THE NEXUS BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN MENA COUNTRIES

JAMAL BOUOIYOUR
University of Pau, France

REFK SELMI
High School of Trade of Manouba, Tunisia

ABSTRACT

We assess 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 using panel cointegration methods and panel causality test. By doing so, we 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. For energy exporters, we support the growth hypothesis in 14.28% of cases at the same way of conservation hypothesis, the feedback hypothesis in 42.88% and the neutrality hypothesis in 28.57%. For energy importers, almost 60% of cases provide support for conservation hypothesis. Additionally, we show that Iran and Turkey behave better than the rest of countries in terms of the focal link. We attribute this apparently result to the good structuring of the electricity sector.

Keywords
Electricity consumption, Economic growth, Causality, MENA countries.

Corresponding Author:
Jamal Bouoiyourame, University of Pau, Avenue de l'Université , BP 576 64012 PAU cedex
Email: jamal.bouoiyour@univ-pau.fr

1. INTRODUCTION

The relationship between electricity consumption and economic growth has been the subject of an intense research during the last decades for American countries (e.g. Apergis and Payne (2009) and Apergis and Payne (2010)) Asian countries (e.g. Asafu-Adjaye (2000), Yoo (2006), Yuan et al. (2007), Gosh (2010) and Niu et al. (2011), among others), European countries (e.g. Narayan and Parasad (2008), Beck et al. (2011) and Dobnick (2011)) and Middle East North African countries (MENA); For instance, Acaravci and Ozturk (2010), Al-Mulati (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 depending to the nature of countries (American versus Asian versus European versus MENA countries, developed versus developing countries, economies with low income versus those with high income, energy importers versus energy exporters, countries with high GDP versus those with low GDP and OECD countries versus non-OECD countries, etc…).[1]

The strand of literature on this field propose four hypothesis for the possible causality outcomes (e.g. Dobnik, 2011): (i) the growth hypothesis suggests that energy consumption is a crucial component in growth. For this case, each economy is called energy dependent at which a decrease in energy consumption causes a decrease in growth rate ; (ii) the conservation hypothesis is based on a uni-directional causal relationship running from growth to energy consumption, showing that lower energy consumption may have little effect on growth ; (iii) the feedback hypothes is based on a bi-directional causal relationship; (iv) the neutrality hypothesis reveals that energy consumption has not any impact on real GDP.

From the review of theoretical and empirical studies on the energy consumption-growth nexus, we find that the prior results tend to vary depending to the nature of countries, time periods and the empirical methods that were used either in bivariate or multivariate frameworks (cointegration analysis and Granger tests).

Apergis and Payne (2010) examine the nexus between electricity consumption and economic growth in a multivariate framework by including measures of real gross fixed capital formation and labor force. They argue that there is short-run and long-run causality from energy consumption to economic growth in a panel of nine South american countries, supporting therefore the growth hypothesis.

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 in a bivariate framework. Accordingly, Ozturk and Acaravci (2011) investigate the dynamic linkage between energy consumption and growth rate in selected MENA 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 Iran, Morocco and Syria. However, the cointegration and causal relationship is found for the rest of selected countries, i.e. Egypt, Israel, Oman and Saudi Arabia. Intuitively,

[1] We can refer to Payne (2010) for a detailed literature survey on the nexus between electricity consumption and economic growth.

they argue that the energy conservation policy of MENA countries can have a no powerful impact on economic growth.

Several studies have been done on the linkage between the above key variables but up to now the area stills not well explored depending to countries'characteristics. Our work fills the void by extending the issue in three directions: (i) To assess whether the electricity consumption per capita and economic growth per capita are cointegrated while trying to check if there is a long run relationship between these variables; (ii) To investigate the causal relationship between electricity consumption and economic growth within a Vector Error Correction Model in a three panels of MENA countries[2] and also country-by-country.

Alternatively, various questions can be raised: What is the nature of the relationship between electricity consumption and economic growth? Is this relationship depend to the nature of countries (i.e. energy importers or energy exporters)? The answers of these questions will elucidate our understanding on the relationship between electricity consumption and growth rate.

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 detailed analysis of the methods used throughout this study and then, we provide empirical results. Section 4 presents the main economic implications of the focal linkage. Section 5 concludes the paper.

