Does Environmental Stress Affect Economic Growth: Evidence from the Gulf Cooperation Council countries?

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Research Article

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Abstract

This paper empirically investigates the influence of environmental stress on economic growth in the GCC countries during (1995-2016). We use a panel cointegration analysis and compute an autoregressive distributed lag model. Our paper is motivated by the high CO_2 emissions per capita and environmental stress in these countries relative to other countries. We assume that the income per capita is a function of the natural resource's rents and environmental stress. Our findings show that environmental stress has a positive and significant effect on economic growth, mainly in the long run. Further, the natural resources' rents have a significant positive effect in the short run, while the long run impact is negative. Our paper's policy implication states that economic policymakers should monitor and evaluate future environmental stress outcomes in these countries. There is no guarantee that the positive influence prevails. Therefore, they should diversify their economies and energy resources.

Declarations

Funding: **There is no funding for this work.**

Conflicts of interest/Competing interests: **The authors declare that they have no conflict of interest.**

Availability of data and material: **All the data are available Mendeley data repository.**

Code availability: **STAT 16 Software**

Authors' contributions: **Both authors worked equally on the paper.**

1. Introduction

Sustainable economics is an old economic thought and has been attracting the attention of many economists. Its core idea concentrates on allocating the limited resources to satisfy the unlimited needs and desires or adjusting the lifestyle to comply with the finite resources (Sweidan, 2016). Nowadays, economic sustainability is growing very fast because of global environmental threats, i.e., global warming and pollution. The concept of sustainability becomes broad. Baumgartner and Quaas (2010) defined sustainability economics as being ethically founded in the idea of not wasting scarce resources while achieving the two normative goals of (1) the fulfilling of the desires of the current population and (2) justice, including justice between the present and future generations and justice towards nature. Likewise, Sabapathy (2007) defined it as a permanent economic and social improvement that respects the limits of the Earth's ecologies and meets everyone's needs and aspirations for a better quality of life, now and for future generations.

Literature has extensive empirical studies on the relationship between economic development, energy consumption, and the environment. Tiba and Omri (2017) briefly summarized around 400 studies in this research area.[1] They reported only two studies, Al-Iriani, 2006; Salahuddin and Gow, 2014, which explored the relationship among these variables in the Gulf Cooperation Council (GCC) countries as a group.[2] On the other hand, one of the new promising research strands of environmental sustainability is the ecological intensity of well-being (EIWB). It refers to the pressure placed on the environment per unit of human well-being (Dietz et al., 2009, 2012; Knight and Rosa,

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[1] Similarly, Kais and Sami (2016) summarized around 27 studies from the same area of research. For more recent work in the same research strand, see Sethi et al. (2020) and Long and Ji (2019).

[2] Tiba & Omri (2017) reported two single studies about Saudi Arabia, Alkhathlan et al. (2012) and Alkhathlan and Javid (2013), and one single study about UAE, Shahbaz et al. (2014).

2011; Jorgenson, 2014; Jorgenson et al., 2014). Tiba and Omri's (2017) review did not report any study that used the EIWB indicator in its model. However, literature shows that Sweidan (2018) and Sweidan and Alwaked (2016) explored the effect of economic growth and performance on the GCC and MENA regions' environmental sustainability. Both studies showed that economic development and performance rose the environmental stress or economic unsustainability in these countries.

Researchers, i.e., Dietz et al., 2012; Jorgenson et al., 2014, defined environmental sustainability as the ratio of ecological footprint, i.e., CO_2 emissions per capita, to life expectancy at birth.[3] Technically, it represents the ratio of the stress on the environment to human well-being. More efficient or sustainable countries have small ratios, while less efficient nations have large ratios. Usually, researchers are interested in answering the following important question: How can economic development shape the EIWB or environmental sustainability? According to economic philosophy, economic development seeks to improve human well-being. However, economic growth generates environmental stress, i.e., pollution and climate change, that negatively affects human well-being.

Our paper investigates empirically if environmental stress influences the GCC countries' economic growth. The paper is motivated by the fact that CO_2 emissions per capita and the environmental stress are high in the GCC countries compared to other nations. Technically, we raise the opposite question of Sweidan (2018) and Sweidan and Alwaked (2016). Based on our knowledge, the literature lacks such a critical study. We claim it is the first study that explores this question in the GCC countries, mainly using the structure

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[3] Some researchers defined it as the ratio of a country's total energy consumption divided by its gross domestic product.

of environmental stress variable. The GCC countries have a severe lack of environmental studies. Thus, our paper contributes to the literature by filling this gap.

We model environmental stress (sustainability) as an input in the production function. We implicitly assume it has an impact on economic growth. The environmental stress is a proxy of exhausting (use) the nation's resources to generate more welfare. Alternatively, environmental stress is initially generated by economic development. Hence, we explore it's influence on economic growth as a feedback effect. If environmental stress has a positive impact on economic growth, it indicates that the positive side of draining resources outweigh its negative ones. On the contrary, if the influence is negative, then the adverse impacts are larger than the positive ones, and the nation should adopt emergency actions, i.e., efficient allocation of resources, to alter the current situation. This paper is organized as follows. Section 2 reviews relevant literature. Section 3 presents some facts about the GCC countries' CO_2 emissions and policy actions. Section 4 introduces the data and methodology of our paper. Section 5 discusses the empirical estimations and the results. Conclusions and policy implications are made in section 6.

2. Literature Review

Tiba and Omri (2017) conducted an extensive literature survey on the relationships between energy, environment, and economic growth. This area of research can be divided into three different directions. First, exploring the relationship between energy indicators and economic growth. It assumes a bi-directional causality link between economic performance and energy consumption. Second, investigating the existence of the Environmental Kuznets Curve (EKC). Third, examining the relationship between

economic growth, energy consumption, and CO_2 emissions.[4] Tiba and Omri (2017) survey confirmed the link between economic growth, energy consumption, and CO_2 emissions. Technically, our paper contributes to the third direction of empirical research. Nevertheless, it differs from the previous studies by the structure of the primary variable that measures economic sustainability.

 Table (1) presents the previous studies of this research strand in the GCC and MENA countries. The information of Table (1) raises the following notes. First, the number of studies in the area of economic growth, energy consumption, and the environment of the GCC and MENA regions is limited. It may be explained by data availability. The current studies' trend reveals a definite increase. It seems scholars are interested to understand the relationship between the region's above-mentioned variables. Second, most of the studies explored the relationship between economic growth, energy consumption, and CO_2 emissions. Nevertheless, Sweidan (2018) and Sweidan and Alwaked (2018) examined the influence of economic development and performance on economic sustainability. So, it is the proper time to move forward and explore the effect of environmental stress on economic growth to complete the knowledge. Third, the previous studies confirmed a link between economic growth, energy consumption, and CO_2 emissions in the GCC countries and the MENA region. Furthermore, economic development and performance in the area rise environmental stress.

3. GCC Countries: CO_2 Emissions

The GCC countries, Bahrain (BA), Kuwait (KW), Oman (OM), Qatar (QA), Saudi Arabia (SA), and the United Arab Emirates (UA), are positioned at the heart of the world

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[4] For more details about the results of these studies, see Tiba & Omri (2017).

