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TITLE: The Anthropogenic Consequences of Energy consumption in E7 Economies: Juxtaposing roles of Renewable, Nuclear, Oil and Gas Energy: Panel Quantile Evidence

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Highlights

- The E7 economics were investigated on renewables, nuclear, oil, gas energy sources and CO_2 pollution
- Unlike economic growth, renewable energy decrease CO_2 emission in E7 countries
- We observe at the 0.95 percentile GDP growth strongly contributes to environmental pollution
- Energy diversification in the E7 countries can abate global dwindling energy market

Environmental sustainability is obtained by decoupling from economic growth in the E7 states.

Manuscript

The Anthropogenic Consequences of Energy consumption in E7 Economies: Juxtaposing roles of Renewable, Nuclear, Oil and Gas Energy: Panel Quantile Evidence

Abstract

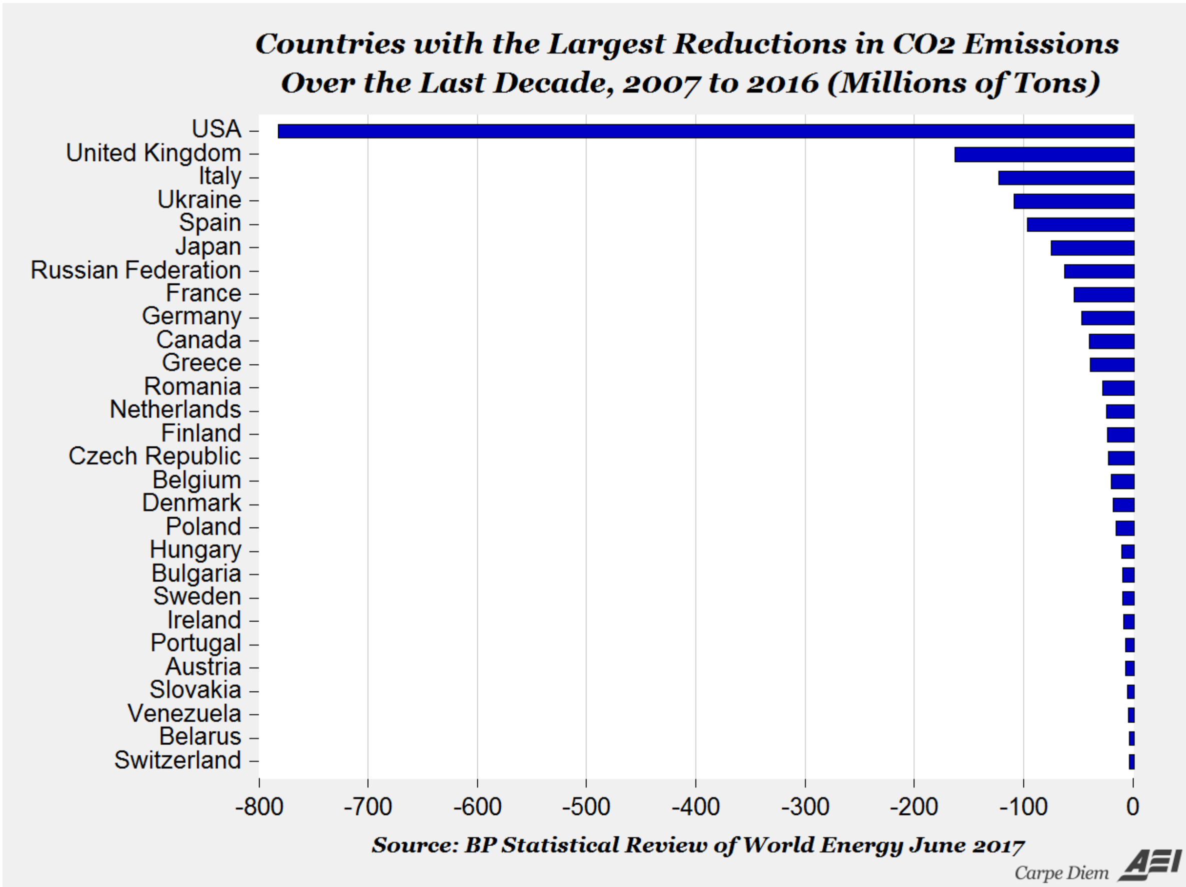
The emerging seven (E7) countries are not excluded from the Global warming issues which is a major problem for most economics. The region has partaken in the policy to mitigate against global warming in terms of decoupling pollution (CO_2) pollution from economic growth. It is from this motivation that this current study considers the connection regarding economic growth, pollutant emissions, coal rent while accounting for the role of other variables like CO_2 damage and power from oil gas energy from 1990 to 2016. This study adopts the use of Panel Ordinary least squares in conjunction with Quantile regression that shows different characterization on tails of the data is used to identify the coal-rent-energy nexus. The result shows a positive and significant effect of both real GDP and coal rent on CO_2 emissions. Nevertheless, we observe that, the 0.95 percentile GDP growth strongly contributes to environmental pollution while at the median tail i.e. 0.5 percentile renewable energy consumption dampens the adverse effect of environmental degradation. Additionally, renewable energy on the other hand was found negative and significant impact on CO_2 emissions in E7 countries. Moreover, the estimated results indicate that regulation of coal consumption through rent in addition to the cost of carbon damage will further increase the CO_2 emissions in E7 countries. The implication of this is that putting stringent regulations on coal consumption as it concerns rising cost of carbon damage will not be of help to environmental sustainability within the E7 economies. The adoption of nuclear energy sources as well as more cost of carbon damage and oil, coal and gas consumption will reduce CO_2 emissions in E7 countries significantly. This is pointing towards the resistant of nuclear energy sources to produce CO_2 while operating unlike the fossil fuel sources.

Keywords: CO_2 pollutions, Coal rents, energy utilization, Regulatory quality and E7 countries.

1. Introduction

Pollutant emissions like CO_2 affects the global atmosphere, resulting in the challenge of global warming. To any viable economy, a stable supply and demand of energy is pertinent to its sustainable economic development. The hallmark of any developing economy is the rate of its developing. Signatories to the Kyoto Protocol, including Brazil, Russia, India, India, China, Indonesia and Turkey (E-7) among others highlight climate change to be one of the significant challenges to sustainable development and economic growth. This consensus comes with the commitment to ensure the reduction of pollutant emissions like greenhouse gas emissions by 2020 (Adedoyin et al., 2019).

Since the late 1990s, many countries have worked toward reducing their greenhouse gas emissions (Ozturk & Acaravci 2009, Ozturk, 2010), because global interest in pollution and greenhouse gas emissions have risen. For instance, a review of the British Petroleum Global Energy Statistical Review (2017) showed eleven (11) states have significantly reduced pollutants pollution over the last decade (2007 to 2016). A similar report emerged from the United States, which was found to have reduced its pollutant by almost 800 million tons, a feat which is five times more than the case of the United Kingdom. According to the BP Global Energy Statistical Review the top ten states that have achieved significant reduction in CO_2 include, the US, UK, Italy, Poland, Spain, Japan, the Russian Federation, France, Germany, and Greece. It appears from the list that, the Russian Federation emerged the only E7 member state to have successfully achieved significant reduction in its pollutants over the last decade. The complete list of twenty-six states and the amount of pollutant-reduction attained over the past decade is shown in figure 1.



Sources: BP Statistical review of the world energy, June 2017.

