Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.4, No.20, 2013

Electricity Consumption-GDP Nexus in Bahrain: A Time Series Analysis

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Abstract
This study aims to explore the nexus between electricity consumption and economic growth in Bahrain over the period 1975-2010. This study uses two different test methods to test for causality, namely, the error correction model and Toda-Yamamoto (1995) procedure. The results based on both approaches consistently show a unidirectional long-run causality from economic growth to electricity consumption. Thus, the results support the neutrality hypothesis of electricity consumption with respect to economic growth. The findings have practical policy implications for decision makers in the area of macroeconomic planning; the absent of causality running from electricity consumption to economic growth implies that electricity demand side management measures can be adopted to reduce the wastage of electricity which would not affect future economic growth in Bahrain.
Keywords: Electricity consumption; economic growth; time series; Bahrain, causality; unit root; cointegration; ECM; Toda-Yamamoto.

1. Introduction

Electricity as a form of energy plays an important role in economic development and it is required for both commercial and non-commercial uses. Commercial usage of power refers to the use of electric power in industry, agriculture and transport. Non-commercial uses include electric power required for domestic lighting, cooking, use of domestic mechanical gadgets like refrigerators and air-conditioners. Electricity is essentially a prime mover of the economic activities, the use of electricity is associated with improving health and education and standards of living, if we provide basic infrastructure, electricity and other essential facilities. It is seen that economic activities would be picking up and result in economic growth and development. Scientific advancement boosts the demand for electricity and leads to rapid economic growth in the region. The causal relationship between electricity and economic growth should be investigated in order to make appropriate energy policies. In fact, various advances in many fields such as science and technology for improving the quality of life lead to shift of resources from manual devices to technological advanced equipments. The development process has created a large demand for energy and as a result exploring every source of energy is important that are able to meet growing electricity requirements to spur economic growth, herewith, this study is going to investigate the relationship between electricity and economic growth in the kingdom of Bahrain. The remainder of this paper is organized as follows: Section two presents the theoretical foundation, section three briefly, reviews the related literature on the electricity-growth nexus. Section four presents the sources of data and research methodology that has been used. The fifth Section discusses the empirical results. Lastly, the study provides the concluding remarks.

2. Theoretical Foundation:

The relationship between energy consumption and economic growth has been theoretically investigated through two main different approaches. In the neoclassical growth models, energy is simply considered to be intermediate input of production (Tsani, 2010). According to Bartleet and Gounder (2010), proponents of this view think that there are some mechanisms by which economic growth could remain in spite of a limited source of energy resources. The underlying explanation for this thought is built upon the possibility of technological change and substitution of other physical inputs for energy so as to use the existing energy resources efficiently, and to generate renewable energy resources that are not subject to binding supply constraints, Solow (1974). Accordingly, energy is merely one of the non-essential inputs in production process. In other words, the advocates of this theory support the 'neutrality hypothesis' and 'conservation hypothesis'. These hypotheses imply that energy supply restrictions might not have any effect on economic growth. Thus, the government can simultaneously adopt the energy conservation and economic growth policies, Bartleet and Gounder, (2010). On the other hand, the ecological economic theory states that energy consumption is a limiting factor to economic growth, especially in modern economies. Ecological economists' judge that technological changes and other physical inputs could not possibly substitute the important role of energy in production process, Stern, (1993, 2000). They even consider energy as the prime source of value because other traditional input factors i.e. labour and capital cannot perform without energy. The promoters of this perspective protect the so-called 'growth hypothesis', and hence, advise that any reduction in energy supply will have a negative impact on economic growth. Understanding the linkage between energy consumption and economic growth is extremely important because energy policy implications mostly depend upon what kind of causal relationship exists. Bartleet and Gounder (2010) state that the more important to know is whether economic growth promotes energy consumption or no causal relationship exists between them. The underlying reason of this justification is that it's really difficult for policy-makers to pursue energy conservation policies if a country is known as energy-dependent. In the presence of such a relationship, any structural policies that aim at reducing energy consumption might possibly slow economic growth, Tsani, (2010).

