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Impact of Financial Deepening, Energy Consumption and Total Natural Resource Rent on CO_2 Emission in the GCC Countries: Evidence from Advanced Panel Data Simulation

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ABSTRACT

The study examined the dynamic nexus between financial deepening, natural resource rent, nonrenewable-energy and renewable-energy consumption and CO_2 emission by using a dataset of six GCC countries (UAE, Saudi Arabia, Qatar, Oman, Kuwait and Bahrain) from 1993 to 2019. For estimation, study applying second-generation panel unit root, cointegration and long-run estimation tests for robust and efficient results. The study confirms the presence of cross-sectional dependency while economic expansion and nonrenewable-energy contribute to CO_2 emissions, financial deepening and renewable-energy consumption have a significant impact on reducing environmental degradation. Furthermore, the Dumitrescu-Hurlin causality test reveals a statistically significant bidirectional correlation between financial deepening, consumption of nonrenewable-energy and renewable-energy and CO_2 emission. In light of these findings, a number of policy recommendations are provided to help the GCC countries overcome on CO_2 emissions while promoting economic growth.

Keywords: CO_2 Emission, Financial Deepening, Natural Resource Rent, Renewable-energy Consumption, Nonrenewable-energy Consumption
JEL Classifications: C12, C23, N50, O10, Q44, Q47

1. INTRODUCTION

The overconsumption of natural resources has harmed both human health and the environment throughout history. If we don't take swift and comprehensive action, the pressure on the environment will only get worse. Economic activity and human well-being should not be viewed as being intertwined with the utilization of natural resources. The use of natural resources has increased by threefold in the last four decades. The Sustainable Development Goals, the Paris Climate Agreement, the Aichi targets of the Convention on Biological Diversity, the Land Degradation Neutrality of the Convention on Combating Desertification, and other global goals cannot be achieved within the planet's current boundaries without urgent and systemic

changes to how natural resources are used and managed. All governments should take into account environmental problems relating to the use of natural resources and more ecologically friendly methods of consumption and production. Fossil fuel extraction, delivery, and usage all contribute to environmental degradation and pollution, particularly in the form of air pollution. What happens to fossil fuels once they are mined has a significant impact on their overall environmental and health implications. There has been a 70% increase in the world's fossil fuel electricity generation capacity recently, but the environment and health have suffered as a result. Because of the high start-up costs and long useful lives of power plants, environmentally harmful technology might become entrenched. In the previous 6 years, the extraction of coal, oil, and natural gas increased from 6 billion to 15 billion metric tons, more than double the previous level. The amount of biomass and mineral resources

produced has increased more than fivefold in the last decade (Global IRP, 2019).

Environmentalists and legislators around the world have taken global warming very seriously in recent years. A primary contributor to global warming is CO_2 emissions, which account for around 60% of the total CO_2 in the atmosphere (Lau et al., 2017). This is especially difficult for developing countries since their governments set very high growth targets in order to improve the lives of their people. Coping with these environmental challenges because of the same causes, these countries misuse their natural resources, resulting in further CO_2 emissions. These countries will be unable to minimize energy consumption because it is a necessary and integral part of the production process. That is why switching from nonrenewable to renewable-energy consumption is the most practical answer for this issue. A more persuasive issue is how emerging countries make the shift from dirty to clean energy sources. On the other side, the transition from nonrenewable-energy to renewable-energy is difficult because of the high cost of resources. Some of the most significant obstacles to using renewable resources of power, such as infrastructure development, operational and start-up expenses, are compared to fossil fuel-based electricity. It is imperative that there is a strong financial structure in place to support and fund the transition from the non-renewable to the renewable energy industry, as well as healthy financial markets to facilitate capital mobility. Weak economic systems may not be able to invest in industries unless they have a sophisticated finance mechanism. A significant financial role is needed to support a growing renewable energy sector in today's global economy.

An overwhelming majority of energy–environment literature has an asserting that economic development is the only element that has an impacts environmental quality and therefore must be addressed first. The Environmental Kuznets curve (EKC) theory provides theoretical justification for this literature (Grossman and Krueger, 1991). According to this idea, economic development causes CO_2 emissions initially because of the exploitation of natural resources and the over reliance on polluted energy sources. Countries, on the other hand, undertake the switch to renewable energy sources once they reach a particular level of income, resulting in improved environmental quality for all.

On the other hand, the GCC countries have oil-based economies and are considered as high-income countries. Furthermore, their economies are rapidly expanding as a result of the substantial income generated by their fossil fuel exports, particularly oil. As a result, the GCC countries are significantly reliant on oil to achieve economic growth. Financial deepening is strong variable than financial development in GCC countries as these countries are financially strong so it emphasizes the importance of establishing strong institutional and regulatory frameworks as financial development continues. Among other things, financial deepening lowers the cost of intermediation, increases risk diversification, and makes it possible for both private and public investors to invest in clean energy projects (Nasir et al., 2019).

Governments and regulators in the GCC countries are eager to adopt innovative, efficient, and applicable renewable technologies to meet their respective renewable energy targets through multi-sector integration, including electricity generation, public transportation, energy-intensive industry, and green building construction. Furthermore, these countries utilize the most energy per capita (6260 MWh) due to their enormous populations, abundant fossil fuel resources, and significant industrial activity. Saudi Arabia is the world's second-biggest oil producer, while Qatar is the world's largest LNG exporter (Bartholdy, 2019). Water desalination accounts for 4–12% of GCC energy consumption, as these nations are arid (90 mm rainfall per year) and lack access to freshwater (Al-Badi and AlMubarak, 2019; Al-Saidi and Saliba, 2019; Krarti et al., 2019). Studies have identified the development of renewable energy technology as a critical component of improving access to cleaner, more sustainable resources (Abdmouleh et al., 2015; Atalay et al., 2017 and AlKhars, 2019). Renewable energy is expected to grow by 45% by 2040 to keep up with global efforts to reduce carbon emissions. Nevertheless, according to the IRENA report 2019, only 0.6% of total electricity generation in the GCC is renewable. Climate change and rising global temperatures have prompted GCC countries to invest extensively in sophisticated renewable energy technologies.

