Time Series Analysis of Environmental Kuznets Curve in the Gulf Cooperation Council (GCC) from 1995-2020

Abstract

Purpose: The mainmotive ofthe presentstudy is toinvestigate the environmental Kuznets curve hypothesis (EKC) in six Gulf Cooperation Council (GCC) countriesfrom the ~~period~~ 1995-2020.To attain this aim the time series model is built by utilizing C_{o2}~~o2~~ emission as an environmental indicator and GDP per capita, energy consumption and urbanization as economic indicators.

Model specification/ Methodology: Phillips Perron's(PP) unit root test is applied to check the maximum order of integration among variables. Auto-regressive distributedlag (ARDL) bounds estimation model is applied to test the existence of co-integration among variables.

Findings: The study found that the EKC hypothesis appliesto Saudi Arabia, UAE and Qatar after comparing thelong runand short-run income elasticities. The results of the Toda–Yamamoto–Dolado–Lütkepohl (TYDL) non-granger causality test showed unidirectional causality between carbon emissions and energy consumption in Kuwait and Qatar. Bidirectional causality is found between economic growth and energy consumption in the UAE while unidirectional causality is from urbanization to energy consumption in Saudi Arabia, Qatar and Bahrain.

Limitations / policy implications: the present study is based on time series data analysis and used limited number of variables for the estimation of environmental Kuznets curve hypothesis (EKC).The future studies should consider other variables (political stability, international trade, FDI, deforestation)~~etc~~etc. for analyzing the association between economic growth and environmental quality.

Originality value: The present study used major Greenhouse gas(Co_2 emissions) as the proxy variable for environmental degradation. Presently, the GCC economies are among the most carbonized countries(emitted highest GHG emissions per unit GDP) in the world. The novelty of this study lies in estimating the long run and short run relationship between environmental indicator (Co_2) and economic growth (GDP) separately, which in my knowledge is the first study on this region

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Keywords:EKC, Energy Consumption, Urbanization, ARDL Model, Co_2 Emissions, GCC Region.

INTRODUCTION

Climate change is a great concern in the current scenario. No corner of the globe is immune or resilient to tackle the devastating consequences of climate change. Human activities of all kinds are considered a significant threat to the environment of this planet. These activities contribute directly or indirectly to climate change (Joshua and Bekum). We are at least **one** degree Celsius above preindustrial levels; we are close to what scientists have warned are “unacceptable risks” according to the World Meteorological Organization report (2019).Reducing greenhouse gas emissions,of which Co_2 emissions are a major contributor, is one way to reduce weather and climate extremes-related disasters and improve environmental quality (Shahbaz et al.2014).Energy consumption in the form of coal, oilandgas playsan important role in the process of growth and development andcannot be overemphasized as it affects every sector of the economy(Nathaniel et al. 2020).This rapid increase ine~~E~~conomic growth energy consumption andurbanization is associated with environmental degradation andhas constituted a challenge to the quality of life across the globe. The Paris Climate Agreement, different conventions on biological diversity, combating desertification, sustainable development and other global targets cannot beachieved without systematic and proper management of natural resources. The Gulf Cooperation Council (GCC) countries of UAE, Saudi Arabia, Kuwait Bahrain, Qatar and Oman are home to 19.8% of the world’s natural gas reserves. The region is rapidly expanding as the major contribution to GDP comes from fossil fuel exports, particularly oil and gas. The GCC countries enjoy a greater absolute advantage in natural gas and oil. They alsoenjoy relatively lower prices of fossil fuels due to huge government subsidies for resources. This over-dependence and excessive exploitation of natural resources cause severe threats to the environment in the region such as desertification; water crises and climate change (Qadar et al. 2022). The total Co2 emission from energy consumption for the whole Middle East region was 2117.2 million~~tonnes~~tones (BP StatisticalReview of World energy2022). Saudi Arabia has been amongst the largest contributors of carbon emissions in the whole GCC region contributing about 575.3Mt in 2021 followed by the U.A.E and Qatar. Furthermore, it appears that Oman is the highest primary energy-consuming countrywith agrowth rate

