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The Role of the Circular Economy in Fostering Sustainable Economic Growth in the GCC

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Abstract: Adopting a circular economy (CE) can play a role in achieving economic sustainability for all countries. Material and production waste must be recycled to make better use of limited resources. Developments in the CE need to transition linear economies into circular ones. Although the CE has a role in reaching economic sustainability, few studies have investigated the effect of transitioning to a CE in emerging economies. Thus, it is critical to examine the effect of circular economic influences on economic growth. This paper analyses particular indicators of the CE in the Gulf Cooperation Council (GCC) countries. The analysis employs econometric techniques such as unit root tests, random-effect models, and the autoregressive distributed lag (ARDL) model to examine different components, including environmental, social, and economic. Panel data are used to determine the dependency of circular economic factors on economic growth in GCC countries. The data was collected from the World Bank database covering the years 2000 to 2020. The paper is based on the analysis of the CE filed in GCC countries and intends to contribute to the studies in the field. The results gained from the GCC situation are valuable for both emerging and developing countries looking to include sustainable development measures in their policies and regulations. The findings highlight the importance of the CE to sustainability within GCC countries. This investigation of CE indicators based on the results of the economic model contributes to the empirical literature on the transition to a CE in emerging and developing countries.

Keywords: circular economy; sustainable development; renewable energy; economic growth; CO_2 emission

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1. Introduction

The circular economy (CE) plays a key role globally in sustainable economic systems. Due to the scarcity of resources and the current rate of economic growth, relying on linear production is not practical today [1]. The recycling of materials used in both production and consumption is necessary to maximize the use of finite natural resources. The increased need to convert linear economies to circular ones is being addressed by recent advances in the CE [2,3]. According to Banait [4] and Rodriguez-Anton et al. [5], the CE focuses on the most effective use of resources to create sustainable development, which in turn helps meet environmental, economic, and social goals. An analysis of the CE's role in promoting sustainable economic growth in various nations is thus crucial. Therefore, it is important to analyse the CE's contribution to enhancing sustainable economic growth in different countries [2,6,7].

The adoption of a CE is becoming increasingly crucial for countries across the world, particularly in the face of the growing challenge of climate change. The concept of a circular economy revolves around reducing, reusing, and recycling resources to minimize waste, conserve energy, and decrease the strain on the environment. Recently, countries have been responding actively to climate change, undertaking various initiatives to mitigate its effects and transition towards more sustainable practices. Developing a CE is instrumental in

achieving economic growth while concurrently addressing climate change. By reimagining the traditional linear model, CE emphasizes resource efficiency as resources become scarcer, and recycling and reusing materials becomes imperative. It has been estimated that the widespread adoption of a CE could lead to a significant reduction in CO_2 emissions, helping countries achieve their climate goals [8,9]. Therefore, the development of a CE is pivotal in addressing climate change and achieving long-term economic growth. It allows countries to transition from a linear to a more sustainable and resource-efficient model. The CE not only helps mitigate the impacts of climate change but also creates new opportunities for economic growth [10].

There is a growing need, especially in emerging and developing countries, to transition to a CE as CE strategies enable countries to be more sustainable in using their limited resources. As a result, a novel approach to economic growth that emphasizes reducing, reusing, and recycling consumer and production-related waste is suggested [11]. Accepting this change would promote sustainability by enhancing economic and environmental performance without increasing costs for managing waste or new resources [6,12]. Successfully implementing a CE will benefit rising nations, especially since it will address waste and resource problems, saving money and the environment for future generations.

The concept of the CE is gaining increasing attention worldwide due to its potential to address environmental concerns and promote sustainable development. The countries within the Gulf Cooperation Council (GCC) region are recognising the importance of adopting CE principles to achieve economic growth while simultaneously mitigating environmental and social challenges. From an environmental standpoint, GCC countries face significant environmental pressures resulting from rapid growth, population growth, and the extraction of natural resources. The CE offers a solution by emphasising the reduction, reuse, and recycling of materials, which can contribute to minimizing waste and conserving natural resources. Additionally, transitioning to a CE has the potential to reduce CO_2 emissions, enhance energy efficiency, and promote the use of renewable energy sources, all of which are essential for mitigating the impacts of climate change. Regarding social aspects, the adoption of CE principles in the GCC context can lead to several benefits. It can create new job opportunities, particularly in the fields of waste management, recycling, and renewable energy. This can contribute to economic variation and reduce dependence on traditional energy sources such as oil and gas [13,14]. In terms of economic growth and sustainability, the CE is closely linked. By promoting resource efficiency and reducing waste production, it can enhance economic effectiveness, attract investment, and stimulate growth [15]. Moreover, the CE fosters innovation and the development of new industries and technologies, opening up opportunities for sustainable economic development. The adoption of CE in the GCC context is crucial for addressing environmental challenges, promoting social development, and driving economic growth.

Although the CE plays a role in achieving economic sustainability, few studies have explored the effect of transitioning to a CE and environmental issues in emerging countries [16,17]. Therefore, it is essential to examine the effect of circular economic factors on economic growth. The study considers that GCC countries are emerging economies with high incomes and petroleum-exporting industries. The extent to which the CE is adopted in the emerging economic setting is a serious limitation, especially since most of the literature focuses on developed countries that have robust and available data. Focusing on the relationship between environmental issues and CE in GCC countries, as an example of petroleum-exporting countries, improves the analysis in this special context. This paper examines specific CE indicators in GCC nations with an emphasis on the environmental, social, and economic components of a CE in order to fill this research field gap. The study aims to evaluate the relationship between economic, social, and environmental issues and sustainability in GCC nations as well as to analyse and explain the effect of a CE on the GCC's economic growth.

The importance and originality of this paper is that it explores the CE indicators used in the different literature and evaluates their applicability and limitations in the context of

GCC countries. In addition, the study determines the benefits and challenges of applying CE indicators and suggests some recommendations to improve these indicators. Therefore, the study may be useful for decision-makers in emerging countries that are facing similar issues in adopting a CE. The analysis of the CE presented here is based solely on regression analysis of CE indicators on economic growth in the context of emerging economies. Most CE indicators are not available for GCC countries; therefore, the paper used a proxy for these indicators [18]. The motivation behind using the econometric technique for the collected panel data is to investigate empirically the vital issue of the relationship between the CE indicators and economic growth. The analysis is based on the literature in the European context [7,12,19]; however, the availability of the data in the GCC context limited the expansion of the model.

How CE indicators support economic progress in GCC nations is the key research question addressed in this study. The research also seeks to identify the CE metrics that positively influence economic growth. By assessing the relationship between CE indicators and economic growth—something that has never been conducted before in the context of emerging countries—this study adds to the body of literature. Additionally, it will advance our understanding of the growing empirical literature on the CE and advance both environmental and economic growth.

The general structure of the paper takes the form of six sections as follows. The Section 1 provides the introduction, and the Section 2 presents the literature review. Section 3 addresses the data collection approaches and the underlying methodology. The results and findings of this study are reviewed in Section 4. Section 5 contains a discussion of the model results. Section 6 outlines the conclusion and recommendations for future research work.

