Article

Green Energy, Economic Growth and Environmental Quality Nexus in Saudi Arabia

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Abstract: This article extends the previous studies on environmental economics literature by examining a possible relationship between economic growth, green energy, and environmental quality. Specifically, this article investigated the three-way linkage between economic growth, renewable energy, and environmental quality in the case of Saudi Arabia using the simultaneous equation modeling approach over the period of 1990–2016. The following are the main findings obtained: (i) a unidirectional causal impact of economic growth on renewable energy consumption was found, confirming the conservation hypothesis; (ii) bidirectional relationships between economic growth and CO₂ emissions and between CO₂ emissions and renewable energy consumption were also found; (iii) the failure of renewable energy in Saudi Arabia to close the gap between growing the economy and protecting the environment in Saudi Arabia; (iv) the environmental Kuznets curve (EKC) hypothesis was supported. Policy implications are also discussed.

Keywords: economic growth; renewable energy; CO₂ emissions; simultaneous equation models

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1. Introduction

Environmental degradation and global warming have been significant environmental concerns for the past few decades. Greenhouse gas (GHG), a troubling problem that is still being addressed in some areas, is responsible for carbon dioxide emissions (CO₂) owing to the high degree of environmental degradation [1,2]. Reference [3] focuses on the contribution to air pollution of CO₂ emissions and estimates that it is considered as a high environmental quality, which contributes 76.7% of total GHG emissions in developing countries [1]. Reducing pollution rates has become a priority for all the economies of the world. Further, increased global climate change and CO₂ emissions have brought to light international issues as illustrated by the launch of international conferences on climate change, for example, the 2015 Paris Climate Change Conference (COP21) and the creation of the United Nations Framework Convention on Climate Change as major international organizations. This is acknowledged also in the Sustainable Development Agenda 2030 and its 17 Sustainable Development Goals [4]. Among several other fields, the Sustainable Development Goals (SDGs) discuss the fundamental complexities of human, environmental, and economic development.

Saudi Arabia is the leading oil-producing country and the 10th largest world emitter of fossil CO₂, and its climate commitment was announced only a couple of weeks before the COP21 [5]. The Saudi government expects a substantial decrease of 130 million tons of CO₂ emissions annually by the year 2030 [6]. We concentrated on the Saudi economy with many different motivations, reasons, and characteristics. Saudi Arabia ranks eighth among the world's leading carbon-emitting economies [7]. Therefore, reducing CO₂ emissions in the country is more complicated as the manufacturing process

is largely based on fossil fuels [5]. According to recent literature, e.g., [8–16], renewable technologies are optimally suited to a sustainable energy consumption system by replacing fossil fuels, thereby leading to fewer emissions of CO₂. Therefore, the development of renewables has been an acceptable way of overcoming global warming and as a viable alternative to fossil fuels to sustained growth [17–19]. Moreover, green technologies are a critical option to close the gap between economic activity and environmental quality for reaching sustainable development [8]. Saudi Arabia has several attractive green energy production areas, particularly in the Arab Gulf and Red Sea coastal areas. Taking into account the world's battle against the current and rising demand for power sustainability, Saudi Arabia has the physical capacity to harness enormous renewable energy sector opportunities. The Kingdom of Saudi Arabia has concentrated on trying to find alternative energy bases, with a view of working alongside Saudi vision 2030 in the development of green electricity [20].

The literature has recently revealed wide attention in the association linking dis(aggregate) energy use, economic growth (hereafter EG), and pollution. The existing literature can be separated into three areas of study (see Section 2): the first strand includes the existing energy literature, which handles a large range of studies of varied findings lying on the connection among the use of green energy and EG (e.g., [21–26], among others); the second strand combines a branch of research that treats the renewable energy consumption–environment nexus (e.g., [15,16,27–30], among others); the third strand includes the existing literature, which presents practical proof on the association linking CO₂ emissions and EG, indicating the famous theory of Environmental Curve of Kuznets, e.g., [31–36]. As the connection between the environment and income continues to be indecisive within the environmental Kuznets curve (EKC), further research may offer the debate valuable information in previously uninvestigated regions and countries.

Through integrating the above three literature branches, our theoretical and empirical contributions in this paper are twofold. First, most of the contemporary research has been focused on the renewable energy consumption–growth–environment nexus without admitting how green energy technologies can close the gap between economic activity and environmental quality in Saudi Arabia. As far as we are concerned, to our knowledge, there is no existing study that has examined the interconnections among green energy use, environmental quality, and economic growth in Saudi Arabia. Second, from an empirical side and compared to existing studies, this paper used simultaneous equations on the basis of structural modeling and generalized method of moments (GMM) estimator to analyze these interconnections. The main reason behind using the simultaneous system technique is to compensate for the simultaneity issue in order to avoid the potential problem of biased assessments posed by econometric researchers [37,38].

The rest of the paper is organized as follows. The literature review is discussed in Section 2, while the methodology and data are clarified in Section 3. In Section 4, the empirical findings are presented and discussed. The conclusion and policy implications are provided in Section 5.

2. Literature Review

The literature has revealed wide attention on the association linking (dis)aggregate energy use, economic growth, and environmental degradation. As mentioned above, the existing literature can be separated into three strands of study. The first one focuses on reviewing the existing literature between renewable energy and economic growth. The association involving both energy and growth received great interest not only for economists but also for policymakers because of its important policy involvement. Some investigators point out that both key macro-variables and economic growth are the most important pillars of energy use and therefore advocate applying these candidate series to plan energy exploitation [11,39]. In this context, a certain number among them showed that energy use has directly and/or indirectly contributed to economic growth (growth assumption, e.g., [18,40,41], among others), while others showed that energy use is deter-

mined by EG and not the opposite (conservation assumption, e.g., [42,43] among others); others too revealed that both real GDP, as well as energy use, are mutually dependent and that there is a strong confirmation of two-way causal association between them (feedback assumption, e.g., [11,44,45]) or that there was no causal link connecting the investigated series (neutrality assumption, e.g., [46,47], among others) [48]. Hence, an additional generation of the literature looked at investigating the association involving economic growth proxied by GDP and disaggregated energy sources. On the other hand, this new generation is not as extended as the earlier one, and the quantity of available studies is relatively low [49]. In this research field, the authors of [50] analyzed panel data by using neo-class production function. In their dataset, economic growth (GDP) represents the reliant series (dependent) regressed by the subsequent autonomous series (independent), i.e., renewable energy, labor, and capital. They found in the case of the Black Sea and Balkan countries that renewable energy boosts the growth of their economies. Likewise, the authors of [51] strongly confirmed that the exploitation of clean energy positively affects the economic growth of new EU member economies. Moreover, the authors of [52,53] found strong evidence that renewable energy appears as a dynamic force for economic growth for the OECD and G-7 economies, respectively.

