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Energy Consumption, Economic Growth and CO_2 Emissions: Evidence from Panel Data for MENA Region

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Abstract: Energy plays a vital role in economic development. It performs a key for sustainable development. Hence, many studies have attempted to look for the direction of causality between energy consumption (EC), economic growth (GDP) and CO_2 emissions. This paper, therefore, applies the panel unit root tests, panel cointegration methods and panel causality test to investigate the relationship between EC, GDP and CO_2 emissions for 15 MENA countries covering the annual period 1973-2008. The finding of this study reveals that there is no causal link between GDP and EC; and between CO_2 emissions and EC in the short run. However, in the long run, there is a unidirectional causality running from GDP and CO_2 emissions to EC. In addition, to deal with the heterogeneity in countries and the endogeneity bias in regressors, this paper applies respectively the FMOLS and the DOLS approach to estimate the long-run relationship between these three factors.

Keywords: MENA countries; Energy consumption; Economic growth; CO_2 emissions; Panel cointegration; Panel causality.
JEL Classification: C33; O13; Q43

1. Introduction

The worldwide concern about the threat of global warming and climate change was increasing during the last two decades. It has become a dominating question both politically and economically. One of the most questions worried out the researchers is: how can we attenuate adverse effects of climate change? The 1997 Kyoto protocol[1] had the objective of reducing greenhouse gases (GHG) that cause climate change by fixing the reduction of GHG emissions to 5.2% lower than the 1990 level during the period 2008-2012, and this came into force since 2005. There are several environmental pollutants which cause climate change, but Carbone dioxide (CO_2) still the dominant gas of total GHG in the world and in 2010 was the highest in history (IEA, 2011). The 2002 Johannesburg summit on sustainable development pointed out the harmful impact of energy on environment despite its fundamental role as an engine of economic development. It is considered the main responsible of pollutant emissions, particularly CO_2 emissions. Exploring the link between energy consumption, economic growth and CO2 emissions become the challenge of recent studies since energy use is being considered as the best tool to obtain sustainable development. Despite the MENA countries didn't sign the Kyoto protocol since they are developing countries, theses countries have to face the same challenges of reducing pollutant emissions and improving energy use and economic development by the way. Reaching these challenges remain difficult to meet in MENA countries since they are still in need of economic growth based essentially on energy use, main source of pollutant emissions.

The MENA region benefits from abundant human and natural resources and it accounts for a large share of world petroleum production and exports. About two thirds of the world's known crude-oil reserves exist in MENA region, with one quarter located in Saudi Arabia. The Islamic Republic of

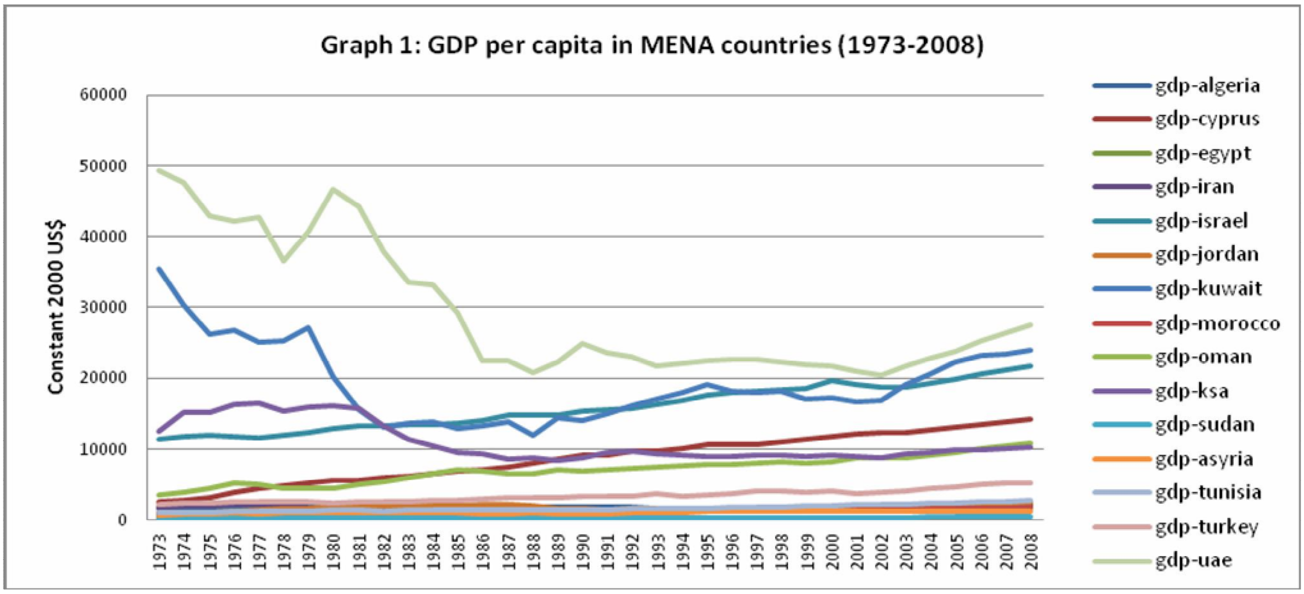
[1] Source : http://unfccc.int/kyoto_protocol/items/2830.php