2. Literature Review

There is an urgent need to transition from a traditional linear economy to a CE considering the finite resources and the requirement for sustainable development in all countries. The implementation of a CE has gained momentum in various countries around the world, representing a shift towards sustainable economic practices. The experiences of several countries exhibit the positive outcomes and the potential of CE practices. The European countries are a leading example of circularity efforts. Most European countries have developed a comprehensive national strategy and setting to achieve a full CE. This has resulted in reduced waste generation and increased resource efficiency [20]. The experiences of various countries highlight the potential of CE practices to address environmental challenges and promote sustainable development.

The theoretical relationship between the CE and sustainable growth can be illustrated through the examination of their respective goals and procedures [3]. The CE seeks to create a regenerative economic system, where resources are continuously used in the production process. This requires reducing waste, maximizing the use of materials, and promoting recycling practices. On the other hand, sustainable growth entails economic development that focuses on long-term growth, environmental activities, and social well-being. By implementing a CE, businesses and industries can reduce their impact on the environment and contribute to the preservation of natural resources. This, in turn, enhances the potential for sustainable growth. In addition, CE strategies can lead to resource efficiency and innovation in production processes. A shift towards a CE can support economies to be more sustainable and address not only environmental concerns but also social and economic variations [13].

Any economy attempting to apply CE techniques must be built on the three primary pillars of reuse, reduce, and recycle production and consumption materials. However, as pointed out by Korhonen et al. [21], practitioners—i.e., politicians, corporations, business consultants, business organizations, and business foundations—have virtually entirely established and led the practice of the circular economy concept. There are various definitions of the CE in the literature. According to Moraga et al. [22], a circular economy is a type of economic structure in which production, reprocessing, and planning are all handled

as processes. Rodriguez-Anton et al. [5] suggest the CE as a potential remedy for issues such as the growing demand for resources, the fluctuating price of raw materials, and the expanding population and consumption globally.

Yamamoto and Hosoda [23] have adopted a different viewpoint, referring to the CE as a waste management method and rethinking the entire economic model to integrate resources and substantially reduce waste production. The CE is similarly described by the Ellen McArthur Foundation as a system that is restorative or regenerative by intention and design and can be achieved by reducing waste through the improved design of materials, products, systems, and, within this, business models [24]. Kirchherr et al. [25] point out that the CE's primary goal is economic growth while discussing the advantages of applying CE techniques. Furthermore, Morseletto [26] noted that the operational principle of the CE for sustainable development has the potential to result in sustainable development while disentangling economic growth from the adverse effects of resource reduction and environmental degradation.

The literature on the relationship between sustainability and the CE has grown in recent years. Sanguino et al. [27] state that the CE has begun to measure a sustainable economic model, facilitated by innovative business models and cautious customers. According to the United Nations' definition of sustainability, it means that we must fulfil current needs without compromising the ability of future generations to meet their own requirements. Most definitions of sustainability also include considerations for economic growth and social equality. The relationships between the circular economy and the Sustainable Development Goals (SDGs) in the European Union (EU) were examined by Rodriguez-Anton et al. [5]. Their study's findings demonstrate that the circular economy and SDGs have a distinct connection. There is a statistically significant correlation between some CE indicators and the SDGs as well as between some CE indicators and average SDG compliance. This demonstrates that the EU can enact policies that tend to make an economy more circular to attain the intended SDGs.

Several systematic reviews have also been conducted on CE and sustainable development. For example, Corona et al. [2] give a review and critical critique of circularity indicators to achieve sustainable development. According to the study's findings, a suitable circularity meter should prevent the burden of measuring the contribution of circular strategies to sustainable development as a result of moving from decreased material use to higher environmental, economic, or social impacts. A clear allocation of recycling's benefits to recyclers and users of recycled materials should be indicated by such a metric, which should also assess the increased value through improved product utility and economic value-added measurements. Their econometric model's findings revealed a large and favourable association between a circular economy and economic growth, underscoring the critical importance of sustainability, innovation, and investment in no-waste programs for advancing prosperity. Frequent economic, social, and environmental problems surround the adaptation of CE techniques. According to Aziz et al. [28], technology and renewable energy are important for reducing environmental footprints. Environmental degradation can be slowed down by converting more industries to technology and changing the energy market by increasing the proportion of sustainable energy.

For European countries, Mihai et al. [29] examine the development of a few key macroeconomic indicators related to the CE in the energy division. The study concludes that there must be a direct correlation between GDP and renewable resources; as the share of renewable energy increases, so does GDP. There is an inverse relationship between GDP and the unemployment rate, and gas emissions and renewable energy sources are inversely related. As a result, as GDP increases, renewable energy also increases, and the unemployment rate and gas emissions fall. Furthermore, Busu and Trica [7] examine the issue of how to convert the present production-consumption-waste consumption pattern into a circular economy (CE) for 27 EU member states. According to the study, the circular economy model is influenced by resource productivity, labour employed in environmental protection, the recycling rate of waste, and renewable energy.

Sadik-Zada and Loewenstein [16] identify the level of per capita income, the size of oil rents, the proportion of fossil fuel-based electricity generation in the energy mix, and the share of the manufacturing sector in GDP as the primary drivers of carbon dioxide emissions in the oil-rich nations. These findings are in line with recent studies on the relationship between income and the environment in petroleum-exporting countries. Energy indicators and blue economic indicators are not developed enough, according to Sarwar et al. [30] to meet carbon neutrality goals. Evidence from Shafiei and Salim [31] and Sarwar [32] suggests that using renewable energy reduces CO_2 emissions whereas using non-renewable energy increases them. Additionally, the findings are consistent with the existence of an environmental Kuznets curve between urbanization and CO_2 emissions, suggesting that the environmental impact diminishes as urbanization increases.

Moreover, Mutezo and Mulopo [33] studied the body of literature pertinent to Africa's energy transition to determine whether it can be facilitated by and directed by the ideas of a CE. According to the study, Africa's energy demand is expected to rise sharply, and it will be fuelled by industrialization and population increase. A circular economy model can facilitate a faster shift to renewable energy sources. Zeeshan et al. [34] compare the link between trade liberalization, CO_2 emissions, energy usage, and economic growth in Southeast Asian and Latin American countries. The empirical findings of this study demonstrate that trade has a positive and statistically significant impact on energy consumption, CO_2 emissions, and gross domestic product (GDP) in Southeast Asian countries. While commerce has a small but positive effect on energy usage in Latin American nations.

Recently, governments of developing countries have strongly emphasised the importance of the CE in nurturing environmental, economic, and social development. Numerous studies have attempted to explain the interrelations of various economic, social, and environmental variables with the CE. The adoption of sustainable management practices as a cornerstone of policy interventions is examined by Bherwani et al. [35] to investigate how decision-makers can facilitate solutions to the issues of natural capital depletion and environmental degradation to produce better gross domestic product (GDP) results. This is especially important in low- and middle-income countries. According to Hysa et al. [3], the shift to a CE relies on the participation of all social players and their ability to connect and establish long-lasting patterns of cooperation and exchange. The CE and economic development exhibit a strong and positive connection, according to the findings of their econometric model, highlighting the critical roles that innovation, sustainability, and spending on zero-waste projects play in fostering prosperity.