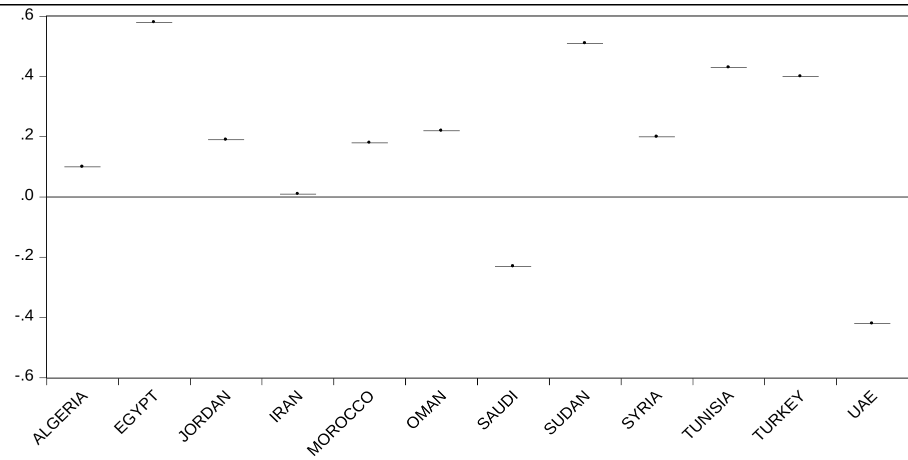
2. AN OVERVIEW OF ENERGY CONSUMPTION AND ECONOMIC GROWTH IN MENA COUNTRIES

This study extend the recent works by applying a panel cointegration methods and panel causality test to investigate the relationship between electricity consumption and economic growth in 12 MENA countries from 1975 to 2010. We depict in Figure 1 a great difference in terms of growth dependency to electricity, which is very high for example in Egypt, Tunisia and Turkey comparable to the rest of countries, particularly, Saudi Arabia and UAE.

In addition, the considered countries are very diverse regarding their structure. We can classify these economies depending to their GDP, energy imports and energy exports 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.

[2] The three groups of countries are successively: 07 MENA energy exporters (Algeria, Egypt, Iran, Oman, Syria, Saudi Aarabia, UAE) and 05 energy importers (Jordan, Morocco, Sudan, Tunisia, Turkey) and the whole considered countries (i.e. the 12 countries above mentionned).

Figure 1. The Dependence of Growth to Electricity Consumption



Source : Usherbrooke data and authors'calculation.

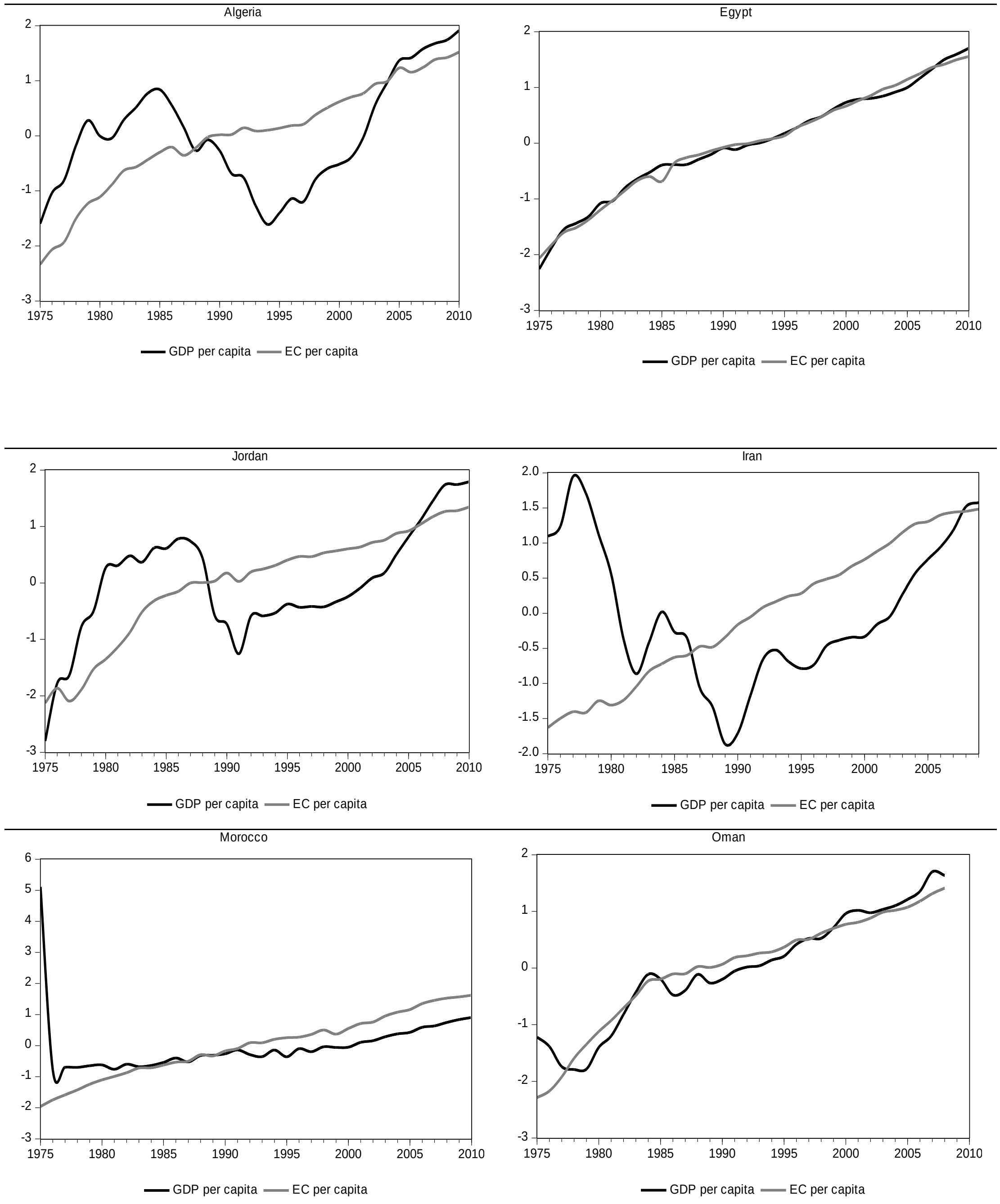
Table 1. The Energy Sector and Per Capita GDP among MENA Countries

