Electricity consumption and economic growth nexus: Evidence from MENA countries

Bouoiyour, Jamal and Selmi, Refk

CATT, University of Pau, ECCOFIGES, High school of trade of Tunis

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Prepared by:

Jamal Bouoiyour [a] and Refk Selmi [b1]

[a] CATT, University of Pau.
[b] ECCOFIGES, High School of Trade of Tunis.

Abstract

The objective of this study is to investigate the causality between electricity consumption and economic growth for a panel of twelve MENA countries (seven energy exporters and five energy importers) over the period 1975–2010 within a bivariate framework. To examine this linkage, we applied panel cointegration methods and panel causality test. Our results show that 16.66% of MENA countries supported the growth hypothesis, 25% the conservation hypothesis, 33.33% the feedback hypothesis and 25% the neutrality hypothesis. Furthermore, we found that 14.28% of MENA energy exporters supported the growth hypothesis at the same way of conservation hypothesis, 42.88% the feedback hypothesis and 28.57% the neutrality hypothesis. Thereafter, we argue that Iran and Turkey are leaders in terms of the interaction between energy usage and growth. This may be mainly due to a good structuring of the electricity sector. This favorable position of these economies comparable to the rest of MENA countries leads to an essential recommendation which is the reorganization of the electricity sector.

Keywords

Electricity consumption, growth, cointegration, causality, MENA countries.

[1] Authors'adresses: CATT-UPPA, Avenue du Doyen Poplawski BP 1633, 64016 Pau, Cédex.
Tel : (33) 5 59 40 80 01
Corresponding authors: jamal.bouoiyour@univ-pau.fr or s.refk@yahoo.fr

1. Introduction

The relationship between electricity consumption and economic growth has been the subject of intense research during the last decades for American countries (e.g. Apergis and Payne (2009) and Apergis and Payne (2010)) Asian countries (e.g. Yoo (2006), Yuan et al. (2007), Gosh (2009) and Niu et al. (2011)), European countries (e.g. Narayan and Parasad (2008), Beck et al. (2011) and Dobnick (2011)) and MENA countries (e.g. Al-Mulati (2011), Ozturk et al. (2010), Acaravci and Ozturk (2011) and Arouri et al. (2012)). Appendix A provides a chronological list of the literature on the causal linkage between electricity consumption and economic growth by the nature of countries (American versus Asian versus European versus MENA countries, developed versus developing countries, upper income versus lower income countries, energy importing versus energy exporting countries, energy importers with high GDP versus importers with low GDP, energy exporters with high GDP versus exporters with low GDP and OECD countries versus non-OECD countries, etc…).[2]

Studies in this field propose four hypothesis for the possible outcomes of causality : First, *the growth hypothesis* suggests that energy consumption is a crucial component in growth, the energy consumption is a factor of production. For this case, each economy is called energy dependent which a decrease in energy consumption causes a decrease of growth rate. Second, *the conservation hypothesis* yields that lower energy consumption may have little effect on growth. This hypothesis is based on a uni-directional causal relationship running from growth to energy consumption. Third, *the feedback hypothesis* shows that we should take into account not only the effect of energy consumption on growth but also the impact of real GDP on energy consumption by implementing regulations to reduce energy use. This hypothesis is based on a bi-directional causal relationship running from growth to energy consumption. Finally, *the neutrality hypothesis* reveals that energy consumption has not any impact on real GDP (e.g. Dobnik, 2011).

From the review of theoretical and empirical studies on the link energy consumption-growth nexus, we note that the flowing results tend to vary by the hypothesis considered above and empirical approaches. It is also noted that despite the large number of studies on this subject and the different types of empirical methods that were used (cointegration analysis and Granger tests…), there's still analytical gaps especially methodological.

Acaravci and Ozturk (2011) investigate the dynamic linkage between energy consumption and growth rate in selected European countries using cointegration analysis developed by Pesaran and Shin (1999), and Granger causality test. The cointegration test results show that there is no cointegration and causal relationship between the electricity consumption and the economic growth in three MENA selected countries (Iran, Morocco and Syria). However, the cointegration and causal relationship is found for the rest of selected countries (Egypt, Israel, Oman and Saudi Arabia). Hence, the results show that there is no

[2] For more detailed analysis, we can see a survey of literature advanced by Payne (2010) on the relationship between electricity consumption and growth.

relationship between the electricity consumption and the economic growth in most of the MENA countries. More precisely, the energy conservation policy of MENA countries can have a little or no powerful impact on economic growth.

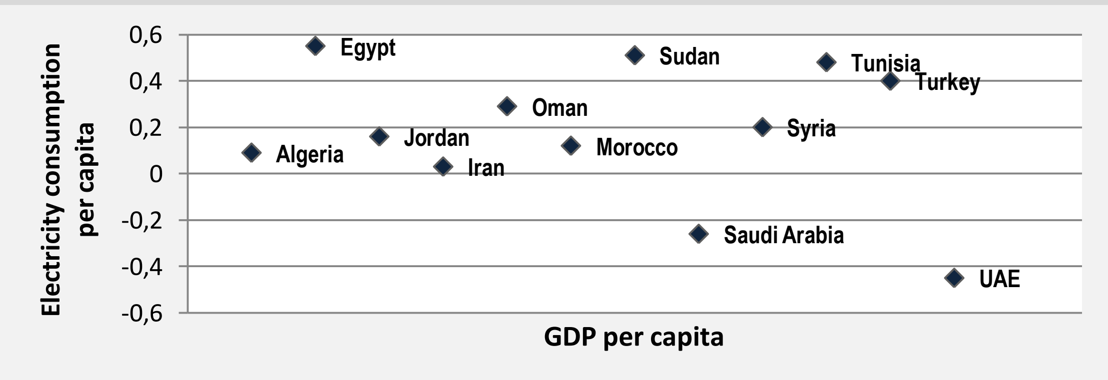
In the same context, Al-Mulali (2011) indicated that energy consumption plays a crucial role in the economic growth of MENA countries. To examine this linkage, he used a panel model based on cointegration and causality tests. Wang *et al.* (2011) confirmed the important role of electricity consumption in growth using panel cointegration techniques for selected provinces of China. They show that economic growth is the long-run cause for energy consumption and vice versa, i.e. they found bidirectional causality between both series.

