Environmental Footprints of Economic Development, Foreign Investment, Tourism, and Electricity Production: Empirical Evidence from GCC Region

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Abstract

Each economic factor generates both positive and negative externalities regarding environmental quality. Owing to this, the current study explores the impacts of various economic factors on the environmental quality of GCC region. By sampling the 24-years (1996–2019) financial statistics of six GCC region countries, we investigate the impact of economic development, foreign investment, trade volume, tourism investment and revenue, and electricity production etc., on CO₂ emissions. The empirical analysis is based upon FMOLS (fully modified ordinary least square) model due to existence of cointegration. Following the results, economic development, foreign investment, tourism investment, electricity production, and population density have positive while trade volume and banking development have negative impact on volume of CO₂ emissions. The results support the pollution haven hypothesis in GCC region and have many policies for environmental economists regarding the protection of natural environment both in short and long-run. The current analysis offers new insights regarding the dynamic role of various economic factors in establishing the CO₂ emission volume in GCC region.

1. Introduction

In 2015, the General Assembly of United Nations argued the famous 17 goals regarding sustainable development. These goals are projected to be accomplished by the year 2030 (UNGA, 2015). Being consider the importance of these goals, the literature has paid much attention on exploration of these goals. Among the others, the literature on sustainable economic growth and the impact of various economic factors on environmental sustainability have gained significant attentions of researchers (Eyuboglu and Uzar, 2020; Huang, et al., 2022). For the time being, each country is concerned about the preservation of natural resources for their future generation. The intensive increment in multiple environment issues has created the serious threats not only for the health of human beings but also other creatures in ocean and air. In the case of GCC, these economies are suffering with intensive climate changes due to sole dependency on fossils fuels as an energy source. According to statistics provided by The World Bank, the four economies of GCC including Bahrain, Oman, Kuwait, and Qatar are 100% relying on non-renewable energy sources. The ratio in other two economies is not less than 80%. Meanwhile, these economies are experiencing the major inflow of FDI during last few decades. Additionally, the GCC region is considered as one the major tourism destination in the world (Chen, et al., 2018). For instance, Saudi Arabia welcomes the millions Muslim pilgrims on Hajj. All these factors substantially impinge upon the climate quality in this region. Therefore, the current study aims to explore the environmental footprints of various economic factors in this region.

Although the development in economic status, foreign investment, and expansion in other economic activities are always endorsed much focus, the sustainability of natural environment is another agenda that should be adopted by policy officials (Charfeddinea and Kahia, 2019). The stimulus behind the staggering focus on environmental sustainability is extensive increment in environmental issues. The exploration of various economic operations by the economic agents has created a panel of environmental issues e.g., distortion of ozone layer, enrichment of harmful gasses in air, and other health issues. Such environmental degradation shows the incompetency of environmental policies and exploitation of natural resources for personal benefits by the economic agents. Meanwhile, a country may adopt some policy relaxation in environmental compliance in order to achieve the various objectives regarding the rapid economic growth and encouraging the domestic industrial zones on more production (Odhiambo, 2016). However, it becomes necessary to regularize such operations and impose some policy restriction to undermine the environmental degradation. From the real world, the China has made a double-digit economic growth in last decade. Parallellly, it has also faced the extensive increment in CO₂ emissions during this era (Chen, et al., 2018). This phenomenon exemplifies the direct impact of various economic factors on CO₂ emissions and urge to investigate the similar trend in GCC region.

In the viewpoint of above discussion, the current study explores the impact of economic development, foreign investment, trade volume, tourism investment and revenue, and electricity production on environmental quality of GCC region. The empirical analysis is based upon 24-years (1996–2019) statistical scores of six GCC region countries including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates. To test the underlying theoretical framework, we employ the FMOLS tests due to existence of cointegration and nature of data (macro-panel). The statistical results reveal that economic development, foreign investment, tourism investment, electricity production, and population density are the significant determinants that are boosting the CO₂ emissions in this region. However, a declining trend in CO₂ emissions was observed due to trade volume and financial development. Both factors mitigate the CO₂ emissions in this region. The empirical results robust the findings of previous literature and suggest the existence of pollution haven hypothesis in GCC region.

