, *i*=1,…,N and *t*=1,…,T. Assuming serially uncorrelated disturbances, ε_{it} are supposed to be independently distributed both across i and t, have zero mean, variance σ_i^2, and finite forth-order moment. Additionally, the common factor f_t is serially uncorrelated with mean zero and constant variance σ_f^2, as well as finite forth-order moment. Generally, σ_f^2 is set equal to one. ε_{it}, f_t and λ_i are assumed to be mutually independent for all *i* and *t*. Considerably, the Pesaran (2007) unit root hypothesis as follow $H_0: \theta_i = 1$ for i = N_1 + 1,…, N against the probably heterogeneous alternative $H_1: \theta_i < 1$ for i = 1,…,N_1. Pesaran (2007) supposes that (N_1/N), the fraction of the individual processes that is stationary, is non-zero and tends to some fixed value *k* such that

$0 < k \leq 1$ as $N \to \infty$. In support of the unit root null hypothesis assumed by Pesaran (2007), he recommends a test based on the t-ratio of the OLS estimate $\hat{\beta}_i$ in the cross-sectionally augmented DF (CADF) equation as follows:

$$\Delta Y_{it} = \pi_i + \beta_i Y_{i,t-1} + \omega_i \overline{Y}_{t-1} + \varphi_i \Delta\overline{Y}_t + \xi_{it} \qquad (17)$$

Where $\overline{Y}_t = (1/N)\sum_{i=1}^{N} Y_{it}$, $\Delta\overline{Y}_t = (1/N)\sum_{i=1}^{N} \Delta Y_{it}$ and ξ_{it} is the regression error.

Besides, the cross-sectional averages, $\overline{Y}_{t-1}$ and $\Delta\overline{Y}_t$, are incorporated into Eq. (17) as a proxy for the unobserved common factor f_t. Subsequently, to facilitate analysis as deriving the asymptotic properties, Pesaran (2007) substitutes the usual estimator for σ_i^2 in the t-value for β_i by a faintly modified and also consistent one. He obtains the asymptotic distribution of the modified t-statistic and proves that it is free of nuisance parameters as $N \to \infty$ for any fixed T > 3, and for the case where $N \to \infty$ followed by $T \to \infty$. Corresponding to Im, Pesaran and Shin (2003), Pesaran (2007) proposes a cross sectional augmented version of the IPS-test as follows:

$$CIPS = (1/N)\sum_{i=1}^{N} CADF_i \qquad (18)$$

Where $CADF_i$ represents the cross-sectionally augmented Dickey-Fuller statistic for the i-th cross-sectional unit given by the t-ratio of β_i in the CADF Eq. (17). Because of the common factor presence, the $CADF_i$ statistics will not be cross-sectionally independent[37]. Accordingly, a central limit theorem cannot be performed to derive the limiting distribution of the CIPS statistic, and it is revealed to be non-standard even for large N. In addition, to guarantee the existence of moments for the distribution of $CADF_i$ in finite samples, Pesaran (2007) used a condensed version of the CIPS test, where for positive constants $\boldsymbol{K_1}$ and $\boldsymbol{K_2}$ such that

[37] Since the null hypothesis of a unit root, $CADF_i$ converges to a functional of Brownian movements, called $\boldsymbol{G(W_f\,;W_i)}$, where $\boldsymbol{W_f}$ and $\boldsymbol{W_i}$ are Brownian motions driven by the common factor and idiosyncratic error, correspondingly.

$\Pr\left[-k_1 < CADF_i < k_2\right]$ is satisfactorily large, values of $CADF_i$ smaller than $-K_1$ or larger than K_2 are substituted by the respective bounds. Lastly, Pesaran (2007) presents values for K1 and K2 got by simulations. A common characteristic of the panel tests mentioned above is that they maintained the null hypothesis of a unit root in all panel members (the only exception is the test by Hadri (2000), whose null hypothesis is stationarity for all panel units). Results from the panel unit root tests, as shown in **Table 3** and **Table 4**, conclude that each variable is integrated of order one.

Table 3: Unit root tests in panel of MENA Net Oil-Exporting Countries.

