Belal, Ibrahim Abdelrasoul Mohammed; Ahmed, Sumaya Awad Khader; Boujedra, Faouzi Hedi

Article

The causal relationship between, electricity consumption and economic growth in Kingdom of Saudi Arabia : a dynamic causality test

IJEEP

INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY

EJ EconJournals

ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(1), 333-340.

EconJournals

The Causal Relationship between, Electricity Consumption and Economic Growth in Kingdom of Saudi Arabia: A Dynamic Causality Test

Ibrahim Abdelrasoul Mohammed Belal[1]*, Sumaya Awad Khader Ahmed[2,3], Faouzi Hedi Boujedra[1]

[1]Department of Economics and Finance, College of Business Administration, University of Hail, Ha'il, Saudi Arabia, [2]Department of Economics, Sudan Academy of Science, Sudan, [3]Department of Business Administration, Al Jouf University, Saudi Arabia.
*Email: fize1970@gmail.com

Received: 20 July 2020 **Accepted:** 22 October 2020 **DOI:** https://doi.org/10.32479/ijeep.10488

ABSTRACT

The main objective of this study is to empirically test whether there exist short run and long run causality between, residential electricity consumption (REC), industrial electricity consumption (IEC) and economic growth in Kingdom of Saudi Arabia (KSA). Time series data for this study spans from 1990 to 2019. The study adopts granger causality and co. Integration analysis to estimate a vector error correction model (VECM). Results from error correction model show that there exist long run co. integration relationship between targeted variables. In addition, VECM results indicates that, industrial electricity consumption is inelastic to the changes in electricity prices with respect to economic growth, while residential electricity consumption shows elastic relationship. Granger causality test indicates there is unidirectional relationship, running from economic growth to industrial electricity consumption, which lead to accept, proactive (conservative) hypothesis. In this case, energy conservative policy will have little or no effect on economic growth. Nevertheless, results proof acceptance of neutrality hypothesis in the case of residential electricity consumption and economic growth. The study therefore, recommends that in Saudi Arabia, policy makers should consider expanding their energy-mix alternatives, in order to cope with the future industrial electricity demand arising from increased economic growth.

Keywords: Electricity Consumption, GDP Growth, Co-integration and Causality
JEL Classifications: O3, O4

1. INTRODUCTION

KSA is one of the largest exporter of petroleum and possess about 18% of the world petroleum reserves, Saudi Arabia oil and gas sector account for about 50% of the GDP, and about 85% exports earning (Maghrebi et al., 2018). In late April 2016 KSA vesion2030 announced, based on three main pillars, they are a vibrant society, a thriving economy and an ambitious nation. A key goal of the thriving economy build on themes of diversified economy of less dependent on oil revenues, to achieve this goal and others, Saudi Arabia authority announced a set of parallel programs, which include the National Transformation Programs, which providing more information about the implication of energy sector(Fattouha and Amrita 2016). As one of the main energy policy implications, at the end of December 2015, the Saudi Arabian government raised some of its administered retail energy prices. For example, the price of automotive diesel fuel increased from 0.25 Saudi Arabian Riyal (SAR) per liter to 0.45 SAR, while the price of 95 gasoline increased from 0.60 SAR to 0.90 SAR increases of 80% and 50%, respectively (Platts, 2015). In addition, the price of natural gas increased from \$0.75/MMBtu to \$1.25/MMBtu, an increase of 67% (Platts, 2015). However, if Saudi Arabia efforts to transitions towards a more diverse and energy efficient-economy are unsuccessful, then social wale fare will remain vulnerable to sowing in international oil markets, increasing the risks of declining GDP growth over time. In KSA, the retail prices of energy (oil products, natural gas, and electricity), have traditionally been set by public authorities, resulting in the retail prices being below the international market price (ECRA, 2015). Given the fact that, energy prices, more specifically oil price has been historically, volatile and uncertain; inevitably it influences KSA economy differently, at different point of time. Electricity consumption in KSA has been a accompanied by large increase in GDP growth. Indeed, EC in Saudi Arabia grow annually at a rate of 12% and 25% during 1970s and 1980s, and by 6%, this high level of EC is due to some main factors, such as growth of industrial sector; electricity subsidies and modernization of cities (Narayan and Smyth, 2009). The largest proportion of EC in KSA is attributed to the residential sector account about 53% of total EC, followed by industrial sector account about 18% (on average) of total EC, this mean that residential sector derive EC rather than industrial sector, which is the case in many developed and developing countries. Nevertheless, many measures have taken by KSA authority to reduce the adverse effects of climate changes and global warning to achieve sustainable development. For instance, acceptance of Kyoto protocol of climate changes (2005), and launch of 2008 National Energy Program (NEP), which takes about eight measures aimed to increase energy efficiency by 30% up to 2030 (Mezghany and Haddad, 2016). The step that has been taken by the Saudi Arabia government to the environment by preserving energy resources have important implications for the sustainable development of the country. Notwithstanding, any effective energy policy should consider the dynamic nature of the relationship between EC and GDP growth should have a long-term vision (Sari and Soytas, 2009) and Micheal and Alegre (2009).

