Khan, Uzma; Khan, Aarif Mohammad

Article

The impact of energy consumption and economic growth on the Saudi Arabia's carbon emissions

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(1), 329-335.

The Impact of Energy Consumption and Economic Growth on the Saudi Arabia's Carbon Emissions

Uzma Khan*, Aarif Mohammad Khan

College of Business Administration Female Section, Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia.
*Email: u.khan@psau.edu.sa

Received: 10 October 2023 **Accepted:** 20 December 2023 **DOI:** https://doi.org/10.32479/ijeep.15285

ABSTRACT

This study is an initial attempt to examine the correlation between energy consumption and economic growth in Saudi Arabia's carbon emissions from 1985 to 2021. Notably, despite the prominence of low-carbon economic growth in the Paris Agreement and the Sustainable Development Goals, this specific link has yet to be previously investigated. The study used an autoregressive distributed lag approach to analyse the relationship between carbon emissions from energy consumption and economic development in Saudi Arabia. The bound test shows that the relationship has been going on for a long time, and the error correction equation shows that the endogenous and exogenous variables are negatively related by 0.58. This indicates that the system adjusts its previous period's imbalance by 58% within a single period. The Granger causality test reveals a one-way causal relationship between energy use and carbon dioxide emissions, economic growth, and oil consumption. Additionally, the generation of energy through oil-based power plants is known to result in the release of carbon emissions, although in a unidirectional manner. It is necessary to prioritize exploring alternate methods for power generation, particularly those that rely on non-conventional or renewable energy sources.

Keywords: Carbon Emissions, Energy Consumption, Economic Growth, Saudi Arabia
JEL Classifications: O13, O44, O53

1. INTRODUCTION

Degradation of the environment, emissions of greenhouse gases (GHG), and changes in the climate have all emerged as some of the most urgent challenges in recent years. Emissions of carbon dioxide and other GHG continue to grow, which poses a significant risk to the world's natural environment. As a direct consequence, the world's economies have ratified the Paris Agreement (often referred to as COP21) and made a pact to slow the increase in greenhouse gas emissions. This is done to cooperatively bring the rise in world temperature in this century down to <2°C over the level it was at before industrialization. The increased production of GHG poses a substantial risk to the health of the environment on a worldwide scale. Consumption of fossil fuels like coal, oil, and gas, which are responsible for the majority of the world's carbon emissions and have received much attention as the primary driver of the greenhouse effect, is causing an increase in the number of residues and wastes that are being released into the atmosphere as a result of the rapid expansion of industry and the rising energy demand. These two factors have led to the rapid growth of the industry. Unfortunately, Saudi Arabia's economy heavily relies on several commodities that need to replenish themselves.

Carbon dioxide was the primary contributor to greenhouse gas emissions in 2018, making up over three-quarters of the total GHG emissions (World Bank, 2021). As a result, it is frequently asserted that such a high level of carbon dioxide emissions is a significant contributor to global warming. As a result, reducing carbon dioxide emissions is generally considered the most significant obstacle facing economies worldwide in terms of achieving compliance with the Paris Accord. In addition, since adopting the Paris Agreement, global carbon emission levels have grown, contrary to the goals of the COP21 conference. According to the projections by National Oceanic Atmospheric Administration, if adequate actions are not taken to stop the development of carbon dioxide emissions, it will increase the earth's temperature by 3–4°C above the pre-industrial level. This would result from a lack of action to stop the growth in carbon dioxide emission levels. Consequently, several nations, including Saudi Arabia, have formulated strategies to achieve carbon neutrality soon.

The Saudi Arabian economy primarily depends on oil revenues and includes energy-intensive manufacturing, construction, and transportation industries. In addition, in 2016, it contributed 517,079,407 tons' worth of carbon emissions, which put it in 11th place globally in terms of its share of carbon emissions, which equated to a 1.45% share of global emissions. In light of this, the country's overall energy consumption is rapidly expanding despite the controls and laws put in place. Saudi Arabia's government has made many significant and positive strides in preserving the country's natural resources.

