RESEARCH ARTICLE

Asymmetric impacts of disaggregated energy consumption and oil price fluctuations on the MENA net oil-exporting and importing economies

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Abstract
This paper asymmetrically analyzes the impact of energy consumption and oil price fluctuations on the economic growth of the MENA net oil-exporting and importing nations from 1990 to 2019 using panel nonlinear autoregressive distributed lag (PNARDL) model developed by (Salisu and Isah, Econ Model 66:258–271, 2017). The findings revealed that for the net-oil exporting countries, the impact of nonrenewable energy on economic growth is nonlinear in both terms, where in the both terms, high consumption of nonrenewable energy is influencing economic growth and its low consumption is limiting it. Furthermore, the impact of renewable energy is linear and it is influencing and limiting economic growth in both terms respectively. Moreover, the impact of oil price fluctuations on economic growth is linear in the long run and nonlinear in the short run, where in the long run, increase in it is not influencing economic growth but in the short run, while its decrease has no effect. For the net-oil importing countries, the impact of nonrenewable energy on economic growth is nonlinear in both terms, where in the long run, high consumption of nonrenewable energy is influencing economic growth but in the short run, it is discouraging it; however, in both terms, low consumption of nonrenewable energy has no effect. In addition, in the long run, the impact of renewable energy is nonlinear but linear in the short run; however, none of its impacts is significant in both terms. Also, the impact of oil price fluctuations on economic growth is linear in both terms and in the both terms, it is influencing economic growth. Nonetheless, for all the variables, the impacts are higher in the net-oil exporting countries. Policy recommendations were provided.

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Introduction

In our day-to-day life, the importance of energy consumption is witnessed. That is why its link with the economy has unquestionably ranked first among the most frequently searched studies on the empirical literature on energy economics (see Ranjbar et al. 2017; and Tugcu and Topcu, 2018). However, oil is considered one of the most influential forms of energy across the globe and the main source of energy production (nonrenewable energy) for emerging, developing, and developed economies. As a result, its consumption has risen significantly, particularly in emerging economies transitioning to industrialized economies such as the Middle East and North African (MENA) countries that rely largely on nonrenewable energy for energy supply and household consumption. The region's countries are

rapidly increasing energy consumers because of expanding GDP, population, and urbanization pressures. Furthermore, for much of their recent history, they have been noted for their abundance of energy. On the other hand, the region is highly diverse in economic and political frameworks, energy resources, and infrastructure. Furthermore, renewable energy and energy efficiency have gained popularity in the region, particularly as the cost of renewable energy technology has declined compared to nonrenewable energy.

However, energy consumption (nonrenewable and renewable) and oil price fluctuations have been discussed in various studies after the oil crisis in 1973 and the realization of its effect by policymakers, economists, businessmen, and households. However, oil as the main subject of energy consumption, its market is frequently exposed to dramatic volatility in its prices. In general, these fluctuations are caused by geopolitical risk, political shocks as Arab spring (Khalifa et al. 2014; Antonakakis et al. 2017; Arayssi et al. 2019), and due to the pandemic sweeping some large economies such as the COVID-19 pandemic that swept China at the end of 2019 ("Oil Market Report, 2020, IEA, Paris," n.d.). Therefore, oil price volatilities affect the economy either directly or indirectly, industrialization, inflation index, finance, stock market, and investment which are all connected to economic growth (Khalifa et al. 2014; Lardic and Mignon, 2008; Jarrett et al. 2019; Khan et al. 2019a, b). For example, upward oil price fluctuations may lead to lower production processes, leading to negative impacts on macroeconomic variables such as real wages and employment, selling prices, basic inflation, profits, and investment (Lescaroux and Mignon, 2008). Even though Jongwanich and Park (2011) found that an increase in oil prices has no direct impact on the inflation index because oil is a commodity of productive inputs rather than a consumer good, it still has effects on the other aspects mentioned above.

The neoclassical theory that investigates the link between crude oil and economic growth is established on the supply-side channel since the energy might be the origin of volatilities in real input and employment (Hamilton, 1988). Furthermore, oil price changes may influence economic performance by the effect of wealth transfer, real balance, the effect of monetary policy, and psychological effect (Khan and Ahmed, 2014). Nonetheless, oil-importing developing countries impose a lower tax rate on oil price fluctuations, severely affected by rising oil prices. On the other hand, oil-importing developed countries impose a higher tax rate on oil, which means they can absorb the oil price fluctuations compared with oil-importing developing countries (Shahbaz et al. 2017).

These dynamic interactions between energy consumption, oil price fluctuations, and economic growth prompted the researchers to conduct extensive empirical studies and offer critical analysis but most of such studies, particularly panel studies, use linear frameworks to analyze the relationship, which may lead to an incorrect conclusion if the relationship is nonlinear (Galadima and Aminu, 2017a, 2017b). Regardless, nonlinear techniques are thought to be more robust than linear techniques. Furthermore, even among the few that employed nonlinear models, some of the models employed are inadequate in dealing with the issue of heterogeneity across the panels.

Hence, this paper makes the following contributions. First, to our knowledge, this is the first study to separate the MENA net oil-exporting and importing countries and investigate the symmetric and asymmetric impacts of disaggregated energy consumption (nonrenewable and renewable) and oil price fluctuations. Second, it makes use of a recent technique of panel nonlinear autoregressive distributed lag (PNARDL) model developed in the study of Salisu and Isah (2017) which appears that it is the first study that makes use of such model on such relation which in addition to its ability to handle the issue of nonlinear effects, it also has the ability capture inherent heterogeneity effects in the slope coefficient of the relationship due to cross-sectional differences. Furthermore, it is suitable even if the sample size is small. Finally, it allows the use of variables with a mixture order of integration, i.e., I (0) and I (1), thus, the reasons for choosing ARDL framework over other panel models. However, the specific objectives of this study include the following:

i. To investigate the impact of disaggregated energy consumption on the economic growth of the MENA net oil-exporting and importing countries;

ii. To examine how hikes and collapse of oil prices affect the economic growth of the MENA net oil-exporting and importing countries; and

iii. To compare the impact of disaggregated energy consumption, and hikes and collapse of oil prices on the economic growth of the MENA net oil-exporting and importing countries.

The rest of the paper is organized as follows: "Literature review" comprising "Theoretical review" and "Empirical review" as the second section, next is the "Methodology" which discusses the methodology for achieving the objectives of the study, then is the "Analysis and discussion of the results" which is the estimation and discussion of the findings, and the "Conclusion and policy recommendations" is the concluding remarks of the paper.

Literature review

Theoretical review

According to the energy consumption theory (also known as the energy cost theory), the cost of using energy

resources in production and service business operations can be offset by these operations' overall positive economic impact. The residual and incremental innovations have had a positive economic impact, leading to an overall improvement in the economy because of the random induced demand multiplier effect on monetary transactions. Furthermore, the aforementioned induced demand improvement in monetary transactions not only boosts the economy and raises people's living standards; it may dynamically trigger a series of innovative events on the part of businesses and relevant stakeholders, potentially resulting in a lower incremental cost of energy production, i.e., even if business clients or customers can afford to pay for the cost of energy consumption because of their improved financial situation, they may be able to pay less for their energy consumption. The initial decision to increase energy consumption falls under the category of initial business innovations, whereas the dynamic effects that could lower the cost of energy consumption in the aforementioned businesses fall under the category of business consequential innovations. This theory extends the existing grand theories that support the economic impact of improved energy efficiency (The Economic Impact of Improved Energy Efficiency in Canada, 2018).