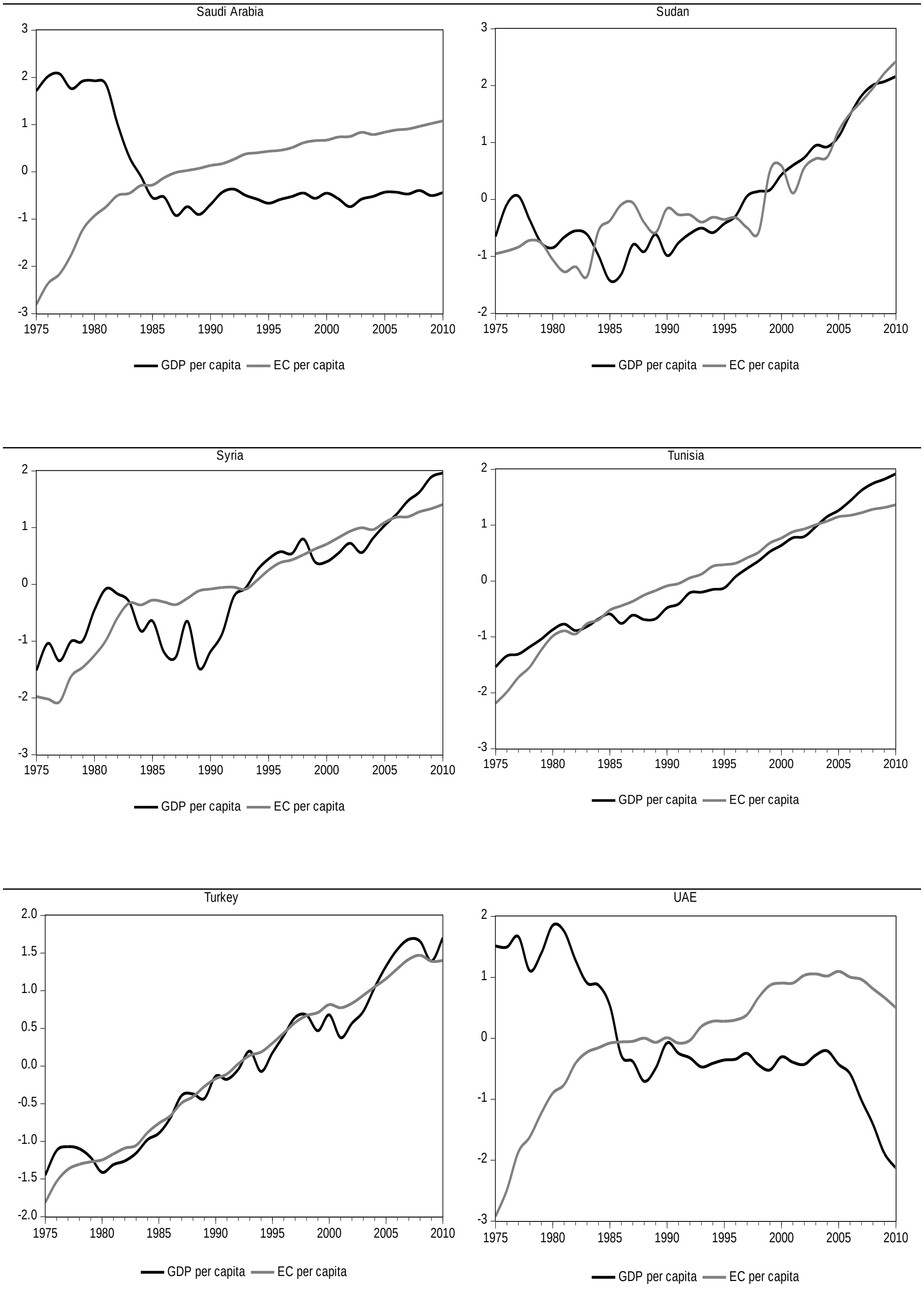
	High GDP	Low GDP
Energy importers	Turkey	Jordan, Morocco, Sudan, Tunisia
Energy exporters	Oman, Saudi Arabia, UAE	Algeria, Egypt, Iran, Syria

Source : IMF (various reports).