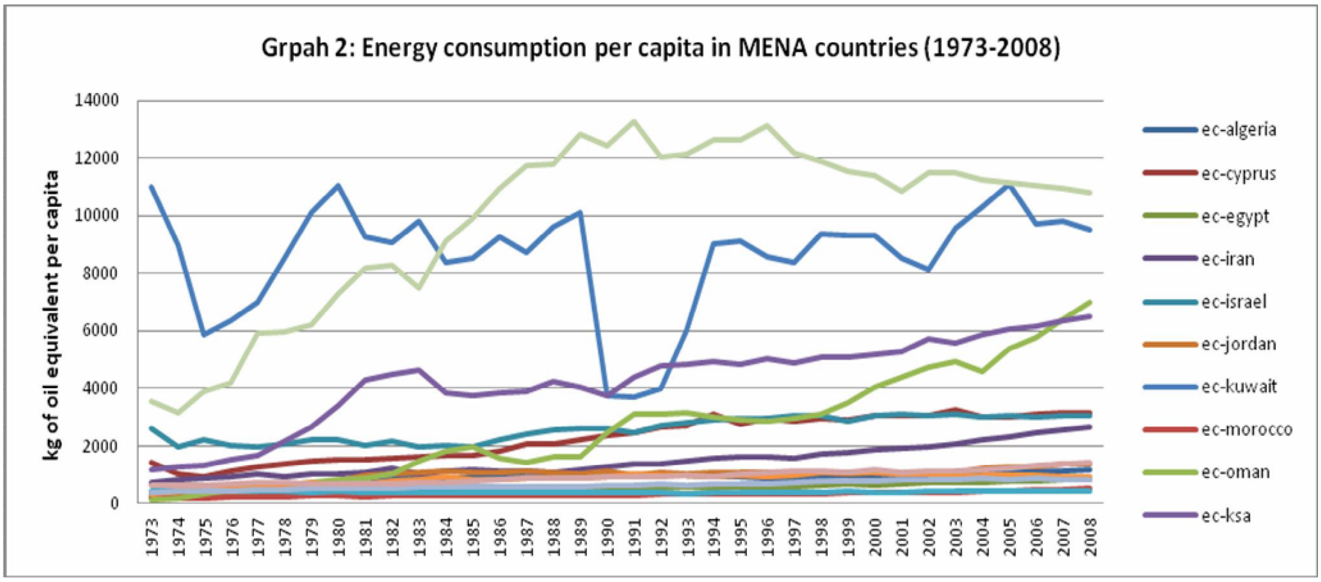
Iran has the about 15 percent of the world's total reserves of natural gas. The region also possesses several non-fuel mineral and non-mineral resources. In fact, Algeria, Morocco, Tunisia, Jordan, and the Syrian Arab Republic account for about one third of the world's phosphate production. Morocco alone has more than 30 percent of the world's phosphate rock and 40 percent of its phosphoric acid trade. The Islamic Republic of Iran possesses several natural resources such as potash, coal, ammonia and urea. Also Israel and Jordan possess potash, Mauritania has iron, and Qatar possesses ammonia and urea. We find copper and gypsum in Mauritania, cotton in Egypt and Sudan, tobacco in the Syrian Arab Republic, and coffee in the Republic of Yemen. In addition, almost all the GCC countries have coasts and fishing grounds (Al-Iriani, 2006).

We note that the region countries vary substantially in resources, economic and geographical size, population, and standards of living. Besides, intra-regional interaction is weak, being restricted principally to labor flows, with limited trade in goods and services.

MENA countries especially trade with industrial economies. Their partners are the United States, Japan but the most important partners are EU countries.

The following graphs (1-3) reveal the evolution of the three variables, GDP, energy consumption and CO2 emissions in 15 MENA countries during 1973-2008.