In this theory, the environmental regulations on GHG and hazardous emissions are the same, with the exception of energy efficiency factors unrelated to the environment are slightly relaxed in the early stages of energy consumption to allow manufacturing and service businesses to continue operations. However, businesses should optimize their non-environmental energy efficiency factors later on. As previously stated, this theory does not allow for any relaxation of environmental regulations. For example, suppose production facilities in dry and hot locations use hydrocarbon and sustainable energy resources (such as solar power) in conjunction with nanogenerators to pumping salty water from the sea or ocean and desalinate the extracted water supply. In that case, sweet water can irrigate and develop urban and rural infrastructure for these regions. This will eventually result in an increased demand for energy to meet the needs of the population and businesses. Furthermore, tourism will thrive in these areas, necessitating more energy to meet the needs of air and ground transportation.

CO^2 converting units or other methods of reducing emissions can be used in HC-consuming facilities. It is worth noting that in some CO2 conversion schemes, CO (syngas) is produced, which can then be reacted with water (water–gas shift reaction) to generate the energy-rich hydrogen gas required to power fuel cell technology (Canada's Oil Sands Innovation Alliance, 2015).

Finally, the energy consumption theory does not require businesses to use a specific energy resource,

and in fact, the use of mixed energy technologies is encouraged to reduce the cost of energy consumption, to comply with environmental regulations, and diversify business revenue by utilizing energy converting units to convert various energy technologies. In future energy-consuming production and service operations, businesses may use fossil fuels, energy harvesting, nanogenerators, conventional sustainable energy resources, HC fuel, hydrogen fuel cells, and other energy resources (Vosooghzadeh, 2020).

Empirical review

Several studies have been carried out to see how economies respond to changes in energy consumption and oil prices. Kang et al. (2017) analyzed the impact of oil price changes and financial vulnerability strategy on oil-security exchange returns. They discovered that oil demand shocks positively affect return, whereas policy uncertainty shocks have a negative impact on oil-stock market returns. Ranjbar et al. (2017) argued that the symmetric and asymmetric connection between energy utilization (positive and negative stuns) and economic development in South Africa from 1956 to 2012 by applying asymmetric causality, following Hatemi-J and Uddin (2012), and Breitung and Candelon (2006) methodology for the frequency-domain test. The findings suggest that negative shocks to energy consumption cause economic growth. Furthermore, the findings revealed that a decrease in energy consumption is likely to limit economic growth. However, there is no evidence that an increase in energy consumption leads to economic growth. Shin et al. (2018) used data from $1991Q_1$ to $2016Q_3$ to investigate whether there was a symmetric or asymmetric effect in Korea's demand for crude oil when oil price changes occurred. They discovered that Korea's demand for oil is more sensitive to an increase in oil prices than to a decrease in oil prices. Furthermore, the asymmetric impact of oil prices was observed only in the long run. Liu (2018) studies the relationship between energy consumption and economic growth in China from 1982 to 2015 using the autoregressive distributed lag (ARDL) model, and his findings show that expanding the use of all types of energy sources can boost China's economic growth in the long run. Tugcu and Topcu (2018) investigated the possibility of an asymmetric relationship between disaggregate energy consumption for G7 economies from 1980 to 2014 using asymmetric causality. The results provide strong support for the long-run asymmetry association between energy consumption and output growth. Ahmed et al. (2019) use the autoregressive distributed lag (ARDL) model to study the dynamic link between renewable and nonrenewable energies, CO2 intensity, and economic

growth in Myanmar from 1990 to 2016. According to the findings, the total energy consumption plays a minor role in encouraging economic growth. However, decomposition study suggests that only renewable energy use considerably boosts economic growth, whereas nonrenewable energy has a negative impact. Jarrett et al. (2019) investigated the impact of financial institutions on oil price shocks in 31 countries from $2006Q_1$ to $2016Q_4$ using a synthetic control methodology and cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model where they focused on 11 oil-exporting countries as a treatment group with poor financial development and the rest as a control group with high-quality financial institutions. The results discovered that the financial institution quality positively impacts oil security, reducing production volatility and promoting growth. Khan et al. (2019a, b) use a nonlinear autoregressive distributed lag pattern to examine the impact of oil price shocks on macroeconomic growth in 13 Asian economies from $1980Q_1$ to $2014Q_2$. They discovered that in the short run, economic growth interacts symmetrically with positive and negative oil price changes in some countries, while it interacts asymmetrically with oil price changes in others. Cunado et al. (2019) used monthly data from February 1974 to August 2017 to examine the impact of geopolitical risks on oil revenues using the time-varying parameter structural vector autoregressive approach. The findings revealed that all geopolitical risks and political tensions cause oil supply shocks, which drive up the oil price. Mohsin et al. (2019) used a hybrid error correction model to examine the integrated influence of energy consumption, economic development, and population expansion on CO2 in Pakistan. The study discovered that economic growth is highly dependent on energy usage. Muhammad (2019) investigates the relationship between economic growth and energy consumption in 68 developed, emerging, and Middle East and North Africa (MENA) countries from 2001 to 2017, employing seemingly unrelated regression (SUR) and dynamic models estimated using the generalized method of moments (GMM) and system generalized method of moments (Sys GMM) for data analysis. According to the results, economic growth in industrialized and rising countries increases with increased energy consumption, while it decreases in MENA countries. Yorucu and Ertac Varoglu (2020) use panel dynamic OLS (DOLS) to test the energy-led growth hypothesis for a sample of 23 tiny island republics from different continents from 1977 to 2017. The findings verified the presence of the energy-led growth hypothesis in the countries. Adebayo (2021) employs the autoregressive distributed lag (ARDL) model to investigate the long-run and causal effects of globalized energy consumption on economic growth in Japan from 1070 to 2015. It was discovered that energy

consumption causes economic growth and that there is a one-way causality between energy consumption and economic growth. Asiedu et al. (2021) use the Granger causality test and investigate the relationship between renewable and nonrenewable energy use and economic growth in 26 European nations from 1990 to 2018. The study found evidence of bidirectional causality between economic growth and renewable energy consumption. Aslan et al. (2021) use panel quantile regression to examine the association between energy use and economic growth in 17 Mediterranean nations from 1995 to 2014. According to the data, energy consumption promotes economic growth at low and medium growth rates. Bouyghrissi et al. (2021) use the ARDL model and the Granger causality test to examine the relationship between renewable and nonrenewable energy use and economic growth in Morocco from 1990 to 2014. The empirical findings confirm the notion that renewable energy has a favorable impact on economic growth, and it is discovered that there is a causal relationship between renewable energy use and economic growth. Irfan (2021) employs a panel autoregressive distributed lag modeling approach to investigate the relationship between low-carbon energy strategies and economic growth in industrialized and emerging economies from 1990 to 2017. According to the results, energy efficiency boosts economic growth in both developed and developing nations, but energy variety only improves economic growth in developing economies. Malik (2021) explores the three-way links between economic growth, energy consumption, and environmental quality in Turkey from 1970 to 2014 using the generalized method of moments (GMM) technique. The findings indicate that bidirectional causality exists between energy consumption and economic growth, CO2 emissions and economic growth, and CO2 emissions and energy consumption. Furthermore, the data show that there is a monotonically growing link between CO2 emissions and economic growth, meaning that the environmental Kuznets curve theory is false.