Theoretically, an appropriate energy policy choice depends on the actual direction of the causal relationship between energy consumption and economic growth. Ozturk (2010) Jumbe, (2004); Apergis and Payne, (2009), and Ozturk and Acaravci (2010) sum up four possible hypotheses about energy-growth nexus:
The first hypothesis is what so called the *growth hypothesis*. it assume that energy consumption is a prerequisite for economic growth given that energy is a direct input in the production process and an indirect input that complements labor and capital inputs. In this case, a unidirectional Granger causality running from energy consumption to GDP means that the country's economy is energy dependent at which a decrease in energy consumption causes a decrease in economic growth. The second hypothesis is the *conservation hypothesis* which asserts that when causality runs from economic growth to energy consumption, an economy is less energy dependent, and thus energy conservation policies, such as phasing out energy subsidies may not adversely affect economic growth. The third hypothesis is the *feedback hypothesis*; confirms the interdependence between energy consumption and economic growth and both variables affect each other. The implication of the bidirectional relationship is that energy consumption and economic growth are complementary, and that an increase in energy consumption stimulates economic growth, and vice-versa. Finally, the *neutrality hypothesis*, It means neither energy conservation nor energy expensive may not adversely affect economic growth. Thus, policies aimed at conserving energy will not harm economic growth. Chen et al. (2007), Ozturk (2010) and Payne (2010) explain the mixed findings from previous studies are due to differences in not only omitted of relevant variables, different time span of study, econometric approaches, but also countries' characteristics. For this reason, it's very dangerous to design future energy policy of one country based on experiences of others. Accordingly, a country-specific causality study between energy consumption and economic growth must be done to provide deep insights into design of energy policies. Therefore, what is the evidence for the Bahrain's energy development strategy that still provides special favour for energy sectors.

2.1 objectives of the Study:

The aim of this study is to establish the association between electricity consumption and economic growth in the kingdom of Bahrain. Accordingly, the objectives of the study are:
i) to established whether any relationship exists between electricity consumption and economic growth.
ii) to determine the direction of relationship.
iii) to determine the extent to which electricity consumption impacts on economic growth.

2.2. Questions of the Study:

The following are the questions of the study:
i) Does long-term equilibrium exist between electricity consumption and economic growth in Bahrain?
ii) Which of the above hypotheses is acceptable for the case of Bahrain?

3. Survey of Related Literature:

The causal relationship between energy consumption and economic growth has been extensively investigated since the seminal paper of Kraft and Draft in 1978. Many studies have conducted in the last decade so as to investigate the causal relationship between energy in general and electricity consumption in specific with economic growth in developed and developing countries, time periods, and proxy variables using different econometric methodologies, Ozturk (2010). However, evidences from empirical researches are still mixed and controversial in terms of the direction of causality and the intensity of impact on energy policy. Although economic theories do not explicitly state a relationship between these variables, overall findings are that there exists a relationship between electricity consumption and economic growth. Herewith, this study displays a number of related studies, such as:

Altinay and Karagol (2005) have investigated the case of Turkey for the period 1950-2000 in which different methodology employed to test: Granger non-causality, Dolado-Lutkepohl test using the VAR in levels standard Granger causality test. The tests of their study have yielded strong evidence for unidirectional causality running from the electricity consumption to income implies that an economy is energy dependent and shortage of electricity may negatively affect economic growth or may cause poor economic performance.

Yoo (2005) investigates the causality issues between electricity consumption and economic growth in Korea by applying the well-known statistical techniques, such as, cointegration and error-correction models. He employs annual data covering the period from 1970 to 2002. The results of the study show that there exists bi-directional causality between electricity consumption and economic growth; this means that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption.

Squalli and Wilson(2006) have studied the relationship between electricity consumption and income hypothesis for Gulf Cooperation Countries (GCC) and applied the bounds test procedure. Their study emphasized a long-run relationship between electricity consumption and economic growth for all G.C.C. It also opined for the efficacy of energy conservation measures except Qatar.