Variables	Levin, Lin & Chu		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Y	-1.16238	0.1225	-1.4157	0.0784	11.1101	0.9952	20.2772	0.7782
ΔY	-3.79199	0.000**	-5.5391	0.000**	81.4906	0.000**	172.373	0.000**
REC	-0.49438	0.3105	0.0790	0.5315	16.8288	0.2654	9.2521	0.8146
ΔREC	-8.43008	0.000**	-6.6969	0.000**	66.2663	0.000**	161.63	0.000**
NREC	12.5241	1.0000	-1.9075	0.9718	0.06289	1.0000	0.0342	1.0000
ΔNREC	-4.60660	0.000**	-6.3471	0.000**	96.2247	0.000**	340.494	0.000**
K	1.77226	0.9618	2.9678	0.9985	23.2864	0.6167	11.142	0.9951
ΔK	-4.72660	0.000**	-4.4807	0.000**	64.869	0.000**	92.0612	0.000**
LF	-1.10455	0.1347	2.1990	0.9861	21.7107	0.7044	38.3242	0.0565
ΔLF	-4.10847	0.000**	-6.9537	0.000**	316.191	0.000**	389.109	0.000**

Variables	Breitung t-stat		Hadri unit root test			
			Hadri Z-stat		Heteroscedastic Consistent Z-stat	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Y	2.09693	0.9820	6.23973	0.000**	6.54455	0.000**
ΔY	-7.12297	0.000**	-0.87948	0.8104	1.50140	0.2549
REC	0.18211	0.5723	5.38119	0.000**	4.37753	0.000**
ΔREC	-5.46189	0.000**	1.45912	0.0723	1.81100	0,3062
NREC	0.96889	0.8337	6.43587	0.000**	4.38541	0.000**
ΔNREC	-3.47415	0.000**	1.33670	0.0907	1.00574	0,1700
K	-0.15994	0.4365	7.73573	0.000**	7.38274	0.000**
ΔK	-2.15356	0.015**	1.40533	0.0800	1.88565	0,3188
LF	-0.45014	0.3263	4.02797	0.000**	5.41329	0.000**
ΔLF	-4.84643	0.000**	-1.39863	0.9190	1.7325	0.2215

Note: Δ = First difference operator. Panel unit root tests include intercept and trend exceptionally Hadri unit root test, which includes intercept only. **denote significance at 5% level.

Variables	Table 4: Pesaran's CADF test					
	t-bar	**cv10**	**cv5**	**cv1**	**Z[t-bar]**	**P-value**
Y	-2.061	-2.660	-2.760	-2.930	1.143	0.873
ΔY	-2,7281	-2.660	-2.760	-2.930	-3.099	0.000**
REC	-1.188	-2.660	-2.760	-2.930	4.720	1.000
ΔREC	-3,6591	-2.660	-2.760	-2.930	-4.171	0.000**
NREC	-2.564	-2.660	-2.760	-2.930	-0.919	0.179
ΔNREC	-2.779	-2.660	-2.760	-2.930	-1.797	0.036**
K	-2.627	-2.660	-2.760	-2.930	-1.177	0.120
ΔK	-1,9121	-2.660	-2.760	-2.930	-2.188	0.000**
LF	-2.441	-2.660	-2.760	-2.930	-0.413	0.340
ΔLF	-3.252	-2.660	-2.760	-2.930	-3.737	0.000**

Note: Δ = First difference operator. Deterministic chosen: constant & trend. **denote significance at 5% level.

Since the unit root test results showed that the considered variables are integrated of order one, the next step is to test panel cointegration among the variables. The concept of co-integration can be defined as a systematic co-movement among two or more variables over the long run (Yoo and Kwak, 2010). The cointegration theory allows the study of non-stationary series but whose linear combination is stationary. It used to specify stable long-term relationships by jointly analyzing the short-run dynamics of the considered variables (Doucouré, 2008). Several tests are based on group-mean estimates, others on pooled estimates. Some take into account cross-sectional dependencies, whereas others do not. We will compute three representative panel cointegration tests: the very popular Pedroni (1999, 2004) and Kao (1999) tests for panel cointegration and the recently introduced test by Westerlund (2007)[38]. The panel cointegration tests results of Pedroni (1999, 2004); Kao (1999) and Westerlund (2007) are presented in **Table 5**, **Table 6** as well as **Table 7**, respectively. Totally, Pedroni (1999, 2004) performed a number of statistics based on the residuals of the Engle and Granger (1987) cointegration regression. Considering a panel containing N countries, T observations and *m* regressors (X_m), Pedroni (1999, 2004) developed the specification as follows:

[38] A comprehensive survey on panel cointegration tests is exposed by Breitung et al (2005).

$$Y_{it} = \phi_i + \theta_i t + \sum_{j=1}^{m} \alpha_{j,i} X_{j,it} + \varsigma_{it} \quad (19)$$