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of 4.8% from 2011-2021 followed by the Qatar and U.A.E (BPSstatisticalreport 2022). The factors that contribute to the high demand for energy in the GCC region are urbanization, population growth and rapid economic development. GCC is among the most urbanized regions in the world, changing demography and the surge of migrant workers attracted to the region by employment opportunities anddemonstrated economic success in recent decades have both contributed to these trends. The rapid increase in urban population puts huge pressure on natural resources and affects the urban ecosystem by reducing the carrying capacity (coffin, 2007). Industrial activities in urban areas attract people for better living standards this is closely linked to environmental degradation (Ali et al, 2019). The growth of urban areas increases the pressure on limited resources and is associated with a wide range of urban conditions that pose unprecedented threats to environmental, social, political and economic challenges to policymakers (Wang et al. 2020). GCCGDP per capita is currentlyamong the highest in the world. As the region's economy has grown, its population has increased significantly over the past few decades and the slit towns have developed into commercial metropolises linked to the global economy (Sharma,et al. 2021).

The associationbetween economic growth and environmental quality is explained by the environmental Kuznets curve (EKC). This curve advocates an inverted U-shaped association between economic growth and environmental degradation which, hasbeen studiedin recent decades. For example,Grossman and Kruger made the first analysis of EKC using panel data across Mexico cities and demarcated three effects i.e. level. Composition, technique effects of NAFTA on the environment. (Ppanayotou,1995),.investigated EKC in the Economic Commission of Europe (ECE) and showed transitional economies are on the left side of the inflection point of EKC, while developed economies are on the right side of the inflection point and emphasize policy structure, removal of subsidies and increased investment in education and training (Destak et al. 2018) found that Mexico,Philippines,Singapore and SouthAfricahave an inverted U-shaped EKC while China, India, South Korea,Thailand and Turkey have a U- Shaped relationship between their ecological footprint and economic growth.(Youssef, Adel et al. 2020) investigated the EKC hypothesis in 14 MENA countries and verified the bidirectional causality between C02 emissions and economic growth.(Shahbaz et.al 2013a) showed that energy consumption and economic growth lead to an increase in Co2 emissions in the Turkish economy.(Liu

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et.al 2014) revealed that the EKC hypothesis is valid in Malaysia, both in the short-run and in the long-run. The study found that FDI and trade decline the environmental quality in Malaysia. (Vohra, 2017) finds that the volatile oil prices create a huge risk to the growth stability in GCC economies.

There arehuge empiricalstudies available on EKC in which GDP, the square of GDP and other explanatory variables such aslabor, capital (Saboori et al. 2016) energy consumption (Saidi and Rehman (2020),Saqiband Hashmi(2021)FDI (Lau et al.2014, Ali,Ffakhar and Abedi 2017) trade liberalization (Ibrahim 2016, Shahbaz et al. 2012, Kahia et al.2019).Dar and Asif (2017) with the use of the ARDL framework examined the verification of EKC inIndia. The study finds the existence of long-run co-integration between financial development, energy consumption and economic growth with Co_2 emission. However, the study did not find any evidence in support of the EKC in the Indian context. Salahuddin et al.(2015) made a panel data analysis of GCC countries from 1980-2012 and showed that bidirectional causality exists between economic development and Co_2 emission while unidirectional causality exists between energy consumption and economic development.Magazzino (2016) exploresthe relationship between GDP, energy consumption and CO_2 emission in six GCC countries from 1960-2013. The study found that the 'conservation hypothesis'ishypothesis'is true for Bahrain, the feedback mechanism is true for Saudi Arabia while the neutrality hypothesis is true only for the U.A.E. Al-Mulali and Ozturk (2015) used the OLS approach to study the cause of CO_2 in MENA countries. They found thattrade openness, urbanization, and energy consumption increase co_2 emissionsin the shortrun while political instability decreases the environmental quality. Some researchers (Bello et al, 2018, Feng et al.2017, Sebri, 2016) have used ecological footprint, material footprint and carbon footprint as proxies for environmental quality. (Amri and Arouri et .al 2019) found that the service sector contribute less to CO_2 emission in MENA countries while energy consumptionand financial development have a significantly lower contribution to CO_2emissions.