Besides and as depicted in Figure 2, we note that the dynamic interaction between electricity consumption and economic growth vary substantively from one country to another and from energy importers to energy exporters. 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).

Figure 2. The Evolution of Economic Growth and Electricity Consumption

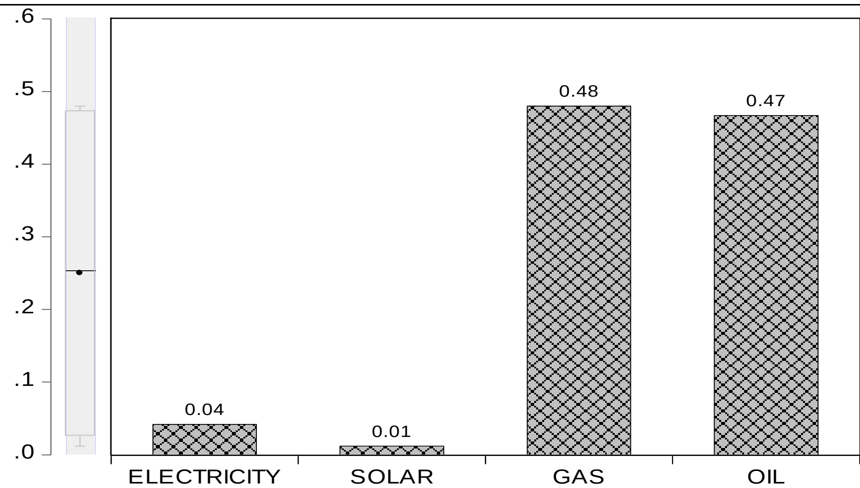




Source : Usherbrooke data.
Energy importers : Jordan, Morocco, Sudan, Tunisia, Turkey.
Energy exporters : Algeria, Egypt, Iran, Oman, Syria, Saudi Aarabia, UAE.

Arguably, Figure 3 indicates a great heterogeneity with respect to the energy sector. 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 and the solar sub-sector contribute respectively to a 4.2% and 1.2% of final energy consumption.

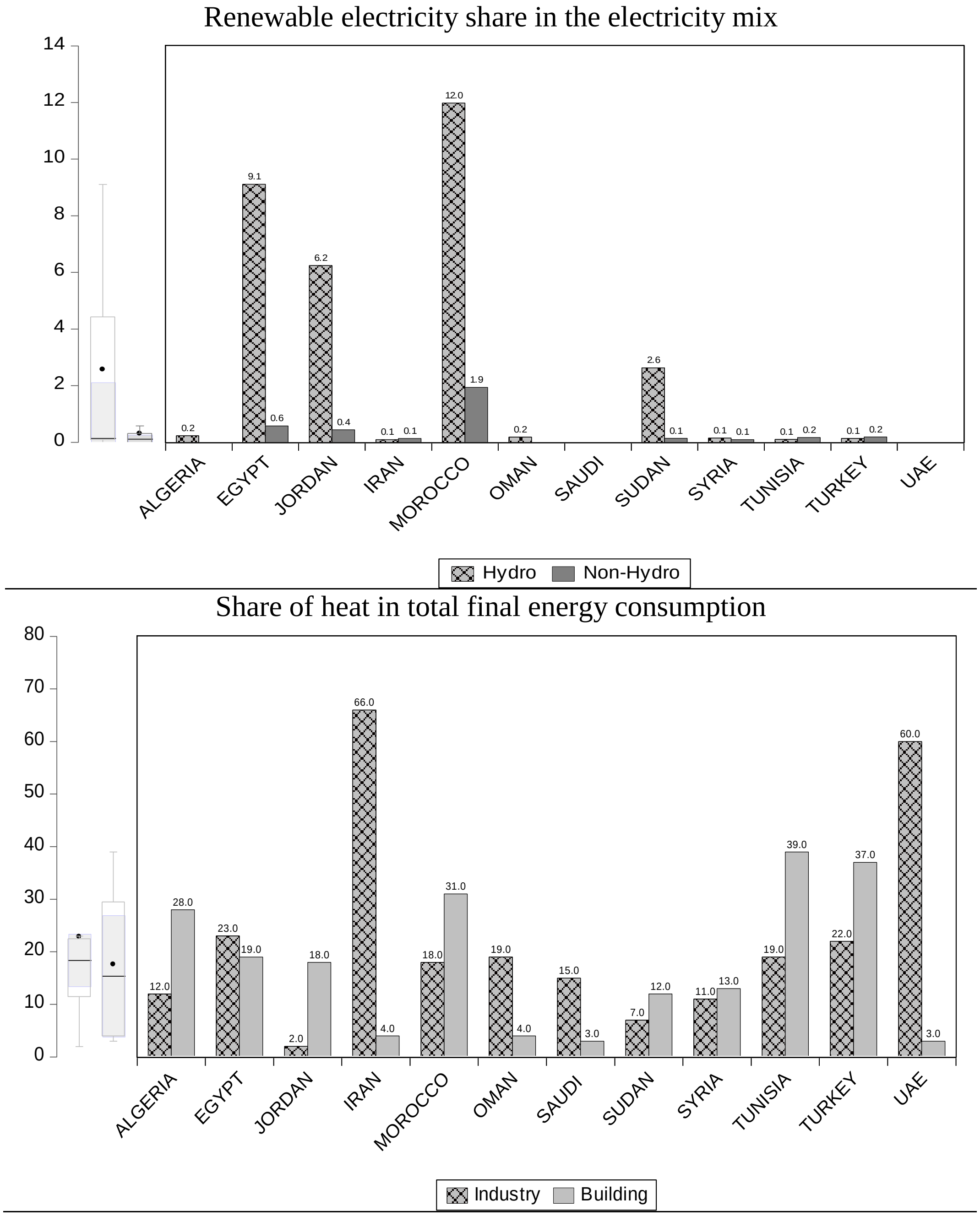
Figure 3. Mix of Final Energy Consumption in MENA Countries