The literature on the circular economy in emerging countries such as the GCC is comparatively scarce. According to recent studies, GCC countries are moving toward circular and sustainable economies in their future plans [36]. This change accelerates the region's industrialization, urbanization, economic expansion, and trade openness. Whereas GCC nations are moving swiftly to adopt the circular economy model in order to realize sustainable growth in line with their strategic goal [37,38]. AlRobayee [39] used a qualitative case study approach to evaluate the suitability of the GCC legal structure and the capacity to establish a circular economy, looking at e-waste management laws and policies in various GCC states to comprehend e-waste management in the region. The research found that the GCC's restricted e-waste recycling regulations make it difficult to achieve a CE. Additionally, unlike in the European context, the area has not embraced the finest technology for recycling electronic waste.

As an example of the GCC, in Saudi Arabia, Waheed [40] investigates the relationship between energy issues and carbon intensity. The findings imply that energy variables' overall influence on carbon emissions is negligible, apart from negative shocks to energy intensity, which over time lead to an increase in carbon intensity. Regarding carbon emissions in the years following Vision 2030, green elements are also unimportant. However, blue elements are important for reducing carbon intensity for the period following Vision 2030. The studies presented thus far provide evidence that developing CE in GCC countries is

important to overcome the insufficient legislative structure and improve environmental sustainability.

Various countries around the world have implemented different strategies to supplement the practice of the CE, leading to valuable experiences and lessons learned [10]. While the experiences of different countries in implementing CE practices are valuable, there are still some shortcomings in existing studies. Many studies focus on developed countries to capture the specific challenges and opportunities faced by different regions. Additionally, the impact of CE strategies on economic growth is not yet well understood. More research is needed to assess the economic viability and scalability of CE practices, particularly in emerging economies. This paper aims to address these gaps by conducting a comprehensive analysis of the CE practices in emerging countries. By examining specific CE indicators in GCC nations with an emphasis on the environmental, social, and economic components of a CE in order to fill this research field gap. The study intends to evaluate the relationship between economic, social, and environmental issues and sustainability in GCC nations as well as to analyse and explain the effect of CE on the GCC's economic growth. By highlighting the shortcomings of existing studies and contributing new knowledge to the field, this paper aims to enrich the discourse on the CE and support policymakers in making informed decisions.

3. Method and Materials

Many researchers have investigated how CE indicators affect economic growth and sustainable development, and they have confirmed that a CE significantly affects economic growth in EU countries [3,19]. To address the CE impact, this paper uses several economic and environmental indicators that directly and significantly affect economic growth in the GCC. These indicators are applied as proxies in the multiple linear regression model. Proxy variables are commonly used in the measurement of CE indicators to capture the concept's multidimensional nature. These variables serve as indirect measurements of the desired phenomena due to the absence of direct data availability in the GCC context. However, their accuracy in representing the CE concept has been a subject of debate. For example, one commonly used proxy variable is renewable energy, which indicates the quality of the environment that a CE generates [41,42]. These proxies are well-accepted in the literature, primarily due to their ease of measurement and data availability. Several studies have utilised these indicators to assess the CE performance of countries [22].

Several studies have applied econometric analysis at the EU level to examine how progress in CE influences economic growth [3,6,7]. This method provides a clear picture of CE strategies and measures the efforts to achieve sustainability. It has been shown to have a positive relationship between economic growth and the CE, and researchers have concluded that using renewable energy sources with some degree of recycling enhances economic sustainability. The GCC has six member countries that joined in 1981—namely, Kuwait, Bahrain, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Due to data availability, the econometric analysis covers the period from 2000 to 2020.

3.1. Data Collection and Sources

This paper aims to highlight the specific indicators and metrics that drive the evaluation and measurement of a CE. Thus, it is essential to clarify the rationale behind the selection and justification of these indicators. The indicators were carefully selected based on their ability to capture the core aspects of a CE and data availability in the GCC context. This paper uses five variables drawn from the literature—namely, carbon dioxide emissions, real labour productivity, renewable energy consumption, unemployment, and electric power consumption. The statistical data were collected from the World Bank database, depending on data availability for all six countries. For example, choosing CO_2 emission and renewable energy as an indicator for CE could be a weak sustainability which assumes the existence of environmental problems because of production [43]. However, changes in both indicators could provide a prior trend towards CE in the GCC context. CO_2 emissions

are a major contributor to climate change and reducing them is a foundational aspect of a CE. Similarly, transitioning towards renewable energy is a crucial step to increasing economic growth and being sustainable [36].

Moreover, employment and real labour productivity can strengthen the CE framework, as investments in renewable energy and recycling activities enhance productivity through job creation and labour development [19,44]. Electricity consumption patterns also reflect a CE through a reduction in the associated environmental impact. Improved energy efficiency can imply a more sustainable use of resources [45]. There are other indicators reflecting the extent of CE adoption, such as the recycling rate of municipal waste, the circular material use rate, and environmental taxes, but they are not available in GCC countries. These indicators reflect the fundamental concepts of minimising resource inputs and waste and maximising the lifecycle of products through reuse and recycling.

There are several challenges and limitations in obtaining accurate and reliable data for CE indicators, such as data availability and quality. Data on circular economy indicators are often limited, especially in emerging countries that have not been extensively studied. Additionally, the quality of available indicators may vary, as CE indicators require detailed data on material flows, resource use, waste generation, and recycling rates. This limits the ability to accurately measure progress and performance across different countries. The complexity of CE transitions also affects the data sources as it involve systemic changes across various sectors and industries. The statistical data were collected from the World Bank database, depending on data availability for all six countries. The World Bank database contains data from different sectors and activities.

There are many indicators reflecting the extent of CE adoption, such as the recycling rate of municipal waste, circular material use rate, and environmental taxes, but they are not available in GCC countries. More collaborative effort is needed from institutions, people, and businesses to improve the effectiveness of the transition to a CE strategy. As such strategies have not yet been applied in some GCC countries, it is impossible to obtain data for some economic, social, and environmental indicators. One of the key contributors to CE performance is renewable energy, as it helps in reducing non-bio renewables and recycling bio renewables [46]. Figure 1 reflects the low level of attention to renewable energy in the GCC. As shown in Figure 1, there is still great variation in renewable energy scores when examined at the country level, particularly in Europe and Asia. On average, GCC countries score the lowest in the total 2022 CE Index published by King Abdullah petroleum studies and research centre KAPSARC [47], with a better performance in the United Arab Emirates and Saudi Arabia [48].

