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Toward Sustainability: Understanding the Impact of Economic Growth, Urbanization, Energy Use, and Resource Management on Carbon Emissions

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ABSTRACT

This research explores the interconnectedness of sustainability and the effects of economic growth, urbanization, energy use, and resource management on carbon emissions. Despite its importance, there has been limited investigation into this nexus, particularly leveraging advanced statistical methods. We employed several econometric methodologies, including Granger's causality test, to assess the direction of causation. The ARDL bounds test reveals a significant long-term relationship, with an adjustment speed towards equilibrium of 37 percent. Analysis indicates that a 1% increase in energy consumption is associated with a 0.98% rise in carbon emissions. The findings imply that carbon emissions play a role in economic growth, highlighting a relationship between Kuwait's energy consumption and tourism. Moreover, urbanization is linked to increased energy consumption, carbon emissions, and economic development. The growth of the economy and rising energy use may indirectly foster tourism. Kuwait can navigate a more sustainable and resilient future amidst global climate challenges by understanding and addressing the complex challenges of tourism, energy consumption, urbanization, and economic growth. This study aims to assist policymakers and researchers in developing more effective environmental and energy policies to reduce carbon dioxide emissions in particular and neighbouring countries.

Keywords: Sustainability, Sustainable Development Goals, Carbon Emissions, Energy Consumption, Urbanization, Economic Growth
JEL Classifications: L83; Q32; Q51; Q56; Q58; R59

1. INTRODUCTION

Because carbon emissions from many human activities keep upsetting the balance of the environment, the world's leaders are emphasizing promoting economic well-being and building low-carbon infrastructure. Therefore, it is crucial to decarbonize the global economy by implementing ecologically friendly measures that promote a shift towards low-carbon production and consumption practices. Promoting environmentally sustainable economic growth has become a global priority due to the recognition that carbon-intensive economic development is a significant driver of many natural disasters. As a result, economies worldwide have been encouraged to devise strategies for fostering environmentally friendly economic growth (Siddik et al., 2023). The substantial rise in energy consumption from non-renewable sources has the potential to expedite the processes of global warming and climate change, both of which are widely recognized as significant challenges confronting our planet. In line with this, the Paris Agreement, which was made under the United Nations Framework Convention on Climate Change (UNFCCC) framework, stresses the need to reduce greenhouse gas emissions, with the primary goal of keeping global warming below 2°C above pre-industrial levels (Murshed et al., 2022). Therefore, effective control and reduction of carbon emissions have become priorities for countries worldwide. Reducing carbon emissions and the harm they cause is a primary goal of many national, regional, and international environmental accords and agreements. For instance, Kuwait is one of the 195 nations that vowed to implement policies and programs to limit the global average temperature increase to below 2°C as part of the 2015 Paris Climate Agreement (COP21). Businesses must improve environmental practices because they must do so under these accords and pacts. Since then, other international treaties have brought light to this pressing environmental issue and pushed the world's economies to take action against climate change by, among other things, cutting back on their carbon dioxide emissions (Wang et al., 2021).

In the heart of the Arabian Peninsula, Kuwait emerges as a dynamic emblem of growth, where economic prosperity, urban development, and tourism have convergent narratives intertwined with abundant energy resources. This small yet resilient nation, perched on the Persian Gulf, has vaulted into the 21st century with a clear vision of becoming a vibrant economic and cultural hub. The avenues of this development are broad and promising, with urbanization, economic growth, and tourism drawing vivid aspirations for advancement. However, an intricate challenge lies beneath this mirage of progress—escalating carbon emissions. Kuwait is snowballing, and this has considerable effects on the environment. Its carbon footprint is growing because it uses more energy, more people are moving into cities, and its tourism industry is doing very well. This introduction starts our journey through the complicated landscape where urbanization, energy use, tourism, and economic growth come together. We will look at the critical point where Kuwait's development meets the need to protect the environment and figure out how to balance progress and sustainability.

The continuous expansion of the economy, the development of tourism, and the increasing urbanization need further measures to achieve both energy security and environmental sustainability. As worries about the environmental effects of urbanization, tourism, economic growth, and rising energy costs grow, many academics have looked into how urbanization, tourism, economic growth, energy use, and carbon dioxide emissions are all linked from different points of view. It is hard to understand the complicated connections between urbanization, tourism, economic growth, energy use, and carbon emissions because there is so much scholarly literature.