Where Y_{it} and $X_{j,it}$ are specifically integrated of order one in levels (***I(1)***).Additionally, Pedroni (1999, 2004) derived two sets of panel cointegration tests (Table 1). The first set, entitled panel cointegration tests, is based on the within dimension approach and contains four statistics: panel *v*-statistic ($\boldsymbol{Z_v}$), panel rho-statistic ($\boldsymbol{Z_\rho}$), panel PP- statistic ($\boldsymbol{Z_{pp}}$), and panel ADF-statistic ($\boldsymbol{Z_{ADF}}$). These statistics pool the autoregressive coefficients across different countries for the unit root tests on the estimated residuals taking into consideration common time factors and heterogeneity across countries. The second set, named group mean panel cointegration tests, is based on the between dimension approach and contains three statistics[39]: group rho-statistic ($\overline{Z}_{\rho}$), group PP-statistic ($\overline{Z}_{pp}$), and group ADF-statistic ($\overline{Z}_{ADF}$). Generally, these statistics are based on averages of the individual autoregressive coefficients linked to the residuals unit root tests for each country. Null hypothesis assumed that all seven tests specify the nonexistence of cointegration $H_0 : \beta_i = 0 \ ; \forall i$, while the alternative hypothesis is defined as $H_1 : \beta_i = \beta < 1 \ ; \forall i$ where β_i is the autoregressive term of the estimated residuals under the alternative hypothesis ($\boldsymbol{H_1}$) and it is specified by in the following equation: $\varsigma_{it} = \beta_i \hat{\varsigma}_{i,t-1} + \eta_{it} \quad (20)$. Pedroni (1999) suggests that all seven statistics have a standard asymptotic distribution that is founded on the independent movements in Brownian motions when T and $N \to \infty$.

$\left(Z - \omega\sqrt{N}\right) / \sqrt{\lambda} \xrightarrow[N,T \to \infty]{} N\left(0,1\right) \quad (20)$ Where Z is one of the seven normalized statistics, and ω and λ are tabulated in Pedroni (1999).

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[39] The between dimension tests are less restrictive in that they allow for heterogeneity of the parameters across countries (Sadorsky, 2009b).

Table 1: Pedroni (1999, 2004) panel cointegration tests

A. Within-dimension (four statistics)	***B. Between-dimension (three statistics)***
1.Panel *v*-statistic $Z_v = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varsigma}_{i,t-1}^{2}\right)^{-1}$	1.Group ρ-statistic $\tilde{Z}_\rho = \sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{\varsigma}_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}\left(\hat{\varsigma}_{i,t-1}\Delta\hat{\varsigma}_{i,t}-\hat{\mu}_i\right)$
2. Panel ρ-statistic $Z_\rho = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varsigma}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}\left(\hat{\varsigma}_{i,t-1}\Delta\hat{\varsigma}_{i,t}-\hat{\mu}_i\right)$	2. Group non-parametric(PP) t-statistic $\tilde{Z}_{pp} = \sum_{i=1}^{N}\left(\hat{\sigma}^2\sum_{t=1}^{T}\hat{\varsigma}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varsigma}_{i,t-1}\Delta\hat{\varsigma}_{i,t}-\hat{\mu}_i\right)$
3. Panel non-parametric(PP) t-statistic $Z_{pp} = \left(\tilde{\sigma}^2\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varsigma}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varsigma}_{i,t-1}\Delta\hat{\varsigma}_{i,t}-\hat{\mu}_i\right)$	3. Group parametric(ADF) t-statistic $\tilde{Z}_{ADF} = \sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{S}_i^{-2}\hat{\varsigma}_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\hat{\varsigma}_{i,t-1}^{*}\Delta\hat{\varsigma}_{i,t}^{*}$
4. Panel parametric(ADF) t-statistic $Z_{ADF} = \left(\hat{S}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varsigma}_{i,t-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varsigma}_{i,t-1}^{*}\Delta\hat{\varsigma}_{i,t}^{*}$	
With a. $\hat{\eta}_{it} = \hat{\varsigma}_{it} - \hat{\beta}_i\hat{\varsigma}_{i,t-1};\ \hat{\mu}_i = T^{-1}\sum_{s=1}^{K}\left[1-\left(s/K_i+1\right)\right]\sum_{t=s+1}^{T}\hat{\eta}_{it}\hat{\eta}_{i,t-1};$ b. $\hat{L}_{11i}^{-2} = T^{-1}\sum_{t=1}^{K}\hat{\gamma}_{it}^{2} + 2T^{-1}\sum_{s=1}^{K}\left[1-\left(s/K_i+1\right)\right]\sum_{t=s+1}^{T}\hat{\gamma}_{it}\hat{\gamma}_{i,t-s}$ where $\hat{\gamma}_{it} = \Delta Y_{it} - \sum_{m=1}^{M}\hat{b}_{m,i}\Delta X_{m,it};$ c. $\tilde{\sigma}^2 = (1/N)\sum_{i=1}^{N}\hat{L}_{11i}^{-2}\hat{\sigma}_i^2$ where $\hat{\sigma}_i^2 = \hat{S}_i^2 + 2\hat{\mu}_i;$ d. $\hat{S}_i^2 = (1/T)\sum_{t=1}^{T}\hat{\eta}_{it}^2;\ \hat{S}^{*2} = (1/T)\sum_{t=1}^{T}\hat{\eta}_{it}^{*2};\ \hat{\eta}_{it}^{*} = \hat{\varsigma}_{it} - \hat{\beta}_i\hat{\varsigma}_{i,t-1} - \sum_{k=1}^{K_i}\hat{\beta}_{ik}\Delta\hat{\varsigma}_{i,t-k}.$	

Source: Author's tabulation based on Farhani and Shahbaz (2014).