Table (1): A summary of the previous studies in the MENA and GCC countries

No.	Study	Countries	Period	Methodology	Results
1	Mahmood et al. (2020)	Saudi Arabia	1968-2014	ARDL model	Industrialization and urbanization disrupt the environment.
2	Sweidan (2018)	13 MENA countries	1995-2013	Panel analysis	The economic performance increases the environmental stress.
3	Sbia et al. (2017)	UAE	1975–2011	ARDL model and VECM Granger causality	A bi-directional causality between electricity consumption and economic growth. The EKC hypothesis exists in the UAE.
4	Sweidan & Al Waked (2016)	The GCC countries	1995-2012	Panel analysis	The economic development increases the environmental stress.
4	Al-Iriani & Trabelsi (2015)	The GCC countries	1980-2011	Time series and panel analyses	A causality relationship exists, but not homogeneous in all countries.
6	Al-Mulali & Ozturk (2015)	14 MENA countries	1996–2012	Panel analysis and the fully modified ordinary least square (FMOLS)	Energy consumption, urbanization, trade openness and industrial development increase environmental damage.
7	Salahuddin & Gow (2014)	The GCC countries	1980−2012	Granger causality test.	The economic growth does not Granger cause CO2 emissions, but economic growth Granger cause energy consumption.
8	Sbia et al. (2014)	UAE	1975–2011	ARDL model and VECM Granger causality	A bidirectional causality between CO2 emissions and economic growth, and a bi-directional causality between CO2 emissions and energy consumption.
9	Shahbaz et al. (2014)	UAE	1975–2011	ARDL model	The EKC hypothesis exists in the UAE. Economic growth Granger cause CO2 emissions. A positive relationship between urbanization and CO2 emissions.
10	Ozcan (2013)	12 MENA countries	1990-2008	Panel cointegration test and the FMOLS	Support the EKC hypothesis in UAE, Egypt, and Lebanon.
11	Alkhathlan & Javid (2013)	Saudi Arabia	1980−2011	ARDL and VECM models	A bidirectional relationship between CO2 emissions and economic growth.
12	Sweidan (2012)	UAE	1973–2008	ARDL model	In the short-run, a bidirectional relationship between energy consumption and real output. In the long-run, a unidirectional relationship from real output to energy consumption.
13	Alkhathlan et al. (2012)	Saudi Arabia	1980−2008	ARDL and VECM models	In the long run, output leads to greater CO2 emissions.
14	Mehrara (2007)	11 oil exporting countries, including 5 GCC countries	1971-2002	Panel cointegration	A unidirectional from output to energy consumption.
15	Squalli (2007)	OPEC members	1980-2003	ARDL model	A bidirectional relationship between energy consumption and output.
16	Al-Iriani (2006)	The GCC countries	1971-2002	Panel cointegration	A unidirectional from output to energy consumption

Source: Compiled by the authors.

and located in the Arabian Peninsula. Their total population number is 58.0 million in 2019, which is around 0.8% of the world's population. They are abundant in natural resources, including massive supplies of natural gas and crude oil. The British petroleum statistical review of the world energy for June 2020 reported that these countries own
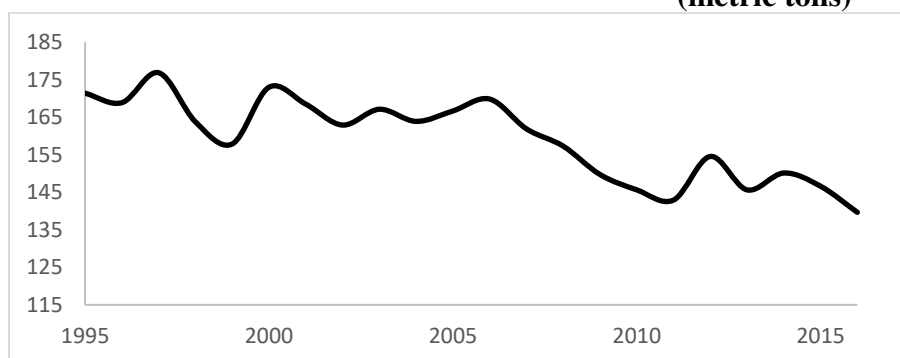
around 30.5% and 19.6% of the world's proven oil and gas reserves, respectively. Consequently, these countries rely heavily on oil and gas sales revenues to enhance economic development, amend social and health indicators, and build a first-class infrastructure. There is no doubt that the oil revenues contribute positively to the public well-being in the GCC countries. For example, the average annual income per capita during the period (1995-2018) is around $40 thousands. Moreover, the average life expectancy at birth increased from 72.8 years in 1995 to 77.2 years in 2018.

The World Bank development indicators display that the GCC countries' average contribution to the world CO_2 emissions reached 2.3% during the period (1995-2014). Table (2) presents and compares the CO_2 emissions per capita between the GCC countries and three industrial countries (France, Japan, and the UK) for the period (1995-2016). On average, Table (2) tells that the CO_2 emission per capita in these countries is higher than that of the industrial countries by more than three times. The extensive CO_2 emissions cause global climate change and pollution. Figure (1) presents the CO_2 emissions per capita for the GCC countries during the same period. It displays that the CO2 emission of these countries is fluctuating but has a descending trend. It is also higher than that of some industrial countries with a higher number of populations. The global ecological footprint can also be a useful indicator for understanding and comparing the environmental threats and challenges on the regional and global levels. Table (3) introduces and compares the ecological footprint of consumption per person of the GCC countries and other countries in 2021 based on data from 2017. The ecological footprint of all the GCC countries is higher than that of the world average (2.8 gha/person). Further, the individual GCC countries have a higher ecological footprint of consumption compared with individual developed and emerging countries. Furthermore,

Qatar (14.6 gha/person) and Luxembourg (12.8 gha/person) have the highest ecological

footprint of consumption worldwide.

**Figure (1): The CO2 emission per capita of the
GCC countries during the period (1995-2016)**

(metric tons)

Source: The World Bank Development Indicators.

**Table (2): The CO2 emissions per capita (metric tons)
of the GCC countries and three industrial countries**

Years	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	Japan	France	UK
1995	26.29	34.04	7.21	61.91	12.55	28.85	9.43	5.86	9.28
2000	28.05	26.12	9.65	58.64	14.3	35.68	9.62	5.95	9.2
2005	21.60	31.43	11.90	58.92	16.63	25.36	9.70	6.10	8.98
2010	23.59	29.89	15.59	40.74	18.91	19.44	9.15	5.43	7.86
2014	23.45	25.22	15.44	45.42	19.53	23.30	9.54	4.57	6.50
2016	22.23	24.95	14.17	38.90	17.37	22.04	8.94	NA	5.78
Avg.	**24.09**	**28.84**	**12.55**	**53.15**	**15.85**	**23.71**	**9.46**	**5.75**	**8.26**

Source: The World Bank Development Indicators via the data stream.