Figure 1. Top ten countries with levels of CO_2 pollution reduction

In the fight against ecological degradation to mitigate negative effects of climate change and global warming, the 21st session in Paris Conference for the Parties (COP21) emerges as focal point to this objective (Esso & Keho 2016). From the conference, participating countries would shift to renewable energies that produce less pollutant that will not endanger the environment. Among the E7 member states, India emerges as one of the pioneers of world renewable energy producers and currently, it spends more on sustainable power than on coal and oil. After achieving a 40% level of renewable energy generation in 2016, a target it set for 2030 for its renewable energy sustainability, its current success is so fast that this aim could be met ten years early. Climate experts estimate that India's plan is consistent with the 2^0 C rise, but it could be 1.5^0 C incompatibility with its national energy plan if the country abandons plans to build new coal-fired plants. Moreover, China, another prominent member of the E7 states is also nearing the achievement of its renewable energy objectives agreed in Paris. However, these targets are exceedingly inadequate, and not realistic enough to reduce warming to below 2^0C or 1.5^oC, as stipulated in the Paris agreement, unless there is a considerably higher commitment by other countries to make substantially greater reductions. Although some current reports suggest, Chinese greenhouse gas emissions are expected to rise till at least 2030, it also expected that China can also make significant strides at peaking gains at reducing pollutants ten years earlier.[1]

Nevertheless, extant studies highlight several causal connections between G7, E7, BRIC, BRICS, OECD, and Sub-Saharan African States in addition to energy consumption and sustainable development (Solarin & Shahbaz, 2013, 2015 Bekun et al., 2019a; Bekun et al., 2019b). The energy consumption and social development nexus established in literature have proven to be bi-directional and unidirectional. By implication, it is suggested that energy consumption influences the degradation of the environment (Yoo, 2006; Apergis and Payne, 2010, and Cowan et al., 2014). A practical implication of this assertion is that increased coal power consumption may enhance the replenishment of the environment, although, this assertion raises a lack of consensus among researchers (Bekun et al., 2019b). For instance, Bekun et al., (2019a) reveals that E7[2] member states are heavily reliant on energy-intensive industries, as other nations across the globe considering fast population growth rates, technology, lifestyle changes and urbanization. These features facilitate the increased demand for energy consumption, thus, posing significant threats to anthropogenic global warming. The increased demand for power and its accompanying global environmental crises raises concerns with how nations pursue their environmentally friendly and sustainable development goals. In the light of economic, political, social diversity, and differing environment-friendly strategies, global concerns regarding the capacity of countries to keep pace with their energy demands and the rising rates of pollutants related to anthropogenic environmental warming, presents a significant problem. Issues as these require continuous focus on the causal relationships between energy consumption, productivity expansion, and pollutant rate or CO_2 emissions by policymakers.

1. [1] Climate change report card: These countries are reaching target. https://www.nationalgeographic.com/environment/2019/09/climate-change-report-card-co2-emissions/
2. E7 Countries: Group of seven global national emergency economies: Brazil, Russia , India, China, Indonesia , Mexico and Turkey, which are all mostly emerging and newly industrialized nations, but which have a big, frequently fast-growing economy and large genetic impact; all are members of the G 20.

In pursuing this goal, the need to first consider climate change reports of major countries, as to whether they are reaching the globally acceptable target. Next, the need to ensure E7 countries (a group of emerging and industrialized nations), are not adversely affecting the global environment with their increased industrial operations. This is because, in observing how energy generated is consumed, consequential to environmental and social challenges such as pollution, and greenhouse gas emission, indicates pollutant emissions mainly emanates from energy generation and utilization (IPCC, 2013). An energy source such as coal, is mainly from fossil fuels, which is highlighted to influence pollutants, green and sustainable growth (Adedoyin et al., 2020**)**. Ben-Amar (2013) commits that energy is an essential factor for socioeconomically progress and other vital mankind action, however, the increased utilization of energy has increased ecological degradation consequences. While the require for socioeconomically revolution rests a crucial tool of government policy within a lot of nations, international pressures created by the threat of global warming and climate change continue to mount on countries. Thus far, the link between economic growth and energy consumption and pollution, particularly coal consumption, must be examined further (Rodionova et al. 2017).

Relative to the current study, coal consumption exists as an essential determinant of economic performance (Rodionova et al. 2017). Along with the nations which rely on coal, E7 member states have shown ample coal supplies and will possibly fulfill their existing and potential energy requirements in terms of socioeconomic progress and ecological change (Figures 2 to 5 illustrate). The E7 countries' ongoing dependency on coal as crucial to their economic growth and future renewable development electricity illustrated by nuclear power (Fig. 2), oil, gas, and coal (Fig. 3), coal rents (Fig. 4), and CO_2 pollutions per capita (Fig. 5).