Besides, Kao (1999) proposes to estimate the homogeneous cointegration relationship through pooled regression allowing for individual fixed effects and he suggested testing the null hypothesis of no cointegration. In fact, Kao (1999) performed an Augmented Dickey-Fuller (ADF) panel cointegration test in which cointegrating vectors are assumed to be homogeneous. Let consider $\hat{\varepsilon}_{it}$ being the estimated residual from the following regression:

$$Y_{it} = \phi_i + \theta X_{it} + \varepsilon_{it}\ \forall t = 1,...,T;\ i=1,...,N. \quad (21)$$

Where ϕ_i and θ are parameters. The ADF test is obtained by the estimated residual:

$$\varepsilon_{it} = \lambda\varepsilon_{i,t-1} + \sum_{j=1}^{p}\rho_j \Delta\hat{\varepsilon}_{i,t-j} + v_{i,t,\mathrm{p}} \qquad (22)$$

Where λ is chosen so that the residual $v_{i,t,\mathrm{p}}$ are serially uncorrelated assuming the null hypothesis of no cointegration. The ADF statistic test can be constructed as:

$$ADF = \overline{T} + \left(\sqrt{6N}\,\hat{\sigma}_v / 2\hat{\sigma}_{0v}\right) \Big/ \sqrt{\left(\hat{\sigma}_{0v}^2 / 2\hat{\sigma}_v^2\right) + \left(3\hat{\sigma}_v^2 / 10\hat{\sigma}_{0v}^2\right)} \qquad (23)$$

Where $\overline{T}$ is the t-statistic of λ in Eq. (22); $\sigma_{0v}^2 = \Omega_u - \Omega_{u\varepsilon}\Omega_{\varepsilon}^{-1}$, Ω is the long run covariance matrix, which defined as $\Omega = \begin{pmatrix} \sigma_{0u}^2 & \sigma_{0uv} \\ \sigma_{0uv} & \sigma_{0v}^2 \end{pmatrix}$ and $\hat{\sigma}_v^2 = \sum_{u\varepsilon} - \sum_{u\varepsilon}\sum_{\varepsilon}^{-1}$. Kao proves that the ADF test converges to a standard normal distribution N (0, 1).

In order to ensure the robustness of our results and to confirm the existence of a cointegration relationship over the period 1980-2012, we computed the recent bootstrap panel cointegration test proposed by Westerlund (2007)[40]. Indeed, Westerlund (2007) developed four new panel cointegration tests (**G_t, G_a, P_t, P_a**) that are based on structural rather than residual dynamics and, therefore, do not impose any common-factor restriction. The idea is to test the null hypothesis of no cointegration by supposing whether the error-correction term in a conditional panel error-correction model is equal to zero. The new tests are all normally distributed and are general enough to accommodate unit-specific short-run dynamics, unit-specific trend and slope parameters, and cross-sectional dependence as well as offer p-values that are robust against cross-sectional dependencies passing through bootstrapping. Two tests are designed to test the alternative hypothesis that the panel is cointegrated as a whole (**G_t, Ga**), while the other two test (**P_t, P_a**) the alternative that at least one

[40] In favor of a description of the respective STATA procedure see Persyn and Westerlund (2008).

unit is cointegrated[41]. Indeed, The Westerlund (2007) error-correction tests consider the following equation:

$$\Delta Y_{it} = \theta_i d_t + \alpha_i Y_{i,t-1} + \lambda_i X_{i,t-1} + \sum_{j=1}^{p_i} \alpha_{ij} \Delta Y_{i,t-j} + \sum_{j=-q_i}^{p_i} \beta_{ij} \Delta X_{i,t-j} + \xi_{it} \quad (24)$$

Where *t*=1,…,T and *i*=1,…,N indicate the time-series and cross-sectional units, correspondingly, while d_t represents the deterministic components, for which there are three cases(see Table 1). α_i determines the speed at which the system corrects back to the equilibrium after an unexpected shock. Additionally, the K-dimensional vector X_{it} is modeled as a pure random walk such that ΔX_{it} is independent of ξ_{it} , ξ_{it} is the error term that is independent across both *i* and *t*. All dependence through *i* is carried by using bootstrap methods. The null hypothesis of no cointegration is $H_0 : \alpha_i = 0$ for all *i*. The alternative hypothesis H_1, which implies that Y_{it} and X_{it} are cointegrated (there is error correction), relies on what is taken on the homogeneity of α_i . Precisely, two of the tests, which entitled group-mean tests (**G_t, G_a**), test $H_0 : \alpha_i = 0$ versus $H_1^g : \alpha_i < 0$ for at least one *i*. Additionally, the second pair of tests, which called panel tests (**P_t, P_a**), design to test $H_0 : \alpha_i = 0$ versus $H_1^p : \alpha_i = \alpha < 0$ for all *i* (see Table 2).