The second strand of literature focuses on reviewing the existing literature on renewable energy and environmental degradation. With the rapid rise in the exploitation of green energy, an increasing number of researchers have studied the fundamental part of green energy exploitation in moderating emissions at the national, regional, and worldwide levels. Many recent studies confirm the benefic effect of green energy on environmental quality [18,40,42,43,45,54,55]. For example, Reference [40] found that the use of green energy causes a drop in CO₂ emission for all investigated regions. Similarly, Reference [18] showed that the exploitation of green energy sources contributes significantly to environmental improvement in 85 developed and developing economies. In addition, some studies confirm the bidirectional causality between green energy on environmental quality [42]. However, the empirical results of some studies do not confirm causality between renewable energy consumption and environmental quality [56,57]. Conversely, Reference [58] found that raising the exploitation of green energy for five selected African economies over the period 1980–2011 allowed for moderation of CO₂ emissions.

The third strand of literature focuses on reviewing the existing studies on the renewable energy–growth nexus and on the validity of the EKC hypothesis. This hypothesis assumes that the association involving both environmental degradation and economic growth bears a resemblance to an upturned U-shape curve. In several observed studies, a U-shaped liaison confirmed that income causes larger deterioration of the environment at a moderately small intensity of growth of per capita until it stabilizes at a middle-income level, after which new growth leads to an environmental improvement [59]. Research studies in this field can be divided into two broad categories. The first category of studies tries to make comparisons between countries for a long period [60–64]. On the other hand, we find the second category of works that concentrate on studying the validity of the hypothesis of the EKC in a single country and for a long period also [5,65–71]. Subsequently, diverse approaches have been applied, and the findings have been varied as well [60]. In this scientific field, Reference [62] provides no confirmation regarding the validation of EKC supposition for a panel of 25 selected African countries. In addition, the EKC hypothesis is supported for only three countries in the study of [60] that was based on a sample of six Sub-Saharan African countries over the period of 1971–2009. However, many studies have confirmed the validation of the EKC assumption [60,61,63,68,69,71]. Further, the authors of [64] confirmed the presence of an N-shaped association between CO₂ emissions and economic growth in five countries of the European Union (EU-5). Recently, [72] examined the dynamics of the use of renewables, CO₂ emissions, and GDP development for the EU membership states over the period 1995–2015 through using various econometric techniques. The findings suggest a corrective retreat as economic growth leads to a rise in the use of renewable energy. The survey also found that candidate and future applicant

countries for EU membership should support the production of renewable energy. In order to ascertain the dynamic interplay between CO₂ emissions, energy use by non-renewable sources (NRES), renewable sources (RES), and GDP growth, the authors of [73] performed the three-series probabilistic model of variability. The authors supported the literature by showing that stochastic RES and NRES volatility also seems to be U-shaped in the Indian economy. The U-shaped model seems to be associated with economic growth. They similarly detected the time differences in the processes for the transmission of CO₂ emissions, energy sources, and GDP. On the basis of a comparative approach, the authors of [47] investigated for Australia and Canada the relationship between renewables, economic development, urbanization, CO₂ emissions, and trade for the period of 1960–2015. The findings in Australia showed that in the long term, as well as in the short term, the growth of the economy is increasing CO₂ emissions. In the case of Canada, it appears that trade raises CO₂ emissions both in the long term and in the short term, while economic growth and the urban population increase carbon dioxide in the long term.

The results found in the literature were dissimilar between the different countries and frequently disputed by various proxies and performance indicators, econometric approaches performed, the existence of omitted variable bias, the time horizons, as well as the model definition and specification. From an empirical perspective and compared to existing studies, this paper used simultaneous equations on the basis of structural modeling and GMM estimator to analyze these interconnections. The main reason behind using the simultaneous system technique was to compensate for the simultaneity issue in order to avoid the potential problem of biased assessments posed by econometric researchers [37,38].

3. Econometric Modeling and Data

3.1. Model Specifications and Estimation Method

To investigate how renewable energy, economic growth, and environmental degradation are interconnected in Saudi Arabia, we performed the production function of Cobb–Douglas, where income depends on labor, capital, and technological progress. In addition to these factors, energy has been also cited as a potential source of economic growth [74–76]. Thus, the extensive production function of Cobb–Douglas was used as follows:

$$Y = AK^{\alpha_1}L^{\alpha_2}E^{\alpha_3}e^{\varepsilon} \quad (1)$$

where Y is the income; A is the level of technological progress; K is the capital; L is the labor force; E is energy consumption; and α_1 , α_2 , and α_3 refer to the output elasticities of capital, labor force, and energy consumption, respectively. There is a linear correlation between energy use and the level of CO₂ emissions at any point in time (C): $E = b.CO$ when considering the level of technology. Moreover, several energy economists support the view that renewable energy (RE) is fundamental for reducing emissions and increasing economic growth and it could be incorporated as an input factor in the production function [77–79]. Therefore, the prolonged production function of Cobb–Douglas appears as follows:

$$Y = AK^{\alpha_1}L^{\alpha_2}bCO^{\alpha_3}RE^{\alpha_4}e^{\varepsilon} \quad (2)$$

The linearized production function Cobb–Douglas is obtained by taking the logarithm as follows:

$$\ln Y_t = \alpha_0 + \alpha_1 \ln CO_t + \alpha_2 \ln RE_t + \alpha_3 \ln K_t + \alpha_4 \ln L_t + \varepsilon_t \quad (3)$$

where $\alpha_0 = \ln(A)$; the subscript $t = 1, T$ indicates the time period; Y is the income; CO is per capita CO₂ emissions; RE is renewable energy consumption; K is capital; L is labor force; and ε is the term of error. This production function is employed to derive analytical models to examine the interrelationships among economic growth, CO₂ emissions, and renewable energy simultaneously. These models are built on the basis of previous theoretical and empirical studies. CO₂ emissions, as well as renewable energy, capital (K), labor (L), squared GDP (Y^2), energy use (EU), urbanization (U), foreign direct investment (F), trade openness

(T), financial development (FD), and oil prices (OP) are incorporated as instrumental variables while assessing the causality among income.

