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Modeling Energy, Education, Trade, and Tourism-Induced Environmental Kuznets Curve (EKC) Hypothesis: Evidence from the Middle East

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Abstract: Global warming has become the main concern in the present world. This research takes a comprehensive look at the interconnections between tourism, gross domestic product (GDP), renewable energy, fossil fuels, education, trade, and carbon dioxide (CO_2) emissions in the Arab Peninsula. Including these variables, the research also checks the environmental Kuznets curve (EKC) hypothesis by analyzing the top 10 tourist destinations from 1997 to 2019. Saudi Arabia, Qatar, the United Arab Emirates, Iran, Israel, Jordan, Bahrain, Oman, Lebanon, and Egypt round out the top 10 countries in Arab in terms of tourist arrivals. The paper uses a novel augmented mean group (AMG) model to explore the problems of slope heterogeneity (SH), cross-sectional dependence (CSD), and the combination of level and first-difference stationery. An association between these variables over time can be discovered using the Westerlund cointegration method. To certify the accuracy of the findings, the research used both the mean group (MG) and common correlated effects mean group (CCEMG). According to the research, the EKC does not exist in the most popular Middle Eastern travel destinations. This basically means that as money grows, environmental conditions will deteriorate. The findings show that tourism can help reduce environmental harm there. Indicators such as rising populations, increased energy consumption, and thriving economies all influence the rise of the environmental degradation level. Trade will also increase environmental deterioration. The only things that will help reduce CO_2 emissions are tourism and renewable energy. Therefore, the MG and CCEMG results corroborate the AMG findings. Governments may push for the widespread use of refillable energy sources and the development of ecotourism. Therefore, policymakers in this country should rethink their tourism strategies and adopt one that places a premium on renewable energy sources and environmental protection.

Keywords: Arabian countries; CO_2 emission; environment Kuznets curve; renewable energy; tourism

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1. Introduction

Today's economic growth is a worldwide phenomenon. Countries are always seeking new-fangled investment gateways and derivations of foreign earnings to boost and prolong economic development. Tourism is recognized as a great source of foreign earnings for many nations, and many depend on tourism for their economic advances. Just before the pandemic occurred in 2019, tourism had already contributed 10.4% to the global GDP [1,2],

which made this industry the third most important contributor to the global economy [3]. Countries are undertaking tourism development projects for their economic advances. In many nations, tourism is the most complex industry, and it offers a wide range of advantages, including the creation of job opportunities, attracting foreign investment and revenue, the bolstering of infrastructure, etc. [4–6]. Thus, the major expectation from the tourism industry is that it will contribute to the economy and enrich social conditions. Similarly, the tourism sector promotes economic growth by generating revenue at the national level, whereas, at the micro level, it enhances the quality of life for people living in a country by generating employment, ensuring equitable wealth distribution, and balanced regional progress [5].

Currently, the Arabian Peninsula, which is recognized as being rich in diverse natural resources, is addressing tourism significance gradually. Travel and tourism contributed almost USD 238.7 billion to the Middle East GDP in 2018 and it will be around USD 486.1 in 2028, which is almost double [7]. As part of its plan to increase the tourism sector's augmentation to the economy from 3% of the country's GDP to 10% by 2030, Saudi Arabia is creating several tourist projects [8]. The United Arab Emirates has reduced its reliance on oil revenues by diversifying its economy into other areas, such as tourism and real estate, to lessen its economic vulnerability. Now, the Kingdom of Saudi Arabia and Qatar are following the same path, where Qatar is the hosting country for the FIFA World Cup 2022, investing over USD 200 billion, which will catch attractions a sizeable number of tourists from all over the world. With an investment of USD 36.8 billion in travel and tourism, Saudi Arabia ranked as the third biggest investor in the industry [9].

The UAE tourism sector grew 41.1% in 2021, with an increase of 48.8% in income from tourists from other countries, making it the third fastest-growing sector in the region [9], while Dubai has been listed as one of the top tourist spots worldwide in 2022 by TripAdvisor. The Middle East received 73 million tourist arrivals in 2019, where the United Arab Emirates had the highest number of international tourists, 21.6 million, and Saudi Arabia received 17.5 million [10]. Tourism's contribution to the Middle East's GDP was 8.4% in the time before the pandemic period, with 8.9% employment in 2019. There was a remarkable year-on-year recovery of 29.3% recorded in Egypt, the biggest travel and tourism industry in Africa, which was helped by a rebound of 28.8% in the number of foreign arrivals and foreign earnings from travelers by 36.4% [9]. However, this situation hides environmental issues.

Over the course of the last several decades, the broader linkage between the growth of tourism and its impact has been investigated at length in the scientific literature, where, additionally, significant emphasis has been focused on the environmental effects of tourism. CO_2 is frequently used as a proxy for measuring contamination and the deterioration of the natural environment. The problems of greenhouse gas emissions, including their effects on air pollution and climate change on a global scale, have recently risen to the forefront of world concern. The most significant environmental challenge facing our generation is global warming [11,12], where CO_2 has been recognized as the prime cause of global warming [13]. The Arab world is now dealing with various environmental concerns, ranging from resource management and water scarcity difficulties to pollution and global warming [14]. The United Arab Emirates, recognized as one of the countries with the least amount of available freshwater, has one of the greatest carbon footprints in the world due to its high levels of individual water and electricity usage [15]. It must rely on the saltwater that has been desalinated to satisfy its need for drinkable water. An increased number of tourist arrivals stimulates the pressure on natural resources.

