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Dynamic Linkages between Electricity Consumption, Urbanization and Economic Growth: A VECM and Causality Analysis for GCC

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Abstract: **During the last decades, the relationship between electricity consumption, urbanization and economic growth has been well documented in the energy economics literature. In term of our present case, limited research had been conducted for GCC countries. This study is an addition to the existing literature by empirically investigates the relationship between economic growth, electricity consumption, and urbanization in the Gulf. A standard growth models will be estimated using both fixed-effects and random effects models. In addition, panel unit root and panel co-integration tests will be employed to check for the efficiency of the data. The long run relationship is estimated using fully modified OLS and: Panel Dynamic Least Squares (DOLS) methods. Panel Vector Error Correction Model (VECM) is also utilized in this study.**

The study found that there exists a long relationship between GDP per capita electricity consumption, Urban population, inflation, and degree of openness. The degree of adjustment was found to be 0.43 percent, meaning that any deviation for FDI from its long run path will be corrected by 0.43 percent each year.

The main policy implication for GCC to have reasonable level of growth depends on their ability to develop and utilize the effective use of electricity power. The study suggests that to move away from oil which is fluctuate over time to establishing a good base for industrialization by the shift of utilizing a strict balance between electricity consumption and urbanization rate which it doesn't affect in the long run the climate change.

Keywords: **Electricity consumption; urbanization; VEC, Causality, Panel Cointegration, GCC.**

1. INTRODUCTION

The purpose of this article is to examine the relationship between energy consumption, urbanization, and economic growth in GCC countries over the period 1990-20019. Urbanization is understood as a hallmark of economic development. A higher level of per capita income is accompanied by a higher level of urbanization in almost every developed country (Jedwab and Vollrath, 2015). However, the impact of urbanization on economic growth in developing countries might vary from substantially negative to nearly neutral to positive using urbanization as the relevant factor (Liddle, 2013).

For GGC, the region has witnessed strong surge in urbanization process with the use of all modern amenities and modern life style enjoyed by its citizens. The average urbanization rate is more than 80% and countries like Kuwait and Qatar are 100% urbanized (UN Habitat, 2012). According to UN (Habitat, 2012), GCC countries are home of about ,53 million populations of which around 67% live in Saudi Arabia. The possible explanations of rapid growth of urbanization in GCC are internal migration and huge inflow of expatriate workers coming mainly from neighboring and South Asian region. So, The Gulf Co-operation Council (GCC) 1countries are one of the world's most urbanized economic regions in the world.

Electricity on the other hand, is one of the most important sectors and plays a major role in the economic development of many countries. Electricity exemplifies as the most resilient types of energy and shapes one of the basic inputs of social and economic development infrastructure.

The rapid demand growth in electrical energy in GCC countries is due to the region's rapid economic growth. Large scale infrastructural development, heavy industry and petrochemicals all required substantial electrical power. High population growth as a result of labor migration and the high birth rate coupled with improving living standards led to the rise in residential and commercial energy consumption. Furthermore, the low pricing of electricity in the GCC countries plays an important role in increasing electrical power demand. Actually the electrical energy is sold below the economic cost, with the result the tariffs in GCC are among the lowest in the world. Moreover, waste due to inefficient buildings and equipment has contributed toward increase in power demand (Abdullah Al-Badi & Imtenan Al Mubarak (2019)

In this study these relationships are investigated for the six Gulf Cooperation Council countries (GCC): Saudi Arabia, United Arab Emirates (UAE), Qatar, Bahrain, Kuwait and Oman. All of these countries have experienced rapid economic growth over the past 40 years due mainly to their vast oil and gas reserves. These include approximately 40% of the world's proven oil reserves and approximately 25% of the world's natural gas reserve.

The main objectives of this paper are to study the relationship between electricity consumption, Urbanization and economic growth a panel of six gulf countries during the period 1990–2019 and to produce new evidence on the economic growth and these variables. Therefore, a test of the relationship between economic growth and electricity consumption, Urbanization for these countries could reveal important information on this issue. Secondly, very few studies were conducted to test the impact of electricity consumption and Urbanization on economic growth of GGC. Overall, this paper examines the dynamic relationship between electricity consumption, Urbanization on economic growth of GGC. A secondary contribution is methodological as it applies a number of sophisticated econometric techniques: the dynamic ordinary least squares (DOLS), the fully modified ordinary least squares (FMOLS) and the dynamic fixed effect model (DFE) to estimate the long-run relationship between the variables. Also panel Granger causality is employed to determine the causal direction between the variables

The remainder of the paper proceed as follows. Section 2 provides the literature review and the link between electricity consumption, Urbanization and economic growth. Section3 provides the methodology. Section 4 presents the analysis and discussion. Section 5 concludes.