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

Furthermore, the total of electricity generation in MENA countries grew by an average of 6.3% per year. We depict in Figure 4 that hydro power grew slightly comparable to renewable electricity. The contribution from hydro is dominated in Egypt and Morocco (12%, 9.2%, respectively) and to lesser extent in Tunisia by 0.1%. It is also worth notable that non-hydro renewable electricity was concentrated in Egypt, Jordan, Morocco, Tunisia and Turkey (i.e. 0.8%, 0.5%, 2.0%, 0.3%, 0.3%, respectively). Algeria, Saudi Arabia and UAE don't report any non-hydro generation. It also worth notable that the 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, i.e. the demand consists to a large extent for food production, especially during the winter season. 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.

Figure 4. Shares of Renewable Electricity and Heat in Energy Consumption (in %)



Source : Energy Information Administration Data, 2010.

3. METHODOLOGY AND EMPIRICAL RESULTS

This paper uses a developed panel techniques (panel cointegration and panel causality) to investigate whether there is a causal link between electricity consumption and growth in selected MENA countries.

3.1 Descriptive Analysis

We report the descriptive statistics in Table 2. The sample means of electricity consumption and economic growth are positive for all cases. The kurtosis measure indicates that distributions of the returns of both key variables are positive. Therefore, the returns of these series are leptokurtic relative to a normal distribution. The Jarque–Bera normality test indicates high levels, which implies the reject of normality for both series for all groups of countries.

