

Article

Impact of Oil Price, Economic Growth and Urbanization on CO₂ Emissions in GCC Countries: Asymmetry Analysis

Haider Mahmood ^{1,*} , Alam Asadov ² , Muhammad Tanveer ³ , Maham Furqan ⁴ and Zhang Yu ^{5,6}

¹ Department of Finance, College of Business Administration, Prince Sattam Bin Abdulaziz University, Al-Kharj 11942, Saudi Arabia

² Department of Finance, College of Business Administration, Prince Sultan University, Rafha Street, Riyadh 11586, Saudi Arabia; aasadov@psu.edu.sa

³ Prince Sultan University, Rafha Street, Riyadh 11586, Saudi Arabia; mtanveer@psu.edu.sa

⁴ School of Public Policy, Oregon State University, Corvallis, OR 97331, USA; furqanm@oregonstate.edu

⁵ School of Economics and Management, Chang'an University, Xi'an 710064, China; zhangyu19@foxmail.com

⁶ Department of Business Administration, ILMA University, Karachi 75190, Pakistan

* Correspondence: h.farooqi@psau.edu.sa; Tel.: +966-115887037

Abstract: Oil prices and rapidly increasing urbanization could have a long-lasting impact on the environment in oil-abundant Gulf Cooperation Council (GCC) countries. Therefore, the environmental role of oil price, economic growth, and urbanization on CO₂ emissions should be tested. The present study investigates the impact of oil price, economic growth, and urbanization on CO₂ emissions in those countries, considering asymmetrical relationships. For this purpose, a nonlinear autoregressive distributive lag cointegration approach is applied in GCC countries during the 1980–2019 period, and cointegration is corroborated in all investigated models. Long-run results show that rising economic growth positively affects CO₂ emissions in Kuwait, Oman, Qatar, and Saudi Arabia. Decreasing economic growth positively affects CO₂ emissions in Bahrain, Kuwait, Qatar, and the United Arab Emirates (UAE). Moreover, the rising oil price has a positive impact on CO₂ emissions and shows a scale effect in Oman, Qatar, and Saudi Arabia. Moreover, it has a negative effect and corroborates technique and composition effects in Kuwait and the UAE. Further, decreasing oil prices has a positive impact on CO₂ emissions in Bahrain and has a negative effect in Kuwait and the UAE. Lastly, urbanization positively affects CO₂ emissions in Bahrain, Oman, Qatar, and the UAE. Economic growth is found asymmetrical in all GCC countries, and the asymmetrical effect of oil price is also observed in all GCC countries except the UAE.

Keywords: oil price; economic growth; urbanization; CO₂ emissions; asymmetry; GCC countries



Citation: Mahmood, H.; Asadov, A.; Tanveer, M.; Furqan, M.; Yu, Z. Impact of Oil Price, Economic Growth and Urbanization on CO₂ Emissions in GCC Countries: Asymmetry Analysis. *Sustainability* **2022**, *14*, 4562. <https://doi.org/10.3390/su14084562>

Academic Editor: Anna Mazzi

Received: 23 February 2022

Accepted: 8 April 2022

Published: 11 April 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Oil, being one of the most valuable natural resources globally, can play a major role in regulating economic and other socioeconomic indicators in a Country. It is especially true for oil-exporting countries such as those in the Gulf Cooperation Council (GCC) region since a significant chunk of the region's income is from oil exports. Hence, an increase in Oil Price (OP) would naturally increase their revenue and bring economic prosperity. Nevertheless, the consequence of that for the energy industry and environmental indicators is not necessarily the same. Therefore, it is crucial to understand how oil prices impact the usage of energy resources and influence CO₂ emissions in a country. However, as the COVID-19 pandemic hit the global economy and growth in markets across the world plummeted, the impact of the pandemic on GCC's regional economy was not an anomaly. An 18% sharp decline was observed in the first quarter of 2020 in the global economy due to COVID-19. The global oil market was notably affected by the declined demand for fuel, and oil prices started sharply dropping. Accordingly, the oil industry in the GCC region has been facing a crisis. Due to this decline being a major source of income, economic

activities in the region are also compromised. The sudden decline in global oil consumption, and the consequential drop in oil production and prices in 2020 undoubtedly affected the real income. The global economy was projected to grow from an estimated 2.9% in 2019 to a higher pace of 3.3% in 2020. However, the end result turned out to be a significant drop in the growth of a global economy that actually contracted by -3.5% in 2020 due to the impact of the COVID-19 pandemic [1,2]. Accordingly, due to social distancing and stay-at-home policies, the transportation and oil sector was affected the most due to a lack of mobility [3–6]. However, the global economy started recovering from the pandemic in 2021 and early 2022 where the growth of the global economy reached an estimated 5.9% in 2021 and is expected to grow at 4.4% in 2022 [7]. Respectively, oil prices have also started to recover, but it has been very volatile in the past decade. For instance, the OPEC basket price went from a high of USD109.45 per barrel in January 2012 to a low of USD14.31 on 24 April 2020, during the COVID-19 pandemic. Following the Russian war on Ukraine, the OPEC basket price reached the newest peak of USD128.46 per barrel on 9 March 2022 [8,9].

Hence, a policy question remains on how GCC countries can shape the oil price policies to cope with the revenues of the region to deal with the problem of changing demand for oil and its price and to control environmental indicators. Oil is a price-inelastic product due to its compulsory nature of demand in all types of industries including the transport sector, household use, manufacturing, etc. Hence, optimum oil pricing policies are needed for the GCC region to balance between oil revenues and environmental quality. We aim to find the asymmetrical effects of oil price on CO₂ emissions because rising or falling oil price policy would not necessarily have the same environmental impact [10]. Hence, the estimated asymmetrical elasticity parameters of this study would support the oil pricing policies in both cases of rising and falling oil prices, considering their environmental impact.

Considering the substantial contribution of the oil sector to the GCC economy, the decline in both demand and price of oil has widespread implications for the economy and other socioeconomic factors in the region. The price of oil determines the economic growth metrics in GCC countries and also leads to understanding the direction of the region's environmental profile and carbon footprint. Since our planet is facing many environmental challenges, including biodiversity loss, high levels of pollution and CO₂ emissions, and desertion of plains. Indraganti and Boussaa [11] claimed that GCC's emissions have been higher than the global average. For instance, the global total ecological footprint was 1.8 hectares per person. For the UAE, this figure was as high as 11.9 hectares per person, and for Kuwait and Saudi Arabia, it was 7.6 and 4.6 hectares per person, respectively [12]. These high emissions are mainly due to activities in both production and consumption of petroleum-based products. Kanaboshi et al. [13] mentioned that the Paris Agreement has a robust implication for oil refineries worldwide and plays a significant role in reducing their CO₂ emissions by applying stricter policies and emission caps. Since oil refineries could play a substantial role in CO₂ emissions, all oil-exporting countries need to adhere to those rules [14,15]. To meet the Kyoto Protocol and Paris Agreement, the countries in the Middle East have to apply proactive environmental policies to curb the environmental impact of activities in the oil sector and implement appropriate emission control strategies to make the oil sector more environmentally friendly.

Being a hub of oil production, the GCC region is the focus of policymakers worldwide and can play important role in finding the solution to counter the environmental side effects of the oil sector. GCC economies carry a major percent of global oil reserves and production. Moreover, these economies also carry a significant portion of world natural gas reserves and production [16]. On the other hand, GCC had a renewable energy capacity that is lower than 1% of its total energy requirement in the year 2018 [17] while contributing more than 3% of global CO₂ emissions in the year 2019 [18]. Hence, GCC economies are carrying a significant chunk of world oil and gas reserves and production, which does have environmental consequences for GCC economies and the world as a whole. Increasing world oil prices motivates the GCC economies to produce more nonrenewable energy which is also responsible for energy depletion. For instance, Alkhateeb and Mahmood [19]

found that increasing oil prices are increasing the energy depletion in the GCC economies, which is a threat to energy sustainability for future generations. In addition, rising oil prices would also have environmental consequences because most of the economic activities in the GCC region depend on the oil sector. Estimating the asymmetrical effects of oil prices on CO₂ emissions would pave the way to reducing environmental problems of the oil sector in the GCC region with the help of oil pricing policies. The asymmetrical analyses would be helpful in particular for policy decisions in case of any oil prices rise or decline. Moreover, the outcomes of this research would equally be helpful for meeting the challenges of global environmental agencies, would benefit the regional environment policymakers, and would also provide partial guidance on reducing the global warming problem. The research outcome would also help meet environmental challenges for other oil-producing countries and regions.

On the energy consumption side, Al-Maamary et al. [20] provided a theoretical context on the matter. They investigated the GCC region to analyze the role that oil prices play in using renewable and other energy sources. They mentioned that in terms of energy use, the GCC region has not been as efficient in the past, and even now, energy usage in the region is growing much faster than the economy's growth. In short, it indicates that there is a lot more energy being used than the benefits this use brings to the economy. It implies that the cost of energy consumption is higher, and the countries need to take some actions to make their energy profile more sustainable. Regulating the activities in the energy sector is also crucial because even with rising oil prices, if these countries earn higher revenue, that economic benefit would increase energy usage at a much faster pace which would eventually ruin the environment.

Due to excessive reliance on fossil fuels, especially oil as a primary export, it is harder for the GCC region to devise a more renewable-energy-focused policy [21]. Due to their high dependence on oil exports, all of the GCC countries are among the top 25 of per capita CO₂ emissions globally, which is an incredibly alarming fact. Understanding the role of OP and other factors in the CO₂ emissions of GCC is essential for the region to devise policies that would let it meet its 2030 renewable energy targets. Investing more in renewable energy could be the best solution to meet environmental goals [22]. While some countries in GCC are attempting to install more awareness about renewable energy and promote innovation in alternative energy, there is still a lot of room for improvement [23]. Moreover, those efforts are not at par with global standards and are not efficient enough for the region to meet its 2030 targets.

There is some interesting economic literature that analyses relations between growth, oil prices, urbanization, and CO₂ emissions in GCC countries. For instance, in an attempt to quantify the impact of oil-induced growth on the environment, Mahmood and Furqan [24] have conducted linear and quadratic analyses to verify the Environmental Kuznets Curve (EKC) in a GCC panel. Similarly, Majeed et al. [25] have examined the effect of urbanization on emissions in the GCC region. To the best of our knowledge, no study has explored the asymmetrical impact of growth on emissions in a GCC region yet. However, some studies in other developing countries such as Pakistan and India evidence the existence of such asymmetry [26,27]. Moreover, the literature also suggests that conducting an asymmetrical analysis of the relationship between OP and emissions can be beneficial in the context of GCC [27–29]. Moreover, Mahmood and Furqan [16] did spatial analyses to find the aggregate impact of oil revenues on different greenhouse gas (GHG) emissions in the whole GCC region. Still, asymmetrical effects of oil price and economic growth on CO₂ emissions focusing on separate analyses of each GCC economy are missing. In the current environment of very volatile oil prices, as they dropped deep during the COVID-19 pandemic and have sharply risen during recovery and due to geopolitical tensions in Ukraine, it is vital to explore this matter in more detail.