2. LITERATURE REVIEW

In recent years, there have been widespread empirical studies on the relationship between energy consumption and economic growth or energy consumption and CO2 for developed and developing economies. However, studies measuring the relationship between energy consumption, urbanization and economic growth are rather limited. Ghosh and Kanjilal [10] examined co-integration relationship between energy consumption, urbanization and economic activity for India using threshold co-integration tests for the period 1971-2008; and found unidirectional causality running from energy consumption to economic activity and economic activity to urbanization. Zhao and Wang [2015] investigated causal relationships between urbanization, economic growth and energy consumption in China for the period 1980e2012; and obtained a bidirectional Granger causal relationship between energy consumption and economic growth, and unidirectional causality running from urbanization to energy consumption and economic growth to urbanization.

On the other hand, Belloumi and Al shehry [2016] investigated the long-term and causal relationship between energy intensity, real GDP per capita, urbanization and industrialization in Saudi Arabia over the period 1971e2012; and found

[1] The Gulf Cooperation Council States(GCC) include Saudi Arabia, Kuwait, Qatar, Bahrain, Oman and United Arab Emirates. They are all located in arid region of the Arabian Peninsula. They are small in area and population and major oil producers; their oil revenues have entirely dominated their economies in every facet of their national life since late sixties and early seventies. The high growth rates have been the result of very high levels of immigration as well as natural increases due to oil revenues being invested in health, welfare, and educational facilities which have reduced mortality rates.

that unidirectional Granger causality running from urbanization, economic output, services share in GDP, and industrialization to energy intensity in the long term. Sadorsky [2013] investigated the relationship between energy intensity, income, urbanization and industrialization for a panel of 76 developing economies; and found that increases in income reduce energy intensity, while the impact of urbanization on energy intensity was mixed. Sadorsky [2014] investigated the impact of urbanization and industrialization on energy consumption in a panel of emerging economies; and indicated that income increases energy consumption, while urbanization decreases energy consumption, but industrialization increases it

Bakirtas and Akpolat (2018) investigated the causal link between economic growth, urbanization and energy consumption in a panel of six new emerging-market countries from 1971 to 2014. The bivariate analysis revealed a unidirectional causality from economic growth to energy consumption on one hand, and from urbanization to economic growth and energy consumption on the other. Kumari and Sharma (2018) explored the causal link between GDP and electricity consumption from 1981 to 2013. Findings revealed that electricity consumption does not only drive economic growth, but also a key determinant of FDI inflow into the country. Elfaki, Poernomo, Anwar, and Ahmad (2018) incorporated urban population and trade as control variables while trying to establish a link between growth and energy consumption in Sudan. Contrarily to what is obtained in extant literature, findings showed that energy consumption inhibits growth

Bilgili, Koçak, Bulut, and Kuloglu (2017) examined the link between urbanization and energy intensity for 10 countries in Asian from 1990 to 2014. The impact of urbanization on energy intensity was negative and significant in both time periods.

In a recent attempt, study by (Al-Mulali et al., 2012) examined the relationship between urbanization, energy consumption and CO2 emission in case of Middle East and North Africa (MENA) countries, covering the sample period of 1980-2009. Using dynamic panel data models and Vector Error Correction Model (VECM) based panel Granger causality, the study reported strong relationship among sample variables. Based on the empirical results, the study found strong evidence of impact of urbanization on energy consumption and subsequently on carbon emission. Based on its findings, the study suggested that the slowdown in urbanization process may help these economies to control upon carbon emission related pollution. To the best of our knowledge and similar to our objectives of this study, this is the only study that covers almost all the GCC countries. But this study fails to provide a deeper understanding about GCC countries carbon emission related issues. The study also uses the data up to 2009 and hence ignores many recent developments and policy measures to curb on carbon related pollution.

