Abid, Mehdi

Article

How does renewable energy consumption affect environmental quality in Saudi Arabia? : evidence from quantile regressions

Reference: Abid, Mehdi (2023). How does renewable energy consumption affect environmental quality in Saudi Arabia? : evidence from quantile regressions. In: International Journal of Energy Economics and Policy 13 (4), S. 574 - 578.
https://econjournals.com/index.php/ijeep/article/download/13773/7425/35346.
doi:10.32479/ijeep.13773.

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(4), 574-578.

How Does Renewable Energy Consumption Affect Environmental Quality in Saudi Arabia? Evidence from Quantile Regressions

Mehdi Abid*

Department of Finance and Investment, Al Jouf University, Saudi Arabia. Email: meabid@ju.edu.sa

Received: 29 October 2022 **Accepted:** 15 April 2023 **DOI:** https://doi.org/10.32479/ijeep.13773

ABSTRACT

This paper explores the relationship between renewable energy consumption, non-renewable energy, economic growth and urbanization on CO_2 emissions of Saudi Arabia during 1990–2019 period. Using the OLS method and the quantile approach developed by Powell (2022), the results prove that the consumption of renewable energy significantly reduces the level of CO_2 emissions; moreover, its impact increases with higher quantiles. On the other hand, non-renewable energy consumption increases CO_2 emissions, while its effect decreases with higher quantiles. The empirical results also confirm the validity of the EKC hypothesis for the case of Saudi Arabia. Policymakers should implement policies and regulations to promote the adoption and use of renewable energy to improve environmental quality.

Keywords: EKC Hypothesis, Renewable Energy, Non-renewable Energy, Saudi Arabia, Quantile Regression
JEL Classifications: F47, G15, G17, Q20, Q40

1. INTRODUCTION AND LITERATURE REVIEW

Like capital and labor, renewable energy is a factor of production and has a major place in economic, social, political and environmental aspects (International Energy Agency, 2014). While it is recognized that renewable energy has an influence on economic growth, the fact remains that its influence on the environment should not be overlooked. Today, one of the major environmental concerns is global warming caused by the accumulation of greenhouse gases. Indeed, the energy sector, based on the consumption of fossil fuels, being the main cause of these gases, has been undergoing structural changes for several years in terms of energy efficiency and the introduction of renewable energies (Alharthi et al., 2021; Dai et al., 2016; Spiegel-Feld et al., 2016; Adebayo and Demet, 2020; Shahbaz, 2018). Given the need to design efficient energy policies, the causal link between energy consumption and economic growth could be a decisive element. Indeed, in recent years, the debate on the causal link between the consumption of renewable energies and environmental degradation closely followed by advances in econometric theory, energy economics and environmental economics has flowed a lot of ink (Aydoğan and Vardar, 2020; Salahuddin et al., 2015; Solarin and Ozturk, 215; Saidi and Omri, 2020; Jebli et al., 2020; Ullah et al., 2020). It then becomes necessary to explore the link between renewable energy consumption and environmental degradation, as well as its potential determinants.

Saudi Arabia is particularly concerned: Saudi Arabia generated more electric power in the Middle East than any other country, with an estimated 362 terawatt hours in 2019, which was about the same as in 2018 (EIA, 2019). After increasing at an average annual rate of 6% between 2000 and 2015, growth in power generation declined significantly because population growth slowed, GDP growth slowed, energy efficiency and demand-side management measures were implemented, and electricity prices increased between 2016 and 2018 (APICORP, 2019). Power generation declined by 1% in 2020, according to data from BP Statistical Review of World Energy (2021), as a result of the economic slowdown from the COVID19 pandemic. Residential power use rose because of the COVID-19-related lockdowns and restrictions, but electricity sales to the commercial and government sectors fell (SEC, 2020). Saudi Arabia fueled nearly all of its electricity generation with natural gas (61%) and crude oil (39%) in 2020, although the Saudi government plans to diversify fuels consumed for electricity output to increase available crude oil for export and to reduce its carbon emissions (BP Statistical Review of World Energy, 2021). The share of natural gas rose substantially over the past decade from 42% of total power generation in 2010 because of expanded natural gas-fired generation capacity that is supported by higher production (BP Statistical Review of World Energy, 2021). In 2019 and 2020, growth in natural gas production slowed substantially, which encouraged crude oil use in the power sector, particularly during the peak summer season. The Saudi government intends to replace most of the crude oil burn and diesel-fired power generators with natural gas and heavy fuel oil in the next few years (Reuters, 2021).