The past literature has ignored the importance of asymmetry analyses in the relationship between oil price and CO₂ emissions in all GCC countries. Hence, the present study is highly motivated to conduct asymmetry analyses of oil price, economic growth, and CO₂

emissions relationships in each economy of the GCC region separately, which would help see where the GCC countries are headed in meeting their emission reduction targets. How much environmental targets can be achieved with increasing or decreasing oil price policies in each country of the GCC region because all GCC economies might not be responded equally to a similar change in oil price. Oil price would have a scale effect on the economy through increasing income and energy demand in GCC oil-dependent economies. On the other hand, increasing oil prices would also become a source of revenue for governments of GCC countries to finance the cleaner technologies in existing production processes or to shift the industry from dirty production processes to cleaner types of industries, which are termed as techniques and composition effects [30,31]. In times of increasing oil prices, there is a chance that technique and composition effects outweigh the scale effect and increasing oil prices become opportunities for a pleasant environment in some GCC economies. On the other hand, the inverse situation may also happen. In addition, it is not necessary that increasing oil price could have the same effect on any economic and environmental performance as decreasing oil price [32]. Therefore, the exact effect of increasing and decreasing oil prices on CO₂ emissions of each single GCC economy is a research question, which the present research is going to explore in all GCC countries. Malik et al. [33] have explored this research question in the case of the oil-importing country Pakistan. Still, the gap exists in GCC literature and the present study will fill it. In the same way, economic growth can also have an asymmetrical effect on CO₂ emissions due to the presence of scale, technique, and composition effects, which has been explored in the case of India and Pakistan [26,27]. However, the asymmetrical effect of economic growth on CO₂ emissions is missing in the case of GCC countries, which is a research question for these economies. Hence, the present research aims to explore this research question in the case of each single GCC economy. Our results are expected to help aid an understanding of the consequences and strength of the effects of oil price and economic growth on CO₂ emissions in GCC countries.

2. Literature Review

Theoretically speaking, when a country witnesses more economic growth, there is a chance of more economic and industrial activities, which can inevitably increase CO₂ emissions. Many studies have analyzed the role of macro- and micro-economic and socio-economic aspects on CO₂ emissions and the environment. The most significant determinant of CO₂ emissions is economic growth as per the established literature. Many studies have investigated this issue in-depth. Some studies focus on testing the EKC in economic growth and pollution emissions relationships, while others test the symmetrical or asymmetrical effects of economic growth on pollution emissions. Moreover, different instruments have been utilized in testing such relationships as per the objectives of the studies and the most prominent drivers of pollution emissions in an economy or a group of economies. In a symmetry analysis, Namahoro et al. [34] found the differential effects of economic growth on emissions while analyzing countries with various income levels and found that energy intensity increases the emissions. Furthermore, their findings also confirm that increase in the use of renewable energy reduces emissions. In the causality analyses, Pejovic et al. [35] pointed out a two-way relationship between growth and emissions where those variables have affected each other. However, their paper also found that extensive use of renewable energy helped reduce emissions. In addition, governance indicators of any economy would help to transform towards renewable sources [36]. Moreover, economic growth after a threshold level would help promote renewable consumption [37–42].

Mahmood [43] corroborated the EKC in GCC countries and an increase in exports accelerated emissions. Mahmood et al. [44] also documented the positive impact of exports on CO₂ emissions in North Africa. Adom et al. [45] corroborated that income accelerated emissions in Senegal and Morocco. Some literature has also been investigated which validates the existence of asymmetry between growth and emissions relationship [26,27]. The increasing economic growth was increasing emissions, and decreasing growth showed an insignificant effect on CO₂ emission, which signifies the importance of conducting

asymmetry analyses in the relationship between economic growth and pollution emissions. Salahuddin and Gow [46] tested the association between income and emissions in GCC countries. The results of their analysis confirmed the existence of a positive relationship between growth and energy usage. However, no significant association was found between growth and emissions. It seems contradictory to many other studies on the topic, but such an outcome could be due to the lack of asymmetrical analysis. Nevertheless, their analysis supports the fact that the adoption of renewable energy and proactive energy conservation policies can reduce CO₂ emissions in the region.

Among the other important determinants, urbanization is also a crucial determinant of emissions, and some literature investigated the urbanization and pollution emissions nexus in symmetry analyses. Meng et al. [47] stated that both urbanization and industrialization increase carbon emissions. They also argued that urbanization increases emissions faster than industrial growth. Their results concluded that while focusing on industrial development and rapid urban activity, countries should estimate the potential benefit and environmental harm to the region since the cost can sometimes be higher than the benefit, and this might leave a permanent negative impact on the environment. The study results confirmed the findings of many other analyses conducted on a similar topic, which showed that industrialization and urbanization seem to harm the environment [48–50]. Wang et al. [51] discussed the effect of urbanization, income level, and other variables contributing to higher CO₂ emissions. They broke down the countries into various categories regarding their income levels, which provided another layer of context to their analysis. They suggest that CO₂ emissions are energy-led, and that is the case for all income levels. Therefore, whether it's a low-, middle- or high-income country, they should pay special attention to the speed of urbanization to protect the environment.

There is also some literature on GCC and the Middle East and North Africa (MENA) countries investigating the nexus between urbanization and emissions. For instance, Mahmood et al. [52] performed asymmetrical analyses on the role of urbanization in determining emissions. Their research was focused on Saudi Arabia, and they utilized data from 1968–2014. Urbanization and emissions have a positive relationship, and urbanization leads to more activity and higher emissions. They also found that the environmentally degrading effects of increasing industrialization have more impact on emissions than the benefits from declining industrialization. Abdallah and Abugamos [53] utilized the semi-parametric approach and explored a similar idea for the MENA region and mentioned that emissions increase with urbanization and rising income. They suggested policies to curb the negative impacts of growth and urbanization. According to them, it can be achieved through multiple channels, including stricter regulation on energy use and adopting more advanced and environment-friendly technology to achieve economic growth and urbanization while still keeping the environment clean and sustainable. Mahmood et al. [10] investigated urbanization, the oil sector, and CO₂ emissions and found a positive effect of urbanization and income on CO₂ emissions in Saudi Arabia. Being an oil-abundant country and the largest oil exporter in the Middle East, Saudi Arabia's oil sector has significant effects on its economy and other socioeconomic indicators. Therefore, there is no doubt that the oil sector in the country would have an inevitable level of CO₂ emissions and can have significant adverse environmental effects. Moreover, Majeed et al. [25] found that oil abundance improved and urbanization deteriorated the environment in the GCC region.

The oil sector and oil price could affect the CO₂ emission in both oil-importing and exporting countries. In their symmetrical analysis, Mensah et al. [54] explored the issue for the African continent using a panel cointegration approach. The panel data from 1990–2015 for 22 African countries were used, and the sample contained both oil-exporting and non-exporter countries. For both categories, a unilateral causal relationship was found between oil price (OP) and income, fossil fuel usage, and emissions. This causality between various proxies of OP and pollution was also found in other studies [55,56]. Sadorsky [57] stated that rising OP negatively affected renewable energy consumption in G7 countries. The result implies that higher oil prices and oil market volatility can lead to higher CO₂ emissions

by reducing renewable consumption. The result has a strong implication, especially for oil-exporting countries, to control and regulate oil prices and ensure reduce fossil fuel usage so that the adverse effects on the environment are not irreversible.

Literature has also focused on the possible asymmetrical effect of the oil sector on pollution emissions. For instance, in their asymmetrical analysis, Zheng et al. [58] argued that oil shocks might significantly impact emissions, and oil supply can also impact carbon allowance prices. With a notable role of oil supply and prices in determining emissions and carbon allowance prices, there is a clear pathway and policy framework for countries to regulate and control their emissions and the oil market, including its supply and price, to meet their long-term environmental goals. There seems to be a substitute relationship between oil and gas prices, and if oil price distortions are controlled, CO₂ emissions can be reduced significantly. Regulating oil prices provides a better governance framework to prevent the use of oil, and as a result, CO₂ emission reduction targets can be met [59]. In spatial analysis, Li et al. [60] studied energy prices and their impact on CO₂ emissions in China. They showed that energy prices could have a significantly negative impact on CO₂ emissions both directly and indirectly, and these energy prices have spillover effects.

In the symmetrical analyses, Wang et al. [61] showed a cointegration between oil dependency, emissions, and income. The countries under analysis in the study, including China and India, have high oil demand and also have a high CO₂ emission rate. However, this cointegration is corroborated in countries such as France and the US. The results suggested oil-exporting high CO₂ emission countries to diversify their oil channels and devise more holistic energy policies that can design action plans for the long term and help maintain a balance between oil demand and CO₂ emissions. They also suggested supporting renewable energy market penetration so that the oil dependency of these countries can be reduced, and their economic and industrial activities can be cleaner. Bohringer et al. [62] argued that domestic CO₂ emissions could be reduced through a uniform economywide emission-pricing policy, and CO₂ revenues can be recycled in Germany. To meet its environmental goals, Germany has set higher CO₂ emission prices, resulting in higher CO₂ revenue from households. In the asymmetrical analyses, Malik et al. [33] used a nonlinear Auto-Regressive Distributive Lag (NARDL) approach to analyze OP and income and their impact on emissions in Pakistan. They explored the relationship both from the symmetric and asymmetric perspectives. In the symmetric model, in the short-run, OP accelerated emissions. However, in the long-term, the relationship is the opposite, and oil prices reduce emissions. In the asymmetric model, rising oil prices were seen to reduce emissions, and a fall in these prices increased long-run emissions. Likewise, Shahbaz et al. [27] have documented a negative asymmetrical impact of OP on emissions in an oil-importing country, namely India.

Ignoring asymmetrical analysis in GCC countries, literature has probed the role of oil prices on CO₂ emissions. Aldubyan and Gasim [29] analyzed the role of energy price reforms in Saudi Arabia and explored demand response and environmental and economic impacts. Investigating the role of energy or oil prices is crucial for Saudi Arabia since a significant chunk of the country's income comes from the oil sector. They mentioned that lower energy prices lead to higher energy demand and consumption. However, it also has a caveat since there is an inevitable waste of energy and relevant resources with a rapid increase in demand. That dynamic leads to less focus on energy efficiency in general, let alone renewable or sustainable energy. Therefore, regulating energy prices can, in turn, lead to direct and indirect effects on emissions. If energy prices are kept at a competitive level, its usage can be efficient, ensuring that the environmental goals are also sustained. They also pointed out that with residential power and gas prices being income inelastic, a new policy complexity is added to the equation that needs to be considered while formulating energy prices and underlying policies in the country. Another study conducted on OP and emissions in the GCC region provides practical insights on the topic. Alkathery and Chaudhuri [28] studied the OP, emissions, and energy equities in the GCC region. They concluded the co-movement of oil prices, emissions, and global clean energy production.

They confirmed the spillover effects of these variables and market volatilities and suggested revenue diversification policies.