With the exception of the studies by Mahadevan and Asafu (2007) and Arouri *et al.* (2012), the previous studies pertaining to MENA countries evaluated the linkage between energy consumption and economic growth with a bivariate framework. In this context, Apergis and Payne (2010) examine the interaction between electricity consumption and economic growth within a multivariate framework by including measures of real gross fixed capital formation and labor force. They argue the existence of short-run and long-run causality from energy consumption to economic growth in a panel of nine South american countries which supports the growth hypothesis. Janesh (2011) used also a multivariate causality between electricity consumption per capita, GDP per capita and exports.

Further, there are also some panel data studies on the relationship between growth and specific components of energy consumption such as coal (e.g. Apergis and Payne, 2010), electricity (e.g. Narayan and Smyth (2009), Acaravci and Ozturk (2010) and Apergis and Payne (2011)), nuclear energy (e.g. Lee and Chiu, 2011), and renewable energy (e.g. Sadorsky, 2009).

This study extend the recent works cited below by applying a panel cointegration methods and panel causality test to investigate the relationship between electricity consumption and economic growth in 12 MENA countries with different degrees of dependency of economic growth to electricity consumption (see Figure 1) from 1975 to 2010.

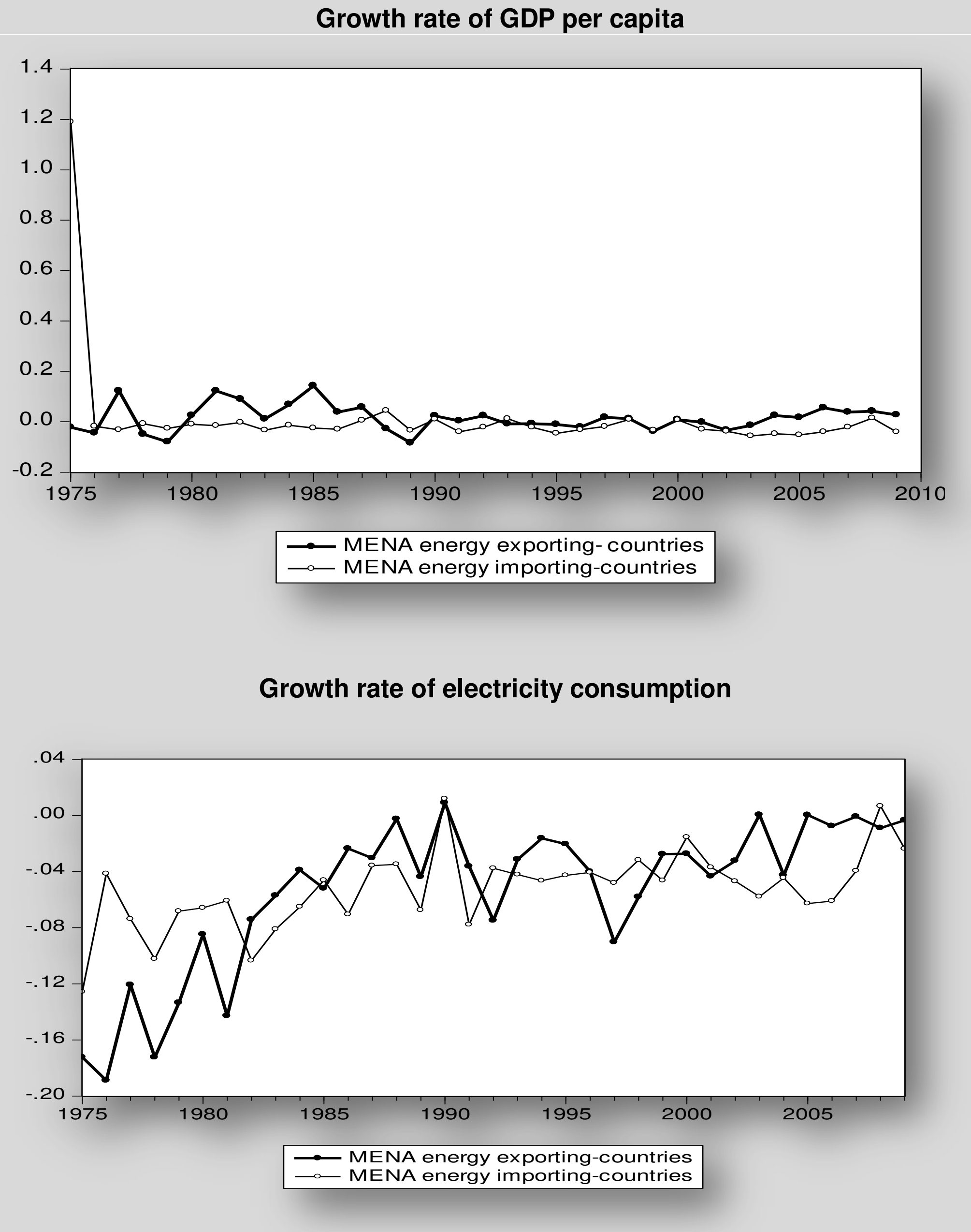
Figure 1. The dependence of growth to electricity consumption in MENA countries



Source : Usherbrooke data and authors'calculation.
Energy-exporting countries: Algeria, Egypt, Iran, Saudi Arabia, Syria, Oman and UAE.
Energy-importing countries : Jordan, Morocco, Sudan, Tunisia, Turkey.