Numerous studies [16,17] have already investigated the link between CO_2 emissions and economic growth using a sophisticated EKC model that takes into account variables such as energy consumption, commerce, financial development, population growth, and the growth of the tourist industry. In the last several years, scholars have investigated the MENA region's tourism business and its connection to the region's environment. These

nations incorporate the literature of North African representatives [18], Saudi Arabia [19,20], Iran [21], Jordan, Tunisia, Morocco, Turkey [22], and Oman [23].

The Arabian Peninsula has some of the world's worst environmental conditions: dry land, lack of vegetation, high temperatures, extreme heat, dry air, and sandstorms. It is becoming worse in terms of its biodiversity every year. The economy of the Arabian Peninsula relies mostly on trade, while in recent years, the region's tourist industry has grown at a rapid clip. The economic weight of the Arab world is expanding rapidly as well. The tourism industry, international trade, and the Arab weather all require a lot of energy to keep the GDP growing rapidly. Consumption of both renewable and fossil fuels is on the rise throughout the Arab world. There is a great deal of interdependence between all of these elements. Overall, the moment has come to determine which aspects are beneficial to the Arabian Peninsula and which are harmful. This paper utilizes tourism-induced EKC rather than traditional EKC. Rapid economic expansion and a subsequent increase in the number of tourists provide ideal conditions for the development of tourism-induced EKC, making it an ideal choice for our purposes. Even if the EKC is not implemented in the Arab region, the researchers believe that tourism will have positive environmental effects.

In several ways, this study will contribute to expanding our present body of knowledge. To begin, this research uses information from the top 10 Arabian nations in terms of tourism to examine the connection between rising tourism and rising CO_2 emissions, along with other variables related to the environment. Secondly, the standard EKC procedure is replaced in this investigation with the tourism-induced EKC hypothesis. Thirdly, by coupling the econometric analysis, the study uses a second-generation econometric technique rather than a first-generation tool, for the reasons given below. The nations of the Arabian Peninsula have extensive linguistic, cultural, religious, and commercial ties to one another. Therefore, the CSD test is crucial in this setting. However, the slope heterogeneity (SH) test is particularly important since the GDP, population, commerce, tourism, and other macroeconomic indicators in the various Arabian nations are not uniform. Once CSD and SH have been verified, the second-generation unit root test and the cointegration test may be applied. Before developing any sort of strategy, it is crucial to know which economic sector is responsible for the bulk of CO_2 emissions. This study employs a novel AMG method that is guaranteed to preserve endogeneity, slope heterogeneity, cross-sectional dependency, and mixed-order unit root. At last, the model has been strengthened and expanded by the addition of MG and CCEMG.

This paper is organized as follows: Section 2 offers a literature analysis of the research most relevant to our findings; Section 3 details the theoretical framework, data, and econometric methods used; Section 4 presents the results and findings; and Section 5 provides a summary of the study's conclusion. Finally, Sections 6 and 7 discuss the study's policy implications, as well as the limitations and suggestions for further research.

2. Literature Review

The effects of tourism related to other economic variables have been identified by previous studies and addressed in developed, developing, and emerging economies by using various econometric techniques [24–29]. Numerous sources [27,30–33] agree that the energy sector and the tourist industry both play important roles in encouraging economic growth. Usman et al. [34] studied how the top 20 emitting nations' economic growth, travel, and energy use affect the environmental gap. According to studies from the augmented mean group (AMG), while the tourism industry helps to alleviate the environmental deficit, financial development and energy use greatly raise the level of pollution. Adebayo et al. [35] examined the effects of the use of renewable energy from 1990 to 2018 on consumption-based carbon emissions in MINT nations. Globalization and the use of renewable energy, on the other hand, help to slow down environmental deterioration, according to research by the augmented mean group (AMG). Economic expansion and the use of non-renewable energy both contribute to ecological deterioration. Guney and Ustundag [36] examined the effects of globalization, economic growth, and wind energy on carbon emissions in

37 nations between 2000 and 2019. The AMG approach demonstrated that, over time, using wind energy has a statistically significant and detrimental impact on carbon emissions. For instance, a 1% increase in wind energy use results in a 0.018% decrease in carbon emissions. However, over the long term, the variable of globalization has a statistically significant and favorable impact on carbon emissions. Globalization raises carbon emissions by 0.107% for every 1% growth. Rahman et al. [37] looked into how the top 10 tourist destinations' CO_2 emissions are impacted by tourism, the energy mix, and renewable energy. The AMG technique showed that nuclear and renewable energy can both help to lower CO_2 emissions. By contrast, tourism alleviates the environmental compatibility level.

Over the course of the last several decades, the UAE has achieved extraordinary strides in maintaining its economic growth and developing its tourist industry [38]. Previous research in the UAE has found evidence to support the hypothesis that increased economic activity is to blame for the country's deteriorating environmental conditions. The environmental Kuznets curve (EKC) model has been used by Shahbaz et al. [39] for the UAE from 1975 to 2011 to investigate the connection between expanding economies, increasing levels of power use, growing urban populations, and worsening environmental conditions. According to his findings, the consumption of electric power and increasing exports contribute to reducing CO_2 emissions in the UAE, which is beneficial to the quality of the environment, but urbanization is associated with higher levels of CO_2 emission. As a means of gauging the environmental effectiveness of the UAE, the ecological footprint was chosen as the metric by Udemba [40] between 1980 and 2018, which validates the EKC and demonstrates an inverted U-shaped linkage with economic development and carbon footprint.