Table 1: The deterministic components cases

The assumption cases	Meanings
1. $d_t = 0$	Eq.(24) has no deterministic terms
2. $d_t = 1$	ΔY_{it} is performed with a constant
3. $d_t = (1,t)'$	ΔY_{it} is performed with a constant and a trend

Source: Author's tabulation based on Persyn and Westerlund (2008).

[41] Persyn and Westerlund (2008)

Table 2: The Westerlund (2007) error-correction tests

The group-mean tests	*The panel tests*
1. $G_t = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$ 2. $G_a = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}$ • Where : * $\hat{\alpha}_i(1) = \hat{\omega}_{ui}/\hat{\omega}_{yi}$; $\hat{\omega}_{ui}$ and $\hat{\omega}_{yi}$ are the usual Newey and West (1994) long-run variance estimators based on $\hat{u}_{it}$ and Δy_{it} ,respectively; * $\hat{u}_{it} = \sum_{j=-q_i}^{p_i}\hat{\beta}_{ij}\Delta X_{i,t-j} + \hat{\xi}_{it}$; * $SE(\hat{\alpha}_i)$ is the conventional standard error of $\hat{\alpha}_i$.	1. $P_t = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$ 2. $P_t = T\hat{\alpha}$ • Where : * $\hat{\alpha} = \left(\sum_{i=1}^{N}\sum_{t=2}^{T}\tilde{Y}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=2}^{T}\frac{1}{\hat{\alpha}_i(1)}\tilde{Y}_{i,t-1}\Delta\tilde{Y}_{it}$; * $SE(\hat{\alpha}) = \left(\left(\hat{S}_N^2\right)^{-1}\sum_{i=1}^{N}\sum_{t=2}^{T}\tilde{Y}_{i,t-1}^{2}\right)^{-1/2}$; * $\hat{\alpha}_i(1) = \hat{\omega}_{ui}/\hat{\omega}_{yi}$; * $\hat{S}_N^2 = 1/N\sum_{i=1}^{N}\hat{\sigma}_i/\hat{\alpha}_i(1)$; * $\hat{\sigma}_i$ is the estimated regression standard error of $\hat{\xi}_{it}$.

Source: Author's tabulation based on Persyn and Westerlund (2008).

Kao (1999)'s residual cointegration tests, all seven panel cointegration tests of Pedroni (1999, 2004) as well as the Westerlund (2007) tests based on the bootstrapped p-values reject the null hypothesis of no cointegration at the 5% significance level. The results present even stronger proof of cointegration. Thus, the results indicate that there is a long-run equilibrium relationship between real GDP, renewable energy consumption, non renewable energy consumption, real gross fixed capital formation, as well as the labor force.

Table 5 : Pedroni (1999, 2004) Cointegration tests for MENA Net Oil-Exporting Countries:

	Within-Dimension				**Between-Dimension**		
	Statistic	**Prob.**	**Statistic**	**Prob.**		**Statistic**	**Prob.**
Panel v-Statistic	4.129857	0,0041**	2.971071	0,0354**			
Panel rho-Statistic	-3.12822	0.0009**	-1.95814	0.0251**	**Group rho-Statistic**	-1.70414	0.0442**
Panel PP-Statistic	-3.35519	0.0004**	-2.5899	0.0048**	**Group PP-Statistic**	-2.50292	0.0062**
Panel ADF-Statistic	-4.33870	0.0000**	-2.74330	0.0030**	**Group ADF-Statistic**	-2.65831	0.0039**

Note: Null hypothesis: No cointegration. Trend assumption: Deterministic intercept and trend. Lag selection: Automatic SIC with a max lag of 5. **Critical values at the 5% significance level.