This study utilized an integrative framework to examine the complex interaction between Kuwait's economic progress, energy usage, tourism, and carbon emissions. The growing alarm over climate change has become a crucial and urgent environmental problem in modern society, attracting significant attention from international organizations, governments, and academics. The Kaya identity suggests that the combined effects of population expansion, energy consumption, and carbon emissions are responsible for the overall carbon emissions linked to climate change (Kaya and Yokoburi, 1997). In contrast, experts and decision-makers attribute the increase in carbon emissions to the rise in energy consumption associated with rapid economic expansion and a greater reliance on fossil fuels (Ahmad et al., 2017; Andreoni and Galmarini, 2016; Sohag et al., 2015). The significant influence of energy consumption on the region's tourism expansion is remarkable, as it requires the development of more energy infrastructure to handle an increasing influx of international tourists. As a result, this occurrence leads to a significant decrease in the income gained by tourism, negatively impacting total economic growth.

Kuwait, a nation marked by rapid economic expansion and urbanization, has a severe environmental problem as it grapples with the delicate interplay of tourism, energy consumption, urbanization, and economic growth. This analysis dissects the interplay between these variables and their combined effect on Kuwait's carbon footprint. Concerns have been raised concerning the long-term viability of Kuwait's economic growth and the environmental effects of the country's increased energy consumption due to its reliance on oil and gas resources, making it a significant player in the global energy market. This study provides insight into Kuwait's carbon dilemma by highlighting the interconnected nature of tourism, energy use, city expansion, and economic development. The research's overarching goal is to help policymakers, urban planners, and stakeholders in Kuwait strike a better balance between economic growth and environmental stewardship in the face of climate change by highlighting potential synergies and conflicts.

It is crucial to examine the significance of this trend, notwithstanding the optimistic and substantial rise reported in Kuwait's emissions. This study aims to investigate Kuwait's carbon emissions performance in terms of energy consumption, economic growth, and urbanization. This present study differentiates itself from previous research endeavours by incorporating supplementary variables that contribute to generating carbon emissions, notably the influence of tourism. A lot of different types of econometric methods are used in the study. These include fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), Canonical Cointegration Regression (CCR), and Granger causality tests.

2. LITERATURE REVIEW

The dynamic nexus of tourism, energy consumption, urbanization, and economic growth in Kuwait has, in recent years, painted a dual canvas of promise and peril. As a nation rich in cultural heritage, abundant oil reserves, and ambitions for economic prosperity, Kuwait finds itself at a crossroads where the pursuit of growth intertwines closely with the escalating challenge of elevated carbon emissions. This literature review embarks on a journey through the vast body of research that explores the intricate connections between these four facets of development, delving deep into the labyrinth of Kuwait's unique socioeconomic landscape. Tourism, energy use, urbanization, and economic growth happen simultaneously in Kuwait. This makes the rise in carbon emissions a stark reality that needs to be carefully looked at and dealt with. This review guides understanding the nuanced relationship between these factors, unveiling their combined effects on Kuwait's carbon emissions and proposing pathways towards sustainability and a greener future.

It is essential to devise and execute plans to reduce carbon emissions to tackle the complex global climate change issues effectively. According to Shahbaz et al. (2016), around 50% of the global population currently lives in cities, and the United Nations predicts that by 2050, 64% of people in developing nations will be living in urban areas. Intensifying attempts to reduce energy usage may lead to higher carbon emissions when considering energy obtained from non-renewable sources. This study comprehensively analyses the scholarly literature, carefully investigating the connections between the dependent variable (carbon dioxide emissions) and related independent factors such as economic growth, urbanization, energy usage, and tourism. The analysis highlights the urgent requirement for a more substantial agreement within the academic discussion concerning the complex relationship between carbon emissions and the factors being examined. The presence of inconclusive findings in prior research has generated increased curiosity in this field of investigation.

Li et al. (2015) performed a series of studies in China, employing the input-output technique, which revealed a positive correlation between urbanization and household CO_2 emissions. Their findings indicated that for each 1% rise in urbanization, there was a corresponding 2.9% increase in household CO_2 emissions. This observed tendency persisted consistently from 1996 to 2012. Zi et al. (2016) found a strong link between people moving to cities and carbon dioxide (CO_2) emissions. Seasonal and regional patterns impact the urbanization process and can either speed up or slow it down. Using the Toda and Yamamoto techniques, Jafari et al. (2015) analyzed the Granger causality links among GDP growth, energy consumption, and emissions in Bahrain between 1980 and 2007. They took into account variables like financial resources and urbanization rates. Urbanization, GDP growth, capital investment, and energy usage were all found to have a substantial relationship with environmental deterioration.

