UCT JOURNAL OF MANAGEMENT AND ACCOUNTING STUDIES 2019(02)

Available online at http://journals.researchub.org

# Energy consumption and resistive economy: Case Study-Electricity consumption in MENA Countries

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ARTICLE INFO

*Article history:*

Received 07 Dec 2018

Received in revised form 9 Jan 2019

Accepted 27 Feb 2019

*Keywords:*

*Information and Communications Technology,*

*electricity Consumption,*

*Economic Growth*

ABSTRACT

Clause 7 of the general policy of resistive economy is explicitly referred to consumption management and consumption pattern reform. One of the important sources of managing consumption is energy. In fact, the need for energy in the world is constantly increasing, while its sources are scarce, so one of the basic steps to achieve economic growth and the realization of a resistive economy is to coordinate this incremental need and scarce resource to optimize its consumption. The factors affecting its consumption should be investigated whether in the field of production as the input of production or in the consumption field as the final product. In this study, the factors affecting power consumption among 16 selected MENA countries through years 2000 to 2015 were investigated using statistical analysis methods and panel data. The results of the model estimation show that the number of mobile subscribers does not have a significant effect on the amount of electricity consumption. Nevertheless, the economic growth variable has a positive and significant effect on the amount of electricity consumption. In addition, the number of Internet users has a significant effect on the electricity consumption.

## 1. Introduction

Energy as a driving force has a special position in most manufacturing and service activities, and since the main core of economic growth process is GDP, energy plays an important role in economic growth of countries. In fact, the role of energy as the driving force of the economy is evident, but since energy resources are limited, the rational and correct use of available energy resources is essential to achieve maximum growth and development. Optimal use of energy can reduce emissions environmental pollutants and reduce environmental pollution while providing economic growth and development. One of the sources of energy that its global demand is also increasing is electricity. Environmental issues caused from the use of fossil fuels, which is one of the major problems of the world led to an increase of global community's desire to use less polluting and healthier fuels. In addition, the growing trend of technology, industrial production, expanding urbanization and increasing general welfare level has increased demand for electricity.

On the other hand, one of the overall goals of resistive economy is to provide dynamic growth and improve economic resistance indices and to achieve the goals of the twenty-year vision document with a jihadi, flexible, opportunistic, productive, endogenous, and progressive and extrovert approach. Regarding achieving these goals, management and optimization of energy consumption is very important. In order to optimize energy consumption, understanding the factors affecting it can play a decisive role. Therefore, the present study attempts to investigate the factors affecting electricity consumption in MENA countries.

### *1.1. Factors affecting energy consumption*

The trend of energy market changes show that price and price expectations, revenue, economic structure, number of energy consuming equipment and devices (according to the derivation of energy demand) and technological changes are factors influencing energy demand. Regarding the effect of energy price on the intensity of energy consumption, it can be said that the relationship between energy price and intensity of energy consumption is inverse. Intensity of energy consumption decreases at the macro level by increasing energy price. The impact of GDP on intensity of energy consumption varies at different stages of economic growth and development. In the initial stages of economic growth, the growth rate of energy consumption is higher than economic growth rate, but this trend will gradually be inversed and the economic growth rate will be higher than the growth rate of energy consumption. In other words, economic growth is more influenced by physical inputs and energy input in the initial stages of economic growth and development while

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*DOI: https://doi.org/10.24200/jmas.vol7iss02pp61-66*

in later stages, the share of technical and technological factors in the growth and development process increases. Therefore, the energy intensity of an economy has a U-shaped curve when per capita income levels is rising, and this issue is caused by structural and technological changes.

On the other hand, information and communication technology (ICT) is one of the factors that can have a significant impact on power consumption. ICT refers to a technology that enables information access through telecommunications including internet, wireless networks, wireless, cell phones and other communication media. In fact, ICT converges with audio and video networks and telephone networks with computer networks by cabling or a wireless connection system. Information technology is called to an interconnected set of communication methods, hardware, software, and equipment that collects, stores, retrieves, processes, transmits information in various forms (voice, image and text), (The Secretariat of the Supreme Informatics Council, 1999)