Several studies have confirmed the feedback causality between CO_2 emissions and renewable energy consumption. For example, Apergis et al. (2010) studied the causal relationship between renewable energy consumption and CO_2 emissions in 19 developed and developing countries. The authors used the VECM and ARDL techniques to study this relationship. The empirical results revealed a bidirectional causality between renewable energy consumption and CO_2 emissions. Sebri and Ben-Salha (2014) conducted a study on the causal relationship between renewable energy consumption and CO_2 emissions in BRICS economies. They used annual data from 1971 to 2010 and the VECM model to explore this causal relationship. The results revealed a bidirectional causality between CO_2 emissions and renewable energy consumption. The conclusions of the study by Attiaoui et al. (2017) corroborate those of Sebri and Ben-Salha (2014), who found a bidirectional causality between CO_2 emissions and renewable energy consumption.

Furthermore, Aydoğan and Vardar (2020) investigated the link between renewable energy consumption and CO_2 emissions in E7 countries. The authors used panel ARDL limit tests and the Granger causality technique to explore this interaction. The results revealed a two-way causality between renewable energy consumption and CO_2 emissions. However, in the case of Thailand, the study by Boontome et al. (2017) found no evidence of causality between renewable energy consumption and CO_2 emissions. Some studies have shown that renewable energies have a negative impact on CO_2 emissions. For example, Zoundi (2017) examined the interaction between CO_2 emissions and renewable energy use in 25 selected African economies by applying panel cointegration and ARDL techniques using data between 1980 and 2012. The results revealed that the consumption of renewable energy improves the quality of the environment. In the study conducted by Qi et al. (2014) on China for the period between 2010 and 2020, the authors found that renewable energy consumption decrease environmental degradation. Additionally, several studies have agreed that renewable energy consumption improves environmental quality (Salahuddin et al., 2015; Rauf et al., 2018; Saidi and Omri, 2020; Jebli et al., 2020; Ullah et al., 2020).

To this end, this paper tests the validity of the EKC hypothesis and investigates the long run relationship between CO_2 emissions and non-renewable energy consumption, renewable energy consumption, economic growth and urbanization. The rest of the paper is organized as follows: Section 2 presents Methodology. Section 3 yields estimation results, and Section 4 provides conclusions and policy recommendations.

2. METHODOLOGY

2.1. Quantile Regression

Quantile regression (QR), introduced by Powell (2022), is a common approach in econometrics for parameter estimation and model analysis. Compared to the ordinary least squares (OLS) method which estimates the conditional mean of the dependent variable, the QR is based on the median and aims to estimate the quantiles of the dependent variable. Suppose that γ and χ are respectively dependent and independent variables. The assumption of linearity in the conditional relation leads to the following:

$$y_p = x_i^{'}\alpha_p \tag{1}$$

Where α_p is the coefficient of the quantile p, $p \in [0, 1]$. α_p can be estimated by minimizing the following sum of the objective function of absolute differences:

$$\min_{\alpha_p} \sum_{i\in\{y_i \geq x_i^{'}\alpha_p\}} p\left|y_i - x_i^{'}\alpha_p\right| + \sum_{i\in\{y_i \prec x_i^{'}\alpha_p\}} (1-p)\left|y_i - x_i^{'}\alpha_p\right| \tag{2}$$

The parameters of equation (2) can be evaluated using linear programming (Buchinsky, 1995). By gradually varying p from 0 to 1 and solving for α_p, we obtain for each explanatory variable a graph explaining its relationship with the dependent variable. The QR estimate is more robust to outliers and large data variations than the OLS estimate. More importantly, when the distribution of the dependent variable does not follow the normal distribution, which is the case for most environmental and economic data, the OLS estimation becomes unreliable while the QR estimation can detect heterogeneous relationships with the dependent variable (Lin and Xu, 2018).

2.2. Model Specifications

This study uses the EKC framework in Eq. (1), following recent studies by Chen et al. (2020) and Usama et al. (2020), to analyze the impacts of economic growth, renewable energy consumption, non-renewable energy consumption and urbanization on CO_2 emissions:

$$\begin{aligned} CO_{2t} &= \alpha_0 + \alpha_1 GDP_t + \alpha_2 GDP_t^2 + \alpha_3 REC_t \\ &+ \alpha_4 NREC_t + \alpha_5 URB_t + \varepsilon_t \end{aligned} \tag{3}$$

Where CO_2 is the carbon dioxide emissions per capita; GDP is the economic growth measured by the real gross domestic product per capita in constant 2015$; RENC denotes renewable energy consumption; NREC is the non-renewable energy consumption; URB is urbanization.