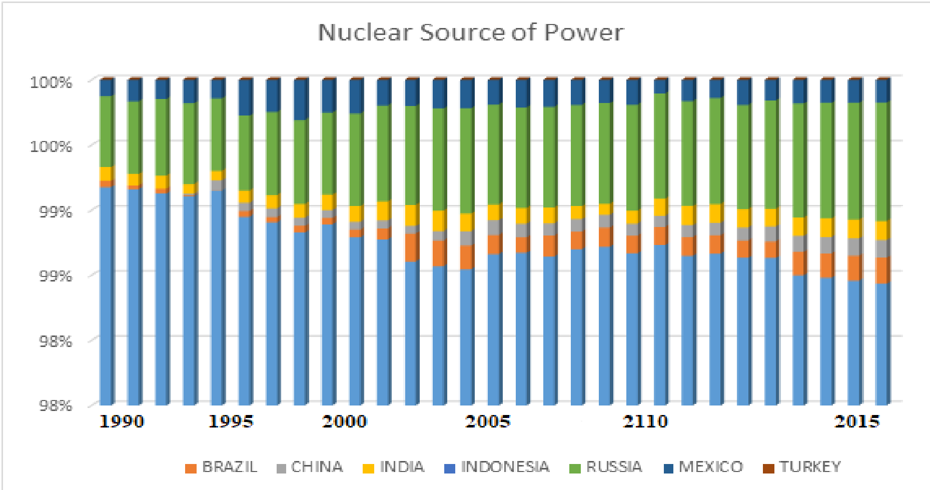


Figure 2. Nuclear power generation (in millions tones) in E7 countries

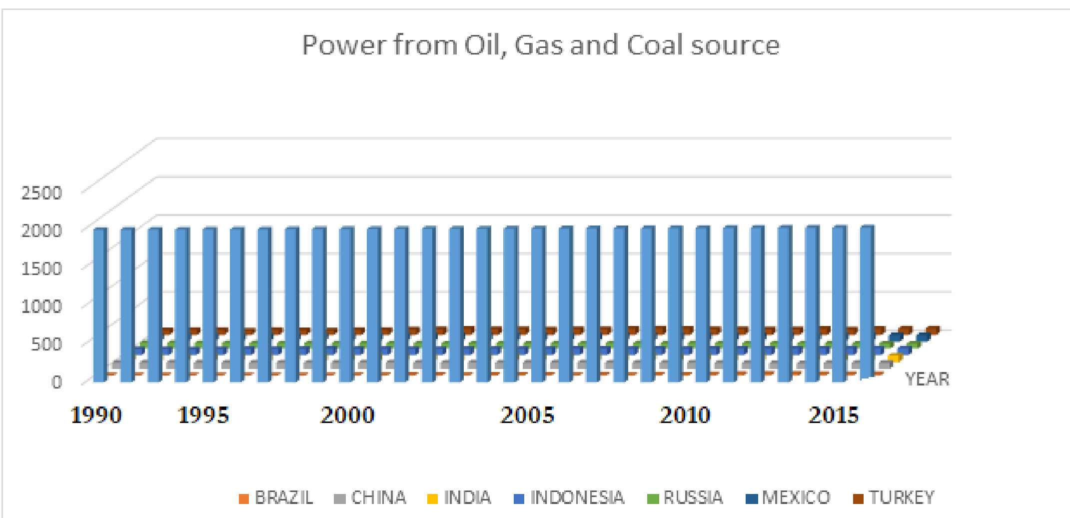


Figure 3. Power from Oil, Gas and Coal (in million tons) in E7 countries

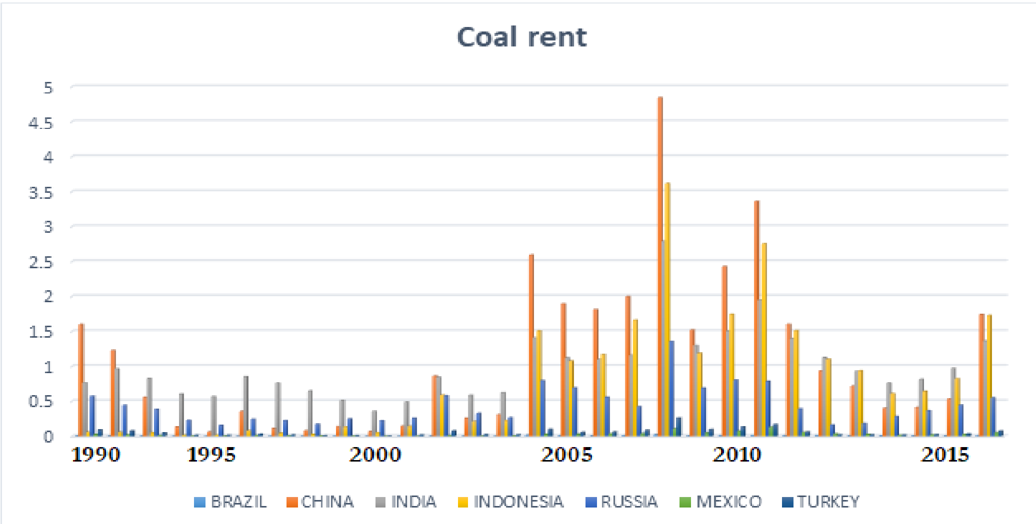


Figure 4. Coal rent (in million tons) in E7 countries

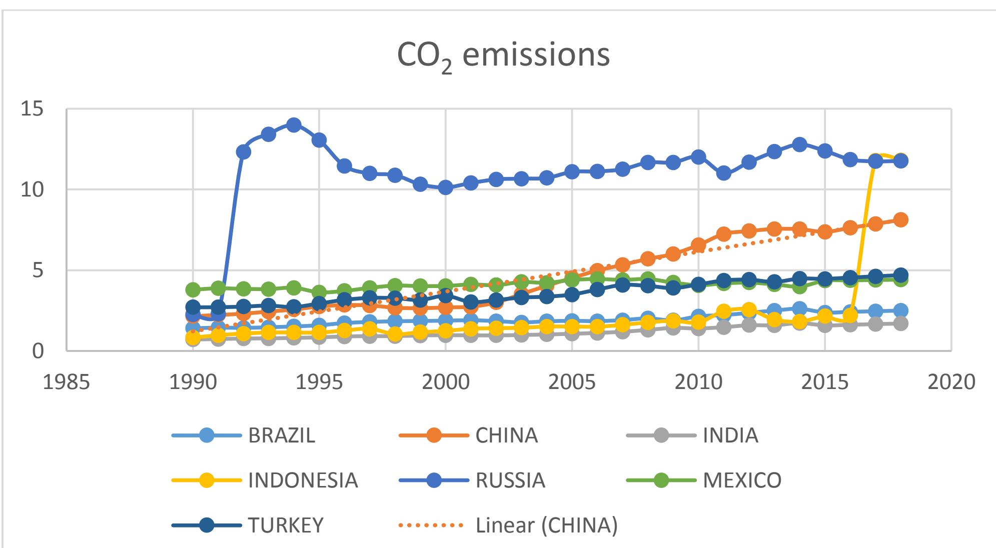


Figure 5. CO_2 emissions per capital (in million tons) in E7 countries

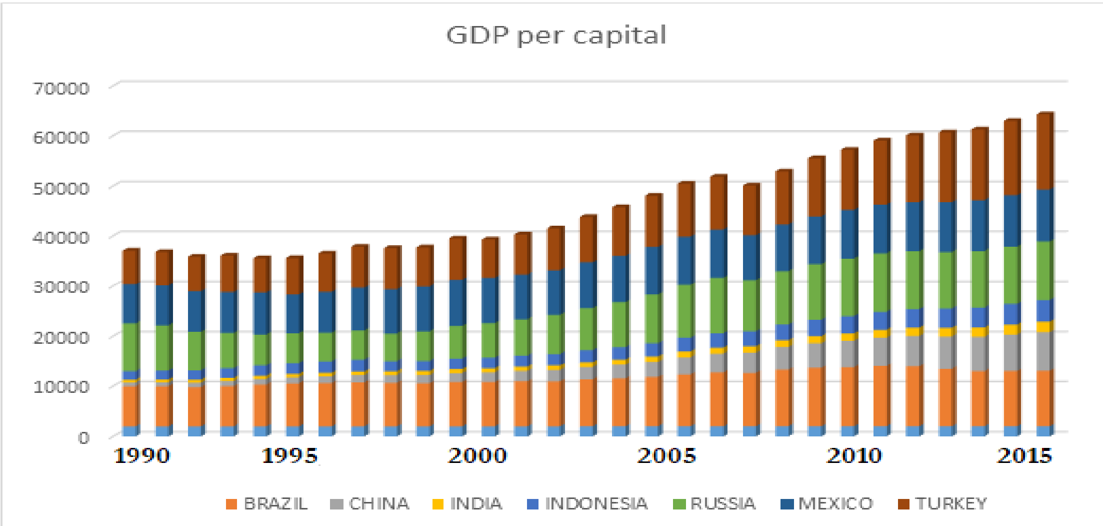


Figure 6. GDP per capita (in millions) in E7 countries

The heavy dependency of most E7 nations and several other developing economies on coal usage and the subsequent strong pollutant emissions requires an awareness of actual impact of rents in coal and environmental growth (Rodionova et al. 2017). Coal rent from coal power offers benefits to coal-exploration firms to use coal to produce power (Arnason, 2008; Mehrara & Baghbanpour, 2015) an indication that coal production is mainly used for power generation. It is estimated that coal rent in E7 markets account for a significant (Brazil 0.01%, China 0.41%, India 0.76%, Indonesia, 0.64%, Russia 0.37%, Mexico 0.02% and Turkey 0.02%)[3] proportion of their GDP. This evidence presupposes that, coal rents play a crucial role in economic development, as with all other natural resources, including oil rents. It is crucial to demonstrate the impact that these natural resources have on environmental sustainability. Owing to the relevance of coal, many prior studies appear to focus on the extent to which electricity or fuel use, economic growth, and pollutant pollutions (CO2) are mixed (Menyah and Wolde-Rufael, 2010, Lin and Wesseh, 2014).

For emerging markets, coal is still an important source of power. The negative impact associated with coal use has raised criticisms from local and international agencies. This makes the need to reduce carbon footprints every nation's obligation. However, many developing economies as well as some developed ones are at crossroads with their energy, climate, and social strategies (ref).

The quest to attain economic parity, and social justice have relegated sustainable development and environmental degradation objectives to the background. If causality between socio-economic development, energy use, and pollutants (CO_2) exists, then current research must focus on methods in which nations will move to clean productions and ecological progress. With the above consideration, this study contributes to this gap to offer an understanding into the influence of coal rents (the disparity between the demands at international prices for robust as well as soft coal output and the overall cost of output) on CO_2 emission in the E7.

The preference of the E7 states is important to this examination since more than 70% of the power supply in most of the E7 nations are generated from coal usage (Adedoyin et al., 2020). Several studies exist on exploring the causal relation involving socioeconomic progress and energy utilization, in addition to extra factors, there are no analysis considering coal rent, nuclear power generation, and pollutants (CO_2), especially in the E7 context.

Although several studies exist on supporting the economic expansion and energy emissions nexus, these studies have neglected the consideration of coal as an energy source, as such literature on coal rents, energy consumption and economic expansion among E7 states is quite deficient (Zakarya et al. 2015). This study is different from previous studies like (Cowan et al. 2014; Zakarya et al. 2015) that examined emission determinants and other energy structures, including electricity. The current study leans toward the discussion on coal rents as well as nuclear energy and its connection to emissions from pollutants (CO_2) in the energy-emissions-growth debate. The study also analyzes how carbon dioxide damage consistency in the E7 states influences this connection, utilizing data from 1990 to 2016 and concentrating on relevant panel research. Moreover, the second-generation estimation was employed to identify how the selected variables affect environmental degradation within the E7 economics. In summary, the report analyzes the connection between coal rents, clean energy association with pollution, and the interaction of energy consumption from oil, gas, coal, and carbon dioxide damage with this connection.

The remainder of this study is structured as follows: a literature summary is provided in the second part of the study. Econometric methods and information are presented in the third section. The fourth section focuses of analytical observations, while the last section contains conclusion and policy implications for implementation.

2. Literature Review

Literature on the correlation between coal output and sustainable development has produced a litany of mixed results[3]. For example, Yang (2000) and Taiwan and Yoo (2006) all found negative causal association between coal utilization and sustainable development, while Wolde-Rufael (2004) contrary to the inverse association earlier reported, showed that coal utilization increases sustainable development. Similar differing findings are reported for coal utilization and economic development between OECD and non-OECD states (Jinke et al. 2008)[3].

Mainly, analysis on this issue establish one-way causality from the social development and coal usage nexus in China and Japan, whereas no causality is identified in the cases of India, South Africa, and South Korea and the intersection of coal use economic development for 2 OECD countries is analyzed by Apergis & Payne (2010), in the form of a multivariate stand. Actual financial development, usage of coal, actual creation of gross fixed capital and labor

Nevertheless, the connection between coal output and sustainable development establishes a positive association between the two in the long-term. For instance, Wolde-Rufael (2010) reviewed the emissions and sustainable development correlation among the top six coal using nations. India and japan showed an, unidirectional causality formed from coal usage to productivity expansion, while China and South Korea attained increased productivity gains from coal usage. However, between coal usage and social expansion in the case of South Africa and the United States, a bi-directional causality was found.