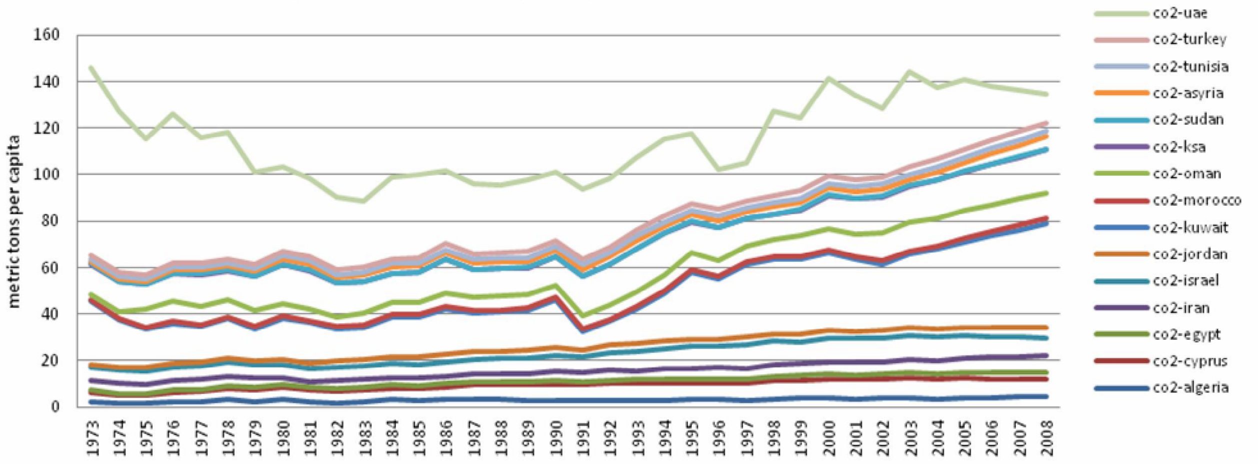


Following theses three graphs, we distinguish a first group from countries (Sudan, Morocco, Egypt, Tunisia, Turkey, Jordan) which present a similar evolution during the period with almost stable consumption energy, lower than 2000 kg of oil equivalent per capita in the end of the period. Morocco and Sudan present the weakest per capita consumption of energy while Jordan and Turkey are the more consumers within this group. The CO_2 emissions in these countries did not cease recording a growth during the studied period, a growth justified by the increased requirements in energy by these countries.

The second group made up of Iran, Israel and Cyprus records a per capita energy consumption which did not cease increasing during the period until to be stabilized around 3000 kg of oil equivalent per capita in 2008. Their CO_2 emissions per capita remain nevertheless relatively weakest compared with the other countries of the area.

The third group joins together the countries which considerably increased their energy consumption exceeding 6000 kg of oil equivalent per capita during the last years. Kuwait and the UEA are the largest consumers of energy. The brutal fall recorded by the consumption of energy in Kuwait was due to the war in this country during the invasion of Iraq beginning of the Nineties.

Graph 3: CO2 emissions per capita in MENA countries (1973-2008)



The UEA is the country which emits the most CO_2 per capita relatively to the other countries of the MENA region, even if this emission knew a fall during the years 2000.

From all that, we deduce that the consumption of energy seems to be the principal source of the CO_2 emissions since the two curves follow the same tendencies for the countries of this region during 1973-2008. Besides, most countries exhibit a positive correlation between growth and energy consumption and between growth and CO_2 emissions.

These conclusions formulated by considering the graphs 1-3 push us to study the bonds of causality between the economic growth, energy consumption and CO_2 emissions in an integrated framework for 15 MENA countries.

The rest of the paper is organized as follows. The next section presents a brief review of the literature on causality link between energy consumption, economic growth and CO_2 emissions. Section 3 describes the data and methodology. Section 4 highlights the empirical results and the last one concludes and states the policy implications of the results.

2. Literature Review

The relationship between energy consumption and economic growth, as well as economic growth and environmental pollution, has been the subject of intense research during the last decades. Studies in this field may be divided into three lines of research.

The first focuses on the relationship between economic growth and energy consumption dating back to the pioneering work by Kraft and Kraft (1978) and leading to the use of Granger causality test approach as a tool for studying the relationship between energy consumption and economic growth in different countries, e.g. Stern (1993), Aqeel and Butt (2000), Yuan and al. (2008), Ghosh (2010), Lau et al., (2011), Binh (2011), and Kaplan et al., (2011). A detailed literature review on energy-growth relationship can be found in the study of Ozturk (2010).