Therefore, in this paper we try to empirically analyzes the impact of changes of electricity consumption on real GDP growth, during the period between 2000 and 2019, to explain significances of energy policy in short-run as well as in the long-run. In fact, the effect of electricity consumption resulting from electricity tariff changes, is differ from one country to another, depending on economic structure of the country, historically, there is no exactly defined direction and causality relationship between electricity consumption, and economic growth. In literature there are four energy consumption and GDP growth hypothesis namely, growth hypothesis; proactive hypothesis; neutrality hypothesis and feedback hypothesis (Syzdykova et al., 2020). Growth hypothesis indicates economic growth is energy dependence; if there exist one-way causality from energy consumption to economic growth in this case increasing energy prices aiming at energy saving will adversely affect economic growth. In the case of proactive (conservative) hypothesis, it is one-way causality running from growth to energy consumption; in this case, energy conservative policy will have little or no effect on economic growth. On the other hand neutrality hypothesis, exist when there is lack of causal relationship between energy consumption and economic growth, finally feedback hypothesis mean, there is two-way causal relationship between energy consumption and economic growth which shows a complementary effect between the two variable (Apergis and Payne, 2010). The choice of Saudi Arabia for this study motivated by the fact that Saudi Arabia has experienced a sharp increase in energy consumption and carbon emissions in recent years because of its strong economic and industrial growth. Historically high international oil prices and large domestic fuel subsidies also play an important role in the recent economic growth and high-energy consumption in the country. This study aims to test empirically the causality between energy consumption represented by electricity consumption for both residential and industrial sectors, and real GDP growth in KSA. The principal hypothesis of this study based on various literatures and other related studies; such that, there exist bidirectional growth hypothesis, running from electricity consumption of both sectors to GDP growth in KSA. Using time series data for the period extended from 1990 to 2019, in the second part theoretical background presented about the historical development of theories of economic growth, third part, summarizes previous studies on the relationship of electricity consumption, and economic growth. The fourth part explain the methodology and the sources of data. In the fifth part, empirical analysis and results discussed, finally main concluding points and recommendations presented.

2. OVERVIEW OF ELECTRICITY SECTOR IN SAUDI ARABIA

Despite stable and favorable macroeconomic indicators in the past years, the Saudi economy faces many challenges. The main concerns are related to its demographic dynamics leading to an urgent need to generate enough employment for its young population and addressing the issue of its energy system sustainability (Said and Marie 2015). The KSA government has prioritized sustainable measures as gateway to better future. As mentioned earlier, the Saudi 2030 Vision was implemented in April 2016; in this respect, the government has taken serious steps to change the country's economy, from oil-based economy to multi-sources economy. Therefor Saudi government introduced many programs and other efficiency measures. For instance in 2017 the International Energy (IEA) stated that, KSA was targeting 120 gigawatt electricity generating capacity by the of 2032 to accommodate the country growing electricity demand, in 2018 the government increase investment fund to increase electricity generation to about 200 gigawatt by the end of 2030 (Institute for Energy Economics and Financial Analysis, 2018).

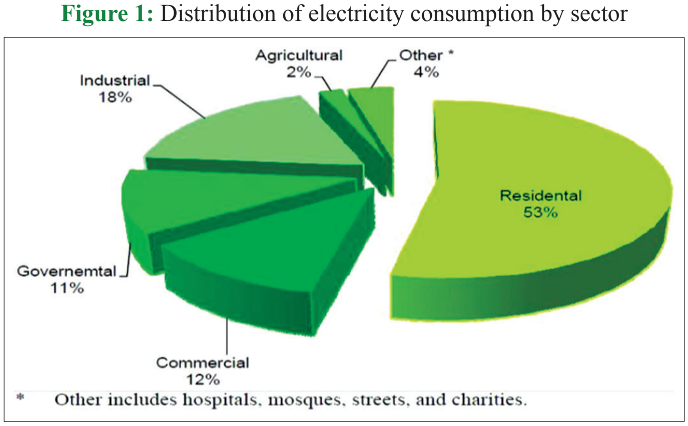
In the context of hot-arid climates, KSA was ranked among the top 10 countries of the highest electricity consumption, nevertheless electricity generation consume nearly one-third of daily oil production in KSA (Alshibani and Alshamrani, 2017). Notwithstanding, annual electricity usage growing by approximately 6-8%, according Saudi Electricity Company (SEC) residential and industrial sectors consuming about 71% of electricity power, commercial consumption 12%, government consumption 11% and about 2% of electricity consumed by agricultural sector (M.O.W.A. Electricity, 2014). Climate is the major factor as 70% of electricity sold attributed to air conditioning. Other factors such as population growth, and rabid increases of industrial sector derived electricity consumption. In light of these facts, there is a wide acceptance in KSA; this path of electricity consumption is not sustainable in long run. Because the rising consumption of electricity and other energy generation sources would result of a net loss of about more than 3 million barrels of oil per day, or so cold "burning oil to get cool" (Lahn and Stevens, 2008). The sectoral distribution of electricity consumption presented in the following Figure 1.

To sum up, it is essential to make plans to promote alternative energy sources. Nonetheless, knowing the causes of high-energy consumption is critical to ensure holistic, sustainable future development. The KSA government implemented several action to avoid future economic crisis as a consequences of high-energy consumption, which include implementing of new Saudi Building Code (SBC) and activate Saudi Energy Efficiency Center (SEEC) and plans for renewable energy sources. Notably the decision to stop subsidizing the electricity has led to growth in energy efficiency uses and awareness (Apicorp Energy Res, 2018). The focus of this study is to test empirically the cases of rabid increases of electricity consumption, with reference to different measures, which has been taken by KSA government to sustain electricity generation and distribution. Notwithstanding, various model has been utilized to explain electricity-growth relationship, this study rely on emerging model to explain causal relationship, between residential electricity consumption (RECTt), industrial electricity consumption (IECt) and GDP growth in KSA, to evaluate the significances of energy policy in short-run as well as in the long-run.