Further, Bhattacharya et al. (2013) emphasizes that, in the case of China, improving productivity of the coal sector would lead to sustainable growth, while Shahbaz et al. (2015) consider that the manufacture and use of industrial coal by Granger induces more CO_2 pollution for India in a comparative analysis between China and India.

On the other hand, in South Africa, Odhiambo (2016) establish a causal one-way connection between coal usage to job creation, and a causal bidirectional connection between jobs and socioeconomic development. Likewise, there was a bi-directional association between coal production and economic growth.

3. Soytas and Sari (2006) and others discuss in context of total energy, we restrict here to coal related studies. See, Ozturk and Acaravci (2013) for an excellent review

In addition, there is a unidirectional association between China's GDP and its coal usage. A related uni-directional causality link exists between coal usages to economic growth for India (Li & Li, 2011), Apergis & Payne (2010) disclosed that the causality involving economic progress and coal intake being negative in the short and bidirectional. Studying the very identical base, Wassung (2010) on Water-Energy Connection in South Africa clarified that electricity production involves large volumes of clean aquatic for freezing, and that the problem is expected to be further exacerbated as more solar energy plants will be constructed to solve South Africa's growing demand for energy.

Over the recent century, academics in the areas such as economics and climate had been charged with the issues to boost output in markets and progress on social deterioration, as a result of pollutants (CO_2) from industrial development, which are deemed the key cause of climate change. This illusion has been the subject of several studies primarily designed to examine the link involving socioeconomic progress and carbon pollutions and to examine the Kuznets Curve (EKC) environmental theory and to implement interventions for environmentally friendly management and effective development. For example, Odhiambo (2012) explained in South Africa that the causal relation flows uni-directionally from development to pollutant emissions, whereas Granger's energy usage causes both pollutant emission and productivity expansion. Results from Dinda (2009) vary from other reports for the OECD and non-OECD nations. Though CO_2 pollutions may not stimulate economic growth development has been shown to improve economic development in non-OECD countries in OECD countries. Accordingly, Richmond & Kaufmann (2006) identified no clear causal connections regarding economic development and pollutant pollution, validating the hypotheses' neutrality.

Moreover, many moderating variables like trade, urbanization as well as globalization were identified to factor with respect to the factors of pollutants (CO_2). For example, there is a significant association regarding real GDP, trade accessibility and power usage, whereas urban settlement has a negative correlation to low-income, middle-income as well as high-income panels by Sharma (2011). Nevertheless, oil use in addition to real GDP are statistically major factors of pollutants, while electricity use has adverse impact on pollutant emissions.

Again, studies to analyze causality among socioeconomic progress and pollutant pollutions in the E7 nation's ecological and financial parts of energy usage was also carried out. BRIC panel nations are correlated with causal correlations in the increase in total power use including energy use, pollutant emissions, and real GDP, increasing pollutant levels from Fossil Oils Pao & Tsai (2010). The causality among power intake and pollutant emissions according to Wang et al. (2011) implies economic growth which the biggest sources of CO_2 pollutions in China are also power intake. Bloch et al. (2012) acknowledged the cause-related link among CO_2 and demand-side coal consumption (D) and supply-side GDP consumption (S). According to these studies, coal intake and factory output in India were Granger's cause of CO_2 emissions, whereas for China the same was the case for feedback among CO_2 pollutions as well as coal use Farhani et al. (2014). And pollutant emissions are driven by the utilization of coal. The determinants of CO_2 pollutions from energy use in Brazil have been analysis by De Freitas & Kaneko (2011) to show that economic and demographic development are the key factors explaining Brazil's pollutant pollutions increase.

The study on causality in some nations in the E7 indicates causal relations among all factors but varies in directions within the nations (Cowan et al., 2014). The presence of co-integration in China was established but was not established in India as presented in the analysis of Govindaraju and Tang (2013), while the same two countries had a causal unidirectional association involving economic development to CO_2 pollutions. Pao et al. (2011) revealed a positive correlation regarding pollutant pollutions, energy intake and real GDP, in assessment of Russia. In short, considering the different causes, we find that there is a need for further investigation on varying energy outlets, their growth and their impact on pollutants less particularly in the E7 blocks.

3. Data and Methodology

3.1 Data and Variables

Past studies have examined the energy consumption and environmental consequence nexus with different macroeconomic and energy variables (see, Adedoyin, Abubakar, Bekun, & Asumadu, 2020; Adedoyin, Alola, & Bekun, 2020; Adedoyin, Bekun, & Alola, 2020; Adedoyin, Gumede, Bekun, Etokakpan, & Balsalobre-lorente, 2020; Adedoyin & Zakari, 2020; Adedoyin, Ozturk, Abubakar, Kumeka, & Folarin, 2020; Etokakpan, Adedoyin, Vedat, & Bekun, 2020; Kirikkaleli, Adedoyin, & Bekun, 2020; Udi, Bekun, & Adedoyin, 2020, Gyamfi et al., 2020a, Gyamfi et al., 2020b). This current study explores the channels through which energy from carbon dioxide damage influence the relationship between coal rent, renewable energy, nuclear energy utilization and CO_2 emissions in E7 states. This study considers a data series spanning from 1990 to 2016, with second-generation estimation methods and the Dumitrescu and Hurlin panel causality test. Appendix Table 1 offers detailed information on of the variables employed in this study. The outcomes of these studies focus on providing technologies for clean and green environment. In this current study, we allow for interactions of different environmental regulatory policies in order to identify how they can be effectively deployed to reduce carbon emissions in E7 countries.

In the bid to attain the goal of this investigation, this section presents the models that show how each of the regulatory variables employed in the study affects the dependent variable (CO_2 emissions). All the variables are specified in their logarithmic forms (ln) in order to get outcomes that are more robust.

3.2 Model and Method

In line with Grossman and Krueger (1991) and Adedoyin et al., (2020) studies, the study employs the following models to estimate the objectives of this study. All variables were log-transformed with the aim of normalizing the data to obtain more intuitive results.

$$CO_{2it} = f\,(CR_{it}, GDP_{it}, REC_{it}, CD_{it}, OGC_{it}, NPG_{it}) \quad (1)$$

$$\log (CO_2)_{it} = \beta_0 + \beta_1 \ln(GDP)_{it} + \beta_2 \ln(REC)_{it}, + \beta_3 \ln(NPG)_{it} + \beta_4 \ln(CR)_{it}\ \beta_5 \ln(CD)_{it}, + \beta_6 \ln(OGC)_{it}, + \mu_{it} \quad (2)$$

$$\log (CO_2)_{it} = \beta_0 + \beta_1 \ln(GDP)_{it} + \beta_2 \ln(REC)_{it}, + \beta_3 \ln(NPG)_{it} + \beta_4 \ln(CR)_{it}\ \beta_5 \ln(CD)_{it}, + \beta_5 \ln(OGC)_{it}, + \beta_6 \ln(CR{*}CD)_{it} + \beta_7 \ln(NPG{*}CD)_{it} + \mu_{it} \quad (3)$$

In the specified models, CO_2 represents carbon emissions, and CR being coal rent as a percentage of GDP. Economic growth is identified by GDP, renewable energy consumption being REC; carbon dioxide damage being CD, electricity power from oil, gas and coal sources is represented by OGC and power from nuclear sources is denoted as NPG. The period under consideration is denoted with *t,* and *i* represents the E-7 countries under consideration. β_i where $i = 1,\ldots,6$ depicts the slope parameters. It is expected that, "*ceteris paribus*" $\beta_1 > 0$; $\beta_2 <$ or >0; $\beta_3 < 0$; $\beta_4 < 0$, and $\beta_5 < 0$. Although the analysis evaluates the individual effects in the model, the study rather emphasizes the interaction effects.