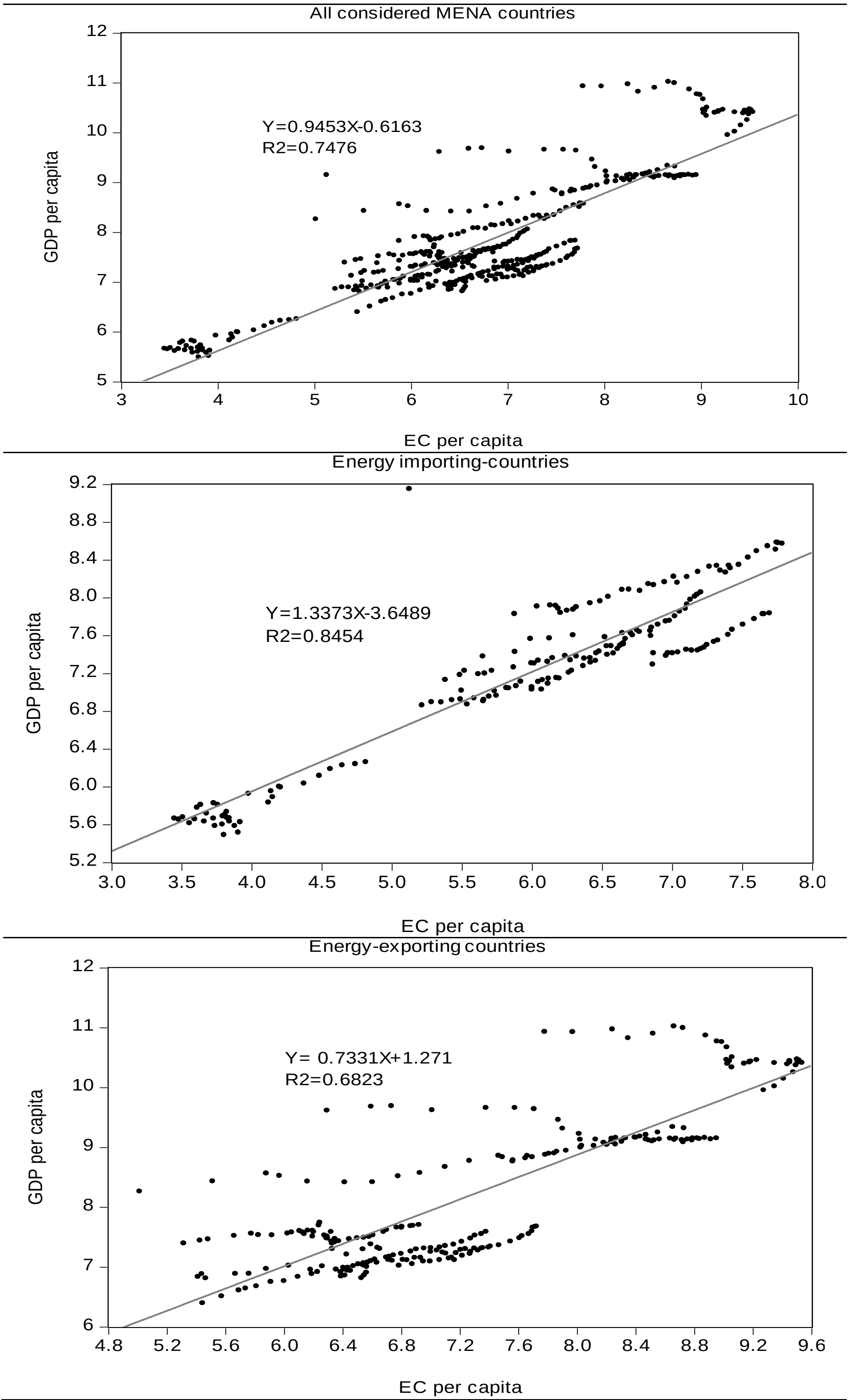
Table 2. Descriptive Statistics

	MENA countries		**Energy exporters**		**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	-0.75764
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.

Figure 5 depicts a positive relationship between electricity consumption and economic growth in both MENA energy importers and energy exporters with more strong effect in the first case than the second case.

Figure 5. Correlation Between Electricity Consumption and Economic Growth



With regard to our preliminary results, it is time to evaluate if there is a causal relationship between electricity consumption and growth, which varies depending to countries'characteristics. To do so, we pass to apply panel unit root analysis, panel cointegration analysis, panel causality analysis panel fully modified ordinary least square and we finish by testing causality per country.

3.2 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 previously test the dynamic heterogeneity. This allows us to assess if the linkage between electricity consumption and economic growth is characterized by heterogeneity in dynamics and error variances. Thus, we carry out 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:

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

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.

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

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

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

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 unit root tests are reported in Table 3, revealing 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 3. Panel Unit Root Tests

	MENA countries		Energy exporters		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.

3.3 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:

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

where i=1, ..., N for each country in the panel and t=1, ..., T refers to the time period. The parameters a_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.

By doing so, we conclude from Table 4 a significant long-run relationship between electricity consumption and growth in all MENA countries. This relation is also valid when when decomposing the whole sample into 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

Within dimension	Statistic tests	Between dimension	Statistic tests
All MENA countries			
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: For 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 observable from Table 5 that a strong and significant linkage runs from electricity consumption to GDP in the three groups of countries using FMOLS method.

Table 5. Panel FMOLS Long-run Estimates

	MENA countries	Energy exporters	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".

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, a_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.

Our results reported in Table 6 reveal that there is a significant short-run causality running from GDP and electricity consumption in MENA countries. In the long -run, all the estimated coefficients associated to the electricity consumption and growth equations are significant, 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. $\lambda\varepsilon$ represents the coefficient of the error correction term. Significance at the 1% level is denoted by "a".

Then, we apply a bivariate Granger test per country. The findings summarized in Table 7 confirm a bi-directional relationship between both considered series in the majority of energy exporters such as Algeria, Egypt and Iran) and 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	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 fails then to reject the null hypothesis of non-causality.

4. OUTCOMES APPRAISAL AND ECONOMIC IMPLICATIONS

Our above findings summarized in Table 8 reveal that the supported hypothesis depends closely to the nature of countries. For instance, 16.66% of the whole countries supported the growth hypothesis, 25% the conservation hypothesis, 33.33% the feedback hypothesis and 25% the neutrality hypothesis. 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. Additionally, almost of 60 % of energy importers provide support for conservation hypothesis.

