TODA-YAMAMOTO CAUSALITY TEST BETWEEN ENERGY CONSUMPTION AND ECONOMIC GROWTH: EVIDENCE FROM A PANEL OF MIDDLE EASTERN COUNTRIES

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ABSTRACT

In this paper, we examine the intertemporal causal relationship between economic growth and energy consumption in the selected sixteen the Middle East and North Africa countries by annual data (1985–2016). Unlike the majority of the previous studies and as an alternative to the conventional method of having the same integration of time series and large samples, the Autoregressive Distributed Lag (ARDL) bounds test approach and causality analysis were applied by Toda & Yamamoto (1995). The results of the bounds test show that there is a stable long run relationship between economic growth and total final energy consumption. On the other hand, the results of the causality test, show that there is a unidirectional causal flow from economic growth to total energy consumption that energy conservation policies may not unfavourable effects on economic growth. Overall, these countries meet the conservation hypothesis which means that the causal aspect is unidirectional from economic growth to total final energy consumption and that energy conservation policies will have little or no negative impact on growth in these energy-dependent countries.

Keyword*: Energy Consumption, MENA Countries, ARDL Bounds Test, Toda-Yamamoto Causality.*

JEL Classification*: C33, Q43.*

1. INTRODUCTION

The role and importance of energy cannot be overlooked, as the energy-consuming industry is a big part of the national economy. Recently, policymakers, who have been pursuing extensive energy-saving policies in terms of energy demand and supply management, are required to estimate the link between economic growth and energy consumption. In particular, the causal relationship between economic growth and energy consumption is expected to play a major factor in achieving the goal of

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economic growth. Key factors in determining energy consumption include economic growth, population and urbanization (Kazim, 2007).

In general, the fact that the energy consumption increased as the size of the economy increased, the oil shock began to pay attention to the causal relationship between economic growth and energy consumption after the economic recession. Consequently, many scientists have studied the relationship between GDP and energy consumption (Tsani, 2010; Asafu-Adjaye, 2000; Erol and Eden, 1990). Also, countries with high per capita GDP have been found to have high per capita energy consumption (Burney, 1995; Leach and Gowen, 1987; Aimer, 2018, 2016). Is economic development more important than energy consumption? or is energy itself a stimulus for economic development? All these questions have aroused and motivated curiosity and interest among economists and policy analysts over the last decade to study the direction of causality between energy consumption and economic variables such as GNP, GDP, income, employment or energy prices (Murry and Nan, 1990; Glasure and Lee, 1998; Cheng and Lai, 1997; Masih and Masih, 1997; Asafu-Adjaye, 2000; Yang, 2000). This is because the direction of causality has significant implications for economic policy. For example, some studies have indicated a two-way causal relationship between GDP and energy consumption (Hwang and Gum, 1991), while others have found a one-way causal relationship (Cheng and Lai, 1997); others have found that there is no correlation between the energy consumption and GDP (Yu and Choi, 1985). The finding of a one-way causality running from energy consumption to GDP means an energy-dependent economy such that energy consumption is a stimulus for GDP growth, implying that lack of energy consumption can negatively affect economic growth or can cause weak economic performance. However, a continuous causality running from GDP to energy consumption means a less energy consumption-dependent economy such as energy conservation policies (eg rationing electricity) can be implemented with little or no harmful effect on the level of economic activity (GDP). If there is no causality between energy consumption and GDP, referred to as Yu & Choi (1985) neutrality assumptions, which implies that energy consumption is not correlated with GDP, and, as such, energy conservation policies can be pursued without compromising the economy.

Scholars have started late on the relationship between GDP and energy consumption, mainly using time series and panel data research methods (Wang et al. 2011; Chaofeng and Weizhong, 2005). In this context, some research results show that GDP is the cause of energy consumption, and there is a long-term correlation between GDP and energy consumption and energy structure; in terms of short-term impact, energy consumption seriously restricts the development of regional economy, but this restrictive effect It will weaken as the economic level continues to increase. Some studies have also concluded that energy consumption has a positive effect on GDP and shows a two-way causal relationship with GDP, but does not have long-term equilibrium.

Within this framework, our study aims to contribute to the current debate on the importance of energy consumption to economic growth. we use the ARDL bounds test approach and Toda &

Yamamoto's causality in which we integrate energy production, as well as energy consumption and GDP. For this purpose, the remainder of the research will be allocated: The second section presents, the theoretical framework for reviewing the literature related to the research topic. With regard to Section III, the methodology of the model used for the study. The final section will be devoted to interpreting the results and recommendations.

2. LITERATURE REVIEW

The analysis of the relationships between economic growth and energy consumption involves an account of the different theoretical studies and related empirical work. This review of literature is very useful in that it allows us to learn about the work done in the field to know the evolution of thoughts on our subject, so it allows us to know the existing to build at better our analysis and detect the powerful techniques to approach our work.

Some economic analysts have found that the relationship between economic growth and energy consumption can be classified into four categories: hypothesis of conservation, hypothesis of growth, hypothesis o hypothesis f feedback, and hypothesis of neutral (Payne, 2010; Ozturk, 2010; Apergis and Payne, 2009; Squalli, 2007; Chen et al. 2007; Yoo, 2005; Jumbe, 2004; Kesgingöz and Dilek, 2016).

First, the conservation hypothesis is the claim that economic activity increases energy consumption. Kraft and Kraft (1978), which attempted to analyze the relationship between energy consumption and economic growth for the first time, analyzed the US GNP and energy consumption using the Sims test from (1947-1974) and found that economic growth leads to higher energy consumption. Abosedra and Baghestani (1989) found that the study following Kraft and Kraft (1978) did not achieve the same results, and the Granger Causality Test was extended from 1947 to 1987, showing that economic growth leads to energy consumption. Tang et al. (2009) verified Grani's real (GDP) and energy consumption in China from (1960-2007) and found that economic growth increases energy consumption. The implementation of energy conservation policies under the conservation hypothesis is actively supported.

Second, the growth hypothesis is that energy consumption leads to economic growth, contrary to the hypothesis of conservation. Stern (1993) used a multivariate vector autoregressive (VAR) approach that included US energy consumption, GDP, labor and capital from 1947 to 1990, energy consumption is driving economic growth. Ho and Siu (2007) found that consumption of electricity leads to economic growth from 1966 to 2002 in the analysis of Hong Kong's electricity use and real GDP using covariance and vector error correction model. These findings suggest that energy conservation policies impede economic growth, so care must be taken in implementing the policies.

Third, the feedback hypothesis is that energy consumption and economic growth do not have a unilateral causal relationship, but mutual effects. Hwang and Gum (1991) found a causal relationship between energy consumption and Taiwan's GNP through covariance and ECOM model, and Oh & Lee

(2004) found that the relationship between Korean economic growth and energy consumption was found to be bi-directional causality between the two variables. Oh & Lee (2004) extended the study of Stern (1993) found that the vector autoregressive model using the difference was not enough to judge the relationship between two variables in the long run. Even in this case, energy consumption conservation policy affect growth, so caution is required in implementing the policies.