3.3 Methodology

To identify the right analytical technique(s) to employ, the authors used the cross-section dependency (CD) test. The outcome from the CD test helps in either going for the first-generation or second-generation panel data econometric technique. The analysis will be bias, meaningless and inconsistence if CD test is not carried out (Dong et al. 2018; Nathaniel et al., 2020). To make sure the mention problems does not occur, the authors employed three CD test which are the Pesaran (2007) CD test and the Pesaran (2015) scaled LM test for the sake of robustness check. More attention was place on the Pesaran (2015) scaled LM test because of how our dataset is shows ie, the time frame (T) figure is larger than that of the cross-sections (N) number. The CD test equation is shown in Eq. 1 as:

$$CD=\left(\frac{TN(N-1)}{2}^{\frac{1}{2}-P}\right) \qquad (3)$$

Whereas from equation (3), $P=\left(\frac{2}{N(N-1)}\right) \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} Pij$, Pij is the Pairwise cross-sectional correlation coefficient of the residual from the ADF regression. T and N are the sample and panel scope separately.

Panel stationarity technique

The proof of CD make in the estimation brings out inefficiency in the first-generation stationarity technique (e.g., Im et al., 2003). Therefore, the authors employed a second-generation stationarity technique (CIPS) to solve the problem of inefficiency in the estimation. From the Pesaran (2007) the CIPS unit root test estimation is shown as;

$$\Delta Y_{it} = \Delta\varphi_{it}+\beta_i X_{it-1}+\varrho_i T+ \sum_{j=1}^{n} \theta\ ij\Delta X_{i,t\text{-}}j + \varepsilon_{it} \qquad (4)$$

Where φit, xit, Δ, T, and εit represent the intercept, study variables, difference operator, time span, and disturbance term respectively. A second-generation cointegration test is performed in the proximity of first differences stationary variables, to assess the long run effects of the factors under consideration.

Panel cointegration test

The findings related to the Westerlund (2007) experiment to obtain proof of co-integration between the parameters. The error correction form (ECM) of the estimation is shown as:

$$\Delta y_{it} = \delta_i d_t + \varphi_i y_{it-1} + \lambda_i x_{it-1} + \sum_{j=1}^{pi} \phi_{ij}\Delta y_{it-j} + \sum_{j=0}^{pi} \gamma_{\ ij}\Delta x_{it-j} + e_{it} \qquad (5)$$

Where δt = (δi1, δi2)', dt = (1, t)', and ϕ are the vector of parameters, deterministic components, and the error correction parameter respectively. To identify cointegration existence, four tests was carried out. These technique (4) were centered on the OLS technique of ϕi in Eq. 3. Group mean statistics was made up of two out of the four estimations and shown as;

$$\mathbf{G\tau} = \frac{1}{N}\sum_{i=1}^{N} \quad = \frac{\hat{}\propto i}{SE(\hat{}\propto i)} \quad \text{and } G\alpha = \frac{1}{N}\sum_{i=1}^{N} \quad \frac{T\hat{}\propto i}{\hat{}\propto i(1)}$$

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

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

Ordinary Least Square (OLS) and Quantile Regression (QR)

The analysis uses the technique for OLS and QR. The existence of cointegration assesses a long-term connection utilizing the OLS econometrically rational. They use the OLS with standard errors made by Driscoll and Kraay (1998). This method allows (1) heteroscedasticity, (2) serial interaction and (3) cross-sectional dependency to be considered. Nevertheless, the QR was the chosen statistical tool based on its superior to the OLS for different reasons**.** The standard circulation as well as the zero mean approval of the OLS error concept is rather unrealistic, since there may be multiple distribution models for socioeconomic measures (De Silva et al. 2016). The QR reinforces this deficit (Salman et al. 2019; Nathaniel et al., 2020). The methodology (QR) does not presume the function of the period (Zhu et al. 2016a, 2016b). In the case of outliers (Bera et al. 2016), forecasts remain robust. No predictions for distribution (Sherwood and Wang, 2016) have been made. The model for QR is shown as;

$$Quant_{\theta}\ (yi/xi) = x\beta_{\theta} + \mu_{\theta},\ 0b\theta 1 \qquad (6)$$

Where x is the exogenous factors, while y is the endogenous factors. The equilibrium place and disruption word of the explicit vector are θth and μ simultaneously. We use the contingent quantile regression that explores the effect of the regressors to be used in our econometric analysis on the foundation of the preliminary factors values. In the past, the QR-technology was utilized in Hübler (2017), Xu & Lin (2018), and Nathaniel et al. (2020) and other studies.

MODEL

The STIRPAT structure is the foundation of this analysis. The STIRPAT hypothesis notes that the destruction of the ecosystem is both economic and social.

$$I_t = \vartheta_o P_t^{\xi 1} A_t^{\xi 2} T_t^{\xi 3} \mu_t \quad (7)$$

From Eq. 7, I is a pointer of ecological deprivation, P, A, and T represents population, affluence, and technology respectively. φ1 - φ3 and μ are the factor evaluators and the error term respectively. T may be broken down based on the purpose of the study (Bello et al. 2018; Anser 2019; Nathaniel et al. 2020). Base on the analysis of Solarin and Al-Mulali studies (2018) and Nathaniel et al. (2020), I, in this analysis, identify the environmental factors in this analysis as stated earlier. From a different perspective, P and A are denoted by economic sustainability and economically globalization respectively. The authors then adopted Foreign Direct Investment (FDI) and renewable energy utilization as a proxy T. The extended layout is shown as:

$$I_t = \vartheta_o GDP_t^{\xi 1} REC_t^{\xi 2} NPG_t^{\xi 3} CR_t^{\xi 4} CD_t^{\xi 5} OGC_t^{\xi 6} \mu_t \quad (8)$$

By taking the logarithm of each of the variables, the formula is further formulated as;

$$\ln I_t = \vartheta o + \xi_1 LnGDP_t + \xi_2 LnREC_t + \xi_3 LnNPG_t + \xi_4 LnCR_t + \xi_5 LnCD_{t+} \xi_6 LnOGC_{t+} \mu_t \quad (9)$$

Where GDP, REC, NPG, CR, CD and OGC denote economic growth, renewable energy intake, power from nuclear sources, coal rent, carbon dioxide damage and oil, gas and coal sources. I, on the other hand represent the environmental indicator used in this analysis, thus, CO_2. To analysis the impact of GDP, REC, NPG, CR, CD, OGC and their regulatory policies on I at the selected quantile level, the authors formulated Eq (10) which is shown as;

$$Q\tau\ (\mathbf{LnCO_2}) = \vartheta\tau + \xi_{1\tau} LnGDP_{it} + \xi_{2\tau} LnREC_{it} + \xi_{3\tau} LnNPG_{it} + \xi_{4\tau} LnCR_{it+} \xi_{5\tau} LnCD_{it+} \xi_{6\tau} LnOGC_{it+} \xi_{7\tau} Ln\ (CR*CD)_{it+} \xi_{9\tau} Ln\ (NPG*CD)_{it} \quad (10)$$

Whereas the remaining variables maintain their original description, CO_2 represent CO_2 emission. For the explicative variables, the reference point is **τ**. Q**τ** corresponds to the **τ**th distributional point regression analysis that can be determined using the formulae in Eq. (11)

$$Q\tau = \arg\min \sum_{k=1}^{q} \sum_{t=1}^{T} \sum_{i=1}^{N} (|y_{it} - \alpha_i - x_{it} Q_\tau| Ħ_{it}) \quad (11)$$

Where q, T, N and $Ħ_{it}$ shows the number of quantiles, years, cross-sections, and weight of the *i*th nations in the *i*th year respectively.

4. Results and Discussions

4.1 Pre-estimation Diagnostics

The study provided the summary of statistics of the variables of interest, which include the mean, median, standard deviation, minimum, maximum, skewness, Kurtosis, Jarque-Bera, probability values, sum of deviation cum squared deviation and the total number of the observations. The outcome of the summary statistics reveals that all the variables of interest are negatively skewed except CO_2 emissions and the Jaque-Bera test confirms the normal distribution of the data series. Based on the average, real GDP has the highest average value of 8.45 with a maximum and minimum of 9.62 and 6.36 respectively.

The correlation matrix is reported in Table 2 to show the level of multicollinearity among the variables of interest. It is discovered that CO_2 emissions has a strong and positive association with all the variables except with renewable energy consumption.