**Table (3): The ecological footprint of consumption per person
of the GCC countries and other countries in 2021**

(Global hectares per person)

Countries	Ecological foot (consumption)	Countries	Ecological foot (consumption)
Bahrain	8.7	China	3.7
Kuwait	8.0	Italy	4.4
Oman	7.3	Japan	4.7
Qatar	14.6	Turkey	3.5
Saudi Arabia	5.7	UK	4.2
United Arab		USA	8.1
Emirates	8.9	Luxembourg	12.8
Canada	8.1	**The World**	2.8

Source: The National Footprint Account Edition 2021.

The Intergovernmental Panel on Climate Change (IPCC) has published many reports about climate change over many years. It assured that global warming is an observable fact and a severe problem. They also warned that there is rising in the temperature of lands and oceans and more frequent heatwaves in most land regions. These dangerous developments will increase poverty and starvation levels, and human health suffers. The reports also warned the Middle East region of a high risk of drought if the region's temperature increased by more than 1.5 degrees Celsius. Further, the Arab Forum for environment and development (AFED) confirmed the GCC countries' low air quality.[5] Air pollution's primary sources are industrial and vehicle emissions, electric power generations, and inappropriate disposal of solid and hazardous waste. Furthermore, Heesterman (2020) confirmed that many of the world's wealthy coastal cities which historically developed as ports will disappear below the sea level. The quick solution to avoid the climate change catastrophic effects is to limit the CO_2 emissions. It requires a unique degree of international cooperation, a high level of taxation on the extraction of coal and crude oil, and the use of pressurized liquid petrol gas as aviation fuel.

3.1 The Governments' Actions

What did the GCC countries do to face regional and global environmental threats and challenges? We can highlight the answer via three dimensions. First, on the institutional level, they have well-established institutional arrangements to achieve sustainable development and protect the environment. The GCC governments' policies and action plans have the following levels: individual country actions, the GCC countries

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[5] For detailed information, see AFED (2008).

arrangements via the GCC general secretariat[6], the League of Arab States decisions via the economic and social council.[7] Second, the GCC countries relied on economic diversification as an extra strategic tool to confront the effects of climate change and boost economic growth. They realized that global warming harms non-oil economic sectors, i.e., agriculture, infrastructure, and tourism. Accordingly, the GCC countries' governments intervened via their strategic visions to support these sectors, preserve the environment, and enhance economic growth (Al-Sarihi, 2018). Further, these countries recognized that the oil sector is finite and experience considerable fluctuations in the oil demand. So, it creates unstable oil prices and weak government revenues. Besides, oil revenues crowd out the other economic sectors. All the GCC countries have currently included an environmental dimension, i.e., energy efficiency, in their long-term development plans.[8] Third, the GCC countries added a market-based instrument (energy price reforms) starting from 2015 to protect the environment and ration energy consumption. Thus, these countries' energy subsidies have fallen from \$116 billion in 2014 to \$47 billion in 2016 (IMF; 2017).

Did the above-mentioned policy actions were enough to generate adequate environmental protection? The answer can be highlighted by the Arab Forum for Environment and Development (AFED) public opinion surveys. They explored the Arab public awareness of environmental threats because of climate change. The AFED performed three surveys in 2006, 2009, and 2017 that covered all the Arab countries. The same main conclusions were reached by the surveys.

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[6] The GCC countries' organization structure consists of the following three units: the supreme council, the ministerial council, and the secretariat general.
[7] For more details about the League of Arab States' institutional arrangements, see Abdel Gelil (2017).
[8] For more details, see Al-Sarihi (2018), pages 17-23.

The surveys found that 98 percent of the respondent believed that the climate is changing, and 89 percent considered this was due to human activities, including excessive use of energy. Survey respondents expressed their willingness to participate in environmental actions to guard the environment. More importantly, it found that practically no work is being implemented to prepare the Arab countries for climate change threats. Technically, there were no research efforts to investigate the effects of climate change on health, infrastructure, biodiversity, tourism, water, and food production. Moreover, the Arab public alleged that the environment has continued to deteriorate over the last ten years. The public said that some governments had initiated specific policies that promoted green and sustainable economy, but these procedures are not enough to tackle the threats.

4.1 Data, Model, and Methodology

4.1. Data and Model

Our paper uses perfectly balanced data of the six GCC countries covering the period (1995-2016) and consists of 132 observations. The data's source is the World Bank World Development Indicators (WBWDI) via Data Stream. This paper uses the idea of the Cobb-Douglas production function to achieve its goal.[9] Nevertheless, we adjust the model to be consistent with the GCC countries' case. The GCC countries are endowed with natural resources, mainly oil and gas. Their incomes are generated based on two items: the rents of natural resources and these resources' use (the stress). Alternatively, economic growth is generated basically from extracting and consuming the natural resources in these countries. As a result, the income per capita is a function of the rent of the total natural resource and environmental stress. The specification of the current paper's model as follows:

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[9] For more details, see Mankiw et al. (1992) and Romer (1990).

$$Y_{it} = A_0 R_{it}^\theta S_{it}^\gamma \tag{1}$$

Where Y_{it} is the income per capita in the country i at time t, A_0 indicates the parameter of the technology progress indicator or total factor productivity, R_{it} represents the rent of the natural resources in the country i at time t. It includes the sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents. S_{it} is the environmental stress in the country i at time t, and θ and γ are the model's parameters or the factors of production shares. Based on economic theory, the expected signs of θ could be positive or negative, and it depends on the validity of the resources curse hypothesis. For example, Adekoya (2020) found that the economic growth of the resource-rich countries adversely responds to oil consumption in the long-run, while the short-run impact is positive. Likewise, Dell'Anno (2020) concluded that resource dependence has three effects (positive, negative, and insignificant) on Iran's economic growth. In the same vein, Abdulahi et al. (2019) confirmed that resource rents impede economic growth conditional on using a threshold value of institutional quality based on data from 14 resource-rich countries of sub-Saharan Africa. Similarly, what is the expected sign of γ, and how can we interpret it? The logical answer is that γ could be positive or negative too. What is the meaning of a positive impact of environmental stress on the GCC countries' economy? We think the interpretation is related to how we design the environmental stress indicator. In our paper, we defined environmental stress as CO_2 emissions divided by life expectancy. Environmental stress can be interpreted as a sign to boost economic activity. If the economic development process succeeded in increasing human well-being more than wasting the resources (the stress), we should expect a positive sign. However, if the economic activities enhanced wasting the resources more than human well-being, we should expect a negative sign. There are no previous warning lights in the GCC countries

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tell that the pollution reached a very high level. Thus, the governments did not adopt emergency actions or procedures. As a result, the governments did not implement any sudden environmental policy that negatively affected economic growth. It indicates that the GCC governments' actions in the environmental area is not sufficient.

We transform equation (1) into the log-linear equation. So, the new form of equation (1) is:

$$LnY_{it} = LnA_0 + \theta LnR_{it} + \gamma LnS_{it} \tag{2}$$

We can rewrite equation (2) in an econometric form as follows:

$$LnY_{it} = a_0 + \theta LnR_{it} + \gamma LnS_{it} + U_{it} \tag{3}$$

where a_0 is the intercept and U_{it} is the error term.