The above review of the literature about the EKC hypothesis has produced mixed results. These studies differ due to different modelspecifications,periods and different proxies for economic growth and theenvironment. As a result, some studies provide support for the existenceof the EKC hypothesis, while others do not find any evidence of the EKC hypothesis for any country or region.

The authenticity behind the selection of the GCC region as a case study is that besides, being the world'smajor oil exporting region, theArab world is under ~~the~~ severe fire of carbon emissions from the large-scale consumption of fossil fuels.The GCC countries like Qatar, SaudiArabia, and UAE are among the world's major per-capita C_{O2} emitters. It is worthwhile to mention that the region has the two-thirds of the world's crude oil reserves andhas enormous potential for wind and solar energy. All countries in the region are financially sound,as the oil rents in the economy have ensured sufficient financial liquidity.

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Against this background, themain motive of the author is to analyze the Environmental Kuznets Curve hypothesis (EKC)in the case of the GCC countries. Severalstudies employed paneldata for GCC countries to investigate the EKC hypothesis (Saqib et.al 2022,Alkhar et al.2022). Thisstudy is based on annual time series data covering the timeperiod from 1995-2020 and may adopt the new pathway of Saboori et al. (2016)to analyze the validity of the EKC hypothesis in GCC countries, which compares the short-run and long-run income elasticity's. Energy consumptionand urbanization are used as control variables to reduce the omitted variable bias. These are empirically recognized asthe main sources of carbon emissions. The study used carbon dioxide (Co2) as a proxy variable for environmental degradation. Since the oil discovery in Saudi Arabia duringthe early1930's the region remains one of the world's most oil-rich areas. The activities related to oil production, extraction and exploration are responsible for greenhouse gas GHGs' emissions. Carbon- dioxide (Co2) accounts for a substantial proportion of GHGS' and is responsible for climate change.

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DATA AND RESEARCH METHODOLOGY

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Data Description

The current study investigates the association between Energy Consumption, urbanization, economic growth and CO2 emissions. The annual data from 1995-2020 is analyzed for all GCC countries namely Qatar, Kuwait, Bahrain, Saudi Arabia, UAE andOman.The annual time series data of Co2 emissions measured in metric tons is used as a proxy variable for environmental deterioration while Gross domestic product(GDP) per capita in 2015 US $ is used as a proxy foreconomic growth. The GDP per capita is measured in the international currencyUS $ which is assumed to

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mitigate to some extent the exchange rate fluctuationson the data series, Energy Consumption (EC) is taken in kg of oil equivalentper capita, the fossil fuel (oil) combustion is considered the main source of greenhouse gas emissions. Urbanization is taken as a percentage of the total population. Urbanization increases the amount of precipitation, and air pollution and affects the weather patterns of the region/country. The data source for all the variables is from World Development Indicators (WDI).

The relationship between environmental degradation and economic growth can be expressed as a quadratic form of income according to the EKC hypothesis. The general equation of EKC canbe expressed as follows

$$\boldsymbol{E} = \boldsymbol{f}(\boldsymbol{Y}, \boldsymbol{Y}^2, \boldsymbol{Z}) \qquad (1)$$

Whereas E is an environmental indicator, Y is economic growth and Z is any other independent variable thatalso affects environmental quality. The problem of co-linearityor multi-co- linearity may arise between GDPand GDP square.To overcome this problem the study first estimates the long-runassociation between economic growth indicators i.e. (GDP) and environmental indicators (Co2). In the second step, the study will proceed with the short-run model. In the next step, the coefficients of long-run and short-runGDPare compared. We can conclude that economic growth leads to less pollution if the long-run coefficient of incomeis smaller than the short-run incomecoefficient, i.e. the EKC hypothesis exists. The EKC model we estimate isspecified as follows.

$$\ln Co2 = \beta 0 + \beta 1 \ln Y_t + \beta 2 \ln EC_t + \beta 3 \ln URB_t + \varepsilon_t \qquad (2)$$

The First stepof the analysis is to reduce heteroscedasticity, forthis all the variables have beentransformed into logarithmicform. In equation (2) $\ln CO_2$ represents the natural log of carbon emissions used as the dependent variable, andLY_T is the natural log of Gross domestic product per capita in constant 2015 US \$. $InEC_t$ isthe natural log of energy consumption. In URB is the natural log of urbanization as a percentage of the population.