Al-Maamary et al. [20] argued that with increasing oil prices and higher energy consumption, CO₂ emissions are rising much faster than economic growth, indicating that the GCC region is inefficient in its energy use. The results imply that the cost of higher energy prices, more economic activity, and higher energy consumption are higher than the benefit from all the economic activity and revenue generation. In a spatial analysis, Mahmood and Furqan [24] conducted a detailed study on the Gulf region from 1980–2014. The study was targeted at exploring the nonlinear impact of oil rents on emissions of various types, including CO₂, CH₄, N₂O, and GHG. The EKC was found to exist between income and emissions, and a similar trend of oil rents was seen with various investigated emissions. Oil rents were also seen to positively impact CO₂ emissions, indicating that with higher oil rent, CO₂ emissions tend to rise. For N₂O and oil rents, this relationship was U-shaped which means that as oil rents increase, N₂O initially declined but eventually started growing again. Moreover, urbanization was found to positively impact CO₂ and other emissions, and so did energy use. It implies that Gulf countries should find a better way to regulate energy use, urbanization, oil prices, and other socioeconomic and financial aspects to contain their environmentally degrading effects. Sadik-Zada and Gatto [63] discussed the scenario of oil abundance and high CO₂ emissions in oil-producing countries. They found a causality from OP to emissions. They suggested tertiarization for oil-abundant nations to eliminate these negative effects of OP and promote de-carbonization. Oil prices are expected to impact the stock market in the GCC region [64,65]. In turn, it can affect the economic and environmental health of the region. Considering the relationship between the variables in the available literature, it would be an insightful analysis to understand how economic growth, oil prices, and urbanization may impact CO₂ emissions in the GCC region. Considering oil prices is especially important in GCC economies since oil is their primary export and source of income. The analysis would add more color to the regional context and how oil pricing and other factors can be controlled to sustain its growth while ensuring a clean environment. After all, if the environment is being negatively impacted, this causes more harm than benefit to the region at the end of the day. The symmetric impact of growth, oil price, and urbanization in the GCC literature is conducted in the different studies in past literature [20,24,28,63]. However, a review of literature has signified the importance of asymmetrical analysis in the relationship between economic growth and pollution emissions [26,27] and the relationship between oil prices and pollution emissions [27,33,58]. These asymmetrical analyses are ignored in GCC economies, which we try to investigate.

3. Methods

3.1. Research Design

At first, we deliver our model to test the hypothesized relationship in a linear setting. Then, oil price and economic growth will be split into increasing and decreasing series using Shin et al. [66]. Afterward, we will apply Ng and Perron's [67] unit root test to check the suitability of variables to proceed with cointegration analyses. In the presence of first difference stationary I(1) or a mixed order of level stationary I(0) and I(1), we may move for the cointegration test proposed by Pesaran et al. [68]. If cointegration is validated in the model, then we may proceed to estimate the long and short-run results. All procedures are mentioned in detail in the following section and a brief outlook is provided in Figure 1 for a graphical display.

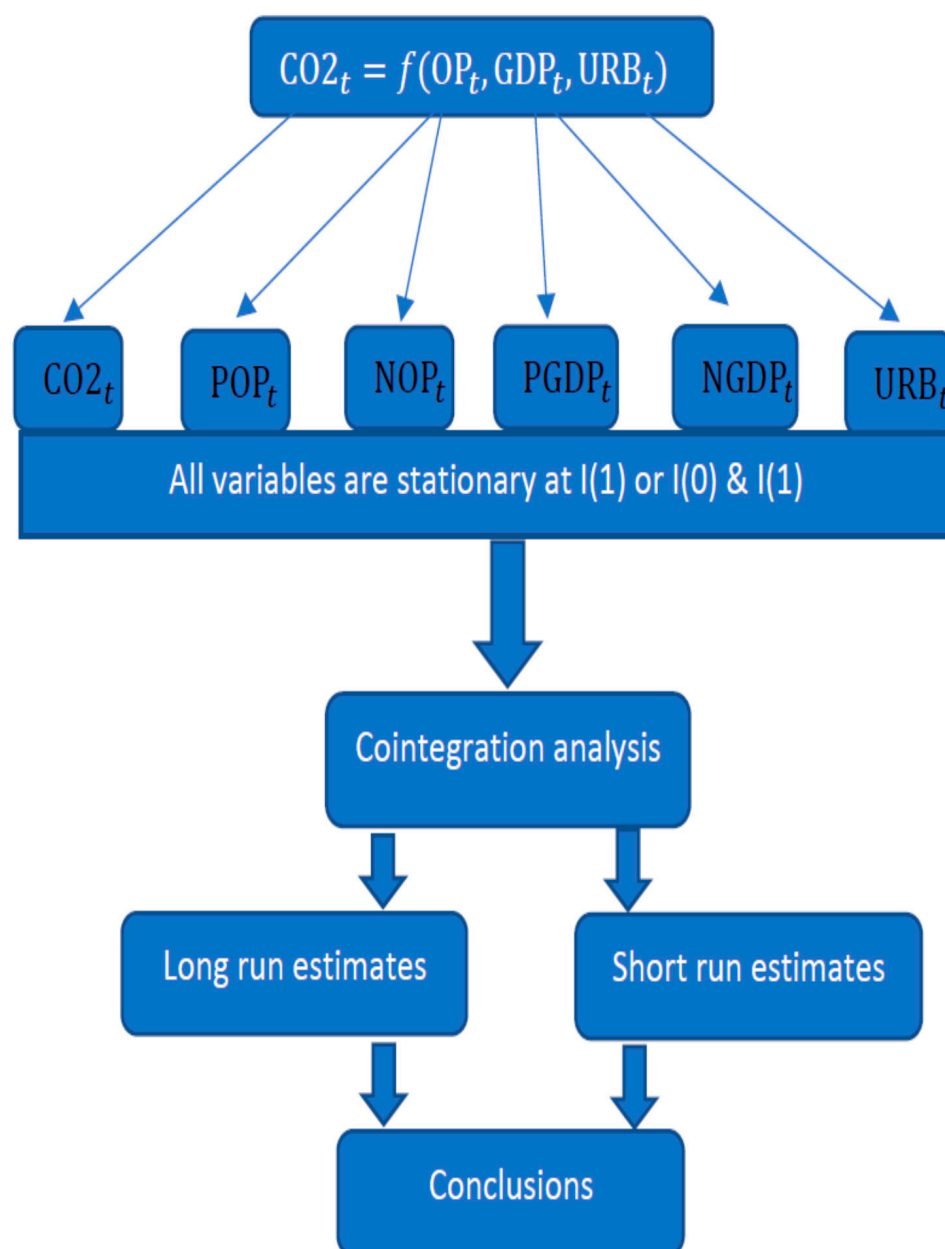


Figure 1. Research Design.

3.2. Data Analysis

We follow Malik et al.'s [33] asymmetrical model to observe the relationship between oil price, economic growth, and CO₂ emissions. This study also tests the quadratic effects of economic growth to test the EKC. However, the present study is not intended to test the EKC, which has already been investigated in the GCC region [24]. Following Malik et al. [33] and Shahbaz et al. [26,27], our research aims to test the asymmetrical effects of economic growth and oil price on CO₂ emissions. At first, the symmetrical model is presented as follows:

$$CO2_t = f(OP_t, GDP_t, URB_t) \quad (1)$$

where $CO2_t$ is CO₂ emissions per capita in tons of CO₂ per person. OP_t is oil price USD per barrel. GDP_t is Gross Domestic Product (GDP) per capita at constant US dollars and URB_t is the urban population percentage of the total. Economic growth could have a positive effect on CO₂ emissions. This is because increasing economic growth results in increased economic activities, which need the energy to run. Keeping the energy efficiency

and type of energy use constant, increasing economic growth would increase the energy consumption and could pollute the environment by emitting CO₂ and other GHG emissions, which is termed as scale effect. On the other hand, increasing economic growth may also motivate the economies to use cleaner technologies for production and/or renewable energy sources, which may reduce the pollution level in the economies and is called the technique effect. Moreover, the economies may switch to cleaner production processes and toward lesser polluting industries, which would help reduce emissions and is called composition effects [30,31]. Therefore, economic growth could have a positive effect on CO₂ emissions if the scale effect is dominant on technique and composition effects. On the other hand, economic growth could have a negative effect on CO₂ emissions if technique and composition effects are dominant on the scale effect. The net positive or negative effect of economic growth on CO₂ emissions is an empirical question, which the present study is going to explore in the case of GCC countries. In the same way, oil prices could have a positive or negative effect on CO₂ emissions due to scale or technique, and composition effects, respectively. This is because increasing oil prices could contribute to economic growth, exports, and government revenues of the GCC countries, which would affect the energy demand and environment in the region. In addition, increasing oil prices would increase the capacity of the government to promote renewable energy projects in an economy by giving financial incentives and support. Thus, a positive environmental effect of increasing oil prices is expected if technique and composition effects are dominant on the scale effect. Otherwise, increasing oil prices may have environmental consequences due to the net scale effect. Moreover, the effect of increasing oil prices on macroeconomic performance could not certainly be the same as declining oil price [32]. Hence, asymmetry may also be expected between oil prices and CO₂ emissions relationship. Likewise, the asymmetry may be hypothesized between the growth and CO₂ emissions relationship [26,27]. Urbanization generally accelerates the energy demand due to greater use of vehicles, electrical products, etc. Moreover, industrial activities may also be enhanced with increasing aggregate demand from the urban population. Hence, urbanization is expected to increase pollution emissions. The asymmetries of effects of oil prices and GDP per capita are introduced in the model, following Shin et al. [66]. The asymmetrical impact of urbanization is ignored because urbanization has a mostly rising trend in all GCC countries. Shin et al. [66] suggested the way to find the positive and negative partial sum of independent variables as follows:

$$POP_t = \sum_{j=1}^t OP_j^+ = \sum_{j=1}^t \max(\Delta OP_j, 0) \quad (2)$$

$$NOP_t = \sum_{j=1}^t OP_j^- = \sum_{j=1}^t \min(\Delta OP_j, 0) \quad (3)$$

$$PGDP_t = \sum_{j=1}^t GDP_j^+ = \sum_{j=1}^t \max(\Delta GDP_j, 0) \quad (4)$$

$$NGDP_t = \sum_{j=1}^t GDP_j^- = \sum_{j=1}^t \min(\Delta GDP_j, 0) \quad (5)$$

POP_t and PGDP_t capture the partial sums of positive changes in OP_t and GDP_t in Equations (2) and (4), respectively. In the same way, NOP_t and NGDP_t capture the partial sums of negative changes in respective variables in Equations (3) and (5), respectively. The positive and negative series of oil prices and economic growth will help us to answer the research questions of whether economic growth and oil prices have symmetrical or asymmetrical effects on the CO₂ emissions in GCC countries. In addition, we apply the Wald test to statistically validate the research question of asymmetry in the hypothesized relationships. Using NOP_t, POP_t, NGDP_t, and PGDP_t and the ARDL model of Pesaran et al. [68], the nonlinear ARDL can be presented as follows:

$$\begin{aligned} \Delta CO_2_t = & a_0 + a_1 CO_2_{t-1} + a_2 POP_{t-1} + a_3 NOP_{t-1} + a_4 PGDP_{t-1} + a_5 NGDP_{t-1} + \\ & a_6 URB_{t-1} + \sum_{i=1}^{l-1} b_{1i} CO_2_{t-i} + \sum_{i=0}^{m-1} (b_{2i} POP_{t-i} + b_{3i} NOP_{t-i}) + \\ & \sum_{i=0}^{n-1} (b_{4i} PGDP_{t-i} + b_{5i} NGDP_{t-i}) + \sum_{i=0}^{m-1} b_{6i} URB_{t-i} + U_t \end{aligned} \quad (6)$$

$$\Delta\text{CO2}_t = \partial\text{ECT}_{t-1} + \sum_{i=1}^{l-1} b_{1i}\text{CO2}_{t-i} + \sum_{i=0}^{m-1} (b_{2i}\text{POP}_{t-i} + b_{3i}\text{NOP}_{t-i}) + \sum_{i=0}^{n-1} (b_{4i}\text{PGDP}_{t-i} + b_{5i}\text{NGDP}_{t-i}) + \sum_{i=0}^{m-1} b_{6i}\text{URB}_{t-i} + V_t \quad (7)$$

The cointegration could be tested by applying the bound test on ($H_0: a_1 = a_2 = a_3 = a_4 = a_5 = a_6$), after selecting the optimum lag length through Schwarz Information Criterion (SIC). A rejection of H_0 would validate cointegration in the model. The critical F-statistics of Kripfganz and Schneider [69] are utilized for bound testing, which are efficient in a small sample size. A negative parameter of ECT_{t-1} may prove the short relation. $-a_2/a_1$, $-a_3/a_1$, $-a_4/a_1$, $-a_5/a_1$, and $-a_6/a_1$ are the long-run effects and b_{1i} , b_{2i} , b_{3i} , b_{4i} , b_{5i} , and b_{6i} are short-run effects. Afterwards, the Wald test can be applied on hypotheses $-a_3/a_1 = -a_4/a_1$ and $-a_4/a_1 = -a_5/a_1$ to test long-run asymmetrical effects of OP and economic growth, respectively.