Recent studies on the above-mentioned issue include papers by Acaravci and Ozturk (2010) and Ozturk and Acaravci (2011). The G.D.P. and E.C. per capita variables were studied to investigate the causal relationship between 15 selected transition countries by Acaravci and Ozturk (2010) using Pedroni Panel co-integration for the period 1990–2006. The authors' estimations confirmed the absence of any relationship between E.C. and G.D.P. In a similar study by Ozturk and Acaravci (2011), the A.R.D.L. bounds testing approach was used to examine the relationship between G.D.P. and E.C. from 1990–2006 for 11 M.E.N.A. (Middle East and North Africa) countries. The authors reported the absence of any long-run relationship between E.C. and G.D.P. in Syria, Morocco and Iraq. The estimations further showed a unidirectional causality in the short-run from G.D.P. to E.C. for Israel. However, a unidirectional causality was found in Saudi Arabia, Oman and Egypt in both the long-run and short-run, as well as from electricity consumption to G.D.P. The authors concluded that the results indicate confirmation of a weak long-run causal relationship between EC and GDP.

However, in the current scenario, the studies pertaining to E.C. and G.D.P. have been extended by using urbanization. The empirical results from many different studies conducted in different countries are varied. Many studies identified that G.D.P., urbanization and E.C. are correlated. Parshall et al. (2010) reported a positive relationship among E.C. and urbanization for the case of the U.S.A. Likewise, similar findings were reported by Salim and Shafiei (2014), who investigated this relationship for O.E.C.D. (Organisation for Economic Co-operation and Development) countries. Lenzen et al. (2006) conducted a study using panel data for different countries, which included Denmark, Japan, Australia and Brazil, by analyzing the influence of urbanization on E.C. The findings of the study indicated that the influence of urbanization on G.D.P. differs, even during the same time period. A similar study was conducted by Liddle (2013) and found a strong association between urbanization and G.D.P. However, the study further suggested that urbanization is the driver of economic growth, and its impact varies across regions, depending on their level of income and development. In their recent study, Liddle and Messinis (2015) further identified that the association between urbanization and G.D.P.

shows an increased correlation in high-income and low-income countries. In another study, Liddle and Lung (2014) utilized panel data and the causality direction moves from E.C. to urbanization. Kasman and Duman (2015) conducted a study for European Union member countries using panel data. Their findings suggested evidence of a one-way causality from urbanization to G.D.P. and G.D.P. to E.C

It has been argued in the literature that there is a positive relationship between economic growth and urbanization. Most of the scholars argued that there is an increase in economic growth at every stage of urbanization. Guan et al. (2015) and Sbia et al. (2017) established a positive relationship between urbanization and economic growth on a country-level basis. Some other authors found that economic growth has a stronger effect on the urbanization compared with the effect of urbanization on economic growth. Liddle and Messinis (2015) found in their study the positive influence of economic growth on urbanization in SSA countries, while urbanization was found to have a negative influence on economic growth. Fox (2012), Poelhekke (2011), and Issaoui et al. (2015) established in their studies that as the level of urbanization increases at the initial stage, economic growth will be negatively affected. Liddle (2013) found that a significant relationship exists between urbanization and economic growth, and the study concluded that the influence of urbanization on economic growth will transit from negative to positive as the country grows.

The interaction relationship between electricity consumption and economic growth has been widely discussed in the empirical literature. For instance, (Zhong et al., 2019; Iyke and Odhiambo, 2014; Bekun and Agboola, 2019)

3. METHODOLOGY

3.1 Model Specification and Data

The study adopted a panel quantitative design to assess the impact of electricity consumption and urbanization on economic growth of the GCC during the period 1990-2019, providing 161 observations for the whole data set.

Following the empirical literature, we construct a model to test the relationship between electricity, urbanization and economic growth over the period 1990–2019.

Ln YIt = f (LNELECTt, LNURBt, INFt, OPPNt)

Where Yt is the real GDP per capita (at constant price, 2011=$100 US) as a proxy for economic growth; ELECTt is a proxy for electric power in kWh per capita, URt is urbanization as measured by total urban population. INFt is a measure of inflation rate; and OPPNt is a measure of trade integration and openness with the rest of the world. The study used annual data over the period of 1990–2019. The world Development Indicators prepared by World Bank are the source of data to this study. All variables have been transformed into natural logarithms (ln) to help mobilize stationarity.

3.2 Panel Cointegration

In this section, we provide a brief description of the cointegration tests utilized for this paper. The Pedroni and Kao tests are based on Engle-Granger (1987) two-step (residual-based) cointegration tests.