Table 1. Summary statistics

VARIABLES	LNCO$_2$	LNCR	LNGDP	LNREC
Mean	1.105777	-2.334471	8.450213	2.967051
Median	1.032805	-1.966998	8.901547	3.188131
Maximum	2.637626	1.576340	9.620394	4.071636
Minimum	-0.343899	-11.77640	6.355242	1.171799
Std. Dev.	0.774087	2.452974	0.908782	0.914188
Skewness	0.279070	-0.918048	-0.795720	-0.643109
Kurtosis	2.253909	4.026182	2.295779	2.165751
Jarque-Bera	7.343290	37.42217	25.61699	19.87985

Probability	0.025435	0.000000	0.000003	0.000048
Sum	224.4726	-473.8976	1715.393	602.3114
Sum Sq. Dev.	121.0404	1215.451	166.8285	168.8195
Observations	189	189	189	189

Table 2. Correlation Matrix

	$LnCO_2$	**LnCR**	**LnGDP**	**LnREC**
$LnCO_2$	1.000			
P-value	-			
LnCR	0.102	1.000		
P-value	(0.15)	-		
LnGDP	0.638a	-0.510a	1.000	
P-value	(0.00)	(0.00)	-	
LnREC	-0.952a	-0.141b	-0.566a	1.000
P-value	(0.00)	(0.04)	(0.00)	-

NOTE: a, b, c represents 1%, 5% and 10% significant levels

4.2 Estimated Results

The results of the cross-sectional dependence are reported in Table 3, which depicts signal for the rejection of the null hypothesis of independent cross-section of the variables under investigation. In short, the analyzed variables of interest are dependently cross sectional

In lieu of the results of the cross- sectional dependency test, we adopt Pesaran's IPS and CIPS panel unit root tests and of which the results are depicted in Table 4. The results of the panel unit root tests are presented at level and first difference while considering the intercept and intercept cum trend. At level, only three variables (coal rent, carbon damage and oil, gas and coal power sources) are stationery as demonstrated in the CIPS unit root test while other variables are found to be stationery at first difference. Thus, the mixed order arrangement of the variables between level and first difference requires more advanced estimation techniques that will be applied in the study The Westerlund, (2007) Cointegration Test is thereby presented in Table 5 to confirm the existence of cointegration among the variables of interest. The cointegration test presents both the group statistics and panel statistics and the outcomes of both provide evidence for the existence of cointegration among the variables in the model. The results obtained from the cointegration test lead us to the application of the appropriate estimation techniques, that is, Ordinary least square (OLS) and Quantile regression (QR).

The outcomes of the OLS and Quantile regressions for the long run relationships between carbon emission and the independent variables are presented in Table 6 of which the study will focus more on the outcomes of the quantile regression. The OLS estimation shows that real GDP has significantly influences carbon emission positively. Precisely a percent increase in real GDP will cause an estimated 40% increase in carbon emission. Contrarily, increased renewable energy consumption negatively influences carbon emission in E7 economies such that, a 1% increase in renewable energy consumption attracts about 59% reduction in carbon emissions. Additionally, nuclear power sources also showed a significant influence with the coefficient of 0.138. Precisely, a 1% increase in power generated from nuclear sources will increase carbon emission by about 14%. More so, coal rent exerts a positive and significant effect on carbon emissions. In that, a unit increase in coal rent will increase carbon emission by about 9%. The cost of carbon damage also exerts a significant effect, indicating a percentage increase in cost of carbon damage will increase carbon emission by about 51%. Oil, gas and coal power generation sources are showed a negative and statistically significant effect. Such that 1% increase in the cost of carbon damage will decrease the carbon emission by about 11%. Furthermore, the OLS estimates shows that, the combined effect of coal rent and cost of carbon damage is positive and statistically significant. Contrarily, the combined effects of power from nuclear sources and cost of carbon damage all exert negative effects on carbon emission and statistically significant at 1%.

The quantile regression estimations results (presented in Table 6) showed that, real GDP positively affects carbon emission across all the quantiles. This implies that increased economic growth experienced in E7 economies is a culprit of economic degradation in the region and the implication of this can be found with the uncontrolled growth rate of the industries that contribute more to the deterioration of the environment as the expand. These results align with the findings of Ozcan et al

(2019) on 35 OECD countries and Sharif et al (2019) on 74 nations selected globally. In addition, the outcomes discovered for the clean energy intakes are negative and statistically substantial across the observed quantiles. This means that increase in the consumption of renewable energy will reduce the environmental degradation experienced in E7 economics. This is another policy direction for policymakers to adopt cleaner energy sources in place of the traditional non-renewable energy sources in a way to promote environmental quality and sustainable development in the region. These results concur with the findings of Danish et al (2019) and Hanif et al (2019) for BRICS and Asian economies respectively. Additionally, nuclear power sources are observed to be positive in 5th and 25th quantiles but only significant in the 25th quantile while other quantiles show a negative and insignificant impact of nuclear power sources on the environmental deterioration in E7 economies. This implies that adoption of low nuclear power sources as observed for the 5th quantile tends contribute immensely to environmental degradation in E7 economies. This evidence is supported in the study of Sarkodie & Adams (2018) on the economy of South Africa.

Furthermore, the outcomes for coal rent are found to be positive across all the observed quantiles but only statistically significant in the three median quantiles, that is, 25th, 50th and 75th quantiles. This indicates that, the introduction of moderate rent on coal consumption in E7 economies observed in the median quantiles increases environmental degradation among the E7 states. This finding is in contrast with findings from Adedoyin et al. (2020) who found no causal relation between coal rent and carbon emission in BRICS. More so, the results for cost carbon damage show a positive effect across all the observed quantiles. This intuitively provides evidence parallel to the claim that, increasing cost of carbon emitted in E7 economies further deteriorates environmental quality if adequate policy measures are not put in place. Power generation from oil, gas and coal sources showed a negative influence across all the observed quantiles, except the 5th quantile where the estimated effect was insignificant. This implies that more power generated from oil, gas and coal sources reduces the level of carbon emission. However, Pata (2018) found contradictory findings with evidence from Turkish.

In the bid for more clarification, the analysis further sought to investigate the effect of some expected regulatory measures on carbon emissions in E7 economies. The outcome of the regulatory measures including coal rent and cost of damage showed positive effects across the observed quantiles. This implies that increasing rent on coal consumption alongside increasing cost of carbon damage, increases environmental deterioration. Additionally, generation of power from nuclear sources alongside increasing cost of carbon damage has negative effects on carbon emission across all the observed quantiles except at 5th quantile. This implies that the regulatory measure that involves nuclear power sources and cost of carbon damage reduces environmental degradation in E7 economies.

Table 3. Cross-sectional dependency test results

	Pesaran(2007) CD Test	Pesaran(2015) LM Test
$LnCO_2$=f(LnGDP, LnREC, LnNPG, LnCR, LnCD, LnOGC)	**4.483a**	**-2.444b**

NOTE: a, b, c represents 1%, 5% and 10% significant levels

Table 4. Panel IPS and CIPS unit root test

Variables	IPS				CIPS			
	Intercept		Intercept & trend		Intercept		Intercept & trend	
	Levels	1st Diff	Levels	1st Diff	Levels	1st Diff	Levels	1st Diff
$LnCO_2$	-1.008	-4.707a	-2.210	-4.638a	-2.826	-4.468a	-2.237	-4.456a
LnGDP	-0.160	-3.765a	-2.032	-3.877a	-1.753	-3.041a	-1.345	-3.323a
LnREC	-0.592	-5.034a	-2.632	-4.958a	-2.657b	-4.672a	-2.657	-4.794a
LnNPG	-1.950	-2.070c	-2.570	-2.930b	-1.889	-3.327a	-2.607	-3.668a
LnCR	-2.027	-5.776a	-2.493	-5.668a	-2.623a	-5.011a	-2.872c	-5.591a
LnCD	-1.868	-4.509a	-2.220	-4.435a	-2.087	-4.925a	-2.808c	-4.981a
LnOGC	-2.164	-6.285a	-3.0348	-6.217a	-2.968a	-5.643a	-3.124a	-5.735a

NOTE: a, b, c represents 1%, 5% and 10% significant levels

Table 5. Westerlund (2007) Cointegration Test

Model/dependent	Group statistics		Panel statistics	
	Gτ	**Gα**	**Pτ**	**Pα**
$LnCO_2$=f (LnGDP, LnREC, LnNPG, LnCR, LnCD, LnOGC)	-1.841b	-3.529c	-6.959a	-6.159c

NOTE: a, b, c represents 1%, 5% and 10% significant levels

.