3.3. Data Sources

To test the hypothesized relationships mentioned in the previous section, we need the macroeconomic data. CO_2 emissions per capita in tons are collected from the Global Carbon Atlas [18]. Oil price USD per barrel is sourced from the Central Bank of Saudi Arabia [70]. GDP per capita at constant US dollars and urban population percentage of the total population are taken from World Bank [71]. All variables are taken in a natural logarithm from 1980–2019. Before cointegration analysis, all data will be tested and validated for stationarity using Ng and Perron's [67] test, which is a pre-condition for cointegration analysis.

4. Results

Table 1 reveals the unit root results from the time series of all targeted GCC countries. The variables POP_t and NOP_t are common for all countries and are non-stationary at the level and stationary at first difference. Moreover, PGDP_t , NGDP_t , URB_t , and CO2_t are non-stationary at the level in all countries except URB_t in Qatar and PGDP_t in the UAE, which are stationary at the level. At the first difference, all variables are stationary in all countries. Hence, the integration level is one for four GCC countries and mixed in Qatar and the UAE.

Table 2 displays the bound testing results and diagnostic tests for selected ARDL models based on SIC. The estimated F-statistics from the bound test show the existence of cointegration at 1% level of significance in models of Kuwait, Qatar, Saudi Arabia, and the UAE since all of their F-statistics are higher than the 1% upper bound critical value which is 4.329. Similarly, cointegration is also found in the models of Oman at 5% and Bahrain at 10% levels of significance since their F-statistics are higher than the upper bound critical values, these are 3.7704 and 3.3408, respectively. Hence, all countries' models are cointegrated. Moreover, reported F-statistics and their corresponding p -values of diagnostic tests confirm that estimated models are econometrically robust. Since none of the diagnostic test results showed p -values lesser than 0.1 (i.e., significant even at 10%), there is no evidence to believe that any of the countries' models suffer from the problem of heterogeneity, serial correlation, normality, or improper functional form. In addition, CUSUM and CUSUMsq tests verify the stability of estimated parameters in Figure 2.

Table 1. Unit root.

Country	Variable	MZa	MZb	MPT	MSB
Bahrain	POP_t	−0.0656	−0.0324	0.4944	18.5816
	NOP_t	−9.5232	−2.1658	0.2274	9.6368
	PGDP_t	−3.2589	−1.1597	0.3559	25.5485
	NGDP_t	−3.4294	−1.2916	0.3766	26.2357
	URB_t	−6.1239	−1.7411	0.2843	14.8726
	CO2_t	−13.6642	−2.5834	0.1891	6.8414

Table 1. Cont.

Country	Variable	MZa	MZb	MPT	MSB
Kuwait	PGDP _t	−8.8484	−2.0505	0.2317	10.4891
	NGDP _t	−5.8098	−1.6945	0.2917	15.6667
	URB _t	−5.6782	1.5335	0.2701	15.7200
	CO2 _t	−11.9566	−2.4167	0.2021	7.7712
Oman	PGDP _t	−0.4768	−0.2419	0.5073	57.5659
	NGDP _t	−2.7532	−0.8395	0.3049	23.8444
	URB _t	−5.5421	−1.6423	0.2963	16.3810
	CO2 _t	−2.8681	−1.0695	0.3729	28.2037
Qatar	PGDP _t	−1.7777	−0.9383	0.5278	50.9040
	NGDP _t	−3.9506	−1.4050	0.3556	23.0600
	URB _t	−16.4571 **	−2.7373 **	0.1663 **	6.3062 **
	CO2 _t	−4.3162	−1.4540	0.3369	20.9705
Saudi Arabia	PGDP _t	−7.4840	−1.8231	0.2436	12.3952
	NGDP _t	−3.6095	−1.2388	0.3432	23.5837
	URB _t	−8.6080	−1.9948	0.2317	10.8539
	CO2 _t	−9.5151	−2.1810	0.2292	9.5780
The UAE	PGDP _t	−16.4549 **	−2.8597 **	0.1739 **	5.5897 **
	NGDP _t	−9.3294	−2.0652	0.2214	10.1418
	URB _t	−7.5229	−1.8818	0.2501	12.2310
	CO2 _t	−7.4991	−1.9289	0.2572	12.1668
Bahrain	ΔPOP _t	−18.3560 **	−3.0023 **	0.1636 **	1.4328 **
	ΔNOP _t	−18.8997 **	−3.0733 **	0.1626 **	4.8262 **
	ΔPGDP _t	−17.7053 **	−2.9726 **	0.1679 **	5.1636 **
	ΔNGDP _t	−17.0449 **	−2.9150 **	0.1712 **	5.3545 **
	ΔURB _t	−15.3405 *	−2.7694 *	0.1805 *	5.9408 *
	ΔCO2 _t	−17.5360 **	−2.9509 **	0.1683 **	5.2573 **
	ΔPGDP _t	−16.0981 **	−2.8049 **	0.1742 **	5.8518 **
	ΔNGDP _t	−18.7519 **	−3.0610 **	0.1632 **	4.8655 **
Kuwait	ΔURB _t	−16.3367 **	−2.8567 **	0.1749 **	5.5862 **
	ΔCO2 _t	−18.7607 **	−3.0627 **	0.1633 **	4.8575 **
	ΔPGDP _t	−15.9734 *	−2.8124 *	0.1761 *	5.7863 *
	ΔNGDP _t	−18.5924 **	−3.0047 **	0.1616 **	5.1673 **
Oman	ΔURB _t	−14.5283 *	−2.6854 *	0.1848 *	6.3290 *
	ΔCO2 _t	−15.1762 *	−2.7454 *	0.1809 *	6.0589 *
	ΔPGDP _t	−17.9083 **	−2.9432 **	0.1644 **	5.3832 **
	ΔNGDP _t	−18.3902 **	−3.0309 **	0.1648 **	4.9638 **
Qatar	ΔURB _t	−16.7376 **	−2.8909 **	0.1727 **	5.4562 **
	ΔCO2 _t	−18.4067 **	−3.0322 **	0.1647 **	4.9597 **
	ΔPGDP _t	−18.1792 **	−3.0076 **	0.1654 **	5.0566 **
	ΔNGDP _t	−16.8689 **	−2.8965 **	0.1717 **	5.4484 **
Saudi Arabia	ΔURB _t	−18.4247 **	−3.0332 **	0.1646 **	4.9581 **
	ΔCO2 _t	−18.4324 **	−3.0344 **	0.1646 **	4.9525 **
	ΔPGDP _t	−17.0185 **	−2.9027 **	0.1706 **	5.4405 **
	ΔNGDP _t	−16.6933 **	−2.8847 **	0.1728 **	5.4848 **
The UAE	ΔURB _t	−17.8841 **	−2.9442 **	0.1646 **	5.3722 **
	ΔCO2 _t	−18.0464 **	−3.0038 **	0.1665 **	5.0502 **

Note: * shows stationarity at 10% and ** indicates stationarity at a 5% significance level.

Table 2. Bound and diagnostic tests.

Country	F-Stat.	Hetero.	Serial Corr.	Normality	Functional Form
Bahrain	3.4337 *	1.6220 (0.1487)	0.0493 (0.9520)	0.8564 (0.6517)	0.6662 (0.4227)
Kuwait	11.5696 ***	1.4238 (0.2238)	1.2791 (0.2946)	1.5407 (0.4521)	0.3251 (0.2275)

Table 2. Cont.

Country	F-Stat.	Hetero.	Serial Corr.	Normality	Functional Form
Oman	4.0715 **	0.6978 (0.6735)	1.5003 (0.2240)	2.9834 (0.2250)	0.1824 (0.8565)
Qatar	4.9553 ***	0.4733 (0.9118)	2.0965 (0.1458)	1.0333 (0.5941)	1.4517 (0.1578)
Saudi Arabia	5.1305 ***	1.8294 (0.1168)	0.0278 (0.9726)	1.4369 (0.4875)	0.7781 (0.4426)
The UAE	5.2967 ***	0.3642 (0.9309)	1.1551 (0.3301)	1.1929 (0.5261)	0.9168 (0.3671)
Critical F-values					
	Lower bound	Upper bound			
At 1%	3.3828	4.6578			
At 5%	2.6202	3.7704			
At 10%	2.2599	3.3408			

Note: *, **, and *** show cointegration at 10%, 5% and 1% level of significance, respectively. () contains *p*-values.