Over the past few decades, information and communication technology has played an important role in many global components, including electricity consumption and economic growth. Information and communication technology is undoubtedly the only technology that affects how energy is consumed in the global economy. It affects the energy consumption process both directly and indirectly. For example, information and communication technology has a direct impact on the development of energy-related electronics industries that this issue can be effective in reducing energy consumption. In recent years, the impact of information and communication technology on the development of microprocessor and microcontrollers could lead to the application of new technologies in control systems and thus optimize and reduce energy consumption. Information and communication technology in the field of controlling industrial processes can provide the following facilities alone or in combination with other technologies in the field of control and optimization of industrial processes. 1. Control technology: Mechanical or electro-mechanical control technologies are replaced with electronic control systems that are very precise in terms of efficiency and cost effective and these systems have the capability of planning and quick operational change in accordance with the required conditions 2- Data collection: Information technology provides the possibility of accurate and fast data collection from processes that causes more efficiency in generating and reducing energy consumption 3. Data storage and processing: Information can be stored in a large volume and after processing, the considered result can be found. Increasing the ability of computers in recent years caused this process of information gathering and processing to be easier. 4- Data communication: Information and instructions and programs can be quickly transmitted or retrieved. This case facilitates the centralized control process, in other words, constructing tool and devices of ICT such as data centers, computers, mobile phones, etc. as well as the construction and operation of factories of these devices require energy consumption and on the other hand, most of these devices work with power which increases power consumption. Another component that affects electricity consumption is economic growth. Economic growth is simply the increase of a country's production in a special year compared to its value in base year. At the macro level, the increase in GNP or GDP in the year considered relative to its value in a base year is economic growth. Applying the factors of production requires energy consumption, I,e we need to spend energy during production, which concludes that we need to consume more energy to produce more. Since economic growth means GDP growth as a result, higher economic growth requires more energy consumption, in addition, economic growth can lead to increase prosperity and demand for new goods and consequently increase productivity and unproductive energy consumption. According to what discussed above, examining whether ICT and economic growth has an impact on power consumption seems to be necessary. In general, ICT has two effects on energy consumption; ICT can reduce energy consumption and thus reduce costs by reorganizing production processes more efficiently (substitution effect)

In contrast, providing new products and services and increasing the energy consumption of the ICT capital inventory will lead to additional demand for energy (revenue effect).

The effect of ict on energy consumption is divided into two opposite effects. The first is that the development of ict reduces the demand for electricity through the process of innovation and the replacement of a new generation technology instead of the old one and reduces the energy consumption. This effect is called the substitution effect. The second effect is that ict equipment needs electricity in order to apply, and as a result, installation, commissioning and operation of ict equipment creates new demand for electricity consumption and ultimately increases energy consumption. This effect is called compensatory or revenue effect. The final effect ict on the energy consumption depends on estimating these two effects. If the substitution effect is greater than the compensatory effect, ict development reduces energy consumption and if the substitution effect overcomes the substitution effect, ict development increases the energy consumption.

### *1.2. Resistive economy and optimization of energy consumption*

General policies of the resistive economy were announced with a jihadi, flexible, opportunistic, productive, endogenous, progressive and extravagant approach for providing dynamic growth and improving economic resistance indices and achieving the goals of the twenty-year vision document. Special attention has been paid to applying resistive economy policies in the field of energy management and optimization in general policies of resistive economy. For example, clause 7 of consumption management emphasizes the implementation of general policies of consumption pattern reform and promotion of the consumption of domestic goods along with planning to promote quality and competitiveness in production. In addition, Article 12 emphasizes on coping with impact of revenue from oil and gas exports to increase electricity exports. In fact, optimizing energy consumption has been considered examples of economic resilience, because it can take an effective step in the development of production and employment creation by optimizing energy consumption.

Another reason to pay attention to energy is that its protection policies and factors affecting supply and demand in recent decades have been considered by scientific and policy communities due to the limitation of energy resources and its importance in the supply chain as final goods for consumers and its importance as an input for producers as well as paying attention to the increasing of greenhouse gas emissions.

The next reason for paying attention to energy is that although energy, as one of the important inputs of production in the economy of societies, has an underlying role and when energy is sufficiently and timely available, one of the preliminaries of economic development is provided but inappropriate and inefficient use leads to undesirable environmental and even non-economic consequences. Therefore, paying attention to improve energy efficiency and studying the factors affecting it is important, because of pollution, increasing temperatures of earth and the limitation of non-renewable resources,

countries are seeking to find strategies to optimize production and energy consumption and prefer to consume less energy to obtained GDP and reduce energy intensity (Jafari 2016)

## 2. Research background

Shafi'ian, Sara (2016) in examining the factors affecting energy consumption in selected OECD countries from 1990 to 2010 showed that the two variables of GDP growth rate and industry growth rate are important and influential factors on energy consumption in countries. Aghaei, Majid (2016) investigated the causal relationship between energy consumption and economic growth over the period 1974 to 2010 in the Iranian economy. The positive impact of energy consumption and economic growth in the whole country and various sectors of the country are confirmed in the short and long term, but the positive effect of all energy carriers on the economic growth of the country and the economic growth of various sectors, except for the industrial sector, cannot be confirmed.