The second line of research focuses on the relationship between economic growth and environment, discussing the inverted U-shaped relationship between environmental pollutants and economic growth by testing the validity of environmental Kuznets curve (EKC) hypothesis. The empirical studies carried out by several authors drew different conclusions. Selden and Song (1994) and Galeotti, Manera and Lanza (2009) provided empirical evidences on the validity of EKC hypothesis. However, Holtz-Eakin and Selden (1995) found a monotonic rising curve and Friedl and Getzner (2003) found an N-shaped curve. On the other hand, Agras and Chapman (1999) and Richmond and Kaufman (2006) concluded that there is no significant relationship between economic growth and environmental pollutants.

The third line of research investigates the relationships between pollutant emissions, energy consumption and economic growth by considering them simultaneously in a modeling framework. These studies have attempted to analyze the causal relationships between theses three variables by combining the literature on EKC with the energy consumption-growth literature (Richmond and Kaufman, 2006; Soytas et al., 2007; Ang, 2007; Soytas and Sari, 2009; Akbostanci et al., 2009; Acaravci and Ozturk, 2010; Apergis and James, 2010; Ozturk and Acaravci, 2010; Arouri et al., 2011; and Wang et al., 2011).

Some earlier panel studies reveal different results which depend upon the countries and the period held in the analysis, as well as the econometric techniques used.

Apergis and James (2010) explore the relationship between carbon dioxide emissions, energy consumption and real output for 11 countries of the Commonwealth of independent states over the period 1992-2004. They found that in the long-run, energy consumption has a positive and statistically significant impact on carbon dioxide emissions while real output follows an inverted U- shape pattern associated with the Environmental Kuznets Curve (EKC) hypothesis. They found bidirectional causality between energy consumption and CO2 emissions in the long run. But the short run dynamics reveal a unidirectional direction from energy consumption and real output, respectively, to carbon dioxide emissions and bidirectional causality between energy consumption and real output.

Acaravci and Ozturk (2010) investigate the dynamic relationship between these variables for 19 European countries by using autoregressive distributed lag (ARDL) bounds cointegration analysis developed by Pesaran and Shin (1999) and Pesaran et al., (2001), and error correction based Granger causality models. The bounds F-test for cointegration test yields evidence of a long-run relationship between carbon emissions per capita, energy consumption per capita, real gross domestic product (GDP) per capita and the square of per capita real GDP only for Denmark, Germany, Greece, Iceland, Italy, Portugal and Switzerland. Also, the cumulative sum and cumulative sum of squares tests reveal that the estimated parameters are stable for the sample period.

Wang et al., (2011) confirm the existence of a relationship between the three variables using panel cointegration and panel vector error correction modeling techniques based on the panel data for 28 provinces in China during 1995-2007. They found bidirectional causality between CO2 emissions and energy consumption as well as between energy consumption and economic growth. The authors also found that energy consumption and economic growth are the long-run causes for CO2 emissions and CO2 emissions and economic growth are the long-run causes for energy consumption.

In another study, Arouri et al., (2012) tried first to verify the existence of EKC in 12 MENA Countries over the period 1981–2005 and, second to characterize the turning points until which the development improves the environmental quality in these countries. Their results provide poor evidence in support of the EKC hypothesis for MENA countries suggesting that not all MENA countries need to sacrifice economic growth to decrease their emission levels but they may achieve CO_2 emissions reduction via energy conservation without negative long run effects on economic growth. Finally, and by using panel unit root tests and cointegration techniques to investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for the 12 MENA countries, they found that energy consumption has a positive significant impact on CO_2 emissions in the long-run and that real GDP exhibits a quadratic relationship with CO_2 emissions for the region as a whole.

Al-Mulali (2011) uses a panel model for the MENA countries during the period 1980-2009. Based on cointegration test results, he found that CO2 emission, and oil consumption has a long- run

relationship with economic growth. The empirical results reveal also a bi-directional Granger causality between oil consumption, CO2 emission and economic growth in short and long run. The author concludes that oil consumption plays a crucial role in the economic growth of the MENA countries.
This study extend the recent works cited above by applying the panel unit root tests, panel cointegration methods and panel causality test to investigate the relationship between energy consumption, economic growth and CO_2 emissions for 15 MENA countries covering the annual period 1973-2008.

3. Data and Methodology

To study the causal relationship between economic growth energy consumption, (GDP) and CO_2 emissions we propose to pass firstly by the identification of the data and the descriptive statistics and secondly by four analysis such as the panel unit root analysis, the panel cointegration analysis, the panel causality analysis and the use of the methods FMOLS (Fully Modified OLS) and DOLS (Dynamic OLS).