Developed and underdeveloped economies worldwide are more concerned about achieving environmental sustainability than ever (Khan et al., 2022). To add to the conversation, Murshed et al. (2022) said that using more productive energy could balance the destructive effects of economic inclusion on the environment. An increase in studies on the linkages between environmental contaminants and economic activity in developed and developing nations can be attributed to rising concerns about climate change and carbon dioxide emissions. Numerous variables, such as patterns of energy production and consumption, the intensity of energy use, the cost of energy, and the availability of energy, all impact the progression of carbon emissions. Since energy is the driving force behind industrialization and economic progress, high energy consumption levels are often connected with high living standards. However, high energy use leads to significant carbon emissions, which harm the natural environment. These emissions contribute to global warming. As a direct consequence of this, academics and industry experts have invested a significant amount of time and effort into comprehending the implications that global warming and climate change would have on the economy of the whole world. The environmental Kuznet curve (EKC) theory seeks to study the link between economic expansion, energy consumption, and pollution levels in the surrounding environment. Much research has been conducted on these topics, yet the empirical literature has not agreed on a single answer. Therefore, it is prudent to investigate the linkages between energy use, the release of carbon emissions, and the economy's growth.

2. LITERATURE REVIEW

In recent years, there has been a significant amount of scholarly focus on the correlation between environmental degradation, energy use, and economic development. The EKC hypothesis posits that a positive relationship exists between greenhouse gas emissions and economic production until a certain threshold is reached, beyond which emissions begin to decline. The investigation of carbon emissions is primarily motivated by their prominent role in issues of environmental preservation and promoting sustainable development. A positive correlation exists between energy consumption and economic expansion since the former catalyses the latter. However, achieving a higher economic growth rate is imperative to optimise the utilisation of energy resources.

The existing body of work about the interplay between economic growth, energy consumption, and environmental pollution may be categorized into three main strands, as identified by Zhang and Cheng (2009). The first scholarly work centres on the relationship between environmental contamination and economic growth. This particular body of work examines the existence of an EKC. It posits that during the initial phases of economic development, there is a negative relationship between per capita income and environmental quality. Nevertheless, beyond a certain threshold, a noticeable resurgence in quality coincides with a rise in per capita income. This association suggests that the ecological impact indicator exhibits an inverted U-shaped pattern concerning per capita income. The EKC hypothesis posits that a quadratic equation represents the logarithm of the indicator variable in terms of the logarithm of income. Grossman and Krueger (1991) introduced and empirically examined the EKC hypothesis. Following this, Stern (2004) and Dinda (2004), along with other scholars, have conducted comprehensive literature reviews on the empirical research examining the relationship between economic growth and environmental pollution. The second aspect of the scholarly literature pertains to the interconnection between energy consumption and economic development. This body of research posits a strong correlation between economic growth and energy consumption, asserting that increased economic development levels necessitate more significant energy consumption. Numerous scholarly investigations have examined the empirical data using the Granger causality test and the co-integration model. The third strand of academic literature involves an integrated approach that challenges the validity of both nexuses within a unified framework. This section provides a concise overview of prior research about the relationships among carbon dioxide (CO_2) emissions, energy consumption, and economic development. Specifically, Table 1 presents a summary of the methodologies, approaches employed, and key conclusions from past studies. This study examines the interplay between economic development, environmental pollution, and energy use.

3. METHODOLOGY

This study investigates the influence of carbon dioxide emissions on economic growth, namely the gross domestic product (GDP), in Saudi Arabia. It also examines the significance of oil and energy consumption, particularly electricity generated from oil and gas sources, within the abovementioned context. The research utilizes data from 1985 to 2021, extracted from BP statistics and World Bank data, as delineated in Table 2 for each variable source and the units. The present study was designed to investigate the interrelationships among carbon emissions, economic growth, and energy consumption in the context of Saudi Arabia. The empirical modelling employed in this study is grounded in the autoregressive distributed lag (ARDL) approach (Gangopadhyay et al., 2023; Pachiyappan et al., 2022; Khan et al., 2022).