The present paper will consider the relationship between electricity consumption and growth by distinguishing between this link in energy exporters and that in energy importers to provide more accurate results. Figure 2 shows that the first correlation between electricity consumption and economic growth in energy importers is greatly different to that of energy exporters.

Figure 2. The evolution of economic growth and electricity consumption



Source : Usherbrooke data and authors'calculation.

Our paper has two main objectives : The first one is to establish if the electricity consumption per capita and economic growth per capita are cointegrated; implying that there is a long run relationship between these variables. Then, we investigate the causal relationship between electricity consumption and economic growth within a Vector Error Correction Model. If there is uni-directional causality from electricity consumption to economic growth, i.e. growth hypothesis is supported, this would imply that electricity consumption has significant influence on economic growth directly. If there is unidirectional causality from economic growth to electricity consumption, the conservation hypothesis is supported and a decrease in electricity consumption will have a little impact on economic growth. If there is bidirectional causality between electricity consumption and economic growth, we support feedback hypothesis. In this case, the decrease in electricity consumption will affect economic growth by economic fluctuations pass-through to energy consumption and vice versa. Finally, if there is no causality between electricity consumption and economic growth, the neutrality hypothesis is supported. This can emerge various questions as starting points of our study : *Is electricity consumption a stimulus for economic growth ? Does economic growth can increase electricity usage ? What differences between energy importers and energy exporters in terms of this relationship ? What do we know and what do we need to know ?* The answers to these questions will be the contribution of our paper.

Hence, the remainder of this paper is organised as follows. Section 2 is an overview of the evolution of energy consumption and economic growth in MENA countries. In section 3, we find a details on the methods used in this study and then, we provide empirical results. Section 4 presents the main economic implications of the considered linkage. Section 5 concludes the paper.

2. A brief overview of energy consumption and economic growth in MENA countries

MENA countries are very diverse regarding their structure. Thus, we can classify MENA countries according to their GDP and energy import and export dependency. From Table 1, we found that Jordan, Morocco and Tunisia are all importers with low GDP, except Turkey having a high GDP. Oman, Saudi Arabia and the UAE are exporters with a high GDP, while Algeria, Egypt, Iran and Syria are low GDP exporters, Figure 2 confirms high GDP for energy exporters than energy importers from 1975 to 2010.

Table 1. The energy sector and per capita GDP among MENA countries

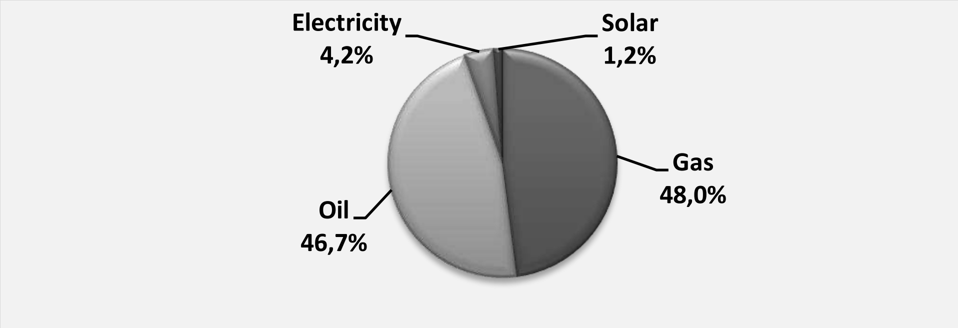
	High GDP	**Low GDP**
Energy importers	Turkey	Jordan, Morocco, Sudan, Tunisia
Energy exporters	Oman, Saudi Arabia, UAE	Algeria, Egypt, Iran, Syria

Source : IMF (various reports).

Furthermore, Algeria, Egypt, Iran and Syria and (to a lesser extent) Tunisia use large shares of domestically produced gas and some oil, whereas Jordan, Morocco, Sudan and Turkey largely depend on imports. Saudi Arabia's fuel mix consists of a 100% use of oil, whereas Oman and the United Arab Emirates predominantly uses domestically produced gas (e.g. Bouoiyour and Selmi, 2012).

It is also remarkable in Figure 3 that the MENA region is very heterogeneous with respect to the energy sector. The total consumption for energy usage has increased in 2009 by 47% since 2000 (e.g. EIA report, 2010). The following graph shows that in MENA countries, there is a dominance of oil and gas with a 46.7% share of oil and 48.0% share of gas used for heat. The electricity sub-sector contributes to a 4.2% of total final energy consumption. The solar sub-sector provides 1.2% of final energy consumption.

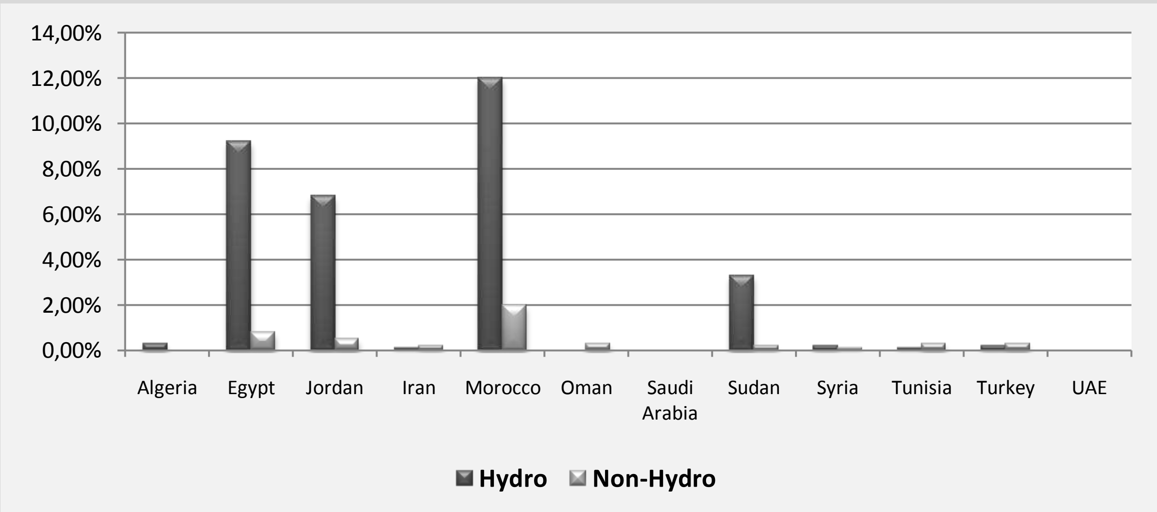
Figure 3. Mix of final energy consumption in MENA countries