Estimation techniques:

The present study is executed toanalyze the EKC hypothesis by examining the long-run relationship between carbon emissions, GDP per capita, and urbanization by applying the autoregressive distributed lag (ARDL) co-integration model developed by Pesaran and Shin (2001). The ARDL framework for the equation (2) is as follows:

$$\Delta lnco_{2t} = \alpha 0 + \sum_{k=1}^{n} \alpha 1k \Delta lnCO2_{t-k} + \sum_{k=0}^{n} \alpha 2k \Delta lnY_{t-k} + \sum_{k=0}^{n} \alpha 3k \Delta lnEC_{t-k} + \sum_{k=0}^{n} \alpha 4k \Delta lnURB_{t-k} + \gamma 1 lnCO2_{t-1} + \gamma 2 lnY_{t-1} + \gamma 3 lnEC_{t-1} + \gamma 4 lnURB_{t-1} + \varepsilon_t$$

Whereas **α0 and εt** are drift component and white noise,Δ is first difference operator **α1, α2, α3 and α4** represents error correction dynamics and the terms represented with γ's indicates long-run association among variables with baseline equation(2). The first step in an Autoregressive distributed lag ARDLbounds model based on ordinary least squares (OLS) is to estimate the equation (2).The joint significance of F- Statistics of the bound is used to test the null hypothesis of no co-integration. $H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4$ against the alternative hypothesis $H_1: \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq 0$. The null hypothesis of no co-integration is rejected if the value of F- statistics turns out to be greater than the upper critical value provided by Pesaran et.al (1997). If the value of F – statistics is less than the lower critical value, then we do not reject the null hypothesis that there is no co-integration. However if the value of F- statistics is in between lower and upper critical values then the results are in-conclusive.

After long-run relationships among variables have been established, the ECM of Eq. (2) can be formulated as in the following equation.

$$\Delta lnco2_t = \alpha 0 + \sum_{k=1}^{n} \alpha 1k \Delta lnco2_{t-k} + \sum_{k=1}^{n} \alpha 2k \Delta lnY_{t-k} + \sum_{k=1}^{n} \alpha 3k \Delta lnEC_{t-k} + \sum_{k=1}^{n} \alpha 4k \Delta lnURB_{t-k} + \theta ECM_{t-1} + v_t$$

Whereas θ is the coefficient of error correction term with a one-year lag, which indicates the speed, at which the variables adjust to the long-run equilibrium.The coefficient of ECT should be negative and statistically significant, which indicates the degree of correction. The study used various diagnostic testslike, normality test, serial correlation test, cumulative sum (CUSUM)and heteroscedasticity testto check the stability ofthe model.

Toda- Yamamoto-Dolado -Lutkepohl (TYDL) Causality Approach

This study used Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) (TYDL) causality approach to determine the direction and degree of causality between selected variables. This approach become so well-known among researchers that many scholars have used this method to determine the causality between oil consumption and ecological footprint (Ssaboori et al. 2016,), and between economic growth and saving(Oladipo, 2010). This method of causality has certain advantages over other alternatives. Forinstance, it is suitable incaseseries is integrated of order zero(1(0)), (1(1)), (1(2)). This approach is applicable regardless of variables that have long-run co-integration. The TYDL method employs theModified Wald Statistic to test the significance of parameters of the VAR (k) model,where k represents the suitable lag length for the VAR model. Therefore, the estimation of VAR ($k+d_{max}$) augments the asymptotic χ2distribution of Wald statistic whereas; d_{max} in the model is the maximum order of the integration. **First step**,while estimating the long-run association among variables, it is customary to check the integration order of variables. To carry out this exercise the study used Phillips- Perron’s unit root test proposed by Phillips and Perron (1998). The significance of this test is that it can control serial correlation as it is a nonparametric test.**Second step**, the lag length of the variables in the model is selected according to the Akaike InformationCriterion (AIC).The **Third step**of the analysis is to conduct the VAR test with its new lag order of$(k+d_{max})$finally; the VAR Ganger causality test is developed by utilizing the standard Wald Test.