Ciarreta and Zarraga (2007) investigated the linear causality between electricity consumption and economic growth in Spain for the period 1971-2005. They used the methodology of Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996). They also apply the standard Granger causality tests in a VAR for the series in first differences to achieve stationarity. The results are similar with both methodologies, which show their robustness. The study found a unidirectional causality running from electricity consumption to real growth domestic product.

Gupta and Sahu (2007) attempted to investigate causality between electricity consumption and economic growth in India by adopting Granger Engel causality model for the period from 1960 to 2006 which included the era of liberalization of the nineties. The results of the study show that electricity consumption has positive effect on economic growth. Their study supports for the reforms in power sector and indicates that electricity act as a catalyst in realizing various social and economic goals.

The causality issue between energy consumption and economic growth for three typical oil-exporting countries, namely, Iran, Kuwait and Saudi Arabia has been investigated by Mehrrara (2007). He applied two different test methods to examine the causality, namely, the error correction model and Toda-Yamamoto (1995) procedure. The results show a unidirectional long-run causality from economic growth to energy consumption for Iran and Kuwait and unidirectional strong causality from energy consumption to economic growth for Saudi Arabia. Therefore, the results support the neutrality hypothesis of energy consumption with respect to economic growth for Iran and Kuwait and vice versa for Saudi Arabia. The findings have practical policy implications for decision makers in the area of macroeconomic planning, as energy conservation is a feasible policy with no damaging repercussions on economic growth for Iran and Kuwait. However, increased GDP requires enormous energy consumption in Saudi Arabia. Thus, each country, even in group of oil-exporting countries, should follow its own policy in energy use and it is misleading to recommend the same policy for all these countries.

In (2010) Acaravci and Ozturk examined the short-run and long-run causality issues between electricity consumption and economic growth in Turkey for the period 1968-2006. They applied Granger causality models augmented with a lagged error-correction term. The bounds F–test for cointegration test yields evidence of a long-run relationship between employment ratio, electricity consumption per capita and real GDP per capita. The results from the three error-correction based Granger causality models show that there is an evidence of unidirectional short-run, long-run and strong causalities running from the electricity consumption per capita to real GDP per capita. But, there is no causal evidence from the real GDP per capita to electricity consumption per capita. The results suggest that electricity consumption plays an important role in economic growth in Turkey.
Hamdi and Sbia (2012), the aim of their paper is to investigate the causal relationship between electricity consumption and GDP growth for the kingdom of Bahrain during the period 1980–2008. By performing an error-correction model, our results reveal that electricity consumption and GDP are cointegrated. The results of their study put forward the Granger causality tests that indicate bi-directional relationship between electricity

consumption and GDP growth in the long-run while results of the short-run reveal unidirectional causality relationship between the two variables.

The foresaid summarized studies clearly state that a relationship exists between electricity consumption and economic growth. But there are no clear trends in the literature, depending on the methodology used, country and time period studied so different results are available. Therefore, in this research an attempt has been made to unravel the existing relationship between the per capita electricity and per capita GDP variables in the kingdom of Bahrain.

4. Research Methodology and Sources of Data:

The direction of causality between electricity consumption and economic growth in the light of the literature overview is not consistent and depends on different econometric methodologies applied. However, many studies used multivariate models so as to investigate the causal relationship between GDP and electricity consumption among them are: Stern (1993), Stern (2000), Oh and Lee (2004), and Ciarreta and Zarraga (2009), and Hamdi, (2013). These types of studies usually analyze the relationship between GDP and electricity consumption within a different specification of production function framework. The multivariate model studies include GDP, electricity, labour, fixed capital formation, and technological change. Second type of studies uses a bivariate model in detecting the causality between GDP and electricity. For example, Yu and Choi (1985), Al-Iriani (2006), Soytas and Sari (2003), Yoo (2005), Mehrara (2007). Ozturk, and Kalyoncu (2010), Yoo and Kwak (2010), and Javid etal (2013) among others, have focused just on the directionality of causality. In this study a bivariate approach were adapted to detecting the direction of causality between electricity consumption and real GDP in the Kingdom of Bahrain.