The remaining of the paper is organized as follows: Previously literature on financial deepening, energy consumption and CO_2 emissions is reviewed in Section 2. Section 3 provides an overview of the research methodology, dataset, and primary outcomes. The final section of the paper brings the paper to a conclusion.

2. LITERATURE REVIEW

CO_2 emissions, energy consumption, and economic growth have all been thoroughly researched and studied in the literature, and different theories have arisen as a result of these subjects and the Environment Kuznets curve (EKC) hypothesis, which is based on (Kuznets, 1955) work and suggests an inverted U-shaped curve when CO_2 emissions is plotted against per capita income. A second perspective states that the relationship between energy consumption and economic growth was established for the United States by (Kraft and Kraft, 1978); they discovered a monotonically increasing relationship between economic growth and energy consumption.

According to (Dasgupta et al., 2002), individuals are more concerned about getting a job and making money than maintaining a clean environment at the beginning of industrialization, which leads to an increase in CO_2. Due to economic expansion and the fact that most people cannot afford to pay for the reduction or removal of environmental contaminants, the environmental repercussions of the second stage of industrialization have been largely overlooked.

Previous studies have found that a country's financial system has a significant impact on the amount of CO_2 emissions that a country produces. Theoretically, the relationship between economic growth and CO_2 emissions can take on several different forms. Strong financial system makes it easier to provide financing for R&D, which boosts economic activity while also improving environmental quality (Frankel and Romer, 1999). It has also

been shown that financial deepening accelerates technological advancements that raise output and lower environmental emissions (Halicioglu, 2009; Zagorchev et al., 2011) expects credit expansion for companies and individuals investing in sustainable energy projects to be made possible by financial deepening as well. To be sure, investing in renewable energy demands a large initial expenditure, which cannot be met without the banking sector's cooperation (Tamazian and Rao, 2010).

In addition (Claessens and Feijen, 2007) assert that reforms in the financial sector will improve the governance structure of enterprises resulting in a reduction in CO_2 emissions. In a recent study (Baulch et al., 2018), discovered that cost constraints are becoming a key obstacle in limiting the adoption of solar household systems. Although there are positive benefits of financial deepening on environmental quality, other authors argue that more financial deepening may actually increase CO_2 emissions. This is at variance with the positive effects of financial deepening on environmental quality. Financial deepening, according to its proponents, enhances industrialization and hence raises industrial pollution (Jensen, 1996). According to (Zhang, 2011), rapid financial deepening will make it easier to obtain loans for large consumer items such as air conditioners, refrigerators, automobiles and residences, which will increase energy consumption and, as a result, increase emissions of pollutants. (Khan and Ozturk, 2021) conducted a panel analysis of 88 developing nations to test the direct and indirect effects of financial deepening on environmental quality. The investigation demonstrated the inherent CO_2 emission of financial deepening in the largely unexplored area. The results verified the EKC and pollution heaven theories in those countries while population size promotes pollution and human capital discourages sustainability.

Acheampong (2019) investigated CO_2 emissions in 46 African economies during 2000–2014. The paper looked into the indirect consequences of financial deepening on CO_2 emissions, such as income and energy use. According to the findings, financial deepening has a significant moderating effect in reducing the negative effects of income and energy consumption on environmental quality. Gyamfi et al. (2021) investigated the polluted heaven theory in sub-Saharan Africa, and the finding confirms the existence of the above-mentioned hypothesis for the region's economies.

According to (Joshua et al., 2020), economic growth is the major contributor in South Africa. The study examined coal use, economic growth, and CO_2 emissions and found that the economy's major emitter is coal use, whereas FDI discourages CO_2. According to (Zafar et al., 2019), green energy improves environmental quality. Ahmed et al. (2020) found an adverse effect of natural resource rent on environmental performance. The overall impact of natural resources on the environment is determined by the magnitude of the positive and negative effects. Baloch et al. (2021) analyze the relationship between financial deepening and environmental quality in OECD economies. The study found that financial growth promotes energy innovation and environmental quality. Al-Mulali and Ozturk (2015) used the Pedroni cointegration test and the completely modified ordinary least square approach to study the causes of CO_2 emissions in

the Middle East and North Africa (MENA) area. The test results show that energy consumption, urbanization, trade openness, and industrial development diminish environmental quality with time. However, political stability promotes environmental quality.

The environmental Kuznets theory combines renewable and non-renewable energy usage with technological progress (Khan et al., 2020). However, empirical studies on renewable energy determinants are rare and found bidirectional causal linkages between renewable and non-renewable energy in OECD countries. Attiaoui et al. (2017) evaluated the roles of economic growth, energy use, and CO_2 emissions in 22 African states for the time period from 1990 to 2011 and found that GDP has no effect on renewable energy usage where CO_2 is negative effect on renewable energy usage but that conventional fossil fuels do. It shows the mixed impact of technological innovation and economic growth on renewable energy use in OECD countries. Yu and Du (2019) concluded that China's industrial revolution harm the environment. Similarly, Santra (2017) revealed that innovations stimulate economic growth but do not reduce carbon emissions. Fisher-Vanden et al. (2004) found negative effects on energy consumption, confirming that innovations are sources of energy efficiency promotion in China. Hang and Tu (2007) concluded that increased fossil-based energy prices could be a viable solution to enhancing energy efficiency. Geng and Ji (2016) found long-term stability between innovation and renewable energy in six key industrialized countries for the time period 1980–2010, and their findings validated causal bidirectionality.

Fodha and Zaghdoud (2010) analyzes whether the EKC hypothesis held true between economic growth and pollutants (CO_2 and SO_2) over the period 1961–2004 in Tunisia. In this study, the researchers discovered that the association between SO2 and GDP is an inverted U-shape relationship, but the relationship between GDP and CO_2 emissions is a monotonically increasing relationship. Ozcan (2013) examined whether the EKC hypothesis was present in 12 Middle Eastern countries over the period 1990–2008; the results of this study show that a U-shape relationship is present in five countries, an inverted U-shape curve is present in three countries, and there is no causal link between economic growth and CO_2 emission in four countries. Based on their findings, (Alola and Joshua, 2020) concluded that fossil fuel usage is detrimental to environmental quality, whereas energy consumption increases environmental quality. Al-Mulali (2011) evaluated the impact of oil use on MENA economic growth from 1980 to 2009 and found a bidirectional Granger causation between CO_2, oil consumption, and economic growth. An analysis of CO_2 emissions, energy consumption, and economic growth in 14 MENA nations from 1990 to 2011 by Omri (2013) found a bidirectional link between energy consumption and economic growth, and a unidirectional causality without a feedback effect from energy use to CO_2 emissions.