Methodology

Data and its sources

Panel data from secondary sources are used in this study for countries in the Middle East and North Africa (MENA). MENA net oil exporters include Algeria, Bahrain, Egypt, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen, while net importers include Armenia, Cyprus, Georgia, Israel, Jordan, Lebanon, Malta, Mauritania, Morocco, Tunisia, and Turkey. Nonrenewable energy

consumption per capita (NREpc), renewable energy consumption per capita (REpc), oil price fluctuations (OP), and real GDP (Y) are the variables used. The variables are from 1990 to 2019. The International Energy Statistics database of the US Energy Information Administration provided the NREpc data (2019). On the other hand, OP is in a unit dollar and comes from the Federal Reserve Economic Data (2019). The World Bank's Sustainable and British petroleum website Energy for All Database (2019) was used to calculate REpc, and both energies are measured in kilograms of oil equivalent (koe). Y was sourced from the World Bank Development Indicators (2019) in the dollar at 2010 constant price, with all variables transformed into a natural logarithm, with the exception of Syria, which is at 2011 constant price. Nonetheless, on the other hand, energy consumption per capita is the ratio of energy consumption to a population in a given country. Furthermore, data on renewable energy consumption in Bahrain and Oman from the MENA net oil-exporting countries is not available for the entire period. The definition and the data sources used in the analysis are listed in Table 1.

Estimation techniques

The estimation techniques comprise nine steps. First is the graphical analysis of the data to depict the series trend. Second is the descriptive statistics to describe the statistical characteristics of the data. Third is the Pesaran (2004) cross-section dependence (CD) test to test which test the null hypothesis that cross-section dependence in a panel. The rule of the following action after the cross-section dependence is that if there is evidence of cross-section dependence in a panel, then conventional unit root tests may be biased; hence, the next line of action is to make use of the Pesaran (2007) cross-section augmented Im, Pesaran, and Shin (CIPS) panel unit root test which is not sensitive to cross-section dependence; thus, in the absence of cross-section dependence, the conventional panel unit root can be used (Salisu and Isah, 2017). As it found in this study that all the panels are cross-section

dependence (Table 2), the fourth is the Pesaran (2007) cross-sectional augmented Im, Pesaran, and Shin (CIPS) panel unit root test, which tests the null hypothesis of homogeneous non-stationary. Fifth, Kao (1999), Pedroni (1999, 2004), and Westerlund (2007) panel cointegration tests were conducted. The first two tests compared the null hypothesis of no cointegration to the hypothesis that all panels are cointegrated, while the third test compares the null hypothesis of no cointegration to the hypothesis that some panels are cointegrated. Sixth is the choosing of the lag length for the PNARDL model's order which is based on automatic selection. Seventh is performing the Hausman test to determine which estimator should be used among the three prominent techniques used in the estimation of a dynamic heterogeneous panel data model, namely the pooled mean group (PMG) estimator, the mean group (MG) estimator, and the dynamic fixed effect (DFE) estimator, where the PMG estimator is based on a combination of pooling and averaging whereas the MG estimator is based on averaging the coefficients of N time-series regressions (Blackburne and Frank, 2007), whereas the DFE estimator is based on that the slopes are fixed, and the intercepts are allowed to vary across countries. However, all the estimators test the null hypothesis that the difference in coefficients between the estimators is not systematic. Eighth is an asymmetric test by executing $W_{i,LR} : a_i^+ = a_i^- = a_i$ as the long-run asymmetry and $W_{i,SR} : \beta_i^+ = \beta_i^- = \beta_i$ as the short-run asymmetry. Ninth is the estimation of the model, i.e., Eq. (1) which depends on the asymmetric test in step eight above; hence, what determines how the variables will enter the PNARDL model.

Panel nonlinear autoregressive distributed lag (PNARDL) model

The panel nonlinear autoregressive distributed lag (PNARDL) model developed in the study of Salisu and Isah (2017) was also used in this study. Following Galadima and Aminu (2019), Salisu and Isah (2017), the nonlinear

Table 1 Sources of data

Variable	Denoted by	Measured in	Source
Real GDP	*Y*	Per capita	World Development Indicators (2019)
Renewable energy	*RE*	Per capita in (kwh of oil equivalent)	World Bank — sustainable and British petroleum website Energy for All Database (2019)
Nonrenewable energy	*NRE*	Per capita in (kwh of oil equivalent)	US Energy Information Administration-International Energy Statistics database (2019)
Global price of Brent Crude	*OP*	US dollars per barrel	Federal Reserve Economic Data (2019)

Source: researcher's formulation

Table 2 Panel cross-section dependence tests of *lnY*, *lnNREpc*, *lnREpc*, and *lnOP* of the (a) MENA net oil-exporting and (b) importing countries

Tests	Statistic	d.f	Prob
a MENA net oil-exporting countries			
Pesaran CD (2004)	29.3916	78	0.0000*
lnY			
Pesaran CD (2004)	11.61178		0.0000*
lnNREpc			
Pesaran CD (2004)	2.953724	78	0.0000*
lnREpc			
Pesaran CD (2004)	48.37355		0.0000*
lnOP			
b MENA net oil-importing countries			
Pesaran CD (2004)	36.4444	55	0.0000*
lnY			
Pesaran CD (2004)	39.23565		0.0000*
lnNREpc			
Pesaran CD (2004)	− 1.635284		0.0932***
lnREpc			
Pesaran CD (2004)	40.62019		0.0000*
lnOP			

Source: researcher's computation. Notes: the symbols * and *** denote significance at the 1% and 10% levels, respectively. In the net-oil exporting nations, the degree of freedom (df) is 78 for all the panels except for lnREpc, which is 45, while for net-oil importing nations is 55 for all the panels

long-run relationship between the variables under consideration is as follows:

$$\ln y_{it} = \theta_{0i} + \theta_{1i}\ln NREpc_t^+ + \theta_{2i}\ln NREpc_t^- + \theta_{3i}\ln REpc_t^+ + \theta_{4i}\ln REpc_t^-$$
$$+\theta_{5i}\ln OP_t^+ + \theta_{6i}\ln OP_t^- + \varepsilon_{it} \tag{1}$$

This is now a nonlinear nine-variable OLS model for each country. Furthermore, the construction of the nonlinear variables in Eq. (1), i.e., the rises and falls of NREpc, REpc, and OP (i.e., asymmetric specification), is obtained by the following expression:

$$\ln NREpc_t^+ = \sum_{k=1}^{t} \Delta \ln NREpc_{ik}^+ = \sum_{k=1}^{t} \max(\Delta \ln NREpc_{ik}, 0), \ln NREpc_t^- = \sum_{k=1}^{t} \Delta \ln NREpc_{ik}^-$$
$$= \sum_{k=1}^{t} \min(\Delta \ln NREpc_{ik}, 0), \ln REpc_t^+ = \sum_{k=1}^{t} \Delta \ln REpc_{ik}^+ = \sum_{k=1}^{t} \max(\Delta \ln REpc_{ik}, 0), \ln REpc_t^-$$
$$= \sum_{k=1}^{t} \Delta \ln REpc_{ik}^- = \sum_{k=1}^{t} \min(\Delta \ln REpc_{ik}, 0), \ln OP_t^+ = \sum_{k=1}^{t} \Delta \ln OP_{ik}^+ = \sum_{k=1}^{t} \max(\Delta \ln OP_{ik}, 0),$$
$$\ln OP_t^- = \sum_{k=1}^{t} \Delta \ln OP_{ik}^- = \sum_{k=1}^{t} \min(\Delta \ln OP_{ik}, 0), \tag{2}$$

where Δ epitomizes the difference operator, *lnNREpc*$_t$, *lnREpc*$_t$, and *lnOP*$_t$ for each independent variable decomposed as $lnNREpc_t = lnNREpc_t^+ + lnNREpc_t^-$, $lnREpc_t = lnREpc_t^+ + lnREpc_t^-$, and $lnOP_t = lnOP_t^+ + lnOP_t^-$. However, the PNARD model, on the other hand, is represented as follows:

$$\Delta lny_{it} = a_{0i} + a_{1i}lny_{i,t-1} + a_{2i}^+lnNREpc_{t-1}^+ + a_{2i}^-lnNREpc_{t-1}^- + a_{3i}^+lnREpc_{t-1}^+ + a_{3i}^-lnREpc_{t-1}^-$$
$$+a_{4i}^+lnOP_{t-1}^+ + a_{4i}^-lnOP_{t-1}^- + \sum_{j=1}^{p}\lambda_{ij}\Delta lny_{i,t-j} + \sum_{j=0}^{q}(\beta_{1ij}^+\Delta lnNREpc_{t-j}^+ + \beta_{1ij}^-\Delta lnNREpc_{t-j}^-$$
$$+\beta_{2ij}^+\Delta lnREpc_{t-j}^+ + \beta_{2ij}^-\Delta lnREpc_{t-j}^- + \beta_{3ij}^+\Delta lnOP_{t-j}^+ + \beta_{3ij}^-\Delta lnOP_{t-j}^-) + \mu_i + \varepsilon_{it}$$
$$i = 1, 2, ..., N; \ t = 1, 2, ..., T \tag{3}$$

where is Δ the first difference operator and y_{it} is the economic growth rate for each country over time t, a_0 is the constant term for each country, $a_1 - a_5$ and $\beta_1 - \beta_4$ are the respective positive and negative changes in *lnNREpc*, *lnREpc*, and *lnOP* for each country in both the long-run and short-run, p and q are the optimum number of lags, and Σ denotes the sum of the number of lags included, which has a minimum of one for the dependent variable and a minimum of 0 for the independent variables, i is the number of sampled countries, t is the time period, μ_i is the fixed effects, and ε is the error term.

Furthermore, for each country, the nonlinear long-run coefficients (i.e., impact multipliers) are calculated as follows: $\theta_{1i} = \frac{-a_{2i}^+}{a_{1i}}, \theta_{2i} = \frac{-a_{2i}^-}{a_{1i}}, \theta_{3i} = \frac{-a_{3i}^+}{a_{1i}}, \theta_{4i} = \frac{-a_{3i}^-}{a_{1i}}, \theta_{5i} = \frac{-a_{4i}^+}{a_{1i}}$, and $\theta_{6i} = \frac{-a_{4i}^-}{a_{1i}}$. Moreover, since in the long-run, it is assumed that $\Delta lny_{1t-j} = 0$, $\Delta lnNREpc_{t-j} = 0$, $\Delta lnREpc_{t-j} = 0$, and $\Delta lnOP_{t-j} = 0$, the asymmetric short-run coefficients for *lnNREpc*, *lnREpc*, and *lnOP* are obtained as $\beta_{1ij}^+, \beta_{1ij}^-, \beta_{2ij}^+, \beta_{2ij}^-, \beta_{3ij}^+$, and β_{3ij}^-. However, the error correction term (ECT) version of Eq. (3) yields the following representation:

$$\Delta lny_{it} = \phi_i\delta_{i,t-1} + \sum_{j=1}^{p}\lambda_{ij}ln\Delta y_{i,t-j} + \sum_{j=0}^{q}(\beta_{1ij}^+\Delta lnNREpc_{t-j}^+ + \beta_{1ij}^-\Delta lnNREpc_{t-j}^- + \beta_{2ij}^+\Delta lnREpc_{t-j}^+$$
$$+\beta_{2ij}^-\Delta lnREpc_{t-j}^- + \beta_{3ij}^+\Delta lnOP_{t-j}^+ + \beta_{3ij}^-\Delta lnOP_{t-j}^-) + \mu_i + \varepsilon_{it} \tag{4}$$

where ϕ_i is the speed of adjustment term that measures how long it takes the system to converge to its long-run equilibrium in the event of a shock, and $\delta_{i,t-1}$ is the error correction term that captures the long-run equilibrium in the PNARDL specified in Eq. (3).

Analysis and discussion of the results

The empirical analysis begins with a graphical representation, descriptive statistics, cross-section dependence test, panel unit root test, panel cointegration tests, the Hausman test, asymmetric test, and estimation of the models.

Figure 1 depicts the trends of lnY, lnNREpc, lnREpc, and lnOP of the MENA net oil-exporting countries from 1990 to 2019 based on time averages. The economy of the net oil-exporting countries displayed an upward trend with less fluctuation, and it is on the increase throughout the period. Nonrenewable energy displayed a moderately fluctuated trend, but there is a huge decline around 2018/2019, i.e., in recent years. Finally, renewable energy and oil price fluctuations displayed fluctuated trends over the period, but renewable energy is at increase in recent years while oil price fluctuations are at decrease.

Figure 2 depicts the MENA net oil-importing countries' lnY, lnNREpc, lnREpc, and lnOP trends from 1990 to 2019 based on time averages. Like in the nest-oil exporting countries, the economy displayed an upward trend with less fluctuation in the net-oil importing countries, and it is on the increase throughout the period. Nonrenewable energy is stable over the period except in recent years, where the series has been a massive decline. Renewable energy displayed a moderately fluctuated trend, but there is a huge decline around 2014/2015; however, it then continues to rise up to the end of the horizon which means at increase in recent years. Oil price fluctuations displayed fluctuated trends over the period.

Table 3 shows descriptive statistics for net oil-exporting and importing countries in the Middle East and North Africa, including mean, maximum, and minimum values and standard deviations for lnY, lnNREpc, lnREpc, and lnOP. From the table, the respective means of the two groups of countries show that net oil-exporting countries have a larger economic growth (lnY) and higher nonrenewable energy consumption (lnNREpc) but lower renewable energy consumption (lnREpc) when compared to net oil-importing countries. At the same time, oil prices (lnOP) are uniform. Furthermore, in both groups of the countries, kewness, kurtosis, and the *p*-values of the Jarque–Bera show that the distribution of all the variables is volatile except that of the NREpc in the net-oil importing countries. However, when standard deviations are taken into account, lnY and REpc of

the net oil-exporting countries are more stable and thus less volatile than in the net oil-importing countries, while NREpc is more stable in the net-oil importing countries.

The cross-section dependence test on the panel of lnY, lnNREpc, lnREpc, and lnOP of the MENA net oil-exporting and importing countries tests the null hypothesis of no cross-section dependence; that is, no correlation across the panel is presented in Table 2. The table shows that the null hypothesis of no cross-section dependence is rejected for all panels at 1% level except lnREpc in net-oil importing countries, which is rejected at 10% level. So, all eight panels have cross-section dependence. Therefore, the study will not employ conventional panel unit root tests since such tests are weak in cross-section dependence among the panels. Hence, it will use the Pesaran (2007) panel unit root test, which is not sensitive to cross-section dependence.

The Pesaran (2007) CIPS panel unit root test of lnY, lnNREpc, lnREpc, and lnOP of the MENA net oil-exporting and importing countries is presented in Table 4. From Table 4 (part a), at level, lnNREpc and lnOP are homogeneous stationary at 1% level while lnY and lnREpc are homogeneous non-stationary. However, when taking the first difference, all the variables become heterogeneous stationary at a 1% level. From Table 4 (part b), lnY and lnOP are heterogeneous stationary at a 1% level, but lnNREpc and lnREpc are homogeneous non-stationary while at first, all the variables are heterogeneous stationary. Therefore, in both the net oil-exporting and importing countries, the panel is a mixture of I(0) and I(1), which paved the way to use the ARDL framework, which accounts for inherent heterogeneity and non-stationarity in panel data series. However, before using the PNARDL model, the paper uses cointegration tests to see if the panels and thus, the variables under investigation have a long-run relationship.