The GCC countries have a constraint on data availability. Thus, we employ the best available choices to estimate the model of equation (3). It justifies why our study covers the period (1995-2016). Researchers in environmental economics paid attention to an important issue when using a ratio as an indicator in the regression analysis. This issue is related to the construction of the ratio. This complication can be described as follows: the variability and the range of the numerator and denominator of the ratio can differ significantly. Thus, the indicator can be dominated by either the former or the latter. In our data illustration, the coefficient of variation (standard deviation divided by the mean) of the CO_2 emissions per capita is 0.52, and its range is 6.7-70.0 metric tons per capita. As for life expectancy, the variation coefficient is 0.03, and its range is 69.8-79.9 years. The two variation coefficients tell that the relative movements in the CO_2 emissions per capita, the numerator, are much larger than the variation in life expectancy, the denominator. It indicates that variation in the numerator is driving the variation of the indicator. As a result, we should resolve this complication before using the ratio in our

regression analysis. We follow researchers from the New Economics Foundation (2009) to solve the problem. The solution method consists of forcing the numerator and denominator's variation coefficient to be equal by adding a constant number to one of them. It shifts the mean without altering the variance. It means the variation coefficient of the two variables will be equal. This technique was used by many researchers in the environmental economics area, i.e., Sweidan, 2018; Sweidan and Alwaked, 2016; Jorgenson et al., 2014; Dietz et al., 2012. We equate the coefficients of variation for the two variables in our data sample by adding the correction factor 462.47^{10} to the CO2 emissions per capita. Therefore, the adjusted S_{it} is computed by the following formula:

$$S_{it} = \left(\frac{[CO2\ emissions\ per\ capita_{it} + 462.47]}{Life\ expectancy_{it}} \right) * 100 \tag{4}$$

Figure (2) presents the adjusted S_{it} of the GCC countries over the period (1995-2016). It reveals that the adjusted S_{it} has a declining trend, which means that human well-being is larger than environmental stress. Despite the massive CO2 emissions in the GCC countries, they can mitigate its negative impacts on the economy by expanding public welfare. Table (4) presents the descriptive statistics of the variables included in the current paper model.
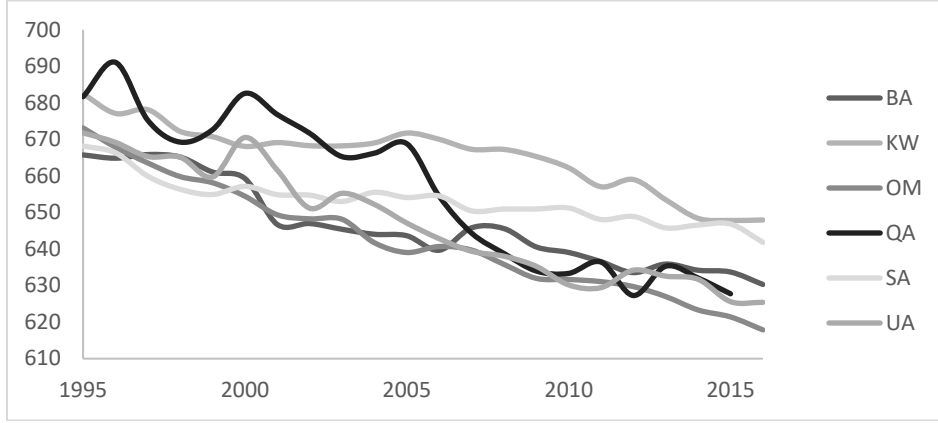
4.2 Methodology

Our paper employs the Panel Autoregressive Distributed Lagged (ARDL) model introduced by Pesaran et al. (1999) to extract the empirical evidence. It detects the presence of a long-run relationship between the variables in the model. It computes short-run and long-run coefficients and estimates the speed of adjustment (error correction term) toward the long-run equilibrium. This approach is valid regardless of the variables'

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[10] The correction factor is estimated based on the following formula, $CF = [(S_{CO2} * M_{LE})/S_{LE}] - M_{CO2}$, where S stands for the standard deviation, M denotes the mean, CO_2 is the emissions per capita, and LE indicates the life expectancy.

Figure (2): The environmental stress, LnS_{it}, of the GCC countries during the period (1995-2016)

Source: computed by the authors.

Table (4): Descriptive statistics

Variable	Mean	Standard deviation	Min	Max
LnY_{it}	10.34	0.49	9.70	11.15
LnR_{it}	3.15	1.62	-0.58	5.70
LnS_{it}	6.48	0.03	6.43	6.54
$LnSG_{it}$	6.30	0.02	6.26	6.35
$LnSP_{it}$	5.66	0.04	5.56	5.75

Source: computed by the authors.

integration orders. It is applicable if the orders of the variables are I (0) or I (1) or I (0) and I (1), but not I (2). The general specification of the ARDL (p, q) model is as follows:

$$Y_{it} = \alpha_i + \sum_{j=1}^{p} \beta_{ij} Y_{i,t-j} + \sum_{j=0}^{q} \acute{\theta}_{ij} X_{i,t-j} + \varepsilon_{it} \tag{5}$$

where Y_{it} denotes the independent variable for a group of countries i, X_{it} indicates a list of explanatory variables for a group of countries i, α_{it} stands for the fixed effect, β_{ij} and $\acute{\theta}_{ij}$ represent the estimated coefficients, ε_{it} is the random disturbance. Pesaran et al. (1999) rewrite equation (5) to match the panel error correction form:

$$\Delta Y_{it} = \mu_i + \varphi_i Y_{i,t-1} + \vartheta_i X_{i,t-1} + \sum_{j=1}^{p-1} \gamma_{ij} \Delta Y_{i,t-j} + \sum_{j=0}^{q-1} \acute{\rho}_{ij} \Delta X_{i,t-j} + \epsilon_{it} \tag{6}$$

where φ_i and ϑ_i are the long-run parameters, and we employ them to estimate the speed of adjustment (error correction term) to long-run steady-state, γ_{ij} and $\dot{\rho}_{ij}$ are the short-run coefficients lagged dependent and independent variables, respectively. We write the paper's model by using the variables' notations in equation (6) as follows:

$$\Delta LnY_{it} = \emptyset_0 + \emptyset_1 LnY_{t-1} + \emptyset_2 LnR_{t-1} + \emptyset_3 LnS_{t-1} + \sum_{i=1}^{p-1} \omega_1 \Delta LnY_{t-i} + \sum_{i=0}^{q-1} \omega_2 \Delta LnR_{t-i} +$$

$$\sum_{i=0}^{q-1} \omega_3 \Delta LnS_{t-i} + u_{it} \tag{7}$$

4.3 Panel unit root tests

The first step in the estimation process is to check the stationarity of our model's dependent and independent variables. It guarantees that our variables satisfy the condition of the variables' order. We conduct three panel unit root tests: Levin, Lin, and Chu (LLC) unit root test, Breitung test, and Pesaran test. The last test is classified among the second-generation unit root tests, which allow for cross-sectional dependence. Nevertheless, the first two tests do not have this feature. The H_0 for the LLC and Breitung test tells that the panels contain unit roots, against the H_1, i.e., the panels are stationary. Whereas, the H_0 for Pesaran test states that all panels are nonstationary. We report the results of the three panel unit root tests in Table (5). The results display that some variables are stationary at the level and/ or at the first difference. Thus, we can use the panel ARDL approach.