Fourth, the neutrality hypothesis (energy consumption is not relevant in economic growth). Akarca and Long (1980) argued that Kraft and Kraft (1978) study selected an unstable period due to an analysis that included an oil shock period, and estimated that Sims (1972) method reduced the analysis period by two years. The result is that energy consumption is not relevant in economic growth. Eden and Hwang (1984) also extended the analysis period and conducted a Sims test on US GNP and energy consumption from 1974 to 1979. Similarly, no causal relationship was found between the two variables. In order to solve the problem of small samples of previous studies, Eden and Jin (1992) conducted a cointegration analysis using monthly data with an emphasis on long-term equilibrium, indicating that there is no causality between the two variables.

Unlike previous studies analyzing the relationship between energy consumption and economic growth in specific countries, Masih and Masih (1996) used causal relationships using real-time data on real income and energy consumption in seven Asian countries as well as Korea. Analyzed. For example, different results have been obtained for different countries, such as energy consumption in India and Korea, and economic growth in Indonesia Lee and Chang (2005) analyzed economic growth and energy consumption using panel data from 18 developing countries, away from previous studies on individual countries. As a result, energy consumption has been unilaterally causal to economies of developing countries. Lee and Chang (2007) analyzed panel covariance and panel error correction model for 22 developed and eighteen developing countries to compare energy and growth of developing and developed countries. Causality has been derived from the estimation that growth has a unilateral causal relationship to energy sources in developing countries.

Contrary to this, Chen et al. (2007); Karanfil (2009) explained that the results vary depending on the duration and frequency of the data used, estimation methods, stages of economic development, and industrial structure. The literature has not yet reached a consensus on the nature of the relationship between economic growth and energy consumption, which can be linked to several factors such as: the structure of the economy, depending on whether the country studied is a developed country or not, the specification of the variables, the energy sources used, the energy policies applied, the level of energy consumption. Understanding the role of energy consumption in the traditional theory of growth is not clear. On the other hand, at the experimental level, we note that discussions have evolved with the use of time series techniques to study the relationship between variables and the direction of causality.

Based on the results of previous studies, when analyzing the relationship between economic growth and energy consumption, it is necessary to be cautious in selecting research methods, data, and target period for each research purpose.

This study is distinguished from previous studies, as it is the first of its kind, from the viewpoint of researcher, which examines the impact of total final energy consumption on the growth of selected MENA countries and the introduction of some economic factors not addressed in previous studies at the level of these countries, such as total final energy consumption and energy production.

The gap in the literature review is that there are no studies which examine the relationship between GDP, energy consumption and energy production within the one multivariate model. Although previous literature has exceeded a short-run horizon characterized by higher frequency and may accommodate duty cycle movements, this study constitutes a longer time horizon but the low frequency and the Toda Yamamoto test to find out the long-term causality between real (GDP) and energy consumption in a multivariate framework using data (1985-2016) for Algeria, Egypt, Iran, Iraq, Kuwait, Jordan, United Arab Emirates (UAE), Bahrain, Lebanon, Libya, Morocco, Saudi Arabia, Syria, Oman, Qatar and Tunisia.

3.   MODEL, DATA AND DESCRIPTIVE STATISTICS

3.1. Model and Data

In this research, we collect cross-sectional data and time series to study the causal relationship between economic growth (real GDP) and independent variables such as total final energy consumption (TFEC) and energy production (EP), in addition, all time series are expressed in the form of a natural logarithm. We get the following Eq. (1):

$$lnGDP_{it} = f(lnEP_{it}; lnTFEC_{it}) \tag{1}$$

We use the real GDP (constant 2010 US $) as a measure of economic growth GDP (the dependent variable) while total final energy consumption (million metric tons of oil equivalent) (TFEC) and energy production (Million metric tons of oil equivalent) (EP) as independent variables. All theis variables are obtained from World Bank and International Energy Agency[1].

The relationship of co-integration we estimate is specified as in Eq. (2).

$$lnGDP_{it} = \beta_{1i}lnEP_{it} + \beta_{2i}lnTFEC_{it} + \varepsilon_{it} \tag{2}$$

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[1] . http://www.iea.org/stats/index.asp

Where $i = 1,\ldots,16$ denotes the country and $t = 1985,\ldots,2016$ denotes the time period.

β_{1i} and β_{2i} are elasticities of real GDP with respect to gross fixed capital formation, labour, renewables, and nonrenewables, respectively. ε_{it} is the error term.

This research considers the relationship between real GDP and total final energy consumption for data set consists of balanced annual data of 512 observations for 16 MENA countries. We analyzed the model between 1985 and 2016, the longest time period for which data are available for the variables. we selected 16: Algeria, Egypt, Iran, Iraq, Kuwait, Jordan, UAE, Bahrain, Syria, Libya, Lebanon, Saudi, Morocco, Oman, Qatar and Tunisia. We excluded Kuwait from the study due to lack of renewable energy consumption data for the period.

3.2. Panel Cooperatıon Tests

All of the tests proposed by Pedroni (1999, 1997) are based on residues from an equation as follows.

$$\Delta y_{i,t} = \alpha_i + \delta_{it} + \beta_{1i,t}\mathcal{X}_{1i,t} + \beta_{2i}\mathcal{X}_{2i,t} + \cdots + \beta_{Mi}\mathcal{X}_{Mi,t} + \varepsilon_{i,t} \qquad (3)$$

The slope coefficients $(\beta_{1i}, \beta_{2i}, \ldots, \beta_{Mi})$ may vary between the horizontal sections in the panel.. The α_i parameter is a constant effect parameter that can be different between fixed or individual sections specific to the sections in the panel. Although mostly neglected, the term δ_{it} deterministic time trend specific to cross-sections in the panel can be included in the equation. Since the horizontal cross-section constant effects and cross-section time trends were not included in the equation, the critical values and asymptotic distribution were calculated, so the critical values for each case were calculated.

3.2.1. The ARDL Bounds Test

In this paper, Bounds test was used to test the long-term equilibrium relationship between the variables of equation (3). Engle and Granger (1987) co-integration tests and Johansen (1988) co-integration tests require the same integral order of time series and a large number of long-term data. The ARDL bounds test approach proposed by Pesaran et al. (1999), overcomes this problem. Bounds test could be implemented regardless of the integral order of time series and has the advantage of being robust to small samples. Narayan (2005) presents the thresholds for the $I(0)$ and $I(1)$ processes for 30 to 80 subsamples. However, if $I(2)$ variables are present, the ARDL bounds test approach cannot be applied. Therefore, the unit root test should confirm that there is no $I(2)$ variable in the integral of the time series.

