Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2019, 9(4), 527-534

RESEARCH ARTICLE

The impact of renewable energy on carbon dioxide emissions: an empirical analysis of selected South Asian countries

W. Ahmad [1], M. T. Majeed[2]

[1] School of Economics, QAU, Islamabad

[2] School of Economics, QAU, Islamabad, Zubaria Andlib, FUUAST, Islamabad

E-mail: awaheed@eco.qau.edu.pk

Received: 18.11.2019. Accepted: 07.12.2019

This study attempts to explore the impact of renewable energy, nonrenewable energy, trade openness and urbanization on carbon dioxide emissions (CO_2) in the selected South Asian countries over the period 1990 to 2014. The study used Panel Fully Modified Ordinary Least Square (FMOLS) for analyzing the relationship between renewable energy, nonrenewable energy, trade openness, urbanization, and carbon dioxide emissions. The results from the FMOLS show that renewable energy is negatively associated with CO_2 emissions, whereas nonrenewable energy is positively associated with CO_2 emissions. Furthermore the empirical estimation revealed that the increase in trade openness increases co_2 emissions. Interestingly, urbanization decreases carbon dioxide emissions in our analysis of selected South Asian region. It implies that increasing the use of renewable energy is an effective policy to mitigate global warming in the South Asian region.

Key words: Renewable energy; nonrenewable energy; CO_2; emissions; FMOLS

Introduction

Since the past decade increase in energy demand causes an increase in carbon dioxide emission one of the leading sources of environmental degradation. Most of the energy produced from conventional sources such oil, coal and gas. Globally 70% of global energy demand is fulfilled from fossil fuels such as coal, oil, and gas. As a result, carbon dioxide emissions increased by 1.4% in 2017 (IEA, 2017). All over the world burning of fossil fuel leads to 38.2 billion tons of carbon dioxide emissions emitted into the environment. On average carbon dioxide emissions have increased to 403.3 ppm in 2016 as compared to 400 ppm in 2015 (WMO, 2017).

Energy is the most important factor in economic development. The rapid increase in the world population, consumption, and industrial activities these factors cause increased demand for energy. In this regard, renewable energy is one of the most effective and efficient solutions. It will not only meet the increasing demand for energy, environmental protection and most sustainable source for sustainable development (Dincer, 2004).

The rapid increase in population, urbanization, industrialization and most share of the energy produced and consumed from fossil fuel has increased the concentration of CO_2 emissions in the atmospheres being a major cause of environmental degradation. Anthropogenic is the main source of degradation (IPPC, 2014). The surge in human activities and industrialization are two most important factors behind an increase in overall global temperature (Pandey and Mishra, 2016). Globally energy demand has increased especially in developing countries. It is mainly due to the increasing economic growth and population in the less developed countries. Most of the energy is produced from nonrenewable sources. The use of fossil fuels has increased the concentration of carbon dioxide emissions and environmental degradation (Dincer, 2000).

The volatile and higher prices of energy, urbanization and population growth create a threat of energy security in the South Asian countries. This region has a limited capacity of energy resources rapid population and energy demands creates a threat of energy security (parnti et al., 2013). South Asian countries have seen higher growth rates. The increase in the growth rate causes a higher demand for energy. The use of a conventional source of energy resulted in carbon dioxide emission and environmental degradation.

South Asian countries dependence on nonrenewable sources of energy not only limited to diversify the source of energy but also create a threat of energy security. (SAARC, 2012). South Asian members states have a rich variety of renewable energy resources that can be used to eradicate the problem of energy security and to attain sustainable development of the economy and access to clean environment-friendly energy (Shukla et al., 2017).

The use of RE sources is an important way to mitigate the CO_2 emissions. Renewable power is the most effective tool for sustainable development. Renewable energy contributes to environmental protection, it has huge potential for regional energy trade, enhances economic growth, creates jobs and boosts business activity and eradicates poverty in the South Asia region (ADB, 2011). The economy of this region grows faster than the global economy. It also increases the demand for energy mainly

due to the increase in economic growth and rapid population growth. To meet the demand of energy renewable energy is the most effective tool in this region because South Asia region has plenty of renewable sources (ADB, 2017).

The combined potential of hydropower generation in South Asia is estimated at 388,775 MW, of which only about 13% of this potential has been used. India has the highest potential of generating 150,000 MW, followed by Pakistan with 100,000 MW, Nepal with 83,000 MW, Bhutan with 30,000 MW, Afghanistan with 23,000 MW, Sri Lanka with 2,000 MW, and Bangladesh with 775 MW. Moreover, renewable power sources provide 12.9% of total energy in the South Asian region. It is estimated that 43% of energy demand will be fulfilled from renewable sources in 2030 and it will be increased up to 77% in 2050. These renewable power sources also help to reduce GHG_e and it will reduce 560 GT of CO_2 emissions (SSARC CCI, 2012).