The importance of current analysis can be categorized theoretically, empirically, and practically. Theoretically, the current study expands the existing literature by exploring the impact of various economic factors that were argued by the previous studies on CO2 emissions in the GCC region. It combines the various strands of literature and offers robust theoretical insights for the GCC region. Empirically, the current analysis investigates the impact of the most discussed economic factors on CO2 emissions and provides empirical support for the stratification of the pollution haven hypothesis in this region. Our study supplements the empirical evidence on both the declining and boosting role of CO2 emissions in the GCC region. Practically, this study suggests direct policies regarding environmental sustainability in this region. Policy officials should focus on sustainable economic progress, introduce some regulations for foreign investors, and develop policies for alternative energy sources. Meanwhile, they should enhance the banking development and trade volume.

The remaining paper is distributed into 5 sections i.e., section 2 presents the review of literature, section 3 data and methodology, and section 4 demonstrates the empirical results. In section 5, we discuss the results and conclude the whole study in section 6. The references are offered at the end of the paper.

2. Literature Review

It is eminent that lethal gasses are mandatory to hold the temperature of the earth at some certain level to maintain life. However, huge amounts of such gasses due to man-made operations e.g., extensive use of fossil fuels and other greenhouse gasses bring scorching temperatures and global warming which change the global warming system. Some empirical studies in early 1990s independently examined the connection between per capita income and ecological degradation (Panayotou 1993). Their findings further asserted that ecological degradation and per capita income unveiled an upturned U-shaped curve, identified as Ecological Kuznets Curve (EKC). The EG has a direct link with CO2 emission (CE) in the long orientation (Grossman and Krueger 1995; Mikayilov, et al., 2018). Over the previous eras, researchers of environment and economics had been examined with the focus to rocketing EG and mitigate on social dilapidation, as a concern lethal gasses from economic growth. This peculiarity has observed numerous empirical studies assumed primarily to scrutinize the causative link between EG and CE, and to examine the hypothesis for EKC, and thus create appliances of achieving green growth and sustainable economic progression. The EG does not influence by CE for non-OECD allies, but they acquired statistical outcomes that economic development indicates an increment in CE (Dinda, 2009; Odhiambo, 2016). Moreover, there is no significant causal connection between CE and EG and thereby confirmed the impartiality of the hypothesis (Richmond and Kaufmann, 2006).

The FDI dynamic encourages economic development. However, it affects the atmosphere in host economies. Huang, et al., (2022) expressed that cross-border inflow tends to raise the CO2 emissions (CE) which exhibits a straight link between FDI and CE. But economic development and regulatory quality avert this positive link into negative. We observed a growing literature on linking FDI and CE while reviewing prior literature. However, this link has got eminent rank in the discussions of scholars for the last few decades. Numerous research has inspected the straight impacts of FDI invasions on CO2 releasing and proposed pollution haven hypothesis, which advocates that invasion of cross border investment led to greater CE. Mostly, the advanced regions prefer to choose developing regions for investment portfolios due to minimum stringent regulations which invite higher CE (Mahadevan and Sun, 2020; Aller, et al., 2021). The amount CE increases due to the enlargement of FDI-led economic operations (Grimes and Kentor, 2003). Grimes and Kentor, (2003) proposed that cross-border invasions significantly upturn CE in less developed regions. Cole, et al., (2006) asserted that high corruption perceptions index countries enhance their CE due to lax ecological strategies.

Tourism is the utmost and mounting industry in the world. The swift advancement of the tourism industry and increasing tourism (TR) mobility has backed significantly to both developed and developing regions. Eyuboglu and Uzar, (2020) asserted that tourism, economic advancement, and energy ingesting affect emissions of CO2 positively both in short and long orientation. Chen, et al., (2018) established the contact amongst, CE and economic advancement in China. They highlighted that tourism advancement is positively affects CE and specifically the transportation zone is the fundamental cause of CE. Raza, et al., (2017) confirmed the associations of TR with CE in the US during 1997– 2016. The findings' declared TR is a determinant of CE. He, et al., (2019) found that the tourism industry's consumptions are lesser than other industries. Dogan, et al., (2015) exhibited that tourism shrinks ecological quality by increasing emissions of CO2. The outcomes regarding causality strategy represented the occurrence of a unidirectional causative liaison from TR to CE. Moreover, Shakouri, et al., (2017) confirmed the links among economic advancement, TR, and CE during 1996–2014 in certain Asia-Pacific economies. They pinpointed that tripper invasions directly lead CE in the long orientation. Azam, et al., (2018) investigated the link between TR and CE, specified that tourism positively leads to CO2 emission.