To better understand the data, this study reports statistics of CO_2 emissions, real GDP, renewable energy consumption, non-

Table 1: Descriptive statistics

Variables	Mean	Minimum	Maximum	Median	SD	Skewness	Kurtosis
CO_2	0.76	−2.55	2.89	1.05	1.22	−0.64	3.22
GDP	8.22	4.27	10.62	8.03	1.35	−1.34	3.54
RENC	5.24	1.98	7.53	6.34	2.06	−0.57	3.84
NREC	7.56	4.081	11.02	8.31	1.11	−0.51	3.77
URB	3.98	1.67	4.01	4.21	0.12	−1.06	4.01

SD: Standard deviation

Table 2: Results of unit root tests

Variables	ADF		PP	
	0	First difference	Level	First difference
CO_2	-1.101	-4.522***	-0.122	-4.507***
GDP	-1.214	-7.974***	-0.214	-6.297***
RENC	-0.044	-4.011***	-0.640	-3.171***
NRENC	-0.248	-6.541***	-0.054	-6.088***
URB	-0.108	-5.051***	-0.201	-4.121***

***indicates 1% level of significant respectively.

renewable energy consumption and urbanization. Table 1 shows the mean, median, minimum, and maximum values of the data, as well as the skewness and kurtosis statistics. It can be said that the analyzed variables are not symmetric and normally distributed because the values of the skewness statistics are different from zero. In addition, the values have heavier tails than a normal distribution because the flattening stats are greater than +3. Finally, the descriptive statistics demonstrate the heterogeneity of the data, suggesting the use of the quantile regression method for reliable empirical results.

3. EMPIRICAL RESULTS

Before estimating equation (3), we use the Augmented Dickey-Fuller (ADF, 1979) and Phillips-Perron (PP, 1988) unit root test to determine the order of integration of these four variables. Table 2 shows the results of the unit root test in levels and first differences with trend and intercept. The results demonstrate that we cannot reject the null hypothesis of unit root for four level variables. However, we reject the null hypothesis of a unit root at the 1% significance level for the first difference of these three variables. Based on the ADF and PP test results, these four data series are integrated in the first order (I(1)).

Table 3 presents the results of the OLS model and the quantile regressions. The results of the OLS and quantile regressions confirm the existence of the EKC hypothesis, except for the lowest quantile. According to the OLS results, a 1% increase in GDP increases CO_2 emissions by 0.661%, and a 1% increase in GDP^2 reduces CO_2 emissions by 0.021% with a statistical significance of 1%. Therefore, the results of the OLS show an inverted U-shaped pattern, and the validity of an inverted U-shaped pattern of the EKC in Saudi Arabia indicates that this country has reached a threshold of economic growth and is point to a green growth phase in its production (Grossman and Krueger, 1995).

Quantile regression results are provided for the quantiles of 0.05, 0.25, 0.50, 0.75 and 0.95 and provide a detailed analysis of the determinants of carbon emissions across the different emission quantiles of carbon. The impact of economic growth on CO_2 emissions is positive and statistically significant at all quantiles except the 0.05^{th} quantile, and the effect of growth on emissions is stronger at other quantiles. The impact of squared economic growth is negative and statistically significant for all quantiles other than the 0.05^{th} quantile. Carbon emissions increase significantly with growth, and the impact is higher in other quantiles. On the other hand, economic growth reduces emissions to a certain level. Thus, the results depict an inverted U-shaped pattern for all quantiles, and the EKC turning points are positioned at different levels. These findings are consistent with findings from previous studies (Dogan and Seker 2016; Anwar ERlkafi, 2021).

On the other hand, according to the OLS regression results, the impact of renewable energy consumption on carbon emissions is statistically insignificant, whereas this impact is statistically significant for all quantiles in the quantile regressions. The impact of renewable energy consumption increases across the quantiles and the coefficient becomes higher for the 0.95^{th} quantile. The effect of renewable energy consumption on carbon emissions is also supported by previous literature (López-Menendez et al., 2014; Shafiei and Salim 2014; Álvarez-Herranz and BalsalobreLorente 2015; Al-Mulali et al., 2016; Akram et al., 2020).