Kuznets [41] stated that income disparity emerges as a direct consequence of growth in per capita earnings during the early phases of development, which starts to diminish after a certain threshold level is achieved. Concurrently, using the EKC theory, Stern [42], Grossman and Krueger [43] discovered the correlation between rising economic activity levels and deteriorating environmental quality standards (environmental Kuznets curve). The EKC hypothesis has gained widespread acceptance and has been validated; moreover, it offers insights that may help to investigate the relationship between different elements such as fossil fuels [44,45]; renewable energy [46–49] and nuclear energy [50]; environmental deterioration income per capita [51]; energy usage and the number of tourists [52–54]; climate change and the rise of international tourism [55,56]; expansion of the economy; increases in urbanization, power usage, and greenhouse gas emissions [35]; GDP and global trade's impact on emissions of CO_2 [57] investing from outside the country [40]; and the human development index [58]. Researchers that test the EKC theory have not focused as much on the Middle East.

Al-Rawashdeh et al. [22] looked into the relationship between rising economic activities and conditions in the natural environment in two indexes, sulfur dioxide (SO_2) and CO_2, in 22 different Middle Eastern and North African (MENA) nations. The data for CO_2 emissions suggest an inverted U-shape curve consistent with the EKC theory for Tunisia, Morocco, Turkey, and Jordan; however, the MENA area collectively did not demonstrate the EKC for SO_2 emissions and CO_2 emissions. They emphasized the necessity for applying some policies in MENA and suggested ways to reduce environmental deterioration. On the other hand, countries such as Iran, Saudi Arabia, Egypt, Qatar, United Arab Emirates, Yemen, Bahrain, Oman, and Israel, which declined the EKC for both of the two indexes, are necessary to stimulate economic development, since there are a substantial amount of data that support that compatibility of the environment grows with the amount of wealth. Thus, the policy has a significant implication in fostering sustainable growth and the environment. Applying data from 24 nations in the MENA, Tang and Abosedra [59] also studied the impacts of tourism, power usage, and political turmoil on economic development. They revealed that tourism and energy usage contribute to the economy's expansion, where political volatility hampers economic advancement and development in the MENA area.

The most significant aspects of the economy as a whole, such as GDP, inflation, and private financing, are negatively impacted by political chaos.

An empirical study conducted by Asghari [60] looked at the connection between two drivers of economic prosperity and environmental compatibility in Iran. The findings indicate that Iran's two growth resources are responsible for an initial decline in CO_2 emissions, which continues until a turning point, at which point pollution levels rise along with economic expansion. However, once the per capita income reaches a particular level, further expansion of the Iranian economy results in environmental degradation, modeling a U-shaped function. Acar [61] used the EKC for developing nations, OECD countries, Middle Eastern countries, and OPEC countries over 47 years and identified an N-shaped association with income and CO_2 emissions, which indicates that as income per capita grows, CO_2 emissions first decline, but after some time, they increase, and then they begin to decrease again. Even though the N-shaped EKC is regarded as a relatively recent discovery, evidence of its existence dates back to the 1990s by Grossman and Krueger [43] and Panayotou [62] who found an N-shaped association with economic development and SO_2.

The tourist industry leaves behind a "carbon footprint", which is applied to determine the total quantity of carbon dioxide generated as a consequence of the many actions associated with tourism in a given area and at a certain point in time. Elshimy and El-Aasar [63] used a carbon footprint as an environmental impact indicator and aimed to empirically analyze livestock's influence on the environment within the EKC model and energy by sources in Arab countries. They hypothesized that the Arab nations' efforts to reduce their carbon footprint may benefit significantly from adopting sustainable patterns of food production and consumption in addition to using renewable sources of energy. The Arab world, with strong potential for further expansion of the overseas tourism business, has a wealth of diverse natural treasures and a rich cultural history, making it an attractive destination for tourists worldwide [64]. According to World Bank data, international tourist arrivals to the Arab world in 2019 were around 14.2 million. In 2019, tourism accounted for 11.4% of the GDP in the Arab area. The total revenue generated by the tourism sector in Arab nations increased to USD 313.6 billion in 2019, up from USD 281.5 billion in 2018 [65].

The EKC hypothesis was examined in Arab countries using a variety of advanced econometric tools in this study. An AMG estimator was used with a panel bootstrapping cointegration method and a cross-sectional dependence estimator to arrive at this result. As a result, the panel's heterogeneity could be used to increase resilience in certain situations. The AMG estimator must take into consideration multifactor error terms and non-stationary variables that are related to the explanatory variables. This would be necessary for reliable panel regression. To figure out the influence of GDP on CO_2 emissions considering the integration of those factors, the independent variables in this research included the consumption of renewable energy sources and tourism receipts. To this end, the present study explores the following hypotheses, namely: (a) To what extent does energy consumption influence emission levels in the Middle East? (b) Do tourist arrivals dampen or improve environmental quality in the Middle East? (c) Does renewable energy exhibit a mitigating effect on emission levels in the Middle East among other controlled variables in a carbon-income function? The empirical findings could be tested with other independent variables. According to the current research, the explanatory variables utilized in this analysis were selected depending on their potential to have the greatest impact on CO_2 emissions. However, this is something that future research can solve; therefore, it might be considered a limitation of this research.