In the South Asian region, most of the existing literature discusses the nexus between energy consumption and carbon dioxide emissions. The present study disaggregates the energy consumption into renewable energy consumption and nonrenewable energy consumption and empirically analyses their affects on carbon dioxide emissions.

Furthermore, to the introductory section (section 1), the rest of this paper is as follows: Section 2 represents the literature review dealing with renewable and nonrenewable energy affect on pollution emissions. Section 3 explains the Methodolgy of the study. Section 4 deals with data and descriptive analysis. Section 5 deals the empirical analysis and results. Section 6 conclude the present study and provie some plicy based on emperical finding.

Literature Review

Numerous studies in the existing literature have examined the relationship between energy, economic growth and environment. In this section, most of the literature is relevant in the two areas, energy consumption on economic growth and literature relevant to energy consumption on environment.

Literature Review on Effect of Energy Consumption on Environment

Soytas et al (2007) highlight the effect of EC and economic growth on CO_2 emissions over the period 1960-2004 in the context of US. The result support the validation of the Environment Kuzunet Curve hypothesis. Furthermore, increase in EC increases the CO_2 emissions. Pao and Tsai (2010) elaborate the nexus among carbon dioxide emission, EC and economic growth over the period 1971-2005 for a panel of BRICE regions. The empirical results revealed that EC show a significant and positive impact on CO_2emissions. In addition, results support the existence of the EKC hypothesis. Panel granger estimation technique demonstrate that bidirectional causality is running energy consumption and output.

Similarly, Hossain (2011) finding revealed that increase in the energy consumption of newly industrialized countries increase carbon dioxide emissions and pollute the environment. In addition, that trade openness reduces CO_2 emissions while urbanization increase the CO_2 emissions in the environment. Chebbi et al. (2011) indicate increase in the volume of trade lead to enhance the emissions. In addition, trade through the channel of per capita income reduces CO_2 emissions. Hossain (2012) examine the nexus between carbon dioxide emissions, EC, EG, foreign trade and urbanization over the period 1960-2009 for Japan. The results indicate that EC stimulate CO_2 emissions that's a major cause of environmental degradation. The results demonstrate that urbanization increases the CO_2 emissions. Moreover, increase in the trade volume lead to mitigates CO_2 emissions.

Similarly, Shahbaz et al. (2013) revealed from empirical results all variables are cointegrated and hold a long-run relationship. Moreover, energy consumption increases CO_2 emissions and economic growth is a major factor of enhancing the carbon dioxide emissions. In addition, increase in trade openness mitigates CO_2 emissions while the results confirm bi-directional relationship between trade openness and CO_2 emissions. (Farhani and Rajeb, 2012; Alom, 2014; Antonakakis et al., 2017; Nkengfack and Fotio 2019) these studies highlight that energy consumption stimulate the concentration of CO_2 emissions in the environment.

Literature Review on Affect of Energy Consumption on Economic Growth

Rehman and Deyuan (2018) highlight nexus among EG, energy access, energy use and growth of population for period 1990-2016 in the context of Pakistan. The result demonstrates that a long-run relationship exists among all the variables. Moreover, the result reveals that energy access to urban area population shows positive affect on EG. In addition, population live in rural area lead to negative affect on EG. Similarly, Aperigs and E. Pyne (2010) empirical finding indicate long-run relationship exists among all the variables. In addition, the result confirms short-run causality is running between economic growth and renewable energy while in the long run bidirectional nexus is valid between renewable energy and economic growth. Aslan et al. (2012) the results demonstrate that long run nexus exists between all variables. Furthermore, the results confirm the bidirectional causality between renewable energy and economic growth.

In another study, Shehbaz et al. (2012) explore long run nexus between energy consumption and economic growth for Pakistan. The results revealed that long-run nexus exist between variables. In addition, the results confirm feedback hypothesis between economic growth and energy consumption. As a result, Bhattacharya et al. (2016) concluded that renewable energy and nonrenewable energy has positive impact on output of world ranked 38 renewable power using countries for 1990-2012. Similarly (Lotz, 2016; Kahia et al., 2016; Dogan, 2016; Atems and Hotaling, 2018) these results demonstrated that both renewable and nonrenewable energy shows a positive impact on economic growth of the economies.