The following hypotheses are tested:

H_{01}: $\varphi_{12,1} = \varphi_{12,2} = \ldots\; \varphi_{12,k} = 0$,means that economic growth does not Granger cause Co_2emissions,

H_{02}: $\varphi_{21,1} = \varphi_{21,2} = \ldots\; \varphi_{21,k} = 0$, means that Co_2 emissions do not Granger cause economic growth.

H_{03}: $\varphi_{31,1} = \varphi_{31,2} = \ldots\; \varphi_{31,k} = 0$,means that energy consumption does not Granger cause $C0_2$emission

H_{04}: $\varphi_{41,1} = \varphi_{41,2} = \ldots \varphi_{41,k} = 0$, means that $C0_2$emissions does not granger cause energy consumption And so on for all other selected variables.

Table (1): Phillips- Pperrron unit root test

country	LnCO2	LnY	Ln EC	LnURB	D_{max}
Saudi Arabia	1(1)	1(1)	1(1)	1(0)	1(1)
UAE	1(1)	1(1)	1(1)	1(1)	1(1)
KUWAIT	1(1)	1(1)	1(1)	1(0)	1(1)
QATAR	1(1)	1(1)	1(1)	1(0)	1(1)
BEHRAIN	1(1)	1(1)	1(1)	1(1)	1(1)
OMAN	1(1)	1(1)	1(1)	1(1)	1(1)

Note: the optimal lag length is selected automatically by bandwidth using the Newly- West method

Empirical results and discussions:

The estimation of the ARDL approach of co-integrationis used toestimate the long-run association between relevant variables. The co-integration is verified by the joint significance of using F-statistics. It is important to apply different lag-ordersof the variables in Eq. (2) in order to find an appropriate lag length. The optimum lag length is selected relying on minimizing the Akaike Information Criterion (AIC) to ensure that assumptions ofclassical regression are not violated.

Table 2: Results of the ARDL model

	F test	ECM	
country	**F statistics**	**coefficient**	**T statistics**
Saudi Arabia	7.71	-0.238	-7.25*
UAE	8.92	-0.768	-7.250*
Kuwait	3.19	-0.567	-4.417*
Qatar	18.17	-0.619	10.59*
Bahrain	7.18	-0.782	-6.851*
Oman	27.72	-0.788	-16.65*

Note : the signs * , represents the level of significance at 1% and 5% and the critical values are obtained from Saboori et .al(2016),critical values for the bound test case III: unrestricted, intercept, no trend**

In the initial stage of our analysis, the F-test was conducted at optimum lags. The results of the co-integration between variables are shown in Table (2). It showsthat the F-Statistic is greater than the upper critical value in all GCC countries i.e.Saudi Arabia, United Arab Emeritus, Qatar, ~~Kuwait,Bahrain~~Kuwait, Bahrain andOman. Following the studies of Saboori et.al (2014) K~~k~~reamers, Ericson,andDaloda(1992) the Error correcting term (ECT $_{-1}$) is estimated to determine the co-integration. These studies showed that a negative and significant coefficient of Error correction term (ECT$_{-1}$) determinesthe adjustmentof concerned variables towards long-run equilibrium. The results of the ARDL bound test showed that the F-statistic is greater than the upper critical bound in all countries and hence, the co-integration is supported, the coefficients of theerror-correcting term are also negative and significant in all countries as shown in the table (2), therefore the long-run relationship between concerned variables is supported. To check the goodness of fit of the model the stability and diagnostic test were also conducted. The diagnostic testsinclude serial correlation tests by Lagrange multiplier(LM) and Durbin-Watson statistics and regressionequation specification error test (RESET) proposed by Ramsey (1969) estimating the square of fitness values. To check the normality of the model Jacque- Berra test based on skewness and kurtosis of residuals isused. The ARCH test was conducted to check the heteroscedasticity of the model that is based on the regression of the square Residuals on square fitted. The CUSUM test and CUSUM square test are used to check the short-run and long-run structural breaks and stability of the model.