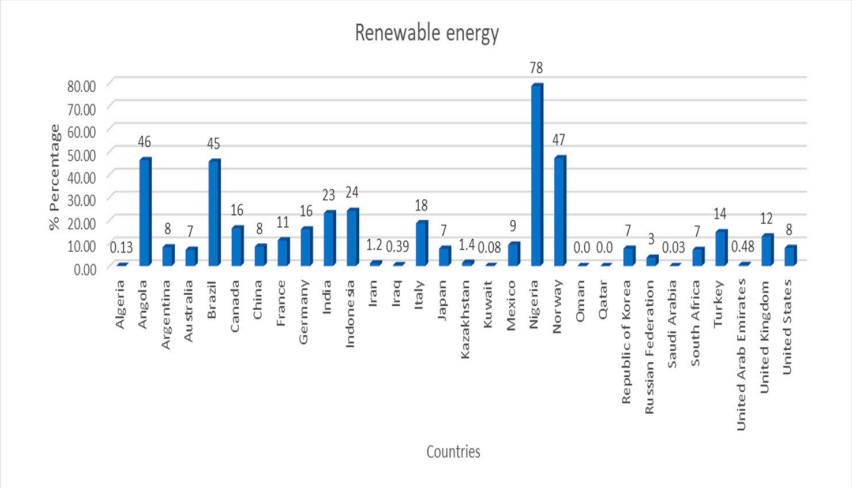

Figure 1. Share of renewables in primary consumption (%, the year 2019). Source: Authors construction using 2021 CCE Index data and codebook. Note: GCC data does not include Bahrain.

3.2. Methodology

The research question was formulated on the basis of previous EU empirical results: What is the CE's impact on economic growth in the GCC context? To answer this question, the paper aims to estimate the five explanatory variables mentioned above and observe their effects on economic growth. Following empirical studies on the EU, these explanatory variables are some of the important and CE available indicators. To analyse the impact of the explanatory variables on the dependent variable, which is economic growth represented by the GDP per capita, we formulate different statistical hypotheses reported in Table 1 below.

Table 1. Hypotheses for quantifying the impact of CE.

Hypothesis Number	Hypothesis
H1	Carbon dioxide emissions are strongly linked with economic growth
H2	Real labour productivity is interrelated with economic growth
H3	The effect of renewable energy consumption on economic growth is positive and significant
H4	Unemployment is highly associated with economic growth
H5	The influence of electricity consumption on economic growth is significant

To test all five hypotheses presented in Table 1, we use panel data analysis. The data from 2000 to 2020 are used to evaluate the GCC regression model. Data were acquired from World Development Indicators for the dependent variable and all other independent variables. Table 2 provides descriptions of the five explanatory variables (X1–X5) and the dependent variable (Y) used in the model.

Table 2. Explanation of variables in the model.

Variable	Variable Name	Definition	Unit
Y	GDP per capita	Gross domestic product per capita in GCC members.	US Dollar
CO_2	CO_2 emissions	Measures the kilo tonnage of carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement.	Kilotons
LP	Real labour productivity		
	Gross domestic product per person employed.	US Dollar	
RE	Renewable energy consumption	The ratio of renewable energy in total final energy consumption.	Percentage (%)
UN	Unemployment	The share of the labour force that is without work.	Percentage (%)
EP	Electricity power consumption	Measures the consumption of electric power per capita.	kilowatt-hour (kWh)

Overall, five variables are proxies for economic, social, and environmental indicators used to measure the CE's effect on economic growth. The choice of these variables is based on two approaches. First, there is consensus in the literature that these indicators affect CE. Second, we confirmed that data for these five variables were available across GCC countries. To examine the link between economic growth and the different variables reflecting a CE, we conducted a panel data analysis.

The natural logarithm transformation is applied for all variables to have compatible values and interpret the estimated coefficients for the independent variables as elasticities [49]. Before displaying the regression analysis, the results of the summary statistics of all variables are shown in Table 3 below. It is apparent from this table that the mean and median values are close to each other for all variables. Therefore, we can assume that the variables used in the analysis are close to the standard normal distribution.

Table 3. Statistical description of variables in the model.

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Log GDP per capita	126	10.295	10.078	0.450	9.664	11.084
Log CO_2 emissions	120	−0.318	−0.258	0.239	−0.809	0.061
Log RE consumption	65	−3.172	−2.995	1.097	−4.605	−0.400
Log real LP	126	11.588	11.628	0.251	10.962	12.132
Log UN	126	0.601	0.777	0.945	−2.302	2.008
Log EP consumption	90	9.300	9.478	0.520	8.071	9.976

Source: Authors' own calculations using STATA software 15.

To examine the possibility of a high correlation between the exogenous variables, a Pearson correlation matrix is used to help identify correlations among the variables. As revealed in Table 4, the correlations are not very high as the coefficients are less than ±0.80, except between electric power and unemployment. Thus, we assume that no multicollinearity problems exist among the variables.

Table 4. Correlation Matrix.

	CO_2-Emissions	Labour Productivity	Electricity Power	Renewable Energy	Unemployment
Log CO_2 emissions	1.0000				
Log LP	0.1059	1.0000			
Log EP	−0.3189	0.0423	1.0000		
Log RE	−0.6595	−0.2668	0.7682	1.0000	
Log UN	0.2627	0.0387	−0.8238	−0.5959	1.0000

Source: Authors' own calculations using STATA software.

Before testing the regression model, we perform a cross-sectional dependence test to determine the appropriate stationary test to apply to the data. Such tests guide us in choosing the best model that considers estimation bias and problems [50]. The test results are listed in Table 5. The results indicate that there is no cross-sectional dependence, as the null hypothesis of no dependence cannot be rejected at the 1% level of significance [51,52]. Therefore, the stationary test for all six variables is applied and listed in Table 6.

Table 5. Cross-section Dependence Test.

Test	Statistic	Prob.
Breusch-Pagan LM	3.494	0.321
Pesaran scaled LM	0.201	0.840
Pesaran CD	0.380	0.703

Source: Authors' own calculations using STATA software.

Table 6. Unit root Test.

Variable	Levin, Lin & Chu t				ADF-Fisher Chi-Square				PP-Fisher Chi-Square			
	Level		1st Difference		Level		1st Difference		Level		1st Difference	
	St	PV	St	PV	St	PV	St	PV	St	PV	St	PV
Log GDP	1.44	0.07	4.74	0.00	11.93	0.45	43.64	0.00	15.26	0.22	60.25	0.00
Log CO_2	0.83	0.20	8.13	0.00	16.10	0.18	77.67	0.00	34.29	0.00	84.77	0.00
Log RE	1.72	0.04	2.50	0.00	8.50	0.20	16.27	0.01	7.47	0.27	38.30	0.00
Log LP	3.27	0.00	3.96	0.00	27.73	0.00	34.27	0.00	49.62	0.00	50.41	0.00
Log UN	1.00	0.84	7.67	0.00	5.00	0.95	60.01	0.00	3.64	0.98	45.15	0.00
Log EP	2.51	0.99	2.74	0.00	4.30	0.97	25.36	0.01	4.42	0.97	52.57	0.00

Source: Authors' own calculations using STATA software.

As can be seen in Table 6, the results indicate that some variables are stationary at the 5% significance level and some in the first difference at the 1% significance level. Therefore, the regression model should consider the condition in which some independent variables were stationary at the level and the first difference. The autoregressive distributed lag (ARDL) method established by Pesaran et al. [53] is applied in addition to the random and fixed models. This model helps in determining co-integration relationships between the variables and in considering the stationary problem in the regression [53].