Literature Review on Effect of Renewable and Nonrenewable Energy Consumption on Environment

Menyah and Rufeal (2010) investigate nexus between REC, NEC, and carbon dioxide emissions for the period 1960-2010. The result indicates that RE and nuclear energy reduces carbon dioxide emissions. Furthermore, the result revealed that increase in NEC lead to reduce the carbon dioxide emissions. similarly, Mnengaki (2011) empirically analyzes long-run causal relation

among greenhouse gas emission, employment, renewable energy sources and growth of the economy by using data on 27 European countries over the period of 1997-2007. The empirical results demonstrate that cointegration exist between variables. Shafiei and Salim (2014) find that renewable energy mitigates CO_2 emissions while nonrenewable energy lead to stimulate the carbon dioxide emissions. In addition, urbanization enhance the emissions and results confirm the existence EKC hypothesis. As a result of Farhani & Shahbaz (2014) conclude that renewable and nonrenewable energy may lead to increase the CO_2 emissions for 1990-2009 based on a panel of MENA countries. Furthermore, results indicate EKC hypothesis is valid.

Similarly, Jebli and Youssef (2015) analyze the nexus between REC, TO and CO_2 emissions over the period 1980-2009 in the context of Tunisia for the period of 1980-2009. The study also examines the Environment Kuznets Curve hypothesis. For the empirical estimations ARDL approach is used. The EKC hypothesis is not valid. The results indicate that trade influence the carbon dioxide emissions while bidirectional causality is running between carbon dioxide emissions and nonrenewable energy. Belaid & Yousaf (2017) finding revealed that nonrenewable energy stimulates carbon dioxide emissions in contrast renewable mitigate carbon dioxide emissions. Jebli et al. (2016) finiding confirm the existence of envioronment kuznut curve hypothesis betweeen GDP and CO_2 emissions for a panel of 25 OECD economies. In addition, the results contrast in the case of developing countries renewable energy consumption increase CO_2 emission. While Goga and Seker evaluate that renewable energy, trade openness and financial development are negatively associated with CO_2 emissions and nonrenewable energy positively associated with CO_2 emissions.

Al-Mulali et al. (2016) examined that renewable energy reduce CO_2 emissions in the central and eastern European region while renewable energy has no effect on CO_2 emissions in the Middle East, North Africa and Sub Sahara Africa. Moreover, the result confirms the existence of Environment Kuznets Curve Hypothesis in the region where RE reduce CO_2 emissions. Bhattacharya et al. (2017) demonstrate that renewable energy mitigates CO_2 emissions for a panel of 85 developed and developing economies. In addition, they concluded that results that institution play a very supportive role to increase in renewable energy usage and mitigate the carbon dioxide emissions. similarly, Liu et al (2017) finding suggest that renewable energy is negatively associated with CO_2 emissions while nonrenewable energy is positively associated with CO_2 emissions. For a panel of 4 Asian economies Lorente et al. (2018) also find similar results that renewable energy lead to reduce the CO_2 emissions in the environment.

Liu et al. (2017) examine the nexus between CO_2 emissions, real GDP, RE, NRE and agriculture 4 ASEAN for 1970-2013. For empirical estimation panel cointegration approach is used. Vector error correction mechanism approach is applied to find the direction of variables. The results revealed that renewable energy mitigates the carbon dioxide emissions in the atmosphere while nonrenewable energy increase carbon dioxide in the environment. Furthermore, the resulting support that bidirectional causality is running among the variables such as carbon dioxide emissions, renewable energy & nonrenewable energy. The unidirectional causality is running from agricultural value add and gross domestic products to carbon dioxide emissions, renewable energy, and nonrenewable energy.

Methodological Framework

Various studies explore this nexus between environmental degradation and energy consumption for different countries around the globe. These studies applied different methodologies with different data sets for example, Farhani and Shahbaz (2014) have analyzed the same nexus in case of MENA region. Other studies such as Hossain (2011) and Jebli & Yousef (2015) used simple linear regression model and explore the relationship between RE, NRE and environment degradation, whereas Zoundi (2017) also employed simple regression model to analyze the nexus between REC and CO_2 emissions for 25 African countries. Moreover, for Algeria, Belaid & Yousef also used similar model to analyze the nexus among REC, NREC, EG and CO_2 emissions. In another study Lotz (2015) used general form of Cobb Douglas Production function to examine the nexuses between EG and EC for selected OECD countries.

