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The Strategic Importance of Energy Consumption to Economic Growth: Evidence from the UAE

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ABSTRACT

Energy consumption is one of the strategic concerns for economies around the world, especially in view of depletion of natural resources which ultimately affects economic growth. Interestingly, policy makers in an oil-rich country such as the United Arab Emirates (UAE) have taken steps to bring about efficiency in energy consumption to accelerate the pace of economic growth. Therefore, the objective of the study was to test the relationship between economic growth and electricity consumption in the UAE. The data for the study related to the years between 1985 and 2017. The research used 4 variables including electricity consumption per capita, GDP in current US dollars, labor force and gross capital formation. The study employed unit root test, cointegration analysis and granger causality for making the analysis. We concluded that the variables had unit root at level and stationery at first difference. The bivariate cointegration test showed that electricity consumption had cointegration equation with capital gross fixed formation, GDP and labor force. Finally, the granger causality test showed one directional causality from GDP to electric power consumption and labor force to electric power consumption.

Keywords: Energy Consumption, Economic Growth, Correlation, United Arab Emirates
JEL Classifications: C33, O13, O38, Q43, O47

1. INTRODUCTION

As described by (John Baldacci) "*Energy consumption matters both to our environment and our economy"* has put forth that energy is one the growing phenomenon which is changing the world that ultimately affects the environment and the economy. Since the recent financial crisis where the energy sector all over the world remained strong made policy makers to think it as a potential sector that contributes to economic growth.(world economic forum).

Recent years have witnessed huge use of energy mainly due to the increase in population, especially in developing countries; in addition to urbanization and large-scale industrialization (Chaudhry et al., 2012). Therefore, energy is one of the most important elements and determinants of economic growth of any country. Energy consumption has been able to attract academic interest because of its ability to improve the efficiency of the country and increase revenues through greater productivity.

Curiously enough, there is no complete consensus on the causal relationship between energy use and economic development. In empirical exercises, many techniques have been used to study the causal relationship between energy consumption and economic activities in some countries, but the results are significantly different and conflicting. This difference can be attributed to the difference in data collection, country characteristics such as the history of politics, economics, energy supplies and socio-economic policies. Also, variations in research designs have led to inconsistent results in available literature (Kao and Wan, 2017).

A review of evidence indicates that the one-way causal relationship between gross national product (GNP) growth and energy

consumption was supported in the case of the United States of America from 1947 to 1974 (Kraft and Kraft (1978). Literature also indicates that there is no sufficient causal relationship between energy consumption and GDP growth and energy and employment based on data for six manufacturing countries (Erol and Yu, 1987). Other researchers, by utilizing Sim's methods, revealed that energy consumption could affect employment negatively. However, by using Granger techniques, they found no relationship between employment and energy, and between GNP and energy in the case of USA (Aqeel and Butt, 2001).

A gap exists in literature due to the fact that there is no empirical study on the relationship between electricity consumption and economic growth in the case of the UAE, although there are many studies focusing on this kind of relationship in the Western world (Li et al., 2011; Abaidoo, 2011; Chandran et al. 2009; Wolde-Rufael, 2009; Soytas and Sari, 2003; Erol and Yu, 1987; Akarca and Long, 1980; Kraft and Kraft, 1978). This study makes an attempt to fill this gap in the literature. The UAE is an important oil-producing country. It has taken strategic steps to accelerate the pace of economic growth through efficient electricity consumption. This kind of study, it is hoped, would be of interest to scholars and policy makers in all parts of the world.

The overarching objective of this research study is to investigate the impact of electricity consumption on GDP of the UAE economy. The hypotheses postulated for the study are as follows.

Hypotheses:
H0: Electricity consumption has no effect on GDP growth.
H1: Electricity consumption has impact on GDP growth.

2. REVIEW OF LITERATURE

Recent decades have witnessed proliferation of literature focusing on electricity consumption in interaction with GDP growth. The initial work of Kraft and Kraft (1978) triggered interesting discussion in literature. They argued that efficient energy consumption would have implications for economic growth. It is now common knowledge that developing nations are consistently supporting the electricity infrastructures along their economic growth pathways. Policy makers give a high priority to the efficient use of energy in the development process. The energy supply needs to be adequate during the time of economic growth for every nation to stimulate the process of growth. Therefore, a proper and sufficient supply of energy is utmost for assisting economic growth of a nation.