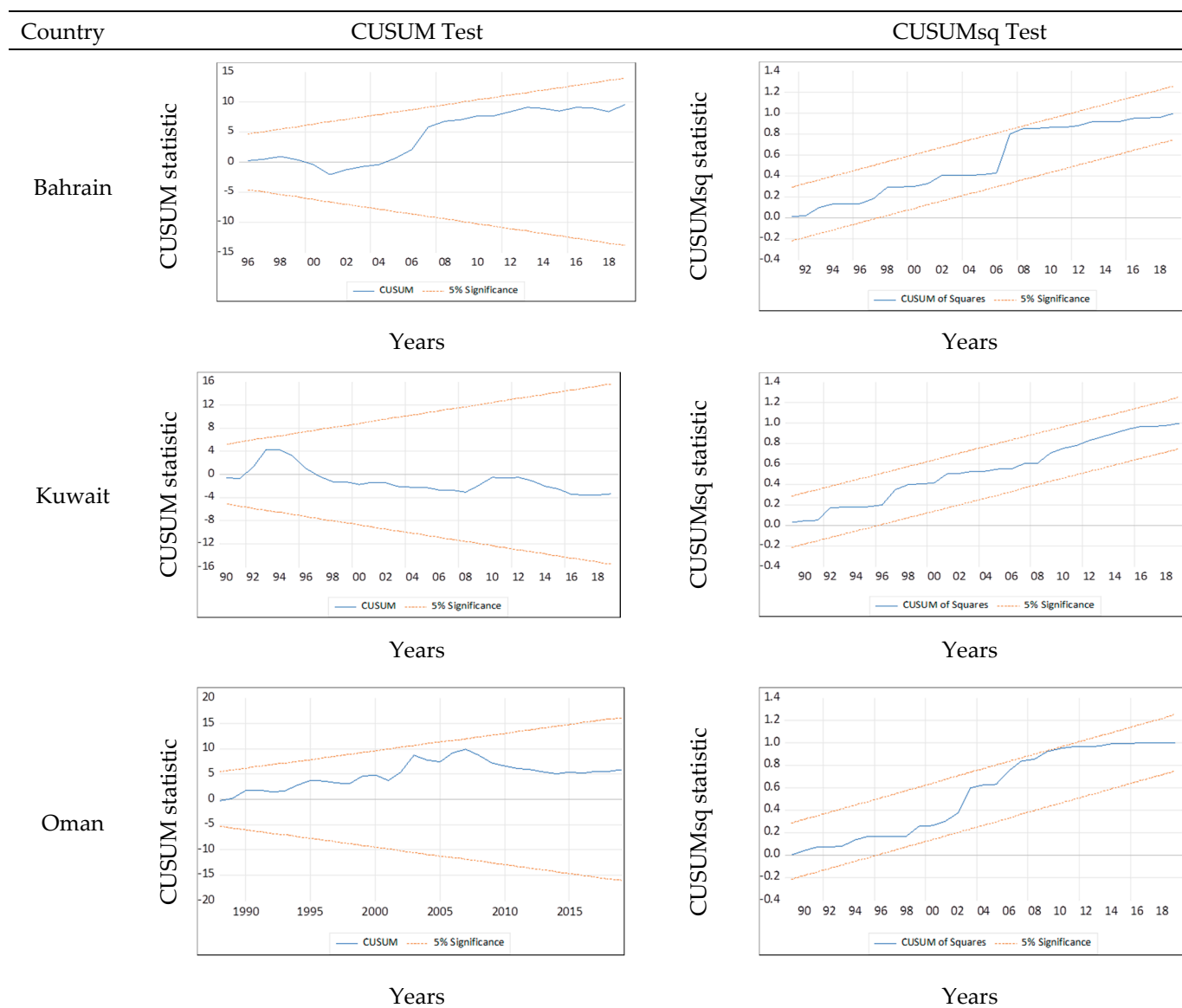


Figure 2. Cont.

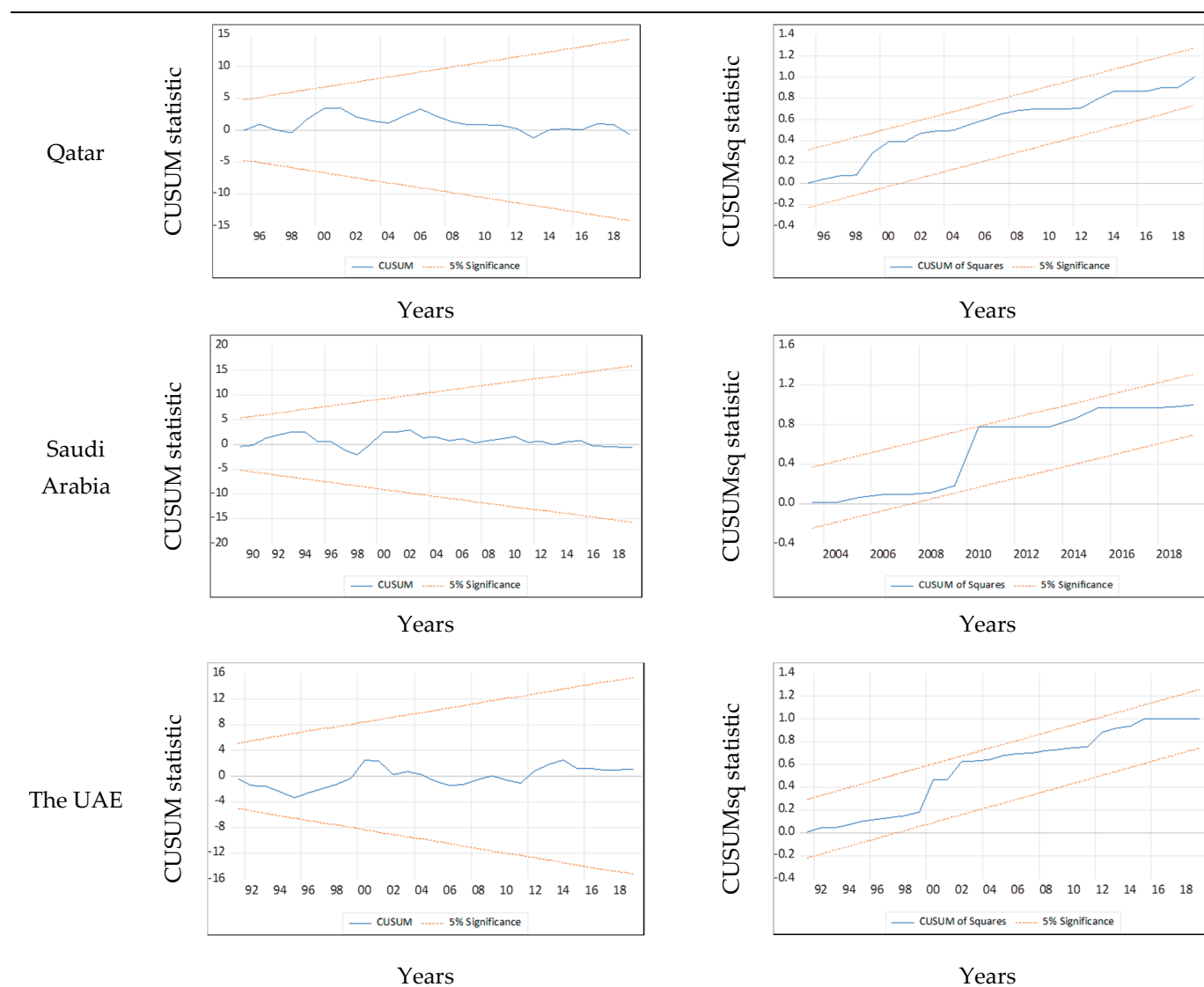


Figure 2. CUSUM and CUSUMsq Tests.

Table 3 shows the long-run impact of growth, oil price, and urbanization on the CO₂ emissions in GCC countries. Increasing growth ($PGDP_t$) positively affects CO₂ emissions in Kuwait, Qatar, Oman, and Saudi Arabia, as 1% increase per capita GDP increases CO₂ emissions in those countries by 0.97%, 1.62%, 1.59%, and 2.16%, respectively. This increasing growth increases emissions in these countries. Furthermore, decreasing growth ($NGDP_t$) positively affects CO₂ emissions in the UAE, Bahrain, Qatar, and Kuwait, as 1% decrease in per capita GDP reduces CO₂ emissions by 0.63%, 2.27%, 0.95%, and 0.62%, respectively. Hence, falling growth helps reduce emissions in these countries. Nevertheless, we did not find a significant impact of increasing growth on CO₂ emissions in the cases of Bahrain and the UAE and of declining growth on CO₂ emissions in cases Oman and Saudi Arabia.

Increasing oil price (POP_t) positively affects CO₂ emissions in Oman, Qatar, and Saudi Arabia, as a 1% increase in oil price increases CO₂ emissions by 0.25%, 0.80%, and 0.22%, respectively. Increasing oil price (POP_t) has a negative effect on CO₂ emissions in Kuwait and the UAE, where 1% increase in oil price reduces CO₂ emissions by −0.69% and 0.97%, respectively. Decreasing oil price (NOP_t) positively affects emissions in Bahrain, where a 1% reduction in oil price reduces CO₂ emissions by 0.19%. Moreover, NOP_t has a negative effect on emissions in Kuwait and the UAE, where a 1% reduction in oil price increases

CO₂ emissions by 0.45% and 0.46%, respectively. Hence, decreasing oil price is contributed to the rise of CO₂ emissions in these countries. Urbanization positively affects emissions in Oman, the UAE, Bahrain, and Qatar, where a 1% increase in urbanization increases CO₂ emissions by 1.72%, 1.05%, 4.23%, and 1.64% respectively.

Table 3. Long-run Estimates.

Country	Variable	Coefficient	S.E.	t-Stat.	p-Value
Bahrain	PGDP _t	−0.9677	0.9730	−0.9946	0.3299
	NGDP _t	2.2686	1.2710	1.7848	0.0869
	POP _t	0.0991	0.0891	1.1112	0.2775
	NOP _t	0.1889	0.0537	3.5153	0.0018
	URB _t	4.2342	1.9152	2.2108	0.0368
	Intercept	−185.1240	85.0302	−2.1772	0.0395
Kuwait	PGDP _t	0.9718	0.1035	9.3890	0.0000
	NGDP _t	0.6204	0.1820	3.4084	0.0019
	POP _t	−0.6929	0.0848	−8.1694	0.0000
	NOP _t	−0.4523	0.1508	−2.9993	0.0055
	URB _t	1.5449	4.3430	0.3557	0.7246
	Intercept	−3.9674	19.8671	−0.1997	0.8431
Oman	PGDP _t	1.5928	0.4930	3.2310	0.0029
	NGDP _t	0.2719	0.8920	0.3049	0.7625
	POP _t	0.2452	0.0715	3.4312	0.0017
	NOP _t	0.0890	0.0911	0.9768	0.3362
	URB _t	1.7162	0.8131	2.1108	0.0430
	Intercept	8.1755	3.1336	2.6089	0.0139
Qatar	PGDP _t	1.6179	0.6144	2.6333	0.0143
	NGDP _t	0.9479	0.4514	2.1001	0.0460
	POP _t	0.7957	0.4587	1.7346	0.0951
	NOP _t	−0.2890	0.2387	−1.2109	0.2373
	URB _t	1.6399	0.5150	3.1842	0.0039
	Intercept	−69.6971	23.1844	−3.0062	0.0059
Saudi Arabia	PGDP _t	2.1591	0.5164	4.1811	0.0002
	NGDP _t	−0.4461	0.5847	−0.7629	0.4515
	POP _t	0.2245	0.1119	2.0069	0.0538
	NOP _t	−0.1214	0.0827	−1.4679	0.1525
	URB _t	−3.4670	6.6869	−0.5185	0.6079
	Intercept	10.4717	1.7482	5.9902	0.0000
The UAE	PGDP _t	0.9350	0.5955	1.5701	0.1290
	NGDP _t	0.6326	0.3120	2.0270	0.0534
	POP _t	−0.9665	0.2160	−4.4736	0.0001
	NOP _t	−0.4605	0.1533	−3.0049	0.0060
	URB _t	1.0546	0.2994	3.5229	0.0017
	Intercept	−36.1921	5.8647	−6.1711	0.0000

The asymmetry is corroborated by the effect of economic growth on the CO₂ emissions in Bahrain, Oman, Saudi Arabia, and the UAE, with the significant or insignificant impact of either PGDP_t or NGDP_t variable. Moreover, the Wald test with a null hypothesis of symmetry finds that F-statistics (*p*-values) are 2.2995(0.0298) and 9.5543(0.0048) in Kuwait and Qatar models. The null hypothesis is rejected for both countries' models, and asymmetries are validated in Kuwait and Qatar. Furthermore, the asymmetrical effect of OP on emissions is also corroborated in Bahrain, Oman, Qatar, and Saudi Arabia, with the significant or insignificant impact of either POP_t or NOP_t variable. The Wald test is applied to the null hypothesis of the symmetrical effect of oil price on CO₂ and finds that F-statistics (*p*-values) are 3.6762(0.0651) and 0.3641(0.3978) in Kuwait and the UAE models, respectively. The null hypothesis is rejected for Kuwait but not for the UAE. Hence, the oil price has an asymmetrical (symmetrical) effect on CO₂ emissions in Kuwait (the UAE).