Alizadeh, Mohammad Gol Khandan, Abolghasem (2015) examined the impact of information and communication technology on energy consumption in selected MENA countries over the period 1995–2011. The results show that ICT expansion increases per capita energy consumption in selected MENA countries in the short and long term.

Mahmoudzadeh and Shahbeiki (2012) examined the effect of ICT on energy intensity in 12 developing countries over the period 1995–2008. The findings of this study using panel cointegration analysis show that some types of ICT capital such as hardware and software have a positive effect on energy consumption and others such as communications have a negative effect. Overall, the net effect of ICT release on energy consumption is positive, thus demand for ICT products increases the intensity of energy.

Salahuddin et al. (2016) in a study on OECD countries proved that ICT and economic growth both change electricity consumption in both the short and long term, as well as electricity consumption increases economic growth and the use of mobile and the Internet increases electricity consumption and economic growth.

Munshi Naser Ibne Afzal (2016) in a study on 11 emerging countries in economy from 1990 to 2014 discovered a positive and significant statistical relationship between the use of information and communication technology and electricity consumption. When using information and communication technology through internet and mobile connections and the percentage of ICT-related imports is measured to total imports. Because the growth of ICT is higher than economic growth, the impact of ICT on electricity consumption is higher than the income, so countries that don't assume ICT as an explanation variable for power consumption may underestimate demand for electricity consumed that this issue can lead to power shortages unintentionally.

Nasreen, Samia and Anwar Sofia (2014) examined the relationship between business freedom, economic growth, and energy consumption in 15 Asian countries using panel data models. This study investigated the long-term relationship between variables using data from 1980 to 2011 and the variables of business freedom, energy price, economic growth and energy consumption, and the use of the concept of cointegration and causality. Estimates of both FMOLS and DLOS methods indicate a positive relationship between energy consumption and economic growth and energy consumption and commercial freedom. However, an inverse relationship between energy consumption and energy price has been observed.

Ishida (2014) has examined the impact of ICT development on energy consumption in Japan over the period 1980-2010. The results of this study, using the ARDL self-regression approach, show a significant and negative impact of ICT investment on energy consumption in the country in short and long term.

## 3. Specifying the Model

In this study, factors affecting electricity consumption in sixteen MENA countries including Algeria- Bahrain- Egypt- Iran- Occupied Palestine- Jordan- Kuwait- Lebanon- Malta- Morocco- Oman- Qatar- Saudi Arabia- Tunisia- United Arab Emirates-Yemen has been investigated from 2000 to 2015 using the panel data method

For this purpose, inspired by Salahuddin's (2016) paper, the model is specified as follows:

$$Ln\ EC_{it} = \beta_0 + \beta_1 ICTMOB_{it} + \beta_2 GDPPC_{it} + \varepsilon_{it}$$

That:

GDPPC= Real GDP per capita

ICT= ICT consumption

EC= electricity consumption kWh per hundred people

ICTINTER= Number of Internet Users per hundred people

ICTMOB = The number of mobile subscribers per hundred people

It should be noted that all information on these variables was obtained from the World Bank.

**Table 1. The results of stationary test of model**

| variables | PP - Fisher Chi-square | | ADF - Fisher Chi-square | | Im, Pesaran and Shin W-stat | | Levin, Lin & Chu t* | |
|---|---|---|---|---|---|---|---|---|
| | Probability level | Calculate static | Probability level | Calculate static | Probability level | Calculate static | Probability level | Calculate static |
| eppcg | 0.0000 | 143.644 | 0.0217 | 50.1280 | 0.0153 | -2.16214 | 0.1231 | -1.15964 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| gdppcg | 0.0000 | 103.696 | 0.0006 | 64.1070 | 0.0001 | -3.66473 | 0.0000 | -4.45185 |
| mobpcg | 0.0000 | 130.338 | 0.0009 | 62.8974 | 0.0006 | -3.24097 | 0.0074 | -2.43644 |
| internetg | 0.0000 | 119.630 | 0.0000 | 84.7610 | 0.0000 | -7.09928 | 0.0000 | -18.0162 |

Source: Research calculations

As it can be seen, the variables are stationary.

**Table 2. The results of F-Limer test**

| Test | Test static | Probability value | Result |
|---|---|---|---|
| Cross-section F | 4.189559 | 0.0000 | H0 hypothesis is rejected (panel data method is selected) |

Source: Research calculations

As it can be seen in the table above, the probability value of the F-Limer test is zero, so the null hypothesis is rejected and the hypothesis is confirmed based on panel data, it is also discussed to determine the estimation of the model with fixed effects or random effects. Hausman test is used for this purpose.