Numerous studies have been done for understanding the relationship between economic growth and the energy consumption process. Actual reasons for having the relation between these two trends were not disclosed properly but the studies could find the rational relationship between the two factors in the present times.

In Africa, several research studies have been done to examine and analyze the connection between electricity consumption and growth iof the economy. Granger causality testing was examined and run by Chikoko et al. (2018) to establish the proper relationship between economic growth and the electricity supply. During the time between 1980s and 2016, Zimbabwe had used a unique framework to align the electricity consumption with its economic growth system and the test had shown a bi-directional result that could be caused by energy consumption process. This means the increasing pattern of electricity consumption could lead to growth in the economy. Alternatively, economic growth requires an uninterrupted supply of electricity to support the bilateral theory. Molele and Ncanywa (2018) stated that the vector error correction and co-integration models were invaluable in the context of the research hypotheses postulated for this study. Oil and electricity both would be consumed hugely along the economic growth. Oil has a positive effect and electricity has a negative relationship with economic growth. A casual and common relationship was also established by Mawejje and Mawejje (2016) to evaluate the results in Uganda through vector error correction process. GDP growth of the country and the electricity consumption would indicate the sustainability of this relationship for measuring the significance of every parameter of it. Mawejje and Mawejje (2016) calculated the intensity of the relationship and applied it in individual sectors including different industries, agriculture and other business-related firms to design the causality of electricity consumption and sectoral output. The researcher had selected different macro-level tests to define the unidirectional flow of the relationship between GDP and electricity consumption. The results reflect a sustainable relationship because electricity is a salient aspect to run industry and every individual sector is differently controlled by the electricity to grow more and create a growth opportunities in the economy.

In Russia, data was also researched by Bass (2018). The information related to 1990 through 2017. Real GDP, proper electricity supply and other management factors were used for the Russian brand to evaluate the long-term relationship between two factors. Additionally, Khobai (2018) designed the same relationship factor between economic growth and energy consumption for BRICS countries. Johansen Fisher panel co-integration and Kao-panel co-integration techniques had been used to determine the results. Granger-causality test was also applied to the process and a long run relationship would be followed to conclude the relationship factor for BRICS nations.

Ogundipe et al. (2016) decided to apply the neoclassical model by using the data from 1970 to 2013. Causality test, vector error correction technique and co-integration process were used in the investigation for defining the relationship of Nigerian economic growth and advancement of electricity consumption. Again, the results supported a typical unidirectional flow and relationship between two factors. Sustainability has an inverse relationship with economic growth and consumption of energy process. It must be observed here that the vector error correction process validated the non-convergence nature for the two parameters. The relationship of the two terms was measured by the local government data of Karsina by Zubair and Kadandani (2017) and they used the monthly data. The results also supported an important and promising relationship between them.

Khan et al. (2016) found that economic growth and electricity consumption of Bangladesh are also related, and the research study also used the vector error correction model and cointegration technique by using the data of 1982-2012. The VECM supports the sustainable approach of electricity consumption and growth in

the country. Similarly, Hossen and Hasan (2018) also carried time series data analysis alongwith other research technique to understand the relationship and other micro variables. CO2 emissions, GDP, electricity consumption, Phillips-Perron tests and Utilizing Augmented Dickey-Fuller method were used in the research. All of the tests confirmed that they are co-integrated. Johansen co-integration tests and its Eagen values also supported the co-integration of the variables in this relationship. Vector autoregression and impulse response functions would also be related to each other to determine the performance of the variables. A unidirectional causality has been run from GDP to CO_2, electricity consumption to CO_2, electricity consumption to GDP and did not have any reverse attitude.

An interesting research study has been done in Taiwan by Wen-Cheng (2017) and it proves an equilibrium relationship factor for 17 different industries in the country. The researcher took data from 1998 to 2014 and aligned all those to have a co-integration test. As mentioned by Wen-Cheng (2017), 102% rise in GDP could increase the electricity consumption (EC) by 1%. Gonzalo and Pitarakis (2006) also stated that there would have a nonlinear relationship between these EC and economic growth for Taiwan. They found that the GDP and the energy consumption practices are an integrated process which means that the energy is indicating the economic growth and supports multiple economic development processes. additionally, they found that there would not have any destructive or damaging effects for the economic growth from energy consumption process.