Source : Energy Information Administration Data (EIA), 2010.

In addition, the total of electricity generation in MENA countries grew by an average of 6.3% per year (e.g. EIA report, 2010). Figure 4 shows that Hydro power grew more slowly than other renewable electricity. The contribution from hydro is dominated in Egypt and Morocco (12%, 9.2%, respectively) and to lesser extent from Tunisia by 0.1%. Besides, non-hydro renewable electricity was concentrated in Egypt, Jordan, Morocco, Tunisia and Turkey (0.8%, 0.5%, 2.0%, 0.3%, 0.3%, respectively). Other MENA countries don't report any non-hydro generation (e.g. Saudi Arabia and UAE).

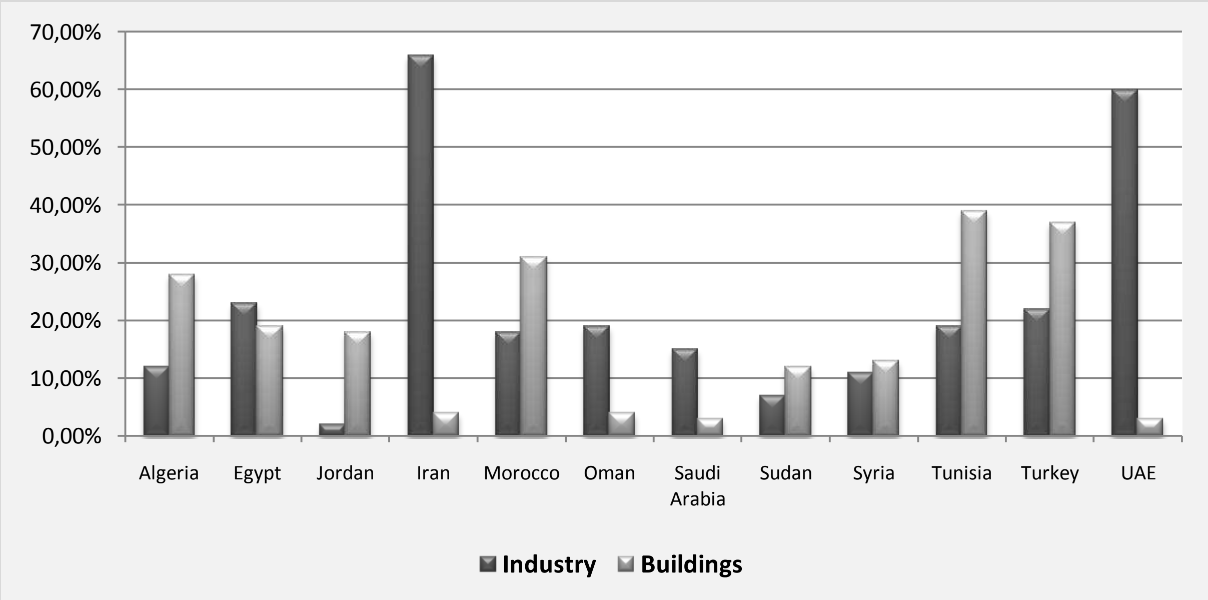
Figure 4. Renewable electricity share in the electricity mix in MENA countries



Source : Energy Information Administration Data, 2010.

It is also important to add that final energy used in MENA region differs per country due to the combination of a Mediterranean climate among North Africa (Algeria, Morocco and Tunsia) where space heating demand is common. In these latter countries, demand consists to a large extent for food production, especially during the winter season (e.g. EIA report, 2010). However, in Middle East countries which are distinguished during a desert climate (especially, Oman, Saudi arabia and the UAE), the demand is absent, although a small share of domestic hot water (see Figure 5).

Figure 5. Share of heat in total final energy consumption in MENA countries



Source : Energy Information Administration Data, 2010.

3. Methodology and empirical results

This paper uses a developed panel techniques (panel cointegration and panel causality) that accommodate structural breaks. We discuss in this section the techniques that are used to analyse the linkage between electricity consumption and growth in selected MENA countries. Hence, we start with a descriptive statistics of these two latter variables for the twelve MENA countries, seven energy exporters and five energy importers (see Table 1). Then, we pass to apply panel unit root analysis, panel cointegration analysis, panel causality analysis and we finish by panel fully modified ordinary least square.