The three-way relationships among environmental quality, economic growth, and renewable energy are empirically investigated by means of the following three specifications:

$$\ln Y_t = \alpha_0 + \alpha_1 \ln CO_t + \alpha_2 \ln RE_t + \alpha_3 \ln K_t + \alpha_4 \ln L_t + \varepsilon_t \quad (4)$$

$$\ln CO_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln RE_t + \alpha_3 \ln Y_t^2 + \alpha_4 \ln EU_t + \alpha_5 \ln U_t + \alpha_6 \ln F_t + \varepsilon_t \quad (5)$$

$$\ln RE_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln CO_t + \alpha_3 \ln OP_t + \alpha_4 \ln FD_t + \alpha_5 \ln T_t + \varepsilon_t \quad (6)$$

Equation (4) indicates that GDP per capita is influenced by the level of CO₂ emissions, renewable energy consumption, labor force, and domestic capital [61,80,81]. Equation (5) states that the CO₂ emission level is determined by per capita GDP, renewable energy use, squared GDP per capita, energy use, urbanization, and foreign direct investment [15,82,83]. Equation (6) states that renewable energy consumption is influenced by per capita GDP, oil prices, CO₂ emissions, and trade openness [49,84].

Equations (4)–(6) are simultaneously measured by using the generalized method of moments (GMM), the most widely used for multi-way relationship models. The GMM uses a collection of instrumental series to address the issue of endogeneity and presents effective and reliable assessments when arbitrary heteroskedasticity occurs. Furthermore, two diagnostic tests are necessary for estimating simultaneous equation modeling, namely, Hansen's test for overidentifying restrictions and the test of Durbin–Wu–Hausman (DWH) for checking the endogeneity issue [81]. The first test offers proof of the validity of the instruments. The alternative hypothesis of this test is that the instruments are appropriate is rejected. The second test will be used to screen for issues of endogeneity in the three predicted specifications. The alternative assumption confirms the endogeneity of instruments. Accepting this hypothesis indicates that the instrumental variable technique is not appropriate.

3.2. Data and Descriptive Statistics

To assess the above three simultaneous equation models, we took annual data for Saudi Arabia spanning the timeframe 1990–2016. The data were sourced from the International Monetary Fund (IMF) [85], the World Development Indicators (WDI) [86], and the British Petroleum Statistical Review of World Energy (BP) [87]. The choice of the timeframe in this study was reliant on data availability. The underlying series were per capita CO₂ emissions measured in metric tons, GDP per capita (constant 2010 USD), renewable energy use as a portion of total final energy use, financial development index (FDI) net inflows as a percentage of GDP, the sum of goods and services exported and imported as a proportion of GDP that refers to trade openness proxy, labor force measured as persons aged 15 or over who provide labor during a given time to produce goods and services, gross fixed capital formation as a share of GDP to measure of domestic capital, oil prices determined by West Texas Intermediate (WTI) spot price on crude oil, urban population, and energy use measured in kilograms of oil equivalent.

Table 1 summarizes descriptive statistics and correlations. We can see from Table 1 that, during the sample period, GDP per capita ranged from USD 16,696.41 to USD 21,399, the range for per capita CO₂ emissions was from 10.497 to 20.402 metric tons per capita, and renewable energy consumption ranged from 0.005% to 0.037% of total final energy consumption. The targets of this program are to reach 3.45 GW by 2020 and 9.5 by 2030, which represent, respectively, 4% and 10% of Saudi's total energy generation [20]. This table also shows that GDP per capita is the most associated with CO₂ emissions per capita, whereas the lowest is for the urbanization variable. Moreover, renewable energy is correlated negatively with per capita CO₂ emissions and positively with per capita GDP, which really means that raising the renewable energy share in the total final energy use would simultaneously minimize emissions of CO₂ and raise GDP per capita.

Table 1. Summary of descriptive statistics and correlations for 1990–2016.

Variables	CO _t	Y _t	RE _t	FD _t	F _t	T _t	L _t	K _t	OP _t	U _t	EU _t
Mean	15.843	19,332.68	0.012	0.377	1.785	74.001	8,005,308	21.147	46.684	18,815,003	115.441
Standard deviation	2.740	1207.243	0.009	0.128	2.622	11.111	2,688,264	3.193	29.967	4,421,896	16.803
Min	10.497	16,696.41	0.005	0.188	−1.30	56.088	5,024,970	17.308	14.420	12,432,320	83.677
Max	20.402	21,399.10	0.037	0.559	8.496	96.102	13,607,874	29.852	99.670	27,057,429	148.902
CO _t	1										
Y _t	0.695 ***	1									
RE _t	−0.608 **	0.154	1								
FD _t	0.684 **	0.519 **	0.694 *	1							
F _t	0.279	0.159	0.319	0.541 **	1						
Tr _t	0.560 **	0.397	0.270	0.630 *	0.703 **	1					
L _t	0.413	0.501	0.507	0.690	0.314	0.434	1				
K _t	0.577	0.616 **	0.365	0.623	0.475	0.416	0.525	1			
OP _t	0.552 **	0.558 ***	0.619 **	0.603 **	0.576 *	0.628 ***	0.703 *	0.579 ***	1		
U _t	0.390	0.522	0.298	0.390	0.376	0.468	0.587	0.488	0.591 **	1	
EU _t	0.658 ***	0.398 ***	0.445 *	0.490	0.501 ***	0.531 ***	0.403 **	0.492 *	0.587 ***	0.483 *	1

Note: ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

4. Empirical Results and Discussion

While estimating simultaneously the three-way links among economic growth, environmental quality, and renewable energy, we incorporated capital (K), labor (L), squared GDP (Y^2), energy use (EU), urbanization (U), foreign direct investment (F), oil prices (OP), trade openness (T), and financial development (FD) as instrumental variables. As indicated above, two diagnostic tests should be performed to use simultaneous equations. The Hansen test is performed for presenting proof of the validity of the instruments that cannot deny the null assumption of over-identification restrictions. The results reported in Table show that the null assumption cannot be dismissed, indicating that the instruments are appropriate. In addition to Hansen's test, the DWH test was used to check the issue of endogeneity in the assessed specifications. The alternative presumption confirmed the endogeneity problem within instruments. Rejecting this hypothesis implies that the instrumental variable techniques are permissible.