Table 6 : kao (1999) Cointegration test for MENA Net Oil-Exporting Countries:		
	t-Statistic	Prob.
ADF	-5.1918	0.0000**
Residual variance	0.0095	
HAC variance	0.0089	

Note: Null hypothesis: No cointegration.
Trend assumption: No deterministic trend.
Automatic lag selection based on SIC with max lag of 6.
****Critical values at the 5% significance level.**

Table 7 : Westerlund(2007) ECM panel cointegration tests:				
Statistic	**Value**	**Z-value**	**P-value**	**Robust P-value**
Gt	-10.569	-2,8121	0.004**	0.029**
Ga	-54.343	-15.422	0.000**	0.000**
Pt	-12.522	-3.051	0.001**	0.032**
Pa	-47.749	-14.180	0.000**	0.000**

Note: Optimal lag and lead length determined by Akaike Information Criterion with maximum lag and lead length of 2. We allow for a constant and deterministic trend in the cointegration relationship. Number of bootstraps to obtain bootstrapped p-values which are robust against cross-sectional dependencies set to 400. Results for H0: no cointegration.
The Bartlett kernel window width set according to $4(T/100)^{2/9}$.
****Critical values at the 5% significance level.**

A variety of estimation methods for panel cointegration model have also been performed. Although the OLS estimator is super-convergent even under panel cointegration, it has a second order asymptotic bias and relies on nuisance parameters related to the existence of serial correlation in the data (Kao and Chiang, 2000; Pedroni, 2001,2000). So as to build valid t-statistics, numerous alternative estimation techniques such as Fully Modified OLS (FMOLS) estimator initially proposed by Phillips and Hansen (1990) and Dynamic OLS (DOLS) estimator of Saikkonen(1991) and Stock and Watson(1993) have been designed. In the case of panel data, Phillips and Moon (1999) proved that the OLS technique shows signs of small sample bias, while the FMOLS estimator emerges to outperform both estimators. Parallel results are found by Kao and Chiang (2000) for the DOLS technique. Generally, both OLS and FMOLS methods exhibit small sample bias and that DOLS estimator emerges to outperform both estimators. Additionally, Kao and Chiang (2000) proved that FMOLS and DOLS methods resulted in normally distributed estimators. Given the strong evidence of panel cointegration among variables, the fully modified OLS (FMOLS) technique[42] for heterogeneous cointegrated panels, which is used by Pedroni (2000) so as to solve the problem of endogeneity between regressors, is performed to estimate the parameters of the cointegrated relationship[43]. The FMOLS results for MENA Net Oil Exporting Countries are reported in **Table 8** below:

Table 8: Parameter estimation using FMOLS for MENA Net Oil Exporting Countries:		
Variables	**Coefficient**	**Prob.**
REC	0.058	[0.0000]**
NREC	0.772	[0.0023]**
K	0.548	[0.0135]**
LF	0.479	[0.0088]**
R^2 = 0.996; Adj. R^2 = 0.993; HE=2.56 [0.326]; RESET=0.74 [0.527]; DW= 2.081		

Note: Method: Fully-modified OLS (FMOLS). Panel method: Grouped estimation. Cointegrating regression contains constant and trend. HE is White's Heteroscedasticity test. REST is Ramsey's regression equation specification error test. DW is the Durbin-Watson test for serial correlation. ** denotes the significance at 5% level. Null hypothesis: Ho: model has no omitted variables and Ho: Homoscedasticity for Ramsey RESET test and White's Heteroscedasticity test, respectively. [.]: Probabilities.

All the coefficients are positive and statistically significant at the 5% significance level and note that all variables are expressed in natural logarithms; the coefficients can be interpreted as elasticity estimates. The results indicate that a 1% increase in renewable energy consumption increases real GDP by 0.058%; a 1% increase in non-renewable energy consumption increases real GDP by 0.772 %; a 1% increase in real gross fixed capital

[42] Intended for robustness check, we performed the grouped-mean estimator technique so as to accommodate potential presence of heterogeneity in the cointegrating relationships. Pedroni (2000, 2001) notes that in the presence of heterogeneity in the cointegrating relationships, the grouped-mean estimator offers the desirable property of providing consistent estimates of the sample mean of the cointegrating vectors, in contrast to the pooled and weighted estimators. The test statistics derived from the between-dimension "group-mean" estimators are built to test the null hypothesis $H_0 : \beta_i = \beta_0$ for all i against the alternative $H_1 : \beta_i \neq \beta_0$, with the intention that the values for β_i are not constrained to be identical under the alternative hypothesis.

[43] According to Banerjee (1999), the estimates from either FMOLS or DOLS are asymptotically equivalent for more than 60 observations .The panel data set of this study contains 429 observations.

formation increases real GDP by 0.548%; and a 1% increase in the labor force increases real GDP by 0.479 %.