In their study, Bhattacharya et al. (2020) analyzed economic data from 70 nations and observed a positive correlation between industrialization and carbon intensity. Nevertheless, the impact can be mitigated through the promotion of total factor productivity, the utilization of renewable energy sources, and the facilitation of urban expansion Bakhsh et al. (2024). Reducing carbon dioxide emissions can be achieved through multiple approaches, including improvements in resource efficiency, the shift towards clean energy sources, and the promotion of sustainable communities in urban areas. Drawing insights from a dataset spanning 33 developing countries from 1996 to 2014, Nguyen et al. (2020) employed the panel-corrected standard error estimator to gauge the amount of CO_2 generated by total energy consumption. Their analysis revealed a correlation between heightened energy demand and increased total carbon emissions.

Murshed et al. (2022) posit that an increase in carbon productivity is anticipated due to various factors, including enhancements in energy efficiency, the utilization of renewable energy sources, the promotion of financial inclusion, economic growth, the process of globalization, and the phenomenon of urbanization. The research was conducted in seven developing nations from 2007 to 2018. Conducting research is of utmost importance as it enables the assessment of the enduring effects of improving energy efficiency on carbon emissions. The completion of this assignment remains outstanding and signifies a deficiency in the existing body of academic literature. The study's results prove that a slight increase of 1% in energy efficiency is associated with a subsequent increase of 0.3% in carbon emissions. Additionally, the anticipated net outcomes indicate that enhancing energy efficiency mitigates the substantial adverse consequences on carbon productivity, financial inclusion, global commerce, and urbanization.

The study by Khan et al. (2022) utilized data spanning from 1997 to 2018 to examine the environmental consequences associated with the increased utilization of renewable energy sources within the G7 and E7 nations. The researchers' analysis incorporated indicators of economic growth and population size. The decrease in load capacity factor levels shows the detrimental effects of economic expansion and population growth on environmental quality. Additionally, the researchers discovered evidence of a unidirectional relationship between economic growth, population size, and load capacity factor levels in the G7 and E7 nations.

Murshed et al. (2023) examined the potential impact of enhancing energy efficiency on the carbon dioxide emission reduction targets of the Next 11 countries. The scholars conducted a comprehensive examination of the principles of financial inclusion, the utilization of renewable energy, the advancement of economic growth, the dynamics of international commerce, and the urbanization process. These nations' adoption of renewable energy sources led to a decrease in their carbon dioxide emissions. Nevertheless, the acceleration of economic growth, the expansion of international commerce, and the ongoing urbanization process have led to a notable increase in carbon dioxide emissions.

The study conducted by Dogan and Turkekul (2016) examined the interconnections among several sectors of the United States economy. The variables encompassed in this study encompassed carbon dioxide (CO_2) emissions, energy consumption, real gross domestic product (GDP), the square of real GDP, trade openness, urbanization, and financial development. The research encompassed the period from 1960 to 2010. The utilization of limits testing provides empirical support for the significant relationship between the variables under investigation in real-world contexts. Both the utilization of energy and the urbanisation process contribute to the exacerbation of long-term environmental damage. The Granger causality test demonstrates a reciprocal relationship between carbon dioxide (CO_2) and gross domestic product (GDP), CO_2 and energy consumption, CO_2 and urbanization, and GDP and urbanization.

This study, conducted by Khan (2023), delves into the intricate relationship among oil consumption, urbanization, economic growth, and greenhouse gas (GHG) emissions in India from 1965 to 2021. The findings from the quantile regression analysis revealed a positive correlation, indicating that a 1% increase in greenhouse gas emissions is associated with a 0.34% increase in economic growth. Moreover, a 0.599% increase in oil consumption and a 0.28% decrease in urbanization were observed, with the same 1% rise in greenhouse gas emissions.

The impact of energy use on the local tourism industry is substantial, as a deficient energy infrastructure dissuades foreign visitors. As Ozturk (2016) points out, this causes a noticeable decline in tourism profits. In a parallel investigation by Khan (2023), the focus shifted to understanding how changes in tourism, urbanization, and the economy influenced greenhouse gas emissions in Bahrain from 1995 to 2020. The author concludes that reducing carbon emissions can attract a plethora of tourists, fostering subsequent economic prosperity that, in turn, catalyzes unidirectional urban expansion. The interplay between urbanization and tourism in this context is bidirectional in causation.

Numerous researchers have undertaken investigations in which they have studied carbon emissions as the dependent variable while considering other factors as independent. This study aims to analyze previous research by comprehensively including several independent factors. According to studies by Khan (2023), Dong et al. (2018), Shahbaz et al. (2016), Shahbaz et al. (2015), Shahbaz et al. (2014), Kasman and Duman (2015), and Wang et al. (2016), there is a unidirectional relationship between urbanization and carbon dioxide emissions. Scholars like Nguyen and Nguyen (2018), Ali et al. (2020a), Adebayo (2021), Yang et al. (2017), and Zheng and Walsh (2019) have thoroughly examined the phenomenon of urbanization as a catalyst for economic growth. Several academic studies, including those by Teng et al. (2020), Rjoub et al. (2021), Wasti and Zaidi (2020), Jafari et al. (2015), and Ali et al. (2020b), have shown that the link between carbon dioxide emissions and economic growth is one-way. The scholarly investigations carried out by Suresh et al. (2017), Tang and Ozturk (2017), and Sherafatian-Jahromi et al. (2016) explore the correlation between tourism and economic expansion. Therefore, our research differentiates itself from other studies in selecting independent variables.