Table 8. Summary of Causality Results

	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%

For energy-importing countries, there is evidence in favour of an unidirectional relationship between electricity consumption per capita and economic growth with causality running from electricity use to economic growth. This implies that restrictions on electricity consumption can threaten economic growth while increases of electricity usage can faster GDP. Thus, a policy here to reduce electricity consumption utilization will harm economic growth and can hinder economic enhancement. More precisely, a negative shock to electricity consumption leads to higher electricity prices or to electricity conservation policies which can affect negatively and significantly GDP per capita (e.g. Narayan and Singh, 2007). This suggests that good energy infrastructures may be considered as stimulus for economic growth.

For energy-exporting countries, there is highly important evidence in favour of neutrality hypothesis. Instead, 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. Bildirici et al. 2012). Accordingly, Wolde-Rufael (2006) and Narayan and Smith (2009) show that the lack of causality in both directions implies that measures to save electricity usage can be taken without compromising economic growth. This can be intensely attributable to the fact that these countries have not yet reached a high level of electricity autonomy which allows them to reduce their energy use.

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, that is to say that when the economy grows, electricity becomes predominant (e.g. Toman and Jemelkova, 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 mitigate economic and human development-damaging, i.e. energy poverty (e.g. Reddy (2000) and Wolde-Rufael (2006)).

Intuitively, we find that Iran in energy exporters and Turkey in energy importers are leaders in terms of the association between energy usage and economic growth. This may be mainly due to the good structuring of the electricity sector that leads necessarily to a positive and significant effect on economic growth.

5. Conclusion

The nexus between electricity consumption and economic growth is a widely studied research topic. Despite this large strand of literature on this issue, the empirical evidence stills 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 the previous results.

As prior studies, we find mixed results in terms of the causal relationship between electricity usage and growth. We support in different percentages various hypothesis (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. It appears also that Iran and Turkey behave better in terms of the focal relationship comparable to the rest of countries of our set sample.

To sum up, we conclude that the nexus between electricity consumption and growth in MENA countries appears complex and depends intensely to the nature of countries (energy importers, energy exporters, with low GDP or with high GDP,…). Hence, this study can be instrumental in the choice of valuable energy policies that will prevent negative impact on economic growth. From our results, it seems important: (i) to reorganize the electricity sector can be a useful and valuable tool of our considered economies, especially under the current energy crisis; (ii) to identify clearly the determinants of electrical energy demand to elucidate the understanding of practitioners in energy markets; (iii) to use modern energy can be a prerequisite for economic and technological progress as it completes the production process (e.g. Ebohon (1996) and Templet (1999)). To make electricity accessible to overall economic sectors can improve the quality of population's lives and ahieve economic growth and then reduce poverty; (iv) to combine rapid urbanization with growth is likely to accelerate the traditional energy pass-through to commercial energy such as electricity usage.

REFERENCES

Acaravci, A. and Ozturk, I. (2010). On the Relationship between Energy Consumption, CO2 Emissionsand Economic Growth in Europe. Energy, 35(12), 5412-5420.

Al-Iriani, M.A. (2006). Energy–GDP Relationship Revisited: An Example from GCC Countries Using Panel Causality. Energy Policy, 34(17), 3342-3350.

Apergis, N., Payne J-E. (2009). CO2 emissions, energy usage, and output in Central America. Energy Policy 37, 3282–3286.

Apergis, N., Payne, J.E. (2010). The Emissions, Energy Consumption, and Growth Nexus: Evidencefrom the Common Wealth of Independent States. Energy Policy, 38(1), 650-655.

Arouri, M.H, Ben Youssef, A., M'Henni, H, Rault, C. (2012). Energy Consumption, Economic Growth and CO2 Emissions in Middle East and North African Countries. CESifo Group Munich, Working Paper Series, 3726.

Asafu-Adjaye, J., (2000) The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries, Energy Economics, 22; 615-625.

Belke, A., Dobnik, F. and Dreger, C. (2011). Energy consumption and economic growth: New insights into the cointegration relationship. Energy Economics 33(5), 782–789.

Bildirici, M., Bakirtas, T. and Kayiksi, F. (2012). Economic growth and electricity consumption: An ARDL analysis. Conference on International energy, Vienna 2012.

Bouoiyour, J. and Selmi, R. (2013). GCC countries and the relationship between oil price and real exchange rate. Working paper CATT, University of Pau.

Dickey, D.A., Fuller, W.A. (1979). Distribution of the Estimators for AutoRegressive Time Series with a Unit Root. Journal of the American Statistical Association, 74(366), 427-431.

Dobnick, F., (2011). Energy consumption and economic growth revisited : structural breaks and cross section dependence, Ruhr Economic Papers n° 303.

Ebohon, O.J., (1996). Energy, economic growth andcausality in developing countries: a case study of Tanzania and Nigeria. Policy 24 (5), 447–453.