5. Empirical estimation

5.1 Panel cointegration tests

We explore the presence of a long-run relationship among the variables using Pedroni (1999, 2004) and Westerlund (2005) panel cointegration tests. These two tests have the same null hypothesis of no cointegration. Pedroni (1999, 2004) alternative hypothesis states that all panels are cointegrated. Whereas, the alternative hypothesis of Westerlund (2005) is that some panels are cointegrated. We present the panel cointegration tests'

results in Table 6. We perform the two cointegration tests by including fixed effect, trend and remove the cross-sectional means. The two tests' results reject the null hypothesis of no cointegration in favor of the existence of a long-run relationship between our variables.

Table (5): Panel unit root tests

Variables	LLC	Breitung	Pesaran
LnY_{it}	-2.73***	0.87	-1.12
ΔLnY_{it}	-2.39***	-4.06***	-2.78*
LnR_{it}	2.06	2.84	-1.29
ΔLnR_{it}	-1.46*	-2.34***	-3.39***
LnS_{it}	-1.65**	-1.98**	-2.36
ΔLnS_{it}	-5.51***	-5.93***	-4.39***
$LnSG_{it}$	-0.60	-1.33*	-2.07
$\Delta LnSG_{it}$	-3.62***	-4.73***	-4.77***
$LnSP_{it}$	-4.1***	-1.43*	-3.18***
$\Delta LnSP_{it}$	-7.45***	-6.67***	-4.75***

Notes:
The LLC test Includes: trend, panel means, and remove cross sectional mean.
The Breitung test includes trend, panel means, remove cross sectional mean, and allow for cross sectional dependence.
*** P < 0.01, ** P < 0.05, and * P < 0.10.

Table 6. Panel cointegration tests

Tests	With fixed effect and trend
Pedroni test for cointegration	
Phillips-Perron t	2.07**
Modified Phillips-Perron t	2.35***
Augmented Dickey-Fuller t	1.94**
Westerlund test for cointegration	
Variance ratio	1.88**

Note: *** P < 0.01, ** P < 0.05, and * P < 0.10.
Cross-sectional means are removed.

5.2 The Results

The presence of a long-run relationship between the variables indicates we can estimate

the ARDL model of equation (7). There are three estimators: pooled mean group (PMG),

mean group (MG), and dynamic fixed effect (DFE). The PMG estimator levies

homogeneity restriction on the long-run coefficients across counties while maintaining

heterogeneity for the intercept and short-run parameters. In contrast, the MG does not

place any restrictions. It allows all parameters to change and to be heterogeneous in the

short and long run. While, the DFE estimator imposes homogeneity restriction on the

slopes, and the intercepts are allowed to alter across countries. Under the long-run

homogeneity assumption, the PMG estimator is more efficient than the MG and DFE

estimators (Pesaran et al., 1999). Accordingly, we should find out the most efficient

estimator for our data among the three estimators. The direct method is to employ the

Hausman test to check if there is a significant difference between PMG and/or MG or

PMG and DFE estimators. The PMG estimator is efficient and consistent under the null

hypothesis of slope homogeneity. The PMG estimator is recommended if the null

hypothesis is not rejected.

The Hausman's test results display that the proper model is PMG.[11] Thus, we compute

the ARDL (2,0,0)[12] model coefficients by the PMG estimator. For robustness check, we

approximate three ARDL model scenarios based on the generated environmental stress

and as follows.[13] Scenario 1 (original model) uses the environmental stress produced
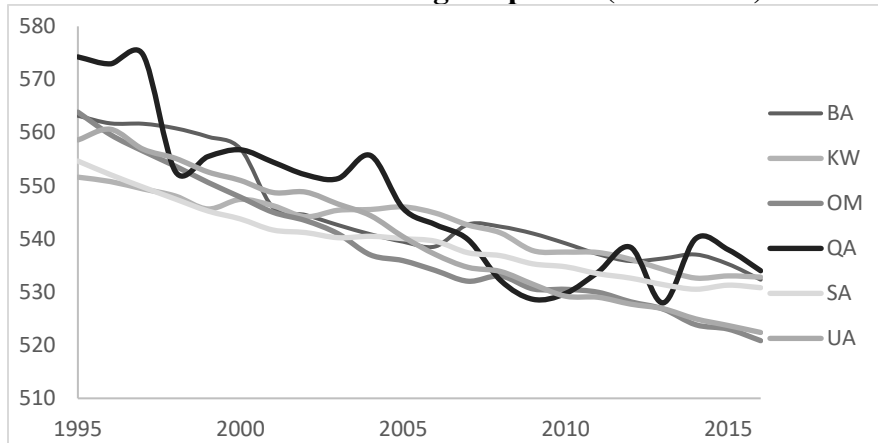
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[11]We conduct two Hausman's tests. The first one between PMG and MG estimators, and the second test between PMG and DFE estimators. The Hausman's tests' results (0.41 (Prob. 0.813) and 0.26 (Prob. 0.880), respectively) are statistically insignificant in both cases. Thus, the long-run PMG estimator is recommended.

[12]These are the computed optimum lags that minimizing the log likelihood by using the FORVAL programming command.

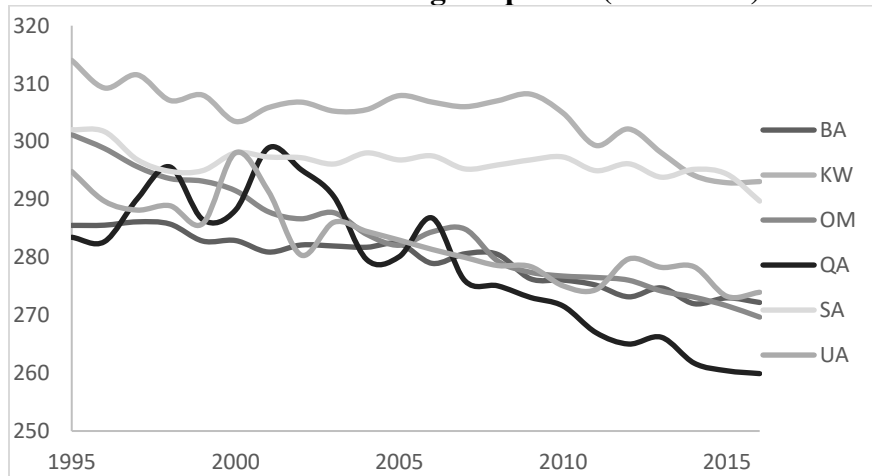[13] We consider scenarios 2 and 3 are different sensitivity analyses to scenario 1.

during the consumption of solid, liquid, and gas fuels and gas flaring (LnS_{it}). Scenario 2 utilizes the environmental stress generated from natural gas ($LnSG_{it}$).[14] Scenario 3 employs the environmental stress created by petroleum-derived fuels ($LnSP_{it}$).[15] Figures (3) and (4) present the environmental stress of scenario 2 and scenario 3, respectively.