Table 5 shows the results of the panel cointegration tests on the MENA net oil-exporting countries, where four of the five Kao panel cointegration test statistics reject the null hypothesis of no cointegration, implying that the panels are cointegrated. However, all the test statistics of the Pedroni panel cointegration test reject the null hypothesis of no cointegration, portraying that the panels are cointegrated. Similarly, the Westerlund panel cointegration test statistic rejects the null hypothesis of no cointegration, which entails the presence of cointegration. In sum, the results of the cointegration tests indicate that the variables of the net oil-exporting nations have a long-term relationship, and thus, the study can use the level of the variables for long-run analysis.

Table 6 reports the panel cointegration test results on the MENA net oil-importing countries. All the Kao panel cointegration test statistics confirm the presence of cointegration among the variables as the null hypothesis of no cointegration was rejected. More so, all the test statistics of the Pedroni panel cointegration test reject the null hypothesis
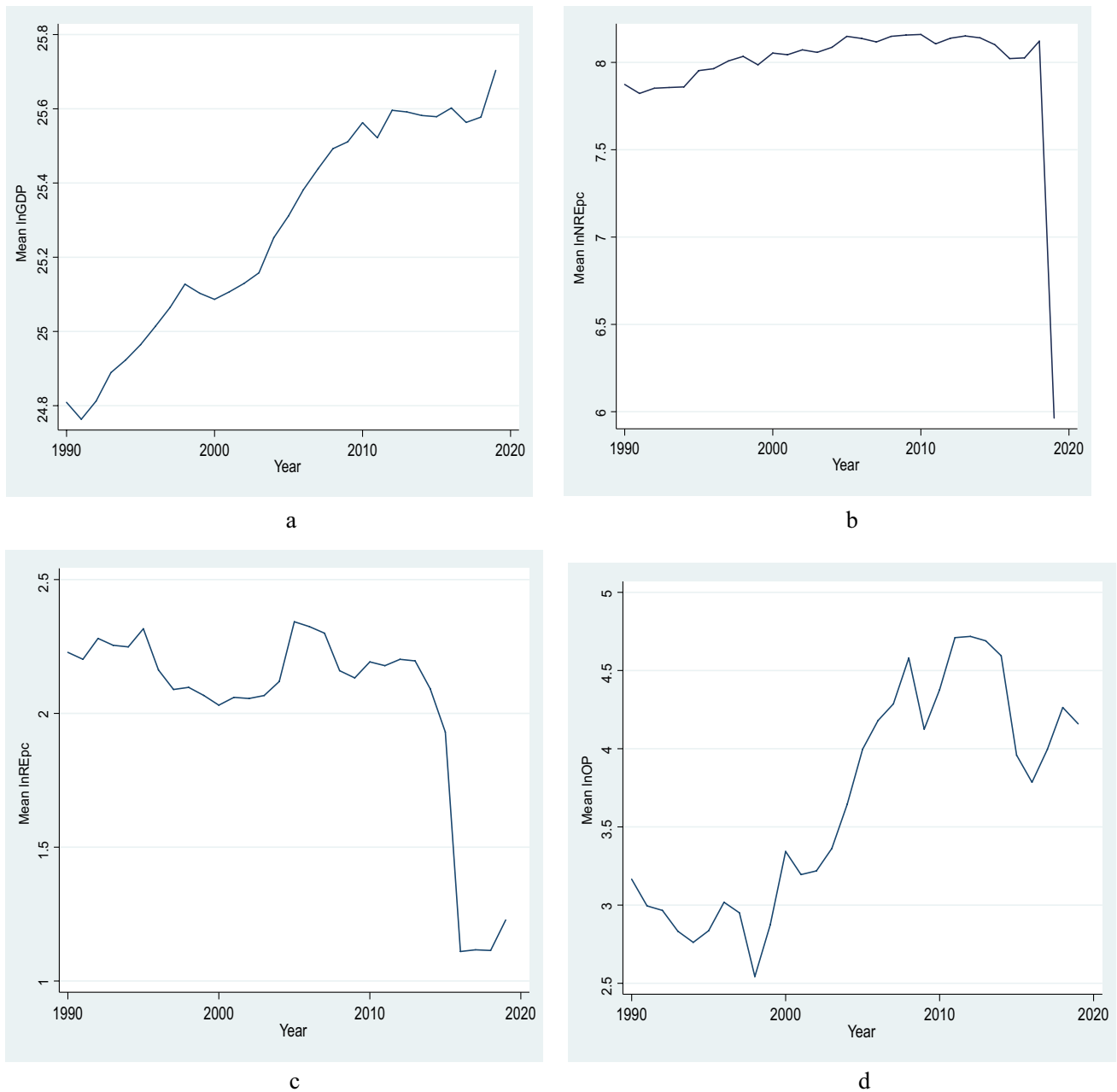
Fig. 1 Graphical representation of MENA net oil-exporting countries' economic growth (lnY), nonrenewable energy (lnNREpc), renewable energy (lnREpc), and oil prices (lnOP)

of no cointegration; thus, there is cointegration among the variables. Moreover, the Westerlund panel cointegration test rejects the null hypothesis of no cointegration. In sum, the results of the cointegration tests indicate that the variables of the net oil-importing nations have a long-term association; hence, the study is free to proceed with the long-run analysis using the level variables.