Descriptive statistics are studied, followed by correlation, to examine the relationship between two sets of time series data. The concept of correlation can be defined as follows:

Table 1: Delineated the comprehensive overview of the extant empirical literature pertaining to the interrelationships among carbon dioxide (CO_2) emissions, energy consumption, and economic development

Study	Countries	Periods	Methodologies	Causality relationship
Carbon dioxide emissions and Economic growth nexus				
Holtz-Eakin and Selden (1995)	130 countries	1951–1986	EKC hypothesis	Monotonic rising curve
Stern (2004)			EKC hypothesis	There is little evidence for a common inverted U-shaped pathway that countries follow as their income rises
Dinda (2004)			EKC hypothesis	Inverted-U shape curve
Richmond and Kaufmann (2006)	36 nations	1973–1997		No relationship
Saboori et al. (2012)	Malaysia	1980–2009	EKC hypothesis	C→G (in the long-run) Inverted-U shape curve (in the long and short-run)
Energy consumption and Economic growth nexu				
Stern (1993)	United States	1947–1990	Multivariate VAR model	E→G
Yuan et al. (2007)	China	1963–2005	Johansen–Juselius, VECM	E→G; G→E
Belloumi (2009)	Tunisia	1971–2004	Johansen–Juselius, VECM	E↔G (in the long-run); E→G (in the short-run)
Ghosh (2010)	India	1971–2006	ARDL bounds test, Johansen–Juselius, VECM	Miscellaneous
Carbon dioxide emissions, Energy consumption and Economic growth nexus				
Ang (2007)	France	1960–2000	EKC hypothesis, Johansen Juselius, VECM, ARDL bounds test.	E→G
Soytas et al. (2007)	United States	1960–2004	EKC hypothesis, Granger causality test	E→G
Apergis and Payne (2009)	6 central American countries	1971–2004	EKC hypothesis, panel VECM	C↔G; E→C; G→C Inverted U-shaped curve
Halicioglu (2009)	Turkey	1960–2005	ARDL bounds test, Johansen–Juselius, VECM	C↔income; C→E C↔square of income
Soytas and Sari (2009)	Turkey	1960–2000	Granger causality test	C↔E (in the long-run)
Zhang and Cheng (2009)	China	1960–2007	Toda–Yamamoto procedure	G→E; E→C
Chang (2010)	China	1981–2006	Johansen cointegration VECM	Miscellaneous
Lean and Smyth (2010)	5 Asean countries	1980–2006	Panel cointegration EKC hypothesis, panel VECM	C→E Inverted U-shaped curve
Lotfalipour et al. (2010)	Iran	1967–2007	Toda-Yamamoto method	G→C (in the long-run)
Ozturk and Acaravci (2010)	Turkey	1968–2005	ARDL bounds test, VECM	C→G (in the long-run)
Shahbaz et al. (2012)	Pakistan	1971–2009	ARDL bounds test, Granger Causality	G→C; E→C
Arouri et al. (2012)	12 MENA countries	1981–2005	Panel unit root tests and co-integration	E↔C (in the long-run)
Shahbaz and Lean (2012)	Pakistan	1972–2009	Granger causality test	E→G
Omri (2013)	14 MENA countries	1990–2011	Cobb-Douglas production function	E→C; G↔C
Shahbaz et al. (2013)	Indonesia	1975Q1–2011Q4	ARDL Bound test, VECM Granger causality	E→C; G↔C (both in long &short run)
Yang and Zhao (2014)	India	1970–2008	Granger causality test	E→C; E→G; C↔G
Mirza and Kanwal (2017)	Pakistan	1971–2009	ARDL, VECM Causality	E↔C; G↔C
Stamatiou and Dritsakis (2017)	Italy	1960–2011	VECM	G→C; G→E; E↔C
Adebayo et al. (2021)	South Korea	1965–2019	ARDL, Gradual Shift Causality	E→G; C→G; G→U
Jahanger et al. (2022)	MINT countries	1990–2018	CS-ARDL	G→C; FDI→C; R→C
Khan (2023)	Bahrain	1995–2020	Granger	C→T
Khan et al. (2023)	Kuwait	1995–2020	VECM, Granger causality	C→T; E→T; G→T
Khan (2023)	India		Quantile Regression, Granger causality	C→G; C→U; O→C; O→U; G→U

→ and↔indicate unidirectional causality and bidirectional causality, respectively. G, C, E, U, T, R, O indicate economic growth, carbon dioxide emissions, energy consumption, urbanization, tourism, renewable energy consumption and oil consumption, VAR represents vector auto regressive model, VECM refers to the vector error correct model, ARDL denotes the auto regressive distributed lag procedure and EKC refers to the environmental Kuznets curve