3. DATA AND METHODOLOGY

The current study employs annual data about carbon emissions (C), energy consumption (E), tourism (R), urbanization (U), and economic development (G). The required variables were obtained from the World Development Indicators (WDI) online database and the BP statistics covering 1995-2020. The study has utilized the Eviews 12 software program to analyze empirical findings. The log forms of both the dependent and independent variables are used. Logarithmic transformation is often used in models to get accurate and desired results (Shahbaz et al., 2014), lessen the effect of variable dimensions (Wang et al., 2016b; Khan, 2020), improve stationarity (Lau et al., 2014), and lower autocorrelation and heteroscedasticity (Bekhet and Al-Smadi, 2015). The current research examines the interconnectedness of Kuwait's carbon emissions, economic growth, urbanization, tourism, and energy consumption as presented in Figure 1. The present study utilizes the autoregressive distributed lag (ARDL) technique for empirical modelling, drawing upon the work of Khan et al. (2023).

In order to investigate the relationship between two sets of time series data, an analysis of descriptive statistics and correlation is conducted. The concept of correlation can be defined as the statistical measure that quantifies the relationship between two or more variables:

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

The covariance between 2-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 methodology was employed in this study owing to its capacity to accommodate a few observations. The proposed approach is suitable for including diverse time delays and a combination of different levels of integration. This methodology provides advantages by effectively displaying coefficients in immediate and extended periods while also tackling the concern of autocorrelation. The efficacy of the suggested policy in this study bolsters its validity. The equation below offers the formal representation of the Autoregressive Distributed Lag (ARDL) modelling framework.

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

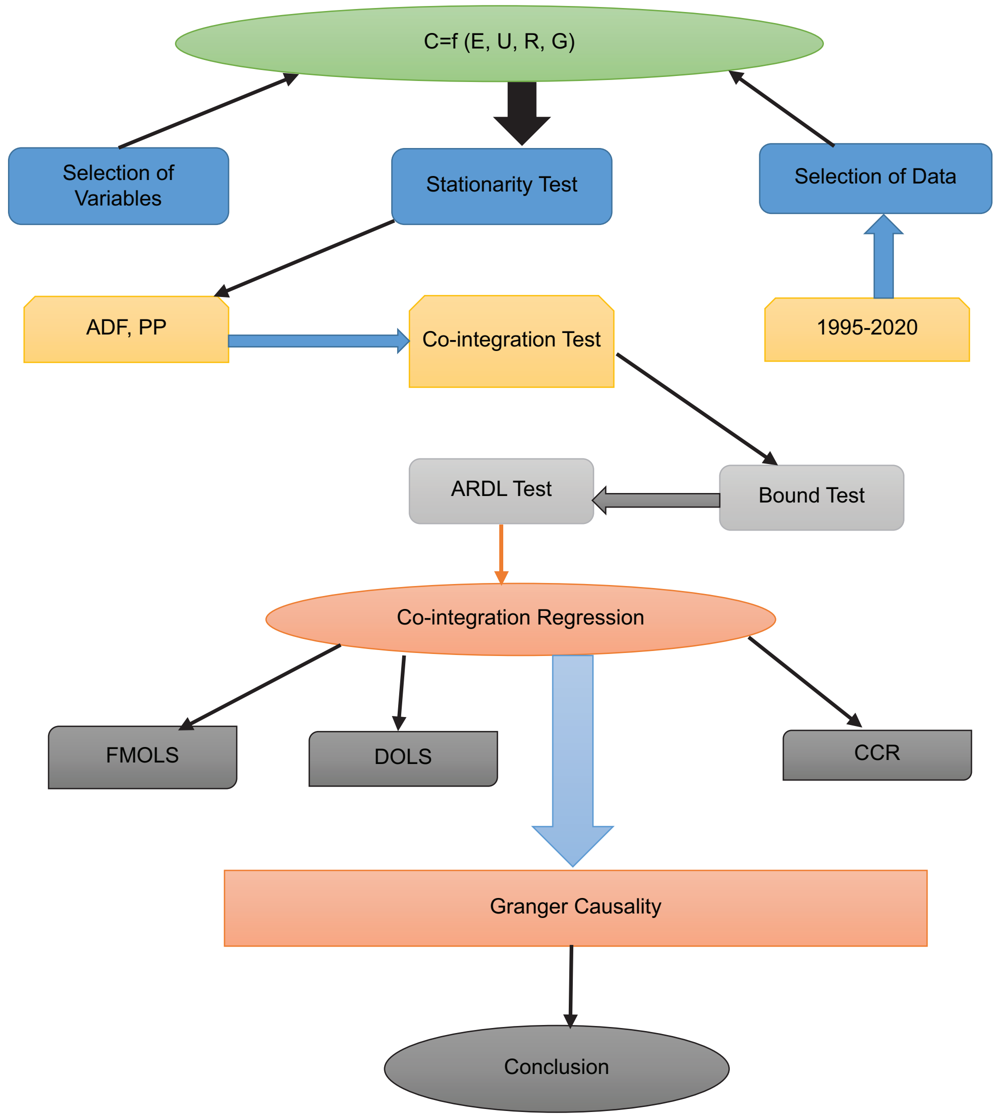
The parameters alpha and beta in this context denote the long-run and short-run components. These parameters indicate the error correction term (ECT), which characterizes the rate at which the system adjusts from a short-run shock to achieve long-run equilibrium. The hypotheses of the autoregressive distributed lag (ARDL) model are shown below.