Table 6. OLS and Quantile Regression Result for long run relationship

	OLS	Q.05	Q.25	Q.50	Q.75	Q.95
Dependent variable: $LnCO_2$						
LnGDP	0.400a	0.321a	0.376a	0.468a	0.499a	0.547a
LnREC	-0.588a	-0.593a	-0.636a	-0.564a	-0.575a	-0.479a
LnNPG	0.138b	0.314a	0.079	-0.096	-0.055	-0.042
LnCR	0.088a	0.315	0.086b	0.068c	0.101a	0.054
LnCD	0.508a	0.341a	0.522a	0.642a	0.693a	0.711a
LnOGC	-0.107b	-0.019	-0.130b	-0.140b	-0.250a	-0.128b
LnCR*LnCD	0.072a	0.078a	0.085a	0.061a	0.033b	0.029c
LnNPG*LnCD	-0.096a	-0.022	-0.082a	-0.128a	-0.128a	-0.108a
Constant	-0.290	-0.124	0.060	-0.858	-0.535	-1.658b
F-Statistic	651.72a					
Wald test	5171.33a					
R2/Pseudo R2	0.9704	0.8369	0.8445	0.8517	0.8561	0.8502
Adj R-square	0.9689					
Observation	189	189	189	189	189	189

NOTE: a, b, c represents 1%, 5% and 10% significant levels

4.3 Dumitrescu and Hurlin Causality test

The panel causality test (Dumitrescu and Hurlin causality test) is necessitated by the need to assess the Granger non-causality moving from the explanatory variables to the explained variable as conceptualized in the study of Dumitrescu & Hurlin, (2012) in a non-heterogeneous panel dataset. A uni-directional association running from coal rent to CO_2 emission is observed in the study. This implies that regulations on coal consumption may further affect the activities of industries, which emit high amounts of carbon dioxide into the atmosphere. In other terms, regulations of demand and supply of coal resources will lead to more environmental deterioration in E7 countries and a way to get rid of this as suggested in the literature is to adopt clean energy sources as alternative for the coal energy consumption in order to keep the global economy safe from environment degradation and climate change. A unidirectional relationship exists involving CO_2 pollutions and economic progress in the study. The implication of this is that, activities that are more productive favor the economy but the channels of the growth fuel environmental degradation in E7 countries. A similar result is reported for CO_2, nuclear energy and renewable energy sources moving from the former to each of the separately. This is in line with the recent climate policy that focuses on the adoption of alternative energy sources that will reduce the CO_2 emission in the global world. In another words, this means that environmental degradation in E7 economies will prompt the government to adopt nuclear energy and renewable energy sources as viable alternatives for fossil fuels in order the quench the CO_2 emissions in E7 countries.

Additionally, a one-way directional relationship is also observed between cost of coal damage to coal rent; coal rent to real GDP; oil, gas and coal sources coal rent; cost of carbon damage to real GDP; nuclear energy sources to real GDP and from renewable energy consumption to nuclear energy sources. The Quantile Regression analysis shows that coal rent has a positive effect on CO_2 emissions, while cost of carbon damage triggers CO_2 emission. Thus, use of coal rent as regulatory measure will increase the cost of producing coal and then accelerate the cost attached to polluting the environment. From another angle, the theoretical basis for these outcomes is that the search for economic transformation through coal consumption will prompt governments and policymakers to map out regulations, which may inform the introduction of coal rent in order to reduce the carbon dioxide emission. Consequently, industrialists would look for alternatives for non-renewable energy sources that deteriorate the environment as claimed in majority of the previous studies found in the literature (see Bekun et al, 2019) by adopting renewable energy and nuclear energy consumption that tend to reduce the CO_2 emissions in E7 countries. However, this has generated a lot debate in the literature. In this regard, the transition from carbon intensive technologies to modern clean technologies will promote sustainable development and reduces the experience of environmental deterioration in E7 economies.

Table 7. Results of Causality Tests

NULL HYPOTHESIS	F-STATISTICS	P-Value	CAUSALITY FLOW
LnCR↗LnCO_2	4.18337b	(0.0422)	**LnCR→LnCO_2**
LnCO_2↗LnCR	0.00426	(0.9480)	
LnGDP↗LnCO_2	1.26118	(0.2628)	**LnCO_2→LnGDP**
LnCO_2↗LnGDP	3.10253c	(0.0798)	
LnNPG↗LnCO_2	1.16505	(0.2818)	**LnCO_2→LnNPG**
LnCO_2↗LnNPG	5.93176b	(0.0158)	
LnREC↗LnCO_2	0.05665	(0.8121)	**LnCO_2→LnREC**
LnCO_2↗LnREC	4.26515b	(0.0402)	
LnCD↗LnCR	12.3992a	(0.0005)	**LnCD→LnCR**
LnCR↗LnCD	3.9E-05	(0.9950)	
LnGDP↗LnCR	2.08027	(0.1508)	**LnCR→LnGDP**
LnCR↗LnGDP	4.99611b	(0.0266)	
LnOGC↗LnCR	8.07409a	(0.0050)	**LnOGC→LnCR**
LnCR↗LnOGC	1.81411	(0.1796)	
LnGDP↗LnCD	1.95802	(0.1633)	**LnCD→LnGDP**
LnCD↗LnGDP	7.10912a	(0.0083)	
LnNPG↗LnGDP	2.77912c	(0.0971)	**LnNPG→LnGDP**
LnGDP↗LnNPG	0.86123	(0.3546)	
LnREC↗LnNPG	7.06945a	(0.0085)	**LnREC↔LnNPG**
LnNPG↗LnREC	5.07429b	(0.0254)	

NOTE: a, b, c represents 1%, 5% and 10% significant levels

5. Conclusion and Policy Recommendations

The main objective of this study is to examine the influence of economic growth, coal CO_2 damage and power from oil gas energy on carbon emissions. It employs a panel dataset of E7 member states over the period of 1990 to 2016. The study uses an OLS and Quantile regression analyses to understand the dynamics of the hypothesized relationships. The quantile regression approach aids to get rid of the bias of the OLS estimator. The results from the estimation techniques reveal a positive effect of real GDP on carbon emission. Increasing economic activities recorded in the region as result in industrialization and the adoption of more advanced production techniques have led to more environmental depletion. Thus, uncontrolled growth is seen as a driver of environmental degradation in E7 economies. Additionally, renewable energy is found to have negative and significant impact on $C0_2$ emissions in E7 countries. This confirms the transition of countries from non-renewable energy (fossil fuels, coal) consumption to renewable energy consumption as a viable way to combat the rising CO_2 emissions and to meet the expectation of growing demand for energy resources.

Furthermore, nuclear power sources exert a positive effect on carbon emission in E7 economies but only when power generated from nuclear sources is low whereas found to have insignificant negative coefficients when more power is generated from nuclear sources. This implies that environmental degradation could be reduced if more power can be generated from nuclear power sources in E7 economies. The results for coal rent show a positive and statistically significant impact of coal rent on carbon emission in E7 economies. However, the influence is most prevalent where coal rent consumption is moderately charged. In addition, the cost of carbon damage shows a positively significant effect on carbon emission. This implies that the rising carbon emissions in E7 economies is because of the increasing economic activities compounding pressure on the environment. Power generation from oil, gas and coal sources is found to benefit the environment, as the findings show a negative impact on environmental degradation in E7 economies. Finally, the study also incorporated some regulatory measures in order to gain more insight to the effect of some energy policies in CO_2 emissions in E7 countries. As such, the estimated results indicate that regulation of coal consumption through rent in addition to the cost of carbon damage will increase CO_2 emissions in E7 countries. The implication of this is that putting stringent regulations on coal consumption at par with rising cost of carbon damage will not be of help to environmental sustainability.

Additionally, commanding adherence to environmental policy could be a good way to reduce CO_2 emissions in E7 countries. However, it could be more effective in circumventing the environmental degradation produced from the generation of power supply from oil, coal and gas sources. This implies that putting regulations on coal consumption at par with oil, coal and gas consumption will be a vital means to promote environmental quality and sustainable development in E7 economies. In addition, strict adoption of nuclear energy sources as well as more cost of carbon damage will reduce CO_2 emissions in E7 countries significantly. This is pointing towards the resistant of nuclear energy sources to produce air pollutants while operating unlike the fossil fuel energy sources. Lastly, power generation from nuclear sources as well as increasing cost of carbon damage is found to give a mixed result as it is found that lesser environmental degradation is attached to lesser regulatory measure.

Based on the results obtained from this study, this study recommends several policies to reduce the CO_2 emissions embattling the environmental sustainability of E7 economics. It is evident from the study that adoption of renewable energy can be an effective way to enhance green growth and sustainable development. The policy implication is that renewable energy makes use of clean technologies that can offset the emissions set out by non-renewable energy consumption. Thus, E7 economies should put more effort on more consumption of renewable energy and less of the traditional non-renewable energy in order to reduce the level CO_2 emissions experienced in the region. Meanwhile, the reduction of the consumption of the carbon emitting non-renewable energy does not have significant effect on the economies (Dogan & Seker, 2016). To achieve this feat at a low transaction cost, research and development should become sector of interest to policymakers in a way to make the energy resources produced from renewable energy sources cheaper.