3. LITERATURE REVIEW

Number of past studies examine the relationship between electricity consumption and GDP growth causal relationship, some of these studies focused on group of countries, while other study individual countries Sheilla et al. (2016), Dossou, (2019), Hasan et al., (2017), Njindan (2014) and Nyasha et al., (2016). The fact that electricity consumption represent the highest percentage of energy consumption in most countries has shifted debates to what our study examine. The first group concludes that electricity consumption causes economic growth (electricity led growth thesis); the second group concludes that economic growth causes electricity consumption (the growth-driven electricity consumption thesis). The third group concludes that there is bidirectional causality between electricity consumption and economic growth (the feedback thesis); finally, the fourth group argues that there is no causal link between electricity consumption and economic growth (the neutrality thesis) Bernard

Figure 1: Distribution of electricity consumption by sector



Source: Saudi Arabia Electricity Company database

(2016). The electricity led growth studies has been confirmed by studies such as, Masih and Msih (1996) for India, Lee (2005) for 15 developing countries, Ho and Siu (2007) for Hong Kong. The growth-driven hypothesis paper has been confirmed by studies such as, Kraft and Kraft (1978) for USA, Al-Iriani (2006) for the gulf co-operation countries and Rufael (2006) UNISA (2016) and Odularu (2008) for the case of Cameron, Ghana and Nigeria. In addition, feedback hypothesis was identified by various studies such as, Asafu-Adjaye (200) for Thailand and Philippines, Soytas and Sari (2003) for Argentina and Odhiambo (2009) for the case of Tanzania and South Africa. Others studies found no causal link between electricity consumption and GDP growth such as, Erol and Chu (1987), and Yu and Jin (1992) for the case of the USA; Murray and Nan (1996) for France; Germany, India, Israel, Luxembourg, Norway, Portugal, UK, USA and Zambia and Akinlo (2008) for Cameron, Cote d`Ivoire and Kenya. Some other studies examine the causal relation between energy consumption as a whole and GDP growth. Such as Athanasois et al. (2020) and Amany (2010) study revisiting the impact of energy prices on economic growth; lesson learned from the European Union, they concluded that, for residential electricity sector shows highest level of influence on real GDP, while industrial electricity sector and crude oil price "Granger Cause" residential electricity prices. Gonand et al. (2018*)*, investigates the intergenerational welfare impact of raising administered retail energy prices in Saudi Arabia, they developed first model of overlapping generation (called MEGIR-SA), it is shown that the additional oil income associated with the increase in domestic energy prices tends to be relatively more beneficial to future generations if it is recycled through public investment. Athanasios et al. (2020), study revisiting the impact of energy prices on economic growth; lesson learned from the European Union; they concluded that, for residential electricity sector shows highest level of influence on real GDP, while industrial electricity sector and crude oil price "Granger Cause" residential electricity prices. The following Table 1 summarizes some empirical studies examining causal relationship between electricity consumption and economic growth.

Most of the previous studies focused on the causal relationship between electricity consumption and economic growth, while our study disaggregates electricity consumption in to residential and industrial sectors to test for short run and long run relationship between the targeted variables. Mostly important here is policy implications of impact of causality results between the target variables; if growth hypothesis is achieved, it indicates that economic growth is energy dependency, in this case economic policy aimed at raising energy prices to reduce energy consumption or energy saving would adversely affect economic growth. A bidirectional relation between energy consumption and economic growth (feedback) reflect interdependence and complementary effects between energy consumption, and economic growth. In the case of neutral hypothesis energy saving policies may has little or no effect of energy consumption changes on economic growth Syzdykova et al. (2020).

4. DATA AND METHODOLOGY

The study adopt causality and co-integration analysis to empirically estimates the short run and long run effects of

Table 1: Summary of empirical studies

Author	Period	Country	Method	Result
Kraft and Kraft (1978)	1947-1974	USA	Granger causality	EG→EC
Asafu-Adjaye (2000)	1973-1995	India, Indonesia	Co-integration, ECM	EC→EG
Alshehry and Belloumi (2015)	1971-2010	KSA	Johansen Co-integration	EG↔EC
Long et al. (2015)	1952-2012	China	Co-integration analysis	EG↔EC
Shahbaz et al. (2016)	1970-2012	Australia	VECM	EG↔EC
Jebli and Yousef (2017)	1980-2011	Tunisia	VECM	EG ↔EC
Riti et al. (2017)	1970-2015	China	ARDL-VECM	EG ←EC
Shabestari (2018)	1970-2016	Sweden	ARDL-VECM	EG↔EC
Bekun et al. (2019)	1960-2016	South Africa	Pesaran et al., 2001	EG←EC
Iyke, 2015	1971-2011	Nigeria	VECM	EC→EG
Saleheen Khan et al., 2018	1991-2014	Kazakhstan	ADRL and VECM	EC→EG
Kumari and Sharma, 2016	1974-2014	India	Co. integration and Granger causality	EG→EC
Anon, 2016	1972-2011	Lesotho	ADRL	EG→EC
Aslan, 12 Aug 2013	1978-2008	Turkey	ADRL	EG↔EC
Sekantsi and Okot, 2016	1981-2013	Uganda	ADRL and Granger Causality	EG↔EC

EG: Economic growth, EC: Energy consumption, →: Represent unidirectional, ↔: Represent bidirectional, ~ represent neutral: Source Syzdykova et al. (2020)

electricity consumption(residential and industrial sectors) on real GDP growth in KSA. The study time spams from 1990-2019, time series data includes real GDP growth, residential and industrial electricity consumptions will be obtain by consulting different sources. Real GDP growth data obtained from World Band database, and electricity consumption (MWh) received from Saudi Arabian Monetary Authority (SAMA) statistics.to test the main study hypothesis.