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

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

The null hypothesis (H_0) posits the absence of co-integration in the model, whereas the alternative hypothesis (H_A) asserts the presence of co-integration. In the autoregressive distributed lag (ARDL) model, the testing procedure involves comparing the F or T statistics obtained with the critical bounds, consisting of lower and upper limits. The diagnostic techniques utilized for evaluating the Best Linear Unbiased Estimators (BLUE) encompass the examination of normality, heteroscedasticity, Ramsey RESET, and serial correlation. Two methodologies, namely the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUM of squares), were employed to evaluate the stability of the model. The researchers also employed the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) tests to examine the long-term coefficient of the autoregressive distributed lag (ARDL) model.

Figure 1: Flow chart of the study



4. FINDINGS AND DISCUSSION

This study investigates the relationship between tourism, energy consumption, urbanization, and economic growth, contributing to the increase in carbon dioxide emissions in Kuwait from 1995 to 2020. The summary statistics presented in Table 1 provide an overview of the central trends and dispersion measures for selected variables. These statistics show that economic growth, tourism, urbanization, and energy consumption have the highest mean values. Furthermore, it is seen that both the maximum value and the standard deviation exhibit a similar trend. All series have a negative skewness, except the tourist series, which displays a positive skewness. Table 2 presents the correlation results, indicating that all variables exhibit a significant link except for urbanization, which weakly correlates with tourism.

Furthermore, the research utilized the Phillips-Perron unit root stationarity methodology to analyze the stationarity properties of the data. The data shown in Table 3 support the findings that the parameters exhibit integration at the first difference. Furthermore, apart from the initial disparity, the series incorporates a lag value of one order.

Table 1: Descriptive statistics

Parameters	LNC	LNE	LNG	LNR	LNU
Mean	4.23	0.1	25.07	20.08	4.6
Median	4.34	0.19	25.39	20.08	4.61
Max.	4.64	0.55	25.88	20.9	4.61
Min.	3.508	−0.62	23.98	19.47	4.59
Standard Deviation	0.38	0.39	0.67	0.38	0.006
Skewness	−0.69	−0.61	−0.43	0.27	−1.49
Kurtosis	2.05	2.02	1.57	2.27	3.52
Jarque-Bera	3.02	2.66	3.02	0.89	9.87
Probability	0.22	0.26	0.22	0.63	0.007

Table 2: Correlation matrix

Parameter	LNC	LNE	LNG	LNR	LNU
LNC	1				
LNE	0.99	1			
LNG	0.94	0.93	1		
LNR	0.8	0.81	0.81	1	
LNU	0.86	0.84	0.77	0.49	1

We first looked at how stationary the series is and then estimated the autoregressive distributed lag (ARDL) framework. The results are shown in Table 4. The results show that the F-test's estimated value is more statistically significant than the lower and upper bounds. This will help establish a long-term relationship between the parameters. In the present case, the null hypothesis of no co-integration is rejected. However, the F-statistic falls below the crucial threshold at the lower bound. In this scenario, the alternative hypothesis about co-integration is rejected. Nevertheless, the outcome could be more conclusive if the F-statistics become indeterminate between the two crucial values.