3.2.1. Pedroni Cointegration Tests

Pedroni proposes several tests for cointegration that allow for heterogeneous intercepts and trend coefficients across cross-sections. Consider the following regression

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \dots + \beta_{Mi} x_{Mi,t} + e_{i,t} \quad (1)$$

Under the null hypothesis of no cointegration, the residuals will be I(1). The general approach is to obtain residuals from Equation (1) and then to test whether residuals are I(1) by running the auxiliary regression,

$$e_{it} = \rho_i e_{it-1} + u_{it} \quad (2)$$

$$e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{p_i} \psi_{ij} \Delta e_{it-j} + v_{it} \quad (3)$$

Pedroni shows that the standardized statistic is asymptotically normally distributed,

$$\frac{\aleph_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0,1) \tag{4}$$

3.2.2 Kao Cointegration Tests

The Kao test follows the same basic approach as the Pedroni tests, but specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors.

In the bivariate case described in Kao (1999), we have

$$y_{it} = \alpha_i + \beta x_{it} + e_{it} \tag{5}$$

Under the null of no cointegration, Kao shows that following the statistics, Kao shows that following the statistics,

$$DF_\rho = \frac{T\sqrt{N}(\hat{\rho}-1) + 3\sqrt{N}}{\sqrt{10.2}}$$

$$DF_t = \sqrt{1.25}\,t_\rho + \sqrt{1.875N}$$

$$DF_\rho^* = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}\hat{\sigma}_v^2/\hat{\sigma}_{0v}^2}{\sqrt{3 + 36\hat{\sigma}_v^4/(5\hat{\sigma}_{0v}^4)}}$$

$$DF_t^* = \frac{t_\rho + \sqrt{6N}\hat{\sigma}_v/(2\hat{\sigma}_{0v})}{\sqrt{\hat{\sigma}_{0v}^2/(2\hat{\sigma}_v^2) + 3\hat{\sigma}_v^2/(10\hat{\sigma}_{0v}^2)}}$$

3.3 VECM Model

A k-dimensional Vector Error Correction Model (VECM) for the VAR(p) process can be written as:

$$\nabla X_t = \Pi_{[k\times k]}\mathrm{X}_{t-1} + \Gamma_1\nabla \mathrm{X}_{t-1} + \cdots + \Gamma_{p-1}\nabla X_{t-p+1} + \varepsilon_t \tag{6}$$

In the VECM, ∇X_t and its lag are all I(0), $\Pi_{[k\times k]}\mathrm{X}_{t-1}$ is an error correction term;$\Pi_{[k\times k]}$ contains long run relationships, with $Rank(\Pi_{[k\times k]})$ = number of cointegration

If there are r co-integration vectors, $\Pi_{[k\times k]}$ can be expressed as $\Pi_{[k\times k]} = \alpha_{[k\times r]}\beta'_{[r\times k]}$

$\boldsymbol{\alpha}$ contains the speed of adjustment parameters which interpreted as the weight with which each co-integration vector appears in a given equation, while $\boldsymbol{\beta}$ contains the coefficient of long-run relationship.

In case $\boldsymbol{rank(\Pi) = 0}$ **then** $\Rightarrow \Pi = 0 \Rightarrow X_t \sim I(1)$ and not cointegrated, the VECM reduces to

$$\nabla X_t = \Gamma_1\nabla X_{t-1} + \cdots + \Gamma_{p-1}\nabla X_{t-p+1} + \varepsilon_t \tag{7}$$

$\Rightarrow \nabla X_t$ follows a VAR(p-1) model

On the other hand if $\boldsymbol{rank(\Pi) = k,} \Rightarrow \Pi$ has full rank$\Rightarrow X_t$ is stationary / I(0), and we can simply analyze X_t directly

If $\boldsymbol{0 < rank(\Pi) = r < k}$, there are r cointegration relations, Π can be written as $\boldsymbol{\Pi_{[k\times k]} = \alpha_{k\times r}\beta'_{r\times k}}$, where β has r linearly independent columns representing the cointegrating vectors

$$\nabla X_t = \alpha\beta' X_{t-1} + \Gamma_1 \nabla X_{t-1} + \cdots + \Gamma_{p-1}\nabla X_{t-p+1} + \varepsilon_t \quad (8)$$

$\boldsymbol{\Pi = \alpha\beta'}$ is not unique since we have:

$$\alpha\beta' = \alpha H H^{-1}\beta' = (\alpha H)\left(\beta H^{-1\prime}\right)' = \alpha^*\beta^{*\prime}$$

Where $\alpha^* = \alpha H,\ \beta^* = \beta H^{-1\prime}$

It is common to require that $\beta' = [I_r, \beta_1{}']$, where I_r is the $r \times r$ identity matrix and β_1 is a $(k - r) \times r$ matrix

For determining the number of Cointegration, Johansen and Juselius (1990) proposed two methods for determining the number of cointegrating relations.