Using panel cointegration, (Farhani, 2013) examined the relationship between renewable energy usage, economic growth, and CO_2 emissions for 12 MENA countries from 1975 to 2008. With significantly modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) calculations, only CO_2

shows an impact on renewable energy consumption. This analysis shows that MENA countries has lack the optimal policy options that can balance renewable energy use, economic growth, and CO$_2$ emission. Salahuddin and Gow (2014) studied the empirical link between economic growth, energy consumption, and CO$_2$ emissions in the GCC. The study found a short- and long-term positive and significant link between energy consumption and CO$_2$ emissions and energy consumption and economic growth. Salahuddin et al. (2015) used panel data for 1980–2012 to study the relationship between carbon dioxide emissions, economic growth, power consumption, and financial deepening in the GCC countries. Using FMOLS, DOLS, and dynamic fixed effect (DFE) models, the authors discovered that there is a robust long-run link, but no short-run relationship, across the multiple econometric models tested in their analysis. The study concluded that economic growth and electricity consumption are positively related in the long run, but financial deepening is negatively related to CO$_2$ emissions in the long run. Additionally, it was found that there is a bidirectional causal relationship between economic development and CO$_2$ emissions and a unidirectional causal relationship between electricity consumption and CO$_2$ emissions. However, according to the Granger test, there is no causal relationship between financial deepening and carbon dioxide emissions according to the Granger test. Furthermore, the concept of economic growth-ecological footprint feedback was confirmed by Destek and Sarkodie (2019). Long-run AMG data shows that financial expansion in BRICS countries considerably accelerates CO$_2$ emissions, validating the EKC hypothesis. Usman et al. (2020) corroborate identical findings in 20 of the world's worst polluting nations.

Magazzino (2016) established a negative VAR response from economic growth to CO$_2$ emissions for six GCC countries and instead CO$_2$ emissions are driven by both all its previous data and energy consumption, implying the existence of the growth hypothesis. There is no evidence that CO$_2$ emissions or energy consumption affect economic growth in the other four non-GCC countries. Bekhet et al. (2017) also investigated the dynamic causal links between CO$_2$ emissions, financial development, economic growth, and energy consumption for GCC nations from 1980 to 2011. This analysis found long-run and causal correlations among all variables studied for all GCC nations except the UAE. A long-run unidirectional causality flow from carbon emissions to energy use was observed for Saudi Arabia, the UAE, and Qatar.

Muhammad (2019) examined the relationship between economic growth, energy consumption, and CO$_2$ emissions in 68 countries (developed, developing, and MENA). The study found that while energy consumption climbed in developed and developing countries, it declined in MENA countries while CO$_2$ emissions increased in all countries. In developed and MENA nations, CO$_2$ emissions climbed while energy consumption decreased; in emerging countries, energy consumption increased while CO$_2$ emissions decreased. Kahia et al. (2019) used a panel vector autoregressive model to assess the impact of renewable energy consumption, economic growth, FDI and trade on CO$_2$ emissions in 12 MENA countries from 1980–2012. The study found a bidirectional causal link between the variables, validating the feedback hypothesis. Given that economic expansion damages

the environment, the study suggests that these countries should transition towards renewable energy, international trade and foreign direct investment to achieve sustainable economic growth and enhanced ecological integrity.

Wang and Dong (2019) looked at the causal links between economic growth, urbanization, renewable and non-renewable energy use, and environmental imprint in 14 Sub-Saharan African countries. They discovered a causal link between non-renewable energy, economic expansion, urbanization, and ecological footprint. They also found discovered that economic expansion, non-renewable energy use, and urbanization exacerbate environmental harm, whereas renewable energy sources reduce it. The same are achieved by (Bhattacharya et al., 2017; Saidi and Omri, 2020).

Ulucak and Khan (2020) discovered that renewable energy and economic growth are major indicators in revealing under-examined countries' sustainable development levels, economic growth and renewable energy consumption rely on increasing human capital. The usage of renewable energy improves environmental quality and energy intensity while increasing national savings, according to (Salahuddin et al., 2020). Additionally, denuclearization is still a result of economic growth.

Gyamfi et al. (2021) examined the relationship between economic growth, pollutant emissions, and coal rent while accounting for various co-variates such as CO$_2$ damage from nuclear, oil, and gas sources. They investigate the coal rent-energy-environment nexus using panel ordinary least squares and panel quantile regression. Both real GDP and coal rent have a positive and considerable effect on CO$_2$ emissions. GDP growth leads to pollution, whereas renewable energy use mitigates the effects of environmental degradation. Moreover, renewable energy has a negative and considerable influence on CO$_2$ emissions in E7 nations, and the predicted results show that regulating coal usage through rent and carbon damage costs will raise CO$_2$ emissions in E7 countries.

3. MODELLING FRAMEWORK AND ESTIMATION RESULTS

Current study has taken the data of six GCC countries over the period 1993–2019. CO$_2$ emission (COE) as per capita. The total natural resource rents (TNR) are the sum of coal rents, oil rents, natural gas rentals (both soft and hard) and mineral rents of carbon dioxide equivalent. Real economic growth (GDP) is measured as constant 2010 US dollars per capita. Non-renewable energy consumption (NRE) is measured in kilograms of oil equivalent per person and renewable energy consumption (RE) is expressed as a percentage of total energy consumption, whereas financial deepening (FD) is expressed as an index. International Monetary Fund (IMF) data is used only for financial deepening (FD) and all other variables are sourced from the World Bank (WDI). Table 1 summarizes all of the above-mentioned variables, and their descriptions. CO$_2$ emission is predicted to have shown the relationship in Equation-1.

$$COE_{it} = f\ (TNR_{it}, FD_{it}, GDP_{it}, GDP_{it}^2, NRE_{it}, RE_{it}) \qquad (1)$$

Whereas; COE_{it} stands for CO_2 emissions per capita, TNR_{it} stands for total natural resource rent, FD_{it}, is a financial deepening, GDP_{it}, ∞ (GDP_{it}^2) is a real GDP per capita and (square of real GDP per capita), NRE_t, and RE_t, are non-renewable energy and renewable energy consumption respectively. Where i, t and ε_{it} denotes the cross-sections time periods.