The long-term and short-term relationships between the variables of interest were estimated, and the results are presented in Table 5. Selecting an appropriate lag is crucial when employing the autoregressive distributed lag (ARDL) model. Therefore, we used the Akaika (1987) suggested AIC criterion. The Akaike Information Criterion (AIC) is thought to be the best method for lag selection because it has better features, according to Udemba et al. (2021) and Zhang et al. (2021). The measure of how well the model fits the data is represented by the R^2 (0.99) and adjusted R^2 (0.99), respectively. The R^2 and adjusted R^2 results demonstrate that economic growth, urbanization, tourism, and energy consumption collectively account for 99% of the variance in carbon dioxide emissions. The remaining percentage may be attributed to residual errors. When there is a significant negative coefficient in the error correction model (ECM), the speed of adjustment helps the parameters get closer over time. The ECT result indicates a value of −0.37, suggesting the presence of co-integration among the parameters. This means that the model could see a 37% rate of adjustment in order to confirm long-term alignment with equilibrium in terms of carbon dioxide emissions, which is affected by the regressors. The autoregressive distributed lag (ARDL) analysis results demonstrate the connections between carbon dioxide emissions and the independent variables. Empirical evidence supports a positive correlation between carbon dioxide emissions and energy consumption in the short and long term. This infers that a 1% rise in energy consumption will lead to a 0.98% increase in carbon emissions in both the long and short run. Furthermore, a negative relationship with tourism indicates that a 1 percent increase in tourism will reduce 0.09% of carbon dioxide emissions in the long run.

This study used different models to get better long-term estimates for the Autoregressive Distributed Lag (ARDL). These models are Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Co-integrating Regression (CCR). Table 6 delineates results and suggests a clear correlation between the sustained rise in carbon dioxide emissions, the expansion of energy usage, and urban development. Nevertheless, the evidence does not strongly support a significant connection between economic growth, tourism, and carbon dioxide emissions.

Different models were used in this study to get better long-term estimates for the autoregressive distributed lag (ARDL). These models are fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), and canonical co-integrating regression (CCR). The results suggest a clear correlation between the sustained rise in carbon dioxide emissions, the expansion of energy usage, and urban development. Nevertheless, the evidence does not strongly support a significant connection between economic growth, tourism, and carbon dioxide emissions.

If two or more variables are co-integrated, you must consider whether their relationships are one-way, two-way, or neutral. According to the Granger causality test findings, Figure 2 demonstrates that the relationships between the variables are one-way. Several scholars have extensively studied and supported the relationship between carbon emissions and economic growth. Tang et al. (2020), Rjoub et al. (2021), Wasti and Zaidi (2020), Jafari et al. (2015), Ali et al.

Table 3: Phillips-Perron stationarity test

Variable	At level (I (0))		At first difference (I (1))		Inference
	Adj. t-stats	Prob.	Adj. t-stats	Prob.	
LNC	−2.232	0.2007	−3.37	0.0224	I (1)
LNG	−1.515	0.5096	−3.453	0.019	I (1)
LNE	−2.507	0.126	−3.77	0.009	I (1)
LNR	−2.05	0.26	−7.49	0.000	I (1)
LNU	−3.36	0.02	−3.69	0.011	

Authors computation

Table 4: ARDL bound test at (1,1,0,1,1)

Test	Value	Significance (%)	I (0)	I (1)	Decision
F-statistics	6.79	10	2.45	3.52	F-statistics
		5	2.86	4.01	is >I (1)
		2.50	3.25	4.49	
		1	3.74	5.06	
t-statistics	−6.52	10	−2.57	−3.86	t-statistics
		5	−2.86	−3.99	is >I (1)
		2.50	−3.13	−4.26	
		1	−3.43	−4.6	

Table 5: ARDL Long-run and Short-run results

Variable	Long-run		Short-run	
	Coefficient	Prob.	Coefficient	Prob
LNE	0.98	0.00	0.98	0.00
LNG	0.01	0.56	0.004	0.59
LNR	−0.09	0.03	−0.012	0.14
LNU	3.16	0.12	−0.51	0.6
ECT (−1)			−0.37	0.00
R-Square			0.99	
Adjusted R			0.99	
Durbin-Watson Stats.			2.21	
F-Statistics			793.57	0.00