To estimate the models, the Hausman test was conducted among the pooled mean group (PMG) estimator, the mean group (MG) estimator, and the dynamic fixed effect (DFE) estimator for each of the three models, as shown in Table 7 as for net-oil exporting and importing nations respectively. From Table 7 (part a), between PMG and MG, the PMG is better estimator because the p-value of the test is not significant; between PMG and DFE, the DFE is better estimator as the p-value of the test is significant at 5% level, but inconclusive between MG and DFE. This show that logically for the net-oil exporting nations, the appropriate estimator to use is DFE, since the test between MG and PMG estimators found the PMG
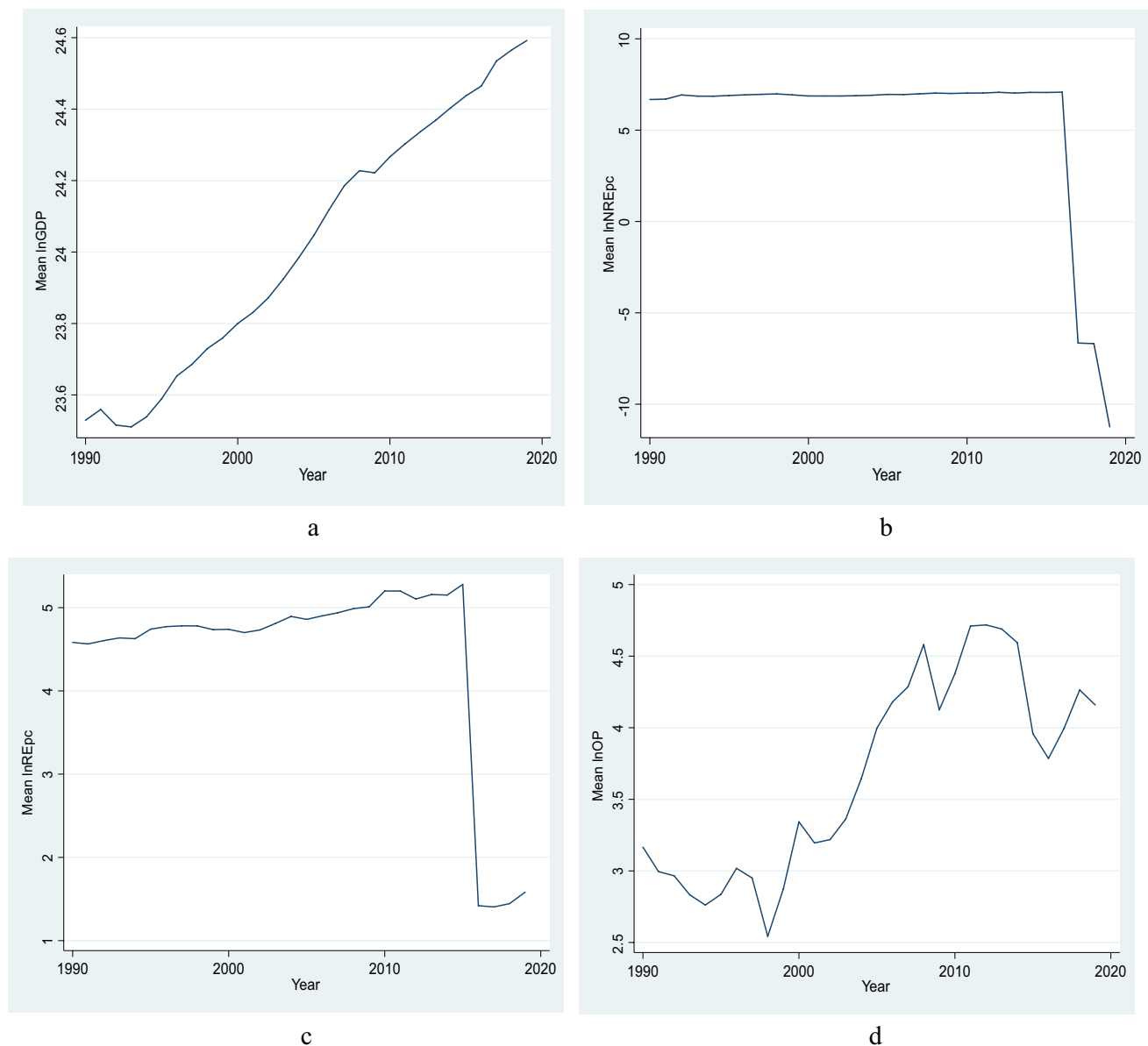
Fig. 2 Graphical representation of MENA net oil-exporting countries' economic growth (lnY), nonrenewable energy (lnNREpc), renewable energy (lnREpc), and oil prices (lnOP)

estimator to be a better choice than MG, while between PMG and DFE estimators, the test found DFE to be the most suitable estimator. From Table 7 (part b), between PMG and MG, the MG is better estimator; between PMG and DFE, it is inconclusive but between MG and DFE, the DFE is the better estimator. This shows that for the net-oil importing nations, the appropriate estimator to use is DFE. Hence, DFE is the choice for both groups of nations.

Table 8 presents the results of the asymmetry test in both the long run and short run for the net-oil exporting and importing nations. Table 8 (part a) is for the net-oil export-ing nations where in both terms, the impact of lnNREpc on

lnY is asymmetry (nonlinear) while that of lnREpc is sym-metry (linear) in both terms, but lnOP is symmetry (linear) in the long run and asymmetry (nonlinear) in the short run. This shows that, in estimating the Panel NARDL model, lnNREpc will be with asymmetry in both terms, lnREpc with symmetry in both terms, but lnOP with symmetry in the long run and asymmetry in the short run. From Table 8 (part b) which is for the net-oil importing countries, in both terms, the impact of lnNREpc on lnY is asymmetry (non-linear) while that of lnREpc is asymmetry (nonlinear) in the long run but symmetry (linear) in the short run, whereas that of lnOP is symmetry (linear) in both terms. This shows that,

Table 3 Descriptive statistics of *lnY*, *lnNREpc*, *lnREpc*, and *lnOP* of the (a) MENA net oil-exporting and (b) importing countries

	lnY	*lnNREPC*	*lnREPC*	*lnOP*
a MENA net oil-exporting countries				
Mean	25.52087	7.476853	2.029844	1.609208
Median	25.57676	7.136982	1.671590	1.794169
Maximum	27.24349	9.894421	4.572059	3.572059
Minimum	23.18511	5.244556	− 0.612643	− 1.612643
Std. dev	0.962794	1.132736	1.378143	1.444913
Skewness	− 0.365486	0.397938	0.368252	− 0.639861
Kurtosis	2.406404	2.424357	2.101017	2.668059
Jarque–Bera	8.312584	9.044832	21.94740	16.38630
Probability	0.015666	0.010863	0.000017	0.000277
Observations	390	390	390	390
b MENA net oil-importing countries				
Mean	24.01835	6.904307	3.873021	1.609208
Median	23.80882	6.895451	4.040680	1.794169
Maximum	27.71525	8.748436	5.739326	3.572059
Minimum	21.44812	5.086162	− 0.504873	− 1.612643
Std. dev	1.519479	0.838347	1.233148	1.444913
Skewness	0.585118	0.024472	− 1.359875	− 0.639861
Kurtosis	2.671771	2.564004	4.915854	2.668059
Jarque–Bera	16.61837	2.165489	131.8882	16.38630
Probability	0.000246	0.338665	0.000000	0.000277
Observations	330	330	330	330

Source: researcher's computation

Table 4 Pesaran ([2007](#)) CIPS panel unit root test results of *lnY*, *lnNREpc*, *lnREpc*, and *lnOP* of the (a) MENA net oil-exporting and (b) importing countries

	CIPS	Lags
a MENA net oil-exporting countries		
lnY	− 2.541	3
lnNREpc	− 2.237*	2
lnREpc	− 2.333*	1
lnOP	− 2.610*	1
Δ*lnY*	− 4.301*	1
Δ*lnNREpc*	− 2.930*	1
Δ*lnREpc*	− 4.253*	1
Δ*lnOP*	− 2.610*	1
b MENA net oil-importing countries		
lnY	− 3.062*	2
lnNREpc	− 1.397	4
lnREpc	− 1.904	1
lnOP	− 2.610*	1
Δ*lnY*	− 4.086*	1
Δ*lnNREpc*	− 5.428*	2
Δ*lnREpc*	− 3.602*	1
Δ*lnOP*	− 2.610*	1

Source: researcher's computation. The symbol * denotes significance at the 1% level

Table 5 Results of (a) Kao, (b) Pedroni, and (c) Westerlund panel cointegration test on the MENA net oil-exporting countries

	Statistic	*p*-value
a Kao panel cointegration test		
Modified Dickey-Fuller t	− 2.1603	0.0154**
Dickey-Fuller t	− 1.6143	0.0532***
Augmented Dickey-Fuller t	0.1168	0.4535
Unadjusted modified Dickey Fuller t	− 2.2720	0.0115**
Unadjusted Dickey-Fuller t	− 1.6658	0.0479**
b Pedroni panel cointegration test		
Modified Phillips-Perron t	1.2945	0.0978***
Phillips-Perron t	− 1.9468	0.0258**
Augmented Dickey-Fuller t	− 1.7879	0.0369**
c Westerlund panel cointegration test		
Variance ratio	0.4624	0.0036*

Source: researcher's computation. The symbols *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively

Table 6 Results of (a) Kao, (b) Pedroni, and (c) Westerlund panel cointegration test on the MENA net oil-importing countries