3.1. Data

The variables used in this study are Energy Consumption (EC) measured in kg of oil equivalent per capita, GDP per capita measured in constant 2000 US$ and CO_2 emissions measured in metric tons per capita. These variables come from the World Development Indicators (WDI, 2010) and the SHERBROOKE University of Canada[2] and employed in their natural logarithms form to reduce the heterogeneity of data.

The annual data are selected to cover the period from 1973 to 2008 for fifteen MENA countries: Algeria, Cyprus, Egypt, Iran, Israel, Jordan, Kuwait, Morocco, Oman, Saudi Arabia, Sudan, Syria, Tunisia, Turkey and United Arab Emirates.

3.2. Descriptive statistics and econometric methodology

The most adapted methodology is that which starts with a descriptive statistics of these three variables for the fifteen MENA countries (Table.1). After that we pass to apply panel unit root analysis, panel cointegration analysis, panel causality analysis and we finish by panel fully modified ordinary least square (FMOLS) and panel dynamic ordinary least square (DOL) estimates.

Table 1. Descriptive statistics

	LNEC	*LNGDP*	*LNCO2*
Mean	7.358301	8.095186	1.595809
Median	7.059020	7.658039	1.455120
Maximum	9.494474	10.80627	4.392472
Minimum	4.792065	5.446306	-0.579818
Std. Dev.	1.054284	1.277332	1.049208
Skewness	0.250844	0.142274	0.252688
Kurtosis	2.180735	2.091851	2.314204
Jarque-Bera	20.76491	20.37830	16.32871
Probabilité	0.000031	0.000038	0.000285
Observations	540	540	540
Cross sections	15	15	15

4. Empirical Results

4.1. Panel unit root analysis

The variables properties need to avoid the possibility of spurious regressions. In order to assess the stationary of the variables employed, this paper employs five different unit root tests including LLC's test (Levin et al., 2002), Breitung (2000)'s t-statistic, IPS-W-statistic (Im et al., 2003), ADF-Fisher Chi-square (Augmented Dickey Fuller, 1979), and PP-Fisher Chi-square tests (Phillips and Perron, 1988). The results of these tests are reported in Table 2 indicating that the statistics significantly confirm that the level values of all series are non-stationary and all variables are stationary at the 5% significance level of the first difference, that is, all variables are I(1).

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[2] Source : http://perspective.usherbrooke.ca/

Table 2. Panel unit root test results

Method	LNEC	LNGDP	LNCO2
LLC-t*			
Level	-4.38869 (0.0000)**	-2.83904 (0.0023)**	-0.52404 (0.3001)
First difference	-13.4303 (0.0000)**	-13.2837 (0.0000)**	-17.9120 (0.0000)**
Breitung-t-stat			
Level	0.19253 (0.5763)	3.02268 (0.9987)	0.10280 (0.5409)
First difference	-6.18153 (0.0000)**	-8.84284 (0.0000)**	-10.8618 (0.0000)**
IPS-W-stat			
Level	-5.25337 (0.0000)**	-1.47048 (0.0707)	-1.24541 (0.1065)
First difference	-13.2486 (0.0000)**	-14.4181 (0.0000)**	-17.5734 (0.0000)**
ADF-Fisher Chi-square			
Level	88.1102 (0.0000)**	60.5225 (0.0008)**	41.1376 (0.0846)
First difference	261.799 (0.0000)**	233.411 (0.0000)**	282.824 (0.0000)**
PP-Fisher Chi-square			
Level	73.6271 (0.0000)**	35.7553 (0.2162)	44.2189 (0.0456)**
First difference	503.510 (0.0000)**	205.127 (0.0000)**	580.049 (0.0000)**

Notes: LLC, IPS, ADF-Fisher and PP-Fisher examine the null hypothesis of non-stationarity, and ** indicates statistical significance at the 5% level. Probabilities for Fisher-type tests were computed by using an asymptotic χ^2 distribution. All other tests assume asymptotic normality. The lag length is selected using the Modified Schwarz Information Criteria. All variables are in natural logarithms (LN).