H_1: There is bidirectional growth hypothesis running from industrial electricity consumption (IECt) and residential electricity (RECt) consumption to GDP growth in KSA, during the study period extended from 1990 to 2019 (Bekun et al., 2019). Alternatively,

H_2: There is unidirectional hypothesis running from industrial electricity consumption (IECt) and residential electricity(RECt) consumption to GDP growth in KSA, during the study period extended from 1990 to 2019 (Shabestari, 2018). For the purpose of data analysis, we specify the following steps:

4.1. Unit Root Test

Unit root test, allow specifying the order of integration, as many econometrics data shows, non-stationary behavior, therefore a series of $\Delta Y = Y_t - Y_{t-1,}$ *is* often stationary. Then the order of integrated series written as I (1) satisfies the first difference of Y_t, We use the ADF test (Dickey and Fuller, 1981), (Dickey and Fuller, 1996) to examine whether a series has a unit root. Consider the ADF tests as follows:

$$\Delta Y_t = \phi\ Y_{t-1} + \sum_{i=1}^{p-1} \beta 1 \Delta Yt - 1 + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \ \alpha_0 \phi\ Y_{t-1} \sum_{i=1}^{p-1} \beta 1 \Delta Yt - 1 + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \ \alpha_0 + \alpha_1 t + \phi\ Y_{t-1} + \sum_{i=1}^{p-1} \beta 1 \Delta Yt - 1 + \varepsilon_t \quad (3)$$

From the above, system equations. It is clear that equation(1) did not include either drift or trend, but the drift term α_0 added to equation (2) and both α_0 and deterministic trend α_1 t added to equation (3). If augmenting lag (p) known, augmented test is identical to the simple augmented Dicky-Fuller test, otherwise, lag dropped until the last lag is statistically significant. Based on ADF test the following hypothesis tested to obtain stationary of the variables.

$$H_0: \phi -1 = 0 \text{ or } H_1: \phi -1 < 0 \quad (4)$$

H_0 mean that the variable not stationary

H_1 mean the variable stationary or has no unit root.

4.2. Johansen Co-integration Test

To estimate short-run and long-run dynamic impact, of electricity consumption on GDP growth, Johansen and Juselus (1990) co-integration test will employ, after determining the optimal lag length (P) for the model. Two-time series data for variables X_t and $Y_{t,\ co}$-integrated, if they have the same order of co-integration and there exist a linear combination of these series. In this paper, we apply Johansen Maximum Likelihood method (1991), to obtain the number of co-integration equations.

4.3. Estimation of Vector Error Correction Model

To estimate VECM, based on the previous co. Integration test, in order to examine the impact of explanatory variables on GDP growth in KSA. The model presented in the following reduced form equations:

$$\text{LnGDPt} = b_0 + b_1 \ln REC_t + b_2 \ln IEC_t + Ut \quad (5)$$

Where: U is the disequilibrium error, t: Time series (1990-2019), GDP: Is real GDP growth rate, residential electricity consumption (REC_t), and industrial electricity consumption (IEC_t) in the short run. Assuming there is only one co-integrated relationship among the examined variables, and then equation (5) as multivariate model used to obtain the following equation.

$$U_t = \ln GDP_{t-} b_0 - b_1 \ln REC_t - b_2 \ln IEC_t \quad (6)$$

Where: U_t is the disequilibrium error, shows the range of changes in real GDP, residential electricity consumption (REC_t), and industrial electricity consumption (IEC_t) in the short run. If the variables are stationary at first difference I (1), and U_t is stationary, it mean there exist a linear combination among the variables. If the variables are stationary at first difference *I* (1), then we can run the following VECM.

$$\Delta GDP_t = \alpha_1\, z_{t-1} + \text{lagged}\,(\Delta GDP_{t,}\ \Delta REC_{t,}\ \Delta IEC_t) + \epsilon_{1t} \quad (7)$$

$$\Delta IEC_t = \alpha_2\, z_{t-1} + \text{lagged}\,(\Delta GDP_{t,}\ \Delta REC_t,\ \Delta IEC_t) + \epsilon_{2t} \quad (8)$$

$$\Delta REC_t = \alpha_3\, z_{t-1} + \text{lagged}\,(\Delta GDP_{t,}\ \Delta REC_t,\ \Delta IEC_t) + \epsilon_{3t} \quad (9)$$

Were, z_{t-1} is the error correction term, obtained from the result of estimation of co-integration relationship, and ϵ is error term stationary at $|\alpha_1|+|\alpha_2|+|\alpha_3|\neq 0$.

Recent developments of the co-integration concept indicate that a vector autoregressive (VAR) model specified in differences is valid only if, the variables under study are not co-integrated. If they are co-integrated, an error correction model (VECM) should be estimated rather than a VAR (Granger, 1988). Hendry and Juselius (2000) emphasize the importance of correct model specification. Following Granger (1988), we use a VECM instead of a VAR model, since the VAR model is miss- specified in the presence of co-integration. In addition, VAR models may suggest a short run relationship between the variables, because long run information removed in the first differencing, while a VECM can avoid such shortcomings. In addition, the VECM can distinguish between a long run and a short run relationship among the variables and can identify sources of causation that cannot detected by the usual Granger causality test (Suharsono et al., 2017).