The Environmental Kuznet curve (EKC) hypothesis between economic growth and CO_2 generation was also investigated in the majority of carbon intensive countries. To test this, we add a new variable, the square rate of economic growth (GDP2), to the model. Expected sign of financial deepening is negative due to the fact that the GCC countries have a sound and developed financial structure, which may be able to overcome the environmental pressure in this region. The expected sign of TNR is positive since the availability of TNR does not suffice to meet the energy requirements of that specific country's population. This practice will increase the country's reliance on fossil fuel imports while simultaneously decreasing environmental quality (Bekun et al., 2019). In contrast, a recent study (Balsalobre-Lorente et al., 2018) discovered a positive relationship between TNR and the CO_2 emissions. Because of the expected nature of RE in terms of reducing CO_2 emissions, the study predicts that the coefficient sign for REC will be negative. However, it is expected that the GDP and NRE positively impact on CO_2 emissions in the long run (Ulucak and Khan, 2020). Furthermore, in the economic growth function, it is assumed that all of the coefficient signs of the variables will be positive in the economic growth function.

The study used the cross-section dependence (CD) test to select the best analytical approach. The CD test results help choose between first-generation and second-generation panel data econometric techniques. There may be a chance of (CD) because of the growing interconnection of countries' panels, which could influence the economic growth processes of member countries (Munir et al., 2020), Assuming and estimating directly may result in model misspecification, which may lead to inefficient long-term estimates because of bias and size distortions (Jiang et al., 2020). The current work tests for CD test in the panel data to ensure that empirical estimators are consistent, efficient, and unbiased. A total of three methods, Pesaran scaled LM, Breusch-Pagan LM, and Bias adjusted scaled LM, are used for this purpose (Pesaran et al., 2004);

Table 1: Data variables and sources

Variables	Symbol	Measurement	Data Sources
CO_2 Emission	COE	CO_2 equivalent per capita	WDI
Total Natural Recourses Rent	TNR	Rents on biodiversity as % of GDP	WDI
Economic growth	GDP	GDP per capita	WDI
Nonrenewable Energy Consumption	NRE	Oil equivalent per capita	WDI
Renewable Energy Consumption	RE	% of total energy consumption	WDI
Financial Deepening	FD	depth, and efficiency of financial institutions and markets	IMF

(Pesaran et al., 2008); (Breusch and Pagan, 1980); and (Baltagi et al., 2012). The CD test equation is shown in Equation-2.

$$CD = \left(\frac{TN(N-1)^{\frac{1}{2}-P}}{2} \right) \qquad (2)$$

Where $P = \left(\frac{2}{N(N-1)} \right) \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} Pij, Pij$ as is the cross-sectional pairwise correlation coefficient of the ADF regression residual. The sample and panel scopes, T and N, are independent.

Table 2 contains the results of the CD tests, which reveal that CD is present in the dataset in a statistically significant manner. Furthermore, all of the variables are statistically significant at the 1% significance level. It shows the possibility that shocks in one country will have an impact on the other countries in the panel. Because of the prevalence of CD, it is likely that the second-generation approaches will produce outcomes that are dependable, robust, efficient, and consistent estimates.

This study tests and verifies the variables' integration order as a reference for the panel unit root analysis technique, which accommodates cross-sectional correlations and panel slope uniformity. Thus, we examined the variables' stationarity using second-generation stationarity tests, specifically the CADF and CIPS (Pesaran, 2007) panel unit root tests. Equation. (3) expresses the CADF test statistics as follows:

$$\Delta Y_{it} = \beta_i + a_i y_{i,t-1} + b_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \qquad (3)$$

the single lag in the preceding Equation (3), the succeeding Equation (4) is as follows:

$$\Delta Y_{it} = \beta_i + a_i y_{i,t-1} + b_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \ddot{A} y_{i,t-j} + e_{it} \qquad (4)$$

Where $\bar{y}_{t-j}$ and $\Delta y_{i,t-j}$ demonstrate the mean of the lagged level and the first difference of each cross-section from each unit. After calculating the CADF statistics, the simple average is used to get the CIPS test statistics. In Equation. (5), the CIPS test statistics are shown:

$$CIPS = N^{-1} \sum_{i=1}^{N} t_i(N,T) \qquad (5)$$

CIPS and CADF unit root tests indicate all variables have a unit root at level I(0). However, all the series become stationary at a first differences level I(1). As a result, the findings indicate that there must be evidence of a long-run cointegration relationship between the variables.

Table 3 summarizes the findings of this testing.

Following the stationarity test, the next step is to assess the cointegrating relationship between the variables. To accomplish this, we use cross-sectional augmented cointegration test

Table 2: Cross-sectional dependence test results

Series	Breusch-Pagan LM		Pesaran scaled LM		Bias-corrected scaled LM		Pesaran CSD	
	Stat.	Prob.	Stat.	Prob.	Stat.	Prob.	Stat.	Prob.
COE	208.008*	0.000	22.375*	0.000	22.156*	0.000	4.399*	0.000
TNR	231.306*	0.000	24.377*	0.000	23.921*	0.000	8.274*	0.000
FD	565.715*	0.000	69.996*	0.000	69.032*	0.000	24.761*	0.000
GDP	652.117*	0.000	81.022*	0.000	80.914*	0.000	25.061*	0.000
NRE	273.887*	0.000	31.893*	0.000	35.605*	0.000	6.961*	0.000
RE	409.996*	0.000	50.433*	0.000	53.046*	0.000	5.096*	0.000