The bounds test uses (ECM) to check for cointegration. The non-constraint ECM based on the long-term equilibrium relationship of Eq. (3) can be expressed as Eq. (4).

$$\Delta lnGDP_t = \beta_0 + \sum_{I=1}^{P} \beta_{1i}\Delta lnGDP_{t-i} + \sum_{i=0}^{q1} \beta_{2i}\Delta \, lnEP_{t-i} + \sum_{i=0}^{q2} \beta_{3i}\Delta \, lnTFEC_{t-i} -$$
$$\alpha(lnGDP_{t-1} + \theta_1 lnEP_{t-1} + \theta_2 lnTFEC_{t-1}) + \upsilon_t \tag{4}$$

3.2.2.   Toda-Yamamoto (TY) Causality

The cointegration test verifies the existence of long-term equilibrium relationships between variables. If there is a cointegration relationship, a long run equilibrium relationship or ECM is applied. If there is no cointegration relationship, the short-term relationship is analyzed through the difference variable. In contrast, the Granger causality test is a way of examining whether one variable helps predict another. Traditional Granger causality testing methods should ensure the stability of time series data and the integration process should be clear. However, the effectiveness of the Granger causality test is poor if the time series integration process is different or unclear. As an alternative, Toda and Yamamoto (TY) method is used (Toda and Yamamoto, 1995).

Causality test by Toda and Yamamoto (1995), require estimating the following VAR ($k+d_{max}$) model:

Real GDP, Eq. (5):

$$lnGDP_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1i}lnGDP_{t-i} + \sum_{j=k+1}^{d_{max}} \beta_{2j}lnGDP_{t-j} + \sum_{i=1}^{k} \theta_{1i}lnTFEC_{t-i} +$$
$$\sum_{i=k+1}^{d_{max}} \theta_{2j}lnTFEC_{t-j} + \sum_{i=1}^{k} \lambda_{1i}lnEP_{t-i} + \sum_{j=k+1}^{d_{max}} \lambda_{2j}lnEP_{t-j} + \varepsilon_{1t} \tag{5}$$

Total final energy consumption, Eq. (6):

$$lnTFEC_t = \widehat{\alpha_0} + \sum_{i=1}^{k} \widehat{\beta_{1i}}lnTFEC_{t-i} + \sum_{j=k+1}^{d_{max}} \widehat{\beta_{2j}}lnTFEC_{t-j} + \sum_{i=1}^{k} \widehat{\theta_{1i}}lnGDP_{t-i} +$$
$$\sum_{i=k+1}^{d_{max}} \widehat{\theta_{2j}}lnGDP_{t-j} + \sum_{i=1}^{k} \widehat{\lambda_{1i}}lnEP_{t-i} + \sum_{j=k+1}^{d_{max}} \widehat{\lambda_{2j}}lnEP_{t-j} + \varepsilon_{2t} \tag{6}$$

Where $lnGDP$ is natural logarithm of real GDP; $lnTFEC$ represents natural logarithm of the total final energy consumption; $lnEP$ is natural logarithm of energy production.

3.3. The Variables Definition

Our study covers 19 MENA countries, on a 16 country basis, and covers the period 1985-2016. These countries are Oman, Egypt, Morocco, Iran, Libya, Iraq, Kuwait, Jordan, UAE, Bahrain, Lebanon, Saudi Arabia, Syria, Qatar and Tunisia. The variables used the GDP (constant 2010 US $) as a measure of growth (GDP); Total final energy consumption (million metric tons of oil equivalent) (TFEC) and energy production (Million metric tons of oil equivalent) (EP). The graphical representations (see appendix) of the different series used allow us to have a first descriptive analysis of our sample, before proceeding to the estimate itself. They show the different variations in energy consumption and GDP for each country in the sample. Energy consumption and GDP follow a similar path for all countries in

the sample. This confirms that these different variables are linked by a common relationship which has justified more in-depth estimates.

3.4. Panel Unit Root Test

In the panel data analysis, unit root tests are sensitive to the horizontal cross-sectional dependence properties that may be found between the variables. Therefore, horizontal cross-sectional dependence relationships between variables should be investigated in panel data models.

Disregarding the features of horizontal cross-sectional dependence that may occur in variables or models may cause deviation estimates. In this context, the variables in the model and the horizontal cross-sectional dependence properties of the model were investigated by Levin et al. (2002); Maddala and Wu (1999); Im et al. (1997); Choi (2001). Table 1 shows unit root results, the statistics solidly confirm that the three series (lnGDP, lnTFEC, lnEP) are the first difference process. The results of this test are presented in Table 1.

Table 1 Unit Root Tests

Test	$lnGDP$	$LnTFEC$	$lnEP$	$D(lnGDP)$	$D(LnTFEC)$	$D(lnEP)$
Pesaran	47.21***	49.79***	31.23***			
Levin	-1.24	-1.39*	-3.02***	-1.56***	-13.50***	-14.09***
Im, Pesaran	-1.18	-1.21	-2.16**	15.53***	15.73***	-14.94***
ADF - Fisher $\mathcal{X}^2$	50.82**	46.88**	64.88***	291.37***	246.64***	243.79***
PP - Fisher $\mathcal{X}^2$	44.64*	35.77	66.95***	549.67***	696.13***	685.37***

Note: ***, ** and * represent significance at 1%, 5% and 10% confidence levels.

For all the variables, we cannot reject the null hypothesis of the absence of the panel unit root at the level. In I(1), this hypothesis is rejected for $lnGDP$, $lnTFEC$ and $lnEP$ of the analysis. The test used to confirm that the series is stationary from the first differences, which leads us to conclude that the panel series are all integrated of order one or $I(1)$. The verification of stationarity properties for all panel variables leads us to study the existence of a long-term relationship between them.

3.5. Panel Cointegration Test

The Pedroni cointegration test consists of seven tests. Four of these tests perform a cointegration test for the overall horizontal cross-sectional units forming within the panel, while 3 of them perform tests for the cross-sectional units, including Koa's (1999) residual cointegration tests. We observe that only nine out of the eleven tests demonstrate evidence for panel cointegration for the 16 selected MENA group. Kao's results, confirm that for the entire MENA region, the hypothesis of common integration cannot be rejected at the 1% significance level.

Table 2. Pedroni and Kao Panel Cointegration Test Results

Pedroni	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-statistic	3.619**	0.000	3.308***	0.000
Panel rho-statistic	-0.333	0.369	0.471	0.681
Panel PP-statistic	-2.452***	0.007	-1.706**	0.043

Panel ADF-statistic	-5.318***	0.000	-2.496***	0.006	
Group rho-statistic	1.245**	0.893			
Group PP-statistic	-1.388*	0.082			
Group ADF-statistic	-2.640***	0.004			
Kao Residual Cointegration Test					
ADF	-1.737**	0.041			
Residual variance	0.008				
HAC variance	0.012				

Notes: *,**,***significance at 1%, 5% and 10%.