Regarding these diagnostic tests, the assessed coefficients of Equations (4)–(6) are reported in Table 2. The empirical results of Equation (4) show that the negative effect of CO₂ emissions per capita on GDP per capita was statistically significant. The value of −0.097 suggests that a 1% rise in per capita CO₂ emissions reduced economic growth by approximately 0.1%. This result is supported by the study of [61], indicating that increased environmental degradation reduces economic growth in Oman, Morocco, Iran, Kuwait, Tunisia, and Egypt. However, renewable energy consumption in Saudi Arabia does not have a significant impact on economic growth, confirming the growth presumption. This result confirms the finding of [88], who confirm that renewables in developed and developing countries do not minimize pollution. However, it contradicts the findings of [89], who proved that using renewables in Netherland, Brazil, India, Finland, Japan, the United Kingdom, and the Sweden has a significant and positive effect on increased revenues. Similarly, in the context of BRICS economies, Reference [77] found that increasing renewable energy share in total energy use contributes to a reduction in economic growth. Moreover, we found that the capital coefficient was significant and displayed a positive sign; however, the labor force coefficient was significant and yielded a negative sign. These outcomes are consistent with [90], who found a 1% increase in domestic capital would lift per capita GDP by about 0.27% and that a 1% rise in the labor force would decrease the per capita GDP by approximately 0.41%.

Table 2. Simultaneous equation generalized method of moments (GMM) estimation for Equations (4)–(6).

Independent Variables	Dependent Variables					
	GDP Per Capita (Y) Equation (4)		CO ₂ Emissions (CO) Equation (5)		Renewable Energy (RE) Equation (6)	
	Coef.	<i>p</i> -Value	Coef.	<i>p</i> -Value	Coef.	<i>p</i> -Value
GDP per capita (Y)	-	-	0.637	(0.000)	0.183	(0.027)
Squared GDP (Y ²)	-	-	−0.088	(0.058)	-	-
CO ₂ emissions (CO)	−0.093	(0.022)	-	-	0.237	(0.000)
Renewable energy (RE)	0.059	(0.154)	−0.048	(0.071)	-	-
Capital (K)	0.416	(0.000)	-	-	-	-
Labor (L)	−0.186	(0.062)	-	-	-	-
Energy use (EU)	-	-	0.371	(0.000)	-	-
Urbanization (U)	-	-	0.142	(0.019)	-	-
FDI (F)	-	-	0.113	(0.042)	-	-
Oil prices (OP)	-	-	-	-	0.116	(0.122)
Financial development (FD)	-	-	-	-	0.193	(0.031)
Trade openness (TO)	-	-	-	-	0.105	(0.111)
Constant	7.148	(0.000)	4.480	(0.011)	10.091	(0.000)
Hansen's test (<i>p</i> -value)	12.429	(0.667)	20.518	(0.293)	17.702	(0.428)
DWH test (<i>p</i> -value)	4.817	(0.033)	10.392	(0.004)	6.279	(0.027)

Note: Values in parentheses are the estimated *p*-values.

The empirical results of Equation (5) show that GDP per capita had the highest contribution to increasing CO₂ emissions in Saudi Arabia. The value of 0.637 suggests that a 1% rise in GDP per capita would increase CO₂ emissions per capita by roughly 0.64%. This suggests that rising economic growth allows environmental quality to deteriorate. This result confirms the outcomes of [61,67,71,91] for Turkey, the United Kingdom, 12 MENA economies, and Algeria, respectively. However, it contradicts the results of [15], who illustrate that economic growth helps to minimize CO₂ emissions in OECD economies. The authors concluded that the 1% rise in GDP per capita decreased per capita CO₂ emissions by approximately 0.7%. Furthermore, the per capita squared GDP was statistically significant and displayed a negative effect on CO₂ per capita emissions. The positive and negative signs of GDP per capita (Y) and squared GDP per capita (Y²), respectively, support the validity of the EKC hypothesis, which suggests that the CO₂ levels per capita initially increase with GDP per capita, but any later increase would lead to a reduction in CO₂ emissions per capita after a certain GDP level has been reached. As shown in Table 1, this result confirmed the findings of [61,71,91], who show the EKC presumption validity; however, it contradicted the findings of [66], who found the invalidity of this hypothesis for Turkey. With regard to the series of renewable energy, we found that consumption of renewable energy had the lowest effect on CO₂ emission reductions. The value of −0.048 meant that a 1% rise in the usage of renewable energy helped to lower per capita CO₂ emissions by approximately 0.05%. This finding was the same as [15], who found that the 1% growth in renewable energy usage reduced per capita CO₂ emissions by around 1% for Belgium, 0.06% for Canada, 0.14% for France, 0.09% for Germany, 0.26% for Sweden, 0.17% for the United Kingdom, 0.12% for the United States, 0.14% for Japan, 0.11 for Switzerland, 0.67 for Finland, and 0.11 for the Czech Republic. For the panel estimation, the authors also confirmed that exploiting renewable energy positively contributes to per capita CO₂ emission reduction. However, our result contradicts the finding of [88], who found that renewable energy consumption has an insignificant impact on CO₂ emissions for both

developing and developed economies. Unlike the renewable energy variable, the energy use series also has a statistically significant influence on CO₂ emissions per capita and displays a positive sign at the level of 1%. The value of 0.371 implies that a 1% rise in energy utilization raises CO₂ emissions per capita by approximately 0.37%. Similarly, it was found that urbanization and trade openness had considerable effects on per capita CO₂ emissions, displaying a positive sign at 5% and 10% levels, respectively. These findings are the same as [61] for 12 MENA countries.