The results of OLS and quantile regressions indicate a positive and statistically significant impact of non-renewables on emissions. This finding was reported with Farhani and Shahbaz (2014) for MENA countries and in Bölük and Mert (2015) for Turkey. OLS results indicate that a 1% increase in non-renewable energy consumption increases CO_2 emissions by 0.51% The results of the quantile regression are interesting since the impact of non-renewable energy consumption shows a decreasing trend when going from the 0.05^{th} quartile to the 0.95^{th} quartile. Non-renewable energy consumption increases CO_2 emissions. A coefficient higher non-renewable energy than renewable energy is also reported. This is because the consumption of renewable energy remains lower; thus, the impact of renewable energy consumption is still limited compared to non-renewable energy consumption. The lower quantiles of the analysis could rely more on fossil fuels to achieve economic progress, resulting in a larger impact of non-renewables on CO_2 emissions (Zafar et al., 2017).

It can be seen that urbanization positively influences CO_2 emissions in the OLS and quantile regressions. According to the regression of the OLS model, if the URB increases by 1%, CO_2 emissions increase by 0.124%. Quantile regression results show that the impact of URB is higher in lower quantiles. From 0.05^{th} quantile to 0.95^{th} quantile, the coefficient is 0.781, 0.525, 0.506, 0.304, and 0.202, respectively. Urbanization is a factor that deteriorates environmental quality,

Table 3: Results from quantile regression

Variables	OLS	Quantile regression				
		q0.05	q0.25	q0.5	q0.75	q0.95
GDP	0.661***	0.504	0.307***	0.567***	0.706***	0.901***
GDP^2	−0.021***	−0.011	−0.021***	−0.027***	−0.033***	−0.031***
RENC	−0.03	−0.03**	−0.022**	−0.043	−0.041***	−0.069***
NRENC	0.510***	0.674***	0.537***	0.466***	0.418**	0.368***
URB	0.124**	0.781**	0.525***	0.506***	0.304***	0.202*
Constant	−9.652***	−10.861***	−8.651***	−9.658***	−11.067***	−10.354***

***, **, and *The significance level of 1%, 5%, and 10%, respectively. OLS: Ordinary least squares

suggesting that urbanization is a major source of emissions. Our results are in agreement with Chu et al. (2022). The difference between the quantiles could be explained by the various stages of development (Poumanyvong and Kaneko, 2010).

4. CONCLUSIONS AND POLICY IMPLICATIONS

This article examined the determinants of carbon dioxide emissions by considering the impact of renewable and non-renewable energy consumption under the EKC using the quantile approach of OLS and Powell (2022) in Arabia Saudi during the period 1990-2015. The quantile regression method provides an understanding of the differences between different carbon emission levels, allowing us to interpret the relationship between carbon dioxide emissions and the determinants at different emission levels.

The purpose of this article is to determine whether renewable and non-renewable energy consumption affects environmental degradation in Saudi Arabia during the period 1990-2019. Using the OLS method and the quantile approach developed by Powell (2022), the results of the analysis validate the existence of EKC and describe an inverted U-shaped pattern in both the OLS regression and the quantile approach. Economic growth increases carbon emissions up to a certain threshold and then slows emissions. The results of the regression of the quantiles give us valuable results in determining different thresholds of the level of GDP. The GDP coefficients in the EKC curve are 0.504; 0.307; 0.567; 0.706 and 0.901 for the 5^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} quantiles, respectively, suggesting that the effect of economic growth on environmental degradation is volatile. This result is not only significant for Saudi Arabia, but may also have valuable implications for other countries.

Consistent with previous studies, renewable energy consumption has a statistically significant negative effect on carbon emissions. This result is also valid for all quantiles. However, the effect of renewable energy consumption is not significant for the OLS regression. The results of the quantile method demonstrate that the substitution of non-renewable energies is an important factor in reducing environmental degradation. However, for Saudi Arabia, there is more room to adopt greener energy sources to reduce CO_2 emissions due to the scale effect. Saudi Arabia should pursue effective strategies to find cheaper avenues to intensify the use of renewable energy sources. The insignificant results of the OLS regression also indicate that future research should adopt quantile approaches, as they give us robust results when the data exhibit heterogeneity. On the other hand, the consumption of non-renewable energy significantly increases CO_2 emissions in both approaches.