Table 2: Unit and genesis of specified variables

Variable	Description	Source	Units
LNC	Carbon dioxide emissions from energy	BP (2022)	Millions Tonnes of CO_2
LNO	Oil Consumption	BP (2022)	Million Tonnes
LNG	Economic growth	WDI (2023)	Constant US\$2015
LNEC	Primary Energy Consumption	BP (2022)	Exajoules
LNELG	Electricity generated by Gas	BP (2022)	Terawatt-Hours
LNELO	Electricity generated by Oil	BP (2022)	Terawatt-Hours

$$Corr\left(X,Y\right)=\frac{Cov\ (X,Y)}{\sqrt{Var\left(x\right)Var(Y)}}$$

The covariance between two-time series, X and Y, is represented as Cov (X, Y), whereby Var (X) and Var (Y) represent the respective values of the time series X and Y.

The ARDL strategy was utilised in this investigation due to its ability to handle restricted observations. The model is appropriate for a model that incorporates various delays and a combination of multiple orders of integration. This approach offers benefits due to its ability to concurrently show coefficients in both the short and long term while also addressing the issue of autocorrelation. The effectiveness of the proposed policy in this study enhances its legitimacy. The equation below presents the definition of ARDL modelling.

$$\begin{aligned}\Delta LNC_t &= \sigma_0+\sum_{i=1}^{t}\sigma_1\Delta LNC_{t-1}+\sum_{i=1}^{t}\sigma_2\Delta LNEC_{t-1}\\ &+\sum_{i=1}^{t}\sigma_3\Delta LNELG_{t-1}+\sum_{i=1}^{t}\sigma_4\Delta LNELO_{t-1}\\ &+\sum_{i=1}^{t}\sigma_5\Delta LNG_{t-1}+\sum_{i=1}^{t}\sigma_6\Delta LNO_{t-1}+\beta_1 LNC_{t-1}\\ &+\beta_2 LNEC_{t-1}+\beta_3 LNELG_{t-1}+\beta_4 LNELO_{t-1}\\ &+\beta_5 LNG_{t-1}+\beta_6 LNO_{t-1}+\rho ECT_{t-1}+\varepsilon_t\end{aligned}$$

Where alpha and beta are the long-run and short-run parameters represent the error correction term, ECT, which is the adjusted speed to long-run balance from short-run shock. The ARDL hypotheses are written below.

$$H_0:\sigma_1=\sigma_2=\sigma_3=\sigma_4=\sigma_5=\sigma_6$$

$$H_A:\sigma_1\neq\sigma_2\neq\sigma_3\neq\sigma_4\neq\sigma_5\neq\sigma_6$$

The null hypothesis (H_0) reiterates that there is no cointegration presence in the model, while the alternate hypothesis (H_A) affirms a contradictory view: the presence of cointegration. The testing technique in the ARDL model involves comparing the generated F or T statistics with the critical bounds, which consist of both lower and upper bounds. The diagnostic methods employed to assess the Best Linear Unbiased Estimators include the normality test, heteroscedasticity test, Ramsey RESET test, and serial correlation test. The assessment of model stability was conducted using two techniques: The cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUM of squares). Additionally, the long-term coefficient of the ARDL model was examined by using the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) tests.

4. RESULTS AND DISCUSSION

The elementary summary statistical characteristics that report the central tendencies outlined in Table 3 show that economic growth reveals the highest average, followed by carbon dioxide emissions, oil consumption, electricity produced by gas and oil, and, at the end, energy consumption. Likewise, it is seen that economic growth has the most pronounced range of both upper and lower limits, with carbon dioxide emissions, power generation from gas and oil, and energy consumption following suit. Electricity generated from gas exhibits the most significant standard deviation, while economic growth demonstrates the lowest standard deviation.

Table 4 presents the correlation coefficient matrix indicating the strong and positive correlations observed among the variables under examination. The primary factor exhibiting the most robust correlation with carbon dioxide emissions is energy consumption, with oil consumption following closely. Additionally, there exists a notable association with economic growth and the generation of electricity from gas and oil. Conversely, economic growth has the weakest connection with carbon dioxide emissions.