Figure (3): The environmental stress indicator, $LnSG_{it}$, of the GCC countries during the period (1995-2016)

Source: computed by the authors.

Figure (4): The environmental stress indicator, $LnSP_{it}$, of the GCC countries during the period (1995-2016)

Source: computed by the authors.

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[14]Scenario 2 Hausman's tests' results (0.94 (Prob. 0.626) and 2.16 (Prob. 0.340), respectively) are statistically insignificant in both cases. Thus, the long-run PMG estimator is recommended.
[15]Scenario 3 Hausman's tests' results (0.28 (Prob. 0.869) and 0.06 (Prob. 0.973), respectively) are statistically insignificant in both cases. Thus, the long-run PMG estimator is recommended.

Table 7 documents the log-term parameters, short-term coefficients, and the error correction terms (ECT) of the three scenarios. These scenarios produced almost very similar results. The ECT in the three scenarios is statistically significant and negative. It approves a converging and stable long-run relationship between the model's variables. The deviations from long-run equilibrium are corrected by an average adjustment speed of 20.3 percent in the current period.

Table 7. The ARDL models' results
(PMG), dependent variable ΔLnY_{it}

	Scenario 1	Scenario 2	Scenario 3
The Long-run coefficients			
LnR_{it}	-0.022*	-0.009	-0.030***
	(0.012)	(0.014)	(0.011)
LnS_{it}	0.560***		
	(0.004)	-	
$LnSG_{it}$		0.925***	
	-	(0.005)	-
$LnSP_{it}$			0.231***
	-	-	(0.004)
The Short-run coefficients			
ΔLnR_{it}	0.079***	0.072***	0.082***
	(0.031)	(0.027)	(0.031)
ΔLnS_{it}	0.970		
	(0.660)	-	-
$\Delta LnSG_{it}$		3.55***	
	-	(1.012)	-
$\Delta LnSP_{it}$			-0.064
	-	-	(0.342)
Constant	1.243***	0.929***	1.922***
	(0.478)	(0.266)	(0.757)
ECT_{it}	-0.187**	-0.207***	-0.215**
	(0.077)	(0.067)	(0.088)
Hausman test Chi. Sq. [Prob.]			
MG vs. PMG	0.41 [0.813]	0.94 [0.626]	0.28 [0.869]
DFE vs. PMG	0.26 [0.880]	2.16 [0.340]	0.06 [0.973]
Log Likelihood	234.96	238.45	233.37
# of countries	6	6	6
# of Obs.	132	132	132

Notes: standard errors are in parentheses.
*** P < 0.01, ** P < 0.05, and * P < 0.10.

All the short-run parameters of the natural resources' rents are statistically significant and positive, with an average value of (0.078). In the long run, they continue to be statistically significant, in two scenarios, but with a negative sign. This evidence supports the resources curse hypothesis in the GCC countries. Moreover, the average size of these long-run parameters (-0.017) is smaller than the short-run coefficients. Furthermore, the short-run parameters of environmental stress are statistically insignificant in two scenarios. However, in the long run, all the parameters switched to be statistically significant and positive. It means the GCC countries' environmental stress succeeded in producing positive effects more than negative ones. Hence, the final observable influence is positive. The environmental stress can be viewed in terms of more consumption, investment, economic activity, and higher economic welfare. It may also indicate that these countries' environmental stress did not reach critical levels that produce significant adverse effects. As a result, the GCC countries are lucky because the positive impacts prevail, and these countries should start giving more attention to the environmental stress before any possible enlargement to the negative influences.

We think our results make sense and consistent with the previous studies' results, i.e., Sbia et al., 2017 and 2014; Alkhathlan and Javid, 2013; Sweidan, 2012; Squalli, 2007. They confirmed a bi-directional relationship between CO2 emissions and economic growth in the GCC countries. From the other direction, Sweidan (2018) and Sweidan and Alwaked (2016) concluded that economic development and performance created more pressure on the environment in the GCC countries and MENA region. Hence, the environmental stress is a proxy to the dynamics of the economic activities, and logically its effect could be positive unless the government took some procedures to reduce the environmental stress, which might adversely affect the economic growth. Overall, our

paper confirms that the GCC countries' environmental stress contributes positively to economic growth, mainly in the long run.

6. Conclusions and Policy Implications

Environmental issues and sustainable development have been attracting the world economic and environmental organizations and scholars alike. Literature has extensive empirical works focused on exploring the relationship between economic development, energy consumption, and the environment. In contrast, there are limited studies focused on the link between environmental stress and economic development. The GCC countries have limited empirical works in this research area. They are oil and gas exporting countries and have around 29.3% and 21.5% of the world's proven oil and gas reserves, respectively. They also use oil and gas sales revenues to enhance economic growth, amend social and health indicators, and build a first-class infrastructure. The different economic and health indicators showed clear improvements during the past four decades. However, many reports displayed high CO_2 emissions per capita and environmental stress in GCC countries.

Our paper empirically investigates the effect of environmental stress or environmental sustainability on the GCC countries' economic growth. We model the environmental stress as an input in the production function. Our paper's primary motivation is the high CO_2 emissions and the environmental stress in the GCC countries relative to other nations. These countries lack such critical study. The literature has two studies, Sweidan (2018) and Sweidan and Alwaked (2016), that explored the opposite question, which is the effect of economic development on the environmental stress in the MENA region and GCC countries. The reports showed that these countries had established a promising institutional framework to deal with environmental and sustainable development.

Unfortunately, the region lacks genuine interest in environmental issues, which prevent establishing useful work, sound policies, and sustainable development evaluations.

We use the ARDL methodology to estimate our models' parameters. The results reveal that environmental stress has a positive and statistically significant effect on the GCC countries' economic growth, mainly in the long run. To check the robustness of our results, we employ three proxies of environmental stress. The three scenarios generated almost similar results. Our conclusion tells that the GCC countries' environmental stress produced more positive impacts than adverse effects. The environmental stress is a signal for more consumption, investment, and higher economic welfare in the GCC countries. If the economic development mechanics achieved more human well-being than damaging the resources (the stress), then a positive feedback effect is expected. The GCC countries' environmental stress did not reach critical levels that produce vast negative influences on the economy. Historically, the governments did not adopt harsh decisions that hindered economic activities. On the contrary, the GCC governments did not give serious attention to environmental and sustainable development problems. The GCC countries are lucky because the positive impacts prevail. However, economic and environmental policymakers should monitor and evaluate the future environmental stress outcomes in these countries. The positive impacts are not guaranteed to dominate over the long-time. The GCC countries should adopt an efficient energy-environmental policy by shifting to the renewable energy, i.e. wind and solar. This move helps these countries to diversify their energy resources and reduce the environmental stress. These countries have initiated some reforms, i.e., the establishment of research and development centers,[16] to enhance

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[16]This includes Masdar City in the United Arab Emirates and King Abdullah City for Atomic and Renewable Energy in Saudi Arabia.

renewable energy deployment. The UAE has initiated its nuclear energy program and built its first power plant in the region.[17] Furthermore, our results confirm that the resource curse hypothesis is valid in the GCC countries in the long run. This finding opens up the debate on the importance of diversifying the GCC economies.