The results of the diagnostic test are reported in Table (3). The study accepted the null hypothesis of no heteroskedasticityand no serialityin all selected countries, as there is no serial correlation in all the model residuals and the model has no ARCH effect. The graphical representation of the CUSUM test showed that the parameters are stable, as the plots of the CUSUM test lie between the critical bounds at a five percent level of significance. The coefficients in Eq. (2) are estimated to determine the long- run association among variables. Similarly, to get short-run estimated results the coefficient of variables of Eq. (3) is estimated.To test the applicability of EKC hypothesis in the selected countries the long-run and short-run coefficients of LnGDP are compared. The long-run and short-run elasticity of income along with long run elasticity of energy consumption and urbanization are reported in Table (4). After comparing the short-run and long-run elasticity of income, it is visible that short-run income elasticity in United Arab emeritus, Saudi Arabia~~andQatar~~and Qatar are greater and significant at 10% level of significance than long- run elasticity, whereas, the long- run impact of income on co2 emission is negative and insignificant. This proves the existence of the EKC hypothesis in these countries. This inverted U-shaped curve reveals that at higher levels of income environmental quality improves in these three countries. The applicability of the EKC hypothesis in these countries may be the outcome of various efforts and initiatives like **Saudi Arabia's Vision 2030. UAE'sVision 2031and Qatar's Vision 2030**. The main motive of these initiatives is toa achieve green economy and reduce overreliance on hydrocarbons. The estimated results of Table (4) showed that short-run income elasticity in Oman, Bahrain, and Kuwait are smaller than long-run elasticity and statistically significant at 5% and 10% levels of significance respectively. This indicates that there is no applicability of EKC in these countries. Looking at the impact of other variables on Co_2 emission the results showed that energy consumption has a positive impact on environmental degradation in Saudi Arabia, UAE, Qatar and Kuwait in the end. The results showed that energy consumption further degrades the environmental quality in these four GCC countries.

Table 3: Results of diagnostic test

country	Serial correlation {P.Value}	Functional form {P.value}	Normality test {P.value}	D.Wstatistics	Heteroscedasticity {p.value}	CUSUM TEST	CUSUM SQ
Saudi Arabia	5.256{0.072}	3.28{0.193}	0.084{0.958}	2.36	1.557{0.45}	S	S
UAE	3.424{0.180}	0.477{0.703	0.1711{0.917}	2.312	6.144{0.10}	S	S
Kuwait	1.6227(0.65}	1.9304{0.0}	0.2108{0.8999}	2.066	2.9100{0.40}	S	S
Qatar	4.254{0.119}	7.408{0.024	0.4089{0.8159}	1.959	1.3357{0.51}	S	S
Bahrain	1.297{0.522}	0.080{0.77}	0.7031{0.7035}	1.888	1.087{0.58}	S	S
Oman	1.5027{0.47}	0.347{0.79	0.248{0.8830}	1.944	1.893{0.59}	S	S

Note: DW stands for Durbin Watson test; S signifies stability of the model.
Authors own calculation

These results are consistent with the findings of Arouri et. al (2012) and Osman et al. (2016) while in Oman and Bahrain, energyconsumption has a negative impact on CO_2 emissions. The coefficient of energy consumption in UAE is 0.747 and is significant at a 10% level of significance. This large coefficient of energy consumption is evidence that with economic Development demand for energy hasbeen growing at a rapid rate overthe past few years therefore the results support the findings of (Alshami et al. 2019). UAE approximately 30% of the country's total energy is used in the desalination of seawater due to the scarcity of freshwater resources