Akadiri, et al., (2018) evaluated the link among TR, economic advancement, and CE during 1995–2014. Their findings suggested that tourism key determinant of CE. Shi, et al., (2019) evaluated the interconnection between tripper invasions, TR expenses, and CE throughout 1995–2015. The outcomes indicated that tourism overheads enlarge CE in below-average income economies, while tourism invasions have a direct effect on CE both in under and above-average income economies.

Non-renewable energy (NRE) somehow increases CO₂ emissions (CE). Various scholars noticed a direct association of NRE with CO₂ emissions which reveals that high consumption of NRE leads to CO₂ emissions (Awodumi and Adewuyi, 2020). Moreover, Jalil and Feridun, (2011) explored the long-oriented impact of advancement in the financial sector and energy consumption on ecological degradation in China throughout 1954–2007. Their outcomes exposed that aggregate energy consumption has a direct effect on ecological pollution. Acaravci and Ozturk, (2010) Jayanthakumaran, et al., (2012), Ozturk and Acaravci, (2013) also recommended a positive link between NRE and CE for India, China, Europe, Indonesia, and Turkey respectively. Bélaïd and Youssef, (2017) and (Alola, et al., 2019) established that energy consumption is positively associated with ecological pollution. Shahbaz, et al., (2013) have declared that trade openness and financial development have a positive link with CO₂ emissions. However, Jalil and Feridun, (2011) disclosed a significant positive contribution to mitigating ecological pollution, but they at the same time stated the positive impact of trade openness with CE. Though, this result is consistent with (Acaravci and Ozturk, 2010; Jayanthakumaran, et al., 2012; Ozturk and Acaravci, 2013).

More than 50 percent population of the entire world lives in urban areas and by 2030, this ratio will reach 60 percent. In some specific states, 70 percent in Europe is forecasted to be surpassed 80 percent by 2050. This demographic upsurge in urban areas leads to 80 percent of energy being consumed in them. The greater population density augments individual energy consumption (Jorgenson and Clark, 2010; Perrián, et al., 2021). In brief, an increase in population density enlarges CO₂ emissions (CE). A mounting of scientific research regarding climate fluctuations causes and consequences has assured instantaneous and continuous reductions in CO₂ emissions (CE) (Lamb, et al., 2014). The interstate quorum on climate disparity (IPCC, 2015) 5th valuation report discloses that CO₂ emissions have the main causative of total lethal gas secretion. Growth in population density (PD) for future few years could affect consumption of energy and emissions of CO₂, (Hossain, 2011; Liddle, 2015) which unveils that PD has a direct liaison with CE. India has achieved 2nd most populated country in the world and the world's 3rd leading CO₂ emitter with a portion of 5.98 percent to aggregate global emissions in 2010 except the U.S. and China (WDI, 2015). The emissions of lethal gasses increase with an increment in population which exhibits a positive association between PD and CE (Babu & Kaechele, 2015).

Among others, the development and advancement through contemporary approaches in the financial sector led to economic growth (EG). Moreover, financial development (FD) stimulates economic growth (Charfeddinea & Kahia, 2019). Their study also recommended a straight link between FD and CO₂ emissions (CE). Presently, FD considers indispensable support for EG because it offers an assortment of funds through savings and enlightens the obligatory information regarding investment operations. The FD plays a mandatory role in observing CE by bringing technological advancement in the energy supply sector for mitigating the degree of CE (Jensen, 1996; Shi, 2003). This expresses that FD represents real accessibility of financial resources for productive operations and funding networks for ventures by banks and stock markets (Sadorsky, 2010). The financial development wanes CO₂ emissions through CSR and eco-friendly strategies. From this viewpoint, environmental dilapidation lessens with financial advancement. In addition, it boosts research and development (R&D) efforts, fascinates FDI, and uninterruptedly upsurge economic operations to inspire the ecological quality due to investments in green-associated ventures (Charfeddine, et al., 2018; Hayat, et al., 2018). FD shrinks the leverage acquiring cost which attracts investment operations and stems the scatterings of lethal gasses by enhancing the efficiency of the energy sector (Tamazian and Rao, 2010). Thus, FD may wane the ecological deterioration by boosting industrial operations which obstruct the green atmosphere (Jensen, 1996). Their results support a direct association between financial development and CO₂ emissions.