5. EMPIRICAL RESULTS

5.1. Unit Roots Test

In time series analysis, financial and economic data is commonly associated with trending behavior or non-stationary, to determine whether a time series data are stationary or not, an important task to avoid the spurious of estimated model and inaccurate forecasting. For the purpose of this study, it is necessary to test for stationary before running the co. Integration analysis. We use the ADF test (Dickey and Fuller, 1981), to examine whether a series has a unit root. Equation (3) employed to test previously mentioned hypothesis of equation (4). Results of test stationary at level and 1^{st} difference, for GDPt growth, RECt and IECt variables obtained and summarized in the following Table 2.

Results in Table 2, unit root tests at the level, show that the values of ADF is less than the critical value at 5% level of significant. This mean that we cannot reject the null hypothesis that the series of GDPt growth, RECt and IECt were not stationary. But when the variable converted to 1^{st} difference, the absolute values of ADF is more than the absolute values of critical values at 5% level of significant for all the three variables, therefore we accept the alternative hypothesis, meaning that GDPt; RECt and IECt variables are stationary in the 1^{st} differences. This result is in line with most of resent studies that, most of macroeconomic series are non-stationary at the levels, only became stationary after taken the first differences (Nelson and Plosser, 1982).

5.2. Johansen Co-integration Test

In order to run Johansen co. Integration test to determine whether the variables has short run and long run causal relationship, the model must satisfies some of basic requirements, firstly the series must stationary at first difference not in the level, in the above discussion, unit root test indicates that all three variables are stationary at first difference. Secondly, perform Johansen co. Integration optimal lag length (P) for the model, shown by VAR lag order selection criteria result presented in the following table.

Referring to results in Table 3, we chose AIC optimal lag, in this case, the lag selected by this criteria is equal two, then we can proceed to run the co. Integration model to determine whether our three variables GDPt growth, IECt and RECt has long run relationship or in the long run they move together. Then, we apply Johansen Maximum Likelihood method (1991), to obtain the number of co-integration equations and the analysis results shown the following table.

Table 4 present unrestricted co. integration rank test, it become clear we rejected the hypothesis of having non-co. integration equation, since Trace test indicates 1 co. integration equation at 5% level, the estimated eigenvalue ratios and trace statistic also indicate at most there is one co. integration equation in this model. We can conclude that there exist long run co. integration relationship between the series and the model that we are going to estimate is not spurious.

5.3. Estimation of Vector Error Correction Model (VECM)

To identify short run and long run causal relationship between the study variables, in order to determine the responsiveness of one variable to each other's. VECM estimated based on the test statistics presented in Table 4. Before running the basic VECM model, we run some of co. efficient diagenetic test to insure if the model has some statistical errors or not. Chi-square is significant there for we reject existence of serial correlation, while Jarque-Bera probability indicate the series under study are normally distributed. In addition $R^2 = 60\%$, meaning that the model has good fit, and P (F.stat. = 0.007) the overall model is suitable to explain the long run causality between targeted variables. Estimates of basic model for the targeted variables presented in the following table.

Table 2: Unit root tests

Variable	Level				1s difference			
	t.stat.	ADF	Prob*.	Result	t.stat.	ADF	Prob*.	Result
GDPt	–2.9677	0.933199	0.9945	Non-stationary	–2.9718	4.498624	0.0014	Stationary
RECt	–3.6891	0.985709	0.7443	Non-stationary	–2.9718	4.923212	0.0005	Stationary
IECt	–2.9677	0.152657	0.9340	Non-stationary	–2.9718	9.214431	0.0000	Stationary

Source: Author's own calculation based on Eviews9. Results. *MacKinnon (1996) one-sided P-values (indicate sig.at 5%)

Table 3: Lag order selection criteria

Endogenous variables: GDPGT RECT IECT						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1029.404	NA	6.20e+30	79.41569	79.56085	79.45749
1	-957.6856	121.3694*	5.02e+28	74.59120	75.17186*	74.75841*
2	-947.6492	14.66860	4.79e+28*	74.51148*	75.52763	74.80410
3	-942.7776	5.995816	7.16e+28	74.82905	76.28070	75.24707
4	-933.5094	9.268215	8.32e+28	74.80842	76.69556	75.35185

Source: Eviews9 software results.*Indicates lag order selected by the criterion

Result in Table 5, shows one co. integration econometric model of VECM estimates, the results indicate that, there exist long run causality running from IECt and RECt to GDPt growth , since the error correction term or speed of adjustment C(1) is negative and statistically significant. This result consistent with various studies that energy consumption-driven growth (Stern and Enflo, 2013). IECt is negatively affect GDPt growth in the long run, provide that 1% decreases in IECt lead to about 3.9% increases in GDPt growth at 5% level of significant. Thus industrial electricity consumption in KSA is inelastic to the changes in electricity prices with respect to GDPt growth. In other words, even if industrial electricity prices raised, industrial electricity consumption did not response to changes because in the long run, industrial sector can absorb these increases, and can Levey the burden to the consumers. Therefore, electricity conservation policy in KSA must implement with some caution, although the result in this analysis indicate that, electricity tariffs did not pose any risks to GDP growth. This will held true, only when Granger causality proof economic growth causes industrial electricity consumption. With respect to residential electricity consumption, result in Table 5 indicate that, there exist positive effect on GDP growth providing 1% increase in RECt will increase GDP growth by about 6% at 5$ level of significant, this mean that raising electricity tariffs in the residential sector, will decreases RECt ,consequently will result in adverse effect on GDP growth.

