THE EFFECT OF NUCLEAR ENERGY AND RENEWABLE ENERGY ON GDP AND CARBON EMISSIONS

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Abstract
At the international level, the importance of clean energy is highly appreciated in the context of development and for the protection of the atmosphere. Therefore, the objective of this article is to determine the effect of the consumption of renewable energy and nuclear energy on economic growth and carbon dioxide emissions in the ten most CO2 emitting countries in a multivariate context for the period 1995-2019. The panel cointegration test, the completely modified ordinary least squares panel and the Dumitrescu and Hurlin heterogeneous causality evaluation panel are used to analyze the long-term estimation of elasticity, as well as the evolution of causality between variables. The panel cointegration test confirms the existence of a long-term equilibrium correlation between the variables. The results of long-term elasticity and causality tests reveal that renewable energy does not contribute to economic growth and CO2 reduction like nuclear power. However, with the exception of renewable energy and nuclear energy is vital to prevent global warming and climate change, as well as to promote economic growth.
Keywords: GDP; renewable energy; nuclear energy; CO2 emissions

Introduction

The industrial revolution, which materialized around the world in the early 19th century, expanded the demand for energy, as emerging automatic manufacturing operations required enormous amounts of energy. To meet the demands of the production system and stimulate economic growth (GDP) in several countries, mainly fossil fuels (FF) were used, for example coal and oil, which released huge amounts of greenhouse gases. Greenhouse gases (GHG) and tremendously motivated climate change. The combustion of FF generates various types of environmental air pollution such as various toxic gases, for example, carbon dioxide (CO2) emissions that damage the environment, reinforce the greenhouse effect and induce global warming. The growing demand for energy is driving GDP, but energy consumption is also a source of GHG emissions with repercussions on the sustainability and potential of the planet. The Fifth Intergovernmental Assessment Report (AR) of the Panel on Climate Change (IPCC) recognized that GHGs, in particular CO2 emissions from anthropogenic companies, have been the main driving force in accelerating universal global warming. The Paris Pact on Climate Change approved at COP21 (also called the 2015 Paris Climate Conference) shows empathy in tackling the problems of climate change after 2020 and intends to keep global warming below 2 ° C and pursue initiatives to limit it to 1.5 ° C.

Along with huge energy demand and rapid growth, environmental challenges are forcing most economies to replace FA with alternative energy sources. These alternative energy sources meet the growing demand for energy and improve the quality of the environment on a global scale. In line with this, the achievement of the Sustainable Development Goals (SDG), one of the objectives is to provide energy sources by stimulating the contribution of renewable energies (RE) in the energy mix, the contribution to green energy projects will be feasible to reduce emissions, provide employment prospects and collectively can facilitate GDP, somewhat improved quality of life. The common characteristics of renewable energy sources such as hydroelectric, solar, wind, biomass, tides, biofuels and geothermal energy are considered clean, natural and environmentally friendly. RE is necessary for community well-being and sustainable economic growth in the future. RE installed capacity represents 53.6% of the total gigawatt, excluding large hydroelectric projects prior to the Journal test. According to the IEA, renewable electricity production is increasing by 25% today and is expected to increase by 40% in 2030.

Several studies have tested the correlation between energy consumption and GDP or between energy consumption / GDP and CO2 radiation, but we believe that the consensus is mixed due to different countries and methodologies. Few researchers have found a one-way causality between ER and CO2 emissions as. Numerous surveys have indicated an inverse causality between GDP, ER and CO2 emissions, such as Apergis et al. analyze the link between energy and growth in 19 developed and developing countries. The results suggest that renewable energy contributes to emissions mitigation, but not renewables. Raza et al.; Saidi & Omri, A (2020). Concluded that GDP is positively related to long-term CO2 emissions, as well as the reverse causality of CO2 emissions to renewable energy consumption in G7 countries. The bidirectional Granger causal link has been found between ER and CO2 emissions for 15 EU states in the short term and in the BRICS states in the long term.

Globally, the use of nuclear energy has increased by more than 37% to achieve stable and significant growth. The correlation between NE, CO2 radiation and GDP has been reviewed for several years. Studies, Lee et al.; Xu et al.; Saidi & Omri, A. (2020) have shown that the use of nuclear energy can reduce emissions. Unfavorable results were recorded for 11 OCED states and Alam et al. for a 25-state panel. Jaforullah et al. found that the use of NE increases CO2 radiation and noted the unfavorable role of NE in carbon emissions. Iwata et al. revealed that NE reduces carbon emissions in France. The empirical results of Sarkodie et al.; Cristiano et al. (2000) ; Shahbaz et al. (2015) revealed that NE encourages ecological pollution. In particular, Yoo et al.; Omri & Kahouli (2014); Pérez-Lombard et al.(2008) have found a unidirectional causal link of NE to GDP and other studies. On the other hand, other researchers have found that there is an assumption of neutrality between NE consumption and GDP.