By the following Farhani and Shahbaz (2014) general form of the model is used

$$\mathrm{CO}_2 = \mathrm{F}\,(\mathrm{RE}, \mathrm{NRE}, \mathrm{TO}, \mathrm{UR}) \qquad (1)$$

For the reliable results and long-run elasticities the present study it transforms into the natural logarithm form.

$$\mathrm{Ln}\left(\mathrm{CO}_{2_{\mathrm{it}}}\right) = \mathrm{Bo} + \mathrm{B1ln(re)}_{\mathrm{it}} + \mathrm{B2\ ln(nre)}_{\mathrm{it}} + \mathrm{B3\ ln(to)}_{\mathrm{it}} + \mathrm{B4ln(ur)}_{\mathrm{it}} + \mathrm{et}_{\mathrm{it}} \quad (2)$$

Where

Co2=Carbon Dioxide emissions; RE=Renewable Power Consumption; NRE=Non-renewable Power Consumption
TO=Trade Openness; UR=Urbanization

Data Collection and Descriptive Analysis

This section explains the source of data, the definition of variables which are used in the present analysis. We used panel data for a sample of five selected South Asian countries. The variables used for analysis are carbon dioxide emissions (CO_2 kg per 2011 PPP $ GDP) as a proxy of environmental degradation, renewable energy consumption (REC) % of total energy, nonrenewable energy consumption (NREC) % of total energy from oil, gas, and coal. Trade openness % of GDP and urbanization as a proxy of urban population growth (annual%).

Table 1. Descriptive Statistics.

	CO2	REC	NREC	TO	UR
Mean	0.177	61.666	46.811	43.699	3.075
Median	0.143	57.605	55.063	41.695	3.128
Maximum	0.429	95.120	73.769	88.636	7.027
Minimum	0.028	36.536	5.051	15.675	0.485
Std. Dev.	0.112	16.740	21.096	17.293	1.550
Skewness	0.904	0.641	-0.796	0.710	0.401
Kurtosis	2.622	2.237	2.258	2.764	3.389
Jarque-Bera	17.774	11.577	16.068	10.782	4.141
Probability	0.000	0.003	0.000	0.005	0.126
Sum	22.083	7708.222	5851.363	5462.376	384.343
Sum Sq. Dev.	1.563	34749.280	55187.120	37081.680	297.856
Observations	125.000	125.000	125.000	125.000	125.000

Table 2: Correlation for the Panel.

Variables	CO_2	NREC	REC	TO	UR
CO2	1	-	-	-	-
REC	-0.630	1.000	-	-	-
NREC	0.658	-0.978	1.000	-	-
TO	-0.509	0.252	-0.363	1.000	-
UR	-0.096	0.374	-0.304	-0.446	1.000

Empirical Analysis and Results

Results of Panel Unit Root Test

Firstly, the study applied different panel unit root tests to check the stationarity of the panel data Schwartz lag selection information criteria for our selected is used. The results from the various panel unit root tests are reported in Table 1 and the result is based on the t-statistics and corresponding probability whether the data is stationary or not. The null hypothesis shows that the data is nonstationary and unit root is present in the selected variable. The results from LLC panel unit root tests revealed carbon dioxide emissions are nonstationary and unit root is present. All the tests show the same results such as Pesaran and Shin W-state, ADF- Fisher Chi-square and PP-Fisher Chi-square that carbon dioxide emissions are non-stationary at level. These tests applied one by one to all the selected variables such as renewable energy consumption, nonrenewable energy consumption, trade openness, and urbanization. These panel unit root tests results indicate that all the selected variables of panel data set are nonstationary and unit root is present at level. After taking the first difference that the null hypothesis is rejected, and the alternative hypothesis is accepted, and unit root is not present data set of selected variables is stationary. The results reported in Table 1 that carbon dioxide emissions are stationary at first difference and unit root is not present. After taking the first difference one by one all the selected variables in the present study the results indicate that all the variables are stationary and unit root is not present. All the tests i.e LLC, Pesaran and Shin W-state, ADF- Fisher Chi-square and PP-Fisher Chi-square revealed the same results that selected variables are stationary after taking the first difference. These different panel unit root test give the same results and improve the reliability and validity of these tests.

Results of Panel Co-Integration Tests

First, check the stationarity of the selected variables. The results from the various panel unit root tests indicate that all the selected variables are stationary after taking the first difference. The condition for panel co-integration test is fulfilled because all the variables are I (1). The next step to apply panel co-integration tests to find the long-run relationship between the selected variables. Pedroni panel co-integration tests results are reported in Table 2 null hypothesis shows all the selected variables are not cointegrated while the alternative hypothesis shows that all the variables cointegrated.