Next, a panel vector error correction model is estimated to perform Granger-causality tests (Pesaran et al. 1999). The two-step procedure of Engle and Granger (1987) is performed by estimating the long run model specified in Eq. (25)[44] at first in order to obtain the estimated residuals. Then, the lagged residuals from Eq. (25) are used as the error correction terms for the dynamic error correction model as follows:

$$\Delta Y \; = (38)$$

Where the term Δ denotes the first differences; θ represents the fixed country effect; *k (k=1,…,q)* is the optimal lag length determined by the Schwarz Information Criterion[45] ; $\varepsilon_{i,t-1}$ is the estimated lagged error correction term which is derived from the long-run cointegration relationship of Eq. (25). The term λ is the adjustment coefficient and μ is the disturbance term assumed to be uncorrelated with zero means. Additionally, the short-run causality is determined by the statistical significance of the partial F-statistic associated with the corresponding variables in Eqs. (26a) - (26e). The long-run causality is determined by the statistical significance of the respective error correction terms using a t-test.

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[44] $Y_{it} = \alpha_i + \delta_i t + \psi_{1i} REC_{it} + \psi_{2i} NREC_{it} + \psi_{3i} K_{it} + \psi_{2i} LF_{it} + \varepsilon_{it} \quad (25)$, Where i=1...N for each country in the panel and t=1, ...,T refers to the time period. The parameters α_i and δ_i allow for the possibility of country-specific fixed effects and deterministic trends, respectively. ε_{it} are the estimated residuals representing deviations from the long run relationship. Given that all variables are expressed in natural logarithms, the ψ parameters of the model can be interpreted as elasticity estimates.

[45] The optimum lag length was set at 2 as determined by the Schwarz information criteria.

Table 9: Panel causality tests for MENA Net Oil Exporting Countries:						
Dependante Variable	***Source Of Causation*** **(Independent variables)** **Short-run**					**Long -run**
	ΔY	ΔREC	$\Delta NREC$	Δk	ΔLF	**ECT**
ΔY $(26a)$	-	0.328 [0.566] (0.035) [0.590]	4.894 [0.031]** (0.076) [0.025]**	12.437 [0.000]** (0.178) [0.001]**	7.841 [0.006]** (0.070) [0.040]**	- 0.245 [0.000]**
ΔREC $(26b)$	4.950 [0.026]** (0.175) [0.000]**	-	1.361 [0.244] (- 0,090) [0.725]	3.999 [0.046]** (0.134) [0.032]**	4.016 [0.043]** (0.120) [0.016]**	- 0.100 [0.006]**
$\Delta NREC$ $(26c)$	8.149 [0.004]** (0.449) [0.003]**	0.098 [0.753] (- 0,082) [0.796]	-	9.004 [0.002]** (0.159) [0.030]**	9.860 [0.001]** (0.117) [0.020]**	- 0.085 [0.000]**
Δk $(26d)$	5.124 [0.024]** (0.196) [0.000]**	0.464 [0.495] (0.007) [0.718]	7.312 [0.009]** (0.238) [0.000]**	-	4.128 [0.040]** (0.116) [0.000]**	- 0.082 [0.004]**
ΔLF $(26e)$	11.916 [0.000]** (0.021) [0.045]**	0.516 [0.596] (0.040) [0.671]	21.011 [0.000]** (0.1121) [0.002]**	6.471 [0.011]** (0.192) [0.021]**	-	- 0.273 [0.000]**

Note: Partial F-statistics reported with respect to short-run changes in the independent variables. The sum of the lagged coefficients for the respective short-run changes is also performed and is denoted in parentheses. ECT denotes the estimated coefficient on the error correction term. The vector error correction model is estimated using panel regression techniques with fixed effects for cross section and Heteroscedasticity robust standard errors. Probability values, which represented the probability values of the partial F-statistic and the Wald chi-square tests, are in brackets and reported underneath the corresponding partial F-statistic and sum of the lagged coefficients, respectively. ** denotes the significance at 5% level.

Table 9 reports the results from the panel error correction model in both the short-run and long-run. Consequently, Eq. (26a) confirms that non-renewable energy consumption, real gross fixed capital formation, and the labor force each have a positive and statistically significant impact on economic growth in the short-run whereas renewable energy consumption is statistically insignificant. Besides, Eq. (26b) shows that economic growth, real gross fixed capital formation and the labor force each have a positive and statistically significant impact on renewable energy consumption whereas non-renewable energy consumption yields a statistically insignificant impact. In terms of Eq. (26c), economic growth, real gross fixed capital formation and the labor force each have a positive and statistically significant impact on non-renewable energy consumption but renewable energy consumption is statistically insignificant. Eq. (26d) reveals that economic growth, non-renewable energy consumption, and the labor force each have a positive and statistically significant impact on real gross fixed capital formation in the short-run while renewable energy consumption has a statistically insignificant impact.