Finally, the empirical results for Equation (6) showed that GDP per capita had a statistically significant effect on renewable energy use, displaying a positive sign at the level of 5%. The value of 0.183 indicated that a 1% increase in economic growth increased the consumption of renewables by approximately 0.18%, which supports the evidence of the conservation hypothesis. The theory for conservation indicates a one-way causal connection that moves from economic growth to energy usage, which means that a rise in economic growth contributes to a rise in energy use [76]. This outcome is the same as the results of [89], who support the conservation hypothesis for Spain, Switzerland, Finland, Argentina, Brazil, and the United Kingdom. They found that a 1% rise in real GDP boosted the usage of renewable energy within a range of 0.17% for Brazil to 0.41% for the United Kingdom. Regarding the environmental variable, we found that an intensification in per capita CO₂ emissions will lead to a rise in the demand for renewable energy. The magnitude of 0.237 implies that a 1% augmentation in per capita CO₂ emissions augments the consumption of renewables by about 0.24%. This outcome indicates that the level of CO₂ emissions per capita increases the request for environmental safety and boosts the production and consumption of sustainable energy that is carbon emission-free, whereas a reduction in the level of per capita CO₂ emissions leads to diminishing the consumption of renewable energy. We also confirm that financial development contributes positively to renewable energy demand. The measure of 0.193 showed that a 1% rise in financial development raised renewable energy usage by roughly 0.19%. This result demonstrates that financial development is a significant catalyst for the promotion of renewable energy production and usage in Saudi Arabia. Indeed, financing is not only a precondition for renewable energy in Saudi Arabia but is also crucial for the ongoing phase of research and development to enhance economic viability; raise awareness investments; increase the involvement of stockholders; and develop new policy steps, such as maximizing customer participation to invest in the green energy sector.

The above-mentioned results showed that clearly there is (i) a one-way causal connection from GDP per capita to renewable energy usage, supporting the conservation assumption; (ii) a bidirectional linkage between per capita CO₂ emissions and per capita GDP, meaning that increasing economic growth leads CO₂ emissions to rise, and the continued rising of CO₂ emissions is likely to reduce economic growth; (iii) a two-way causal linkage among renewable energy usage and CO₂ emissions, indicating that an increase in CO₂ emissions allows for boosting the renewable energy demand that will, in turn, reduce CO₂ emissions.

5. Conclusions and Policy Implications

The key purpose of this paper was to analyze the interconnections among economic growth, CO₂ emissions, and renewable energy use and to show the renewable energy potential in narrowing the disparity between Saudi Arabia's economic growth and CO₂ emissions for the timeframe of 1990–2016. We are inspired by the fact that there is no current research, to the best knowledge, that has examined these interconnections using the simultaneous equation models method, particularly in terms of Saudi Arabia. This method allows us to concurrently check the (i) impacts of renewable energy and CO₂ emissions on GDP, impacts of GDP and renewable energy on CO₂ emissions, and (iii) impacts of GDP and CO₂ emissions on renewable energy.

Our empirical findings indicate that there are unidirectional causal impacts that support the theory of conservation, from economic growth to renewable energy use. The in-

significant causal impact of renewable energy on economic growth confirms the neo-classical hypothesis that energy is neutral for growth in the case of Saudi Arabia. We also found bidirectional relationships between economic growth and CO₂ emissions and between CO₂ emissions and renewable energy consumption. Our results also highlight the failure of renewable energy in closing the gap between growing the economy and protecting the environment in Saudi Arabia.

The main policy implications emerging from the above findings are as follows. First, we found a bidirectional linkage between per capita GDP and per capita CO₂ emissions, indicating that augmenting economic growth results in a rise in CO₂ emissions, and a continuous rise in CO₂ emissions will reduce economic growth. Hence, CO₂ emissions may be decreased at the cost of economic growth or encouraging the use of effective energy technologies and importing environmentally friendly technologies from developed countries. Moreover, the research and development in green energy should become an important part of the CO₂ emissions mechanism in terms of the controlling process. Second, a two-way causal linkage between renewable energy usage and CO₂ emissions, indicating that an increase in CO₂ emissions allows for increasing the renewable energy demand that will reduce CO₂ emissions consecutively. Therefore, Saudi Arabia is geographically well positioned, having a high potential for solar and wind production of renewable energy. Regarding the economic and social side, it is recommended that the Saudi government and policymakers encourage not only the use of renewable energy but also provide financing and improve the performance of consumer and industry use of renewable energy. These initiatives would make it possible for them to profit entirely from the benefits of renewables. Saudi Arabia should further rebuild the market in renewable energy, establish an institutional and administrative framework in this field, and seek to increase the skills and knowledge needed. Explicitly, the Saudi government should therefore make it easier to obtain funds and use public funds to mobilize and enable companies to invest in R&D and to introduce large-scale economic technologies on renewable energy. Indeed, investment in renewable energy is likely to increase economic growth. The purpose of this relationship is the idea of creating jobs. For example, it will make it easier to promote investments in renewable sources to generate new opportunities for business, such as credit reduction, endangered species banking, and wetland banking. These measures will generate new jobs and thereby improve economic growth. Concerning the environmental side, in view of the key role of renewable energy in CO₂ reduction, policymakers in Saudi Arabia should design and enforce efficient and useful support policies to promote new and sustainable technology investment and build energy expertise to enhance environmental quality. An over-usage of the clean development mechanism (CDM), which has definitely been developed as part of environmental and security protection, is a major step to both the energy efficiency and renewable energy systems in the country. This is due to the fact that the country is an ideal CDM destination because it has a large gas and oil industry and is wealthy in renewable energy sources. A set of appropriate and effective incentives and policies that encourage lower carbon finance is thus an important objective to conserve the resources of Saudi Arabia. The key drawback in this study is the limited data for Saudi Arabia, especially for renewable energy indicators. Potential extensions of this research may include inclusion of other institutional and sociodemographic measures and environmental degradation proxies.