In Table 2 Pedroni co-integration results revealed that null hypothesis can be rejected as shown by values panel v-statistics, panel rho-statistics, group rho-statistics, and grouped-ADF-statistics. Furthermore, eleven tests out of seven tests can reject the null hypothesis. These results in the favor of accepting the alternative hypothesis that all the selected variables are cointegrated that there exists a long-run relation between the variables. Kao residual co-integration tests results are reported in Table 3, the null hypothesis shows no-cointegration while the alternative hypothesis shows all the variables are cointegrated significance. Kao residual cointegration test indicates that accepting the alternative hypothesis and in the favor of all the variables are cointegrated and exit long-run relationship between the variables. Finally, we conclude on the basis of both the panel cointegration test results that all the selected variables are cointegration and there exists a long-run relationship among all the selected variables.

Table 3. Panel Unit Root test.

Method	CO2	Δ(CO2)	REC	Δ(REC)	NREC	Δ(NREC)	TO	Δ(TO)	UR	Δ(UR)
Levin, Lin and Chu	1.894	-7.453	0.264	-5.459	-0.377	-7.419	-1.152	-8.65	0.03	-3.579
	-0.97	0	-0.6	0	0.35	0	-0.12	0	-0.5	0
Breitung t-stat	1.165	-3.588	0.081	-4.74	0.124	-3.888	-0.172	-5.281	0.45	-2.519
	-0.87	0	-0.53	0	-0.54	0	-0.43	0	-0.7	0
Pesaran and Shin W-stat	0.483	-7.453	-0.37	-5.833	0.366	-6.298	-0.631	-7.151	0.22	-2.483
	-0.68	0	-0.35	0	-0.35	0	-0.26	0	-0.6	0
ADF - Fisher Chi-square	14.052	64.021	14.19	48.81	12.32	52.028	10.759	57.27	8.4	22.51
	-0.17	0	-0.16	0	-0.26	0	-0.37	0	-0.6	-0.01
PP - Fisher Chisquare	9.785	182.973	6.438	64.91	4.81	67.3	10.647	60.3	5.66	16.73
	-0.45	0	-0.77	0	-0.9	0	-0.38	0	-0.8	-0.02

Shows significance at 1% and 5% level of significance

Table 4. Pedroni panel cointegration test results.

	statistics	p-value	w-statistics	p-value
Panel v-Statistic	1.76	0.03	0.34	0.36
Panel rho-Statistic	-0.18	0.42	-0.10	0.45
Panel PP-Statistic	-2.37	0.00	-1.45	0.07
Panel adf-Statistic	-2.66	0.00	-1.63	0.05
Group rho-Statistic	-	-	0.83	0.79
Group PP-Statistic	-	-	-1.49	0.06
Group ADF-Statistic	-	-	-2.05	0.02

Indicate significance level at 10%; Indicate -significance level at 5-%; Indicate significance level at 1%.

Fully Modified Ordinary Least Square Estimation Results

Since the Pedroni panel co-integration and Kao estimation techniques confirm that the cointegration exists among the selected variables in the present study. The next step to find the long run coefficients of all the selected variables such as renewable energy consumption, nonrenewable energy consumption, trade openness, and urbanization. For this purpose, Fully Modified Ordinary Least Square method is used to estimate the long-run coefficients. Pedroni has developed the fully modified ordinary least square in 2001. The technique fully modified OLS used to estimate the long- run coefficients Farhan and Shahbaz 2013, Jebli et al. 2016 and Liu et al. 2017. The Fully Modified OLS estimation technique most reliable approach as compared to the OLS approach. Full Modified Ordinary Least Square is the nonparametric approach. The main benefit of this technique resolves the problem of serial correlation and endogeneity.

The long-run coefficients are estimated by using fully modified ordinary least square the results are reported in Table 4. All coefficients are transformed into the natural logarithms to the find the long-run elasticities. According to the fully modified ordinary least square, the results demonstrated that all the variables are statistically significant at 1% level of significance.

Table 4 shows that the results estimated by Fully Modified Ordinary Least Square approach, panel estimate results revealed that the long run elasticity of carbon dioxide emissions with respect to REC is approximately equal to 0.567. The result exposed that 1% increase in renewable energy consumption it reduces the carbon dioxide emissions by approximately 0.567% also 1% rise in the non-renewable energy consumption increase the carbon dioxide emissions approximately by 0.103%. Furthermore, 1% rises in trade openness rise in carbon dioxide emissions by 0.182% while in case of urbanization rise by 1 % will result in decrease of carbon dioxide emissions by 0.323%.

The result also shows that the increase in the use of REC reduces carbon dioxide emissions. So, REC is the most important source for sustainable development and economic prosperity. It also helps to protect the environment and reduce global warming threats. Renewable energy is a good solution for South Asian countries to reduce global warming. Moreover, the result is consistent with Liu et al. (2017) shows that the use of REC reduces carbon dioxide emissions. Furthermore, the empirical results are supported from the previous studies (Farhani and Shahbaz, 2014; Shafie and Salim 2014) found that rise in the REC reduces carbon dioxide emissions and Jebli et al (2016) supported that increase renewable power reduce carbon dioxide emissions for the selected panel of 25 OECD states. The results are not consistent with Apergis et al. (2010) find that the rise in the use of REC enhances carbon dioxide emissions for the selected panel of 19 developing and developed countries.