3.6. Panel Cointegration Estimation

Energy consumption, economic growth, and energy production in long run relationships between variables will be investigated using Bounds testing method. Pesaran et al. (2001), the advantage of the ARDL boundstest approach, regardless of the degree of integration of variables between the variables whether there is a cointegration relationship is investigated. On the other hand, this method is considered suitable for three reasons.

First; The bounds test procedure is easy and, unlike multivariable cointegration methods such as Johansen and Juselius (1990), the existence of a cointegration relationship is determined after the lag length of the model is estimated by the least-squares method. Second, the boundstest procedure does not require pretesting of the variables included in the unit root test model and can be applied only if the series in the model are I(2), I(0) and I(1), or all of them are mutually integrated I(1). Third; this method is considered suitable for the bounds test is more suitable for small samples compared with traditional cointegrating techniques (Haug, 2002).

Compared to other cointegration tests, which assume that the series are stationary of the same order such as Johansen & Juselius (1990), bounds testing method by Pesaran et al. (2001) does not require the determination of the stationary levels of the variables. Therefore, this test can be used when all series are at the level or the first difference or a combination of these two conditions. It is only checked that the variables are stationary in the second order. On the other hand, this method is considered suitable for the bounds test is more suitable for small samples compared with traditional cointegrating techniques (Haug, 2002). The ARDL bounds testing method consists of three steps. In the first step, it is determined whether there is a cointegration relationship between these variables. In the second step, long-run coefficients are determined under the existence of cointegration, and in the last step, the estimation of short-term coefficients is started.

Table 3 Estimated the ARDL bounds approach

Countries	Model	*lnEP*	*lnTFEC*	C	ECM(-1)	F-stat[a]	LM	HET
Algeria	(7,0,0)	0.67***	0.56***	20.63***	-0.57***	8.10	0.54(0.76)	14.05(0.12)
Egypt	(1,4,1)	-0.79	1.27***	24.94	-0.07***	42.88	0.16(0.91)	4.70(0.78)
Iran	(2,4,4)	0.22	0.63***	22.39***	-0.69***	7.39	0.46(0.79)	6.76(0.87)
Iraq	(1,3,2)	0.71***	2.23***	15.43***	-0.39***	4.58	1.04(0.59)	6.20(0.62)
Kuwait	(7,1,3)	-1.91	1.81*	30.35***	-0.15**	1.53	2.36(0.30)	6.02(0.94)
Jordan	(8,0,1)	-0.49***	1.50***	20.97***	-0.21***	10.90	0.95(0.62)	4.96(0.93)
UAE	(7,0,1)	10.95	-5.67	-7.92	-0.04***	9.57	2.07(0.35)	6.37(0.78)

Bahrain[b]	(1,0,0)	0.007	1.04***	22.30***	-0.37***	30.74	2.66(0.36)	7.47(0.11)
Lebanon	(6,4,4)	0.89	-1.31	0.05***	-0.17***	25.15	2.38(0.30)	16.36(0.49)
Libya	(4,4,2)	1.27***	-0.14	19.38***	-0.70***	6.13	1.26(0.53)	6.35(0.89)
Morocco	(1,3,5)	0.64	0.94***	22.94***	-0.14***	4.09	4.31(0.11)	8.82(0.63)
Saudi	(2,1,1)	0.25*	0.65***	22.42***	-0.11***	10.46	0.93(0.62)	5.01(0.54)
Syria	(7,2,4)	-0.05	1.30***	21.55***	-0.80***	9.72	2.40(0.30)	11.34(0.72)
Oman	(1,1,1)	0.70***	0.18***	21.41***	-0.45***	13.00	3.69(0.15)	5.02(0.41)
Qatar	(1,2,0)	-0.04	1.55***	21.67***	-0.28***	7.15	0.36(0.83)	2.83(0.72)
Tunisia	(2,0,0)	0.38***	1.06***	21.70***	-0.28***	23.98	3.52(0.17)	3.67(0.45)

		$I(0)$		$I(1)$	
Critical values[a] at 1%		4.13		5	
Critical values[a] at 5%		3.1		3.87	
Critical values[a] at 10%		2.63		3.35	

Notes: The critical values for the lower $I(0)$ and upper $I(1)$ bounds by Narayan (2005) (Narayan, 2005).

In the determination of whether there are structural changes in the long-term coefficients of the ARDL models, CUSUM was performed for systematic changes in coefficients, and CUSUMQ tests were used for detection of sudden and random changes in coefficients (Brown et al., 1975).