- Trace Statistics based on a likelihood ratio test about a trace of the matrix
- Maximum Eigenvalue Statistics based on eigenvalues (maximum) obtained from estimation procedure. These cointegration tests are formulated in term of the estimated eigenvalues $\hat{\lambda}_i$ of the matrix Π

3.4 The fixed effects model

The fixed effects (or least squares dummy variables model, or within model) is based on the notion that differences across countries can be captured in differences in the constant term:

$$y_{it} = \alpha_i + \beta'_{xit} + \varepsilon_{it} \quad (9)$$

The fixed model is a reasonable approach when we can be confident that the differences between countries can be viewed as parametric shifts of the regression function.

3.5 The Random effects model:

If we believe that sampled cross sectional units are drawn from a large population, it may be more appropriate to use the random effects model (or variance components model), in which individual constant terms are randomly distributed across cross sectional units:

$$y_{it} = \alpha + \beta'_{xit} + \mu_i + \varepsilon_{it} \quad (10)$$

where E(μi = 0), E(μi2) = σμ2, E(μiμj) = 0 for i≠ j, and E(εit μj) = 0, for all i, t, and j. Thus, μi is a random disturbance which characterizes the ith observation and is constant through time; it can be regarded as a collection of factors that are specific to region i and are not included in the regression..

4. EMPIRICAL FINDINGS

4.1 Descriptive Analysis

Table 1 shows the summary statistics for the main variables of the model: GDP per capita (LNGDPGR), Electricity (LNELECT), Urban Population (LNURB), rate of inflation (INF), degree of openness (OPPN), and The values of, GDP per capita, electricity and Urban population were taken in natural logarithms to reduce variability.

TABLE 1: SUMMARY STATISTICS FOR THE MODEL VARIABLES

Variables	Mean	Median	Maximum	Minimum	Std. Dev.	CV
LNGDPGR	4.474577	4.349021	4.843102	4.173278	0.219825	4.91%
INF	4.953130	3.414350	144.6836	-25.95839	15.13707	305.6%
LNELECT	4.002335	4.077695	4.365718	3.333333	0.266525	6.65%
LNURB	6.447326	6.335951	7.451101	5.640595	0.484387	7.52%
OPPN	106.3745	94.96867	210.1610	56.08838	32.80927	30.84%

Table 1 shows that GDP per capita (LNGDPGR), Electricity (ELECT) and Urban Population (LNURBI) variables exhibited small variations across the GCC countries during the period 1990-2019, as indicated by the coefficient of variation (CV). However, inflation rate (INF) and degree of openness (OPPN) have shown great variations, amounting to 306 percent and 31 percent for the two variables respectively. This might be the case of fluctuations in oil prices and food prices during the mentioned period.

TABLE 2: CORRELATION MATRIX FOR THE MODEL VARIABLES

Variables	LNGDPGR	INF	URB	OPPN	LNELECT
LNGDPGR	1.000000				
INF	0.0805731	1.000000			
URB	-0.3201009	-0.04785675	1.000000		
OPPN	0.0070929	-0.05853372	-0.377076	1.000000	
LNELECT	0.4878668	0.03222759	-0.251952	0.4995955	1.000000

Table 2 shows that GDP per capita (LNGDPGR), is positively correlated with Trade Openness (OPPN), electricity consumption (LNELECT) and inflation (INF), and negatively with Urban population (LNURB).