Table 4 shows the short-run effects. Both ΔPGDP_t and ΔNGDP_t in the short run have a positive impact on emissions in Kuwait, Qatar, and Saudi Arabia. Hence, increasing growth

is increasing CO₂ emissions, and decreasing growth is helping in reducing CO₂ emissions. Increasing oil price (ΔPOP_t) positively impacts emissions in Bahrain and negatively in Qatar and the UAE. Moreover, its one-year lag term (ΔPOP_{t-1}) has a negative impact in Bahrain and Qatar and a positive impact in the UAE. Decreasing oil price (ΔNOP_t) has a positive effect on CO₂ emissions in the UAE and negatively affects Bahrain. So, decreasing oil prices helps reduce CO₂ emissions in the UAE and accelerates emissions in Bahrain. Urbanization (ΔURB_t) positively affects emissions in Bahrain, Oman, and Saudi Arabia. Hence, it contributes to CO₂ emissions in GCC in the short run. A one-year lag term of urbanization (ΔURB_{t-1}) positively affects emissions in Bahrain and Qatar.

Table 4. Short-run Estimates.

Country	Variable	Coefficient	S.E.	t-Stat.	p-Value
Bahrain	ΔPGDP_t	0.4740	0.7235	0.6552	0.5186
	ΔNGDP_t	0.0468	0.6962	0.0672	0.9470
	ΔPOP_t	0.3009	0.0947	3.1781	0.0040
	ΔPOP_{t-1}	−0.2975	0.0903	−3.2965	0.0030
	ΔNOP_t	−0.1409	0.0760	−1.8531	0.0762
	ΔURB_t	1.5076	0.5994	2.5154	0.0190
	ΔURB_{t-1}	2.1550	0.6412	3.3611	0.0026
	ECT_{t-1}	−0.7834	0.1429	−5.4813	0.0000
Kuwait	ΔPGDP_t	0.9643	0.1505	6.4063	0.0000
	ΔNGDP_t	0.8929	0.2175	4.1045	0.0003
	ΔPOP_t	−0.1745	0.1126	−1.5500	0.1320
	ΔNOP_t	0.0127	0.0971	0.1305	0.8970
	ΔURB_t	1.5330	4.3285	0.3542	0.7258
Oman	ECT_{t-1}	−0.9923	0.1004	−9.8865	0.0000
	ΔPGDP_t	0.0156	0.3132	0.0498	0.9606
	ΔNGDP_t	0.2187	0.7126	0.3069	0.7610
	ΔPOP_t	0.1972	0.0735	2.6843	0.0116
	ΔNOP_t	0.0716	0.0771	0.9285	0.3603
	ΔURB_t	−1.3803	0.6997	−1.9727	0.0575
	ECT_{t-1}	−0.8043	0.1379	−5.8324	0.0000
	ΔPGDP_t	0.6602	0.3307	1.9968	0.0568
Qatar	ΔPGDP_{t-1}	0.8977	0.3219	2.7887	0.0100
	ΔNGDP_t	0.5977	0.3335	1.7926	0.0852
	ΔPOP_t	−0.5133	0.1909	−2.6887	0.0126
	ΔPOP_{t-1}	−0.4206	0.1961	−2.1448	0.0419
	ΔNOP_t	−0.1823	0.1595	−1.1427	0.2640
	ΔURB_t	2.2088	2.2765	0.9702	0.3412
	ΔURB_{t-1}	0.6813	0.2635	2.5862	0.0159
	ECT_{t-1}	−0.6306	0.0962	−6.5584	0.0000
Saudi Arabia	ΔPGDP_t	1.3464	0.6460	2.0843	0.0457
	ΔNGDP_t	−0.2782	0.4946	−0.5625	0.5780
	ΔPOP_t	0.1400	0.1064	1.3152	0.1984
	ΔNOP_t	−0.0757	0.0865	−0.8751	0.3885
	ΔURB_t	1.2654	0.4448	2.8452	0.0079
	ECT_{t-1}	−0.6236	0.1041	−5.9928	0.0000
	ΔPGDP_t	0.7867	0.6903	1.1396	0.2652
	ΔNGDP_t	0.2279	0.2738	0.8322	0.4132
The UAE	ΔPOP_t	−0.5004	0.1293	−3.8719	0.0007
	ΔPOP_{t-1}	0.5560	0.1169	4.7573	0.0001
	ΔNOP_t	0.3875	0.1552	2.4970	0.0195
	ΔURB_t	3.1248	1.3663	2.2871	0.0309
	ECT_{t-1}	−0.8414	0.1362	−6.1754	0.0000

5. Discussion

Results show that increasing growth positively affects CO₂ emissions in Kuwait, Qatar, Oman, and Saudi Arabia. Hence, increasing growth has environmental consequences in these countries, which is also corroborated in MENA economies [53], ignoring asymmetrical

analyses. Moreover, Adom et al. [45] have corroborated the positive effect of growth in the symmetrical analyses of African countries. In the asymmetry analyses, some studies have found the positive impact of increasing economic growth on CO₂ emissions in oil-importing countries [26,27]. Our results could not validate the statistically significant effect of increasing economic growth on the CO₂ emissions in Bahrain and the UAE. It may be claimed due to a fact that both economies of Bahrain and the UAE have more than 50% share of GDP in the service sector, which is more environmentally friendly compared to the industrial sector. Moreover, the UAE and Kuwait have a diversification policy for a lesser dependence on the oil sector and have also achieved some diversification from the oil sector compared to other GCC economies by focusing on the tourism sector. Further, our results display that decreasing economic growth positively impacts CO₂ emissions in the UAE, Bahrain, Qatar, and Kuwait and could not affect CO₂ emissions in Saudi Arabia and Oman. It reflects a fact that both Saudi and Omani economies are heavily industrialized, and their major imports are machinery and transport equipment, which are majorly responsible for pollution emissions in these economies. However, Shahbaz et al. [26,27] found an insignificant effect of decreasing growth in asymmetry analyses of oil importers, contradicting our estimated results in the case of oil exporter economies. The GCC literature is specifically missing the analyses of the asymmetrical relationship between economic growth and CO₂ emissions. Here, the present study has contributed to GCC literature by inquiring about this issue and delivers the country-specific environmental effects of any positive or negative movement of economic growth in the GCC economies, which should be kept in mind while tracing the economic growth policies. In the asymmetry analyses, increasing and decreasing economic growth show either positive or insignificant effects on CO₂ emissions in Bahrain, Oman, Saudi Arabia, and the UAE, which corroborate the asymmetry in the relationship between growth and CO₂ emissions. Moreover, both increasing and decreasing economic growth showed positive effects on CO₂ emissions in Kuwait and Qatar, and asymmetry is corroborated with different magnitudes of effects of increasing and decreasing economic growth on CO₂ emissions applying the Wald test. In conclusion, the research question of asymmetry in the relationship between economic growth and CO₂ emissions is proven in all GCC countries.

Increasing oil price positively affects CO₂ emissions in Oman, Qatar, and Saudi Arabia. So, increasing oil price has a scale effect on these economies and increases CO₂ emissions. A pioneering study of Sadorsky [57] in this context has also reported the same results in G7 countries' symmetrical analyses. Moreover, in the symmetrical analyses, Al-Maamary et al. [20] reported the positive effect of OP on CO₂ emissions in GCC economies. Sadik-Zada and Gatto [63] have found this finding in the case of oil producer countries. The literature also reported similar results in asymmetrical analyses [33]. However, our results show that increasing oil prices has a negative effect on CO₂ emissions in Kuwait and the UAE. Here, the technique and composition effects are dominant on the scale effect of increasing oil prices in Kuwait and the UAE and are helped to shift the economies toward cleaner technologies and production processes. For instance, Kuwait and the UAE have diversification policies in their long-run plans and are also more diversified from the oil sector compared to other GCC countries. Thus, increasing oil prices helps these economies to invest the oil revenues into diversification policies to have net pleasant environmental effects of increasing oil price. The negative impact of rising oil price has also been reported in oil-importing countries in asymmetrical analyses [27,33] and symmetrical analyses [60]. Our results show that decreasing oil price has a positive effect on emissions in Bahrain. Hence, reducing oil price decreases emissions in Bahrain. However, decreasing oil price has a negative effect on emissions in Kuwait and the UAE. The literature reports the asymmetrical negative impact of reducing OP on emissions in oil importer countries [27,33]. Moreover, our results show that the asymmetrical effect of OP on emissions is corroborated by the significant or insignificant impact of increasing and decreasing oil price in Bahrain, Oman, Qatar, and Saudi Arabia. On the other hand, both increasing and decreasing oil prices have positive effects on CO₂ emissions in Kuwait

and the UAE. However, asymmetry is corroborated by the Wald test because of different magnitudes of effects in Kuwait but not in the UAE. On whole, the research question of asymmetry in the relationship between oil prices and CO₂ emissions is validated in all GCC countries except the UAE.

Urbanization positively affects emissions in Oman, the UAE, Bahrain, and Qatar. Urbanization carries an average upward trend in the sample period of all GCC countries. Hence, the increasing urban population is putting pressure on the environment in terms of increasing CO₂ emissions. It is because of the fact that GCC countries are the consumers of heavy energy-consuming cars and electrical appliances, and most of the energy demand is served by fossil-fuel energy sources. The rapid urbanization in GCC countries is increasing the demand for such consumer products, which has environmental consequences for the GCC region due to excessive fossil fuel consumption. Moreover, the increasing urbanization may also affect the production-side pollution emissions because industrial activities may rise because of the increasing demand for products in urban areas, and most industries in the GCC region are primarily dependent on fossil fuel consumption. In past literature, Majeed et al. [25] and Mahmood and Furqan [24] also shared the same finding of a positive relationship between urbanization and CO₂ emissions in the case of GCC countries. Moreover, a vast literature reported the same results in the case of other countries [10,47–50,52,53].

6. Conclusions

The GCC region has a vast oil sector, which would affect the economies and environments of GCC countries. Moreover, rapidly increasing urbanization and economic growth in the GCC region would also contribute to environmental degradation. Some past research has been conducted on the issue, ignoring the asymmetry effects of oil prices and economic growth on CO₂ emissions. Hence, the present study aims at examining the asymmetrical effects of oil price and economic growth on CO₂ emissions in oil abundant GCC countries using a nonlinear ARDL cointegration approach from 1980–2019, which would help in identifying the environmental effect of any rising or falling oil price and economic growth policies.

Results showed that cointegration is validated in all GCC countries' models. In the long run, increasing economic growth carries a positive impact on CO₂ emissions in all GCC countries except Bahrain and the UAE. Decreasing growth positively impacts CO₂ emissions in four out of six GCC economies. The effect of economic growth is found asymmetrical in all GCC countries. Increasing oil price positively impacts CO₂ emissions in Oman, Qatar, and Saudi Arabia and has a negative impact on CO₂ emissions in Kuwait and the UAE. Hence, it has a net scale effect in Oman, Qatar, and Saudi Arabia and has the net technique and composition effects in Kuwait and the UAE. On the other hand, decreasing oil price has a positive impact on CO₂ emissions in Bahrain and has a negative impact in Kuwait and the UAE. The effect of oil prices is asymmetrical in all GCC countries except the UAE. Urbanization has an average positive trend in all GCC countries and has a positive effect on CO₂ emissions in four out of six GCC economies. In the short run, both rising and declining trends of growth show a positive impact on CO₂ emissions in Kuwait, Qatar, and Saudi Arabia. Hence, increasing economic growth increases emissions, and declining growth is found helpful in reducing CO₂ emissions in these three GCC countries. Increasing oil price carries a positive impact on CO₂ emissions in Oman and Bahrain and negatively affects CO₂ emissions in Qatar and the UAE. On the other hand, decreasing oil prices reduces CO₂ emissions in the UAE, but it raises CO₂ emissions in Bahrain. Lastly, we found that urbanization deteriorates the environment in Bahrain, Oman, and Saudi Arabia. In the asymmetry analyses, in the long run, the research question of asymmetry is validated in all GCC countries in the relationship between economic growth and CO₂ emissions. Moreover, the research question of asymmetry in the relationship between oil prices and CO₂ emissions is also corroborated in all GCC countries except the UAE.