3. Data And Methods

3.1 Data, Sample, and Variables

The current empirical analysis is based upon the balanced panel data of 6 GCC region countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates). The sampling period is 1996 to 2019. The statistical information of under-consideration variables was extracted from the WDI (world development indicators), The World Bank. The impetus behind the selection of the GCC region is an extensive exploration of non-renewable energy that is causing numerous environmental issues (Al-mulali & Tang, 2013). Similarly, the

selection of span is based upon data availability and consistent change in underlying economic situations e., economic development, FDI inflow, energy dependency, etc., during this era. The current study responds to the research question of how various economic factors including economic development, foreign investment, trade volume, tourism investment and revenue, electricity production, etc., influence the environmental quality in the GCC region. In addition, the existing empirical analysis considers other variables e.g., population density and banking development as control variables. To assess the environmental quality, we use the proxy of CO2 emissions which is a metric ton per capita emission of CO2. This proxy illustrates the net exhaust of CO2 into the air by main CO2 emitters. It further shows the impact of other economic operations on environmental quality. A range of studies has specified a similar measurement of CO2 emissions (Charfeddine & Kahia, 2019). Economic development, foreign investment, trade volume, tourism investment, tourism revenue, and electricity production serve as explanatory variables.

For measurement, we use the annual % GDP growth for economic development, FDI inflow for foreign investment, and a sum of exports and imports for the measurement of trade volume. Similarly, expenditures on the facilitation of tourism activities and the development of tourist points were used as a proxy of tourism investment. Tourism revenue is a net receipt of income from tourism and scaled as % of total exports. Electricity production was proxied by the production of electricity from the primary sources of energy in this region i.e., non-renewable energy sources including coal, gas, and oil. For the measurement of control variables, the people resided on per square kilometer area of land were used as a proxy of population density and the proxy variable for banking development is the volume of domestic credit (% of GDP) extended by private sector banks. The measurement of these variables is based upon the WDI, The World Bank. Additionally, some recent studies have also recommended a similar measurement of these variables (Ameer & Munir, 2020; Gao, et al., 2021; Farooq, 2022). Table 1 presents the brief description of variables.

Table 1
Variables

Variable	Role	Measurement	References
CO2 emissions	Dependent	Metric tons/capita	(Charfeddine & Kahia, 2019; Gao, et al., 2021)
Economic development	Independent	GDP growth rate	(Ameer & Munir, 2020)
Foreign Investment	Independent	FDI inflow (% of GDP)	(Luo, et al., 2021)
Trade volume	Independent	(Exports + Imports) % of GDP	(Shahbaz, et al., 2013)
Tourism Investment	Independent	International tourism, expenditures (% of total imports)	(Paramati, et al., 2018)
Tourism Revenue	Independent	International tourism, receipts (% of total exports)	(Paramati, et al., 2018)
Electricity Production	Independent	Electricity production from oil, gas and coal sources (% of total)	(Bakay & Ağbulut, 2021)
Population density	Independent	Population density (people per sq. km of land area)	(Rahman & Alam, 2021)
Banking Development	Independent	Domestic credit to private sector by banks (% of GDP)	(Acheampong, 2019)
Source: previous literature.			

3.2 Equations and Estimation Technique

To present the underlying theoretical framework for current study, we develop the following equation.

$$CO2_{it} = \beta_0 + \alpha_1 ED_{it} + \alpha_2 FDI_{it} + \alpha_3 TDV_{it} + \alpha_4 TRI_{it} + \alpha_5 TRR_{it} + \alpha_6 EPR_{it} + \gamma_1 POD_{it} + \gamma_2 DCB_{it} + \mu_i + \omega_t + \epsilon_{it}eq. (1)$$

In Eq. (1), CO2 is a vector of CO2 emissions, ED is economic development, FDI is FDI inflow, TDV is trade volume, TRI is tourism investment, TRR is tourism revenue, and EPR shows the electricity production. Similarly, POD is an acronym of population density, and DCD shows the banking development. Other symbols e.g., β_0 is a constant, showing the intercept while α and γ are the coefficients of explanatory variables. Similarly, μ_i is for country and ω_t is an indication of time fixed effect. The subscripts i, t represent variation of countries and time respectively while ϵ_{it} denotes the residual term.