3. Materials and Methods

3.1. Data and Variables Selection

Examining the yearly time series from 1997 to 2019, this work seeks to dissect the impact of income, tourism, renewable energy, fossil fuel, and trade openness on CO_2 emissions in the ten top tourist destination nations in the Arab world. COVID-19 prevented

us from including the most recent data (2020–2021). Tourist activity plummeted during that time. CO_2 emissions serve as the dependent variable, with GDP, GDP^2, LTA, LREN, LFOS, LEDU, and LTO serving as the explanatory variables. Before an estimation, the variables were converted to their logarithmic form. The World Bank data were used in this study. Table 1 shows the growth or decline in ten Arabian countries' per capita GDP, CO_2 emissions, and international tourist arrivals.

Table 1. Variables and their description.

Log of Acronym	Indicator	Variable Type	Explanation	Unit of Measure
lnCO_2	CO_2 emission	Dependent variable	The indicator shows the total amount of CO_2 released.	Kiloton is the unit of measurement
lnGDP	GDP	Explanatory variable	The indicator is calculated as the total GDP size.	GDP (constant 2015 USD)
lnGDP^2	GDP square	Explanatory variable	The indicator is calculated as the square of total GDP.	GDP square
lnTA	Tourism	Explanatory variable	The indicator measures the number of total tourist arrivals.	Total tourists' arrival
lnREN	Renewable energy	Explanatory variable	The indicator measures the renewable energy consumption.	Percentage of total energy
lnFOS	Fossil fuel	Explanatory variable	The indicator measures the fossil fuels' energy consumption.	Percentage of total energy
lnEDU	Education	Explanatory variable	The indicator measures the government expenditure on education.	Percentage of total expenditure
lnTO	Trade openness	Explanatory variable	The indicator measures the combination of export and import.	Percent of total GDP

Source: WDI (2022) [66].

According to the descriptive statistics in Table 2, the data set does not contain any peculiar patterns. The mean statistics for all variables are consistent. The standard deviation demonstrates the greater volatility of some variables over others, such as GDP square and fossil fuel use. The GDP square has the highest value, and renewable energy has the lowest value.

Table 2. Summary statistics of data.

Variables	N	Mean	sd	Min	Max
lnCO_2	230	2.248	0.923	0.491	3.931
lnGDP	244	9.535	0.996	7.751	11.08
lnGDP^2	244	91.90	18.88	60.08	122.9
lnTA	224	15.15	0.918	13.23	17.05
lnREN	211	−0.372	2.310	−4.707	2.206
lnFOS	219	4.584	0.0246	4.456	4.605
lnEDU	190	2.530	0.361	1.705	3.277
lnTO	240	4.394	0.427	3.375	5.257
Countries			10		

3.2. EKC Hypothesis

The impact of economic growth on environmental degradation is being studied using a variety of metrics, and policies are focused on fostering growth that does not compro-

mise ecological health [67]. Since it was initially hypothesized, the environment–growth nexus has been the focus of extensive theoretical and empirical debate in environmental economics [60,61,68–72]. The following model was applied in regression form to assess the reliability of the EKC hypothesis in the top 10 tourist-arrival nations between 1997 and 2019. To further explore the implications of tourism on climatic changes, a new study has incorporated sustainable tourism into the conventional EKC model [17,73–78]. To evaluate the long-run relationship including environmental damage and related factors, the literature advises using the following Equation (1) in the analytical and functional framework of the EKC.

$$CO_2 = f\left(GDP,\ GDP^2,\ TA,\ REN,\ FOS,\ EDU,\ TO\right) \tag{1}$$

where CO_2 denotes the carbon emissions and GDP, GDP^2, TA, REN, FOS, EDU, and TO are the economic growth, economic growth square, tourists, renewable energy, fossil fuel, education, and trade openness, respectively. Rahman et al. [37] used the environmental Kuznets curve (EKC) model to analyze the implications of tourism on the environment in the top 10 tourist destinations worldwide from 1997 to 2019. Equation (2) below displays the statistical measures required to demonstrate the suggested model.

$$\begin{aligned} CO_{2it} = {} & \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP^2{}_{it} + \beta_3 TA_{it} + \beta_4 REN_{it} + \beta_5 FOS_{it} \\ & + \beta_6 EDU_{it} + \beta_7 TO_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

Prior to being used in the econometric analysis, all data were transformed into their natural logarithms. Multicollinearity complications are eliminated with this method, and the outcomes are credible [79–81]. This is based on research conducted by Balsalobre-Lorente et al. [82]. The empirical model employed in this paper is as follows:

$$\begin{aligned} \ln CO_{2it} = {} & \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln \beta_2 GDP^2{}_{it} + \beta_3 \ln TA_{it} \\ & + \beta_4 \ln REN_{it} + \beta_5 \ln FOS_{it} + \beta_6 \ln EDU_{it} \\ & + \beta_7 \ln TO_{it} + \varepsilon_{it} \end{aligned} \tag{3}$$

It is anticipated that β_1 and β_2 will have positive and negative values, respectively. This indicates that an increase in real GDP per capita will first lead to a rise in CO_2 emissions before eventually causing a decline. The reliability of the EKC hypothesis for a nation will be indicated by this time-based directional relationship. The signals of β_3 and β_4 are simultaneously anticipated to be positive and negative, respectively. This indicates that when tourism grows in the main tourist destinations in the Arab world, CO_2 emissions will start to decline, and it is also estimated that renewable energy will reduce the emissions level. It is also assumed that fossil fuel and trade openness have a positive impact on environmental degradation; by contrast, education is supposed to hurt environmental sustainability.