Fisher, R.A. (1932). Statistical Methods for Research Workers (4th Ed.). Edinburgh, Scotland: Oliver and Boyd.

Im, K., Pesaran, M.H., Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. Journal of Econometrics, 115(1), 53-74.

Mahadevan, R. and Asafu-Adjaye, J. (2007). Energy consumption, economic growth and prices: A reassessment using panel VECM for developed and developing countries. Energy Policy 35(4), 2481–2490.

Narayan, P-K., and Prasad, A. (2008). Electricity consumption-real GDP causality nexus: evidence from a bootstrapped causality test for 30 OECD countries. Energy Policy 36, 910–8.

Narayan, P.K. and Singh, B. (2007). The electricity consumption and GDP nexus for the Fiji Islands. Energy Economics, 29: 1141-1150.

Narayan, P. K. and R. Smith (2009). Multivariate Granger causality between electricity consumption, exports and GDP: Evidence from a panel of Middle Eastern countries. Energy Policy 37(1), 229–236.

Niu, S., Ding, Y. Niu, Y. Li, Y. and Luo, G. (2011). Economic growth, energy conservation and emissions reduction: A comparative analysis based on panel data for 8 Asian-Pacific countries. Energy Policy 39(4), 2121–2131.

Ozturk, I. (2010). A literature survey on energy-growth nexus. Energy Policy, 38, 340-349.

Ozturk, I., Acaravci, A. (2011). CO2 Emissions, Energy Consumption and Economic Growth in Turkey. Renewable and Sustainable Energy Reviews, 14(9), 3220-3225.

Payne, J-E., (2010). A survey of the electricity consumption and growth literature, Applied energy 87, 723- 731.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP. Econometric Theory, 20(3), 597-625.

Pesaran, M.H., Shin, Y. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. Journal of the American Statistical Association, 94(446), 621-634.

Phillips, P.C.B., Perron, P. (1988). Testing for a Unit Root in Time Series Regressions. Biometrika. 75(2), 335-346.

Reddy A-K. (2000). Energy and Social Issues, in "World Energy Assessment", UNPD, New York. ISBN 92-1-126-126-0.

Toman, M. and Jemelkova, B., (2003). Energy and Economic Development: An Assessment of the State of Knowledge. Energy Journal, 24, 93-112.

Tang, C-F. (2008). A re-examination of the relationship between electricity consumption and economic growth in Malaysia. Energy Policy 36, 3077–85.

Templet, P H. (1999). Energy, diversity and development in economic systems: an empirical analysis. Ecological Economics 30 (2), 223–233.

Wolde-Rufael Y. (2006). Electricity consumption and economic growth: a time series experience for 17 African countries. Energy Policy, 34,1106–14.

Yoo, S-H. (2006). The causal relationship between electricity consumption and economic growth in the ASEAN countries. Energy Policy 34, 3573–82.

Yuan, J., Zhao, C., Yu, S. and Hu, Z. (2007). Electricity consumption and economic growth in China: cointegration and co-feature analysis. Energy Economics 29, 1179–91.

Appendix A. An Overview of Studies on the Energy Consumption-growth Nexus

Authors	Period	Countries	Causality test	Hypothesis
		American countries		
Narayan and Parasad (2008)	1971-2002	Canada Mexico USA	Energy ↔ Growth Energy ↔ Growth Energy ↔ Growth	Neutrality hypothesis Neutrality hypothesis 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 Developing	Energy → Growth Growth → Energy	Conservation hypothesis Growth hypothesis
		European countries		
Narayan and Parasad (2008)	1960-2002	Belgium Netherlands France Italy Greece Spain Poland Norway Sweden United Kingdom	Energy ↔ Growth Growth → Energy Energy ↔ Growth Energy ↔ Growth Energy → Growth Energy ↔ Growth Energy ↔ Growth Energy ↔ Growth Energy ↔ Growth Energy ↔ Growth	Neutrality hypothesis Growth hypothesis Neutrality hypothesis Neutrality hypothesis Conservation hypothesis Neutrality hypothesis Neutrality hypothesis Neutrality hypothesis Neutrality hypothesis Neutrality hypothesis
Belke et al. (2011)	1981-2007	OECD countries	Energy ↔ Growth	Feedback hypothesis
Dobnick (2011)	1971-2009	OECD countries	Energy ↔ Growth	Feedback hypothesis
		MENA countries		
Al-Iriani (2006)	1971-2002	GCC countries	Growth → Energy	Growth hypothesis
Mohadevan (2007)	1971-2002	Energy exporters Energy importers	Energy ↔ Growth Energy ↔ Growth	Feedback hypothesis 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 literature survey on energy consumption-economic growth nexus, we can see Payne (2010), Dobnick (2011) and Ozturk (2010).

Appendix B. Hypothesis of Causality Outcomes

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