As the analysis contains many macroeconomic variables, therefore it is necessary to check the stationarity of data. For this purpose, the current study employs the unit root testing and considers the results of the ADF test (Dickey & Fuller, 1979), and Im, Pesaran, and Shin test (Im, et al., 2003) to unveil the stationarity status. The statistical analysis shown in Table 3 demonstrates the stationarity of most variables at level 1. This non-stationary status of variables at a level further motivates to check the integration among the variables. We test the long-run cointegration among the variables by employing the Johansen cointegration test proposed by Johansen (1988) and select the Kao-residual cointegration. This test produces more reliable results as it can detect the cointegration even when there is more than one explanatory variable. Additionally, it tests all the series in the long run and produces unbiased analysis (Ozturk, et al., 2021). The significant p-values ($p \leq 0.05$) of the Kao-residual test affirms the alternative hypothesis i.e., there exists cointegration among the variables.

Owing to existence of cointegration, the current analysis mainly considers the fully modified ordinary least square (FMOLS) tests to investigate the regression among the variables. FMOLS model was first formulated by Phillips & Hansen, (1990) to estimate the coefficients in the long run. Additionally, this model is more appropriate in macro-panel analysis ($N < T$) and has the capacity to resolve the potential issue of endogeneity observed in explanatory variables. FMOLS model is effective in order to eliminate the successive problem of high correlations and overlapping of the error terms. All these assumptions support the implication of the FMOLS test in the current case. The contemporary literature has also utilized the FMOLS model to investigate the regression analysis (Wen, et al., 2021; Ozturk, et al., 2021; Farooq, 2022).

4. Empirical Results

4.1 Descriptive Analysis

Table 2 presents the overall descriptive analysis for the variables of study while Table 3 demonstrates the mean trends of main variables across the under-analysis countries. Concentrating on statistics shown in Table 3, Qatar has the highest CO2 emission value of 36.820, illustrating the worst environmental quality in Qatar. Comparably, the economic growth in Qatar is 8.258 which is the highest compared to other companion countries. Bahrain is experiencing the highest FDI inflow of 5.621% of its total GDP. As likely to FDI, Bahrain also has the highest volume of trade 146.707. However, Kuwait is making the highest tourism investment of 22.779 while the highest tourism revenue is earned by Bahrain which is 11.771% of its total exports. In most GCC region countries (Bahrain, Kuwait, Oman, and Qatar), non-renewable energy sources are the only sources for producing electricity. The highest population density value is 157.387 which is owned by Kuwait. Lastly, the highest banking sector development score is 65.530 which is earned by Kuwait.

Table 2
Descriptive Results

	Mean	Median	Std. dev.	Maximum	Minimum	observations
CO2	22.471	21.821	0.054	47.699	7.071	144
ED	4.397	3.724	0.073	26.170	-7.076	144
FDI	2.506	1.528	0.078	33.566	-3.175	144
TDV	106.534	96.324	0.158	191.876	56.088	144
TRI	12.481	9.561	0.064	28.717	2.855	144
TRR	5.066	3.160	0.138	18.493	0.507	144
EPR	96.232	100.000	0.081	100.000	67.673	144
POD	299.429	93.699	0.091	2104.056	7.226	144
DCB	51.343	45.858	0.083	105.187	20.792	144

Acronym's detail: CO2 = co2 emissions, ED = economic development, FDI = FDI inflow, TDV, trade volume, TRI = tourism investment, TRR = tourism revenue, EPR = electricity production, POD = population density, DCB = domestic credit by banks Source: own calculation.