4. Results

For computing the empirical results for different models, first, the random effects (RE) and fixed effects (FE) models are applied, and the Hausman test helps in identifying the preferred model [54]. According to the null hypothesis of the test, the RE is appropriate, and the alternative hypothesis highlights the need to reject the RE model, meaning that FE is the appropriate model for the data analysis. The Hausman test implies with Prob. > Chi2 = 0.8523; therefore, we cannot reject the null hypothesis. This result indicates that RE is appropriate for the regression analysis. As we adopt double logarithmic values for all variables, the RE analysis has the following form:

$$\log GDP = a_0 + a_1 \log CO_{2it} + a_2 \log Un_{it} + a_3 \log LB_{it} + a_4 \log EB_{it} + a_5 \log RE_{it} + \varepsilon_{it} \quad (1)$$

where i represents the number of groups (countries) for t time (panel data time period). a_1 to a_5 are the regression coefficients used to interpret the explanatory variables and ε_{it} is the error term. Different RE models were estimated using STATA software [55]. The first model estimates all the explanatory variables; however, the number of observations is limited as the renewable energy variable has many missing data. The results of the regression indicate that between 2000 and 2020, all five coefficients have a significant effect on economic growth—that is, carbon dioxide emissions, real labour productivity, renewable energy consumption, unemployment, and electric power consumption are statistically significant with 1% p-levels as shown in Table 7. The adjusted R-square in Model 1 accounts for around 93% of the variability of the dependent variable, which is explained by the independent variables in the model.

The CO_2 coefficient implies that if CO_2 increases by one kiloton, it is associated with a 0.43% decrease in economic growth. Furthermore, as shown in Model 1, a 1% increase in renewable energy consumption is associated with a 0.10% increase in economic growth. In terms of labour productivity, the regression outcome indicates that a dollar increase in GDP per person employed is correlated with a 0.55% increase in economic growth. Furthermore, the electric power consumption variable indicates that a one-kilowatt increase in electricity consumption leads to a 0.98% increase in economic growth. Finally, increasing the unemployment share is associated with a 0.08% decrease in economic growth. Regarding the hypotheses, all the explanatory variables included in the model indicate that all the assumptions are valid, and all the variables have an association with economic growth.

Table 7. The random-effect model.

Variables	Model 1		Model 2	
	Coefficient	***p*-Value**	**Coefficient**	***p*-Value**
Constant	−4.89	0.000	−0.88	0.000
Log CO_2	−0.43	0.000	−0.46	0.000
Log LP	0.55	0.000	0.49	0.000
Log EP	0.98	0.000	0.56	0.000
Log Un	−0.08	0.000	0.01	0.509
Log RE	0.09	0.000	NA	NA
Model fit	R^2 = 0.93	N = 45	R^2 = 94	N = 90

In Model 2, the renewable energy variable is excluded to include more observations. Based on the regression results, we can state that most of the variables have a statistically significant effect on economic growth. The association is explained by the sign and magnitude of the coefficient, which have similar results. However, the unemployment variables are found to be insignificant in Model 2. Therefore, the variable is excluded from the ARDL model. Depending on the unit root test that gives support to the use of the ARDL model, the random-effect model is reported as a first step of the analysis and then increases the model's robustness by estimating the ARDL model. However, the ARDL model is adopted because it is more suitable for small sample sizes, it is a flexible model as different lags can be applied for different variables, and the autocorrelation and endogeneity issues are considered [56]. The model is estimated to consider the effects of the independent variables on the dependent variable. The ARDL estimation method is used to estimate dynamic panel models in light of short-term and long-term effects. This method is used to solve stationery and endogeneity problems between variables. The ARDL model has the following form:

$$\Delta \log GDP_{it} = \phi_i \left(\log GDP_{it-1} - \beta_i X_{it-1} \right) + \sum_{j=1}^{p} \lambda_{ij} \log GDP_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} X_{i,t-j} + \varepsilon_{it} \quad (2)$$

where p and q are the lags of the dependent and independent variables, respectively. The log GDP denotes the dependent variable, X is the vector of explanatory variables, and ε_{it} is the error component. In particular, λ represents the short-term parameters of the lagged dependent variable, while δ refers to the short-term coefficients of the lagged explanatory variables. ϕ reflects the long-term impact of the explanatory variables. Table 8 shows the results of the ARDL panel model using pooled mean group (PMG) estimation [57].

Table 8. ARDL model.

	Variables	**Coefficient**	***p*-Value**
Long-run coefficients	Log CO_2	−0.75	0.000
	Log LP	0.73	0.000
	Log EP	0.19	0.019
Short-run coefficients	ECM *	−0.06	0.047
	Log CO_2	−0.05	0.448
	Log LP	0.83	0.000
	Log EP	0.04	0.473
	Constant		

Note: * denote 5% significant levels.

As can be observed from the CO_2, regardless of the model used, there is a negative and significant impact on economic growth in the long term. Similarly, a negative but insignificant relationship is identified in the short term. The model detects a significantly

positive relationship between the other variables and economic growth in the long term. Therefore, there is a sustainable relationship between all the variables in the long term but, this relationship is not supportable in the short term.

According to the estimation results, the error correction term is negative at a statistically significant level of 5%. This means that a 1% variation in the long-term equilibrium leads to a 0.06% reduction in the deflection. The estimation results indicate the role of some CE indicators in promoting economic growth. The next section, therefore, moves on to discuss these results and their relation to economic literature.

5. Discussion

This research aims to examine the CE's effect on economic growth in GCC countries by using several economic and environmental indicators that directly and significantly affect economic growth. The model employs five variables—namely, carbon dioxide emissions, real labour productivity, renewable energy consumption, unemployment, and electric power consumption indicators—as proxy variables. Due to data availability, the econometric analysis covers the period from 2000 to 2020.

To examine the association between economic growth and the different variables that reflect CE, panel data analysis is used. The results of the summary statistics of all variables show that the mean and median values are similar for all variables; therefore, the variables used in the analysis are close to the standard normal distribution. Pearson's correlation matrix shows that the correlation is not very high in all cases as the coefficients are less than ± 0.80, except between electric power and unemployment. Thus, it is assumed that no multicollinearity problems exist among the variables. The results of the cross-section dependence test indicate that there is no cross-sectional dependence since the null hypothesis of no dependence cannot be rejected at the 1% significance level. Therefore, the stationary test for all six variables is applied. The results indicate that some variables are stationary at the level and some in the first difference.

The ARDL model established by Pesaran et al. [53] is adopted, in addition to the RE and FE models. The Hausman test with Prob. > Chi2 = 0.8523 suggests that we cannot reject the null hypothesis. This result indicates that RE is appropriate for the regression analysis. When analysing the results of different RE models' panel data methods, we can state that the results match each other, and all the selected indicators positively impact economic growth in the GCC. Therefore, all the variables are statistically significant at 1% p-levels, except for the unemployment variables. This model helps to determine co-integration relationships between the variables and to consider the stationary problem in the regression [53].

Regarding the study hypotheses, all explanatory variables included in the model indicate that all the assumptions are valid, and all the variables have an association with economic growth. The results of the ARDL panel model using PMG estimation, show a negative and significant impact on economic growth in the long term; however, an insignificant negative relationship is found in the short term. The model in the long term detects a significantly positive relationship between the other variables and economic growth. Therefore, there is a sustainable relationship between all the variables in the long term. The estimation results indicate the role of some CE indicators in promoting economic growth.