To chick for short run dynamic, Wald Test employed. Results in Table 6 indicate, Chi-square probability of null hypothesis C(4) = C(5) = 0 is insignificant at 5% level , which mean there is no short run causality running from IECt to GDPt growth, also the null hypothesis C(6) = C(7) = 0 shows no short run causality running from RECt to GDPt growth in KSA.

5.4. Granger Causality Test

According to Granger theory, if variables are co. integrated there must be at least one direction of causality between the variables to sustain the long run equilibrium relationship. Notwithstanding, Engle-Granger, 1987, stated that in present of co. integration, there exist always a corresponding error-correction representation. The present of co. integration vector in the electricity consumption-GDP growth model in KSA, shows that the variables included in the model of this study are co. integrated and possess long run relationship. VECM plays an important role in detecting the indigeneity and exogenity of the variables, and direction and causality effects between these variables. Since, not captured in the co. integration model (Masih et al., 2009). Table 7 summarized results of Granger Causality test based on VECM model as follows:

Table 4: Unrestricted co. Integration rank test (trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical value	Prob.**
None*	0.585862	29.94355	29.79707	0.0481**
At most 1	0.202468	6.141513	15.49471	0.6788
At most 2	0.001229	0.033200	3.841466	0.8554

Source: Eviews9 software results. Trace test indicates 1 co. Integrating eqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **Denotes stationary at 5% significant level

Table 5: VECM estimates

Cointegrating Eq:	CointEq1
GDPGT(–1)	1.000000
IECT(–1)	–3.96E-08
	(4.3E-08)
	[–0.92695]
RECT(–1)	6.06E-05
	(0.00051)
	[0.11943]
C	–2.109404

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–1.106088	0.315674	–3.503897	0.0024
C(2)	0.138789	0.204744	0.677868	0.5060
C(3)	0.011452	0.176479	0.064889	0.9489
C(4)	–9.98E-08	6.35E-08	–1.571044	0.1327
C(5)	–9.67E-08	6.57E-08	–1.471080	0.1576
C(6)	–0.000370	0.004128	–0.089534	0.9296
C(7)	0.004348	0.004072	1.067714	0.2990
C(8)	-0.456559	1.351428	-0.337834	0.7392

Source: Eviews9 software results

Table 6: Wald test: Null hypothesis: C (4)=C (5)=0

Normalized restriction (=0)	Chi-square	Probability
C(4)=C(5)=0	3.031161	0.2197
C(6)=C(7)=0	1.143965	0.5644

Source: Eviews9 software results

Table 7: Granger causality test results from VECM

Pairwise Granger causality tests			
Lags: 1			
Null hypothesis	Obs	F-Statistic	Prob.
IECT does not Granger cause GDPGT	29	0.00586	0.9396**
GDPGT does not Granger cause IECT		4.41644	0.0454**
RECT does not Granger cause GDPGT	29	2.38337	0.1347*
GDPGT does not Granger cause RECT		0.74377	0.3963*

Source: Eviews9 software results. **Donates 5% level of significant. *Donates 1% level of significant

Results in Table 7 indicates there is unidirectional relationship between industrial electricity consumption (IECt) and GDP growth, since the relevant test reject the null hypothesis. This results support proactive (conservative) hypothesis, it is one-way causality running from growth to energy consumption, in this case, energy conservative policy will have little or no effect on economic growth. This finding implies that in KSA economic growth derives industrial electricity consumption. This mean that KSA is growth-dependence industrial electricity consumption, and any indiscriminate energy-saving policy to promote economic growth, may result in adverse effects on industrial sector, therefore policy makers should consider expanding their energy-mix options, in order to cope with the future demand arising from increased economic growth. The result is in line with Kraft and Kraft (1978) study of US energy-growth relationship and Cheng and Lai (1997) study of Taiwan. Result shows that bidirectional or feedback hypothesis developed from the hypothesis of this study, which relate the relationship between industrial electricity consumption (IECt) and GDP growth in KSA is invalid. On the other hand, result in Table 7, indicates acceptance of neutrality hypothesis, since there is lack of causal relationship between residential electricity consumption (RECt) and GDP growth. Our finding is in line with Khalid (2012), who found the absent of causality between electricity consumption and GDP growth in KSA, but our study is differ slightly from the others. Because we focus solely in Saudi Arabia, while most other studies focus on group if countries, also we disaggregates electricity consumption in to main sectors, namely residential and industrial sector, which adding values to the analysis results.

6. CONCLUSION AND POLICY IMPLICATIONS

In this study, we try to critically, evaluate the causal relationship between electricity consumption and GDP growth in Saudi Arabia. Using time series data for sample period extended from 1990 to 2019, the fundamental differences of other energy-growth nexus we disaggregate electricity in residential and industrial sectors to capture their effects on economic growth in KSA within multivariate framework. For this purpose, we employ co. integration and Vector Error Correction Model to capture short run as well as long run elasticities. Two-stapes of Engle-Granger (1987) methodology followed for estimating VECM. The empirical results, indicate that there exist long run co. integration relationship between the series, while VECM results is quite robust, indicating that in the long run, industrial electricity consumption in KSA is inelastic to the changes in electricity prices with respect to economic growth, while residential electricity consumption shows elastic relationship. Granger causality test indicates there is unidirectional relationship between industrial electricity consumption and economic growth running from economic growth to industrial electricity consumption. Nevertheless, results proof acceptance of neutrality hypothesis, since there is lack of causal relationship between residential electricity consumption and economic growth. The study therefore, recommends that in Saudi Arabia, policy makers should consider expanding their energy-mix alternatives, in order to cope with the future demand of electricity arising from increased economic growth. In addition, there is urgent need to address the challenge of fast growing energy demand by attracting more private investment in the electricity sector, and by introducing more competition to increase efficiency and reduce the burden on the public budget.