Table 3
Mean Trend across the Countries

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
CO2	22.322	24.377	13.133	36.820	14.296	23.875
ED	4.393	3.165	3.224	8.258	3.027	4.314
FDI	5.621	0.408	2.282	2.372	1.996	2.357
TDV	146.707	93.280	102.650	91.913	74.050	130.603
TRI	7.959	22.779	7.189	19.045	8.533	9.378
TRR	11.771	1.374	4.448	5.755	3.445	3.578
EPR	100	100	100	100	77.466	99.929
POD	1397.462	157.387	10.083	130.173	12.109	89.360
DCB	57.822	65.530	45.989	46.122	37.512	55.081
Acronym's detail: CO2 = co2 emissions, ED = economic development, FDI = FDI inflow, TDV, trade volume, TRI = tourism investment, TRR = tourism revenue, EPR = electricity production, POD = population density, DCB = domestic credit by banks Source: own calculation						

4.2 Correlation Analysis

Table 4 is presenting the correlation statistics among the variables. Most correlation statistics are less than 0.70, rejecting the existence of multicollinearity issue. Excluding TDV, column 2 shows that all variables have positive correlation statistics with CO2, implying the direct correlation between CO2 emissions and other variables of study.

Table 4
Correlation Results

	CO2	ED	FDI	TDV	TRI	TRR	EPR	POD	DCB
CO2	1.000								
ED	0.418	1.000							
FDI	0.063	0.188	1.000						
TDV	-0.008	-0.011	0.381	1.000					
TRI	0.550	0.099	-0.262	-0.284	1.000				
TRR	0.038	-0.075	0.183	0.313	-0.226	1.000			
EPR	0.412	0.138	0.063	0.466	0.268	0.182	1.000		
POD	0.035	-0.014	0.240	0.606	-0.181	0.632	0.235	1.000	
DCB	0.016	-0.312	-0.106	0.429	0.296	0.232	0.323	0.309	1.000
Acronym's detail: CO2 = co2 emissions, ED = economic development, FDI = FDI inflow, TDV, trade volume, TRI = tourism investment, TRR = tourism revenue, EPR = electricity production, POD = population density, DCB = domestic credit by banks Source: own calculation									

4.3 Panel Regression Results

Prior to analyzing the regression, we test the stationarity of variables by employing the unit root testing and report the results in Table 5. The statistical outcomes imply that most variables show the stationarity status at level 1, claiming to investigate the cointegration in the long run. To identify the cointegration, we explore the Johnsen cointegration test and choose Kao Residual test (analysis is shown in Table 6). The significant probability value of this test rejects the null hypothesis i.e., no cointegration exists. The existence of cointegration tests signifies the implication of the FMOLS test for testing Eq. 1. As the analysis is shown in Table 7, economic development has a significant coefficient value of 1.104, illustrating that a one-unit increase in economic development can

enhance the CO2 emissions by 1.104%. The coefficient value of the foreign investment is 1.494, implying the positive contribution of foreign investment in CO2 emissions. Nonetheless, trade volume has a negative coefficient value of -0.584, indicating that trade volume can reduce environmental degradation. Tourism investment has a positive significant adherence while tourism revenue has an insignificant association with CO2 emissions. Other factors e.g., electricity production and population density positively while banking development negatively contribute to the CO2 emissions volume in the GCC region.

Table 5
Unit Root Testing

	Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square	
Variables	Statistics	Probability	Statistics	Probability
CO2 Emissions (-1)	-3.817	0.000	36.502	0.000
Economic development	-3.076	0.000	31.957	0.001
FDI inflow (-1)	-5.277	0.000	49.950	0.000
Trade volume	-1.277	0.090	19.512	0.084
Tourism investment (-1)	-11.936	0.002	3.2.404	0.000
Tourism revenue (-1)	-6.570	0.000	62.928	0.000
Electricity production (-1)	-1.948	0.025	11.183	0.000
Population density	-2.907	0.003	35.279	0.000
Banking development (-1)	-5.546	0.000	52.545	0.000
Note: <i>most variables are stationary at level 1. Source: self-estimation.</i>				

Table 6
Cointegration Diagnostic

<i>Kao Residual Cointegration Test</i>		
Test name	t-statistics	Probability
ADF	-1.993	0.023
Residual variance	1.794	-
HAC variance	1.947	-
Note: <i>The significant value of ADF rejects Ho: i.e., No cointegration. Source: self-estimation</i>		