4.1 Sources of Data:

Data used in this analysis are time series type of real per capita gross domestic product and per capita electricity consumption for the 1975-2010 periods in the Bahrain. Data are obtained from the World Development Indicators (2011). In this study, per capita electricity consumption is expressed in terms of kg oil equivalent and real per capita GDP is expressed in constant 2004 local currency. Both series are transformed into natural logarithms. The choice of starting period was constrained by the availability of data on per capita GDP. The whole process of causality between economic growth and electricity consumption can be performed in four steps.

Step 1: Test for stationarity (i.e. for order of integration) in the per capita electricity consumption and per capita GDP.

Step 2: Test for cointegration to know the existence of long run equilibrium relationship between electricity consumption and economic growth.

Step 3: Granger causality test to assess the short run cointegration and the direction of causality between the two series.

Step 4: Toda-Yamamoto version of Granger causality to test for causality between integrated time series based on asymptotic theory.

4.2 Granger Causality and Unit root tests:

Prior to conducting any econometric analysis, the time series properties of the data must be investigated. Therefore, the unit root tests are applied to test the stationarity of series. Stationarity properties of electricity consumption and GDP series are evaluated using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. PP test takes the problem of serial correlation into consideration which makes it more authentic than the ADF test. If the series is found to be non-stationary then, by using the Difference Stationary Process, the series is differenced to order one and the stationarity is tested.

4.3 Cointegration approach:

To test the long run relationship between two variables in the Engel-Granger cointegration approach, all the variables must be non-stationary in levels and become stationary after taking first differences, and their linear combination is stationary in levels. If two or more time-series are cointegrated, then there must be Granger causality between them, which is known as feedback or bilateral causality; either one-way or in both directions, is called unidirectional causality. When both variables are simultaneously caused of one another without any lag, this called instantaneous causality, and the last one is no causality with or without lag. Two tests have been adopted to test for wither a linear combination of the two series is stationary: First is the ADF cointegration test developed by Engle-Granger (1987), and second Johansen test developed by Johansen (1988) and Johansen and Juselius (1990).

4.4 Vector error correction mechanism (VECM):

Granger Causality test has been traditionally used to examine the nature of causal relationship. A time series (X) Granger causes another time series (Y) if the prediction error of current Y diminishes by using past values of X along with the past values of Y.

The VECM allow examining whether the relationship between electricity consumption and economic growth is weak Granger causality, long-run Granger causality, or strong Granger causality. The VECM in two variables case can be written as follows:

$$\Delta LGDP_t = \delta_{10} + \sum_{i=1}^{n} \delta_{11i} \Delta LEC_{t-i} + \sum_{i=1}^{n} \delta_{12i} \Delta LGDP_{t-i} + \delta_{13} ECT_{t-1} + \varepsilon_{1t} \dots \dots (1)$$

$$\Delta LEC_t = \delta_{20} + \sum_{i=1}^{n} \delta_{21i} \Delta LEC_{t-i} + \sum_{i=1}^{n} \delta_{22i} \Delta LGDP_{t-i} + \delta_{23} ECT_{t-1} + \varepsilon_{2t} \dots (2)$$

