Modelling Economic Growth and Energy Consumption in MENA Countries: Cointergration and Causality Analysis

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DOI: 10.6007/IJARBSS/v6-i4/2106 URL: http://dx.doi.org/10.6007/IJARBSS/v6-i4/2106

Abstract: This paper investigates the causal relationship between energy consumption and economic growth for Algeria, Egypt, Iran, Jordan, Morocco, Saudi Arabia, Tunisia and United Arab Emirates from 1975 to 2011. To examine this relationship, we use approach of cointegration and Granger causality analysis.
The cointegration test results show that there is no cointegration between the energy consumption and the economic growth in six of the eight countries. there is no a relationship between energy consumption and economic growth in Jordan; Saudi Arabia; Tunisia and United Arab Emirates. The granger causality indicate that one-way Granger causality from economic growth to energy consumption in Algeria and one-way strong Granger causalities from energy consumption to economic growth in Egypt; Morocco and Iran.
The overall results indicate that there is no relationship between the energy consumption and the economic growth in most of the MENA countries.

Keywords: Economic Growth; Energy Consumption; Cointegration Test; Granger Causality; MENA Countries.

1. Introduction

The topic of causal relationship between energy consumption and growth has been well studied in the energy economics literature. The relationship between energy consumption and economic growth is studied by many authors using various methodologies for different time periods and different countries. The directions that the causal relationship between the energy consumption and the economic growth could be categorized into four types: (1): Neutrality hypothesis: this hypothesis assumes the absence of a causal relationship between energy consumption and economic growth. Neutrality hypothesis states that energy conservation policies will have no effect on economic growth and economic growth will not stimulate energy consumption. (2) Conservation hypothesis: it is called unidirectional causality running from economic growth to energy consumption. This implies that energy conservation policies designed to reduce energy consumption and waste will have a little or no effect on economic growth. (3) Growth hypothesis: it implies that causality runs from energy consumption to economic growth. This hypothesis suggests that energy consumption plays an important role in

the economic growth. In this case, the reduction in energy consumption due to energy conservation oriented policies may have a detrimental impact to economic growth. (4) Feedback hypothesis: This hypothesis assumes bidirectional causality between energy consumption and economic growth. It is important to ascertain empirically whether there is a causal link between energy consumption and economic growth and the way of the causality. This is because the direction of causality has significant policy implications for government for designing and implementation of this energy policy.

Due to the mentioned developments in energy consumption and limited studies has been done on this object of MENA region, it is important to examine this relationship. Thus, the purpose of this study is to investigate the relationship between energy consumption and economic growth in the selected 8 MENA countries from 1975 to 2011 using approach of cointegration and causality analysis. The results obtained in this study are depended on the sample period, the variables used and the methodology employed.

The rest of the paper is organized as follows. The next section presents review of literature. The third section reports the methodology and data description. The fourth section presents the empirical finding of the study. The last section concludes the paper.

2. Review of literature

The studies that have tested the causality between energy consumption and economic growth reveal conflicting results on the issue mainly due to the different data set, different time periods, different econometric methodologies and different countries characteristics. Some of the survey on energy-growth nexus also shows that the empirical results have yielded mixed results in terms of the four hypotheses related to the causal relationship between electricity consumption and economic growth (see Ozturk (2010) for the recent energy-growth literature survey). Also in the study of Payne (2010), the results for the specific countries that are surveyed, show that 31.15% supported the neutrality hypothesis; 27.87% the conservation hypothesis; 22.95% the growth hypothesis; and 18.03% the feedback hypothesis.

In spite of a substantial number of studies concerning relations between energy consumption and economic growth for several countries, some studies analyzed data for some MENA countries. Bouoiyour et al. (2014) found that the conservation hypothesis is widely associated to American and European countries. However, conservative policies are likely to have an adverse effect on the economic growth in Asian and MENA countries.

Few studies explored energy-growth nexus for group countries. Examples of these studies that addressed MENA countries are Omri (2013) and Al-Mulali (2011). The latter examined the impact of oil consumption on the economic growth of the MENA countries during the period 1980–2009. Based on the cointegration test results, it was found that oil consumption has a long run relationship with economic growth and is a bi-directional Granger causality between oil consumption and economic growth in both the short run and the long run.