4.2. Panel cointegration analysis

To determine whether the regressions are spurious, the results of the panel cointegration tests must be examined. Given the results, it is appropriate to test the cointegrating relationship between the three variables. This paper employs three kinds of panel cointegration tests, i.e. Pedroni's (2004), Kao's (1999), and Johansen's (1988) Fisher panel cointegration tests. A panel cointegration model of energy consumption, which allows for considerable heterogeneity, is implemented as follows:

$$LNEC_{i,t} = \alpha_i + \beta_i LNGDP_{i,t} + \delta_i LNCO2_{i,t} + e_{i,t} \quad ; \quad i=1,\ldots,N \text{ and } t=1,\ldots,T \tag{1}$$

As shown in Table 3, the results of Pedroni's (2004) heterogeneous panel tests indicate that the null of no cointegration can be accepted at the 5% significance level except for the panel PP-statistic and the group PP-statistic.

Table.3: Pedroni (2004)'s residual cointegration test results (LNEC as dependent variable)

	Test statistic	Prob.		Test statistic	Prob.
Within-dimension			**Between-dimension**		
Panel υ-stat	0.300635	0.3813			
Panel r-stat	0.034778	0.3987	Group r-stat	-0.503907	0.3514
Panel PP-stat	-2.860317**	0.0067	Group PP-stat	-3.540408**	0.0008
Panel ADF-stat	-0.629855	0.3272	Group ADF-stat	0.000800	0.3980

Notes: The null hypothesis is that the variables are not cointegrated. Under the null tests, all variables are distributed normal (0, 1). ** indicates statistical significance at the 5% level.

Table 4 reports the results of Kao's (1999) residual panel cointegration tests, which also reject the null of no cointegration at the 5% significance level.

Table 4. Kao (1999)'s residual cointegration test results (LNEC as dependent variable)

	t-statistic	Prob.
ADF	-5.201604**	0.0000

Note: ** indicates statistical significance at the 5% level.

Finally, the results of Johansen's (1988) Fisher panel cointegration test reported in Table 5, are based on Fisher's tests (trace test statistics) and support the presence of a cointegrated relationship between the three variables at the 5% significant level, respectively. Thus, we conclude the existence of a panel long- run equilibrium relationship between these three variables, meaning that energy consumption, real income (GDP), and the CO_2 emissions move together in the long run.

Table 5. Panel cointegration test results of Fisher test using an underlying Johansen (1988)'s methodology

	Fisher statistic (from trace test)	Prob.
None	111.5**	0.0000
At most 1	43.08	0.0577
At most 2	30.18	0.4563

Notes: Asymptotic p-values are computed using χ^2 distribution. ** indicates statistical significance at the 5% level. Fisher (1932)'s test applied regardless of the dependent variable.

4.3. Panel causality analysis

A panel-based on error correction model (ECM) followed by the two steps of Engle and Granger (1987) is employed to investigate the long-run and short-run dynamic relationships. The first step estimates the long-run parameters in Eq. (1) in order to obtain the residuals corresponding to the deviation from equilibrium. The second step estimates the parameters related to the short-run adjustment. The resulting equations are used in conjunction with panel Granger causality testing:

$$\Delta LNEC_{i,t} = \theta_{1,i} + \sum_{k=1}^{m} \theta_{1,1,i,k}.\Delta LNEC_{i,t-k} + \sum_{k=1}^{m} \theta_{1,2,i,k}.\Delta LNGDP_{i,t-k} + \sum_{k=1}^{m} \theta_{1,3,i,k}.\Delta LNCO2_{i,t-k} + \lambda_{1,i}.ECT_{i,t-1} + u_{1,i,t} \quad (2)$$

$$\Delta LNGDP_{i,t} = \theta_{2,i} + \sum_{k=1}^{m} \theta_{2,1,i,k}.\Delta LNEC_{i,t-k} + \sum_{k=1}^{m} \theta_{2,2,i,k}.\Delta LNGDP_{i,t-k} + \sum_{k=1}^{m} \theta_{2,3,i,k}.\Delta LNCO2_{i,t-k} + \lambda_{2,i}.ECT_{i,t-1} + u_{2,i,t} \quad (3)$$

$$\Delta LNCO2_{i,t} = \theta_{3,i} + \sum_{k=1}^{m} \theta_{3,1,i,k}.\Delta LNEC_{i,t-k} + \sum_{k=1}^{m} \theta_{3,2,i,k}.\Delta LNGDP_{i,t-k} + \sum_{k=1}^{m} \theta_{3,3,i,k}.\Delta LNCO2_{i,t-k} + \lambda_{3,i}.ECT_{i,t-1} + u_{3,i,t} \quad (4)$$

where the term Δ denotes first differences; $\theta_{j,i,t}$ (j=1,2,3) represents the fixed country effect; k (k=1,…,m) is the optimal lag length determined by the Schwarz Information Criterion; and $ECT_{i,t-1}$ is the estimated lagged error correction term derived from the long-run cointegrating relationship of Eq. (1), in which $ECT_{i,t} = LNEC_{i,t} - \hat{\beta}_i LNGDP_{i,t} - \hat{\delta}_i LNCO2_{i,t}$. The term $\lambda_{j,i}$ (j=1,2,3) is the adjustment coefficient and $u_{j,i,t}$ is the disturbance term assumed to be uncorrelated with zero means.