Table 7
Regression Analysis

Dependent variable = CO2 emissions				
	Fixed effect		FMOLS	
	Coefficient	Probability	Coefficient	Probability
Constant	28.470***	0.001	-	-
Economic development	0.156***	0.008	1.104***	0.009
FDI inflow	0.149**	0.060	1.494**	0.064
Trade volume	-0.078***	0.000	-0.584***	0.004
Tourism investment	-0.093	0.329	0.573*	0.090
Tourism revenue	-0.281***	0.008	-1.113	0.253
Electricity production	0.034**	0.070	0.248***	0.044
Population density	-0.003***	0.044	0.274*	0.109
Banking development	0.030	0.181	-0.304**	0.089
Adjusted R-squared	0.889		0.327	
S.E of regression	0.089		0.053	
Prob (F-statistics)	0.000		-	
Long-run variance	-		45.343	
Note: *** denotes significance at 1%, ** represent the significance at 5% and * at 10% level. Source: own calculation.				

5. Discussion

The current analysis probes the influence of various macroeconomic factors on the environmental quality of GCC region countries. For empirical assessment, we employ the FMOLS test and mentioned the results in Table 7. As the coefficient values prevail, the economic development has a direct impact on CO2 emissions, signifying the deteriorating role of economic development in environmental quality. For quick economic development, the different activities e.g., production and consumption of pollution-intensive products are performed at a massive level. This factor causes environmental degradation. Additionally, the propagation of economic growth requires the massive production of various products by industrial units and hence causes environmental degradation (Ameer & Munir, 2020). The overall economic growth reflects the consistent increment in net domestic products that enhance the exhaust of CO2 emissions. Supporting this, the study of Ozturk, et al., (2021) inferred similar results in the GCC region. FDI inflow positively influences the volume of CO2 emissions, corroborating the underlying assumptions of the pollution haven hypothesis in this region. This theory claims that the inflow of foreign investment boosts the production of such particles that impede the environmental quality. The exploration of foreign investment enhances the pace of industrial establishments, extensive economic activities, and disregarding the environmental sustainability by foreign investors (Farooq, 2022). Foreign investors are interested in enhancing the profit volume by leaps and bounds and mostly ignore environmental sustainability due to the occurrence of extra costs for compliance with environmental protection. Additionally, they also enjoy the relaxation in environmental regulations by local governments and hence undermine the activities regarding the preservation of the natural environment (Luo, et al., 2021). All these factors substantially lead to environmental degradation.

Trade volume has a negative coefficient, indicating the favorable impacts of trade volume on environmental quality. Unlike common literature findings (Ansari, et al., 2020; Essandoh, et al., 2020), this inverse relationship between trade volume and CO2 emissions can be explained as a higher trade volume allows for the transformation of modern technology and hence reduces the CO2 emissions. Trade volume also reflects the trade liberalization, incurring the bi-directional sharing of modern production systems and favorable competition (Sbai, et al., 2014). Both factors lead to reduce environmental degradation. This inverse relationship between trade volume and CO2 emissions stands with the theoretical description of the pollution halo hypothesis. Tourism investment which is an

expansion and modification in tourists points positively contributes to CO2 emissions. The development in tourist points attracts more tourists and hence more economic activities incurred in this region which eventually led to extensive emissions of CO2. The empirical results of the studies conducted by Koçak, et al., (2020), and Ravinthirakumaran and Ravinthirakumaran (2022) aligned with such results. Nonetheless, tourism revenue does not impact CO2 emissions in GCC region.