Where Δ is a deference operator; where $LGDP_t$ and LEC_t represent natural logarithms of real per capita GDP and electricity consumption, respectively, ECT is the lag error correction term and is derived from the long-run cointegration relationship and measures the magnitude of the past disequilibrium. The coefficients, δ_{13} and δ_{23} of the ECT_{t-1} represent the deviation of the dependent variables from the long-run equilibrium; ε_{1t} and ε_{2t} are error terms assume to be serially uncorrelated. Moreover, the optimal lag length is determined by using (HQ) Hannan-Quinn information criterion, (AIC) Akaike information criterion and Final Prediction Error (FPE). For equation 1, if the estimated coefficients on lagged values of electricity consumption (δ_{11}s) are statistically significant, then the implication is that electricity consumption Granger-causes real per capita GDP in the short run, some, like Masih and Masih (1996), interoperated this as weak Granger causality. This test can be conducted by a joint F-test. Finally, the strong Granger-causality can be exposed through a joint test of the statistical significance of δ_{11}s and δ_{13} by a joint F-test. Similar reasoning is possible for examining whether real GDP Granger-causes electricity consumption in equation 2. If δ_{13} and δ_{23} coefficients in equation 1 and equation 2 are negative and statistically significant then VECM exist and this supports the long run relationship, this can be tested using t-test. If none of the coefficients are significant Granger-causes electricity consumption in equation 2; then the neutrality hypothesis existed by similar manner on can test real GDP equation.

4.5 Toda-Yamamoto Augmented Granger Causality Test:

The Toda–Yamamoto (1995) test for Granger causality has been commonly used in empirical studies (see e.g. Keho, 2007, Gurgul and Lach, 2012). The most important features of this test are: (1) It is valid regardless of whether the series is I(0), I(1) or I(2), cointegrated or non-cointegrated, and (2) its simplicity since it is just a small modification of the standard Wald test. The VAR in the case of the TY Test is constructed in their levels with a total of ($k + d_{max}$) lags, where k is the optimal number of lagged terms, and d_{max} is the order of integration for the group of time. The augmented VAR ($k + d_{max}$) model is expressed as follows:

$$LGDP_t = \omega_{10} + \sum_{i=1}^{k+d_{max}} \omega_{11i} LEC_{t-i} + \sum_{i=1}^{k+d_{max}} \omega_{12i} \Delta LGDP_{t-i} + \varepsilon_{1t} \dots \dots (3)$$

$$LEC_t = \omega_{20} + \sum_{i=1}^{k+d_{max}} \omega_{21i} LEC_{t-i} + \sum_{i=1}^{k+d_{max}} \omega_{22i} \Delta LGDP_{t-i} + \varepsilon_{2t} \dots \dots \dots (4)$$

In equation 1, LEC does not Granger cause LGDP if $\omega_{11j}s = 0$. In the same manner, in equation 2, LGDP does not Granger cause LEC if $\omega_{22j}s = 0$. The asymptotic χ^2 distribution critical value can be applied when the test for causality between the integrated variables are conducted (see Toda and Yamamoto, 1995).

5. Results and Discussion:

In order to conduct a comprehensive initial analysis one should also make use of charts
generated for all the time series used in the study. Figure (1) contains plots of logarithmically transformed time series:

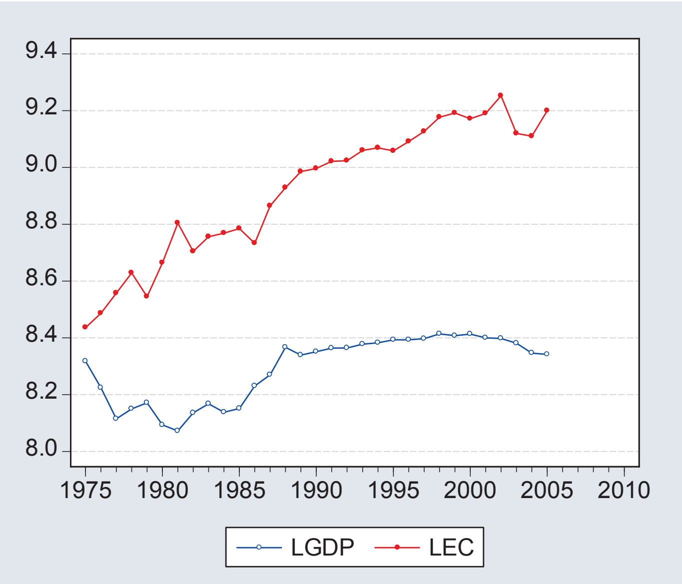

Figure 1. Electricity consumption and real GDP in Bahrain

The null and alternative hypotheses for the two tests are as follows:
H_0: the series contains unit root
H_1: the series is stationary