Table 6. Panel causality test results

Dependent variable	*Sources of causation (Independent variable)*			
	Short run			*Long run*
	ΔLNEC	*ΔLNGDP*	*ΔLNCO2*	*ECT*
ΔLNEC	-	0.51431 (0.4736)	0.41963 (0.5174)	9.92842 (0.0000)**
ΔLNGDP	2.74003 (0.0984)	-	0.55781 (0.4555)	0.37624 (0.5426)
ΔLNCO2	4.68020 (0.0310)**	0.26403 (0.6076)	-	2.90866 (0.0930)

Notes: Figures denote F-statistic values. P-values are in parentheses. ECT indicates the estimated error-correction term.
** indicates statistical significance at the 5% level

As shown in Table 6, we cannot find evidence of short-run causality running from LNGDP and LNCO2 to LNEC. We note also that, in accordance with this result, energy consumption will not be influenced by economic growth and CO_2 emissions. In addition, there is only a short-run causality running from LNEC to LNCO2. Furthermore, the results indicate that an increase in energy consumption may lead to the income and the CO_2 emission, and that the policies for reducing energy consumption may not retard economic growth and income. In the long run, only the estimated coefficient of ECT in the energy consumption equation is significant, implying that energy consumption could play an important adjustment factor as the system departs from the long-run equilibrium.

4.4. Panel OLS, FMOLS and DOLS estimates

Pedroni (2001, 2004) suggested more powerful test compared to single equation methods which investigates directly the condition on the cointegrating vector that is required for strong relation to hold. Furthermore, these methods allow us to pose the null hypothesis in a more natural form, so that we test whether or not strong relationship between energy consumption, economic growth and CO_2 emissions holds consistently for all countries of the panel. Our models are based on the regression between these three factors as presented in Eq. (1), where the energy consumption and the economic growth slopes β_i with as well as the energy consumption and the CO_2 emissions slopes δ_i, which may or may not be homogeneous across i.

$$LNEC_{i,t} = \alpha_i + \beta_i.LNGDP_{i,t} + \delta_i.LNCO2_{i,t} + \sum_{k=-K_i}^{K_i} \phi_{i,k}.\Delta LNGDP_{i,t-k} + \sum_{k=-K_i}^{K_i} \varphi_{i,k}.\Delta LNCO2_{i,t-k} + \varepsilon_{i,t} \tag{5}$$

OLS, FMOLS and DOLS test results are reported in Table 7. This table reports the results of individual and panel OLS, FMOLS and DOLS which indicates that whether economic growth and CO_2 emissions stimulate energy consumption or not in MENA countries. Individual OLS, FMOLS and DOLS estimates and the respective t-statistics for H_o: β_i = 1 are provided in the first 15 entries, while results for the panel estimators are shown at the bottom of the table.

Table 7. OLS, FMOLS DOLS estimates for MENA countries (LNEC as dependent variable)

	LNGDP			***LNCO2***		
Country	***OLS***	***FMOLS***	***DOLS***	***OLS***	***FMOLS***	***DOLS***
Algeria	1.151752**	0.744552	0.859525	0.821824**	1.066094**	1.092564**
Cyprus	0.140630	0.144254	0.432256	1.091795**	1.127924**	0.704437
Egypt	1.431668**	1.588599**	1.368452**	-0.174678	-0.320819	-0.159623
Iran	-0.970720**	-1.004857**	-0.930040**	1.430511**	1.512976**	1.423080**
Israel	0.323313**	0.401183**	0.401183**	0.429073**	0.400466**	0.400466**
Jordan	0.207357**	0.166784	0.166784	0.842639**	0.840772**	0.840772**
Kuwait	0.017406	-0.133662	-0.133662	0.359539**	0.381042**	0.381042**
Morocco	0.241627**	0.155722	0.155722	0.637267**	0.692909**	0.692909**
Oman	3.325720**	3.214382**	3.214382**	-0.005964	-0.033346	-0.033346
KSA	-1.459520**	-1.380601**	-1.372710**	1.248258**	1.411960**	1.492538**
Sudan	0.949054**	1.078695	1.238313	0.829502	0.943832	0.677401
Syria	0.389076	0.310683	0.319519	0.575186**	0.568836**	0.517927**
Tunisia	0.442829**	0.409770**	0.391524**	0.468405**	0.504313**	0.570541**
Turkey	0.618565**	0.605767**	0.603556**	0.320711**	0.335675**	0.340094**
UAE	-0.932482**	-0.912945**	-0.777997**	-0.360185**	-0.418848**	-0.468658**
Panel	0.305198**	0.294265**	0.279302**	0.457827**	0.471758**	0.483903**

Notes: Asymptotic distribution of t-statistic is standard normal as T and N go to infinity.
** Indicates that the parameter is significant at the 5% level.