Figure 1. Plot of CUSUM and CUSUMQ tests
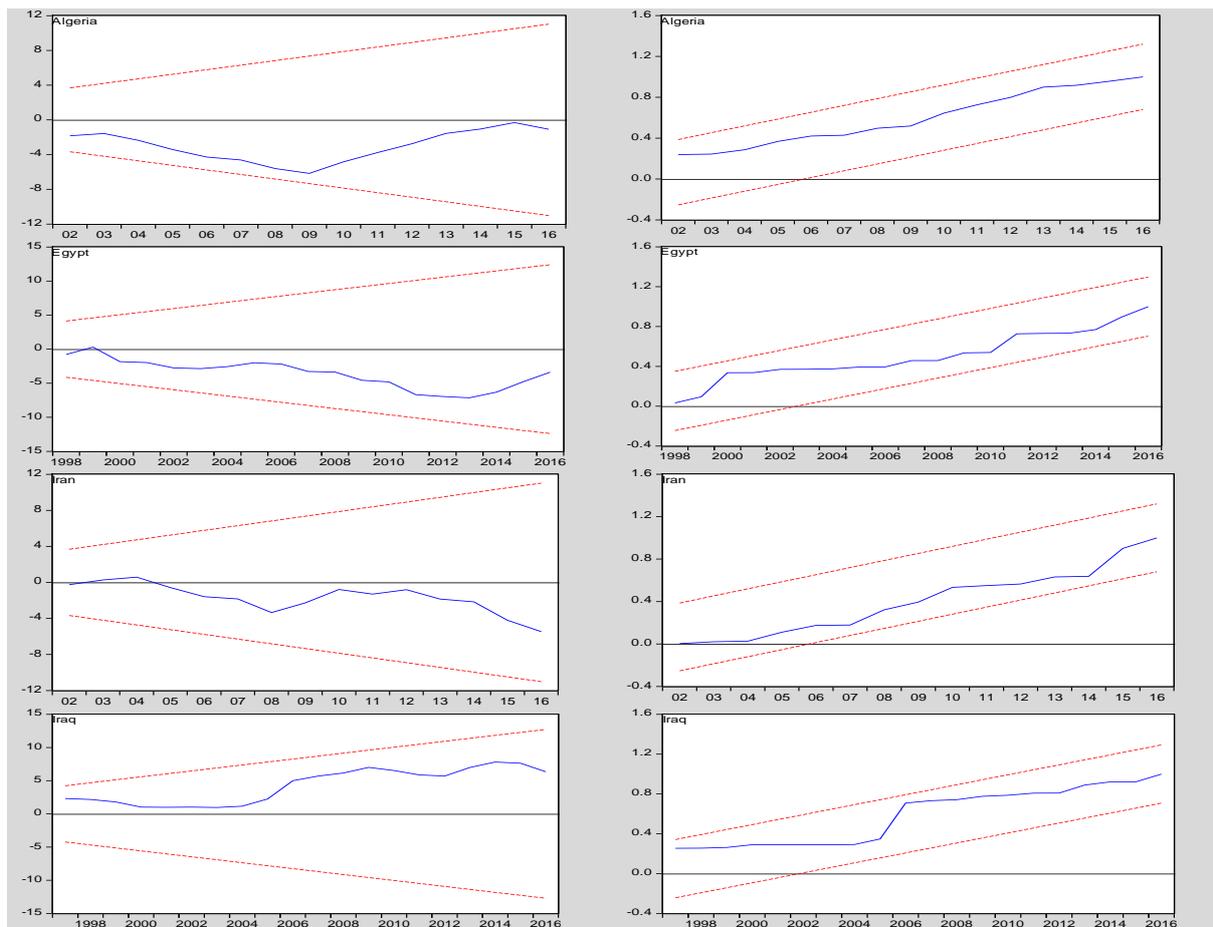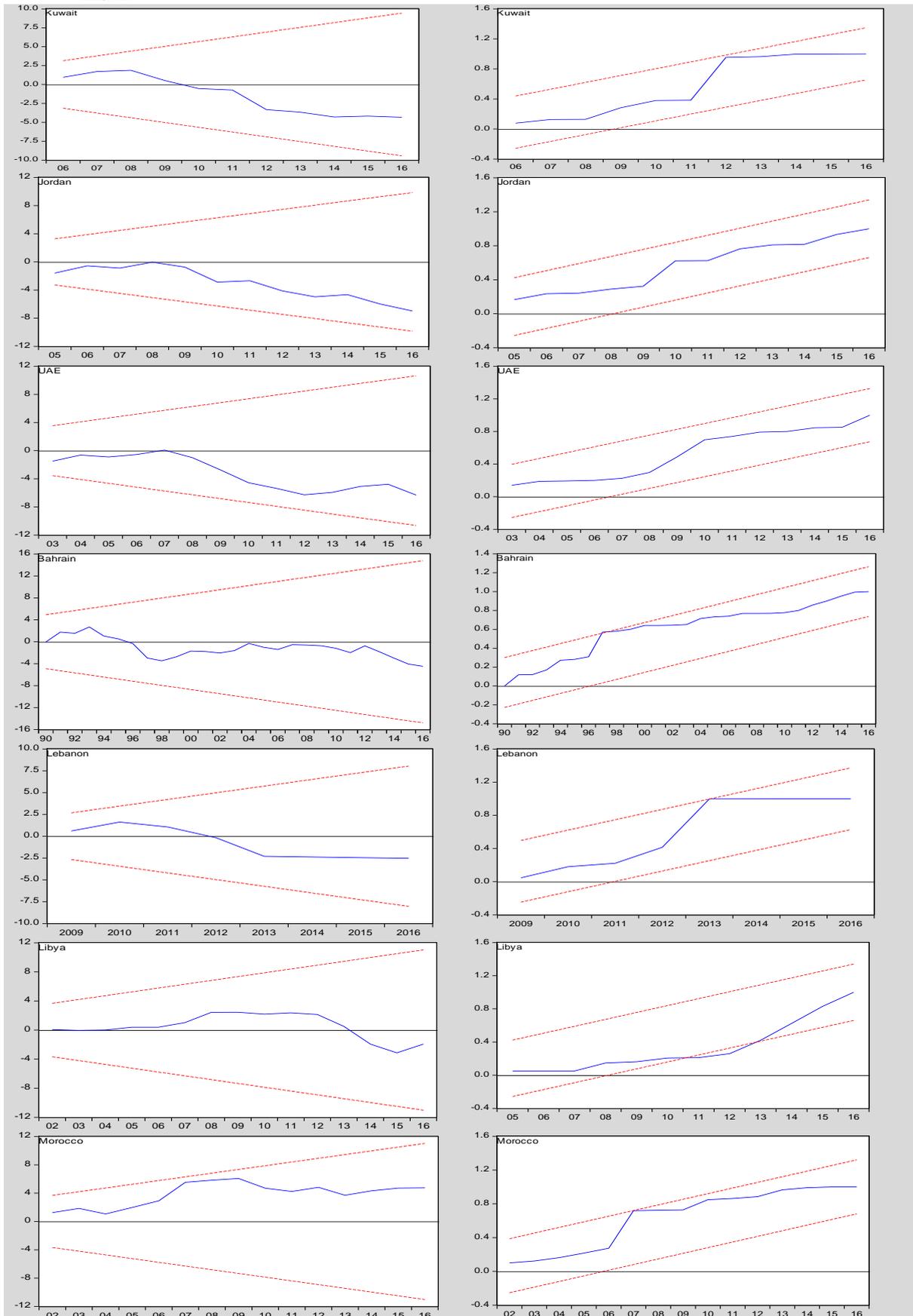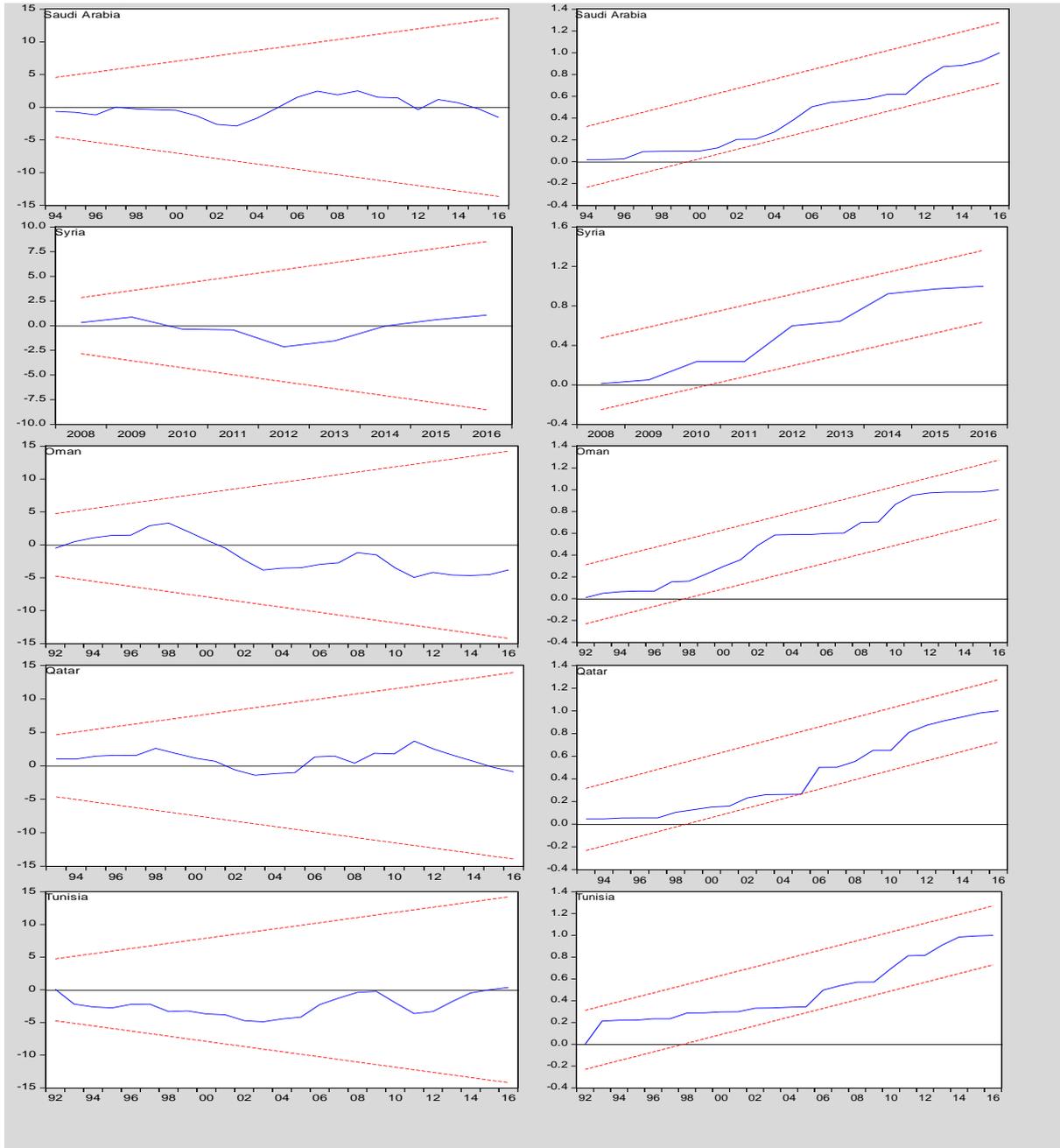
According to the stability tests (Figure 1), it was concluded that the parameters were stable because the curves of the error term remained within the confidence interval and no artificial variables were needed to maintain stability.