The fixed effects method, by entering virtual variables, separates the effects of different cross- sections, and the random effects method removes the heterogeneity of intergroup variance. The Hausman test is used to determine which method (fixed effects or random effects) is more appropriate to estimate. The null hypothesis in the Hausman test is that there is no relationship between the disturbance component related to the intercept and the explanatory variables. In other words, if they are independent from each other, the null hypothesis is rejected and the alternative hypothesis is accepted, the fixed effects method is compatible and random effects method is incompatible and we must use fixed effects method. The Hausman test statistic has a chi-square distribution and if its probability is smaller than 5%, the fixed effects model is accepted at 95% confidence level; otherwise the random effects model is used to estimate the model.

**Table 3. Hausman test results**

| Test | Test static | Probability value | Result |
|---|---|---|---|
| Cross-section random | 12.426936 | 0.0061 | H0 hypothesis is rejected (fixed effects method is appropriate) |

Source: Research calculations

As it can be seen in the table above, the probability value of the Hassman test is less than 5%, so the null hypothesis is rejected, and this means that the fixed effects method should be used in the estimated model.

The model estimation results using Eviews9 software are summarized in the following table:

**Table 4. Results of panel data estimation**

| Dependent Variable: EPPCG<br>Method: Panel EGLS (Cross-section weights) | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | 1.803697 | 0.345534 | 5.220031 | 0.0000 |
| MOBPCG | 0.002143 | 0.006571 | 0.326197 | 0.7446 |
| GDPPCG | 0.044612 | 0.020535 | 2.172483 | 0.0310 |
| INTERNETG | 0.010087 | 0.005420 | 1.860997 | 0.0642 |
| F-statistic | 5.163435 | Durbin-Watson stat | 2.391385 | |
| Prob(F-statistic) | 0.000000 | R-squared=0.311946 | Adjusted R-squared=0.251532 | |

Source: Research calculations

The results of the model estimation show that the variable of the number of mobile subscribers has no significant effect on the amount of electricity consumption. Accordingly, mobile can be considered as a consumable product that has no role as an input of production in these countries. In addition, per capita GDP has a positive and significant effect on the amount of electricity consumption. The positive effect of economic growth on power consumption can be investigated from two perspectives: electricity as a consumable product: in this case, by increasing economic growth and higher prosperity of consumable products, electricity consumption increases. And electricity as an intermediary product and input of production: In this case, electricity is one of the inputs of production, I,e the producers begin to produce product with other production entities in the trend of production with its combination. Therefore, to produce more, higher amounts of inputs of production, including electricity should be used.

The results of model estimation show that the number of internet users at 10% confidence interval has a positive and significant effect on the amount of electricity consumption. In general, ICT has two effects on energy consumption; ICT can reduce energy consumption and thus reduce costs by

reorganizing production processes more efficiently (substitution effect). In contrast, providing new productions and services and increasing energy consumption available of the ICT capital leads to an additional demand for energy (revenue effect). On the other hand, information in the cycle of economic activities can play a role as a input of substituting energy. Substitution of information rather than energy in its economic concept requires the application of more information in economic activities along with a reduction in energy. In other words, the information causes the amount of energy consumption per unit of production to be reduced or more economic value to be created by consuming the same amount of energy. Here, the revenue effect of electricity consumption is greater than its substitution effect, and most countries in their region are among the largest producers of energy, so energy price in these countries are cheap, as a result, these countries in production process don't replace ICT for energy. Also, because of cheapness and high amounts of energy, they do not focus on increasing energy efficiency and do not feel the need to use ICT to save energy and make energy efficient.

## 4. Conclusion

Investigating the factors affecting energy consumption is one of the key issues in the economy. Since developed and industrialized countries use energy as one of the main inputs in various economic processes and have allocated a high level of energy consumption, identifying and how influencing important variables in energy consumption can help planners to draw the future goals of the community.

Paying attention to electricity and factors affecting it can play an important role in implementing the policies of the resistive economy and its realization. One of the factors affecting the power consumption is information and communication technology, the development of information and communication technology in recent decades as well as its impact on all aspects of human life including the impact on energy consumption and power consumption has been considered. Other factors affecting electricity consumption are economic growth. Therefore, examining the impact of economic growth on the electricity consumption is essential because it will guide the planners in the field of electricity and economy to plan for the supply and production of electricity needed by the country.

Given that the impact of information and communication technology and economic growth has a positive and significant impact on the amount of electricity consumption, and regarding that planners in the field of electricity production as well as economic policy makers and decision makers in the country need to predict the amount of electricity consumed of the country, they must look at the values of economic growth and the growth of the country's information and communication technology variables to predict the amount of future electricity consumption in the country and also to plan for the export of this energy in order to realize a resistive economy.

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