Table 3: Descriptive Statistics

Variables	LNC	LNEC	LNELG	LNELO	LNG	LNO
Mean	5.795	1.765	4.386	4.372	26.798	4.475
Median	5.751	1.731	4.515	4.32	26.77	4.418
Maximum	6.427	2.412	5.375	5.213	27.366	5.142
Minimum	5.068	0.966	3.393	3.087	26.113	3.828
SD	0.45	0.45	0.61	0.57	0.36	0.46

SD: Standard deviation

Table 4: Correlation coefficient matrix

Variables	LNC	LNEC	LNELG	LNELO	LNG	LNO
LNC	1					
LNEC	0.998	1				
LNELG	0.973	0.976	1			
LNELO	0.972	0.969	0.925	1		
LNG	0.987	0.984	0.972	0.962	1	
LNO	0.994	0.996	0.964	0.957	0.974	1

Table 5: Unit root stationarity test

Variables	Augmented Dickey-Fuller				Phillips-Perron				Decision
	I (0)		I (1)		I (0)		I (1)		
		P		P		P		P	
LNC	−1.098	0.71	−6.265	0.00	−1.15	0.685	−6.274	0.00	I (1)
LNEC	−1.54	0.5	−3.155	0.03	−1.464	0.54	−5.812	0.00	I (1)
LNELG	−0.605	0.857	−3.511	0.01	−0.341	0.91	−3.501	0.014	I (1)
LNELO	−3.195	0.03	−3.848	0.006	−3.195	0.03	−3.802	0.007	I (0), I (1)
LNG	−0.694	0.84	−6.022	0.00	−0.692	0.84	−6.0097	0.00	I (1)
LNO	−0.67	0.84	−5.587	0.00	−0.671	0.84	−5.62	0.00	I (1)

In addition, the study employed the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) techniques to assess the stationarity properties of the data. The results indicate that the parameters are integrated in a combination of mixed orders, namely I(1) and I(0), as seen in Table 5. After confirming that the series is stationary with a lag value of one, we estimate the ARDL framework, which can be seen in Table 6.

The F-value that was determined is 17,702, which is greater than the upper and lower limits tests combined. At a significance level of 1%, the upper bound critical value is calculated to be 4.68. In addition, the t-statistic value is -6.739, which is more than the lower limits and the upper bounds. The null hypothesis of no cointegration connection can be thrown out. Carbon dioxide emissions are linked to energy use, oil and gas-based electricity generation, economic growth, and oil consumption. Therefore, a connection exists between the variables over the long term, which is delineated in the Table 7.

Table 6: Autoregressive distributed lag bound test at (1,1,1,0,0)

Test	Value	Significance	I (0)	I (1)	Decision
F-statistics	17.702	10%	2.26	3.35	*F*-statistics
		5%	2.62	3.79	is greater
		2.50%	2.96	4.18	than I (1)
		1%	3.41	4.68	
t-statistics	-6.739	10%	−2.57	−3.86	*t*-statistics
		5%	2.86	−4.19	is greater
		2.50%	3.13	−4.46	than I (1)
		1%	−3.43	−4.79	

Table 7: Error correction model regression

Variable	Coefficient	SE	*t*-statistics	P
C	−5.22	0.46	−11.256	0.00
D (LNEC)	0.62	0.07	8.63	0.00
D (LNELG)	−0.1	0.04	−2.48	0.02
D (LNELO)	−0.58	0.05	−11.25	0.00
Coint Eq(-1)	−0.58	0.05	−11.25	0.00
Adjusted *R*-square			0.94	
Durbin-Watson Stat			2.5	
F-statistics			134.32	0.00

The coefficient of the Coint Equation (-1) is −0.58, making it a negative equation. This suggests that the adjustment rate towards a long-run equilibrium is 58% or that the system corrects its prior period disequilibrium at a speed of 58% during a single period. The t-statistics come out to −11.25, and the coefficient reaches a significance level of 1%. Consumption of energy has a positive coefficient of 0.62, which is likewise significant; in contrast, the electricity generated from oil and gas has negative coefficients of 0.58 and 0.1, respectively; both are significant. The long-run regression is also stable and significant, as evidenced by the significance of its F-statistics and Durbin-Watson.