This study replaced the conventional EKC model with an alternative theory: the EKC hypothesis of tourism. To serve the purpose, the study employed a second-generation econometric approach, as opposed to a first-generation tool, by linking the econometric analysis; this is explained in detail below. All of the countries in the Arabian Peninsula are quite close to one another economically, culturally, religiously, and linguistically. That is why the CSD test is so important here. Since GDP, population, trade, tourism, and other macroeconomic variables in the many Arabian states are not homogeneous, the slope heterogeneity (SH) test is of special importance. When CSD and SH are confirmed, the second-generation unit root test and the cointegration test may be used. The research applied a cross-sectionally augmented IPS (CIPS) unit root test and Waterlund [83] cointegration test to check unit root and cointegration tests. Knowing which industry produces the most greenhouse gases is essential before formulating any type of strategy. Endogeneity, slope heterogeneity, cross-sectional dependence, and mixed-order unit root were all

safeguarded by a unique AMG approach used in this investigation. The incorporation of MG and CCEMG has greatly improved and extended the scope of the model.

4. Empirical Results and Discussion

This study applied several tests such as CSD, homogeneity test, unit root, panel bootstrap cointegration approach, and the AMG estimator, which were developed by Westerlund and Edgerton [84], and Eberhardt and Teal [85], respectively. Estimates may be biased and inconsistent if panel estimating techniques are used without considering the CSD and population heterogeneity. This means that researchers should check for CSD before diving into a panel data estimation. To verify that T > N (as in the author's study), the LM CSD test described by Breusch and Pagan can be used [86].

4.1. CSD Test

The panel data were being analyzed in this study, and it is critical that CSD be checked in the data (Table 3). The same socio-economic structures, bilateral and multilateral trade, and international treaties are responsible for the occurrence of the CSD. The conclusions of this analysis serve as a framework for the application of subsequent tests. As a result, the CSD test developed by Pesaran [87] was utilized in this study. The following Equation (4) is the famous CSD formula:

$$\mathrm{CSD} = \sqrt{\frac{2\mathrm{T}}{\mathrm{N}(\mathrm{N}-1)\mathrm{N}}\left(\sum_{\mathrm{i}=1}^{\mathrm{N}-1}\sum_{\mathrm{K}=\mathrm{i}+1}^{\mathrm{N}}\widehat{\mathrm{Corr}}_{\mathrm{i,t}}\right)} \tag{4}$$

where T represents the cross-sections and N represents the times.

Table 3. Results of CSD test.

Variable	Test Statistics (*p*-Value)
$\ln CO_2$	7.22 [a] (0.00)
lnGDP	3.07 [a] (0.002)
$\ln GDP^2$	18.41 [a] (0.00)
lnTA	14.92 [b] (0.00)
lnREN	2.30 [b] (0.02)
lnFOS	−3.20 [a] (0.00)
lnEDU	4.35 [b] (0.00)
lnTO	10.93 [b] (0.00)

Note: [b] and [a] explain the level of significance at 5% and 1%, respectively, whereas the values in parentheses contain *p*-values.

To eliminate the prospect of erroneous cointegration of the data, Table 3 displays the outcomes of the CSD test. At a significance level of 1%, the null hypothesis of no CSD for all of the parameters, including lnCO2, lnGDP, $\ln GDP^2$, lnTA, lnREN, lnFOS, lnTO, and lnEDU are rejected. This substantiates that CD is included in the data set being examined. This CSD is the result of having social and economic policies that are very similar to one another.

4.2. Slope Homogeneity (SH) Test

In addition to this, it is critically important to apply SH. Data were compared to see whether they have any commonalities. As a result, the Hashem Pesaran and Yamagata [88] method was conducted. For the sake of completeness, here is the formula for SH:

$$\check{\Delta} = \sqrt{\mathrm{N}}\left(\frac{\mathrm{N}^{-1}\mathrm{S}\% - \mathrm{k}}{\sqrt{2\mathrm{k}}}\right) \text{ and } \check{\Delta}_{\mathrm{adj}} = \sqrt{\mathrm{N}}\left(\frac{\mathrm{N}^{-1}\mathrm{S}\% - \mathrm{k}}{\sqrt{\frac{2\mathrm{k}(\mathrm{T}-\mathrm{k}-1)}{\mathrm{T}+1}}}\right) \tag{5}$$

The conclusions of the SH test [87] are displayed in the aforementioned. This test makes the assumption that the slope values are uniform throughout. A 1% significance level is shown in the results in Table 4.

Table 4. Slope homogeneity test.

Slope Homogeneity Tests	Δ Statistic
$\check{\Delta}$ test	0.228 [a]
$\check{\Delta}_{adj}$ test	0.591 [a]

The null hypothesis for slope heterogeneity test is that slope coefficients are homogeneous. a denotes less than 1% level.