The originality of this study lies in the categorisation of variables shaped by the sustainable economic indicators adopted for the CE related to environmental, social, and economic components and the investigation of their effects on economic growth. Furthermore, it explores the situation of CE transition in GCC countries to propose some policy implications that accelerate this transformation. According to these data, we can infer that there are correlations between the different components of the CE and economic growth in GCC countries.

The results of both models used to determine the relationship between CE and economic growth could be linked to other studies, similar to Busu [12], who argues that the CE

model is driven by resource productivity, labour employed, and recycling rate. Moreover, Hysa et al. [3] find a positive and robust association between CE and economic growth. Mihai et al. [29] explore the development of some important indicators regarding the CE in the energy sector in Europe. Evidence from Shafiei and Salim [31] and Sarwar [32] demonstrates that adopting renewable energy reduces CO_2 emissions. A circular economy model can also help with a quicker transition to renewable energy sources, according to research by Mutezo and Mulopo [33] on Africa's energy transition to a circular economy. The conclusion of this study is, therefore, that the relationship between GDP and renewable resources is essential, as a share of renewable energy [33,58]. As a result, the unemployment rate and CO_2 emissions are expected to decline.

This is in contrast to the studies by Houtia and Houtia [38] and Mahmood [37], which indicate that GCC countries are transferring towards circular and green economies in their long-term visions. Moreover, AlRobayee [39] examines the suitability of the GCC legal structure and the ability to reach a CE using only a qualitative methodology. The study's findings support our prior assertions that the GCC has made only little progress in achieving a CE because there are few rules and regulations governing recycling waste. In addition, as compared to European standards, GCC nations have not adopted innovative technologies for recycling e-waste. To establish a CE in GCC nations, it is necessary to overcome the absence of a regulatory framework and enable appropriate e-waste recycling.

Although extensive research has been carried out on the CE, no single study exists that focuses on emerging countries in a specific context. The limitation of data in these countries controlled the models; however, the findings provide a deeper insight into the CE's importance in the GCC context to achieve economic growth and sustainability. In addition, the paper analyses different CE indicators and applies econometric regression techniques. Considerably more work will need to be completed to determine the association between the CE and economic growth in the GCC and other emerging countries.

6. Conclusions

The results of this paper are useful to governments and policymakers involved in formulating growth and development policies and implementing accurate structures and targets of a CE. The research's originality resides in its panel data econometric study of GCC countries to ascertain how CE and economic growth are related to each other. All GCC countries have a CE orientation and seek to achieve their environmental and economic goals in the long term [59,60]. At some point, CE indicators won't be used to the same extent in every GCC nation. Kuwait, Qatar, Bahrain, and Oman need to work harder to improve their CE macroeconomic metrics even if the United Arab Emirates and Saudi Arabia have achieved good results and are at the top of the GCC rankings [46].

The data of the macroeconomic indicators for the years 2000 to 2020 served as the basis for the multiple linear regression analysis. The core limitation of the paper is related to data availability for the main important indicators that reflect the extent of CE adoption, such as the waste recycling rate, circular material use rate, and environmental taxes. However, the proxy indicators used in the study show that CE is an important goal to accelerate economic growth in the GCC. A more collaborative effort is needed from governments, people, and businesses to improve the effectiveness of the transition to a CE strategy. In addition, investments must be made in infrastructure for recycling and renewable energy. The implementation of the CE model declines the levels of CO_2 emissions and increases the employment rate, which is coupled with increases in renewable energy consumption, labour productivity, and electric power consumption.

Regarding the study hypotheses, in particular, all the explanatory indicators included in the model indicated that all the assumptions were valid, and all the variables had an association with economic growth. The results of this analysis show that any efforts related to the environment will positively impact economic growth [2,6,7]. Beyond the account of the current view of the implementation of CE in the GCC context, the paper presents the relationship between economic growth and CE using an econometric model based on

a proxy of economic, social, and environmental sources for sustainable economic growth. Declines in CO_2 emissions and unemployment, in conjunction with the application of a CE model, have a good impact on economic growth.

The empirical findings in this paper provide a new understanding that GCC countries are still shifting towards CE. GCC countries need the work more to achieve their environmental goals, especially in the context of CE model implementation necessitating regular and sizeable expenditures on the environmental infrastructure [37]. In addition, the labour force's performance in the areas of resource productivity and environmental protection was found to be lacking. The local, regional, and national authorities of all GCC countries, which are involved in laying the foundation for new legislation, require effective CE implementation and continuous assessment [36]. Therefore, the study provides the first assessment of the CE position in the GCC and emphasizes the need for a rapid transition to the CE.

The paper was limited by the absence of the primary data for some significant variables used in the analysis. In spite of this limitation, the study certainly adds to our understanding of the EC and how developed countries are improving their recycling, reducing, and reusing techniques [61]. Thus, learned from their challenges and attempted to apply some regulations and policies. To get a more complete picture of the analysis of CE indicators, future studies should include more indicators to reflect the need for improvement. In order to shed light on the most recent advancements, the analysis can be further enhanced by utilizing other variables compatible with the qualities of the CE. Such as including additional control variables and choosing a longer period that further enhances the results. Another suggestion for future research is implementing such models in a larger set of countries and establishing some comparisons between GCC and non-GCC countries. More information and data on the CE would help to establish a greater degree of precision in this field.

The CE is an area of research that holds great potential for advancing sustainable development in emerging economies. In order to further enhance our understanding of this concept and its applicability in such economies, there are several suggested directions for future research that can be explored. Firstly, it is crucial to investigate and identify potential additional variables that could impact the implementation and effectiveness of CE practices in emerging economies. For example, social factors, such as attitudes towards waste, consumption patterns, and level of awareness about environmental issues, may significantly influence the adoption of a CE [62]. Therefore, future research should aim to incorporate these variables into the analysis to provide a more comprehensive understanding of the CE in emerging economies. Moreover, exploring different data sources can further improve the study of CE in emerging economies. Conducting comparative studies among different countries can contribute to a better understanding of the CE in emerging economies. By analysing variations in policies, regulations, infrastructures, and socio-economic contexts, researchers can identify best practices and learn lessons for sustainable development. Comparisons with developed economies can also provide valuable insights into the challenges and opportunities faced by emerging economies in their CE transition.

The findings of the paper hold significant relevance and implications for the CE policies and initiatives in GCC countries. The results shed light on the current state of renewable energy practices and the barriers to achieving a sustainable circular economy in the region, providing crucial insights to inform policy decisions. Firstly, the paper highlights the need to focus on renewable energy infrastructure to improve the energy system and to prevent unfavourable movement in economic growth and sustainability. There is, therefore, a definite need for GCC countries to invest in recycling infrastructure that supports environmental issues. Growth in the economy and environmental performance must coexist. A key policy priority should, therefore, be to plan for the long-term attention of the CE and benefit from its goal. The CE goal indicates that using natural resources effectively is needed to produce services and goods as well as limit waste rate and pollu-

tion. Furthermore, the paper's findings highlight the need for policymakers to consider introducing policies such as tax incentives, subsidies, and funding schemes to encourage public and private sector involvement and innovation in circular economy practices. In conclusion, the results of this paper offer valuable insights that inform policy decisions in the context of EC policies and initiatives in GCC countries. By focusing on improving waste recycling, promoting renewable energy, and providing economic incentives, policymakers can effectively address the barriers to achieving a sustainable circular economy, fostering economic growth, and protecting the environment in the region.