Our long-run results suggest that increasing growth has environmental consequences in Kuwait, Oman, Qatar, and Saudi Arabia. So, these high fossil-fuel energy user countries should switch towards cleaner sources of energy and cleaner technologies to reduce the negative environmental consequences of economic growth. Moreover, increasing oil prices carry a positive long-run impact on CO₂ emissions in Oman, Qatar, and Saudi Arabia. Thus, these countries should invest their oil revenues in cleaner technologies and production processes in times of high oil prices, which would help them to control the environmental consequences of increasing oil price. In this way, the net scale effect of rising oil prices would be transformed into net technique and composition effects. Moreover, urbanization has negative environmental consequences in Oman, Bahrain, Qatar, and the UAE. Hence, these countries should impose a carbon tax on energy-intensive urban activities to discourage pollution emissions, and these tax revenues should be utilized to encourage the cleaner use of energy in the urban area. In summary, economic growth is responsible for increasing CO₂ emissions in 4 out of 6 GCC countries and increasing oil price is increasing CO₂ emissions in 3 out of 6 GCC countries. As per ARENA's [17] report, the GCC region is far away from renewable energy transition as less than 1% of energy is sourced from renewable sources. Hence, GCC countries should speed up the renewable energy transition process by installing renewable energy projects on an urgent basis, which would reduce the environmental consequences of rising oil price and economic growth.

Author Contributions: Conceptualization, H.M. and A.A.; methodology, H.M.; software, H.M.; validation, M.T. and A.A.; formal analysis, H.M. and A.A.; investigation, H.M. and A.A.; data curation, M.T.; writing—original draft preparation, H.M., Z.Y. and M.F.; writing—review and editing, H.M., M.F., Z.Y. and M.T.; visualization, H.M.; supervision, H.M.; project administration, H.M.; funding acquisition, M.T. and A.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are publicly available [10,51,52].

Acknowledgments: The authors would like to thank Prince Sultan University for their support and for paying the Article Processing Charges (APC) of this publication in *Sustainability*.

Conflicts of Interest: The authors declare no conflict of interest.

Acronyms and Nomenclature

Acronyms

ARDL	Auto-Regressive Distributive Lag
CH ₄	Methane
CO ₂	Carbon dioxide
GHG	greenhouse gases
CUSUM	Cumulative sum
CUSUMsq	Cumulative sum square
GDP	Gross domestic product
EKC	Environmental Kuznets Curve
GCC	Gulf Cooperation Council
MENA	Middle East and North Africa
NARDL	Nonlinear Auto-Regressive Distributive Lag
N ₂ O	Nitrous oxide
OP	Oil Price
SIC	Schwarz Information Criterion
UAE	United Arab Emirates
US	United States (of America)

Nomenclature

CO_2t	CO ₂ emissions per capita in tons
ECT_{t-1}	The coefficient of the error correction term
GDP_t	GDP per capita at constant US dollars
OP_t	Oil price in USD per barrel
$NGDP_t$	The partial sums of negative changes in GDP _t
NOP_t	The partial sums of negative changes in OP _t
$PGDP_t$	The partial sums of positive changes in GDP _t
POP_t	The partial sums of positive changes in OP _t
URB_t	Urban population percentage of the total

References

1. International Monetary Fund. World Economic Outlook Update, January 2020: Tentative Stabilization, Sluggish Recovery? International Monetary Fund. 2020. Available online: <https://www.imf.org/en/Publications/WEO/Issues/2020/01/20/weo-update-january2020> (accessed on 17 March 2022).
2. International Monetary Fund. World Economic Outlook Update, January 2021: Policy Support and Vaccines Expected to Lift Activity. International Monetary Fund. 2021. Available online: <https://www.imf.org/en/Publications/WEO/Issues/2021/01/26/2021-world-economic-outlook-update> (accessed on 17 March 2022).
3. Khan, S.A.R.; Ponce, P.; Thomas, G.; Yu, Z.; Al-Ahmadi, M.S.; Tanveer, M. Digital Technologies, Circular Economy Practices and Environmental Policies in the Era of COVID-19. *Sustainability* **2021**, *13*, 12790. [CrossRef]
4. Khan, S.A.R.; Ponce, P.; Tanveer, M.; Aguirre-Padilla, N.; Mahmood, H.; Shah, S.A.A. Technological Innovation and Circular Economy Practices: Business Strategies to Mitigate the Effects of COVID-19. *Sustainability* **2021**, *13*, 8479. [CrossRef]
5. Mahmood, H. The Effects of Natural Gas and Oil consumption on CO₂ Emissions in GCC Countries: Asymmetry Analysis. *Environ. Sci. Pollut. Res.* **2022**, 1–17. [CrossRef] [PubMed]
6. Yu, Z.; Khan, S.A.R.; Umar, M. Circular economy practices and industry 4.0 technologies: A strategic move of automobile industry. *Bus. Strategy Environ.* **2022**, *31*, 796–809. [CrossRef]
7. International Monetary Fund. World Economic Outlook Update, January 2022: Rising Caseloads, a Disrupted Recovery, and Higher Inflation. International Monetary Fund. 2022. Available online: <https://www.imf.org/en/Publications/WEO/Issues/2022/01/25/world-economic-outlook-update-january-2022> (accessed on 18 March 2022).
8. OPEC Basket. Oil Price Charts: Opec Basket. 2022. Oilprice.com. Available online: <https://oilprice.com/oil-price-charts/#Opec-Basket> (accessed on 18 March 2022).
9. Organization of the Petroleum Exporting Countries. OPEC: OPEC Basket Price. Organization of the Petroleum Exporting Countries. 2022. Available online: https://www.opec.org/opec_web/en/data_graphs/40.htm (accessed on 18 March 2022).
10. Mahmood, H.; Alkhateeb, T.; Furqan, M. Oil Sector and CO₂ Emissions in Saudi Arabia: Asymmetry Analysis. *Palgrave Commun.* **2020**, *6*, 88. [CrossRef]
11. Indraganti, M.; Boussaa, D. An Adaptive Relationship of Thermal Comfort for the Gulf Cooperation Council Countries: The Case of Offices in Qatar. *Energy Build.* **2018**, *159*, 201–212. [CrossRef]
12. Raouf, M. Climate Change Threats, Opportunities, the GCC Countries, 2008. Retrieved from MEI Website. Available online: <https://www.mei.edu/publications/climate-change-threats-opportunities-and-gcc-countries> (accessed on 18 May 2021).
13. Kanaboshi, H.; Sano, F.; Oda, J.; Akimoto, K.; Onishi, N. Cost-efficient Measures in the Oil Refinery and Petrochemical Sectors for the Reduction of CO₂ Emissions under the Paris Agreement and Air Pollution Under the MARPOL Convention. *Energy Clim. Chang.* **2021**, *2*, 100027. [CrossRef]
14. Mogaddam, A. Allocating the CO₂ Emissions of an Oil Refinery with Aumann–Shapley Prices: Comment. *Energy Econ.* **2020**, *32*, 243–255.
15. Lei, T.; Guan, D.; Shan, Y.; Zheng, B.; Liang, X.; Meng, J.; Zhang, Q.; Tao, S. Adaptive CO₂ Emissions Mitigation Strategies of Global Oil Refineries in All Age Groups. *One Earth* **2021**, *4*, 1114–1126. [CrossRef]
16. Mahmood, H.; Adow, A.H.; Abbas, M.; Iqbal, A.; Murshed, M.; Furqan, M. The fiscal and monetary policies and environment in GCC countries: Analysis of territory and consumption-based CO₂ emissions. *Sustainability* **2022**, *14*, 1225. [CrossRef]
17. Irena. Renewable Energy Market Analysis: GCC 2019. Available online: <https://www.irena.org/publications/2019/jan/renewable-energy-market-analysis-gcc-2019> (accessed on 15 July 2021).
18. Global Carbon Atlas. 2021. Available online: <http://www.globalcarbonatlas.org/en/CO2-emissions> (accessed on 20 June 2021).
19. Alkhateeb, T.T.Y.; Mahmood, H. Oil Price and Energy Depletion Nexus in GCC countries: Asymmetry Analyses. *Energies* **2020**, *13*, 3058. [CrossRef]
20. Al-Maamary, H.; Kazem, H.; Chaichan, M. The Impact of Oil Price Fluctuations on Common Renewable Energies in GCC Countries. *Renew. Sustain. Energy Rev.* **2017**, *75*, 989–1007. [CrossRef]
21. Reiche, D. Energy Policies of Gulf Cooperation Council (GCC) Countries—Possibilities and Limitations of Ecological Modernization in Rentier States. *Energy Policy* **2010**, *38*, 2395–2403. [CrossRef]
22. Mahmood, H. Consumption and Territory based CO₂ Emissions, Renewable Energy Consumption, and Trade Nexus in South America: Spatial Analyses. *Pol. J. Environ. Stud.* **2022**, *31*, 1183–1191. [CrossRef]