4.3. Stationarity Test

In addition to the CSD and SH tests, the data can be examined for a unit root using these methods. This test provides information regarding the degree of integration. Cointegration was the next test to be run in light of the unit root test results. The cross-sectionally augmented Im–Pesaran–Shin (CIPS) test was utilized for this particular experiment. The CIPS test designed by Pesaran [89] was used after assessing whether the panel data set had a potential CSD problem. The SH and CSD problem will be taken into consideration for this test. Conventional unit root tests, such as ADF, PP, and KPSS, have a limited capacity to account for CSD and SH, resulting in inaccurate results. Consequently, we have used a second-generation unit root test known as CIPS, established by Pesaran [89], to determine whether or not the variables under study are stationary in the existence of CSD and slope heterogeneity. To gain an estimate for the CIPS, the following Equation (6) can be illustrated.

$$\text{CIPS} = \frac{1}{N}\sum_{i=1}^{N} t_i(N, T) \quad (6)$$

The outcomes of the unit root test are presented in Table 5. The conclusions indicate that there is no movement in any of the variables after the initial difference. Four of the variables are stationary at level or I (O) and another four are stationary at first difference or I (1). This shows that all of the parameters, including $\ln CO_2$, lnGDP, $\ln GDP^2$, lnTA, lnREN, lnFOS, lnEDU, and lnTO are integrated at I (0) or I (1). In order to use the panel tools of the second generation, the variables were cointegrated in different orders. Due to the nature of our mixed-order stationary, we were able to utilize AMG, MG, and CCEMG methods.

Table 5. Second-generation unit root test.

Variable	CIPS Test	
	At Level	1st Differences
$\ln CO_2$	−1.957	−3.211 ***
lnGDP	−2.340 **	
$\ln GDP^2$	−2.549 **	
lnTA	−1.058	−4.258 ***
lnREN	−1.171	−6.190 ***
lnFOS	−3.05 ***	
lnEDU	−1.024	−4.124 ***
lnTO	−3.551 ***	

Standard errors enclosed by brackets, *** $p < 0.01$ and ** $p < 0.05$.

4.4. Cointegration Test

The next stage, following the test for the unit root, is to verify the cointegration, and the panel cointegration test developed by Westerlund and Edgerton [90] was utilized in this investigation. Authentic results are provided by this examination of panel data, which capture the CSD and SH in question. The following is the formula for equivalence.

After evaluating whether or not the variables are stationary, the following step is to find out whether or not the long-run variables are cointegrated. This is completed after identifying whether or not the variables are stationary. Tests of cointegration based on Westerlund [83] have been applied by us for the aim of achieving this goal, and the outcomes of those tests can be found in Table 6. Table 5 illustrates that the null hypothesis suggested by Westerlund [83] cannot be supported by the data supplied by Gt and Pt statistics when the threshold of significance is set to 1%. This is demonstrated by the concept that the null hypothesis cannot be supported by the data. The P-values are used to draw this conclusion. As a consequence of this, we are in a position to state that the integration of our long-run variables has taken place. Table 5, in Westerlund and Edgerton [84], shows results that disprove the null hypothesis. Because of this, a strong cointegrating relationship can be established between the $lnCO_2$, lnGDP, $lnGDP^2$, lnTA, lnREN, lnFOS, lnEDU, and lnTO.

Table 6. Cointegration tests.

Variable	Westerlund Test for Cointegration		
	Value	**Z-Value**	***p*-Value**
Gt	−2.252	3.953	0.00
Ga	−1.158	4.869	0.000
Pt	−0.513	6.745	0.59
Pa	−2.170	4.786	1.00

4.5. AMG Test

Finally, the long-run coefficients in Equation (3) can be estimated when it has been established that the cointegrated variables are the relevant ones. In the present study, this is accomplished with the use of the augmented mean group (AMG) estimator, proposed by Eberhardt and Teal [85]. Since it accounts for the CSD, mixed-order stationarity, and heterogeneity in the panel data, the AMG estimator generates more credible results than first-generation estimators. In order to obtain an accurate assessment from the AMG, this procedure consisted of two steps. In the initial phase of the process, a pooled regression model was utilized, and it was then supplemented with year dummies that were produced using first-difference OLS in Equation (7):

$$\Delta_{yit} = \propto_i + \beta_i \Delta x_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \quad (7)$$

The AMG's second phase is defined as Equation (8):

$$\hat{\beta}_{AMG} = N^{-1} \sum_{i} \hat{\beta}_i \quad (8)$$

where the first-difference operator is Δ, D is the time dummies and c_t is the coefficient of it, and $\hat{\beta}_{AMG}$ is the coefficient of the AMG estimator.