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[17] For more details, see Al-Saidi and Haghirian (2020).

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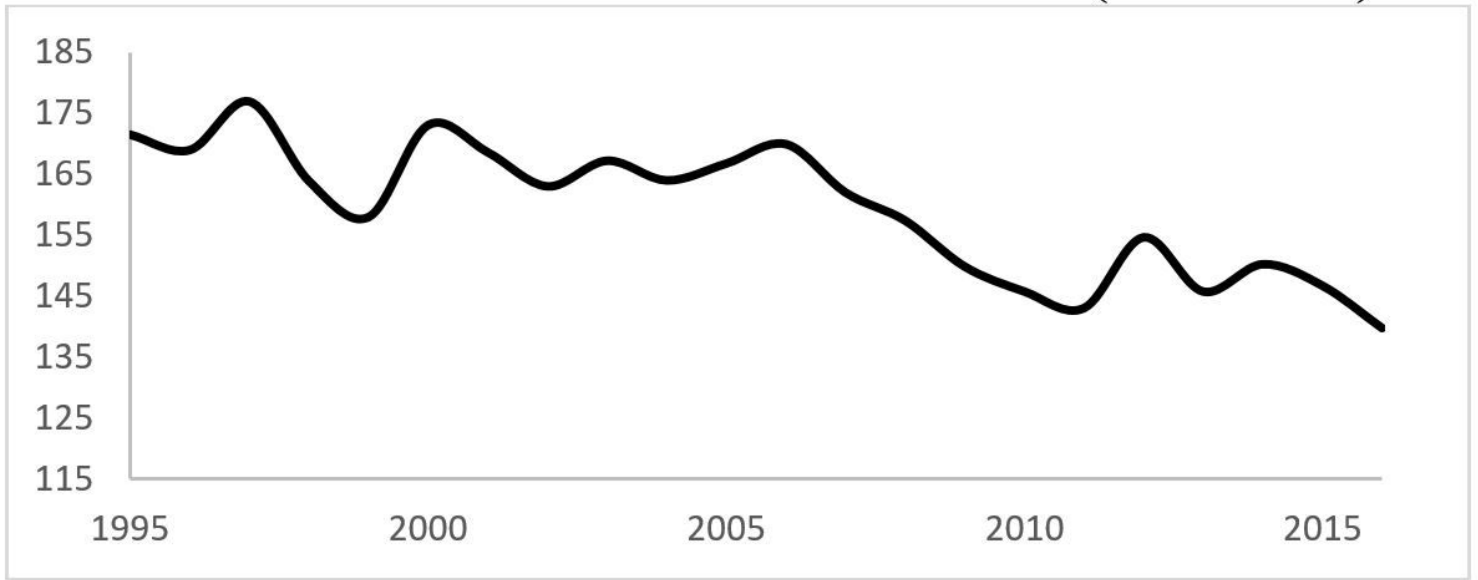
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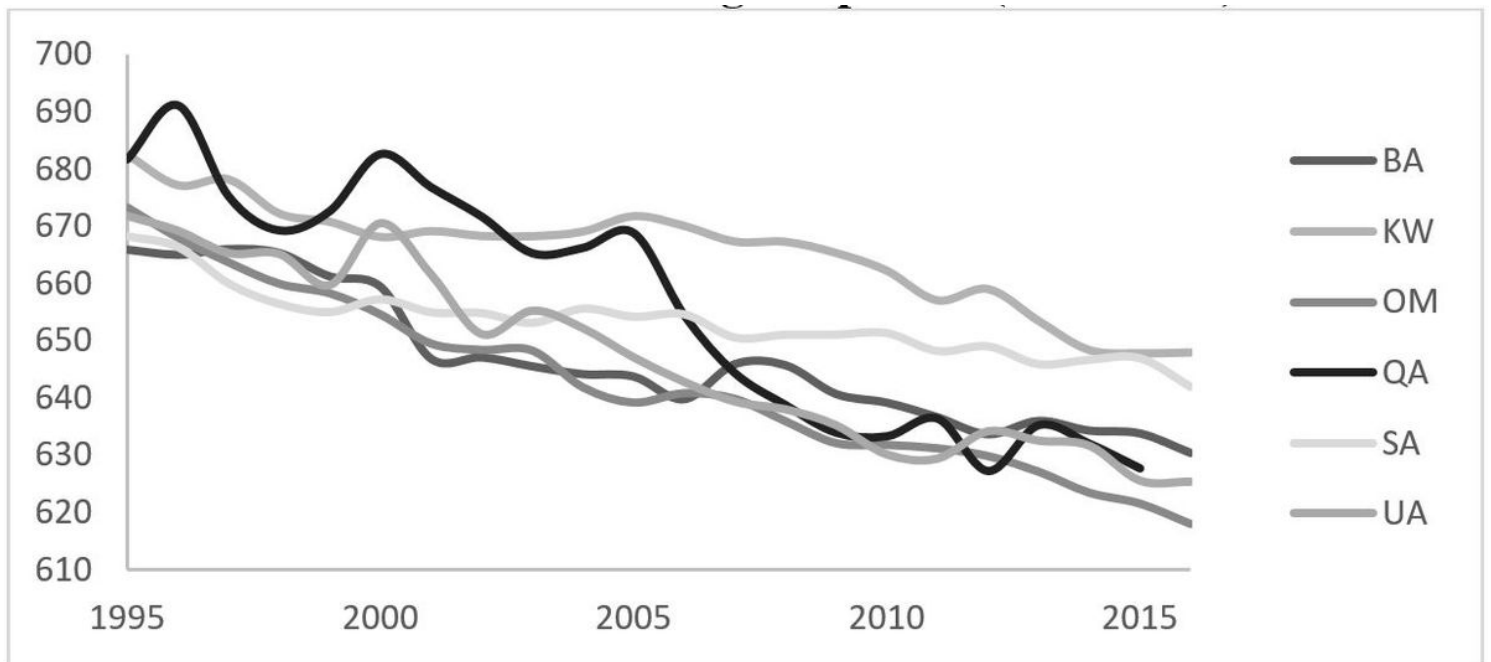
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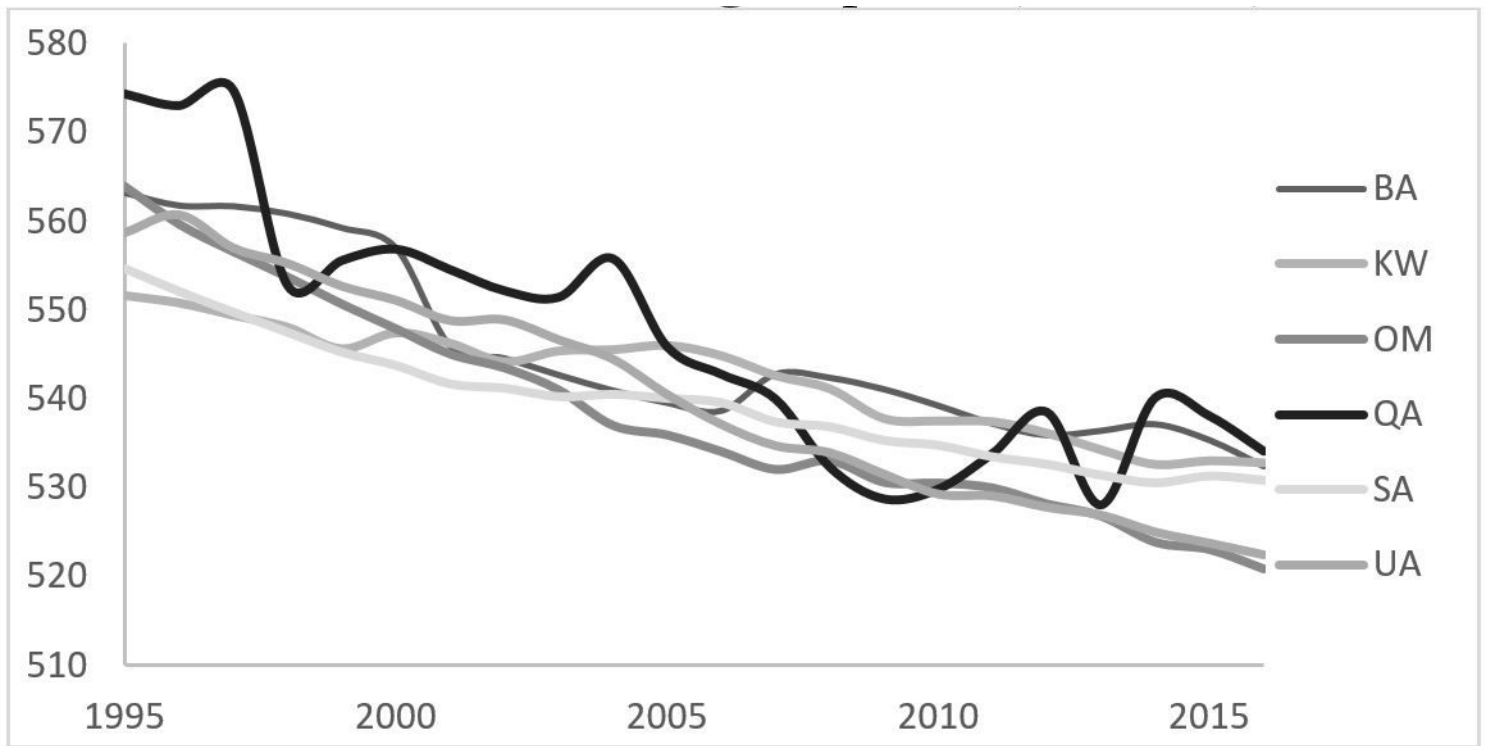
Figures