Furthermore, policies should be focused on aggravating the cost of production for coal exploitation vis-a-vis introduction of coal rents. The study found that charging lower rent on coal consumption might put the carbon emitting firms to overlook the impact of their activities on the environment, as their revenue seems to be affected when lower rent is charged. Therefore, the findings from this study have shown that the introduction of more stringent environmental regulations and policies that will enforce the transition of industries from carbon emitting energy sources to cleaner energy sources that improve the environmental quality and encourage sustainable development.

Lastly, the study shows that research and developmental efforts of the governments to improve the climate condition may not be enough to curb environmental degradation in the region. The study recommends that governments and policy makers should look towards the direction infrastructural developments by increasing the yearly capital expenditure. Theoretically, more capital expenditure attracts more investment, thus, this policy will make a turnaround as more FDI will flow into the countries and importance of the FDI is found in the need to adopt clean technologies that will save the masses from the menace of CO_2 emissions. This strengthens the bloc of the environmental quality and sustainable development

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Appendix

Table A.1. Description of variables

Variables	**Abbreviation**	**Definition**	**Data Source**

CO_2 emissions (metric tons per capita)	CO_2	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	WDI
Renewable energy consumption (% of total final energy consumption)	REC	Renewable energy consumption is the share of renewable energy in total final energy consumption.	WDI
Power from nuclear sources (% of total)	NPG	Sources of electricity refer to the inputs used to generate electricity. Nuclear power refers to electricity produced by nuclear power plants.	IEA Statistics
Economic Growth	GDP	GDP per capita (constant 2010 US$)	WDI
Coal rents (% of GDP)	CR	Coal rents are the difference between the value of both hard and soft coal production at world prices and their total costs of production.	WDI
carbon dioxide damage (% of GNI)	CD	Cost of damage due to carbon dioxide emissions from fossil fuel use and the manufacture of cement, estimated to be US$30 per ton of CO_2 (the unit damage in 2014 US dollars for CO_2 emitted in 2015) times the number of tons of CO_2 emitted.	WDI
Power from oil, gas and coal sources (% of total)	OGC	Sources of electricity refer to the inputs used to generate electricity. Oil refers to crude oil and petroleum products. Gas refers to natural gas but excludes natural gas liquids. Coal refers to all coal and brown coal, both primary (including hard coal and lignite-brown coal) and derived fuels (including patent fuel, coke oven coke, gas coke, coke oven gas, and blast furnace gas). Peat is also included in this category.	IEA Statistics

Source: author's compilation

Table A.2: VIF Estimations

Variables	**VIF**	**1/VIF**
LnGDP	7.20	0.108662
LnREC	6.81	0.113549
LnCD	5.62	0.177864
LnCR	2.75	0.364046
LnOGC	2.58	0.388111
LnNPG	2.28	0.438534

Mean VIF	4.54

DECLEARATION OF INTEREST

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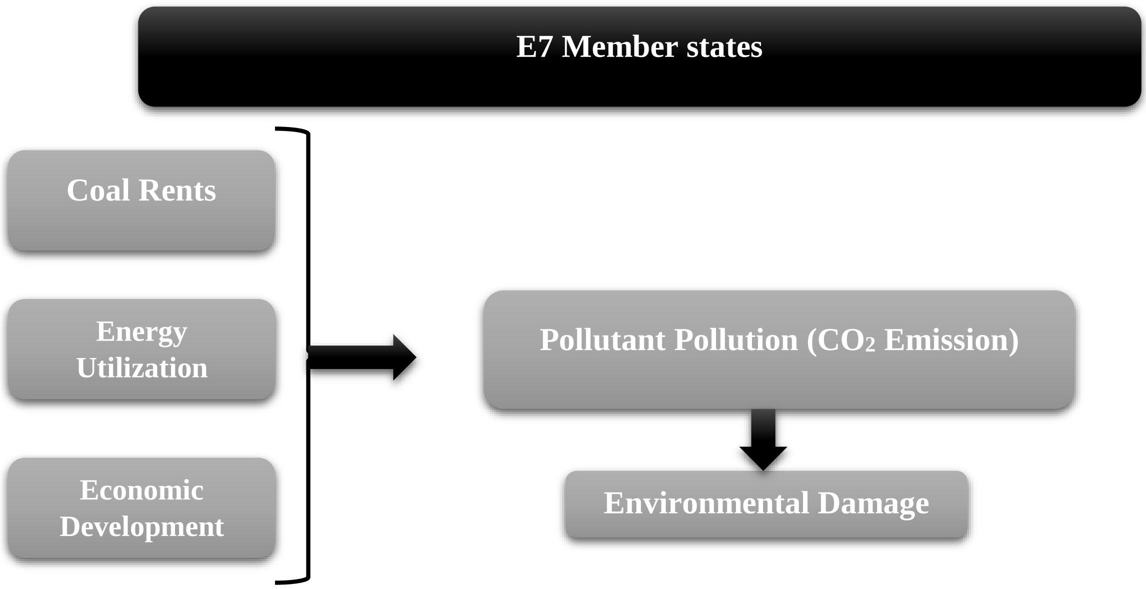
Compliance with Ethical Standards

I wish to disclose here that there are no potential conflicts of interest at any level of this study

Graphical Abstract



COVER LETTER

To

The Editorial Board,

Journal for Cleaner Production,

Subject: Submission of a research article for possible publication in your journal – Regards

Journal title: **Journal for Cleaner Production.**

Article Title: **The Anthropogenic Consequences of Energy consumption in E7 Economies: Juxtaposing roles of Renewable, Nuclear, Oil and Gas Energy: Panel Quantile Evidence**.

Dear Sir,

Herewith we submit our article titled "**The Anthropogenic Consequences of Energy consumption in E7 Economies: Juxtaposing roles of Renewable, Nuclear, Oil and Gas Energy: Panel Quantile Evidence**" for possible publication in your highly esteemed journal.

Authors have carefully gone through the author guidelines and we assure that this article is prepared as per the author guidelines. We also confirm that our article and has not been published or submitted anywhere apart from your journal.

Dear Prof. Please find attached our manuscript for possible publication in your esteem journal. The title of our study is "**The Anthropogenic Consequences of Energy consumption in E7 Economies: Juxtaposing roles of Renewable, Nuclear, Oil and Gas Energy: Panel Quantile Evidence**." The emerging seven (E7) countries made up of Brazil, India, Indonesia, China, Russia, Mexico and Turkey are not excluded from the Global warming issues which is a major problem for most economics. The region has partaken in the policy to mitigate against global warming in terms of decoupling pollution (CO_2) pollution from economic growth. It is from this motivation that this current study considers the connection regarding economic growth, pollutant emissions, coal rent while accounting for the role of other variables like CO_2 damage and power from oil gas energy. A balance panel annual data from 1990 to 2016 was use for the analysis. This study adopts the use of Panel Ordinary least squares in conjunction with Quantile regression that shows different characterization on tails of the data is used to identify the coal-rent-energy nexus. The result shows that, a positive and significant effect of coal rent on CO_2 emissions. Furthermore, there was a positive and significant relationship between real GDP and CO_2 emissions. We observe at the 0.95 percentile GDP growth strongly contributes to environmental pollution while at the median tail i.e. 0.5 percentile renewable energy consumption dampens the adverse effect of environmental degradation. Additionally, renewable energy on the other hand was found negative and significant impact on CO_2 emissions in E7 countries. Moreover, the estimated results indicate that regulation of coal consumption through rent in addition to the cost of carbon damage will further increase the CO_2 emissions in E7 countries. The implication of this is that putting stringent regulations on coal consumption as it concerns rising cost of carbon damage will not be of help to environmental sustainability within the E7 economies. The adoption of nuclear energy sources as well as more cost of carbon damage and oil, coal and gas consumption will reduce CO_2 emissions in E7 countries significantly. This is pointing towards the resistant of nuclear energy sources to produce CO_2 while operating unlike the fossil fuel sources.

The choice of the journal is informed by (i) the high repute established by the journal over the years (ii) suitability of our study to the journal scope.

The manuscript has been proofread by a native speaker.

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Yours truly,

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