3.1. Panel unit root test

The properties of electricity consumption per capita and GDP per capita need to avoid the possibility of spurious regressions. In order to assess the stationary of these variables, we will use a tests of dynamic heterogeneity. These tests allows us to indicate that the linkage between electricity consumption and economic growth is characterized by heterogeneity in dynamics and error variances. Thus, this paper employs three different unit root tests including 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 IPS test is given by the following autoregressive specification :

$$Y_{i,t} = \rho_i + Y_{i,t-1} + \delta_i X_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where i=1, ..., N for each country in the three panel samples in question (All MENA countries, MENA energy exporters, MENA energy importers); t=1, ..., T refers to the time period; $Y_{i,t}$ represents the endogenous variable of the considered model ; $X_{i,t}$ represents the exogenous variables in the model including fixed effects or individual time trend; ρ_i are the autoregressive coefficients; and $\varepsilon_{i,t}$ are the stationary error terms.

According to Im et al. (2003), the IPS test averages the ADF-Fisher Chi-square unit root test allowing different orders of serial corrections. This latter is expressed as follows:

$$\varepsilon_{i,t} = \sum_{j=1}^{p} \varphi_{i,j} \varepsilon_{i,t-j} + \mu_{i,t} \qquad (2)$$

Then, the substitution of equation (2) into equation (1) yields :

$$Y_{i,t} = \rho_i + Y_{i,t-1} + \delta_i X_{i,t} + \sum_{j=1}^{p_i} \varphi_{i,j} \varepsilon_{i,t-j} + \mu_{i,t} \qquad (3)$$

Where p_i represents the number of lags in the ADF regression. The null hypothesis is that each series in the panel contains a unit root (H_0:ρ_i=1). The alternative hypothesis is that at least one of the individual series in the panel is stationary (H_0:ρ_i<1).

The results of these tests are reported in Table 2 indicating that the GDP per capita is stationary at the 5% significance level of the first difference I(1) and electricity consumption per capita is stationary at I(0) for all MENA countries, the seven MENA energy exporters and the five MENA energy importers.

Table 2. Descriptive statistics

	All MENA countries		**MENA energy exporters**		**MENA energy importers**	
	Ln(EC)	*Ln(GDP)*	*Ln(EC)*	*Ln(GDP)*	*Ln(EC)*	*Ln(GDP)*
Mean	6.57235	7.577190	8.238640	7.311124	7.241326	6.034652
Median	6.63002	7.455004	7.587564	7.098891	7.414573	6.287852
Maximum	8.95001	9.691655	11.02476	9.534306	9.151121	7.785496
Minimum	3.44776	5.493061	6.398595	5.012567	5.493061	3.447763

Std. Dev.	1.16709	0.922263	1.256213	1.114944	0.836671	1.216851
Skewness	-0.61591	0.143520	0.672195	0.336762	-0.648468	-0.757642
Kurtosis	3.59940	3.002271	2.152000	2.078687	2.637893	2.487352
Jarque-Bera	30.9653	1.359555	26.52811	13.67575	13.59872	19.19168
Observations	433	433	252	252	181	181

Notes: EC : the electricity consumption per capita ; source : Usherbrooke data (Canada).

3.2. Panel cointegration

One of the reason of testing cointegration link between electricity consumption and economic growth is to determine whether the regressions are spurious. Before estimating the relationship between two variables and before testing whether there is a causal link, it is appropriate to test the cointegrating interaction between the series in question. Thus and after verifying the heterogeneity of GDP per capita and electricity consumption per capita using panel unit root tests which indicate that the first variable is integrated of order one and the second is integrated of order zero, the heterogeneous panel cointegration advanced by Pedroni (2004) is tested, expressed as follows :

$$LnGDP_{i,t} = \alpha_i + \delta_{i,t} + \beta_i LnEC_{i,t} + \varepsilon_{i,t} \qquad (4)$$

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. $\varepsilon_{i,t}$ denote the estimated residuals which represent deviations from the long-run relationship.

A summary of results of the panel cointegration test is reported in Table 3 which indicates that the null hypothesis of no cointegration can be accepted at the 5% significance level except for the panel PP-statistic and the group PP-statistic.

Table 3. Panel unit root tests

	All MENA countries		**MENA energy exporters**		**MENA energy importers**	
	Ln(EC)	*Ln(GDP)*	*Ln(EC)*	*Ln(GDP)*	*Ln(EC)*	*Ln(GDP)*
Im. Pesaran and Chin w-stat	2.3890	3.5286	-2.66877[a]	-4.93156[a]	0.2295	-8.5418[a]
ADF-Fisher-Chi-Square	24.089[a]	9.1857	29.2989[a]	39.9338[a]	11.8740	59.0159[a]
PP-Fisher-Chi-Square	63.996[a]	42.244[a]	77.7892[a]	46.4846[a]	23.4849[a]	56.1519[a]

Notes: Critical value at the 1% significance level denoted by “a” ; Panel unit root test includes intercept and trend.

Hereafter and more interestingly, we conclude from Table 4 a long-run relationship between electricity consumption and growth in all MENA countries. This relation is also valid when considering MENA energy exporters (i.e. Algeria, Egypt, Iran, Oman, Saudi Arabia, Syria and UAE) and MENA energy importers (i.e. Jordan, Morocco, Sudan, Tunisia and Turkey).

Table 4. Panel cointegration tests

All MENA countries			
Within dimension	Statistic tests	Between dimension	Statistic tests
Panel *v*-Statistic	0.683227[a]	Group ρ-Statistic	0.601640[a]
Panel ρ-Statistic	-0.166775[a]	Group PP-Statistic	0.204507[a]
Panel PP-Statistic	-0.278584[a]	Group ADF-Statistic	-0.780932[a]
Panel ADF-Statistic	-1.149631[a]		
MENA energy exporters			
Panel *v*-Statistic	0.508051[a]	Group ρ-Statistic	0.628082[a]
Panel ρ-Statistic	0.205490[a]	Group PP-Statistic	0.635769[a]
Panel PP-Statistic	0.340837[a]	Group ADF-Statistic	-0.569899[a]
Panel ADF-Statistic	-0.871675[a]		
MENA energy importers			
Panel *v*-Statistic	1.265027[a]	Group ρ-Statistic	-0.216878[a]
Panel ρ-Statistic	-0.774489[a]	Group PP-Statistic	-0.497774[a]
Panel PP-Statistic	-0.730422[a]	Group ADF-Statistic	-1.518145
Panel ADF-Statistic	-1.590007		

Notes: Of the seven tests, the panel *v*-statistic is a one-sided test where large positive values reject the null hypothesis of no cointegration whereas large negative values for the remaining test statistics reject the null hypothesis of no cointegration. Critical values at the 1% significance level denoted by "a".