Figure 1

The CO2 emission per capita of the GCC countries during the period (1995-2016)(metric tons) Source: The World Bank Development Indicators.
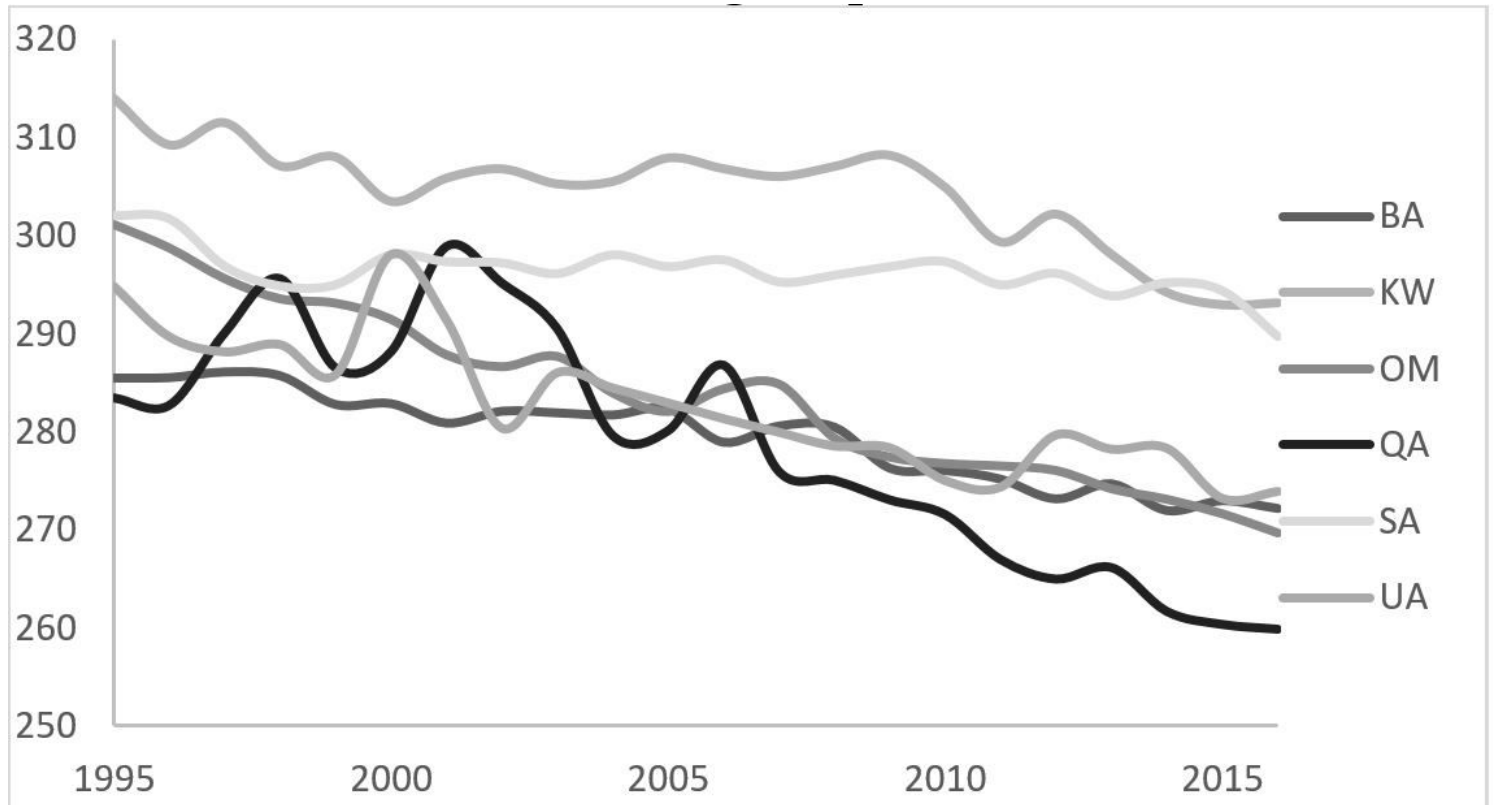

Figure 2

The environmental stress, LnSit, of the GCC countries during the period (1995-2016) Source: computed by the authors.

Figure 3

The environmental stress indicator, LnSGit, of the GCC countries during the period (1995-2016) Source: computed by the authors.

Figure 4

The environmental stress indicator, LnSPit, of the GCC countries during the period (1995-2016). Source: computed by the authors.