The results from both the individual tests and the panel tests overwhelmingly reject the null hypothesis of strong relation which runs from GDP and CO_2 emissions to EC. Starting by the relationship runs from GDP to EC and among the individual country tests, data from all countries produce rejections at the 5% level for the OLS except Cyprus, Kuwait and Syria. In the same line, data from all countries produce rejections at the 5% level for the FMOLS except Algeria, Cyprus, Jordan, Kuwait, Morocco, Sudan and Syria. On the other hand, data from all countries produce rejections at the 5% level for the DOLS except Algeria, Cyprus, Jordan, Kuwait, Morocco, Sudan and Syria. Moreover, there is a positive relationship between EC and GDP for all these countries except for Kuwait. It means that as GDP increases, EC will increase at least for these six countries. In most cases, the results of the FMOLS and DOLS are in agreement.

For the relationship runs from CO_2 to EC and among the individual country tests, data from all countries produce rejections at the 5% level for the OLS except Egypt, Oman and Sudan. In the same line, we find the same result for the FMOLS, but for the DOLS, we except Cyprus too and we will obtain four countries: Cyprus, Egypt, Oman and Sudan.

For the panel tests, it is observed that the strong relationship which runs from GDP to EC and from CO2 to EC was overwhelmingly rejected.

5. Conclusion and Policy Implications

The principal aim of this paper was to seek for the linkages among energy consumption, economic growth and carbon emissions in 15 MENA countries and during the period starting from 1973 to 2008. We employed in this study the panel unit root, panel cointegration method and panel causality test. Our panel cointegration test reveal the existence of a panel long- run equilibrium relationship between energy consumption, real income (GDP), and the CO_2 emissions, meaning that these three variables move together in the long run.

A panel-based on error correction model (ECM) followed by the two steps of Engle and Granger (1987) was employed to investigate the long-run and short-run dynamic relationships. In sum, our empirical results show that in the short run, there is no evidence of short-run causality running from economic growth and CO_2 emissions to energy consumption. But we found a short-run causality running from energy consumption to economic growth and CO_2 emissions. The results indicate that an increase in energy consumption may lead to increase in the income and the CO_2 emission. Furthermore, we can say that the policies attempting to consume more efficient energy may not retard economic growth and income. In fact and in the long run, only the estimated coefficient of ECT in the energy consumption equation is significant, implying that energy consumption could play an important adjustment factor as the system departs from the long-run equilibrium. The policymakers should then take into consideration the degree of economic growth in each country when energy consumption policy is formulated.

We then test whether or not strong relationship between energy consumption, economic growth and CO_2 emissions holds consistently for all countries of the panel by doing individual and panel OLS, FMOLS and DOLS. The results show that for some countries (Algeria, Cyprus, Jordan, Morocco, Sudan and Syria), a high level of economic growth leads to high level of energy-demand of energy explaining the strong relationship between energy consumption and economic growth. For the relationship runs from CO_2 to EC and among the individual country tests, data from all countries produce rejections at the 5% level for the OLS except Egypt, Oman and Sudan. In the same line, we find the same result for the FMOLS, but for the DOLS, we except Cyprus too and we will obtain four countries: Cyprus, Egypt, Oman and Sudan. For the panel tests, it is observed that the strong relationship which runs from GDP to EC and from CO2 to EC was overwhelmingly rejected.

The empirical results of this study provide policymakers a better understanding of energy consumption–economic growth nexus and energy consumption-CO_2 emissions nexus to formulate energy and climate policies in these countries. The examination of the causal relationship between energy consumption and economic growth has important policy implications. When energy consumption leads growth positively, it suggests that the benefit of energy use is greater than the externality cost of energy use. Conversely, if an increase in economic growth brings about an increase in energy consumption, the externality of energy use will set back economic growth. Under this circumstance, a conservation policy is necessary. The findings of this study have important policy implications and it shows that this issue still deserves further attention in future research.

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