Table 1: Empirical results of a unit root tests:

Variable	ADF		PP	
	Level	1st deference	Level	1st deference
	P-value	P-value	P-value	P-value
LGDP	0.2662	0.0011*	0.2009	0.0011*
LELC	0.2445	0.0000*	0.3063	0.0000*

Notes: Lag order is selected on the basis of Schwarz info criterion for ADF test, while for PP test the Newey-West using Bartlett kernel criteria was used.
* Significant at 1%.

When testing for unit roots and co-integration the authors have chosen to use a probability value of 0.05. The results of the unit root tests for the series of *LEC* and *LGDP* variables are shown in Table (1). The ADF and PP tests provide the formal test for unit roots in this study. From the figures in table 1, the p-values of both tests values calculated for the two series are larger than 0.05. This indicates that the series of both the variables are non-stationary at 5% level of significance and thus any causal inferences from the two series in levels are invalid. However, non-stationarity can be rejected for first differences of these series at 5% level of significance. Hence, the Granger-causality models are estimated with first-differenced data.

Table 2: Results of Johansen's maximum likelihood tests for multiple cointegrating relationships (intercept no trend).

	Trace		Maximum eigenvalue	
Null hypotheses	Statistics	P-values	Statistics	P-values
r=0	17.14947[a]	0.0279	15.14562[a]	0.0362
r≤1	2.003853	0.1569	2.003853	0.1569

Note: The optimal lag length is chosen as two by using Akaike information criterion, Final prediction error, and Hannan-Quinn criterion. The p-values are calculated under the corresponding null hypothesis. r denotes the number of co-integrating equation.

To investigate the integration of two series is of the same order, it is necessary to test whether the two series are co-integrated over the sample period. The results of the Johansen cointegration test for the series *LEC* and *LGDP* are reported in table (2). Trace and Max-Eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level. In addition, the ADF cointegration test for residual is significant at five percent significant level. The results indicate the existence of cointegration relationships between the two variables indicating that there must be

Granger causality in undetermined direction. However, these results don't indicate the direction of the causality among the two time series.

Table (3) Engel Granger stationarity test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.781991	0.0076
Test critical values:	5% level	-2.963972	

* Significant at 5% level.

5.1 Granger Causality Test:

Determining the causality and identifying the long and short runs as causalities require testing the ECM rather than the standard Granger-causality. Therefore, an ECM was set up to investigate both short- and long-run causality. In the ECM, the first difference of each endogenous variable (electricity consumption and real GDP) was regressed on a period lag of the co-integrating equation and lagged first differences of all the endogenous variables in the system, as shown in Equations (1) and (2). The results of Granger causality between per capita electricity consumption and real GDP, along with their respective probabilities for both the variables during the period 1975-2010 with specific lag period. The lag lengths were chosen by Using Akaike's information criterion, Final Prediction Error (FPE, and Hannan-Quinn criterion are given in table (4) below.

Table 4. Lag order selection criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	50.83390	NA	8.01e-05	-3.756454	-3.659677	-3.728586
1	95.66209	79.31142*	3.47e-06	-6.897084	-6.606754*	-6.813480
2	100.6482	8.054512	3.24e-06*	-6.972940*	-6.489057	-6.833599*
3	104.1017	5.047397	3.44e-06	-6.930900	-6.253464	-6.735823
4	104.7563	0.856076	4.60e-06	-6.673565	-5.802575	-6.422752
5	112.5169	8.954537	3.63e-06	-6.962842	-5.898299	-6.656292

Table 5. The table has three major blocks illustrating the short-run effects, long-run effects represented by the error correction coefficients, and the joint short-run and long run effects, respectively.