REFERENCES

Adedokun, A.J. (2012), Oil export and economic growth: Descriptive analysis and empirical evidence from Nigeria. Pakistan Journal of Social Sciences, 9(1), 46-58.

Akinlo, A.E. (2008), Energy Consumption and Economic Growth: Evidence from 11 African Countries.

Al-Iriani, M.A. (2006), Energy-GDP relationship revisited an example from GCC countries using panel causality. Energy Policy, 34(17), 3342-3350.

Alshibani, A., Alshamrani, O.S. (2017), ANN/BIM-based model for predicting the energy cost of residential buildings in Saudi Arabia. Journal of Taibah University for Science, 11, 1317-1329.

Amany, A.E. (2010), Oil Prices and Economic Growth in Oil-Exporting Countries. Abu Dhabi: United Arab Emirates University.

Apergis, N., Payne, J.E. (2010), The emissions, energy consumption, and growth nexus: Evidence from the commonwealth of independent states. Energy Policy, 38(1), 650-655.

APICORP. (2018), Saudi energy price reform getting serious. APICORP Energy Research, 3, 3-5.

Asafu-Adjaye, J. (2000), The relationship between energy consumption, energy prices and economic growth: Time series evidence from Asian developing countries. Energy Economics, 22, 615-625.

Aslan, A. (2013), Causality between electricity consumption and economic growth in Turkey: An ARDL bounds testing approach. Energy Sources, Part B: Economics, Planning, and Policy, 9, 25-31.

Athanasois, SD., Micheal, L.P., Symeoni, E, (2020), Revisiting the impact of energy prices on economic growth: Lessons learned from the European Union. Economic Analysis and Policy, 66, 85-95.

Bekun, F.V., Emir, F., Sarkodie, S.A. (2019), Another look at the relationship between energy consumption, carbon dioxide emissions, and economic growth in South Africa. Science of the Total Environment, 655, 759-765.

Bernard, N.I. (2016), Electricity Consumption and Economic Growth in Nigeria: A Revisit of the Energy-Growth Debate, MPRA Paper No. 70001. Available from: https://www.mpra.ub.uni-muenchen.de/70001.

Cheng, B.S., Lai, T.W. (1997), An investigation of co-integration and causality between energy consumption and economic activity in Taiwan. Energy Economics, 19, 435-444.

Dickey, D.A., Fuller, W.A. (1996), Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74, 427-431.

Dossou, T.A.M. (2019), Electricity consumption and economic growth nexus in the Republic of Benin. Socio-Economic Challenges, 3(2), 63-69.

ECRA. (2015), Annual Report 2014. Riyadh. Available from: http://www.ecra.gov.sa/en-us/MediaCenter/DocLib2/Pages/SubCategoryList.aspx?categoryID=4.

Erol, U., Yu, E.S.H. (1987), On the causal relationship between energy and income for industrialized countries. Journal of Energy Development, 13, 113-122.

Fattouha, B., Amrita, S. (2016), Saudi Arabia's Vision 2030, Oil Policy and the Evolution of the Energy Sector. Oxford: The Oxford Institute for Energy Studies, Oxford Energy Comment.

Gonand, F., Hasanov, J.F. (2018), Estimating the impact of energy price reform on Saudi Arabian intergenerational welfare using the MEGIR-SA model. The Energy Journal, 40(3), 55-77

Granger, C.W.J. (1988), Some recent developments in a concept of causality. Journal of Econometrics, 39, 199-211.

Hasan, D., Serhat, Y., Zafer, A. (2017), Identifying causality relationship between energy consumption and economic growth in developed countries. International Business and Accounting Research Journal, 1(2), 71-81.

Hendry, D.F., Juselius, K. (2000), Explaining cointegration analysis: Part 11. The Energy Journal, 22, 5161060.

Ho, C.Y., Siu, K.W. (2007), A dynamic equilibrium of electricity consumption and GDP in Hong Kong: An empirical investigation. Energy Policy, 35(4), 2507-2513.

Institute for Energy Economics and Financial Analysis. (2018), 14900 Detroit Avenue, Suite 206, Lakewood, OH 44107, 216-712-6612, Available from: http://www.staff@ieefa.org.

IEEFA. (2018), Sunny Saudi Arabia Plans a $200 Billion Bet on Solar. Cleveland: Institute for Energy Economics and Financial.

Iyke, B.N. (2015), Electricity consumption and economic growth in Nigeria: A revisit of the energy growth debate. Energy Economics, 51(C), 166-176.

Johansen, S. (1995), Likelihood-Based Inference in Co Integrated Vector Autoregressive Models. Oxford: Oxford University Press.

Johansen, S., Juselus, K. (1990), Maximum likelihood estimation and inference on cointegration-with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52, 169-210.

Khalid, H.A. (2012), Causal relationship between energy consumption and economic growth in the Kingdom of Saudi Arabia. Journal of Energy and Development, 37(1), 129-142.