Ozturk and Acaravci (2011) investigates the short-run and long-run causality issues between electricity consumption and economic growth in the selected 11 Middle East and North Africa

(MENA) countries by using Autoregressive Distributed Lag (ARDL) bounds testing approach of cointegration and vector error-correction models.
It employs annual data covering the period from 1971 to 2006. The unit root tests results indicate that some of the variables for Algeria, Jordan, Tunisia and United Arab Emirates do not satisfy the underlying assumptions of the ARDL bounds testing approach of cointegration methodology before proceeding to the estimation stage. Thus, we drop these countries from the ARDL bounds testing approach of cointegration and causality analysis. The cointegration test results show that there is no cointegration between the electricity consumption and the economic growth in three of the seven countries (Iran, Morocco and Syria). Thus, causal relationship cannot be estimated for these countries. However, the cointegration and causal relationship is found in four countries (Egypt, Israel, Oman and Saudi Arabia). The overall results indicate that there is no relationship between the electricity consumption and the economic growth in most of the MENA countries. Further evidence indicates that policies for energy conservation can have a little or no impact on economic growth in most of the MENA countries.Studies that considered Gulf Cooperation Council (GCC) include Al-Iriani (2006) which investigated the causality relationship between GDP and energy consumption in the six countries of the GCC.

In a different study, Farhani and Rejeb (2012) finding for MENA region reveals that there is no causal link between GDP and EC; and between CO2 emissions and EC in the short run. However, in the long run, there is a unidirectional causality running from GDP and CO2 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. Finally, Zeshan and Ahmed (2013) found long term relationship between Real GDP, energy consumption and CO2 emission in South Asia for the period of 1980-2010. Empirical findings show that a 1 % increase in energy consumption increases output by 0.81 % in long run whereas for the same increase in CO2 emission output falls by 0.17 % in long run.

3. Methodology and empirical results

3.1. The model and data

Following the empirical literature, the standard log-linear function specification of long run-relationship between energy consumption and economic growth is selected 8 MENA countries may be expressed as:

$$GDP_t = \alpha + \beta EC_t + \varepsilon_t$$

Where GDP_t is the real GDP per capita; EC_t is the energy consumption and ε_t is error term. All variables are employed with their natural logarithms prior to conducting the empirical analysis. The annual time series data for Algeria, Egypt, Iran, Jordan, Morocco, Saudi Arabia, Tunisia and United Arab Emirates are obtained from the World Development Indicators (WID) for 1975 to 2011 period. These countries are selected according to data availability.

International Journal of Academic Research in Business and Social Sciences
April 2016, Vol. 6, No. 4
ISSN: 2222-6990

Table 1. Descriptive statistics of GDP

	Algeria	Egypt	Iran	Jordan	Morocco	Saudi	Tunisia	Emirates
Mean	2651.233	967.1708	2378.715	2065.698	1587.897	14845.31	2432.644	50494.13
Median	2603.590	907.1107	2150.084	2042.444	1485.026	12891.46	2193.111	45700.44
Maximum	3171.735	1551.398	3316.305	2826.526	2432.824	22109.70	3861.509	81947.24
Minimum	2236.595	451.4822	1579.396	1221.518	1092.931	11605.39	1532.320	23795.86
Std. Dev.	272.4271	300.5708	508.4714	379.2645	359.3291	3448.695	702.9404	15471.33
Skewness	0.464613	0.333573	0.469535	0.303775	0.880537	1.126760	0.725617	0.497714
Kurtosis	2.129824	2.259025	2.005133	2.901974	2.773618	2.706337	2.256566	2.521383
Jarque-Bera	2.498529	1.532613	2.885404	0.583871	4.860304	7.962072	4.098947	1.880756
Probability	0.286716	0.464726	0.236288	0.746817	0.088023	0.018666	0.128803	0.390480
Sum	98095.62	35785.32	88012.44	76430.82	58752.17	549276.5	90007.82	1868283.
Sum Sq. Dev.	2671795.	3252340.	9307555.	5178296.	4648226.	4.28E+08	17788506	8.62E+09
Observations	37	37	37	37	37	37	37	37

Table 2. Descriptive statistics of EC

CE

	Algeria	Egypt	Iran	Jordan	Morocco	Saudi	Tunisia	Emirates
Mean	23239.71	37583.65	100098.4	3955.737	8713.065	84995.51	5762.942	27159.95
Median	23477.28	33214.99	87116.67	3802.131	8080.050	80966.27	5447.889	23513.57
Maximum	41852.00	77648.74	213422.8	7457.751	17282.68	192003.9	9673.822	66108.31

Minimum	5520.637	9817.968	26643.06	753.3420	3423.836	8768.920	2173.274	1937.391
Std. Dev.	9742.673	19668.49	59413.97	2017.795	3853.887	51161.26	2338.870	18192.25
Skewness	0.050194	0.573823	0.597388	0.210068	0.585646	0.440486	0.195001	0.512824
Kurtosis	2.416528	2.334990	2.105333	1.997287	2.268675	2.309810	1.741865	2.343812
Jarque-Bera	0.540382	2.712299	3.434707	1.822170	2.939589	1.930895	2.674800	2.285574
Probability	0.763234	0.257651	0.179541	0.402088	0.229973	0.380813	0.262527	0.318929
Sum	859869.2	1390595.	3703640.	146362.3	322383.4	3144834.	213228.8	1004918.
Sum Sq. Dev.	3.42E+09	1.39E+10	1.27E+11	1.47E+08	5.35E+08	9.42E+10	1.97E+08	1.19E+10
Observations	37	37	37	37	37	37	37	37

3.2. Unit root test

Testing for non-stationarity of the time series of economic growth, energy consumption, for the eight countries under consideration yields the following results:

The various time series have been tested for stationarity under the assumptions that they do possess an intercept and no trend. The first assumption is justified by the fact that none of the countries started at zero levels of consumption or economic growth. The second assumption is justified by the fact that none of the economies will be faced with ever increasing rates of either economic growth or consumption.