*Indicates the significance level at 1%

Source: Authors' Estimation

Table 3: CIPS & CADF Unit Root Test

Variable	CIPS		CADF	
	I (0)	I (1)	I (0)	I (1)
COE	−2.188	−6.301*	−0.950	−3.671*
TNR	−2.596	−5.558*	−1.137	−4.718*
FD	−2.001	−5.873*	−1.795	−4.654*
GDP	−2.756	−4.046*	−2.069	−3.060*
NRE	−1.887	−5.690*	−1.056	−3.293*
RE	−2.000	−6.110*	−1.931	−4.208*

*Indicates the significance level at 1%

Source: Authors' Estimation

Table 4: Westerlund cointegration test

Statistics	G_t	G_a	P_t	P_a
Values	−1.910**	−10.599***	−12.783**	−9.960*
Z-values	−1.445	−0.453	−4.066	0.295
Robust P values	0.010	0.069	0.029	0.000

*, **, *** indicate the significance level at 1%, 5% and 10% respectively

Source: Authors' Estimation

(Westerlund, 2007) in the initial step, despite the fact that the data is spatially dependent. The advantage of employing this cointegration methodology over other tests available in the literature is that it is readily available to use because it does not require data to be corrected for temporal dependence; it is also robust to cross-sectional dependence and panel heterogeneity (Dogan et al., 2020). This strategy is based primarily test statistics: two mean-group tests (Gt and Ga) and two-panel tests (Pt and Pa). The two out of four estimations shown as;

$$G_t \frac{1}{N}\sum\nolimits_{i=1}^{N} = \frac{\hat{\alpha}i}{SE(\hat{\propto} i)} \quad \text{and} \quad G_\alpha \frac{1}{N}\sum\nolimits_{i=1}^{N} \frac{T\,\hat{\propto}\,i}{\hat{\alpha}i(1)}$$

Where $\hat{\alpha}i$ is denoted by $SE(\hat{\propto} i)$ as the standard error. The semiparametric kernel technique of $\propto i(1)$ is $\hat{\alpha}i(1)$. Two of the four remaining panels mean estimations which proof that the whole panel is cointegrated is shown as;

$$P_\tau \frac{\hat{\alpha}i}{SE(\propto i)} \quad \text{and} \quad P_\alpha = T\hat{\alpha}$$

The tests results indicate that all group (Gt and Ga) and panel (Pt and Pa) reject the null hypothesis of no cointegration between the series. However, the Gt and Pt values represent significant probability values and confirm long-run cointegration between the series. Table 4 summarizes the results obtained with dimensions and within dimensions, confirming that the variables are cointegrated in the long run in the carbon emission model.

After confirming the presence of cointegration, we next estimate the long-run parameters. The estimation incorporates the panel AMG estimator (Eberhardt and Bond, 2009), the MG estimator (Pesaran and Smith, 1995) and the CCEMG estimator (Pesaran, 2006) to estimate long-run coefficients. These approaches were

applied to scrutinize concerned explanatory variables' influence the carbon emission model. First and second stage AMG estimators are investigated by Eq. (6) and Eq. (7) and CCEMG estimator investigated by Eq. (8) as follows:

$$Y_{it} = \theta_i + \beta_i \Delta X_{it} + \pi_i f_t + \sum\nolimits_{t=2}^{T} \rho_i \Delta D_t + e_{it} \tag{6}$$

$$\hat{\beta}_{AMG} = N^{-1} \sum\nolimits_{i=1}^{N} \hat{\beta}_i \tag{7}$$

$$X_{it} = \theta_{1i} + \lambda_i Y_{it} + \lambda_i \rho_{it} + e_{it} \tag{8}$$

Whereas θ_i is the intercept, X_{it}, Y_{it} are observe variables f_t is unobserved variable. $\hat{\beta}_{AMG}$ is AMG mean group estimators, λ_i denotes individual slop of cross-section, ρ_{it} use for the heterogeneity and e_{it} is denote as an error term.

Table 5 shows the MG, AMG, and CCEMG test estimation results. The results show that a negative and statistically significant coefficient of financial deepening (FD) affects emissions in the GCC countries. In particular, 1% change in financial deepening reduces CO_2 emissions by 0.491%. A sophisticated financial industry also encourages low emissions and good energy efficiency. Sound financial institutions encourage energy supply sector innovation, reducing CO_2 emissions. Specifically, a 1% change in TNR will result in a 0.491% rise in CO_2 emissions. These findings are in line with (Ahmed et al., 2020 and Erdoğan et al., 2020), validating the positive influence of sustainability of natural resources in the GCC countries. Similarly, economic growth (GDP) has a significant and favorable positive impact on the environmental degradation, according to the coefficient. CO_2 emissions will increase by 0.309% over the long term for every 1% increase in GDP. Additionally, we studied the existence of an Environmental Kuznet curve (EKC) between economic growth and CO_2 emissions in the majority of carbon-emitting countries. To investigate this, we create a new variable, the square rate of economic growth, denoted by GDP², and incorporate it into the model. As seen in Table 5, economic growth has a positive value,

Table 5: Long-run elasticity estimates results

Variable	MG Estimator		AMG Estimator		CCEMG Estimator	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
TNR	0.073**	0.036	0.491**	0.018	0.982*	0.000
FD	−0.501*	0.003	−0.482*	0.000	−0.156***	0.0721
GDP	0.090***	0.086	0.309*	0.002	1.555**	0.045
GDP²	−0.007	−0.000	−0.002	−0.009	−0.006	−0.001
NRE	0.224*	0.0000	0.705***	0.069	0.039	0.600
RE	−0.149	0.050	−0.501**	0.053	−0.447***	0.060
Constant	10.993***	0.090	11.285***	0.051	6.029	0.561
RMSE	0.040	-	0.0311	-	0.025	-

*, **, *** indicate the significance level at 1%, 5% and 10% respectively

Source: Author Estimation

but the square rate of economic growth has a negative value. This confirms the Kuznets curve hypothesis, i.e., the inverted U-shaped relationship between economic growth and CO_2 emissions. This means that economic expansion first raises CO_2 emissions, but after reaching a certain level, it begins to decrease them.