Continuing the discussion, the production of electricity from non-renewable sources of energy has positive adherence with CO2 emissions. GCC region is mostly relying on oil, gas, and oil to produce electricity. The combustion of such energy sources substantially enhances the emissions of smoke and other particles that cause environmental degradation. In addition to electricity, the sole dependency of industrial units and the transportation sector on non-renewable energy is continuously reinforcing the degradation of the natural environment in this region. The direct impact of electricity production from non-renewable energy sources on CO2 emissions provides robustness to the empirical findings of Shafiei and Salim (2014) and Zmami and Ben-Salha (2020). Explaining the effect of control variables, both population density and banking development have a positive correlation with CO2 emissions. The region with more population density necessarily experiences outstanding economic activities e.g., consumption of industrial goods. This factor enhances the emissions of CO2 in this region. Additionally, higher population density reflects the more burden on natural resources e.g., water, air, and other consumable goods which eventually results in impeding the level of such resources and hence causes more emissions of CO2 (Zmami & Ben-Salha, 2020). Lastly, the negative association of financial development with CO2 emissions is claiming that the development of the financial sector can enhance the pace of technological development and thus significantly reduces environmental degradation. The development status of the banking sector allows the industrial sectors to adopt the modern production systems, import updated technology, and low-cost financing for eliminating the operations causing high environmental deteriorations. In coalition, all these factors reduce the emissions of CO2. A list of studies has asserted the similar role of financial development in mitigating environmental deterioration (Shahbaz, et al., 2013; Charfeddine & Kahia, 2019; Lv & Li, 2021).

6. Conclusion And Policies

The current analysis is an attempt to explore the environmental footprints of various economic factors including economic development, foreign investment, trade volume, tourism revenue and investment, electricity production, etc., in the GCC region. To estimate the regression, we mainly use the FMOLS tests and check the effect of economic factors in the long run. The statistical results imply that economic development, foreign investment, tourism investment, electricity production, and population density have a positive impact on environmental degradation. The adverse impact of foreign investment on environmental quality confirms the pollution haven hypothesis in this region. Economic development induces CO2 emissions due to increments in economic activities. Similarly, the foreign investment makes the domestic market a pollution haven by exploration of more industrial units and disregarding environmental sustainability. Tourism investment enhances the economic activities in the region, resulting in excessive consumption of goods which further produces more CO2. The positive impact of the production of electricity from fossils fuels can be regarded as it creates numerous negative externalities in the form of smoke and combustion of pollution-intensive sources. Similarly, population density deteriorates the environmental quality by inducing more pressure on natural resources. Nonetheless, the empirical analysis argued the negative impact of trade volume and financial development on CO2 emissions in GCC region countries. Both factors can mitigate the volume of CO2 by boosting the knowledge transformation and availability of funds to explore the pollution mitigation activities.

From the underlying relationship of various economic factors with CO2 emissions, the following policies can be recommended. In parallel to economic development, the policy officials from the GCC region should focus on environmental sustainability. They should exert more effort for developing sustainable economic growth policies. Similarly, they should introduce some regulations e.g., green productivity, and environmental tax for foreign investors in order to reduce the volume of CO2 emissions. It is further recommended to policy economists in the GCC region that they should enhance the trade volume and development of the banking sector. Both factors can mitigate the CO2 emissions. More specifically, energy economists in the GCC region should immediately develop policies that transform the energy dependency from non-renewable to renewable energy sources. It looks that the extensive combustion of fossil fuels is a primary source of environmental degradation in this region as most economies are producing 100% energy from such sources (follow statistics in Table 3).

The current study has a limitation as it considers all GCC economies in a panel and check underlying relationships combinedly. Each country might have a separate trend. Despite this limitation, the empirical analysis extends the existing literature and provides

multiple policies. Future studies can be arranged by following the assumptions of the famous Environmental Kuznets Curve (EKC) hypothesis in this region.

Declarations

Ethical Approval

I (Umar Farooq) hereby confirmed that paper is solely submitted to this journal and not under the publication process in any other journal.

Consent to Participate

In this research, no human being/Animals involved in direct research or observation. Analysis purely based upon secondary data available on different data sites.

Consent to Publish

We hereby grant the consent and acknowledge that paper should be sent for peer review, or any other publication process required by journal.

Authors Contribution

Umar Farooq: drafting, funding acquisition, Writing- Original draft preparation, methodology

Mosab I. Tabash: Supervision, Conceptualization, Data curation,

Suhaib Anagreh: Reviewing and Editing, Methodology

Ghaleb A. El Refae: Data curation, Writing- revised draft preparation

Mahmoud Al-Rdaydeh: formal analysis, Conceptualization, Software

Samar Habib: Grammatical correction, Validation, reviewing

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Competing Interest

I (Umar Farooq), acting as corresponding author hereby declare on the behalf of my co-authors that we have no conflict of interest.

Availability of Data and Materials

Data that were used in formal analysis do not require any formal consent and can be provided on demand.

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