The bounds F-test yields evidence of a long-term positive relationship between total final energy consumption, GDP and energy production at 1% significance level for Algeria, Egypt, Iran, Bahrain, Saudi, Syria, Jordan, Oman, Qatar and Tunisia, and 10% significance level for Iraq, and Morocco. The magnitude of the impact ranges from 2.23 in the case of Iraq to 0.18 in the case of Oman. For the UAE, Lebanon and Libya, the effect of total final consumption of energy consumption on real GDP is negative but not statistically significant at any level. However, bounds test results show that there is not any long

run equilibrium relationship between total final GDP and energy consumption in Kuwait. As a result of the accelerated growth in energy consumption in Kuwait at a pace that exceeded the population growth, it resulted in an increase in per capita energy consumption from 52 barrels of oil equivalent in 1995 to 58 barrels of oil equivalent in 2018. This remarkable acceleration in energy consumption compared to the volume of production This has led to a rise in the share of domestic energy consumption to total energy supply from 12% in 1995 to 21% in 2018. Although Kuwait is paying increasing attention to improving energy efficiency and rationalizing its energy consumption, its growth in energy consumption accelerated during 1995-2018 at a pace that exceeded GDP growth Measured at purchasing power parity (PPP), Kuwait's energy density index remained at the global average of 0.9 barrels of oil equivalent per thousand dollars of output. One of the highlights of the development of energy consumption in Kuwait during the period 1995-2018 is the steady rise, where it increased by more than 430 thousand barrels of oil equivalent per day during the period 1995-2018, rising from 278.5 thousand barrels of oil equivalent per day in 1995 to 711 thousand barrels oil equivalent per day in 2018, an annual growth rate of 4.2%. The concerned government agencies seek to develop a mix of fossil fuels and renewable sources in a sustainable manner that allows the preservation of the depleted state's sources of oil and natural gas for future generations.

Econometric analysis indicates that no causal relationships can be estimated when there is no long-term equilibrium between variables. In the case of Kuwait, there is no equilibrium relationship, which indicates that there is no causality between the two variables. The existence of a cointegration relationship between GDP and total final energy consumption in Algeria, Jordan, Iran, Egypt, Iraq, UAE, Bahrain, Libya, Lebanon, Morocco, Saudi, Syria, Qatar, Oman and Tunisia suggests that there must be causality in at least one direction.

Turning to the effect of energy production on GDP, we find that for Algeria, Iraq, Libya, Saudi Arabia, Oman and Tunisia, energy production has a positive and statistically significant impact on GDP. The magnitude of the impact ranges from 0.38 in the case of Tunisia to 1.27 in the case of Libya. For Jordan, energy production has a negative and statistically significant effect on GDP.

The results show that the estimated coefficients of the error correction terms are all significant. These results indicate that all variables used in this research respond to deviations from long-run equilibrium. In terms of the speed of adjustment towards long-term equilibrium, we found that for the whole sample, the real GDP and energy production respond to deviations from long-run equilibrium.

3.7. Toda-Yamamoto Causality Analysis

This long run relationship between the two variables also shows that these variables have a causal relationship. The causality relationship between these variables was investigated by Granger causality based on Toda-Yamamoto method.