Table 3. Results of Augmented Dickey-Fuller unit root test for *GDP*

ADF test for EC

	ADF statistic	Critical value 5%	Probability	Conclusion
First difference				
Algeria	-6.396434	-2.948404	0.0000	No unit root
Saudi	-5.894689	-2.948404	0.0000	No unit root
Egypt	-4.369221	-2.948404	0.0014	No unit root
Emirates	-4.792830	-2.948404	0.0004	No unit root
Morocco	-4.621941	-2.948404	0.0007	No unit root
Iran	-5.977469	-2.948404	0.0000	No unit root
Jordan	-5.811575	-2.948404	0.0000	No unit root
Tunisia	-10.92303	-2.948404	0.0000	No unit root
	ADF test for GDP			
	ADF statistic	Critical value 5%	Probability	conclusion
First difference				
Algeria	-3.364610	-1.950687	0.0014	No unit root
Saudi	-3.548640	-1.950687	0.0008	No unit root
Egypt	-3.669144	-2.948404	0.0091	No unit root
Emirates	-4.912127	-2.948404	0.0003	No unit root

International Journal of Academic Research in Business and Social Sciences
April 2016, Vol. 6, No. 4
ISSN: 2222-6990

Morocco	-10.84877	-3.544284	0.0000	No unit root
Iran	-3.884006	-2.948404	0.0053	No unit root
Jordan	-4.538172	-2.948404	0.0009	No unit root
Tunisia	-4.212496	-2.948404	0.0022	No unit root

Thus all time series were stationary at the level of first differences, which allows continuing with the next step of the testing strategy, the test of cointegration.

3.3.Cointegration test

The study of cointegrating relationships has been a particularly active area of research. Since the unit root tests confirm that both variables are I(1) for all countries, then the next step would be to test if they are cointegrated or, in other words, if they are bound by a long-run relationship. This study applies Johansen's cointegration approach to test for cointegration and to determine the number of cointegrating equations. The results of cointegration test are shown in Table 4 and Table 5.

Table 4. Unrestricted Cointegration Rank Test (Trace)

country	Hypothesized No. of CE(s)	Eigenvalue	Trace	Statistic	Prob
Algeria	None *	0.303245	20.21979	18.39771	0.0275
	At most 1 *	0.194576	7.573532	3.841466	0.0059
Saudi	None	0.214506	9.145662	18.39771	0.5652
	At most 1	0.019667	0.695192	3.841466	0.4044
Egypt	None	0.289421	12.42974	18.39771	0.2783
	At most 1	0.013369	0.471084	3.841466	0.4925
Emirates	None	0.129325	4.850651	18.39771	0.9431
	At most 1	0.000104	0.003637	3.841466	0.9508
Morocco	None	0.197488	10.81272	18.39771	0.4055
	At most 1	0.085087	3.112421	3.841466	0.0777

Iran	None *	0.528628	31.08113	18.39771	0.0005
	At most 1 *	0.127091	4.757347	3.841466	0.0292
Jordan	None	0.221664	11.11523	18.39771	0.3793
	At most 1	0.064787	2.344345	3.841466	0.1257
Tunisia	None	0.197088	11.38602	18.39771	0.3568
	At most 1	0.100400	3.703174	3.841466	0.0543

Based on Trace method, presented in Table 4, the null hypotheses of no cointegration is rejected in the case of Algeria and Iran. The results of unrestricted cointegration rank test using Maximum Eigenvalue method, shown in Table 5 are almost similar to those of Trace method. Thus, we may conclude that there is no relationship between energy consumption and economic growth in most of the MENA countries.