Researchers of Pakistan analysed the factors to understand the possible effects in their country. Zaman et al. (2015) had chosen the annual data for testing the relationship of EC and economic growth for the country in Johansen co-integration and Granger causality test. They found that a bi-directional flow is present that could conclude the research on the favour of EC. Chaudhry et al. (2012) had carried the research to find the exact importance and significance of electricity consumption with the economic growth for a country. Chaudhry et al. (2012) used the annual data of Pakistan to generalise the proper significance and analyse it to support the importance of the relationship. The data from 1972 to 2012 had been used and analysed for the research to understand the empirical study that stimulating the energy source distribution with economic growth. Chaudhry et al. (2012) also supported and agreed that the electricity consumption process is significant and plays an important role to improve the economic standard of a country by supporting the general community, system and another trading system. Needless to say, oil consumption thus also affects the economic growth as importing a massive amount of oil would be required. The research study strongly supports the relationship and reflects the exact connection between every factor.

Saidi and Hammami (2015) mentioned that there would be numerous variables responsible to support and demonstrate the trading system. The variables are real GDP per capita, capital stock, CO2 emissions, financial development, EC per capita, trading nature and many more.

Additionally, Hossain and Saeki (2012) applied the Granger causality tests and cointegration process to study the relationship between EC and GDP in different time scale. Generally, 1960 to 2008 timescale had been chosen for it and the researcher also found a bilateral relationship. Hossain and Saeki (2012) stated that the countries with high-income level have a bi-directional relationship between two factors. The middle-income based countries would show a unidirectional relationship between two factors. Thirdly, the low income-based countries might not have any causality factor.

Ghana has few study samples and research studies for understanding the relationship between the two parameters. Iyke and Odhiambo (2014) collected informations at the time range of 1971-2012 for analysing their economic development, growth and EC. The researchers had realised that long and short-term impacts are present for the country as inflation was also included in the analysis. Adom (2011) carried out a research study to find a causal relationship between EC and economic development. Most importantly, the Granger Causality test was applied here to arrive at proper results for aligning all the parameters according to the requirement. Finally, the research found unidirectional causality flow for the EC to economic growth as well.

It is thus clear that considerable research studies have come to exist focusing on energy consumption and its relationship with economic growth. These researches adopted refined methods of investigation and analysis. However, no serious study has taken place focusing on the UAE. This study makes an attempt to contribute to existing knowledge related to electricity consumption and economic growth of the UAE.

3. DATA AND METHODOLOGY

The present study shows the relationship between growth and electricity consumptions. The database for the study was composed of secondary data on annual basses for the period from 1985 to 2017 for UAE. The variables were taken at their natural log. The study uses 4 variables that is GDP in current $ as a dependent variable whereas the independent variables were represented by total Labor force, gross fixed capital formation and finally electric power consumption. The source of the data was World Bank's World development indicators (WDI) and index Mundi.

The model is as follows.

$$Y= (K, E, L)$$

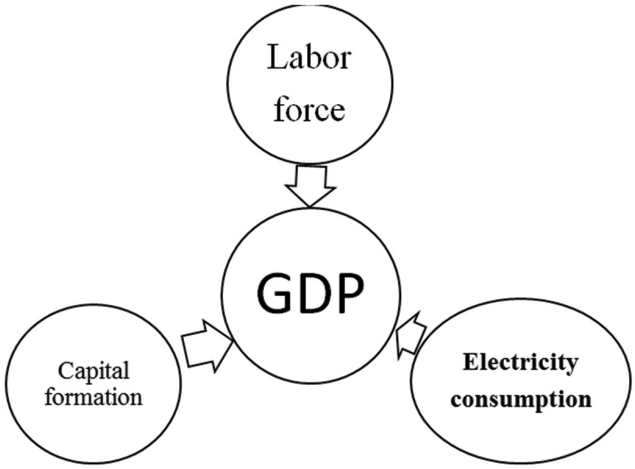
Y=GDP
K=gross fixed capital formation
L=Labor force
E=Electricity consumption.

The description of variables is as follows: (GDP) that is final value of all the goods and services produced with geographical boundary of country on a yearly basis. The value of GDP was taken in current US dollars.