Table 7 explains the findings of the augmented mean group results. The coefficient of GDP is negative and insignificant, narrating that a 1% rise in economic development causes a 10.59% reduction in greenhouse gas emissions. Usman et al. [49], in advanced economics, also found the same results that the GDP alleviates the environmental deterioration level. However, GDP^2 raises the emissions level because GDP^2 shows a positive association with CO_2. That is, a 1% rise in the GDP^2 causes a 0.586% increase in the emissions level. Yet, both coefficients are insignificant. The EKC hypothesis does not hold in this paper. Dogan et al. [91] in BRICS also found that GDP^2 lessens the environmental compatibility level. Tourists also reflect a negative and significant coefficient, which means tourists play a significant role in the alleviation of greenhouse gas emissions. This shows a 1% rise in tourists, suggesting a 0.0120% decrease in the greenhouse gas emissions. Rahman et al. [37] in the top 10 tourist arrivals, Wei and Ullah [92], and Rahman et al. [93] in Bangladesh

also experienced that tourists alleviate greenhouse gas emissions. Renewable energy also reduces carbon emissions, suggesting a 1 unit rise in renewable energy reduces 0.0331 unit greenhouse gas emissions. Renewable energy ensures the environmental compatibility level. The sign of the renewable energy coefficient is consistent with that of the available researchers such as Voumik and Sultana [94] in BRICS, Voumik et al. [95] in ASEAN countries, Voumik et al. [96] in Bangladesh, Olanrewaju et al. [97] in G7 countries, and Wang et al. [98] in G7 countries, who also narrated that renewable energy significantly alleviates the emissions.

Table 7. Outcomes of AMG.

Variables	AMG	
lnGDP	−10.59	(13.20)
$lnGDP^2$	0.586	(0.618)
lnTA	−0.0120 **	(0.0564)
lnREN	−0.0331 *	(0.0556)
lnFOS	2.100 ***	(0.210)
lnEDU	0.0766	(0.197)
lnTO	0.0859 *	(0.0567)
Constant	47.32	(53.79)
Observations	167	

Standard errors enclosed by brackets, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

By contrast, fossil fuels enhance the environmental degradation level because they are a source of non-renewable energy, reflecting that a 1 unit rise in the usage level of fossil fuel causes a 2.1 unit increase in the greenhouse gas emissions level. This conclusion is consistent with Erdogan et al. [99], and Omri and Saadaoui [100]. Education also raises the environmental degradation level, suggesting a 1 unit increase in education causes a 0.0766 unit rise in the CO_2 emissions. The same output is produced by Zafer et al. [101], Liu et al. [102], and Zhang et al. [103]. Similarly, trade openness also lessens the environmental sustainability level by raising the emissions level in the environment. That is, a 1 unit rise in trade openness causes a 0.0859 unit increase in the emissions level. Wang et al. [98], Kartal et al. [104], and Fatima et al. [105] illustrated that trade openness raises carbon emissions. This result contradicts Sakordie et al. [106]. Therefore, it is clear from this table that GDP, tourists, and renewable energy contribute to the mitigation of the CO_2 emissions level; by contrast, GDP^2, fossil fuels, education, and trade openness reduce the environmental sustainability level in the top 10 tourist arrival destinations.

The robustness findings from the MG and CCEMG tests are shown in Table 8. MG ensures a negative relation with GDP, REN, EDU, and CO_2, with coefficients' values of −33.43, −0.139, and −0.0702. That is, GDP, renewable energy, and education have a detrimental impact on CO_2. The CCEMG estimator shows a negative relation with GDP^2, tourists, renewable energy, and CO_2, with coefficient values of −0.753, −0.207, and −0.126. Both methods of MG and CCEMG suggest that renewable energy contributes a lot to the mitigation of carbon emissions in the top 10 tourist arrival destinations. The usage of renewable energy, which reduces emissions, is an expected sign of the outcome.

Table 8. Robustness check.

Variables	MG	CCEMG
lnGDP	−33.43 * (12.28)	−13.68 (13.68)
$lnGDP^2$	2.200 (0.252)	−0.753 (0.812)
lnTA	−0.0331 (0.0361)	−0.207 * (0.354)
lnREN	−0.139 (0.0982)	−0.126 * (0.0646)
lnFOS	0.769 * (1.992)	0.514 *** (0.594)
lnEDU	0.0702 (0.200)	0.0389 (0.202)
lnTO	0.130 *** (0.0516)	0.0458 * (0.146)
Constant	153.3 *** (33.36)	68.66 (35.69)
Number of countries	10	

Standard errors enclosed by brackets, *** $p < 0.01$, and * $p < 0.1$.

5. Conclusions

The purpose of this study was to assess the applicability of the tourism-led EKC hypothesis for the top 10 nations for international visitor arrivals. This research combined some significant variables of tourism, GDP, renewable energy, fossil fuels, energy use, trade openness, and their environmental consequences. The interaction of these variables has long been a crucial aspect for all stakeholders, policymakers, and researchers. Tourism, GDP, renewable energy, fossil fuels, energy use, nuclear energy, and trade openness are all the variables accountable for globalization [107] and induce huge economic, social, and environmental activities which may have positive and negative effects on society.

This study used the augmented mean group method (AMG) method. Prior to applying the AMG method, various tests such as cross-sectional dependence, slope homogeneity tests, stationarity tests, and cointegration tests were conducted. For cross-sectional dependency, the Pesaran [87] test was used, the Pesaran and Yamagata [88] test was applied for slope homogeneity tests, the Pesaran [89] test was utilized for checking the unit root problem, and for checking the long-run cointegration the Westerlund and Edgerton [84] test was applied. The calculated outcomes suggest the EKC hypothesis is not working in these countries. This implies that rising real per capita GDP precedes rising CO_2 emissions and ultimately causes rising real per capita GDP over time (displayed in a U-shaped pattern). So, the EKC is not present in the Arabian Peninsula.