More energy intensive primary manufacturing processes in GCC sectors boost economic expansion without consideration for environmental quality due to this the NRE's consumption coefficient is positive and significant, implying that NRE decreases environmental quality in the region while increasing environmental pressure. The findings show that a 1% increase in NRE causes a 0.705% increase in CO_2 emissions and on the other RE coefficient has a negative and statistically significant impact on CO_2 emissions, 1% rise in RE, would result in a 0.501% reduction in CO_2 emissions in GCC countries. Because fossil fuels generate waste, harm public health, deplete natural resources, and emit massive volumes of CO_2, convectional energy usage contributes to environmental deterioration. We recommend investing in green technologies can help to reduce CO_2 emissions based on the findings of Ulucak and Khan (2020).

Finally, a DH test was done, which has three advantages over prior panel causality tests: it takes into account cross-sectional dependency; it ignores time dimension and cross-sectional size; and it works well in imbalanced panels (Dumitrescu and Hurlin 2012). The linear model provided by Dumitrescu and Hurlin to test panel causality is presented in Equation-9:

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} X_{i,t-k} + \varepsilon_{i,t} \qquad (9)$$

Where $\beta_i = (\beta_i^{(1)}, \beta_i^{(2)}, \ldots, \beta_i^{(K)})$, α_i=individual fixed effects, $\gamma_i^{(k)}$ = Lag parameters, K = lag length and $\beta_i^{(k)}$=slope parameters. $\gamma_i^{(k)}$ and $\beta_i^{(k)}$ show the units' differences.

The results of the D-H causality test are shown in Table 6. When the current value of a dependent variable is approximated using the lag value of an explanatory variable, causality is proclaimed (Maddala and Wu, 1999). There are four causation hypotheses: growth, conservation, feedback, and neutrality. No growth hypothesis was created for COE. The conservation hypothesis assumes COE causes these variables, which are not seen. Conversely, the feedback hypothesis posits a two-way connection between COE and GDP. It is supported by (Apergis and Payne, 2015; Dogan and Turkekul,

Table 6: Results of Dumitrescu-Hurlin panel causality test

Null Hypothesis	F-Stats.	Prob.
GDP does not homogenously cause COE	4.483	0.071
COE does not homogenously cause GDP	3.233***	0.048
FD does not homogenously cause COE	4.956	0.000
COE does not homogenously cause FD	1.527*	0.032
TNR does not homogenously cause COE	5.210	0.036
COE does not homogenously cause TNR	0.070**	0.867
NRE does not homogenously cause COE	3.852	0.000
COE does not homogenously cause NRE	4.451	0.000
RE does not homogenously cause COE	1.654	0.031
COE does not homogenously cause RE	2.611**	0.000

*, **, *** indicate the significance level at 1%, 5% and 10% respectively

2016). These findings show that all investigated regressors cause the COE. Based on this mounting burden, GCC should shift its focus to renewable-energy sources, as fossil fuels significantly exacerbate the environmental degradation. Based on the long-run coefficient, study conclude that REC endorsement can assist these GCC economies overcome COE and environmental degradation.

4. CONCLUSION AND POLICY RECOMMENDATION

GCC Countries has a unique perspective on energy independence and renewable energy (RE) because it has vast oil and gas reserves. The GCC countries are taking several strategic initiatives to integrate RE into their conventional energy mix. According to their vast resources and future expectations, each GCC country's RE priority should be adjusted. Reduced reliance on fossil fuels and more economic diversification are all benefits of incorporating RE technologies into the future energy mix. To be a competitive alternative fuel, RE technologies must be able to compete with existing energy sources. Governments should prioritize high-potential RE technologies based on available infrastructure, metallurgical status, geographic location, and material abundance. Furthermore, GCC countries must acknowledge that reducing reliance on oil and gas usage can increase exports and revenue and continue to improve their energy efficiency measures to meet their energy, economic, and environmental goals. These policies must be implemented wisely, in combination with other programs, and be amenable to the GCC context.

Moreover, our findings suggest that the GCC countries' governments should design energy policies that reduce reliance

on conventional energy sources and shift to clean and renewable energy alternatives, as fossil fuel usage degrades environmental quality. Combining renewable energy goals with wider strategies for long-term energy market management, energy conservation, and technical advancement will benefits renewable energy implementation. GCC countries should promote renewable energy sources and setting decarbonization targets, appliance standards, energy subsidies, and import duty exemptions are some of the options.

The main energy-intensive industries in the GCC include upstream oil and gas, oil refining, petrochemicals, aluminum, steel, and cement, which are generally run by state-owned corporations. Nevertheless, the GCC countries give insufficient priority to renewables in transportation and manufacturing. It is stressed that without clear energy policies and regulations on renewables, it is difficult to set realistic goals and promote their use in the energy mix.

Because this study used panel data, it is difficult to make particular recommendations for each country. As a result, it is suggested that future research investigate the effects of financial deepening and natural resource rent on energy conception for each GCC country in order to provide more relevant policy implications. Also due to a paucity of data, other factors that affect CO_2 emissions, such as human capital, FDI, trade openness, and ICT, were not considered. Ongoing research could expand on these areas, and this study could also examine the variables' relationships with other environmental deficit indicators, such as natural catastrophes, global warming, and health impacts, to provide a more complete view of the environment's influence.

5. ACKNOWLEDGMENTS

REFERENCES

Abdmouleh, Z., Alammari, R.A., Gastli, A. (2015), Recommendations on renewable energy policies for the GCC countries. Renewable and Sustainable Energy Reviews, 50, 1181-1191.

Acheampong, A.O. (2019), Modelling for insight: Does financial development improve environmental quality? Energy Economics, 83, 156-179.

Ahmed, Z., Asghar, M.M., Malik, M.N., Nawaz, K. (2020), Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological footprint in China. Resources Policy, 67, 101677.

Al-Badi, A., AlMubarak, I. (2019), Growing energy demand in the GCC countries. Arab Journal of Basic and Applied Sciences, 26(1), 488-496.

Al-Mulali, U. (2011), Oil consumption, CO2 emission and economic growth in MENA countries. Energy, 36(10), 6165-6171.

Al-Mulali, U., Ozturk, I. (2015), The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. Energy, 84, 382-389.

Al-Saidi, M., Saliba, S. (2019), Water, energy and food supply security in the Gulf Cooperation Council (GCC) Countries – A risk perspective. Water, 11(3), 455.

AlKhars, M.A. (2019), Survey and analysis of the quantitative methods used in electricity research on GCC countries: 1983–2018. Heliyon, 5(10), e02634.