The increase in the nonrenewable energy increase CO2 emissions. The result is similar with Jebli and Youssef (2015) they find the use of nonrenewable energy increase carbon dioxide emissions in the long-run. Moreover, the result is also consistent with the Jebli et al. (2016) their finding support that more of nonrenewable power consumption enhances the CO2 emissions in the long-run.

The results revealed an increase in trade openness increase the CO2 emissions. The main reason that trade need more goods and need more energy to produce goods and services and also increase transportation shows a positive impact on carbon dioxide emissions. As the South Asian countries most of the energy produce conventional sources (oil, gas and coal) have positive impact on CO_2 emissions. Our results are consistent with Hossain (2011) increase in trade openness increase the carbon dioxide emissions due to the trade need more energy for the production of goods lead to increase the carbon dioxide emissions. Jebli &Youssef (2015a) empirical results revealed rise in TO it also enhances the CO_2 emissions. in addition, the result is also consistent with Halicioglu (2009) rising TO in turkey enhance carbon dioxide emissions. Moreover, empirical result is contradictory with Jebli et al. (2015) they show that increase in trade openness reduce CO_2 emissions.

The empirical results show that an increase in the urbanization reduces the CO_2 emissions in the long run. The effect of urbanization become positive or negative depend upon country contribution, infrastructure development and technological innovation Zhang et al. (2017). The finding suggest urbanization shows two types of affect spillover and direct affect. The impact of urbanization becomes positive or negative Ding and Li (2017). This phenomenon is called as pollution transfer effect. Carbon dioxide emissions increase because population move to big cities through the spillover effect. In addition, spillover effect lead to increase the carbon dioxide emissions. The direct effect reason is that concentration of urbanization derives industries agglomeration which making the industrial structure and resource allocation more effective and reasonable. Moreover, rise in the urbanization higher the portion of tertiary industry, and tertiary industry in general reduce carbon dioxide is low. Furthermore, human capital in urbanization promote technological innovation through the process of learning skills it reduces the carbon dioxide emissions. in addition, improvement in technology efficiency and energy efficiency, in big cities infrastructure development and automobile technology efficiency all they have a negative impact on carbon dioxide emissions. For reason may be increase in urbanization people use more public transport and efficient use of resources. Mover the result is consistent with (Zheng et al. 2017; Fan and Zou 2019) find an increase in urbanization reduce the carbon dioxide emissions. As well the result also similar with Hossain (2011). The result is not similar with Shahbaz at al. (2014), Shahbaz et al. (2013) in case of Indonesia they show that increases in urbanization increase the CO_2 emissions.

Table 5 Results of OLS Fully Modified.

Variables	Coefficients	t-Statistic	Prob.
RE	-0.567	2.4	0.01
NRE	0.105	-12.35	0.00
TO	0.182	3.99	0.00
UR	-0.323	-4.84	0.00

Shows significance level at 1%.

Conclusions

Since the past decade increase in energy demand cause increase the carbon dioxide emissions in the atmosphere. South Asian countries achieve the highest growth rate 6.9% in 2018 and expected average growth rate 7.1% in 2019-2020 in most of the South Asian region (World Bank, 2018). This increase in growth rate increases energy demand. The dependence on single source of energy has emitted huge amount of carbon dioxide emissions which is major cause of global warming.

Most of studies in the existing literature discuss the effect of energy consumption on carbon dioxide emissions. Siddique and Majeed (2016) investigate the impact of urbanization and energy consumption on carbon dioxide emissions in South Asian region. The present study disaggregates the energy into renewable and nonrenewable energy consumption and analyze the effect on carbon dioxide emissions. The aim of this study is to investigate the impact of renewable energy consumption on carbon dioxide emissions over the period of 1990-2014 for the perspective of selected South Asian countries. Due to the lack of availability of data this study selects only five South Asian countries namely Bangladesh, India, Nepal, Pakistan and Sri Lanka namely Bangladesh, India, Nepal, Pakistan, and Sri Lanka. Beside the above-studied relation, the study also investigates the impact of nonrenewable energy consumption, trade openness and urbanization on carbon dioxide emissions.

The results are estimated by Pedroni cointegration indicate the existence of long-run relationships among selected variables. Since the cointegration in the selected variables, the next step study applied fully modified ordinary least square to find the long run relationship between the variables.