It is also worth observable from Table 5 that a strong and significant linkage runs from electricity consumption to GDP in the three samples of considered countries, all MENA countries, energy importers and energy exporters using FMOLS method (e.g. Payne and Apergis, 2010).

Table 5. Panel FMOLS long-run estimates

	All MENA countries	MENA energy exporters	MENA energy importers
C	3.2650[a]	1.4341[a]	3.4262[a]
	(22.045)	(4.828)	(27.470)
Ln (EC per capita) $_{t-1}$	0.6561[a]	0.9307[a]	0.6321[a]
	(29.569)	(23.173)	(31.200)
R^2	0.68	0.68	0.84

Notes: t-statistics are reported in parentheses. In our estmates, we take account into White's heteroskedasticity test.Significance at the 1% level denoted by "a".

3.3. Panel causality

To examine the direction of causality between electricity consumption and economic growth, we use a dynamic panel error-correction specification.

$$\Delta LnGDP_{i,t} = \alpha_i^e + \sum_{k=1}^{q} \theta_{i,k}^e \Delta LnGDP_{i,t-k} + \sum_{k=0}^{q} \theta_{i,k}^e \Delta LnEC_{i,t-k} + \lambda_i^e \varepsilon_{i,t-1}^e + \mu_{i,t}^e \quad (5)$$

$$\Delta LnEC_{i,t} = \alpha_i^v + \sum_{k=1}^{q} \theta_{i,k}^v \Delta LnEC_{i,t-k} + \sum_{k=0}^{q} \theta_{i,k}^v \Delta LnGDP_{i,t-k} + \lambda_i^v \varepsilon_{i,t-1}^v + \mu_{i,t}^v \quad (6)$$

where i = 1, ..., N represents the samples of countries (all MENA countries, MENA energy exporters, MENA energy importers) and t = 1, ..., T denotes the time period while $GDP_{i,t}$ and $EC_{i,t}$ are economic growth and electricity consumption, respectively. Δ denotes the first-difference operator, α_i stands for the fixed effects, k denotes the lag length, $\varepsilon_{i,t-1}$ represents the one period lagged error-correction term, and $u_{i,t}$ is the serially uncorrelated error term with mean zero. The coefficients $\theta^j_{i,k}$ where $j = e$, v denote the short-run dynamics while λ^j_i where $j = e$, v represent the speeds of adjustment.

According to Table 6, we can find evidence of short-run causality running from GDP and electricity consumption in MENA countries. In the long -run, all the estimated coefficients associated the the electricity consumption and growth equations are significant in both short and long run, implying that energy consumption could play an important adjustment factor as the system departs from the long-run equilibrium.

Table 6. Panel causality results

Dependent variable	Sources of causation (independent variables)		
	Short run		Long run
	ΔLnGDP	*ΔLnEC*	*λε*
All MENA countries			
ΔLnGDP	-	1.11E-11[a] (16.5072)	-1.15E-12[a] (-5.0236)
ΔLnEC	-2.02E-11[a] (-6.6640)	-	-4.98E-12[a] (-4.1541)
MENA energy exporters			
ΔLnGDP	-	-2.96E-11[a] (-2.9585)	-2.86E-11[a] (-1.0826)
ΔLnEC	-3.46E-11[a] (-3.5328)	-	1.63E-11[a] (1.04113)
MENA energy importers			
ΔLnGDP	-	6.46E-13[a] (8.6974)	-6.08E-13[a] (-4.6671)
ΔLnEC	-5.18E-13[a] (-6.4702)	-	4.05E-13[a] (2.0798)

Notes: 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 denoted in parentheses. *λε* represents the coefficient of the error correction term. Significance at the 1% level is denoted by "a".

Table 7 found the results of bivariate Granger test by country from our sample. These results confirm a bi-directional relationship between both considered series either in the majority of energy exporters such as Algeria, Egypt and Iran) or in very few energy importing countries such as Sudan.

Table 7. Pairwise probability of Granger causality test

MENA energy exporting-countries							
Null hypothesis	Algeria	Egypt	Iran	Oman	Saudi Arabia	Syria	UAE
EC does not cause GDP	0.0773	0.0773	0.0001	0.0040	0.1569	0.4304	0.1838
GDP does not cause EC	0.0984	0.0984	0.0200	0.8485	0.1443	0.0507	0.5459

MENA energy importing-countries					
Null hypothesis	Jordan	Morocco	Sudan	Tunisia	Turkey
EC does not cause GDP	0.5175	0.0698	0.0127	0.9432	0.0466
GDP does not cause EC	0.0214	0.1662	0.0783	0.2857	0.1550

Note: the statistics are F-statistic calculated under the null hypothesis of no causation. The coefficient of lag of error correction term is equal to zero is null hypothesis of short run causality test which denotes statistical insignificance and, hence fails to reject the null hypothesis of non-causality.

4. Outcomes appraisal and some economic implications

As mentionned above, an increase in electricity consumption per capita can be viewed as a leading indicator of growing economy. Our results summarized in Table 8 reveal that, in MENA countries, 16.66% supported the growth hypothesis, 25% the conservation hypothesis, 33.33% the feedback hypothesis and 25% the neutrality hypothesis. Furthermore, we found that 14.28% of MENA energy exporters (i.e. Algeria, Egypt, Iran, Oman, Saudi Arabia, Syria and the UAE) supported the growth hypothesis at the same way of conservation hypothesis, 42.88% the feedback hypothesis and 28.57% the neutrality hypothesis.