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References

1. Zafar, M.W.; Saud, S.; Hou, F. The impact of globalization and financial development on environmental quality: Evidence from selected countries in the organization for economic co-operation and development (OECD). *Environ. Sci. Pollut. Res.* **2019**, *26*, 13246–13262. [CrossRef] [PubMed]
2. Adedoyin, F.; Ozturk, I.; Abubakar, I.; Kumeka, T.; Folarin, O.; Bekun, F.V. Structural breaks in CO₂ emissions: Are they caused by climate change protests or other factors? *J. Environ. Manag.* **2020**, *266*, 110628. [CrossRef] [PubMed]
3. IPCC. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC*; Cambridge University Press: Cambridge, UK, 2013.
4. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development United Nations. Available online: <https://sdgs.un.org/2030agenda> (accessed on 25 January 2021).
5. Omri, A.; Euch, J.; Hasaballah, A.H.; Al-Tit, A. Determinants of environmental sustainability: Evidence from Saudi Arabia. *Sci. Total Environ.* **2019**, *657*, 1592–1601. [CrossRef] [PubMed]
6. Kingdom of Saudi Arabia. The Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia under the UNFCCC. Available online: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf> (accessed on 25 January 2021).
7. Alkhatlan, K.; Javid, M. Carbon emissions and oil consumption in Saudi Arabia. *Renew. Sustain. Energy Rev.* **2015**, *48*, 105–111. [CrossRef]
8. Bekhet, H.A.; Othman, N.S. The role of renewable energy to validate dynamic interaction between CO₂ emissions and GDP toward sustainable development in Malaysia. *Energy Econ.* **2018**, *72*, 47–61. [CrossRef]
9. Goh, T.; Ang, B.W. Quantifying CO₂ emission reductions from renewables and nuclear energy—Some paradoxes. *Energy Policy* **2018**, *113*, 651–662. [CrossRef]
10. Kahia, M.; Ben Aïssa, M.S.; Charfeddine, L. Impact of renewable and non-renewable energy consumption on economic growth: New evidence from the MENA Net Oil Exporting Countries (NOECs). *Energy* **2016**, *116*, 102–115. [CrossRef]
11. Kahia, M.; Ben Aïssa, M.S.; Lanouar, C. Renewable and non-renewable energy use-economic growth nexus: The case of MENA net oil importing countries. *Renew. Sustain. Energy Rev.* **2017**, *71*, 127–140. [CrossRef]
12. Kahia, M.; Kadria, M.; Ben Aïssa, M.S.; Lanouar, C. Modelling the treatment effect of renewable energy policies on economic growth: Evaluation from MENA countries. *J. Clean. Prod.* **2017**, *149*, 845–855. [CrossRef]
13. Kahia, M.; Ben Jebli, M.; Belloumi, M. Analysis of the impact of renewable energy consumption and economic growth on carbon dioxide emissions in 12 MENA countries. *Clean Technol. Environ. Policy* **2019**, *21*, 871–885. [CrossRef]
14. Dong, K.; Sun, R.; Hochman, G. Do natural gas and renewable energy consumption lead to less CO₂ emission? Empirical evidence from a panel of BRICS countries. *Energy* **2017**, *141*, 1466–1478. [CrossRef]
15. Saidi, K.; Omri, A. Reducing CO₂ emissions in OECD countries: Do renewable and nuclear energy matter? *Prog. Nucl. Energy* **2020**, *126*, 103425. [CrossRef]
16. Saidi, K.; Omri, A. The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. *Environ. Res.* **2020**, *186*, 109567. [CrossRef]
17. Bekhet, H.A.; Harun, N.H. Elasticity and causality among electricity generation from renewable energy and its determinants in Malaysia. *Int. J. Energy Econ. Policy* **2017**, *7*, 202–216.
18. Bhattacharya, M.; Churchill, S.A.; Paramati, S.R. The dynamic impact of renewable energy and institutions on economic output and CO₂ emissions across regions. *Renew. Energy* **2017**, *111*, 157–167. [CrossRef]
19. Charfeddine, L.; Kahia, M. Impact of renewable energy consumption and financial development on CO₂ emissions and economic growth in the MENA region: A panel vector autoregressive (PVAR) analysis. *Renew. Energy* **2019**, *139*, 198–213. [CrossRef]
20. Khan, M. Saudi Arabia's vision 2030. *Def. J.* **2016**, *119*, 36–42.
21. Bayar, Y.; Gavriltea, M.D. Energy efficiency, renewable energy, economic growth: Evidence from emerging market economies. *Qual. Quant.* **2019**, *53*, 2221–2234. [CrossRef]
22. Bhattacharya, M.; Paramati, S.R.; Ozturk, I.; Bhattacharya, S. The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. *Appl. Energy* **2016**, *162*, 733–741. [CrossRef]
23. Mahmood, N.; Wang, Z.; Hassan, S.T. Renewable energy, economic growth, human capital, and CO₂ emission: An empirical analysis. *Environ. Sci. Pollut. Res.* **2019**, *26*, 20619–20630. [CrossRef]
24. Destek, M.A.; Aslan, A. Renewable and non-renewable energy consumption and economic growth in emerging economies: Evidence from bootstrap panel causality. *Renew. Energy* **2017**, *111*, 757–763. [CrossRef]
25. Ozcan, B.; Ozturk, I. Renewable energy consumption-economic growth nexus in emerging countries: A bootstrap panel causality test. *Renew. Sustain. Energy Rev.* **2019**, *104*, 30–37. [CrossRef]
26. Yazdi, S.K.; Shakouri, B. Renewable energy, nonrenewable energy consumption, and economic growth. *Energy Sources Part B Econ. Plan. Policy* **2017**, *12*, 1–8.