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References

1. Suárez-Eiroa, B.; Fernández, E.; Méndez-Martínez, G.; Soto-Oñate, D. Operational principles of circular economy for sustainable development: Linking theory and practice. *J. Clean. Prod.* **2019**, *214*, 952–961. [CrossRef]
2. Corona, B.; Shen, L.; Reike, D.; Carreón, J.R.; Worrell, E. Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics. *Resour. Conserv. Recycl.* **2019**, *151*, 104498. [CrossRef]
3. Hysa, E.; Kruja, A.; Rehman, N.U.; Laurenti, R. Circular economy innovation and environmental sustainability impact on economic growth: An integrated model for sustainable development. *Sustainability* **2020**, *12*, 4831. [CrossRef]
4. Banaitė, D. Towards circular economy: Analysis of indicators in the context of sustainable development. *Soc. Transform. Contemp. Soc.* **2016**, *4*, 142–150.
5. Rodriguez-Anton, J.; Rubio-Andrada, L.; Celemín-Pedroche, M.; Alonso-Almeida, M. Analysis of the relations between circular economy and sustainable development goals. *Int. J. Sustain. Dev. World Ecol.* **2019**, *26*, 708–720. [CrossRef]
6. Tantau, A.D.; Maassen, M.A.; Fratila, L. Models for analyzing the dependencies between indicators for a circular economy in the European Union. *Sustainability* **2018**, *10*, 2141. [CrossRef]
7. Busu, M.; Trica, C.L. Sustainability of circular economy indicators and their impact on economic growth of the European Union. *Sustainability* **2019**, *11*, 5481. [CrossRef]
8. Macarthur, E.; Heading, H. How the circular economy tackles climate change. *Ellen MacArthur Found.* **2019**, *1*, 1–71.
9. Gallego-Schmid, A.; Chen, H.-M.; Sharmina, M.; Mendoza, J.M.F. Links between circular economy and climate change mitigation in the built environment. *J. Clean. Prod.* **2020**, *260*, 121115. [CrossRef]
10. Schroeder, P.; Anggraeni, K.; Weber, U. The relevance of circular economy practices to the sustainable development goals. *J. Ind. Ecol.* **2019**, *23*, 77–95. [CrossRef]
11. Ngan, S.L.; How, B.S.; Teng, S.Y.; Promentilla, M.A.B.; Yatim, P.; Er, A.C.; Lam, H.L. Prioritization of sustainability indicators for promoting the circular economy: The case of developing countries. *Renew. Sustain. Energy Rev.* **2019**, *111*, 314–331. [CrossRef]
12. Busu, M. Adopting circular economy at the European Union level and its impact on economic growth. *Soc. Sci.* **2019**, *8*, 159. [CrossRef]
13. Padilla-Rivera, A.; Russo-Garrido, S.; Merveille, N. Addressing the social aspects of a circular economy: A systematic literature review. *Sustainability* **2020**, *12*, 7912. [CrossRef]
14. Sharma, M.; Joshi, S.; Prasad, M.; Bartwal, S. Overcoming barriers to circular economy implementation in the oil & gas industry: Environmental and social implications. *J. Clean. Prod.* **2023**, *391*, 136133.
15. Lin, B.C.A. Sustainable growth: A circular economy perspective. *J. Econ. Issues* **2020**, *54*, 465–471. [CrossRef]

16. Sadik-Zada, E.R.; Loewenstein, W. Drivers of CO_2-Emissions in Fossil Fuel abundant settings:(Pooled) mean group and nonparametric panel analyses. *Energies* **2020**, *13*, 3956. [CrossRef]
17. Sadik-Zada, E.R.; Gatto, A. The puzzle of greenhouse gas footprints of oil abundance. *Socio-Econ. Plan. Sci.* **2021**, *75*, 100936. [CrossRef]
18. Fomby, T.B.; Hill, R.C.; Johnson, S.R. *Advanced Econometric Methods*; Springer Science & Business Media: Berlin, Germany, 2012.
19. Trica, C.L.; Banacu, C.S.; Busu, M. Environmental factors and sustainability of the circular economy model at the European Union level. *Sustainability* **2019**, *11*, 1114. [CrossRef]
20. Chioatto, E.; Sospiro, P. Transition from waste management to circular economy: The European Union roadmap. *Environ. Dev. Sustain.* **2023**, *25*, 249–276. [CrossRef]
21. Korhonen, J.; Honkasalo, A.; Seppälä, J. Circular economy: The concept and its limitations. *Ecol. Econ.* **2018**, *143*, 37–46. [CrossRef]
22. Moraga, G.; Huysveld, S.; Mathieux, F.; Blengini, G.A.; Alaerts, L.; Van Acker, K.; de Meester, S.; Dewulf, J. Circular economy indicators: What do they measure? *Resour. Conserv. Recycl.* **2019**, *146*, 452–461. [CrossRef] [PubMed]
23. Yamamoto, M.; Hosoda, E. *The Economics of Waste Management in East Asia*; Routledge: New York, NY, USA, 2016.
24. MacArthur, E. Towards the circular economy. *J. Ind. Ecol.* **2013**, *2*, 23–44.
25. Kirchherr, J.; Reike, D.; Hekkert, M. Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.* **2017**, *127*, 221–232. [CrossRef]
26. Morseletto, P. Targets for a circular economy. *Resour. Conserv. Recycl.* **2020**, *153*, 104553. [CrossRef]
27. Sanguino, R.; Barroso, A.; Fernández-Rodríguez, S.; Sánchez-Hernández, M.I. *Current Trends in Economy, Sustainable Development, and Energy: A Circular Economy View*; Springer: Berlin/Heidelberg, Germany, 2020; pp. 1–7.
28. Aziz, G.; Sarwar, S.; Nawaz, K.; Waheed, R.; Khan, M.S. Influence of tech-industry, natural resources, renewable energy and urbanization towards environment footprints: A fresh evidence of Saudi Arabia. *Resour. Policy* **2023**, *83*, 103553. [CrossRef]
29. Mihai, M.; Manea, D.; Titan, E.; Vasile, V. Correlations in the European circular economy. *Econ. Comput. Econ. Cybern. Stud. Res.* **2018**, *52*, 61–78.
30. Sarwar, S.; Waheed, R.; Aziz, G.; Apostu, S.A. The nexus of energy, green economy, blue economy, and carbon neutrality targets. *Energies* **2022**, *15*, 6767. [CrossRef]
31. Shafiei, S.; Salim, R.A. Non-renewable and renewable energy consumption and CO_2 emissions in OECD countries: A comparative analysis. *Energy Policy* **2014**, *66*, 547–556. [CrossRef]
32. Sarwar, S. Role of urban income, industrial carbon treatment plants and forests to control the carbon emission in China. *Environ. Sci. Pollut. Res.* **2019**, *26*, 16652–16661. [CrossRef]
33. Mutezo, G.; Mulopo, J. A review of Africa's transition from fossil fuels to renewable energy using circular economy principles. *Renew. Sustain. Energy Rev.* **2021**, *137*, 110609. [CrossRef]
34. Zeeshan, M.; Han, J.; Rehman, A.; Ullah, I.; Afridi, F.E.A.; Fareed, Z. Comparative analysis of trade liberalization, CO_2 emissions, energy consumption and economic growth in southeast asian and latin american regions: A structural equation modeling approach. *Front. Environ. Sci.* **2022**, *10*, 79. [CrossRef]
35. Bherwani, H.; Nair, M.; Niwalkar, A.; Balachandran, D.; Kumar, R. Application of circular economy framework for reducing the impacts of climate change: A case study from India on the evaluation of carbon and materials footprint nexus. *Energy Nexus* **2022**, *5*, 100047. [CrossRef]
36. Tiwari, S.; Mohammed, K.S.; Mentel, G.; Majewski, S.; Shahzadi, I. Role of circular economy, energy transition, environmental policy stringency, and supply chain pressure on CO_2 emissions in emerging economies. *Geosci. Front.* **2023**, 101682. [CrossRef]
37. Mahmood, H. Trade openness, industrialization, urbanization and pollution emissions in GCC countries: A way towards green and circular economies. *Int. J. Energy Econ. Policy* **2022**, *12*, 309–314. [CrossRef]
38. Houtia, A.; Houtia, F.Z. (Eds.) Applying the Circular Economy Model in Improving Waste Management and Treatment Systems in the Arab Gulf States (With the Potential to Benefit from Global Experiences). In *Sustainable Energy-Water-Environment Nexus in Deserts: Proceeding of the First International Conference on Sustainable Energy-Water-Environment Nexus in Desert Climates*; Springer: Berlin/Heidelberg, Germany, 2022.
39. AlRobayee, A.S. Coping with E-Waste: Prospects of E-Waste Circular Economy within the GCC: Analyzing the Legal Framework on Recycling of E-Waste within the GCC. SJD Dissertation, Pace University, New York, NY, USA, 2022.
40. Waheed, R. The significance of energy factors, green economic indicators, blue economic aspects towards carbon intensity: A study of Saudi vision 2030. *Sustainability* **2022**, *14*, 6893. [CrossRef]
41. Majeed, M.T.; Luni, T. Renewable energy, circular economy indicators and environmental quality: A global evidence of 131 countries with heterogeneous income groups. *Pak. J. Commer. Soc. Sci. PJCSS* **2020**, *14*, 866–912.
42. Robaina, M.; Villar, J.; Pereira, E.T. The determinants for a circular economy in Europe. *Environ. Sci. Pollut. Res.* **2020**, *27*, 12566–12578. [CrossRef] [PubMed]
43. Pelenc, J.; Ballet, J.; Dedeurwaerdere, T. Weak Sustainability versus Strong Sustainability. Brief for GSDR United Nations; 2015; pp. 1–4. Available online: https://sustainabledevelopment.un.org/content/documents/6569122-Pelenc-Weak%20Sustainability%20versus%20Strong%20Sustainability.pdf (accessed on 18 October 2023).
44. Georgescu, I.; Kinnunen, J.; Androniceanu, A.-M. Empirical evidence on circular economy and economic development in Europe: A panel approach. *J. Bus. Econ. Manag.* **2022**, *23*, 199–217. [CrossRef]