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The impact of urbanizationin the long- run onCO_2 emission is negative in UAE, Qatar, and Bahrain whereas, in SaudiArabia, Kuwait and Oman urbanization has a positive and insignificant impact on CO_2 emission.For Kuwait,the share of the urban population remained at 100%(World Bank 2021), this imbalance in urban populationhas caused serious and complicated health and environmental issues, especially in coastalareas where oil refineries, water desalination stations, and power plants are located (Alshali and Alharbi, 2022). The growth an urban population inthe U.A.E,Oman, Qatar and Bahrain is negative and significant; thecoefficient ranges from -12.99 in Qatar to -0.326 in theU.A.E,which confirmthat the government of the concerned countriesis taking positive steps to sustain the environment along with proper and planned urban development. For example, the "Estidama"framework 2008 by the Abu DhabiUrban Planning Counciland other initiatives like green building regulations,and the Pearl RatingSystem (PRS) all aimed to create a smart and sustainable city. The Initiative by the transport authority is to replace or modify old vehicles to use low sulfur-diesel to cutcarbon emissions. The present study supports and is consistent with the work done by (Majumdar et.al 2022)that showed urban population positively impacts the UAE environmental quality due to steps taken by the UAE government towards urbandevelopment. For the proper implementation of the TYDL model, the determination of maximum order of the integration of variables is needed. Forthis Phillips Peron (PP) unit root test was employed. The optimum lag length was selected based on theAIC criterion. The VAR model was conducted in the levels of the data for each country with the lag length (k + d_{max}).

Causality results

Finally, the study proceeds with anon-granger causality test based on the Standard Wald test. The results of the TYDL causality test are shown in table (5). The existence of unidirectional Causality was found betweenenergy consumption and economic growth in theUnitedArab Emirates, Bahrainand Oman, which supports the "Growth hypothesis" which implies that energy consumption (fossil fuels) is the maindeterminant of economic growth of these economies.Only bidirectional causality is found in the U.A.E between these two variables.Whereas in most of the GCC Countries (three out of sixcountries) urbanization granger causes energy consumption. The high level of urbanization in these countries is mainly due to their economicallysustainable infrastructure.In the case of Qatar and UAE, emissions appear to mainly cause urbanizationimplicitly and high growth of carbon emissions may thwart urbanization activities. The results indicate that in two out of six GCC countries (Qatar andKuwait) there is a unidirectional causal relationship between Co2Emission to energy consumption. Lastly, we analyze the relationship between economic growth and energy

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consumption, the results showed that it is economic growth that causes energy consumption in the case of UAE, Kuwait and Qatar. While unidirectional causal relationship moving from CO2 emissions to economic growth in Kuwait implies that high, CO2 emissions cause ahigh growth trajectory in Kuwait. It is apparent from the results that energy consumption helps to create an inverted an U-Shaped EKC curve because it is the main source of government revenue, export earnings and an important determinant of economic growth in GCC Countries. With higher purchasing power, the demand for green technologies and a pollution-free environment increases.

Conclusion aAnd Policy Implications

Thepresent study reexaminedthe hypothesis of the Environmental Kuznets curve (EKC) inthe Gulf Corporation Council (GCC) from the period 1995- 2020.The study utilized Co2 emissions as an indicator of environmental degradation and GDP growth, energy consumption, and urbanization asexplanatory variables. The Auto-regressive-distributed- lag (ARDL) model is applied to study the co-integration among variables. The Toda- Yamamoto-Dolado- Lutkepohl (TYDL) model is applied for Granger causality analysis among variables. For testing EKC hypothesis the study, compare short-run and long-run income elasticities. According to (table 4) Saudi Arabia, UAE and Qatar have inverted U-shaped curves. For these countries, economic growth helps in the adoption of modern and environmentally friendly technologies to bring down the emission levels. Moreover, economic growth represents the major source of environmental damage in Kuwait, Oman and Bahrain,as it has asignificant impact on CO2 emission. The current trend of growing Co2 emissions and consequent climate issues needed substantial economic and energy policy reforms to sustain economic growth while protecting theenvironment. Accordingly, the establishment of a higher energy committee is required to increase cooperation among ministers, and regulatory agencies, for theproper implementation of energy conservation policies and codes. To mitigate Extreme weather conditions Saudi Arabia and UAE are leading in the energy transition towards renewable sources in the GCC region. The Saudi Arabia Vision 2030 and Al-Dafra plant in UAE is expected to be the world's largest single-site solar power plant and Green Saudi initiative (GSI). In this regard still more emphasis on sustainable energy consumption is required to tackle climate change.

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Likewise the policy implications and recommendations.