	Statistic	*p*-value
a Kao panel cointegration test		
Modified Dickey-Fuller t	− 8.0039	0.0000*
Dickey-Fuller t	− 5.8695	0.0000*
Augmented Dickey-Fuller t	− 5.7695	0.0000*
Unadjusted modified Dickey Fuller	− 7.4807	0.0000*
Unadjusted Dickey-Fuller t	− 5.7819	0.0000*
b Pedroni panel cointegration test		
Modified Phillips-Perron t	1.3878	0.0826***
Phillips-Perron t	− 5.2813	0.0000*
Augmented Dickey-Fuller t	− 4.6553	0.0000*
c Westerlund panel cointegration test		
Variance ratio	0.6342	0.0001*

Source: researcher's computation. The symbols * and *** denote significance at the 1% and 10% levels, respectively

in estimating the panel NARDL model, lnNREpc will be with asymmetry in both terms, lnREpc with asymmetry in the long run but symmetry in the short run while lnOP with symmetry in both terms. Therefore, in the net-oil exporting countries, the relationship between nonrenewable energy consumption and economic growth is nonlinear in both terms while that with renewable energy consumption is linear in both terms but that with oil price fluctuations is linear in the long run and nonlinear in the short run. However, in the net-oil importing countries, the relationship between nonrenewable energy consumption and economic growth is nonlinear in both terms just like in the net-oil exporting countries while that with renewable energy consumption is

Table 7 Hausman test results to select model among MG, PMG, and DFE on the (a) MENA net oil-exporting and (b) importing countries

Ho: difference in coefficients not systematic	PMG and MG	PMG and DFE		MG and DFE
a MENA net oil-exporting countries				
Chi2 (3)	12.03	4.76		− 9.00
p-value	0.3516	0.0035**		The asymptotic assumptions of the Hausman test fails to meet
9 Decision	Difference in coefficients not systematic	Difference in coefficients not systematic		Inconclusive
Which model is good?	PMG	DFE		Inconclusive
b MENA net oil-importing countries				
Chi2 (3)	5.22	− 31.66		2.00
p-value	0.0042*	The asymptotic assumptions of the Hausman test fails to meet		0.0000*
Decision	Difference in coefficients not systematic	Inconclusive		Difference in coefficients not systematic
Which model is good?	MG	Inconclusive		DFE

Source: author's computation. The symbols * and ** denote significance at the 1% and 5% levels, respectively

Table 8 Asymmetry test on the (a) MENA net oil-exporting and (b) importing countries

Long-run asymmetry				Short-run asymmetry			
Repressors	Chi2	p-value	Decision	Repressors	Chi2	p- value	Decision
a MENA net oil-exporting countries							
lnNREpc	4.74	0.0294**	Asymmetry	ΔlnNREpc	11.89	0.0006*	Asymmetry
lnREpc	0.70	0.4030	Symmetry	ΔlnREpc	1.18	0.2773	Symmetry
lnOP	0.32	0.5738	Symmetry	ΔlnOP	3.84	0.0500**	Asymmetry
b MENA net oil-importing countries							
lnNREpc	7.95	0.0048*	Asymmetry	ΔlnNREpc	67.15	0.0000*	Asymmetry
lnREpc	4.83	0.0280**	Asymmetry	ΔlnREpc	1.10	0.2953	Symmetry
lnOP	1.08	0.2981	Symmetry	ΔlnOP	0.75	0.3857	Symmetry

Source: author's computation. Note: * and ** stand for 1% and 5% levels of significance, respectively

nonlinear in the long run but linear in the short run whereas with oil price fluctuations is linear in both terms.

Table 9 shows the PNARDL model's estimate of the impact of disaggregated energy consumption per capita and oil price fluctuations on the MENA net oil-exporting nations' economic growth. According to the long-run coefficients, $lnNREpc^+$, $lnNREpc^-$, $lnREpc$, and $lnOP$ are positively related with lnY but only $lnNREpc^-$ and $lnREpc$ are significant and at 5% and 10% levels where a 1% increase in $lnNREpc^-$ induces 10.65512% increase in lnY, and a 1% increase in $lnREpc$ induces 4.816791% increase in lnY.

On the other hand, the short-run coefficients revealed that $\Delta lnNREpc^+$ and $\Delta lnOP^+$ are positively related with lnY and significant at 10% and 5% levels, respectively, where a 1% increase in $\Delta lnNREpc^+$ and $\Delta lnOP^+$ will lead to increase in lnY by 0.4378081% and 2.646614%, respectively. While

$\Delta lnNREpc^-$, $\Delta lnREpc$, and $\Delta lnOP^-$ are negatively related with lnY but only $\Delta lnNREpc^-$ and $\Delta lnREpc$ are significant which are at 1% and 5% levels, respectively, where a 1% increase in $\Delta lnNREpc^-$ and $\Delta lnREpc$ will lead to decrease in lnY by 1.218441% and 0.7695405%, respectively. However, the δ term, which is the error correction term (ECT) coefficient that measures speed adjustment of the model in the event of shock from the short run to the long-run equilibrium, is negative and significant at 1% level, which implies three things. First, the significance reaffirms the earlier findings of the cointegration tests that the variables are cointegrated. Second, since the coefficient is significantly negative and between − 1 and 0, there is a long-run causality from the three variables to the countries' economic growth. Third, it shows that in the event of a shock, the model will take approximately 11 years (1/0.0940627) to recover at a rate of 9% per year.

Table 9 Panel nonlinear autoregressive distributed lag (PNARDL) model estimate for the MENA net oil-exporting countries

Variable	Coefficients	Std. err	Z	$p > |z|$
Long-run coefficients				
$lnNREpc^+$	.4726755	2.117569	0.22	0.823
$lnNREpc^-$	10.65512	5.1043	2.09	0.037**
$lnREpc$	4.816791	2.865008	1.68	0.093***
$lnOP$	1.213024	2.308136	0.53	0.599
Short-run coefficients				
$\Delta lnNREpc^+$	.4378081	.2558642	1.71	0.087***
$\Delta lnNREpc^-$	− 1.218441	.3068689	− 3.97	0.000*
$\Delta lnREpc$	−.7695405	.3819083	− 2.01	0.044**
$\Delta lnOP^+$	2.646614	1.102316	2.40	0.016**
$\Delta lnOP^-$	−.7880713	1.000282	− 0.79	0.431
Constant	1.426169	1.169573	1.22	0.223
$\delta_{i,t-1}$	−.0940627	.0288981	− 3.25	0.001*

Source: researcher's computation. The symbols *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively

Table 10 Panel nonlinear autoregressive distributed lag (PNARDL) model estimate for the MENA net oil-importing countries

Variable	Coefficients	Std. err	Z	$p > |z|$
Long-run coefficients				
$lnNREpc^+$	.2555569	.052856	4.83	0.000*
$lnNREpc^-$	.0017597	.008844	0.20	0.842
$lnREpc^+$	(omitted)	-	-	-
$lnREpc^-$	− .0711574	.0439461	− 1.62	0.105
$lnOP$	.2810578	.0411851	6.82	0.000*
Short-run coefficients				
$\Delta lnNREpc^+$	− .0538427	.0046749	− 11.52	0.000*
$\Delta lnNREpc^-$	− .0013286	.001465	− 0.91	0.364
$\Delta lnREpc$	− .0006962	.0052755	− 0.13	0.895
$\Delta lnOP$	.0375003	.0085739	4.37	0.000*
Constant	3.126873	.421515	7.42	0.000*
$\delta_{i,t-1}$	− .1334256	.0182376	− 7.32	0.000*

Source: researcher's computation. The symbols * denotes significance at the 1% level. The coefficient of $lnREpc^+$ was omitted due to multicollinearity

Therefore, for the net-oil exporting countries, the impact of nonrenewable energy consumption on economic growth is nonlinear in both the long run and short run, where in both terms, high consumption of nonrenewable energy is influencing the economic growth and its low consumption is limiting it. Furthermore, the impact of renewable energy consumption is linear and it is influencing and limiting the economic growth in the long run and short run, respectively. Moreover, the impact of oil price fluctuations on economic growth is linear in the long run and nonlinear in the short run, where in the long run, increase in it is not influencing the economies but in the short run, its increase is influencing the economies but its decrease has no effect.