The empirical results show that the impact of renewable energy on CO_2 emissions is negative and statistically significance. However, the impact of nonrenewable energy consumption on CO_2 emissions is positive and statistically significance most of the share of nonrenewable energy produces from conventional sources such as coal, oil and gas. This it is main cause to CO_2 emissions and degrade the environment.

The empirical results also show that the impact of trade openness on CO_2 emissions is positive and statistically significance. The increase in cross border trade increase the demand of energy most of the energy in South Asian region produce from conventional sources so it has the positive impact on CO_2 emissions and degrade the environment. In addition, the results revealed the effect of urbanization on CO_2 emissions negative and statistically significance. The impact of urbanization becomes negative due to investment in human capital and promote technological innovation through the learning and skills, improve production efficiency and energy efficiency, infrastructure development and automobile technology efficiency all these factors have urbanization shows a negative impact on CO_2 emissions.

For these findings, we conclude that research and investment in clean energy should be an integral part of the process to reduce CO_2 emissions. CO_2 emissions can be reduced the use of efficient technologies and it should be import environment friendly technology from advance countries. It also substitutes nonrenewable energy to renewable sources. South Asia region has a vast variety and potential to produce energy from renewable energy sources.

Renewable energy is the fastest growing source of energy in the world. Renewable power technology capacity and output continue to grow then the conventional source of energy. It enhances access to modern energy and has the key source to mitigate climate change. Renewable energy has the engine of sustained development and economic prosperity. Renewable energy contributes to environmental protection, it has huge potential for regional energy trade, enhance economic growth, create jobs and boost business activity and eradicate poverty in the South Asia region.

References

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.

Alom, K. (2014). Economic Growth, CO2 Emissions and Energy Consumption: Evidence from Panel Data for South Asian Region. Journal of Knowledge Globalization, 7(1), 43-63.

Ang, J. (2007), CO2 Emissions, Energy Consumption, and Output in France. Energy Policy, 35(10), 4772-4778.

Antonakakis, N., Chatziantoniou, I., Filis, G. (2017). Energy consumption, CO2 emissions, and economic growth: An ethical dilemma. Renewable and Sustainable Energy Reviews, 68, 808-824.

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., Menyah, K., Wolde-Rufael, Y. (2010). On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecological Economics, 69(11), 2255-2260.

Asian Development Bank. (2011). Asian Development Outlook 2011 Update: Preparing for Demographic Transition. Asian Development Bank.

Asian Development Bank. (2017). Asian Development Outlook 2017 Update: Sustaining Development Through Public-Private Partnership.

Atems, B., Hotaling, C. (2018). The effect of renewable and nonrenewable electricity generation on economic growth. Energy Policy, 112, 111-118.

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.

Bélaïd, F., & Youssef, M. (2017). Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria. Energy Policy, 102, 277-287.

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.

Bhattacharya, M., Paramati, S. R., Ozturk, I., Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. Applied Energy, 162, 733-741.

Breitung, J., Das, S. (2005). Panel unit root tests under cross-sectional dependence. Statistica Neerlandica, 59(4), 414-43

Chebbi, H. E., Olarreaga, M., Zitouna, H. (2011). Trade openness and CO2 emissions in Tunisia. Middle East Development Journal, 3(01), 29-53.

Choi, I. (2001). Unit root tests for panel data. Journal of international money and Finance, 20(2), 249-272.

Dincer, I. (2000). Renewable energy and sustainable development: a crucial review. Renewable and sustainable energy reviews, 4(2), 157-175.

Ding, Y., Li, F. (2017). Examining the effects of urbanization and industrialization on carbon dioxide emission: Evidence from China's provincial regions. Energy, 125, 533-542.

Dogan, E. (2016). Analyzing the linkage between renewable and non-renewable energy consumption and economic growth by considering structural break in time-series data. Renewable Energy, 99, 1126-1136.

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.

Engle, R. F., Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: journal of the Econometric Society, 251-276.

Fan, J. S., Zhou, L. (2019). Impact of urbanization and real estate investment on carbon emissions: Evidence from China's provincial regions. Journal of Cleaner Production, 209, 309-323.

Farhani, S., Ben Rejeb, J. (2012). Energy consumption, economic growth and CO2 emissions: Evidence from panel data for MENA region. University of Sousse, Tunisia.

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.

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

Hossain, M. S. (2011). Panel estimation for CO2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. Energy Policy, 39(11), 6991-6999.

Hossain, S. (2012). An econometric analysis for CO2 emissions, energy consumption, economic growth, foreign trade and urbanization of Japan. Low Carbon Economy, 3(3).