The Cointegration regression test by FMOLS, dynamic least squares (DOLS) and canonical cointegration regression (CCR) was also estimated. The result presented in Table 8 below shows that economic growth significantly impacts carbon emission in the long run in all three methods mentioned above. Besides the economic growth, the electricity produced by oil significantly impacts carbon emissions in the long run by the FMOLS and CCR. In comparison, oil consumption positively impacted carbon emissions by the DOLS.

Table 9 delineates the pairwise Granger causality outcomes at one lag, where energy consumption has a unidirectional causality with carbon dioxide emissions, economic growth, and oil consumption. The other variables do not demonstrate any causal relationship among the variables, even though oil-based electricity also has a one-way causality with carbon dioxide emissions. Figure 1

Table 8: Co-integration regression

Variables	FMOLS		DOLS		CCR	
	Coefficient	P	Coefficient	P	Coefficient	P
LNEC	0.496	0.038	0.054	0.81	0.338	0.19
LNELG	0.016	0.72	0.063	0.155	0.038	0.44
LNELO	0.095	0.011	0.098	0.03	0.098	0.03
LNG	0.249	0.0001	0.385	0.00	0.26	0.0002
LNO	0.135	0.4	0.41	0.008	0.252	0.114
C	−2.833	0.081	−7.17	0.0006	−3.597	0.047

CCR: Canonical cointegration regression

Figure 1: CUSUM and CUSUM square stability test

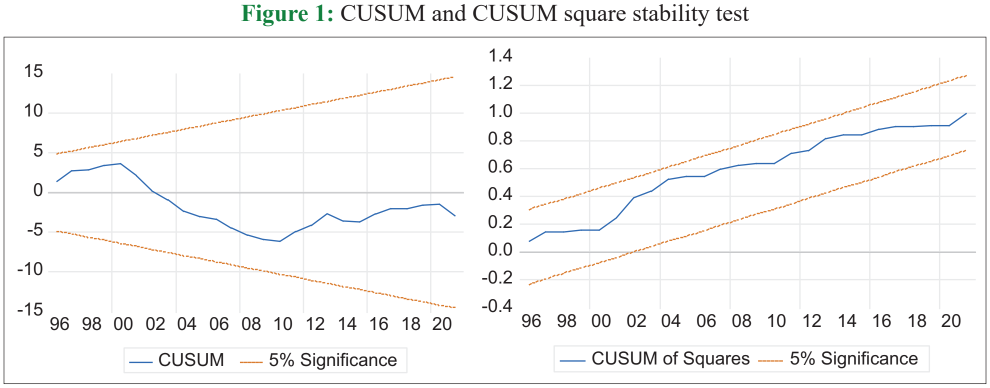

Table 9: Granger causality

Observation	X	Y	*F*-Statistics	P	Inference
36	LNEC	LNC	6.78	0.014	LNEC→LNC
36	LNELO	LNC	8.17	0.007	LNELO→LNC
36	LNEC	LNG	7.19	0.01	LNEC→LNG
36	LNEC	LNO	4.133	0.05	LNEC→LNO

demonstrates the stability of the model, as seen by the blue line falling inside the boundaries defined by the two red lines of the CUSUM and CUSUM squares. This observation suggests that the CUSUM and CUSUM squares possess statistical significance.

5. CONCLUSION

This paper contributes to the extant body of literature by examining the relationship between carbon dioxide emissions, energy consumption, gas and oil-generated power, economic growth, and oil consumption in Saudi Arabia. The analysis utilizes annual data spanning the period from 1985 to 2021. The aims are achieved by utilizing the ARDL limits and Granger causality tests. The results indicate a combination of statistically significant and non-significant relationships between carbon emissions and the independent variables. The results of the limits test indicate that there exists a long-term relationship among all the indicators.