Figure 2: Depicts the results of granger causality and its movement

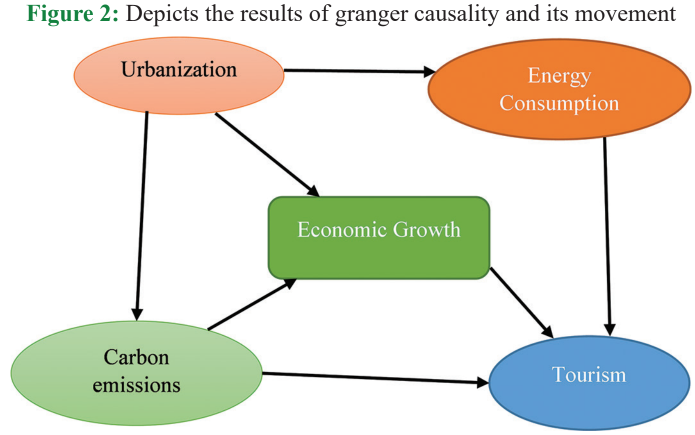


Figure 3: (a and b) represents the CUSUM test and CUSUM square

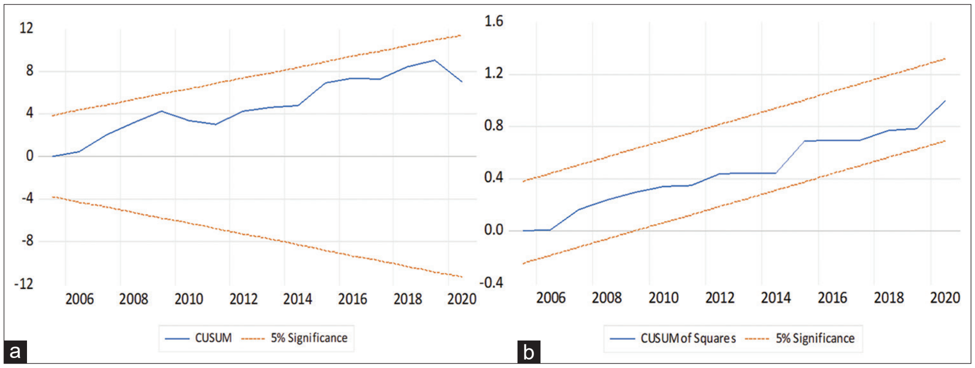


Table 6: FMOLS, DOLS and CCR results

Variable	FMOLS		DOLS		CCR	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
LNE	0.91	0.00	0.88	0.00	0.91	0.00
LNG	0.01	0.05	0.0004	0.96	0.02	0.07
LNR	−0.02	0.33	0.007	0.83	−0.02	0.49
LNU	3.46	0.01	6.2	0.01	3.34	0.02
C	−12.02	0.04	−24.55	0.02	−11.47	0.09

Table 7: Diagnostic tests

Variable	Tests			Inference
Breusch-godfrey serial correlation LM test				
LNC	F-stats	0.697	0.42	The Null hypothesis of no serial Correlation could not be rejected
	Obs*R-squared	1.11	0.29	
Heteroscedasticity test: Breusch-Pagan-Godfrey				
LNC	F-stats	0.74	0.66	The Null hypothesis of homoscedasticity could not be rejected
	Obs*R-squared	6.75	0.56	
Normality test				
LNC	Jarque-Bera	1.42	0.49	The Null hypothesis of normal distribution could not be rejected

(2020), Alam et al. (2024) and Al-Dhubaibi et al. (2024) have all provided substantial evidence to support the notion that carbon emissions unidirectional cause economic growth. Similarly, the impact of carbon emissions on tourism has also been investigated, with Jebli et al. (2014) and Al-Mulali et al. (2013) providing strong support for the claim that carbon emissions unidirectional cause tourism. At the same time, urbanization causes carbon emissions to go only in one direction, as shown by the research by Dong et al. (2018), Shahbaz et al. (2014), Kasman and Duman (2015), Behdioğlu and Çelik (2018), and Wang et al. (2016b). Urbanization is also a unidirectional catalyst for energy use. The research done by Shahbaz et al. (2015) supports the claims made. Many studies, including those by Dong et al. (2018), Nguyen and Nguyen (2018), Ali et al. (2020b), Adebayo (2021), Yang et al. (2017), and Zheng and Walsh (2019), and Houaneb et al. (2025) have shown that urbanization leads to economic growth that goes only in one direction. Additionally, there is a unidirectional relationship between energy consumption and tourism, with energy consumption influencing tourism Faisal et al. (2024). Furthermore, economic growth also has a unidirectional impact on tourism, corroborated by the studies conducted by Hatzigeorgiou et al. (2011), Zaman et al. (2016), Tang and Ozturk (2017), and Suresh et al. (2017).

Furthermore, a range of post-estimation tests are conducted. The Ramsey, normality, serial correlation, and heteroscedasticity tests prove that the model is appropriately specified and lacks serial correlation. Furthermore, the findings indicate the absence of heteroscedasticity, as seen by the data presented in Table 7. In addition, the results of the CUSUM and CUSUMSQ analyses are presented in Figure 3a and b, respectively, demonstrating the stability of the model.