Table 8. Summary of causality results

Countries	Growth hypothesis	Conservation hypothesis	Feedback hypothesis	Neutrality hypothesis
All MENA countries	16.66%	25%	33.33%	25%
MENA energy exporters	14.28%	14.28%	42.88%	28.57%
MENA energy importers	20%	40%	20%	20%

It is remarkable that for overall MENA countries and MENA energy exporters, the feedback hypthesis is the most supported which mean that there is bidirectional causality between electricity consumption and economic growth. However, 40% MENA energy importers (i.e. Jordan, Morocco, Sudan, Tunisia and Turkey) supported conservation hypothesis, 20% the growth hypothesis, 20% the feedback hypothesis and 20% the neutrality hypothesis.

The previous studies on this subject maintaining different results depending to the country considered advance various explanations of their empirical findings: If the electricity usage determines economic growth; this indicates that the economy depends on energy consumption, implying that a deficiency in the energy supply can have a negative impact on economic growth (e.g. Masih and Masih (1998), Asafu-Adjaye (2000) and Jumbe (2004)). In addition, if the causal mechanism is reversed (i.e. growth hypothesis), it suggests hat the considered economy is less dependent on energy. Thus, implementing energy-saving policies may have little effect or have no impact on income (e.g. Jumbe, 2004). Further, a lack of causality in one direction or the other, or the neutrality hypothesis (e.g. Yu and Choi, 1985) means that the energy saving policies do not affect economic growth. In this case, a policy of energy saving can be done without damaging economic dynamics, development and growth.

Therefore, energy importing countries supports an unidirectional relationship between electricity consumption per capita and economic growth with causality running from electricity use to economic growth. Thus, a policy here to reduce electricity consumption utilization will harm economic growth and can hinder economic enhancement. This worthly mean that a negative shock to electricity consumption leads to higher electricity prices or more precisely to electricity conservation policies which can affect negatively and significantly GDP and GDP per capita (e.g. Narayan and Singh, 2007). This suggests that good energy infrastructures are a prerequisite for economic growth.

Besides, the fact that 60 % provide support for conservation hypothesis indicates the insignificant behavior of electricity conservation policies (i.e. demand management policies). This implies that restrictions on electricity consumption can threaten economic growth while increases of electricity usage can faster GDP. In this vein, Shaari et al. (2012) advance that «conservation hypothesis essentially flatten the demand curve for electricity, while peak load demand is reduced relative to the average load.» The use of modern energy is a prerequisite for economic and echnological progress as it completes the production process (e.g. Ebohon (1996) and Templet (1999)). Nevertheless, a deficiency in the supply of electricity may limit economic growth and technological progress. Therefore, the electricity may be a major source of improvement in the standards living, health, education and technology (e.g. EIA, 2002).

But in the same time the role of energy can be neutral vis-à-vis economic growth because the energy cost is very low relative to GDP, and thus energy consumption is not likely to have a significant impact on output growth. Hence, imposing taxes to reduce electricity consumption or implementing a conservation policy will not harm economic growth (e.g. Acaravci, 2012). Wolde-Rufael (2006) and Narayan and Smith (2009) advance also that the lack of causality in both directions (i.e. neutrality hypothesis) implies that measures to save electricity usage can be taken without compromising economic growth. This can be explained by the fact hat developing countries have not yet reached a high level of electricity autonomy which allows them to reduce their energy use. This not means that these economies can not prevent the negative consequences associated to an increase of electricity consumption. Instead of making electricity accessible to overall economic sectors, this can improve the quality of population's lives and ahieve economic growth and then reduce poverty. More recently and in the same context, Shaari et al. (2012) add that any policy in terms of energy consumption should be revisited to ensure that it will not affect economic growth.

Furthermore, there is evidence to support the growth hypothesis for 14.28% in energy exporters and for 20% in energy importers. In these countries, electricity consumption acts as a stimulus for economic growth. When the economy grows, electricity becomes predominant (e.g. Toman, 2003). Although, a decrease in economic growth can lead to an absence of sufficient choice providing access to modern, adequate and efficient energy services able to to support the economic and human development, i.e. energy poverty (e.g. Reddy (2000) and Wolde-Rufael (2006)). Meanwhile, MENA countries consume lower share of electricity sector comparable to developed countries (e.g. EIA, 2002). So, rapid urbanization combined with economic growth is likely to accelerate the pass-through from traditional energy to commercial energy such as electricity usage. With these findings, energy policies have as main objectives to improve the energy infrastructure and increase energy supply which are itselfs the appropriate options able to faster economic growth. We should add that this effect is characterized by its permanent behavior, i.e an increase in GDP may continuously increase electricity consumption, which lead to make great attention to this linkage (e.g. Gurgul and Lach (2012) and Bildirici et al. (2012)).

Interestingly, our results show also that Iran in energy exporting countries and Turkey in energy importers are leaders in terms of the intensity of interaction between energy usage and economic growth (see Table 7). This may be mainly due to a good structuring of the electricity sector that leads necessarily to a positive and significant effect on economic growth (EIA, 2009). The favorable position of Iran and Turkey in comparisonto other countries of our set sample leads to an essential recommendation which is the reorganization of the electricity sector. This latter policy can be a useful and valuable tool of our considered economies yields slowly in each country, especially under the current energy crisis. It is also crucial to identify clearly the determinants of electrical energy demand in order to better understand changes in electricity consumption in recent years while it hardly reflects the economic growth of MENA countries either in energy importers or in energy exporters (see Figure 2).