4.   Table 4. Toda-Yamamoto Causality (modified WALD) Test Result

	long-run Granger causality		Lag (k)	Lag (k+d_{max})	Causality Direction
	GDP no TFEC	TFEC no GDP			
Algeria	11.46(0.02)**	1.57(0.81)	4	4+1	GDP→TFEC; TFEC ↛ GDP
Egypt	2.60(0.10)	1.33(0.24)	1	1+1	GDP→TFEC; TFEC ↛ GDP
Iran	2.91(0.40)	4.20(0.24)	3	3+1	GDP↛TFEC; TFEC↛GDP
Iraq	11.67(0.00)***	3.48(0.32)	2	2+1	GDP→TFEC; TFEC ↛ GDP
Jordan	1.78(0.18)	0.14(0.70)	1	1+1	GDP↛TFEC; TFEC↛GDP
UAE	12.54(0.02)**	20.81(0.00)***	5	5+1	GDP ↔ TFEC
Bahrain	8.60(0.00)***	0.02(0.86)	1	1+1	GDP→TFEC; TFEC ↛ GDP
Lebanon	1.79(0.40)	6.35(0.04)*	2	2+1	GDP↛TFEC; TFEC→GDP
Libya	3.01(0.08)*	21.45(0.00)***	1	1+1	GDP ↔ TFEC
Morocco	0.49(0.48)	4.00(0.04)**	1	1+1	GDP↛TFEC; TFEC→GDP
Saudi	0.00(0.96)	0.03(0.84)	1	1+1	GDP↛TFEC; TFEC↛GDP
Syria	0.08(0.95)	11.96(0.00)***	2	2+1	GDP↛TFEC; TFEC→GDP
Oman	0.98(0.61)	8.09(0.01)**	2	2+1	GDP↛TFEC; TFEC→GDP
Qatar	1.69(0.63)	4.21(0.23)	3	3+1	GDP↛TFEC; TFEC↛GDP
Tunisia	0.81(0.66)	1.80(0.40)	2	2+1	GDP↛TFEC; TFEC↛GDP
Panel	11.97(0.03)**	2.86(0.72)	6	6+1	GDP→TFEC; TFEC ↛ GDP

Note: The (k+dmax) denotes VAR order. *, ** and *** denotes 1% and 5%, 10% significance level.

The causality results are reported in Table 4. There is long run unidirectional causality running from energy consumption to GDP in Lebanon, Morocco, Syria and Oman. which means, an expansion in energy consumption increases GDP in Lebanon, Morocco, Syria and Oman. The growth hypothesis expresses unidirectiona causality from energy consumption to economic growth. Accordingly, while the increase in energy consumption leads to economic growth, decreases in energy consumption will have a negative impact on economic growth. This result corresponds to the results of Bhattacharya et al. (2017) which suggests that the deployment of renewable energy consumption and institutions has an important role to play in promoting growth and reducing CO2 emissions Mehrara's (2007) findings for eleven oil-exporting countries and Al-Iriani (2006) results for the 6 countries of the GCC. Both studies found that unidirectional causality emanates from energy consumption consumption to GDP. According to Lütkepohl (1982) in each of these studies, the results could be affected by the omitted variable bias due to the use of bivariate models.

For Libya and UAE, bi-directional causality between GDP and energy consumption consumption. Also, an expansion in GDP increases consumption of energy in Libya and UAE. Furthermore, an increase in energy consumption results in higher GDP for Libya and UAE. In addition to the direct impact of energy used in commercial use that contributes to GDP, the increase in energy consumption leads to an increase in energy production, which means expanding in infrastructure and the use of energy. Overall, These countries meet the feedback hypothesis which means that consumption and energy consumption and economic growth are jointly determined and affect each other and indicate the presence of a bi-directional causality relationship between variables. These results are consistent with the study of (e.g. Amri, 2017; Kahia et al. 2016).

There is a unidirectional causality running from GDP to energy consumption in Algeria, Egypt, Iraq, Bahrain and as well as for the panel as a whole. Finding neutrality or detecting unidirectional

causality from GDP to energy consumption means that energy conservation policies can occur without compromising economic growth.

While there is no statistically significant relationship between energy consumption and GDP of the countries of Iran, Jordan, Saudi Arabia, Qatar and Tunisia. Once this hypothesis is confirmed, conservative or expansionary policies in renewable energies will have no impact on growth (Ozturk, 2010). The lack of a causal relationship between energy consumption and economic growth eliminates the possibility that energy conservation policies will adversely affect economic growth (Aytaç, 2010).

4. CONCLUSIONS

Today, energy has become the most important factor that shapes the world economy and policies. The main objectives of all countries are to produce more energy, to deliver the produced energy to more people, to ensure the development of poor countries and to leave a livable world to the next generations without damaging the environment. The increasing importance of energy requires an in-depth examination of the energy market. Analyzing the variables in the energy market is an important indicator for the policies to be determined by energy companies, consumers, governments, regulatory agencies and international organizations.

Panel unit root tests, ARDL model and Granger causality tests based on Toda Yamamoto method were used. Firstly, all variables were determined to be stationary in the first order by unit root tests. The cointegration between the variables was then determined by ARDL test. In addition, the Granger causality test based on Toda method was used for variables with long term relationships between them. According to the test results, the bounds F-test yields evidence of a long-term positive relationship between energy and GDP for Jordan, Egypt, Iran, Algeria, Bahrain, Tunisia, Syria, Oman, Qatar, Iraq, Saudi and Morocco. However, for the UAE, Lebanon and Libya, the effect of energy consumption on real GDP is negative but not statistically significant at any level. Olso, there is not any long-term equilibrium relationship between total final energy consumption and GDP in Kuwait. Thus, the econometric analysis suggests that any causal relationships within the dynamic VECM for Kuwait cannot be estimated.

Toda-Yamamoto causality tests show unidirectional causality running from energy consumption to growth in Lebanon, Morocco, Syria and Oman. which means, an expansion in energy consumption increases GDP in Lebanon, Morocco, Syria and Oman in the long-run. For Libya and UAE, bidirectional causality between GDP and energy consumption, these countries meet hypothesis of feedback which means that consumption of energy consumption and economic growth are jointly determined and affect each other. While there is a unidirectional causality running from GDP to energy consumption in Algeria, Egypt, Iraq, Bahrain and as well as for the panel as a whole. Finding neutrality or detecting unidirectional causality from GDP to energy consumption means that energy conservation policies can occur without compromising economic growth. While there is no statistically significant relationship

between GDP and energy consumption of the countries of Iran, Jordan, Saudi Arabia, Qatar and Tunisia. Once this hypothesis is confirmed, conservative or expansionary policies in renewable energies will have no impact on economic growth. However, increasing GDP requires massive energy consumption in Middle Eastern countries. Therefore, it seems misleading to recommend the same policy to different Middle Eastern countries.