Alola, A.A., Joshua, U. (2020), Carbon emission effect of energy transition and globalization: Inference from the low-, lower middle-, upper middle-, and high-income economies. Environmental Science and Pollution Research, 27(30), 38276-38286.

Apergis, N., Payne, J.E. (2010), Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. Energy Policy, 38(1), 656-660.

Apergis, N., Payne J.E. (2015), Renewable energy, output, carbon dioxide emissions, and oil prices: Evidence from South America. Energy Sources, Part B: Economics, Planning, and Policy, 10, 281-287.

Atalay, Y., Kalfagianni, A., Pattberg, P. (2017), Renewable energy support mechanisms in the Gulf Cooperation Council states: Analyzing the feasibility of feed-in tariffs and auction mechanisms. Renewable and Sustainable Energy Reviews, 72, 723-733.

Attiaoui, I., Toumi, H., Ammouri, B., Gargouri, I. (2017), Causality links among renewable energy consumption, CO 2 emissions, and economic growth in Africa: Evidence from a panel ARDL-PMG approach. Environmental Science and Pollution Research, 24(14), 13036-13048.

Baloch, M.A., Ozturk, I., Bekun, F.V., Khan, D. (2021), Modeling the dynamic linkage between financial development, energy innovation, and environmental quality: Does globalization matter? Business Strategy and the Environment, 30(1), 176-184.

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., Farhani, S. (2018), How economic growth, renewable electricity and natural resources contribute to CO2 emissions? Energy Policy, 113, 356-367.

Baltagi, B.H., Feng, Q., Kao, C. (2012), A Lagrange Multiplier test for cross-sectional dependence in a fixed effects panel data model. Journal of Econometrics, 170(1), 164-177.

Bartholdy, K. (2019), BP Statistical Review of World Energy. Economics of Transportation, 1(1), 123-134.

Baulch, B., Do, T.D., Le, T.H. (2018), Constraints to the uptake of solar home systems in Ho Chi Minh City and some proposals for improvement. Renewable Energy, 118, 245-256.

Bekhet, H.A., Matar, A., Yasmin, T. (2017), CO2 emissions, energy consumption, economic growth, and financial development in GCC countries: Dynamic simultaneous equation models. Renewable and Sustainable Energy Reviews, 70, 117-132.

Bekun, F.V., Alola, A.A., Sarkodie, S.A. (2019), Toward a sustainable environment: Nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. Science of the Total Environment, 657, 1023-1029.

Bhattacharya, M., Churchill, S.A., Paramati, S.R. (2017), The dynamic impact of renewable energy and institutions on economic output and CO2 emissions across regions. Renewable Energy, 111, 157-167.

Breusch, T.S., Pagan, A.R. (1980), The Lagrange multiplier test and its applications to model specification in econometrics. The Review of Economic Studies, 47(1), 239-253.

Claessens, S., Feijen, E. (2007), Financial Sector Development and the Millennium Development Goals (No. 89). Washington DC: World Bank Publications.

Dasgupta, S., Laplante, B., Wang, H., Wheeler, D. (2002), Confronting the environmental Kuznets curve. Journal of Economic Perspectives, 16(1), 147-168.

Dogan, E., Turkekul, B. (2016), CO2 emissions, real output, energy consumption, trade, urbanization and financial development: Testing the EKC hypothesis for the USA. Environmental Science and Pollution Research, 23, 1203-1213.

Dumitrescu, E.I., Hurlin, C. (2012), Testing for Granger non-causality in heterogeneous panels. Economic Modelling 29, 1450-1460.

Destek, M.A., Sarkodie, S.A. (2019), Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development. Science of the Total Environment, 650, 2483-2489.

Dogan, E., Ulucak, R., Kocak, E., Isik, C. (2020), The use of ecological footprint in estimating the environmental Kuznets curve hypothesis for BRICST by considering cross-section dependence and heterogeneity. Science of the Total Environment, 723, 138063.

Eberhardt, M., Bond, S. (2009), Cross-section Dependence in Nonstationary Panel Models: A Novel Estimator. Munich Personal RePEc Archive Working Paper No. 17692.

Erdoğan, S., Yıldırım, D.Ç., Gedikli, A. (2020), Natural resource abundance, financial development and economic growth: An investigation on Next-11 countries. Resources Policy, 65, 101559.

Farhani, S. (2013), Renewable energy consumption, economic growth and CO2 emissions: Evidence from selected MENA countries. Energy Economics Letters, 1(2), 24-41.

Fisher-Vanden, K., Jefferson, G.H., Liu, H., Tao, Q. (2004), What is driving China's decline in energy intensity? Resource and Energy Economics, 26(1), 77-97.

Fodha, M., Zaghdoud, O. (2010), Economic growth and pollutant emissions in Tunisia: An empirical analysis of the environmental Kuznets curve. Energy Policy, 38(2), 1150-1156.

Frankel, J.A., Romer, D.H. (1999), Does trade cause growth? American Economic Review, 89(3), 379-399.

Geng, J.B., Ji, Q. (2016), Technological innovation and renewable energy development: Evidence based on patent counts. International Journal of Global Environmental Issues, 15(3), 217-234.

Global, I.R.P. (2019), Resources Outlook 2019: Natural Resources for the Future we Want. Nairobi, Kenya: United Nations Environment Programme.

Grossman, G.M., Krueger, A.B. (1991), Environmental Impacts of a North American Free Trade Agreement. In: National Bureau of Economic Research Cambridge, Mass., USA. Working paper No. 3914.

Gyamfi, B.A., Bein, M.A., Udemba, E.N., Bekun, F.V. (2021), Investigating the pollution haven hypothesis in oil and non-oil sub-Saharan Africa countries: Evidence from quantile regression technique. Resources Policy, 73, 102119.

Halicioglu, F. (2009), An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37(3), 1156-1164.

Hang, L., Tu, M. (2007), The impacts of energy prices on energy intensity: Evidence from China. Energy Policy, 35(5), 2978-2988.

Jensen, V. (1996), The pollution haven hypothesis and the industrial flight hypothesis: Some perspectives on theory and empirics. In: Centre for Development and the Environment (Working Paper 1996.5), University of Oslo; Oslo.