27. Zhang, B.; Wang, B.; Wang, Z. Role of renewable energy and non-renewable energy consumption on EKC: Evidence from Pakistan. *J. Clean. Prod.* **2017**, *156*, 855–864.
28. Sarkodie, S.A.; Adams, S. Renewable energy, nuclear energy, and environmental pollution: Accounting for political institutional quality in South Africa. *Sci. Total Environ.* **2018**, *643*, 1590–1601. [\[CrossRef\]](#) [\[PubMed\]](#)
29. Van Hoang, T.H.; Shahzad, S.J.H.; Czudaj, R.L. Renewable energy consumption and industrial production: A disaggregated time-frequency analysis for the US. *Energy Econ.* **2019**, *1*, 104433. [\[CrossRef\]](#)
30. Saidi, H.; El Montasser, G.; Ajmi, A.N. The role of institutions in the renewable energy growth nexus in the MENA region: A panel cointegration approach. *Environ. Model. Assess.* **2019**, *25*, 259–276. [\[CrossRef\]](#)
31. Awaworyi Churchill, S.; Inekwe, J.; Ivanovski, K.; Smyth, R. The environmental kuznets curve across australian states and territories. *Energy Econ.* **2020**, *90*, 104869. [\[CrossRef\]](#)
32. Boubellouta, B.; Kusch-Brandt, S. Testing the environmental kuznets curve hypothesis for E-waste in the EU28+2 countries. *J. Clean. Prod.* **2020**, 123371. [\[CrossRef\]](#)
33. Lau, L.S.; Choong, C.K.; Ng, C.F.; Liew, F.M.; Ching, S.L. Is nuclear energy clean? Revisit of environmental kuznets curve hypothesis in OECD countries. *Econ. Model.* **2019**, *77*, 12–20. [\[CrossRef\]](#)
34. Pata, U.K.; Aydin, M. Testing the EKC hypothesis for the top six hydropower energy-consuming countries: Evidence from Fourier Bootstrap ARDL procedure. *J. Clean. Prod.* **2020**, *264*, 121699. [\[CrossRef\]](#)
35. Pontarollo, N.; Serpieri, C. Testing the environmental kuznets curve hypothesis on land use: The case of Romania. *Land Use Policy* **2020**, *97*, 104695. [\[CrossRef\]](#)
36. Ulucak, R.; Bilgili, F. A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. *J. Clean. Prod.* **2018**, *188*, 144–157. [\[CrossRef\]](#)
37. He, J.; Richard, P. Environmental Kuznets curve for CO₂ in Canada. *Ecol Econ.* **2010**, *69*, 1083–1093. [\[CrossRef\]](#)
38. Ben Youssef, A.; Hammoudeh, S.; Omri, A. Simultaneity modeling analysis of the environmental Kuznets curve hypothesis. *Energy Econ.* **2016**, *60*, 266–274. [\[CrossRef\]](#)
39. Skeer, J.; Wang, Y. China on move: Oil price explosion. *Energy Policy* **2007**, *35*, 678–691. [\[CrossRef\]](#)
40. Dong, K.; Hochman, G.; Zhang, Y.; Sun, R.; Li, H.; Liao, H. CO₂ emissions, economic and population growth, and renewable energy: Empirical evidence across regions. *Energy Econ.* **2018**, *75*, 180–192. [\[CrossRef\]](#)
41. Omri, A.; Kahouli, B. Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneous-equations models. *Energy Policy* **2014**, *67*, 913–922. [\[CrossRef\]](#)
42. Irandoust, M. The renewable energy-growth nexus with carbon emissions and technological innovation: Evidence from the Nordic countries. *Ecol. Indic.* **2016**, *69*, 118–125. [\[CrossRef\]](#)
43. Waheed, R.; Chang, D.; Sarwar, S.; Chen, W. Forest, agriculture, renewable energy, and CO₂ emission. *J. Clean. Prod.* **2018**, *172*, 4231–4238. [\[CrossRef\]](#)
44. Cho, S.; Heo, E.; Kim, J. Causal relationship between renewable energy consumption and economic growth: Comparison between developed and less-developed countries. *Geosystem Eng.* **2015**, *18*, 284–291. [\[CrossRef\]](#)
45. Saidi, K.; Ben Mbarek, M. Nuclear energy, renewable energy, CO₂ emissions, and economic growth for nine developed countries: Evidence from panel Granger causality tests. *Prog. Nucl. Energy* **2016**, *88*, 364–374. [\[CrossRef\]](#)
46. Menegaki, A.N. Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. *Energy Econ.* **2011**, *33*, 257–263. [\[CrossRef\]](#)
47. Rahman, M.M.; Vu, X.B. The nexus between renewable energy, economic growth, trade, urbanisation and environmental quality: A comparative study for Australia and Canada. *Renew. Energy* **2020**, *155*, 617–627. [\[CrossRef\]](#)
48. Payne, J.E. A survey of the electricity consumption-growth literature. *Appl. Energy* **2010**, *87*, 723–731. [\[CrossRef\]](#)
49. Sadorsky, P. Renewable energy consumption and income in emerging economies. *Energy Policy* **2009**, *37*, 4021–4028. [\[CrossRef\]](#)
50. Koçak, E.; Şarkgüneşi, A. The renewable energy and economic growth nexus in black sea and Balkan Countries. *Energy Policy* **2017**, *100*, 51–57. [\[CrossRef\]](#)
51. Alper, A.; Oguz, O. The role of renewable energy consumption in economic growth: Evidence from asymmetric causality. *Renew. Sustain. Energy Rev.* **2016**, *60*, 953–959. [\[CrossRef\]](#)
52. Inglesi-Lotz, R. The impact of renewable energy consumption to economic growth: A panel data application. *Energy Econ.* **2016**, *53*, 58–63. [\[CrossRef\]](#)
53. Balcilar, M.; Ozdemir, Z.A.; Ozdemir, H.; Shahbaz, M. The renewable energy consumption and growth in the G-7 countries: Evidence from historical decomposition method. *Renew. Energy* **2018**, *126*, 594–604. [\[CrossRef\]](#)
54. Ben Jebli, M.; Ben Youssef, S. Renewable energy consumption and agriculture: Evidence for cointegration and Granger causality for Tunisian economy. *Int. J. Sustain. Dev. World Ecol.* **2016**, *24*, 149–158. [\[CrossRef\]](#)
55. Bélaïd, F.; Youssef, M. Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria. *Energy Policy* **2017**, *102*, 277–287. [\[CrossRef\]](#)
56. Apergis, N.; Payne, J.E.; Menyah, K.; Wolde-Rufael, Y. On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. *Ecol. Econ.* **2010**, *69*, 2255–2260. [\[CrossRef\]](#)
57. Menyah, K.; Wolde-Rufael, Y. CO₂ emissions, nuclear energy, renewable energy and economic growth in the US. *Energy Policy* **2010**, *38*, 2911–2915. [\[CrossRef\]](#)