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APPENDIX

Evolution of Total Final Energy Consumption and GDP of the 16 Countries in the MENA
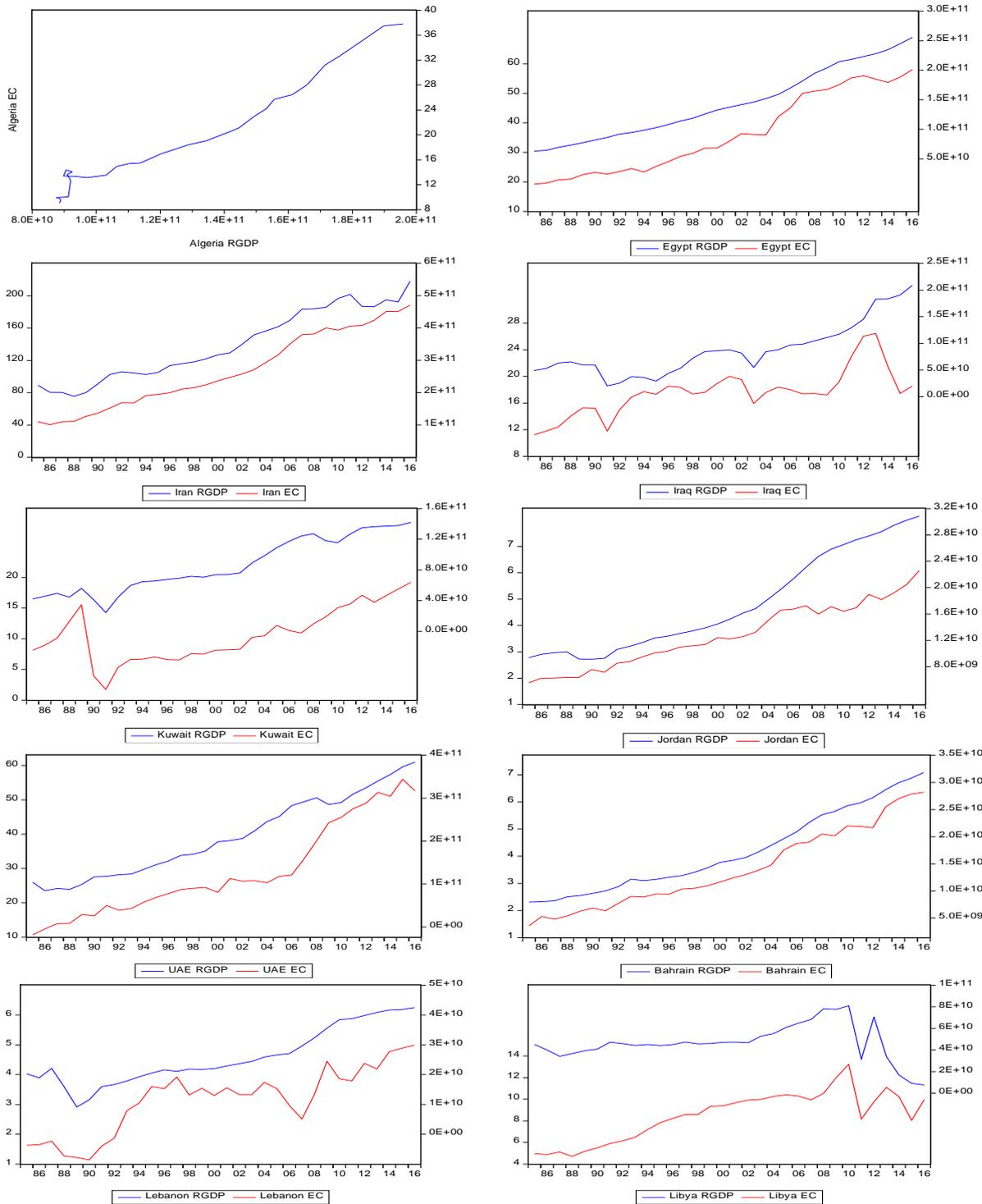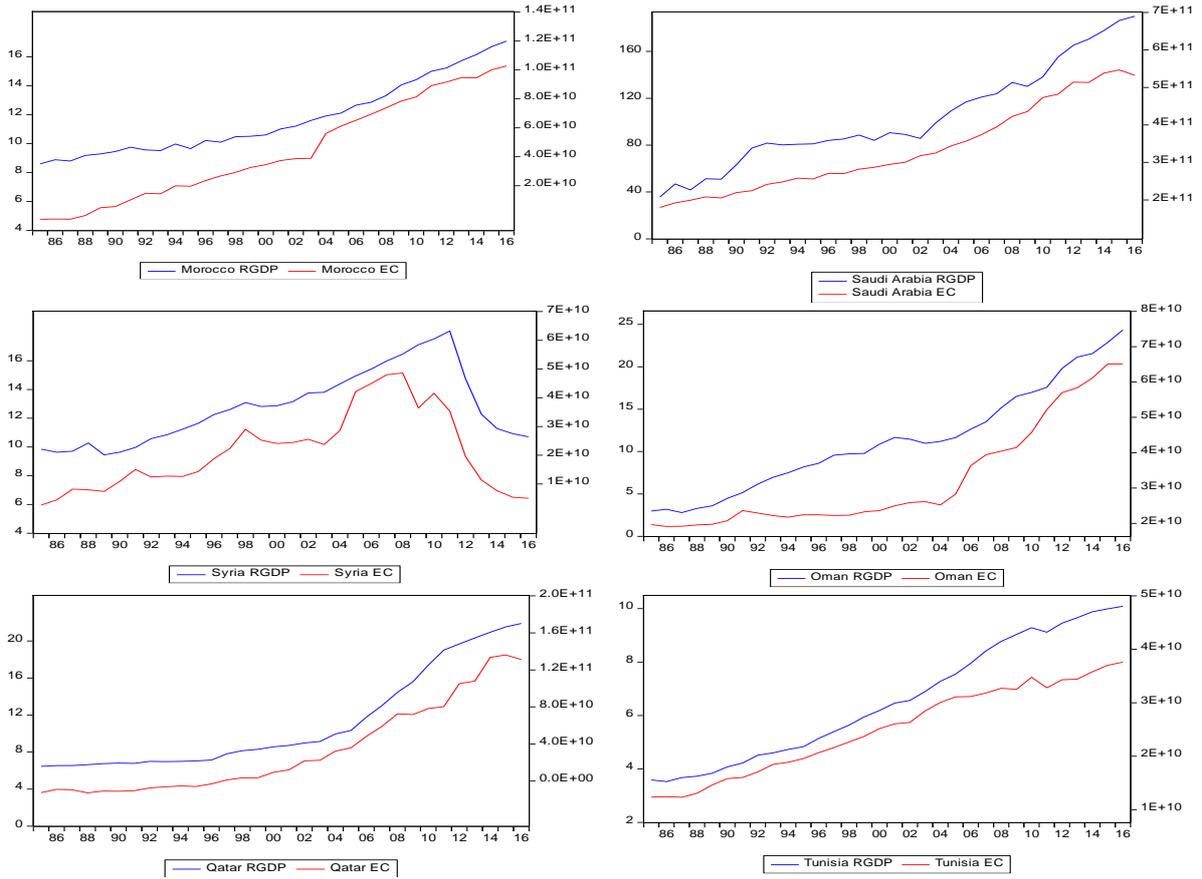
The blue line represents GDP, while the red line represents energy consumption.