Jiang, H., Dong, X., Jiang, Q., Dong, K. (2020), What drives China's natural gas consumption? Analysis of national and regional estimates. Energy Economics, 87, 104744.

Joshua, U., Bekun, F.V., Sarkodie, S.A. (2020), New insight into the causal linkage between economic expansion, FDI, coal consumption, pollutant emissions and urbanization in South Africa. Environmental Science and Pollution Research International, 27(15), 18013-18024.

Kahia, M., Jebli, M.B., Belloumi, M. (2019), Analysis of the impact of renewable energy consumption and economic growth on carbon dioxide emissions in 12 MENA countries. Clean Technologies and Environmental Policy, 21(4), 871-885.

Khan, A., Muhammad, F., Chenggang, Y., Hussain, J., Bano, S., Khan, M.A. (2020), The impression of technological innovations and natural resources in energy-growth-environment nexus: a new look into BRICS economies. Science of the Total Environment, 727, 138265.

Khan, M., Ozturk, I. (2021), Examining the direct and indirect effects of financial development on CO2 emissions for 88 developing countries. Journal of Environmental Management, 293, 112812.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. The Journal of Energy and Development, 3, 401-403.

Krarti, M., Dubey, K., Howarth, N. (2019), Energy productivity analysis framework for buildings: A case study of GCC region. Energy, 167, 1251-1265.

Kuznets, S. (1955), Economic growth and income inequality. The American Economic Review, 45(1), 1-28.

Lau, W.K., Kim, K.M., Leung, L.R. (2017), Changing circulation structure and precipitation characteristics in Asian monsoon regions: Greenhouse warming vs. aerosol effects. Geoscience Letters, 4(1), 1-11.

Maddala, G.S., Wu, S. (1999), A comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and Statistics 61, 631-652.

Magazzino, C. (2016), CO2 emissions, economic growth, and energy use in the Middle East countries: A panel VAR approach. Energy Sources, Part B: Economics, Planning, and Policy, 11(10), 960-968.

Marchand, J., Weber, J. (2018), Local labor markets and natural resources: A synthesis of the literature. Journal of Economic Surveys, 32(2), 469-490.

Muhammad, B. (2019), Energy consumption, CO2 emissions and economic growth in developed, emerging and Middle East and North Africa countries. Energy, 179, 232-245.

Munir, Q., Lean, H.H., Smyth, R. (2020), CO2 emissions, energy consumption and economic growth in the ASEAN-5 countries: A cross-sectional dependence approach. Energy Economics, 85, 104571.

Nasir, M.A., Huynh, T.L.D., Tram, H.T.X. (2019), Role of financial development, economic growth foreign direct investment in driving climate change: A case of emerging ASEAN. Journal of Environmental Management, 242, 131-141.

Omri, A. (2013), CO2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy Economics, 40, 657-664.

Ozcan, B. (2013), The nexus between carbon emissions, energy consumption and economic growth in Middle East countries: A panel data analysis. Energy Policy, 62, 1138-1147.

Pesaran, M.H. (2006), Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica, 74(4), 967-1012.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Pesaran, M.H., Schuermann, T., Weiner, S.M. (2004), Modeling regional interdependencies using a global error-correcting macroeconometric model. Journal of Business Economic Statistics, 22(2), 129-162.

Pesaran, M.H., Smith, R. (1995), Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79-113.

Pesaran, M.H., Ullah, A., Yamagata, T. (2008), A bias-adjusted LM test of error cross-section independence. The Econometrics Journal, 11(1), 105-127.

Saidi, K., Omri, A. (2020), The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. Environmental research, 186, 109567.

Salahuddin, M., Gow, J. (2014), Economic growth, energy consumption and CO2 emissions in Gulf Cooperation Council countries. Energy, 73, 44-58.

Salahuddin, M., Gow, J., Ozturk, I. (2015), Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in Gulf Cooperation Council Countries robust? Renewable and Sustainable Energy Reviews, 51, 317-326.

Salahuddin, M., Habib, M.A., Al-Mulali, U., Ozturk, I., Marshall, M., Ali, M.I. (2020), Renewable energy and environmental quality: A second-generation panel evidence from the Sub Saharan Africa (SSA) countries. Environmental Research, 191, 110094.

Santra, S. (2017), The effect of technological innovation on production-based energy and CO2 emission productivity: Evidence from BRICS countries. African Journal of Science, Technology, Innovation and Development, 9(5), 503-512.

Tamazian, A., Rao, B.B. (2010), Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. Energy Economics, 32(1), 137-145.

Ulucak, R., Khan, S.U.D. (2020), Determinants of the ecological footprint: Role of renewable energy, natural resources, and urbanization. Sustainable Cities and Society, 54, 101996.

Usman, M., Kousar, R., Makhdum, M.S.A. (2020), The role of financial development, tourism, and energy utilization in environmental deficit: Evidence from 20 highest emitting economies. Environmental Science and Pollution Research, 27(34), 42980-42995.

Wang, J., Dong, K. (2019), What drives environmental degradation? Evidence from 14 Sub-Saharan African countries. Science of the Total Environment, 656, 165-173.

Westerlund, J. (2007), Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709-748.

Wu, S., Li, L., Li, S. (2018), Natural resource abundance, natural resource-oriented industry dependence, and economic growth: Evidence from the provincial level in China. Resources, Conservation and Recycling, 139, 163-171.

Yu, Y., Du, Y. (2019), Impact of technological innovation on CO2 emissions and emissions trend prediction on 'New Normal' economy in China. Atmospheric Pollution Research, 10(1), 152-161.

Zafar, M.W., Zaidi, S.A.H., Khan, N.R., Mirza, F.M., Hou, F., Kirmani, S.A.A. (2019), The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: The case of the United States. Resources Policy, 63, 101428.

Zagorchev, A., Vasconcellos, G., Bae, Y. (2011), Financial development, technology, growth and performance: Evidence from the accession to the EU. Journal of International Financial Markets, Institutions and Money, 21(5), 743-759.

Zhang, Y.J. (2011), The impact of financial development on carbon emissions: An empirical analysis in China. Energy Policy, 39(4), 2197-2203.