GFCF: Gross fixed capital formation which is represented by K is a net investment.

L (labor): The total number of people who are employed or able to work and looking for job.
E electricity: Consumption which is taken total electricity energy consumed with in a year.

Graphical presentation of model



The graphical model presents that GDP growth as a function of electricity consumption, capital formation and labor force.

3.1. Time Series Analysis

3.1.1. Unit root test

There are a lot of factors needed to be considered while making time series analysis; the series might have unit root at level which makes difficult for making some analysis. Finding long-term relationship between variables with stationary data creates various issues. Sometimes finding stationary data testing. The study uses Augmented Dicky Fuller test (ADF named after statisticians David Dickey, Wayne Fuller 1979), to test the stationarity of the series. The following model is the base of ADF.

$$\Delta Y = a + bT + (r - 1)Yt - 1 + d\Delta Yt - 1 + elt$$

The series should be integrated in the same order that is non-stationary at level and stationary at first difference. The criteria for doing cointegration test is that the series should be stationary and then only ADF test could be employed.

The following model is being employed which was used before by Chaudhry et al. (2010).

GDP= (Labor, ELEC, capital)

Taking natural logarithm

$$LGDP=\beta_0 + \beta_1 LLabor + \beta_2 LELEC + \beta_3 Lcapital + Ut$$

The above equation describes the function of LGDP natural logarithm of gross domestic product, L Labor which is total labor force, LELEC which is electricity consumption per capita and L capital is gross fixed capital formation.

3.1.2. Johansen test of cointegration

Johansen co-integration is a technique used to show a long-term relationship between the variables. Two or more variables are said to be cointegrated if they have some mutual trends. Performing a cointegration analysis involves various steps were by we start with unit root test through ADF test and Philip perron. It is crucial that the cointegration should be performed on series that has unit root at level and becomes stationary at first difference. In a bivariate model a series could be said to be cointegrated if they a same type of trends.

3.2. Granger Causality

A comprehensive literature review revealed that Granger causality (Granger, 1969) is one of the traditional methods employed by researchers to find the relationship between two variables.

The phenomena of granger causality are described as the tool that is used to show the relationship between variables either Uni directional or bidirectional (Granger, 1969). According to the theory Engle and Granger (1987) if there exists a cointegration between the variables there must be at least uni directional causality. The study will investigate the bivariate relationship between each variable with appropriate lag selection. The important rule for employing the granger causality in that the series must not have unit at L(1).

4. ANALYSIS

4.1. Unit Root Test

For the purpose of testing the stationarity in the series ADF and PP test had been employed. The results from e-views has been presented below. We cannot reject null hypothesis at level that the series has unit root. However, at first difference the null hypothesis can be rejected.

4.2. Granger Causality

Granger causality test is used to investigate a bivariate relationship between the variables the result of the analysis is presented below. The results indicate that a Uni directional relationship exists between capital fixed formation and labor force. The course of direction is from L capital fixed to L labor. The Uni directional causality also

Stationary testing					
	Augmented Dicky-Fuller test		Phillip-Perron test		
	At level t-statistic Prob.*	At 1st diff. t-statistic Prob.*	At level t-statistic Prob.*	At 1st diff. t-statistic Prob.*	Integration-order I(0) at level I(1) at first difference
Fisher Chi-square	1.27876 0.9958	58.5092 0.0000	1.32047 0.9953	64.9804 0.000	I (1)
Choi Z-stat	2.57007 0.9949	−6.31075 0.0000	2.40106 0.9918	−6.72282 0.0000	I (1)
Intermediate ADF test results D (Untitled)					
Capital	0.9836	0.0054	0.9647	0.0044	I (1)
Electricity	0.6680	0.0001	0.6682	0.0037	I (1)
GDP	0.9301	0.0000	0.9281	0.0000	I (1)
Labor	0.8633	0.0001	0.8638	0.0001	I (1)

exist from LGDP and L labor to L electricity. A Uni directional causality exist from L labor to L GDP and L GDP to L capital.