IEA. (2017). International Energy Outlook. Available at; Energy Information Administration, EIA.

Inglesi-Lotz, R. (2016). The impact of renewable energy consumption to economic growth: A panel data application. Energy Economics, 53, 58-63.
IPPC. (2014). Climate change 2014, synthesis report. IPPC, Geneva, Switzerland.
Jebli, M. B., Youssef, S. B. (2015). The environmental Kuznets curve, economic growth, renewable and non-renewable energy, and trade in Tunisia. Renewable and Sustainable Energy Reviews, 47, 173-185.
Jebli, M. B., Youssef, S. B., Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. Ecological Indicators, 60, 824-831.
Kahia, M., Aïssa, M. S. B., & Charfeddine, L. (2016). Impact of renewable and non-renewable energy consumption on economic growth: New evidence from the MENA Net Oil Exporting Countries (NOECs). Energy, 116, 102-115.
Liu, X., Zhang, S., Bae, J. (2017). The impact of renewable energy and agriculture on carbon dioxide emissions: investigating the environmental Kuznets curve in four selected ASEAN countries. Journal of Cleaner Production, 164, 1239-1247.
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(S1), 631-652.
Menegaki, A. N. (2011). Growth and renewable energy in Europe: a random effect model with evidence for neutrality hypothesis. Energy Economics, 33(2), 257-263.
Menyah, K., Wolde-Rufael, Y. (2010). CO2 emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy, 38(6), 2911-2915.
Palit, D. (2013). Solar energy programs for rural electrification: Experiences and lessons from South Asia. Energy for Sustainable Development, 17(3), 270-279.
Pandey, S., Mishra, M. (2015). CO2 Emissions and Economic Growth of SAARC Countries: Evidence from a Panel VAR Analysis. World Journal of Applied Economics, 1(2), 23-33.
Pao, H. T., Tsai, C. M. (2010). CO2 emissions, energy consumption and economic growth in BRIC countries. Energy policy, 38(12), 7850-7860.
Pedroni, P. (1996). Fully modified OLS for heterogeneous cointegrated panels and the case of purchasing power parity. Manuscript, Department of Economics, Indiana University.
Pedroni, P. (1997). On the role of cross-sectional dependency in panel unit root and panel cointegration exchange rate studies. Indiana University manuscript.
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., Shin, Y., Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634.
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.
Rehman, A., Deyuan, Z. (2018). Investigating the Linkage between Economic Growth, Electricity Access, Energy Use, and Population Growth in Pakistan. Applied Sciences, 8(12), 2442.
SAARC CCI Policy paper. (2012). South asian association regional cooperation chamber of commerce and industry. Energy policy in south asia the way forward to promote regional trade. Islamabad; SAARC CC.
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., Hye, Q. M. A., Tiwari, A. K., Leitao, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25, 109-121.
Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., Jabran, M. A. (2016). How urbanization affects CO2 emissions in Malaysia? The application of STIRPAT model. Renewable and Sustainable Energy Reviews, 57, 83-93.
Shahbaz, M., Sbia, R., Hamdi, H., Ozturk, I. (2014). Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. Ecological Indicators, 45, 622-631.
Shahbaz, M., Zeshan, M., & Afza, T. (2012). Is energy consumption effective to spur economic growth in Pakista? New evidence from bounds test to level relationships and Granger causality tests. Economic Modelling, 29(6), 2310-2319.
Shukla, A. K., Sudhakar, K., Baredar, P. (2017). Renewable energy resources in South Asian countries: Challenges, policy and recommendations. Resource-Efficient Technologies, 3(3), 342-346.
Soytas, U., Sari, R., Ewing, B. T. (2007). Energy consumption, income, and carbon emissions in the United States. Ecological Economics, 62(3-4), 482-489.
WMO. (2017). World meteorological organization No. 13: Greenhouse gas bulletin.
World Bank (2010) http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators
World Bank (2018) http://www.worldbank.org/en/region/sar/overview
Zhang, N., Yu, K., Chen, Z. (2017). How does urbanization affect carbon dioxide emissions? A cross-country panel data analysis. Energy Policy, 107, 678-687.
Zheng, Y., (2006). The study of industrialization, urbanization, marketization and China's energy consumption. Northern Economy, 5, 11-12.
Zoundi, Z. (2017). CO2 emissions, renewable energy and the Environmental Kuznets Curve, a panel cointegration approach. Renewable and Sustainable Energy Reviews, 72, 1067-107.

Citation:
Ahmad, W., Majeed, M. T. (2019). The impact of renewable energy on carbon dioxide emissions: an empirical analysis of selected South Asian countries *Ukrainian Journal of Ecology, 9*(4), 527-534.