To end with Eq. (26e), which exposes that economic growth, non-renewable energy consumption, and real gross fixed capital formation each have a positive and statistically significant impact on the labor force while renewable energy consumption is statistically insignificant. As for the long-run dynamics, the respective error correction terms in Eqs. (26a) to (26e) are statistically significant telling that economic growth, renewable energy consumption, non-renewable energy consumption, real gross fixed capital formation, and the labor force each respond to deviations from long-run equilibrium. Indeed, the results show that there is unidirectional causality from economic growth to renewable energy consumption in the short-run whereas bidirectional causality in the long-run. Alternatively, the results indicate bidirectional causality in both the short-run and long-run between non-renewable energy consumption and economic growth. It is interesting to note that this unidirectional causality from economic growth to renewable energy consumption in the short-run can be explained by the fact that the MENA Net Oil Exporting Countries have committed more recently to developing renewable energy technologies, albeit for different reasons. In fact, there is growing recognition of the opportunity cost of oil and gas used for domestic purposes, mainly electricity production, desalination, as well as air conditioning, all of which are experiencing speedy increases in demand, driven by rising GDP, urbanization, and population growth in much of the exporting region. On the other hand, these exporting countries have facing several barriers and obstacles, which hold back the development of renewable energy sector. In reality, investors, researchers, and international organizations (for instance the IEA) mention the pervasiveness of energy subsidies for fossil fuels as one of the constraints to the development of renewable energy and energy efficiency measures in the MENA Net Oil Exporting Countries. Further, energy subsidies for fossil fuels remain a key challenge as they distort the energy markets by negatively affecting the price competitiveness of renewable energy sources. Reducing energy subsidies for fossil fuels is politically challenging and requires undertaking a pragmatic approach, which could include increasing spending on health, social welfare and education by creating more skilled employment and more business opportunities in order to avoid the lack of comprehensive renewable energy policy frameworks and incentive schemes. Additionally, political instability in some parts of the MENA exporting region, regulations and market-based policies, public awareness, political unrest, financial uncertainty, and policy risk continue to remain barriers to investment. Government of the MENA exporting countries should undertake different approaches to foster and stimulate domestic renewable energy industries by the development of several important regional and regionally based institutions, which serve like a dedicated framework to promote and strengthen regional partnerships on renewable energy development, foster the development of the most promising renewable energy technologies, discuss the national renewable energy programmes of the MENA Net Oil Exporting countries as well as identify barriers and obstacles that so far slow down the renewable energy development in these countries and search for potential solutions. Actually, Successful and effective or efficient policies depend on predictable, transparent, and stable framework conditions, as well as on good design, which help expand renewable energy markets, encourage investment, as well as stimulate renewable industry developments.

4. Concluding remarks and policy implications:

Similar to other countries, the MENA Oil Exporting Countries have to somehow react to the fundamental global energy and environmental challenges of our time, namely the massive increase in global energy demand and climate change to which the massive use of non-renewable energy is considerably contributing. In fact, due to the population growth, which cause a major energy demand growth in the MENA exporting countries, the energy transition towards a renewable energy supply has become indispensable to meet the rising energy needs and mitigate the risks of oil prices volatility as well as the trend to declining reserves of fossil fuels, which is appreciably affecting markets and reducing emissions of greenhouse gases. Renewable energy is, therefore, an alternative to fossil fuels. It can effectively facilitate meeting current and future energy needs so as to support sustainable economic growth and the fight against poverty. This investigation supposes the simultaneous use of renewable and non-renewable energy so as to differentiate the relative impact of each these sources on economic growth for a panel of thirteen MENA Net Oil Exporting Countries over the period 1980-2012 within a multivariate framework. The panel cointegration tests of Pedroni (1999, 2004), Kao (1999) as well as the recently Westerlund(2007) expose that there is a long-run equilibrium between real GDP (Y), renewable and non-renewable energy consumption, real gross fixed capital formation and labor force with elasticities estimated positive and statistically significant in the long-run. The panel causality results are evidence for a unidirectional causality between renewable energy consumption and economic growth in the short-run and bidirectional causality in the long-run while bidirectional causality was remarked between non-renewable energy consumption and economic growth in both the short and long-run that suggests the importance of this energy sources in these exporting economies. These findings reveal that the renewable energy sector is in its immaturity in the case of MENA exporting economies that have experienced remarkable growth, but as economic growth continues, more resources will become accessible for the renewable energy sector development. Further, barriers and obstacles related to the high cost of renewable energy in competition with subsidies to fossil fuels, the small size of the local market and the absence of a regional market, the lack of mastery of the technology and the weak capacity of local production of goods and services remain to hinder the renewable energy development in these countries. Obviously, the transition towards a renewable energy supply necessitates some form of government intervention in an attempt to conquer market distortions favoring fossil fuels. In fact, there are several initiatives and policies must be undertaken to promote and stimulate the introduction of renewable energy such as the development of several important regional and regionally based institutions and cooperation, renewable energy production tax credits, installation rebates for renewable energy systems, renewable energy portfolio standards, as well as the creation of markets for renewable energy certificates.

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