Table 10 shows the PNARDL model's estimate of the impact of disaggregated energy consumption per capita and oil price fluctuations on the MENA net oil-importing nations' economic growth. According to the long-run coefficients, $lnNREpc^+$, $lnNREpc^-$, and $lnOP$ are positively related with lnY while $\Delta lnNREpc^-$, $\Delta lnREpc$, and $\Delta lnOP^-$ are negatively related with lnY but only $lnNREpc^+$ and $lnOP$ are significant and at 1% level where a 1% increase in $lnNREpc^+$ induces 0.2555569% increase in lnY, and a 1% increase in $lnOP$ induces 0.2810578% increase in lnY. While $\Delta lnREpc^-$ is negatively related with lnY but it is not significant.

On the other hand, the short-run coefficients revealed that $\Delta lnNREpc^+$, $\Delta lnNREpc^-$, $\Delta lnREpc$, and $\Delta lnOP^+$ are negatively related with lnY but only $\Delta lnNREpc^+$ is significant and at 1% level where a 1% increase in $\Delta lnNREpc^+$ will lead to decrease in lnY by 0.0538427%, while $\Delta lnOP$ is positively related with lnY and is significant at 1% level where a 1% increase in $\Delta lnOP$ will lead to increase in lnY by 0.0375003%. However, the δ term is negative and statistically significant at

1% level which and means reconfirms the earlier findings that the variables are cointegrated; there exist a long-run causality from the three variables to economic growth, and that in the event of a shock, the model will take approximately 7.5 years (1/0.1334256) to recover at a rate of 13% per year.

Therefore, for the net-oil importing countries, the impact of nonrenewable energy consumption on economic growth is nonlinear in both the long run and short run, where in the long run, high consumption of nonrenewable energy is influencing the economic growth but in the short run, it is discouraging the growth of the economies; however, in both terms, low consumption of nonrenewable energy has no effect. Furthermore, in the long run, the impact of renewable energy consumption is nonlinear but linear in the short run; however, none of its impacts is significant in both terms. Moreover, the impact of oil price fluctuations on economic growth is linear in both terms and in the both terms, it is influencing the economies.

However, when the results of the net oil-exporting and importing countries were compared, it was discovered that the impacts of nonrenewable energy consumption, renewable energy consumption, and oil price fluctuations on the economic growth of the net oil-exporting nations are higher than that of the net-oil importing nations.

With regard to the evidence of asymmetry in the impact of nonrenewable energy consumption on the economic growth of both group of countries in both terms, the impact of renewable energy of the net-oil importing countries in the long run, and that of the impact of oil price fluctuations of the net-oil exporting in the short run, is in line with the findings of Tugcu and Topcu (2018) for G7 economies that energies impacts are asymmetry. On the evidence of symmetric impacts of renewable energy consumption

on the economic growth of the net-oil exporting nations in both terms, oil price fluctuations of the net-oil exporting in the long run, and oil price fluctuations of the net-oil importing in both terms, are in line with the findings of Khan et al. (2019a, b) in 13 Asian economies that energy impacts are symmetry. Furthermore, the findings that energy consumption is causing economic growth are in line with the findings of Liu (2018) in China, Mohsin et al. (2019) in Pakistan, Yorucu and Ertac Varoglu (2020) for a sample of 23 tiny island republics from different continents, Asiedu et al. (2021) in 26 European nations, Aslan et al. (2021) in 17 Mediterranean nations, Bouyghrissi et al. (2021) in Morocco, Irfan (2021) in developed and developing nations, and Malik (2021) in Turkey, but in contrast with the findings of Ranjbar et al. (2017) in South Africa that it is not causing growth but limiting it, Ahmed et al. (2019) in Myanmar on nonrenewable energy, Muhammad (2019) in the Middle East and North Africa (MENA) countries that it is not causing growth but limiting it.

From the above foregoing of how the findings of this paper are similar or different from the findings of the existing studies, it can be observed that there is only one study on MENA countries and its finding is in opposite with that of this study; however, the possible reason of why the difference in findings may be because this study conducts its estimate using a nonlinear model that allows pre-test of whether the impact is nonlinear and allows the estimate of the linear and nonlinear impacts in the same model.

Conclusion and policy recommendations

Shocks and fluctuations in energy markets have sparked various reactions at the world's economies, particularly those of the MENA countries. At the same time, previous literature on such issues assumes a symmetric relationship between and among the variables while variation in such variables may not always have the same impact on economic growth, or vice versa, thus, asymmetric, hence the reason for coming up of this paper to asymmetrically analyze the impact of disaggregated energy consumption (negative and positive impacts) and oil price fluctuations (hikes and collapse) on the economic growth of the MENA net oil-exporting and importing countries from 1990 to 2019 using panel nonlinear autoregressive distributed lag (PNARDL) model developed by Salisu and Isah (2017).

The findings revealed that for the net-oil exporting countries, the impact of nonrenewable energy consumption on economic growth is nonlinear in both the long run and short run, where in both terms, high consumption of nonrenewable energy is influencing the economic growth and its low consumption is limiting it. Furthermore, the impact of renewable energy

consumption is linear and it is influencing and limiting the economic growth in the long run and short run, respectively. Moreover, the impact of oil price fluctuations on economic growth is linear in the long run and nonlinear in the short run, where in the long run, increase in it is not influencing the economies but in the short run, its increase is influencing the economies but its decrease has no effect. For the net-oil importing countries, the impact of nonrenewable energy consumption on economic growth is nonlinear in both the long run and short run, where in the long run, high consumption of nonrenewable energy is influencing the economic growth but in the short run, it is discouraging the growth of the economies; however, in both terms, low consumption of nonrenewable energy has no effect. Furthermore, in the long run, the impact of renewable energy consumption is nonlinear but linear in the short run; however, none of its impacts is significant in both terms. Moreover, the impact of oil price fluctuations on economic growth is linear in both terms and in the both terms, it is influencing the economies.

Considering the findings, the paper offers the following recommendations. With regard to the evidence of asymmetry in the impact of nonrenewable energy consumption on the economic growth of both the MENA net-oil exporting and importing countries, that of the renewable energy of the MENA net-oil importing countries in the long run, and oil price fluctuations of the net-oil exporting in the short run, the respective regions should give unequal weights to policies aimed at increasing or stabilization of the variables and counter policies aimed to tackle decrease or deterioration of those variables. Furthermore, the MENA net oil-exporting and importing countries could maintain their statuesque with possible improvement in managing the nonrenewable energy sector as the current status is improving the economy. Moreover, renewable energy sectors in both the MENA net oil-exporting and importing countries need to be adjusted and developed so that they will be stimulating the growth the economies which will aid the countries in terms of energy-saving costs, as well as contributing their quarter in maintaining the world statuesque of reducing greenhouse gas emission, thus, keeping the global temperature to a minimum. Additionally, the MENA net oil-exporting and importing countries should be cautious in formulating policies aiming at reducing their consumption of nonrenewable energy in shifting from fossil fuel to green energy as doing so could retard their economies. Equally, the MENA net oil-exporting nations should be vigilant and cautious in spending the oil fortunes. In the same vein, the MENA net oil-importing countries should maintain the current statuesque in handling oil price fluctuations in the countries.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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