Null hypothesis	F-statistic	Prob.
L Labor does not Granger cause L capital	1.59917	0.2134
L capital does not Granger cause L Labor	3.12112	0.0379
LGDP does not Granger cause LELEC	4.27603	0.0248
L ELEC does not Granger cause LGDP	0.40816	0.6691
L Labor does not Granger cause LELEC	4.13142	0.0513
LELEC does not Granger cause L Labor	1.19102	0.2841
L Labor force does not Granger cause LGDP	3.49451	0.0318
LGDP does not Granger cause Labor force	1.43112	0.2594
L capital does not Granger cause LELEC	0.44344	0.6466
LELEC does not Granger cause L capital	0.56287	0.5764
LGDP does not Granger cause L capital	8.73995	0.0061
L capital does not Granger cause LGDP	0.18338	0.6716

4.3. Cointegration Test

Cointegration test is usually performed as a multivariate approach, however; we have employed bivariate analysis after obtaining the optimal lag. The lag length criterion was chosen through var estimation, were majority of bivariate relation had lag 1 as optimal selection. Once the lag is chosen the next phase is to select appropriate model of cointegration. According to Harris and Sollis 2003 there are 5 models to choose from for co integration. Model 1 (without deterministic trend), Model 2 (without any linear trends), Model 3 (without any linear trend, unrestricted), Model 4 (restricted linear trend) and Model 5 (linear trends). All the bivariate combination has at least one cointegration equation. Majority of the combination were integrated at model 3 and rarely 2, 4 however 1, 5 were completely avoided.

4.4. Correlation Test

The test of relationship, either negative or positive, is done through correlation. The table below shows that some of the series are positively correlated and some are negatively correlated. L Capital, L GDP and L labor are negatively related to L ELEC, on other hand L GDP, L Labor are positively related to L capital. L GDP is positively related to L labor.

	L Capital	L ELEC	L GDP	L Labor
L Capital	1			
L ELEC	−0.3296080	1		
L GDP	0.19943999	−0.3005857	1	
L Labor	0.31015883	−0.1874726	0.15447928	1

5. CONCLUSION AND POLICY IMPLICATIONS

The debate among policy makers is intense with respect to having balance between electricity consumption and GDP growth. This study attempted to find a relationship between economic growth and electricity consumptions with the help of econometric techniques. The research also aimed at finding the causal direction of those relationships. Empirical studies reveal that there is strong nexus between energy and development. Wen-Cheng (2017) found that with effective energy consumptions a sustainable growth could be achieved.

This study was conducted in the UAE for the period between 1985 and 2017. We employed unit root test, Granger causality test and cointegration test to base the analysis. The variables had unit root at level and becomes stationary at first difference. The results reveal that there is uni directional relation from GDP to electricity and capital formation. Labor force also has unidirectional causality towards electricity consumptions. Cointegration test reveals a bivariate long run relation among variables, which shows that GDP will be affected by changes in variables.

According a report published by UAE government in 2015, the demand for electricity in the country is about 20-30 kilowatt- hours each day, and with growing economy it is expected that the demand for overall energy will increase up-to 9% on annual basis. The generation of electricity should be done with more efficient methods that use less resources and increase the supply. It is crucial for the policy makers to know the impact of consumption of electricity on GDP, labor force and capital fixed formation. The government should also focus on providing adequate amount of energy to critical sectors of the economy to facilitate economic growth.

In view of rapid economic development, energy consumption in the UAE has been growing at an annual rate of 4% over the past five years. This growth rate is likely to increase to 5% through the years to 2020. It is therefore, absolutely necessary to design and implement strategies to bring about efficiency in electricity consumption in the UAE.

Unrestricted cointegration Rank Test				Max Eigenvalue		
	Eigen value	λ TRACE Rank value	0.05 critical value	λ max rank value	0.05 critical value	Prob.*
L CAPITAL-LELEC	0.439363	16.7826	15.4947	.439363	16.7817	0.0196
L CAPITAL-L GDP	0.452189	18.89425	15.4947	.452189	14.2646	0.0095
L CAPITAL-L LABOR	0.509860	23.40935	15.49471	.509860	14.2646	0.0026
LELEC-L GDP	0.58500	35.15329	20.26184	27.26378	15.8921	0.0002
LELEC-L LABOR	0.449072	17.32202	15.49471	17.28838	14.2646	0.0161
L GDP-L LABOR	0.44778	19.24060	15.49471	18.40830	14.2646	0.0105
LELEC-L GDP	0.435503	17.21096	15.49471	17.15463	14.2626	0.0170

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