45. Khan, A.M.; Osińska, M. Energy consumption under circular economy conditions in the EU countries. *Energies* **2022**, *15*, 7839. [CrossRef]
46. Luomi, M.; Yilmaz, F.; Alshehri, T. *The Circular Carbon Economy Index 2022—Results*; King Abdullah Petroleum Studies and Research Center: Riyadh, Saudi Arabia, 2022.
47. KAPSARC. The Circular Carbon Economy INDEX Data and Codebook. 2022. Available online: https://cceindex.kapsarc.org/cceindex/downloads (accessed on 15 February 2022).
48. Luomi, M.; Yilmaz, F.; Alshehri, T. The Gulf Cooperation Council and the Circular Carbon Economy: Progress and Potential. 2022. Available online: https://ideas.repec.org/p/prc/dpaper/ks{-}{-}2022-dp06.html (accessed on 18 October 2023).
49. Benoit, K. *Linear Regression Models with Logarithmic Transformations*; London School of Economics: London, UK, 2011; Volume 22, pp. 23–36.
50. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*; MIT Press: Cambridge, MA, USA, 2010.
51. De Hoyos, R.E.; Sarafidis, V. Testing for cross-sectional dependence in panel-data models. *Stata J.* **2006**, *6*, 482–496. [CrossRef]
52. Sarafidis, V.; Yamagata, T.; Robertson, D. A test of cross section dependence for a linear dynamic panel model with regressors. *J. Econom.* **2009**, *148*, 149–161. [CrossRef]
53. Pesaran, M.H.; Shin, Y.; Smith, R.J. Bounds testing approaches to the analysis of level relationships. *J. Appl. Econom.* **2001**, *16*, 289–326. [CrossRef]
54. Hausman, J.A. Specification tests in econometrics. *Econom. J. Econom. Soc.* **1978**, *46*, 1251–1271. [CrossRef]
55. StataCorp LP. *Stata Statistical Software: Release 14. [Computer Program]*; StataCorp LP: College Station, TX, USA, 2015.
56. Nkoro, E.; Uko, A.K. Autoregressive Distributed Lag (ARDL) cointegration technique: Application and interpretation. *J. Stat. Econom. Methods* **2016**, *5*, 63–91.
57. Pesaran, M.H.; Shin, Y.; Smith, R.P. Pooled mean group estimation of dynamic heterogeneous panels. *J. Am. Stat. Assoc.* **1999**, *94*, 621–634. [CrossRef]
58. Apostu, S.A.; Hussain, A.; Kijkasiwat, P.; Vasa, L. A comparative study of the relationship between circular economy, economic growth, and oil price across South Asian countries. *Front. Environ. Sci.* **2022**, *10*, 1036889. [CrossRef]
59. Alghazo, J.; Ouda, O.; Alanezi, F.; Asam, Z.-u.-Z.; Rehan, M.; Salameh, M.H.; Nizami, A.-S. Potential of electronic waste recycling in Gulf Cooperation Council states: An environmental and economic analysis. *Environ. Sci. Pollut. Res.* **2019**, *26*, 35610–35619. [CrossRef]
60. Alhumoud, J.M.; Al-Ghusain, I.; Al-Hasawi, H. Management of recycling in the Gulf Co-operation Council states. *Waste Manag.* **2004**, *24*, 551–562. [CrossRef]
61. Soto-Paz, J.; Arroyo, O.; Torres-Guevara, L.E.; Parra-Orobio, B.A.; Casallas-Ojeda, M. The circular economy in the construction and demolition waste management: A comparative analysis in emerging and developed countries. *J. Build. Eng.* **2023**, *78*, 107724. [CrossRef]
62. Patwa, N.; Sivarajah, U.; Seetharaman, A.; Sarkar, S.; Maiti, K.; Hingorani, K. Towards a circular economy: An emerging economies context. *J. Bus. Res.* **2021**, *122*, 725–735. [CrossRef]