This study revealed that GDP, tourism, and renewable energy help to alleviate CO_2 emission. There is a popular thought that tourism influences increased CO_2 emissions; however, this study narrates the unexpected finding that tourism is unlikely to result in increased CO_2 emissions in the area. This can be because low-carbon technology and eco-friendly technology are being used in the operation of tourism activities. By contrast, GDP^2, fossil fuel, education, and trade openness increase carbon emissions in the environment. The robustness result of the mean group (MG) narrates that GDP, renewable energy, and education enhance the ecological sustainability level, and the CCEMG suggests that GDP^2 and renewable energy alleviate the carbon emissions from the environment.

6. Policy Recommendation

This report provides crucial policy foundations for the Arabian countries as tourism is a growing industry in that region. A policymaker should emphasize the discovered sectors with a greater possibility for creating green jobs that should receive special attention since they help protect and preserve the environment and hasten the transition to sustainable growth. The necessary policies are given in below.

The GDP helps to reduce the greenhouse gas emissions. So, the governments of the top 10 tourist arrival destinations should focus on increasing the production level. Moreover, the government should ensure green technology in the production process so that the production level can rise, and at the same time, the pollution level also decreases. GDP^2 raises the environmental degradation level. The government should prioritize ecological preservation alongside broad economic growth. If this does not change, the rise of the GDP

on a large scale will have a negative impact on the environment. All kinds of high-emitting technology should be banned immediately. In addition, the firms or industries who are using high-emitting technology should take them under penalty. Therefore, some incentive program should be taken by the government and non-government organizations, such as subsidies. Tourists alleviate the greenhouse gas emissions level. Therefore, the governments of these countries should give more attention to the tourist sector. Along with the government, private organizations should come forward to make the tourist sectors more attractive to the visitors. In these nations, it is important to promote low-carbon tourism demand products and services among the tourists which will play a significant role in reducing carbon emissions. This will also help to promote the use of sustainable energy and sustainable consumption. Renewable energy promotes the ecological sustainability level. Florea et al. [108] showed that GDP and trade positively impact renewable energy in Europe. The gross domestic product and trade in the Arab Peninsula are the two most consequential macroeconomic variables. Therefore, as in Europe, if Arab countries can verify rising GDP and trade with the increased use of renewable energy, the strategy will be good for both the economies and the environment. So, the governments of these countries should research additional renewable energy sources in order to enhance the dependability on renewable resources, which would lead to a decrease in the amount of CO_2 in the atmosphere. The government should offer greater incentives, such as subsidies or lower taxes, to encourage people to switch from non-refillable to refillable energy sources [109]. Additionally, the government can assist the renewable industries by providing soft financing (low-interest rates), a lengthened payment schedule, and lowering the cost of new renewable energy installation projects. On the other hand, fossil fuels revealed a positive relationship with CO_2. Due to the use of non-renewable resources, carbon emissions rise. Therefore, it is crucial for the top 10 tourist arrival countries to look for new sources of renewable energy and to encourage people to transition from using non-renewable sources. In addition, taxing fossil fuels is a successful way to cut down on their use. In addition, fossil fuels increase production costs and degrade the environment. Consequently, fossil fuel energy consumption will be lower, will lower CO_2 emissions in the top 10 tourist arrival countries, and will ensure environmental compatibility by improving energy efficiency. A recent study by Balaguer and Cantavella [110] found that education actually had a detrimental effect on increasing environmental quality, which is counterintuitive. These results show that without an ecologically relevant curriculum, education alone cannot curb CO_2 emissions. If we want to reap the benefits of education without contributing to environmental degradation by increasing people's purchasing power and energy consumption, we need a comprehensive set of environmental laws. To enhance the environmental advantages of education, appropriate policy choices include environmental material, increasing media awareness, and training the workforce on energy efficiency [111–113]. So, the governments of these countries should re-arrange the education system so that education can motivate people to recycle household garbage and use water and energy resources more wisely. Environmental deterioration in these countries is increasing as trade grows. Therefore, in considering this issue, the governments of these nations should assure energy efficiency and the importation of green technologies that aid in climate mitigation. Trade will therefore encourage the spread of green technologies, which will improve environmental quality. Arabian countries may apply environmental taxes to minimize pollution. Environmental taxes will, over the course of time, have a considerable impact on both Romania and Sweden in terms of the reduction in emissions of greenhouse gases [114]. Environmental taxes work in various ways: some people think before harming the environment, and the government earns money that it can spend to improve the environment.

7. Limitations and Future Research

The present research was conducted on the top ten Arabian nations. However, future research could be conducted on the regional level in the Middle East to obtain a bigger picture or other regions such as Asian clusters and the South Asian Association for regional

cooperation (SAARC) to either refute or corroborate the current study's position [115–118]. Future research may be addressed to find the current actions taken to reduce CO_2 emissions. The study's main drawback is that panel studies generally suffer from aggregation bias, which obscures the results because economic systems vary considerably between nations. If a greater number of studies are carried out for the Arabian region, they may offer more insights regarding the implications for policy. To overcome this problem, each investigation's future aim is to use disaggregated data in subsequent analyses.

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Abbreviation

EKC	Environmental Kuznets curve
GDP	Gross domestic product
CO_2	Carbon dioxide
CSD	Cross-sectional dependency
PHH	Pollution haven hypothesis
SH	Slope heterogeneity
MG	Mean group
CCEMG	Common correlated effects mean group
AMG	Augmented mean group

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