58. Ben Jebli, M.; Ben Youssef, S. The role of renewable energy and agriculture in reducing CO₂ emissions: Evidence for North Africa countries. *Ecol. Indic.* **2017**, *74*, 295–301. [\[CrossRef\]](#)
59. Frankel, J. Global Environmental Policy and Global Trade Policy. Available online: belfercenter.ksg.harvard.edu/files/Frankel2Web.pdf (accessed on 25 January 2021).
60. Kiviyiro, P.; Arminen, H. Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa. *Energy* **2014**, *74*, 595–606. [\[CrossRef\]](#)
61. Omri, A.; Daly, S.; Rault, C.; Chaibi, A. Financial development, environmental quality, trade and economic growth: What causes what in MENA countries. *Energy Econ.* **2015**, *48*, 242–252. [\[CrossRef\]](#)
62. Zoundi, Z. CO₂ emissions, renewable energy and the Environmental Kuznets Curve, a panel cointegration approach. *Renew. Sustain. Energy Rev.* **2017**, *72*, 1067–1075. [\[CrossRef\]](#)
63. Sapkota, P.; Bastola, U. Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. *Energy Econ.* **2017**, *64*, 206–212. [\[CrossRef\]](#)
64. Balsalobre-Lorente, D.; Shahbaz, M.; Roubaud, D.; Farhani, S. How economic growth, renewable electricity and natural resources contribute to CO₂ emissions? *Energy Policy* **2018**, *113*, 356–367. [\[CrossRef\]](#)
65. Akbostanci, E.; Turut-Asik, S.; Tunc, G.I. The relationship between income and environment in Turkey: Is there an environmental Kuznets curve? *Energy Policy* **2009**, *37*, 861–867. [\[CrossRef\]](#)
66. Ozturk, I.; Acaravci, A. CO₂ emissions, energy consumption and economic growth in Turkey. *Renew. Sustain. Energy Rev.* **2010**, *14*, 3220–3225. [\[CrossRef\]](#)
67. Fosten, J.; Morley, B.; Taylor, T. Dynamic misspecification in the environmental Kuznets curve: Evidence from CO₂ and SO₂ emissions in the United Kingdom. *Ecol. Econ.* **2012**, *76*, 25–33. [\[CrossRef\]](#)
68. Sephton, P.; Mann, J. Further evidence of an environmental Kuznets curve in Spain. *Energy Econ.* **2013**, *36*, 177–181. [\[CrossRef\]](#)
69. Shahbaz, M.; Ozturk, I.; Afza, T.; Ali, A. Revisiting the environmental Kuznets curve in a global economy. *Renew. Sustain. Energy Rev.* **2013**, *25*, 494–502. [\[CrossRef\]](#)
70. Farhani, S.; Chaibi, A.; Rault, C. CO₂ emissions, output, energy consumption, and trade in Tunisia. *Econ. Model.* **2014**, *38*, 426–434. [\[CrossRef\]](#)
71. Bouznit, M.; Pablo-Romero, M.d.P. CO₂ emission and economic growth in Algeria. *Energy Policy* **2016**, *96*, 93–104. [\[CrossRef\]](#)
72. Bilan, Y.; Streimikiene, D.; Vasylieva, T.; Lyulyov, O.; Pimonenko, T.; Pavlyk, A. Linking between renewable energy, CO₂ emissions, and economic growth: Challenges for candidates and potential candidates for the EU membership. *Sustainability* **2019**, *11*, 1528. [\[CrossRef\]](#)
73. Kang, S.H.; Islam, F.; Kumar Tiwari, A. The dynamic relationships among CO₂ emissions, renewable and non-renewable energy sources, and economic growth in India: Evidence from time-varying Bayesian VAR model. *Struct. Chang. Econ. Dyn.* **2020**, *50*, 90–101. [\[CrossRef\]](#)
74. Hall, C.; Balogh, S.; Murphy, D. What is the minimum EROI that a sustainable society must have? *Energies* **2009**, *2*, 25–47. [\[CrossRef\]](#)
75. Bozoklu, S.; Yilanci, V. Energy consumption and economic growth for selected OECD countries: Further evidence from the Granger causality test in the frequency domain. *Energy Policy* **2013**, *63*, 877–881. [\[CrossRef\]](#)
76. Omri, A. An International literature survey on energy-economic growth nexus: Evidence from country-specific studies. *Renew. Sustain. Energy Rev.* **2014**, *38*, 951–959. [\[CrossRef\]](#)
77. Venkatraja, B. Does renewable energy affect economic growth? Evidence from panel data estimation of BRIC countries. *Int. J. Sustain. Dev. World Ecol.* **2020**, *27*, 107–113. [\[CrossRef\]](#)
78. Mahjabeen, N.; Shah, S.Z.A.; Chughtai, S.; Simonetti, B. Renewable energy, institutional stability, environment and economic growth nexus of D-8 countries. *Energy Strategy Rev.* **2020**, *29*, 100484. [\[CrossRef\]](#)
79. Tiwari, A.K. Tourism, exports and FDI as a means of growth: Evidence from four Asian Countries. *Rom. Econ. J.* **2011**, *14*, 131–151.
80. Anwar, S.; Sun, S. Financial development, foreign investment and economic growth in Malaysia. *J. Asian Econ.* **2011**, *22*, 335–342. [\[CrossRef\]](#)
81. Omri, A. CO₂ emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Econ.* **2013**, *40*, 657–664. [\[CrossRef\]](#)
82. Sharma, S.S. Determinants of carbon dioxide emissions: Empirical evidence from 69 countries. *Appl. Energy* **2011**, *88*, 376–382. [\[CrossRef\]](#)
83. Lee, W.J. The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy Policy* **2013**, *55*, 483–489. [\[CrossRef\]](#)
84. Salim, R.A.; Rafiq, S. Why do some emerging economies proactively accelerate the adoption of renewable energy? *Energy Econ.* **2012**, *34*, 1051–1057. [\[CrossRef\]](#)
85. IMF Data. 2020. Available online: <https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b> (accessed on 25 January 2021).
86. World Development Indicators (WDI). 2020. Available online: <https://databank.worldbank.org/source/world-development-indicators> (accessed on 25 January 2021).
87. British Petroleum Statistical Review. 2020. Available online: <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html> (accessed on 25 January 2021).

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88. Apergis, N.; Payne, J.E. Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy* **2010**, *38*, 656–660. [[CrossRef](#)]
 89. Omri, A.; Ben Mabrouk, N.; Sassi-Tmar, A. Modeling the causal linkages between nuclear energy, renewable energy and economic growth in developed and developing countries. *Renew. Sustain. Energy Rev.* **2015**, *42*, 1012–1022. [[CrossRef](#)]
 90. Shahbaz, M.; Zeshan, M.; Afza, T. Is energy consumption effective to spur economic growth in Pakistan? New evidence from bounds test to level relationships and Granger causality tests. *Econ. Model.* **2012**, *29*, 2310–2319. [[CrossRef](#)]
 91. Halicioglu, F. An econometric study of CO₂ emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy* **2009**, *37*, 1156–1164. [[CrossRef](#)]