The cointegration equation also shows a negative sign coefficient, meaning the adjustment rate is 58% towards the long-term equilibrium. The regression analysis of the error correction model reveals a positive relationship between energy consumption and carbon dioxide emissions, indicating that an increase in energy consumption leads to higher levels of carbon dioxide emissions. Additionally, the analysis suggests that producing electricity from gas and oil sources harms Saudi Arabia's carbon dioxide emissions. Therefore, Saudi Arabia must consider alternate strategies for power generation, such as embracing renewable energy sources or fulfilling its electrical demands through other means. The Granger causality analysis reveals a significant presence of causation throughout the series as a whole.

Nevertheless, there needs to be more empirical evidence supporting bidirectional causal relationships among the variables under consideration. However, it is worth mentioning that a unidirectional causality has been observed between energy consumption and carbon dioxide emissions, economic growth, and oil consumption. Specifically, energy consumption has significantly impacted carbon dioxide emissions, economic growth, and oil consumption. Additionally, it has been observed that producing electricity using oil also contributes to carbon dioxide emissions. According to Murshed et al. (2022), implementing measures to increase the utilization of renewable energy sources and generate renewable power is a viable strategy for mitigating the environmental impact. Thus, policymakers can also think about this.

6. ACKNOWLEDGEMENT

The authors extend their appreciation to Prince Sattam bin Abdulaziz University for funding this research work through the project number (PSAU/2023/02/25858).

REFERENCES

Adebayo, T.S., Awosusi, A.A., Kirikkaleli, D., Akinsola, G.D., Mwamba, M.N. (2021), Can CO_2 emissions and energy consumption determine the economic performance of South Korea? A time series analysis. Environmental Science and Pollution Research, 28(29), 38969-38984.

Ang, J.B. (2007), CO_2 emissions, energy consumption, and output in France. Energy Policy, 35, 4772-4778.

Apergis, N., Payne, J.E. (2009), CO_2 emissions, energy usage, and output in central America. Energy Policy, 37(8), 3282-3286.

Arouri, M.H., Ben Youssef, A., M'henni, H., Rault, C. (2012), Energy consumption, economic growth and CO_2 emissions in Middle East and North African countries. Energy Policy, 45, 342-349.

Belloumi, M. (2009), Energy consumption and GDP in Tunisia: Cointegration and causality analysis. Energy Policy, 37, 2745-2753.

Chang, C.C. (2010), A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. Applied Energy, 87, 3533-3537.

Dinda, S. (2004), Environmental Kuznets curve hypothesis: A survey. Ecological Economics, 49, 431-455.

Gangopadhyay, P., Das, N., Alam, G.M.M., Khan, U., Haseeb, M., Hossain, M.E. (2023), Revisiting the carbon pollution-inhibiting policies in the USA using the quantile ARDL methodology: What roles can clean energy and globalization play? Renewable Energy, 204, 710-721.

Ghosh, S. (2010), Examining carbon emissions-economic growth nexus for India: A multi-variate cointegration approach. Energy Policy, 38, 2613-3130.

Halicioglu, F. (2009), An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37, 1156-1164.

Holtz-Eakin, D., Selden, T.M. (1995), Stoking the fires? CO_2 emissions and economic growth. Journal of Public Economics, 57, 85-101.

Jahanger, A., Yu, Y., Hossain, M.R., Murshed, M., Balsalobre-Lorente, D., Khan, U. (2022), Going away or going green in NAFTA nations? Linking natural resources, energy utilization, and environmental sustainability through the lens of the EKC hypothesis. Resources Policy, 79, 103091.

Khan, A.M., Basit, A., Khan, U., Khan, M.K. (2022), The progressive correlation between carbon emission, economic growth, energy use, and oil consumption by the most prominent contributors to travel and tourism GDPs. Frontiers in Environmental Science, 10, 945648.

Khan, A.M., Khan, U., Naseem, S., Faisal, S. (2023), Role of energy consumption, tourism and economic growth in carbon emission: Evidence from Kuwait. Cogent Economics and Finance, 11, 2218680.

Khan, U. (2023), Effects of oil consumption, urbanization, economic growth on greenhouse gas emissions: India via quantile approach. International Journal of Energy Economics and Policy, 13(3), 171-176.

Khan, U. (2023), The impact of tourism growth, urbanization and economic growth on greenhouse gas emissions of Bahrain. International Journal of Sustainable Development and Planning, 18(6), 1761-1767.