These results provide new insights for policymakers in the Saudi Arabia. This country should focus on policies to promote the adoption and use of renewable energy sources to prevent environmental deterioration. This is particularly crucial for the most carbon-emitting sectors; thus, the promotion of research and investment activities to increase the production and consumption of renewable energy sources should be a priority to reduce carbon emissions. Despite the high costs of renewable energy, the government should promote investment in different clean energy sources, such as wind and solar. Since renewable energy sources are critically important in reducing emissions, it is essential to design regulations to prevent environmental degradation. In addition, the country should allocate more funds to technological advancements and research to encourage the shift from non-renewable sources to cleaner renewable energy sources. In addition, policymakers in this country should design and implement policies aimed at economic growth to achieve a steady decline in carbon emissions. Growth-oriented economic policies encourage the use of cleaner sources and could enhance the reduction of environmental degradation.

5. ACKNOWLEDGMENTS

This work was funded by the Deanship of Scientific Research at Jouf University through the Fast-track Research "Funding Program.".

REFERENCES

Adebayo, T.S., Kalmaz, D.B. (2020), Ongoing debate between foreign aid and economic growth in Nigeria: A wavelet analysis. Social Science Quarterly, 101(5), 2032-2051.

Akram, R., Chen, F., Khalid, F., Ye, Z., Majeed, M.T.(2020), Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries. Journal of Cleaner Production, 247, 119122.

Alharthi, M., Dogan, E., Taskin, D. (2021), Analysis of CO2 emissions and energy consumption by sources in MENA countries: Evidence from quantile regressions. Environmental Science and Pollution Research, 28(29), 38901-38908.

Al-Mulali, U., Ozturk, I., Solarin, S.A. (2016), Investigating the environmental Kuznets curve hypothesis in seven regions: The role of renewable energy. Ecological Indicators, 67, 267-282.

Álvarez-Herranz, A., Balsalobre-Lorente, D. (2015), Energy regulation in the EKC model with a dampening effect. Journal of Environmental Analytical Chemistry, 2(3), 1-10.

Anwar, N., Elfaki, K.E. (2021), Examining the relationship between energy consumption, economic growth, and environmental degradation in Indonesia: Do capital and trade openness matter? International Journal of Renewable Energy Development, 10(4), 769-778.

Apergis, N., Payne, J.E. (2010), Renewable energy consumption and growth in Eurasia. Energy Economics, 32(6), 1392-1397.

Arab Petroleum Investment Corporation (APICORP). (2019), MENA Power Investment Outlook 2019-2023. Saudi Arabia: APICORP. p8.

Attiaoui, I., Toumi, H., Ammouri, B., Gargouri, I. (2017), Causality links among renewable energy consumption, CO2 emissions, and economic growth in Africa: Evidence from a panel ARDL-PMG approach. Environmental Science and Pollution Research, 24(14), 13036-13048.

Aydoğan, B., Vardar, G. (2020), Evaluating the role of renewable energy, economic growth and agriculture on CO2 emission in E7 countries. International Journal of Sustainable Energy, 39(4), 335-348.

Bölük, G., Mert, M. (2015), The renewable energy, growth and environmental Kuznets curve in Turkey: An ARDL approach. Renewable and Sustainable Energy Reviews, 52, 587-595.

Boontome, P., Therdyothin, A., Chontanawat, J. (2017), Investigating the causal relationship between non-renewable and renewable energy consumption, CO2 emissions and economic growth in Thailand. Energy Procedia, 138, 925-930.

BP Statistical Review of World Energy. (2021), BP Statistical Review of World Energy 2021: Two Steps Forward, One Step Back. Annual Report 2021. Saudi Arabia: Saudi Electricity Company. p. 91. Available from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-statsreview-2021-full-report.pdf [Last accessed on 2021 Jun].

Buchinsky, M. (1995), Estimating the asymptotic covariance matrix for quantile regression models a Monte Carlo study. Journal of Econometrics, 68(2), 303-338.

Chen, J., Xian, Q., Zhou, J., Li, D. (2020), Impact of income inequality on CO2 emissions in G20 countries. Journal of Environmental Management, 271, 110987.

Chu, L.K., Le, N.T.M. (2022), Environmental quality and the role of economic policy uncertainty, economic complexity, renewable energy, and energy intensity: The case of G7 countries. Environmental Science and Pollution Research, 29(2), 2866-2882.

Dai, J., He, K., Sun, J. (2016), Instance-Aware Semantic Segmentation via Multi-task Network Cascades. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. New York: IEEE. pp. 3150-3158.