4.2 Panel Unit Root Test

Different panel unit root tests were used to check for the stationarity of the series. The results are reported in Table 3. It is shown that all the series except for inflation rate (INF) are non-stationary at level. However, in the first differenced form (Table 3), we found that all series are stationary, as the outcomes of the probabilities (p-values) are less than 5 percent significance level, therefore we can reject the null hypothesis of unit root, and accept the alternative hypothesis of no unit root, meaning that all series became stationary at the first difference

TABLE 3: PANEL UNIT ROOT TEST

Variables	Levin, Lin & Chu t		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Level p-value	First Difference p-value	Level p-value	First Difference p-value	Level p-value	First Difference p-value	Level p-value	First Difference p-value
LNGDPGR	0.1975	0.0000	0.0568	0.0000	0.0803	0.0000	0.0235	0.0000
LNELECT	0.6844	0.0000	0.5411	0.0000	0.0643	0.0000	0.8457	0.0000
LNURB	0.3953	0.0023	0.9995	0.0050	0.9871	0.0000	0.5643	0.0078
INF	0.0328	0.0000	0.0470	0.0000	0.0295	0.0000	0.4948	0.0000
OPPN	0.0946	0.0000	0.2216	0.0000	0.2184	0.0000	0.3876	0.0000

4.3 Panel Cointegration results

Having confirmed the order of integration of the panel series, the next step is to check the possibility of long-run relationship between variables. So, Pedroni (1999) Kao (1999) and Johansen co-integration tests are applied to check for Cointegration. The null hypothesis for all tests is that there is no co-integration in the series, and the alternative hypothesis is that there is Cointegration in the series. Table 4, 5 and 6 report the results of the panel Cointegration tests. The Results of Pedroni (1999) test are reported in Table 4. Since all the coefficients are statistically significant at 5% level percent, we can reject the null hypothesis of no Cointegration, and accept the alternative hypothesis of Cointegration,

Table 4: Results of Pedroni's Residual Cointegration

	No Deterministic Trend		***Deterministic Intercept and Trend***		***No Deterministic Intercept or Trend***	
Alternative hypothesis: common AR coefs.	(within-dimension)					
	Statistics (Prob.)	***Weighted Statistic (Prob.)***	***Statistics (Prob.)***	***Weighted Statistic (Prob.)***	***Statistics (Prob.)***	***Weighted Statistic (Prob.)***
Panel v-Statistic	0.2933	0.7424	0.8174	0.9748	0.1229	0.5924
Panel rho-Statistic	0.0636	0.2495	0.3637	0.6925	0.0119	0.1364

Panel PP-Statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel ADF-Statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Between-dimension)						
Group rho-Statistic	0.3181		0.7987		0.1274	
Group PP-Statistic	0.0000		0.0000		0.0000	
Group ADF-Statistic	0.0000		0.0000		0.0000	

TABLE 5: RESULTS OF KAO'S RESIDUAL COINTEGRATION TEST

	t-Statistic	Prob.
ADF	-4.024979	0.0000
Residual variance	0.221295	
HAC variance	0.231746	

TABLE 6: JOHANSEN COINTEGRATION TEST

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-Eigen test	Prob.
None	255.2	0.0000	194.8	0.0000
At most 1	113.3	0.0000	86.67	0.0000
At most 2	45.43	0.0000	38.87	0.0001
At most 3	18.67	0.0968	15.25	0.2282
At most 4	18.52	0.1007	18.52	0.1007

Trace test indicates 3 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

The result of Kao (1999) as presented in Table showed that the p-values is less than 5% therefore we can reject the null hypothesis of no cointegration and accept the alternative hypothesis of cointegration.

Table 6 show the results of Johansen co-integration test. The trace test indicates three co-integrating equations at the 0.05 level. The results of the Johansen's test, Pedroni and Kao's test agree. Thus, it can be concluded that the all variables have robust long-run association in GCC countries

TABLE 7: VECTOR ERROR CORRECTION MODEL (VECM)

Error Correction:	D(LNGDPGR)	D(LNELECT)	D(LNURB)	D(INF)	D(OPPN)
CointEq1	-0.004322	0.000994	-12.00653	0.056258	-0.002327
	(0.00134)	(0.00054)	(28.1805)	(0.00982)	(0.00813)
	[-3.22537]	[1.84683]	[-0.42606]	[5.73135]	[-0.28613]

Table 7 shows the results of the vector error correction model (VECM). The Error Correction Term (ECT) showed a negative and significant coefficient. This result indicates that approximately 0.43 per cent of total disequilibrium in GDP per capita will be corrected each year.

4.4. FMOLS and DOLS results

The results of both FMOLS and DOLS are reported in Table 8. Based on the evidence of the long association and co-integration between the variables at 5% significance level, we can proceed further to estimate the magnitude of the long run relationship between the variables by applying panel Fully Modified Ordinary Least Squares (FMOLS) and panel Dynamic Ordinary Least Squares (DOLS) estimators.