Table 5. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

	Hypothesized No. of CE(s)	Eigenvalue	Eigenvalue	Statistic	Prob
Algeria	None	0.303245	12.64625	17.14769	0.2009
	At most 1 *	0.194576	7.573532	3.841466	0.0059
Saudi	None	0.214506	8.450470	17.14769	0.5538
	At most 1	0.019667	0.695192	3.841466	0.4044
Egypt	None	0.289421	11.95865	17.14769	0.2428
	At most 1	0.013369	0.471084	3.841466	0.4925
Emirates	None	0.129325	4.847014	17.14769	0.9135
	At most 1	0.000104	0.003637	3.841466	0.9508
Morocco	None	0.197488	7.700301	17.14769	0.6360
	At most 1	0.085087	3.112421	3.841466	0.0777
Iran	None *	0.528628	26.32378	17.14769	0.0018

	At most 1 *	0.127091	4.757347	3.841466	0.0292
Jordan	None	0.221664	8.770884	17.14769	0.5196
	At most 1	0.064787	2.344345	3.841466	0.1257
Tunisia	None	0.197088	7.682845	17.14769	0.6379
	At most 1	0.100400	3.703174	3.841466	0.0543

3.4. Testing for Granger causality

The Granger causality test was performed by testing for bivariate causality, that is, by comparing example given for a test between energy consumption and growth economic the significance of:

$$GDP_t + \beta_1 + \sum_{i=1}^{T} \beta_{2i} GDP_{t-1} + \sum_{j=1}^{T} \beta_{3j} EC_{t-1} + \varepsilon_t$$

With the significance of:

$$GDP_t = \beta_4 + \sum_{i=1}^{T} \beta_{5i} GDP_{t-i} + \varepsilon_t$$

And the significance of:

$$EC_t = \beta_6 + \sum_{i=1}^{T} \beta_{7i} EC_{t-i} + \sum_{j=1}^{T} \beta_{8j} GDP_{t-j} + \varepsilon_t$$

With the significance of:

$$EC_t = \beta_9 + \sum_{i=1}^{T} \beta_{10i} EC_{t-i} + \varepsilon_t$$

Table 6 presents the results of testing Granger's causality that runs from GDP to energy consumption for 8 MENA countries. The results do not reject the null hypotheses of no causality in the case of each MENA country with the exception of Alger. In Table 6, there is clear evidence that no causality runs from energy consumption to GDP except in the case of Egypt; morocco and Iran.

Table 6. Results of Granger causality test for no causality from GDP to EC

	H_0 : GDP DOES NOT GRANGER CAUSE ENERGY CONSUMPTION H_1 : GDP CAUSE ENERGY CONSUMPTION			
	OBSERVATION	F-STATISTIC	PROBABILITY	Décision
ALGERIE	36	5.94117	0.0203	causality
ARABIE SAUDIE	36	0.40228	0.5303	no causality
EGYPTE	36	0.62165	0.4361	no causality
EMARATES	36	0.04859	0.8269	no causality
MAROC	36	3.94726	0.0553	no causality
IRAN	36	0.28503	0.5970	no causality
JORDAN	36	0.98644	0.3278	no causality
TUNISIE	36	0.16556	0.6867	no causality

Table 7. Results of Granger causality test for no causality from EC to GDP

	H_0 : ENERGY CONSUMPTION DOES NOT GRANGER CAUSE GDP H_1 : ENERGY CONSUMPTION CAUSE GDP			
	OBSERVATION	F-STATISTIC	PROBABILITY	Décision
Algeria	36	0.00662	0.9357	no causality
Saudi	36	3.28003	0.0792	no causality
Egypt	36	19.3282	0.0001	causality
Emirates	36	3.05118	0.0900	no causality
Morocco	36	5.36600	0.0269	causality
Iran	36	10.0915	0.0032	causality
Jordan	36	0.92531	0.3431	no causality
Tunisia	36	2.17463	0.1498	no causality

As a result, no cointegration is found in six out of the eight countries studied in this paper. The cointegration and causal relationship is found only in three countries. Thus, we may conclude that there is no relationship between energy consumption and economic growth in most of the MENA countries.

4. Conclusion

This paper investigates the causal relationship between energy consumption and economic growth for Algeria, Egypt, Iran, Jordan, Morocco, Saudi Arabia, Tunisia and United Arab Emirates from 1975 to 2011. To examine this relationship, we use approach of cointegration and Granger causality analysis.

The results suggest that there is weak evidence on the causal relationships between energy consumption and economic growth in MENA countries. The main findings of our study are as follows:

(1) The existence of a cointegration relationship between energy consumption and economic growth in Algeria and Iran suggests that there must be Granger causality in at least one direction;
(2) there is no a relationship between energy consumption and economic growth in Jordan; Saudi Arabia; Tunisia and United Arab Emirates;
(3) one-way Granger causality from economic growth to energy consumption in Algeria;
(4) one-way strong Granger causalities from energy consumption to economic growth in Egypt; Morocco and Iran.

The empirical results of this study provide policy makers a better understanding of energy consumption-economic growth nexus to formulate energy policies in these countries. As a policy implication MENA countries should invest in energy infrastructure and step up energy conservation policies to avoid a reduction in energy consumption adversely affecting economic growth. Further evidence indicates that policies for energy conservation can have a little to no impact on economic growth in the other seven MENA countries.

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