5. Conclusion

The linkage between electricity consumption and economic growth is a widely studied research topic, however, the empirical evidence is conflicting in terms of the direction of causation. Our study finds an empirical survey of the literature on the link between electricity consumption and growth in MENA countries (energy importers versus energy exporters), to compare it with theoretical aspects in the same subject applied on American, Asian and European economies.

Our empirical results yield mixed results in terms of hypothesis linked to the causal relationship between electricity usage and growth (i.e. neutrality, growth, conservation and feedback). We show that for the specific countries surveyed (see Appendix A), 35.48% supported the neutrality hypothesis, 29.03% the conservation hypothesis, 12.9% the growth hypothesis and 22.58% the feedback hypothesis.

Briefly, we argue that if the electricity consumption causes economic growth (i.e. the case of energy importing-countries), the reduction of electricity consumption could lead to a decline in economic growth. However, if the economic growth determines the level of electricity consumption, this implies that policies electrical energy savings can be implemented without slowing economic growth. In addition, if there is no causality that operates in both directions, reducing electricity consumption should not affect income and energy saving policies may not affect economic growth. Finally, if there is a bidirectional causality, economic growth may require more electricity while an increase in electricity consumption can accelerate economic growth: electricity consumption and economic growth complement and measures energy savings can negatively affect economic growth. In this context, our study can be instrumental in the choice of valuable energy policies that will prevent negative impact on economic growth.

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Appendix A. An overview of studies on the link energy consumption- growth nexus

Authors	Period	Countries	Causality test	Hypothesis
American countries				
Narayan and Parasad (2008)	1971-2002	Canada	Energy ↔ Growth	Neutrality hypothesis
		Mexico	Energy ↔ Growth	Neutrality hypothesis
		USA	Energy ↔ Growth	Neutrality hypothesis
Apergis and Payne (2009)	1980-2004	Central America	Energy → Growth	Conservation hypothesis
Apergis and Payne (2010)	1980-2005	South America	Energy → Growth	Conservation hypothesis
Asian countries				
Gosh (2009)	1950-1997	India	Growth → Energy	Growth hypothesis
Lee and Chang (2005)	1954-2003	Taiwan	Energy → Growth	Conservation hypothesis
Yoo (2006)	1970-2002	Korea	Energy → Growth	Conservation hypothesis
Yuan et al. (2007)	1978-2004	China	Energy → Growth	Conservation hypothesis
Tang (2008)	1972-2003	Malaysia	Energy → Growth	Conservation hypothesis
Niu et al. (2011)	1971-2005	Developed countries	Energy → Growth	Conservation hypothesis
		Developing countries	Growth → Energy	Growth hypothesis
European countries				
Narayan and Parasad (2008)	1960-2002	Belgium	Energy ↔ Growth	Neutrality hypothesis
		Netherlands	Growth → Energy	Growth hypothesis
		France	Energy ↔ Growth	Neutrality hypothesis
		Italy	Energy ↔ Growth	Neutrality hypothesis
		Greece	Energy → Growth	Conservation hypothesis
		Spain	Energy ↔ Growth	Neutrality hypothesis
		Poland	Energy ↔ Growth	Neutrality hypothesis
		Norway	Energy ↔ Growth	Neutrality hypothesis
		Sweden	Energy ↔ Growth	Neutrality hypothesis
		United Kingdom	Energy ↔ Growth	Neutrality hypothesis
Belke et al. (2011)	1981-2007	OECD countries (without Canada and USA)	Energy ↔ Growth	Feedback hypothesis
Dobnick (2011)	1971-2009	OECD countries (18 European countries and 02 American countries (Canada and USA))	Energy ↔ Growth	Feedback hypothesis
MENA countries				
Al-Iriani (2006)	1971-2002	GCC countries	Growth → Energy	Growth hypothesis
Mohadevan (2007)	1971-2002	Energy exporters	Energy ↔ Growth	Feedback hypothesis
		Energy importers	Energy ↔ Growth	Feedback hypothesis
Ozturk et al. (2011)	1971-2005	Upper and lower income countries	Energy ↔ Growth	Feedback hypothesis
Al-Mulati (2011)	1980-2009	MENA countries	Energy ↔ Growth	Feedback hypothesis
Arouri et al. (2012)	1981-2005	MENA countries	Energy → Growth	Conservation hypothesis

Notes : For detailed overview on energy consumption-economic growth nexus, we can see Payne (2010), Dobnick (2011) and Ozturk (2010).

Appendix B. Hypothesis of the outcomes of causality

Countries	Causality	Causality test	Hypothesis
ALL MENA Countries	Growth ↔ Energy	Not verified	Neutrality hypothesis
MENA energy exporters	Growth ↔ Energy	Not verified	Neutrality hypothesis
Algeria	Growth ↔ Energy	Verified	Feedback hypothesis
Egypt	Growth ↔ Energy	Verified	Feedback hypothesis
Iran	Growth ↔ Energy	Not verified	Neutrality hypothesis
Oman	Growth →Energy	Verified	Conservation hypothesis
Saudi Arabia	Growth ↔ Energy	Verified	Feedback hypothesis
Syria	Energy → Growth	Verified	Growth hypothesis
UAE	Growth ↔ Energy	Verified	Feedback hypothesis
MENA energy importers	Energy → Growth	Verified	Growth hypothesis
Jordan	Energy → Growth	Verified	Growth hypothesis
Morocco	Growth →Energy	Verified	Conservation hypothesis
Sudan	Growth ↔ Energy	Not verified	Neutrality hypothesis
Tunisia	Growth ↔ Energy	Verified	Feedback hypothesis
Turkey	Growth →Energy	Verified	Conservation hypothesis