5. CONCLUSION

Numerous economic models can facilitate a deeper understanding of the interconnections among carbon dioxide emissions, population expansion, energy consumption, economic advancement, and tourism. Several models used in this study include unit root models, ARDL bound tests, vector error correction models, and the Granger causality test. The findings of the econometric models provide a more comprehensive understanding of the causal relationship in Kuwait throughout the time under investigation. This analytical approach demonstrates utility across other nations, extending beyond the specific context of Kuwait. Employing this analysis method is essential for better comprehending how carbon dioxide emissions, tourism, urbanization, economic growth, and energy use are all connected in complex ways. It aims to identify strategies for mitigating carbon dioxide emissions while sustaining tourism, economic growth, energy consumption, and urbanization in various countries or regions.

The study's results provide evidence that urbanization and energy consumption significantly influence carbon emissions in Kuwait. Simultaneously, the urbanization process exerts a direct influence on the carbon emissions level of Kuwait. Furthermore, the primary factors contributing to the phenomenon of tourism are heightened energy consumption, elevated carbon emissions, and accelerated economic development. The report suggests that the government of Kuwait should implement supplementary energy-saving methods to mitigate carbon emissions and enforce stringent environmental and energy legislation. The implementation of environmental and energy regulations has the potential to regulate carbon dioxide emissions effectively.

According to Kelly and Williams (2007), there is a growing recognition of the energy-related implications of tourism on global ecosystems. As the understanding of energy consumption's effects on tourism destinations' sustainability expands, there is an increasing demand for planners to formulate proactive strategies for managing energy. Consequently, this would reduce environmental pollution, safeguarding millions of individuals from the adverse impacts of natural catastrophes. Additionally, such measures would contribute to the promotion of tourism. Promoting innovative technology within the industrial sector fosters economic growth while mitigating pollution.

6. RECOMMENDATIONS

To fully understand how tourism, energy use, urbanization, and economic growth affect Kuwait's carbon emissions, we need a thorough approach that includes in-depth research and careful data analysis. The following recommendations are proposed to address this issue adequately:

6.1. Appraisal of the Impact of Tourism

- Surveys of tourists: Implement surveys to approximate the carbon footprint of visitors to Kuwait. Please consider the modes of transportation they employ, their patterns of energy consumption, and their preferences regarding lodging.
- Tourist profiles: Construct profiles of normative visitors to gain insights into their travel inclinations and idiosyncrasies, thereby facilitating the estimation of their emissions footprint.

6.2. Monitoring Energy Consumption

- Energy audits: Perform comprehensive energy audits encompassing residential, commercial, and industrial sectors to discern energy usage patterns. Determine the industries with the most significant energy consumption and emissions.
- Encourage incorporating renewable energy sources, including wind and solar, and evaluate their potential for mitigating emissions associated with energy consumption.

6.3. Assessment of Urbanization

- Urban planning and land use: Examine the impact of land-use and urban planning policies on emissions. Encourage the implementation of ecological building practices, public transportation, and mixed-use development.
- Evaluation of infrastructure efficiency: Conduct an assessment of the energy efficiency of urban infrastructure, encompassing transportation systems, waste management, and buildings.

6.4. Impact on Economic Growth

- Analysis of economic sectors: Assess the relative importance of various economic sectors in generating carbon emissions. Determine the industries undergoing substantial expansion and assess their carbon intensity.
- Green business initiatives: Employ incentives, grants, and regulations to encourage and support businesses adopting sustainable and low-carbon practices.

6.5. Carbon Accounting and Monitoring

- Carbon accounting system: Establish a carbon accounting system to facilitate real-time emissions monitoring and tracking of reduction progress.
- Annual emission reports: Disseminate yearly reports detailing emissions and their origins, encompassing urbanization, energy consumption, tourism, and economic expansion.

6.6. Public Education and Awareness

- Educational campaigns: Incorporate public awareness campaigns to enlighten visitors, businesses, and individuals about carbon emissions. Promote the development of conscientious behaviors, energy conservation, and sustainable practices.
- Foster stakeholder engagement: Partner with governmental entities, non-governmental organizations (NGOs), and the private sector to promote awareness and support efforts to mitigate emissions.

6.7. Policy Development

- Policies for reducing emissions: Formulate and execute strategies to mitigate emissions in each industry sector, considering the distinct attributes of tourism, energy usage, urban expansion, and economic development.
- Regulations and incentives: Besides implementing regulations to limit emissions, implement incentives for sustainable practices, such as tax rebates or subsidies.

Following these suggestions, Kuwait can understand how tourism, energy consumption, urbanization, and economic growth interplay with its carbon emissions. Consequently, Kuwait can devise efficacious approaches to mitigate its carbon footprint while preserving sustainable economic growth.

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