Khan, S., Jam, F.A., Shahbaz, M., Mamun, M.A. (2018), Electricity Consumption, Economic Growth and Trade Openness in Kazakhstan: Evidence from Cointegration and Causality. Available from: https://www.mpra.ub.uni-muenchen.de/87977.

King Abdullah Petroleum Studies and Research Center. (2017), Available from: https://www.kapsarc.org/research/publications.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. Journal of Energy and Development, 3, 401-403.

Lahn, G., Stevens, P. (2011), Burning Oil to Keep Cool: THE hidden Energy Crisis in Saudi Arabia. London: Chatham House.

Lee, C.C. (2006), The causality relationship between energy consumption and GDP in G-11 countries revisited. Energy Policy, 34, 1086-1093.

M.O.W.A. Electricity. (2014), Chapter 30: State Plans, Performance and Problems, in 9th Development Plan, KSA, Ministry of Water and Electricity. p581.

Maghrebi, F., Zouaoui, C.E., Ibrahim, A. (2018), Test of causality between oil prices and GDP: Case study Saudi Arabia. Economic Computation and Economic Cybernetics Studies and Research, 52(3), 279-289.

Masih, A.M.M., Masih, R. (1996), On the temporal causal relationship between energy consumption, real income, and prices: Some new evidence from Asian-energy dependent NICS based on a multivariate cointegration/vector error-correction approach. Journal of Policy Modeling, 19(4), 417-440.

Masih, M., Al-Elg, A., Madani, H. (2009), Causality between financial development and economic growth: An application of vector error correction and variance decomposition methods in Saudi Arabia. Journal of Applied Economics, 41(13), 1691-1699.

Mezghany, I., Haddad, H.B. (2016), Energy consumption and economic growth: An empirical study of the electricity consumption in Saudi Arabia. Renewable and Sustainable Energy Reviews, 75(C), 145-156. Available from: https://www.elsevier.com/locate/rser.

Michael, S., Alegre, J.G. (2009), Fiscal Policy Challenges in Oil Exporting Countries. A Review of Key Issues; Social Research Network, Electronic Library. Available from: http://www.ssrn.com/abstract.

Narayan, P.K., Smyth, R. (2009), Multivariate granger causality between electricity consumption, exports and GDP: Evidence from a panel of Middle Eastern countries. Energy Policy, 37, 229-236.

Nelson, C.R., Plosser, C.R. (1982), Trends and random walks in macroeconomics time series: Some evidence and implications. Journal of Monetary Economics, 10(2), 139-162.

Njindan, I.B. (2014), Electricity Consumption and Economic Growth in Nigeria: A Revisit of Energy-Growth Debate. Available from: https://www.mpra.ub.uni-muenchen.de/70001.

Nyasha, S., Gwenhure, Y., Odhiambo, N.M. (2016), Energy Consumption and Economic Growth in Ethiopia: A Dynamic Causal Linkage.

Odhiambo, N.M. (2009), Energy consumption and economic growth nexus in Tanzania: An ARDL bounds testing approach. Energy Policy, 37(2), 617-622.

Odularu, G.O. (2008), Crude Oil and the Nigerian Economic Performance, Oil and Gas Business. Available from: http://www.ogbus.ru/eng.

Platts. (2015), Available form: http://www.platts.com/latest-news/natural-gas/dubai/saudi-arabia-hikes-price-of-gas-for-power-production-26323825.

Said NACHET, Marie-Claire AOUN. (2015), The Saudi Electricity Sector: Pressing Issues and Challenges. Ifri-Bruxelles, Brussels-Belgium. Available from: http://www.ifri.org.

Sari, R., Soytas, U. (2009), Are global warming and economic growth compatible? Evidence from five OPEC countries? Applied Energy, 86, 1887-1893.

Sekantsi, L.P., Thamae, R.I. (2016), Electricity consumption and economic growth in Lesotho. Energy Sources, Part B: Economics, Planning, and Policy, 11(10), 969-973.

Shabestari, N.B. (2018), Energy Consumption, CO_2 Emissions and Economic Growth: Sweden's Case. Available from: http://www.diva-portal.org/smash/get/diva2:1214695/fulltext01.pdf.

Sheilla, N., Yvonne, G., Nicholas, M.O.(2016), Energy Consumption and Economic Growth in Ethiopia: A Dynamic Causal Linkage. South Africa: UNISA, Economic Research Working Paper Series No. 10/2016.

Soytas, U., Sari, R. (2009), Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecological Economics, 68, 1667-1675.

Stern, D.I., Enflo, K. (2013), Causality between energy and output in the long run. Energy Economics, 39, 135-146.

Suharsono, A., Aziza, A., Pramesti, W. (2017), Comparison of vector autoregressive (VAR) and vector error correction models (VECM) for index of ASEAN stock price. AIP Conference Proceedings, 1913, 020032.

Syzdykova, A., Gulmira, A., Khairulla, M., Aigul, K., Darkhan, S. (2020), Analysis of the relationship between energy consumption and economic growth in the commonwealth of independent states. International Journal of Energy Economics and Policy, 10(4), 318-324.

The World Bank. (2014), Nigeria Economic Report. Available from: https://www.worldbank.org/data.

Wolde-Rufeal, Y. (2006), Electricity consumption and economic growth: a time series experience for 17 African countries. Energy Policy, 34, 1106-1114.

Yu, E.S.H., Jin, J.C. (1992), Cointegration tests of energy consumption, income and employment. Resources and Energy, 14, 259-266.