Based on the evidence of the long association and co-integration between the variables at 5% significance level, we can proceed further to estimate the magnitude of the long run relationship between the variables by applying panel Fully Modified Ordinary Least Squares (FMOLS) and panel Dynamic Ordinary Least Squares (DOLS) estimators as shown in Table 8.

TABLE 8: FMOLS AND DOLS RESULTS

Variable	FMOLS	DOLS
LNELECT	0.696029 (0.081092) (8.583176}**	0.165991 (0.310095) (0.535291}
LNURB	0.189614 (0.055940) (3.389618}**	0.563837 (0.212294) (2.655920}**
INF	-0.001714 (0.001456) -1.177351}	-0.011462 (0.010805) (-1.060770}
OPPN	0.002182 (0.000663) (3.291215}**	-0.000406 (0.130857) (0.291044}

The results of both FMOLS and DOLS are reported in Table 8. The results show some similarities and differences between them. For Electricity consumption (LNELECT), Urban population (LNURB) and trade openness (OPPN) the results are statistically significant as p-values are less than 10 percent, 5 percent and 1 percent significance levels but inflation rate (INF) show a negative and insignificant sign for both FMOL and DOLS. For other variables DOLS they are all insignificant except for LNURB.

4.5 Random Effect Results

To decide between fixed effect model or random effect model, we run simple Hausman test where the null hypothesis is that the random effect model is more appropriate vs. the alternative hypothesis the fixed effect model is more appropriate

H0: Random Effect Model is appropriate

H1: Fixed Effect Model is appropriate

Table 9 show the result of the hausman test as the p-value >0.05 then Ho is not rejected, so we select the Random effect model (REM).

Table 9: Hausman Test Result

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.536113	4	0.9699

As the Hausman test is in favor of Random effect model, we run regression for panel random effect and the results are given in Table 10. As the initial step, we examine the impact of Electricity consumption, urbanization, inflation rate and trade openness on economic growth. Trade openness and Urban population are significant but with negative signs. inflation is insignificant

Table 10: Random Effect Results

Dependent Variable: LNGDPGR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.674744	0.208737	22.39540	0.0000
LNELECT	0.185627	0.033693	5.509343	0.0000
LNURB	-0.125218	0.023068	-5.428220	0.0000
INF	-0.000310	0.000219	-1.416659	0.1586
OPPN	-0.001115	0.000200	-5.564301	0.0000
	Effects Specification			
			S.D.	Rho
Cross-section random			0.384240	0.9894
Idiosyncratic random			0.039699	0.0106

4.6 Results of Granger-Causality Tests

Table 11 reveals the causality effect of the variables of interests adopted in this paper. The analysis shows that there is unidirectional causality running from LNURB and OPPN to real growth rate.

Table 11: Granger Causality Tests

Variables	F-Stat.	p-value	Causality
LNELECT → **LNGDPGR**	0.91080	0.4045	No
LNURB → **LNGDPGR**	5.39480	0.0055	Yes
OPPN → **LNGDPGR**	7.65784	0.0007	Yes
INF → **LNGDPGR**	0.26785	0.7654	No

5. CONCLUSION AND IMPLICATIONS

The paper is concerned with the growth impact of electricity consumption and urbanization in GCC countries. By employing a panel data methodology for the period of 1990–2019 the study investigates whether the electricity consumption and urbanization have a positive effect on GCC countries. For initial check of the series, the study employ four panel unit root test and the results show that all series are integrated of order one after the first difference.

Panel co-integration methodology is used to test for the existence of a long relationship between the variables. Three tests, Pedroni (1999), Kao (1999) and Johansen cointegration tests are applied to check for co-integration. The results of the three tests reveal that there exist a long run co-integrating relationship between the variables and economic growth in GCC countries. To test the magnitude of the long relationship among variables fully modified least square (FMOLS) and dynamic ordinary least square (DOLS) were used. The results show that electricity and urbanization variables are positive and have significant impact on the long run growth of the economy.

Further, Random –effects method is selected as fixed - effect model is rejected based on Hausman test result. The results of random effect show that electricity and urbanization variables are statistically significant but with negative coefficient for urbanization.

The main policy implication for GCC to have reasonable level of growth depends on their ability to develop and utilize the effective use of electricity power. The study suggests that to move away from oil which is fluctuate over time to establishing a good base for industrialization by the shift of utilizing a strict balance between electricity consumption and urbanization rate which it doesn’t affect in the long run the climate change.

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