23. Praveen, R.; Keloth, V.; Abo-Khalil, A.; Alghamdi, A.; Eltamaly, A.; Tlili, I. An Insight to the Energy Policy of GCC Countries to Meet Renewable Energy Targets of 2030. *Energy Policy* **2020**, *147*, 111864. [\[CrossRef\]](#)
24. Mahmood, H.; Furqan, M. Oil Rents and Greenhouse Gas Emissions: Spatial Analysis of Gulf Cooperation Council Countries. *Environ. Dev. Sustain.* **2021**, *23*, 6215–6233. [\[CrossRef\]](#)
25. Majeed, A.; Wang, L.; Zhang, X.; Muniba; Kirikkaleli, D. Modeling the Dynamic Links among Natural Resources, Economic Globalization, Disaggregated Energy Consumption, Environmental Quality: Fresh Evidence from GCC Economies. *Recourses Policy* **2021**, *73*, 102204. [\[CrossRef\]](#)
26. Shahbaz, M.; Shahzad, S.J.H.; Ahmad, N.; Alam, S. Financial development and environmental quality: The way forward. *Energy Policy* **2016**, *98*, 353–364. [\[CrossRef\]](#)
27. Shahbaz, M.; Sharma, R.; Sinha, A.; Jiao, Z. Analyzing nonlinear impact of economic growth drivers on CO2 emissions: Designing an SDG framework for India. *Energy Policy* **2021**, *148*, 111965. [\[CrossRef\]](#)
28. Alkathery, M.; Chaudhuri, K. Co-movement between Oil Price, Emission, Renewable Energy and Energy Equities: Evidence from GCC Countries. *J. Environ. Manag.* **2021**, *297*, 113350. [\[CrossRef\]](#)
29. Aldubyan, M.; Gasim, A. Energy Price Reform in Saudi Arabia: Modeling the Economic and Environmental Impacts and Understanding the Demand Response. *Energy Policy* **2021**, *148*, 111941. [\[CrossRef\]](#)
30. Grossman, G.M.; Krueger, A.B. Economic growth and the environment. *Q. J. Econ.* **1995**, *110*, 353–377. [\[CrossRef\]](#)
31. Grossman, G.M.; Krueger, A.B. *Environmental Impacts of the North American Free Trade Agreement*; NBER Working Paper; National Bureau of Economic Research: Cambridge, MA, USA, 1991; p. 3914. [\[CrossRef\]](#)
32. Siddiqui, A.; Mahmood, H.; Margaritis, D. Oil Prices and Stock Markets during the 2014–16 Oil Price Slump: Asymmetries and Speed of Adjustment in GCC and Oil Importing Countries. *Emerg. Mark. Financ. Trade* **2020**, *56*, 3678–3708. [\[CrossRef\]](#)
33. Malik, M.; Latif, K.; Khan, Z.; Butt, H.; Hussain, M.; Nadeem, M. Symmetric and Asymmetric Impact of Oil Price, FDI and Economic Growth on Carbon Emission in Pakistan: Evidence from ARDL and Nonlinear ARDL Approach. *Sci. Total Environ.* **2020**, *726*, 138421. [\[CrossRef\]](#)
34. Namahoro, J.; Wu, Q.; Zhou, N.; Xue, S. Impact of Energy Intensity, Renewable Energy, Economic Growth on CO2 Emissions: Evidence from Africa across Regions and Income Levels. *Renew. Sustain. Energy Rev.* **2021**, *147*, 111233. [\[CrossRef\]](#)
35. Pejovic, B.; Karadzic, V.; Dragasevic, Z.; Backovic, T. Economic Growth, Energy Consumption and CO2 Emissions in the Countries of the European Union and the Western Balkans. *Energy Rep.* **2021**, *7*, 2775–2783. [\[CrossRef\]](#)
36. Mahmood, H.; Tanveer, M.; Furqan, M. Rule of Law, Corruption Control, Governance, and Economic Growth in Managing Renewable and Nonrenewable Energy Consumption in South Asia. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10637. [\[CrossRef\]](#)
37. Mahmood, H.; Alkhateeb, T.T.Y.; Tanveer, M.; Mahmoud, D.H.I. Testing the Energy-Environmental Kuznets Curve in the Renewable and Nonrenewable Energy Consumption Models in Egypt. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7334. [\[CrossRef\]](#)
38. Khan, S.A.R.; Quddoos, M.U.; Akhtar, M.H.; Rafique, A.; Hayat, M.; Gulzar, S.; Yu, Z. Re-investigating the nexuses of renewable energy, natural resources and transport services: A roadmap towards sustainable development. *Environ. Sci. Pollut. Res.* **2022**, *29*, 13564–13579. [\[CrossRef\]](#)
39. Yu, Z.; Khan, S.A.R.; Ponce, P.; Zia-ul-Haq, H.M.; Ponce, K. Exploring essential factors to improve waste-to-resource recovery: A roadmap towards sustainability. *J. Clean. Prod.* **2022**, *350*, 131305. [\[CrossRef\]](#)
40. Khan, S.A.R.; Yu, Z.; Umar, M. A road map for environmental sustainability and green economic development: An empirical study. *Environ. Sci. Pollut. Res.* **2022**, *29*, 16082–16090. [\[CrossRef\]](#) [\[PubMed\]](#)
41. Khan, S.A.R.; Godil, D.I.; Yu, Z.; Abbas, F.; Shamim, M.A. Adoption of renewable energy sources, low-carbon initiatives, and advanced logistical infrastructure—A step toward integrated global progress. *Sustain. Dev.* **2022**, *30*, 275–288. [\[CrossRef\]](#)
42. Yu, Z.; Zia-ul-Haq, H.M.; Irshad, A.U.R.; Tanveer, M.; Jameel, K.; Janjua, L.R. Nexuses between crude oil imports, renewable energy, transport services, and technological innovation: A fresh insight from Germany. *J. Petrol. Explor. Prod. Technol.* **2022**, 1–11. [\[CrossRef\]](#)
43. Mahmood, H. The spatial analyses of consumption-based CO2 emissions, exports, imports, and FDI nexus in GCC countries. *Environ. Sci. Pollut. Res.* **2022**, 1–11. [\[CrossRef\]](#)
44. Mahmood, H.; Alkhateeb, T.; Furqan, M. Exports, Imports, Foreign Direct Investment and CO2 Emissions in North Africa: Spatial Analysis. *Energy Reports* **2020**, *6*, 2403–2409. [\[CrossRef\]](#)
45. Adom, P.K.; Bekoe, W.; Amankwah-Mensah, F.; Mensah, J.T.; Botchway, E. Carbon Dioxide Emissions, Economic Growth, Industrial Structure, Technical Efficiency: Empirical Evidence from Ghana, Senegal, Morocco on the Causal Dynamics. *Energy* **2012**, *47*, 314–325. [\[CrossRef\]](#)
46. Salahuddin, M.; Gow, J. Economic Growth, Energy Consumption, CO2 Emissions in Gulf Cooperation Council Countries. *Energy* **2014**, *73*, 44–58. [\[CrossRef\]](#)
47. Meng, G.; Guo, Z.; Li, J. The Dynamic Linkage among Urbanisation, Industrialisation and Carbon Emissions in China: Insights from Spatiotemporal Effect. *Sci. Total Environ.* **2021**, *760*, 144042. [\[CrossRef\]](#)
48. Al-Mulali, U.; Ozturk, L.; Lean, H. The Influence of Economic Growth, Urbanization, Trade Openness, Financial Development, Renewable Energy on Pollution in Europe. *Nat. Hazards* **2015**, *1*, 621–644. [\[CrossRef\]](#)
49. Cherniwchan, J. Economic Growth, Industrialization, the Environment. *Resour. Energy Econ.* **2012**, *34*, 442–467. [\[CrossRef\]](#)
50. Dong, F.; Wang, Y.; Hua, Y.; Zhang, Y. The Process of Peak CO2 Emissions in Developed Economies: A Perspective of Industrialization and Urbanization. *Resour. Conserv. Recycl.* **2019**, *141*, 61–75. [\[CrossRef\]](#)

51. Wang, S.; Li, G.; Fang, C. Urbanization, Economic Growth, Energy Consumption, CO₂ Emissions: Empirical Evidence from Countries with Different Income Levels. *Renew. Sustain. Energy* **2018**, *81*, 2144–2159. [\[CrossRef\]](#)
52. Mahmood, H.; Alkhateeb, T.; Furqan, M. Industrialization, Urbanization and CO₂ Emissions in Saudi Arabia: Asymmetry Analysis. *Energy Rep.* **2020**, *6*, 1553–1560. [\[CrossRef\]](#)
53. Abdallah, A.; Abugamos, H. A Semi-Parametric Panel Data Analysis on the Urbanisation-Carbon Emissions Nexus for the MENA Countries. *Renew. Sustain. Energy Rev.* **2017**, *78*, 1350–1356. [\[CrossRef\]](#)
54. Mensah, I.; Sun, M.; Gao, C.; Sasu, A.; Zhu, D.; Ampimah, B.; Quarcoo, A. Analysis on the Nexus of Economic Growth, Fossil Fuel Energy Consumption, CO₂ Emissions and Oil Price in Africa based on a PMG Panel ARDL Approach. *J. Clean. Prod.* **2019**, *228*, 161–174. [\[CrossRef\]](#)
55. Ji, Q.; Chang, D.; Geng, J. Information Linkage, Dynamic Spillovers in Prices and Volatility between the Carbon and Energy Markets. *J. Clean. Prod.* **2018**, *198*, 972–978. [\[CrossRef\]](#)
56. Hammoudeh, S.; Nguyen, D.; Sousa, R. Energy Prices and CO₂ Emission Allowance Prices: A Quantile Regression Approach. *Energy Policy* **2014**, *70*, 201–206. [\[CrossRef\]](#)
57. Sadorsky, P. Renewable Energy Consumption, CO₂ Emissions and Oil Prices in the G7 Countries. *Energy Econ.* **2009**, *31*, 456–462. [\[CrossRef\]](#)
58. Zheng, Y.; Zhou, M.; Wen, F. Asymmetric Effects of Oil Shocks on Carbon Allowance Price: Evidence from China. *Energy Econ.* **2021**, *97*, 105183. [\[CrossRef\]](#)
59. Wang, X.; Bai, M.; Xie, C. Investigating CO₂ Mitigation Potentials and the Impact of Oil Price Distortion in China's Transport Sector. *Energy Policy* **2019**, *130*, 320–327. [\[CrossRef\]](#)
60. Li, K.; Fang, L.; He, L. The Impact of Energy Price on CO₂ Emissions in China: A Spatial Econometric Analysis. *Sci. Total Environ.* **2020**, *706*, 135942. [\[CrossRef\]](#) [\[PubMed\]](#)
61. Wang, K.; Su, C.; Lobont, O.; Umar, M. Whether Crude Oil Dependence and CO₂ Emissions Influence Military Expenditure in Net Oil Importing Countries? *Energy Policy* **2021**, *153*, 112281. [\[CrossRef\]](#)
62. Bohringer, C.; Rutherford, T.; Schneider, J. The Incidence of CO₂ emissions Pricing under Alternative International Market Responses: A Computable General Equilibrium Analysis for Germany. *Energy Econ.* **2021**, *101*, 105404. [\[CrossRef\]](#)
63. Sadik-Zada, E.; Gatto, A. The Puzzle of Greenhouse Gas Footprints of Oil Abundance. *Socio-Econ. Plan. Sci.* **2021**, *75*, 100936. [\[CrossRef\]](#)
64. Arouri, M.; Rault, C. Oil Prices and Stock Markets in GCC Countries: Empirical Evidence from Panel Analysis. *Int. J. Financ. Econ.* **2011**, *17*, 242–253. [\[CrossRef\]](#)
65. Refai, H.; Zeitun, R.; Eissa, M. Impact of Global Health Crisis and Oil Price Shocks on Stock Markets in the GCC. *Financ. Res. Lett.* **2021**, *45*, 102130. [\[CrossRef\]](#)
66. Shin, Y.; Yu, B.; Greenwood-Nimmo, M. Modelling asymmetric cointegration and dynamic multiplier in an ARDL framework. In *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*; Horrace, W.C., Sickles, R.C., Eds.; Springer Science and Business Media: New York, NY, USA, 2014; pp. 281–314. ISBN 1489980075.
67. Ng, S.; Perron, P. Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica* **2001**, *66*, 1519–1554. [\[CrossRef\]](#)
68. Pesaran, M.H.; Shin, Y.; Smith, R.J. Structural analysis of vector error correction models with exogenous I(1) variables. *J. Econ.* **2001**, *97*, 293–343. [\[CrossRef\]](#)
69. Kripfganz, S.; Schneider, D.C. *Response Surface Regressions for Critical Value Bounds and Approximate p-Values in Equilibrium Correction Models*; Economics Department Discussion Papers Series; Paper Number 19/01; University of Exeter: Exeter, UK, 2019. Available online: <http://www.people.exeter.ac.uk/RePEc/dpapers/DP1901.pdf> (accessed on 18 March 2022).
70. Central Bank of Saudi Arabia. *Annual Data Sheet*; Central Bank of Saudi Arabia: Riyadh, Saudi Arabia, 2021.
71. World Bank. *The Worldwide Governance Indicators*; The World Bank: Washington, DC, USA, 2021.