Khan, U., Khan, A.M., Khan, M.S., Ahmed, P., Haque, A., Parvin, R.A. (2023), Are the impacts of renewable energy use on load capacity factors homogeneous for developed and developing nations? Evidence from the G7 and E7 nations. Environmental Science and Pollution Research, 30(9), 24629-24640.

Lean, H.H., Smyth, R. (2010), CO_2 emissions, electricity consumption and output in ASEAN. Applied Energy, 87, 1858-1864.

Lotfalipour, M.R., Falahi, M.A., Ashena, M. (2010), Economic growth, CO_2 emissions, and fossil fuels consumption in Iran. Energy, 35, 5115-5120.

Mirza, F.M., Kanwal, A. (2017), Energy consumption, carbon emissions and economic growth in Pakistan: Dynamic causality analysis. Renewable and Sustainable Energy Reviews, 72, 1233-1240.

Murshed, M., Khan, A.M., Khan, U., Khan, M.S., Parvin, R.A. (2022), Can utilising renewable and nuclear energy harness the environmental sustainability agenda of the G7 countries? The importance of undergoing clean energy transition. International Journal of Ambient Energy, 44, 958-972.

Murshed, M., Khan, U., Khan, A.M., Ozturk, I. (2022), Can Energy Productivity Gains Harness the Carbon Dioxide-Inhibiting Agenda of the Next 11 Countries? Implications for Achieving Sustainable Development. Sustainable Development. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/sd.2393

Omri, A. (2013), CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy Economics, 40, 657-664.

Ozturk, I., Acaravci, A. (2010), CO_2 emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14, 3220-3225.

Pachiyappan, D., Alam, M.S., Khan, U., Khan, A.M., Mohammed, S., Alagirisamy, K., Manigandan, P. (2022), Environmental sustainability with the role of green innovation and economic growth in India with bootstrap ARDL approach. Frontiers in Environmental Science, 10, 975177.

Richmond, A.K., Kaufmann, R.K. (2006), Is there a turning point in the relationship between income and energy use and/or carbon emissions? Ecological Economics, 56, 176-189.

Saboori, B., Sulaiman, J., Mohd, S. (2012), Economic growth and CO_2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve. Energy Policy, 51, 184-191.

Shahbaz, M., Hye, Q.M.A., Tiwari, A.K., Leitao, N.C. (2013c), Economic growth, energy consumption, financial development, international trade and CO_2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25, 109-121.

Shahbaz, M., Lean, H.H. (2012), The dynamics of electricity consumption and economic growth: A revisit study of their causality in Pakistan. Energy, 36, 146-153.

Shahbaz, M., Lean, H.H., Shabbir, M.S. (2012), Environmental Kuznets curve hypothesis in Pakistan: Cointegration and Granger causality. Renewable and Sustainable Energy Reviews, 16(5), 2947-2953.

Soytas, U., Sari, R. (2009), Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecological Economics, 68, 2706-2712.

Soytas, U., Sari, R., Ewing, B.T. (2007), Energy consumption, income, and carbon emissions in the United States. Ecological Economics, 62, 482-489.

Stamatiou, P., Dritsakis, N. (2017), Dynamic modeling of causal relationship between energy consumption, CO_2 emissions, and economic growth in Italy. In: Advances in Applied Economic Research. Springer, Proceedings in Business and Economics. Ch. 8. Cham: Springer.

Stern, D.I. (1993), Energy growth in the USA: A multivariate approach. Energy Economics, 15, 137-150.

Stern, D.I. (2004), The rise and fall of the environmental Kuznets curve. World Development, 32, 1419-1439.

World Bank. (2021), World Bank. World Development Indicators. Available from: http://databank.worldbank.org/data/reports

Yang, Z., Zhao, Y. (2014), Energy consumption, carbon emissions, and economic growth in India: Evidence from directed acyclic graphs. Economic Modelling, 38, 533-540.

Yuan, J., Zhao, C., Yu, S., Hu, Z. (2007), Electricity consumption and economic growth in China: Cointegration and co-feature analysis. Energy Economics, 29, 1179-1191.

Zhang, X.P., Cheng, X.M. (2009), Energy consumption, carbon emissions, and economic growth in China. Ecological Economics, 68, 2706-2712.