Table 4: Short run and long run coefficients

SHORT RUN			LONG RUN	
Country	**dlnY**	**lnY**	**lnEC**	**lnURB**
Saudi Arabia	0.214(0.015) ***	0.212(0.79)	0.332(0.64)	1.8224(0.896)
UAE	0.2638(0.006) **	0.115(0.420)	0.747(0.009**	-0.326(0.462)
Kuwait	0.328(0.0197) ***	0.579(0.0001) *	0.084(0.081)	0.484(0.915)
Qatar	0.479(0.0004) *	0.204(0.184)	0.549(0.002)*	-12.990(0.000)*
Bahrain	0.667(0.021) ***	1.271(0.016) ***	-0.531(0.236)	-12.852(0.043) **
Oman	-0.7745(0.005) *	7.001(0.0003) *	-1.485(0.009) **	5.605(0.002)*

Note: the numbers in the parentheses are P values.*, **, * represents the level of significance at 1%,5% and 10% respectively.**

The present research revisited the EKC hypothesis in the GCC region by unfolding the nexus between Co2 emissions, economic growth, energy consumption, and urbanizationusing a reliable econometric approach. Thus, for further research on this question, the researcher can consider a new set of variables (renewable energy consumption, international trade, human capital formation, social indicators, and geographical factors ~~etc~~etc.~~,~~)for the EKC hypothesis analysis. Energyconsumption (fossil fuels) also declines the environmental quality and therefore, countries need to diversify their income sources and shift their energy resources by investing in renewable energy

The impact of urbanization has also found to degrade the environmental qualityin Saudi Arabia, Kuwait and Oman.Therefore, the policy implication is that the local government has a proactive role informulating a holistic approach towards urban development. These countries should impose a carbon tax on energy-intensive urban activities to discourage pollutionemissions. Furthermore, to ensure a sustainable future, it is recommended that decision-makers in GCC nations regulate urban patterns in such a manner that is proportional to their existing consequences.

Table 5: TYDL granger causality test results

Saudi Arabia	**LnCO2**	**lnY**	**lnEC**	**lnURB**
lnCO2	-	4.579(0.101)	0.767(0.6813)	0.061(0.969)
lnY	5.6211(0.06)	-	1.721(0.4229)	0.818(0.664)
lnEC	22.168(0.00)*	2.7355(0.254)	-	1.716(0.423)
lnURB	10.272(0.005)**	1.729(0.421)	10.66(0.004)**	-
UAE				
lnCO2	-	3.2812(0.193)	1.349(0.509)	14.96(0.0006)**
lnY	3.372(0.185)	-	7.100(0.028)	2.702(0.258)
lnEC	1.9704(0.373)	9.007(0.011)***	-	11.199(0.003)
lnURB	0.414(0.812)	11.606(0.003)***	0.311(0.855)	-
Kuwait				
LnCO2	-	7.686(0.021)**	30.91(0.000)*	0.5587(0.756)
lnY	0.109(0.946)	-	12.013(0.002)	0.933(0.627)
lnEC	0.034(0.982)	5.603(0.060)	-	14.058(0.0009)**
lnURB	0.337(0.844)	3.659(0.145)	4.595(0.1005)	-
Qatar				
LnCO2	-	0.943(0.624)	6.970(0.030)***	15.266(0.005)*
lnY	4.248(0.119)	-	16.756(0.0002)**	2.635(0.267)
lnEC	0.075(0.963)	1.800(0.406)	-	5.053(0.070)
lnURB	3.031(0.219)	2.055(0.357)	11.65(0.002)**	-
Bahrain				
Lnco2	-	4.943(0.624)	1.000(0.606)	1.379(0.501)
lnY	5.540(0.062)	-	1.3997(0.496)	0.652(0.721)
lnEC	4.47(0.106)	21.544(0.000)	-	1.783(0.410)
lnURB	10.11(0.006)*	29.70(0.000)	10.76(0.004)	-
Oman				
Lnco2	-	5.565(0.061)	5.286(0.071)	4.110(0.128)
lnY	4.825(0.089)	-	4.214(0.121)	4.704(0.095)
lnEC	2.379(0.304)	14.18(0.008)	-	4.271(0.118)
lnURB	4.096(0.129)	1.425(0.490)	3.141(0.207)	-

The numbers in brackets~~barketts~~ indicated p. values and signs *, **, * shows the level of significance at 1%, 5% and 10 % respectively**.

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