Dickey, D.A., Fuller, W.A. (1979), Distribution of the estimators for auto-regressive time series with a unit root. Journal of the American Statistical Association, 74, 427-431.

Dogan, E., Seker, F. (2016), The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. Renewable and Sustainable Energy Reviews, 60, 1074-1085.

EIA's Annual Energy Outlook 2019 Projects Growing Oil, Natural Gas, Renewables Production. Available from: https://www.eia.gov/todayinenergy/detail.php?id=38112

Farhani, S., Shahbaz, M. (2014), What role of renewable and non-renewable electricity consumption and output is needed to initially mitigate CO2 emissions in MENA region? Renewable and Sustainable Energy Reviews, 40, 80-90.

Grossman, G.M., Krueger, A.B. (1995), Economic growth and the environment. The Quarterly Journal of Economics, 110(2), 353-377.

International Energy Agency. (2014), World Energy Outlook 2014. Paris: OECD/IEA.

Jebli, M.B., Farhani, S., Guesmi, K. (2020), Renewable energy, CO2 emissions and value added: Empirical evidence from countries with different income levels. Structural Change and Economic Dynamics, 53, 402-410.

Lin, B., Xu, B. (2018), Factors affecting CO2 emissions in China's agriculture sector: A quantile regression. Renewable and Sustainable Energy Reviews, 94, 15-27.

López-Menéndez, A.J., Pérez, R., Moreno, B. (2014), Environmental costs and renewable energy: Revisiting the environmental Kuznets Curve. Journal of Environmental Management, 145, 368-373.

Phillips, P.C.B., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Poumanyvong, P., Kaneko, S. (2010), Does urbanization lead to less energy use and lower CO2 emissions? A cross-country analysis. Ecological Economics, 70(2), 434-444.

Powell, D. (2022), Quantile regression with no additive fixed effects. Empirical Economics, 63, 2675-2691.

Qi, T., Zhang, X., Karplus, V.J. (2014), The energy and CO2 emissions impact of renewable energy development in China. Energy Policy, 68, 60-69.

Rauf, A., Liu, X., Amin, W., Ozturk, I., Rehman, O.U., Sarwar, S. (2018), Energy and ecological sustainability: Challenges and panoramas in belt and road initiative countries. Sustainability, 10(8), 2743.

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., 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.

Sebri, M., Ben-Salha, O. (2014), On the causal dynamics between economic growth, renewable energy consumption, CO2 emissions and trade openness: Fresh evidence from BRICS countries. Renewable and Sustainable Energy Reviews, 39, 14-23.

Shafiei, S., Salim, R.A. (2014), Non-renewable and renewable energy consumption and CO2 emissions in OECD countries: A comparative analysis. Energy Policy, 66, 547-556.

Shahbaz, M., Zakaria, M., Shahzad, S.J.H., Mahalik, M.K. (2018), The energy consumption and economic growth nexus in top ten energy-consuming countries: Fresh evidence from using the quantile-on-quantile approach. Energy Economics, 71, 282-301.

Solarin, S.A., Ozturk, I. (2015), On the causal dynamics between hydroelectricity consumption and economic growth in Latin America countries. Renewable and Sustainable Energy Reviews, 52, 1857-1868.

Spiegel-Feld, D., Rudyk, B., Philippidis, G. (2016), Allocating the economic benefits of renewable energy between stakeholders on Small Island Developing States (SIDS): Arguments for a balanced approach. Energy Policy, 98, 744-748.

Ullah, S., Ozturk, I., Usman, A., Majeed, M.T., Akhtar, P. (2020), On the asymmetric effects of premature deindustrialization on CO2 emissions: Evidence from Pakistan. Environmental Science and Pollution Research International, 27(12), 13692-13702.

Usama, A.M., Solarin, S.A., Salahuddin, M. (2020), The prominence of renewable and non-renewable electricity generation on the environmental Kuznets curve: A case study of Ethiopia. Energy, 211, 118665.

Zafar, M.W., Shahbaz, M., Hou, F., Sinha, A. (2019), From nonrenewable to renewable energy and its impact on economic growth: The role of research and development expenditures in Asia-Pacific Economic Cooperation countries. Journal of Cleaner Production, 212, 1166-1178.

Zoundi, Z. (2017), CO2 emissions, renewable energy and the environmental Kuznets Curve, a panel cointegration approach. Renewable and Sustainable Energy Reviews, 72, 1067-1075.