Regarding the error correction term (*ECT)* is found to be significant in Equation (2) and insignificant in Equation (1), which indicates that long-run Granger causality from real *GDP* to electricity consumption exists, but the reverse does not. This reveals the fact that any changes in electricity per capita consumption that disturb long-run equilibrium are corrected by counter-balancing changes in the per capita *GDP*. Short-run causality dos not found from both sides as it indicated by the insignificancy of the coefficients of ΔLEC and $\Delta LGDP$ terms. The statistical insignificance of the estimated coefficients on lagged values of change in electricity consumption along with the *ECT*, electricity equation means that there is no strong Granger-causality running from electricity consumption to real *GDP*. Results of the significance of the estimated coefficients on lagged values of change in real *GDP*, along with the *ECT* in *GDP* equation are consistent with the presence of strong Granger-causality running from economic growth to electricity consumption. These indicate that whenever a shock occurs in the system, changes in real *GDP* would make short-run adjustments to restore long-run equilibrium.

Table 5: Temporal Granger-causality results based on the error correction model

	Sources of Causation				
	Short Run		Long Run	Joint (short-run/long run)	
	ΔLEC	*DLGDP*	*$ECT_{(t-1)}$*	*ΔLEC, $ECT_{(t-1)}$*	*ΔLGDP, $ECT_{(t-1)}$*
	F-statistics		*t-statistics*	*F-statistics*	
Electricity consumption does not cause economic growth	1.73 (0.20)	–	-1.37 (0.18)	2.39 (0.097)	–
Economic growth does not cause electricity consumption	–	1.29 (0.30)	-3.33 (0.00)	–	4.82 (0.00)

Turning now to the second method, namely, the Toda-Yamamoto procedure, the equations (3) and (4) are estimated and *MWALD* test statistic is calculated. The *MWALD* statistic is asymptotically distributed as a χ^2 Square, with degrees of freedom equal to the number of "zero restrictions", irrespective of whether *LGDP* and *LEC* are I(0),or I(1), non-cointegrated or cointegrated of an arbitrary order. The results of the *MWALD* test statistic, as well as its p-values are reported in table 6.

Table 6: Toda-Yamamoto Tests of Granger Causality

Null hypothesis	MWALD statistics	Prob.
Electricity consumption does not cause economic growth	*5.323973*	*0.0698*
Economic growth does not cause electricity consumption	*11.01306*	*0.0041*

Note: The test statistic is the $\chi 2$ value with 2 degrees of freedom.

These results are in line with the ones obtained by ECT. Again, there is a unidirectional causality running from per capita GDP to per capita electricity consumption. Hence, it may conclude that Bahrain does not face an electricity consumption restricted economic growth.

6. Concluding Remarks:

The study investigates the causal relationship between per capita electricity consumption and per capita GDP for Kingdom of Bahrain during the period 1975-2010. For this purpose, a time series analysis based on various cointegration testing approaches are applied before testing Granger causality. The results suggest the existence of unidirectional causality running from per capita GDP to per capita electricity consumption. The research results strongly support the neoclassical view that electricity consumption is not a limiting factor for the Bahrain's economic growth. This in turn implies that the rise in electricity prices can be a good opportunity for the economy to promote substitution and technological innovation. From a policy perspective, findings of this research are consistent with the conservation hypothesis. Since a high level of economic growth leads to a high level of electricity demand, but not vice versa, the government can enact the conservation electricity policies that aim at curtailing electricity use for environmental friendly development purposes. It should be gradually establishing a competitive electricity market in order to allocate these resources into the most productive uses in the economy. While this investigation demonstrates causal relation between electricity consumption and economic growth, it should be stressed that the usual production function also includes capital and labour. Hence, in future work, the techniques employed in such study can be readily extended to other multivariate systems, where per capita electricity consumption and per capita GDP are exposed to be determined by other economic factors such as capital stock and employment to improve the model. Furthermore, such analysis could reveal the structural channels by which real income and electricity consumption are inherently causal (Mehrara 2007).

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