Given the above context, the literature shows that most surveys have examined the energy-GDP link, but less attention has been paid to decomposed energy sources with carbon radiations from GDP. As far as we know, there are no studies on the top ten emitting countries to look at the long-term impacts, as well as the causality of disaggregated energy consumption on economic growth and CO2 emissions, Ogunmodede et al. (2021) therefore our study will fill this gap. Therefore, it is important to explore the effect of NE and RE on the environment and GDP in emitting countries. We develop the theoretical structure of this study because it will help us decide on the variables of the model. The countries analyzed in our study are considered in terms of strengthening economic growth; this improvement in economic performance was strongly correlated with energy consumption, which ultimately increases CO2 in the selected countries. Therefore, clean and efficient energy is vital to removing carbon emissions for economic prosperity and development.

Our study is decisive in the recent stage of "sustainable development"; most developing countries are now contributing to the global transition to an environmentally friendly, low-carbon energy process after achieving the SDGs. The main contributions of this work are the following: First, the analysis observed the effects of disaggregated energy consumption on economic growth and CO2 in ten selected polluting states; this disaggregation would help us better understand the relative strength of energy types for economic and environmental sustainability. We believe this is the first study of its kind on the major emitting countries with the most recent data that will provide important information to state policy makers. Selected sample states include the United States, Canada, India, Iran, Japan, Russia, the United Kingdom, South Korea, Germany, and China; this article uses the journal's pretest method to co-integrate heterogeneous panels that allows cross-sectional heterogeneity and has power in cross-sectional and time series data. To see the long-term effects of the independent variables on GDP and CO2, the fully modified least squares technique (FMOLS) is applied. Finally, to address cross-sectional dependence, we used the Dumitrescu and Hurlin test of heterogeneous causality to deduce the direction of causality between the variables. The rest of the article is structured as follows: the next section explains the general description of emissions in some countries; Section 3 presents the data and methodology; the empirical findings and discussion are reported in section 4 and final section 5 discusses the conclusion and policy implications.

An overview of energy strategies in selected countries

The top ten economies: United States (US), Canada, India, Iran, Japan, Russia, United Kingdom, South Korea, Germany and China are considered the largest consumers of energy and CO2 emitters in the world. These countries achieve high GDP and are also the largest providers of CO2 emissions globally. The total CO2 emission of these regions that comes from energy consumption exceeds 75%. According to the IPCC, each year, the per capita CO2 emissions of these economies are 5.7 t CO2 higher than the global CO2 emissions per capita.

United States of America

In the United States of America (USA), CO2 increased in the 20th century not only due to the combustion of FF but also due to changes in land use, industrial and agricultural activities. US emissions decreased in 2007, as shown in Figure 2. It was the first country to integrate energy strategies into the economic process. Accelerate the development and adaptation of sustainable technologies such as NE and RE solar, wind, biomass technologies, improve domestic energy efficiency, electricity production from clean energy with low or no carbon consumption, develop CO2 innovation that seizes and stores Carbon emissions, to stimulate Public and private innovations that will reduce the cost of emissions and improve performance, lessen market challenges have been established in more recent times.

India

India's energy strategies focus on the deployment of alternative energy sources such as NE, the pre-test magazine solar and wind, preserving the environment and efficient consumption of resources. The energy plan will first analyze in depth the development of the region in the energy sector and address the challenges associated with long-term sustainable energy. In 2008, India proclaimed a 20-25% CO2 reduction at the Conference of the Parties (COP). India's first nationally determined contribution is heavily focused on reducing the emissions intensity of GDP from 33% to 35% by 2030, with energy efficiency, to increase investment in the latest technology and reduce emissions.

Canada

In 2014, the National Energy Board, NE safty and the Research and Development Program further contributed to the development of Canada's energy policy. Canada's energy strategies consist of three fundamental aspects that are like stock market: ensuring prosperous and efficient energy, fostering provincial and federal jurisdiction and selective federal interventions in the field of the energy system to guarantee the objectives of the energy policy. In 2018, Canada joined the partnership agreement strategy through Prime Minister Justin Trudeau based on “Clean Energy for All Europeans”. Energy policies were based on a secure and sustainable energy supply, market transparency and overcoming its challenges, increasing research and development in the energy sector, energy efficiency and increasing the share of renewable energy and nuclear energy. , producing electricity from clean sources and developing innovation towards a low-carbon energy future In 2019, the goal of the Paris agreement was to reduce GHG emissions by 30% by 2030.

Iran

Globally, Iran is the largest supply reserve for oil, as well as a great potential for renewable energy. The development of renewable energy sources ensures social welfare and a sustainable growth economy in Iran. Renewable energy policies have been implemented in Iran to increase the importance of AF in the industrial energy sector to achieve sustainable development. Sustainable energy strategies to improve energy security by developing natural resources, conserving the environment, promoting the financial sector, supporting research and development to increase natural and clean energy sources.

Japan

For excess energy, Japan relies on imports of FF resources and enjoys unchanging energy supply by implementing policies to expand supply. Energy policies are based on the “Basic Energy Plan” approved by the Japanese cabinet until 2030. The main objective of this plan is to guarantee an excess of sustainable and independent energy supply for the future that would develop the economies. The Basic Energy Plan focuses on energy security and renewable resources that is (solar, wind, biomass, and geothermal, small and medium hydroelectric plants) for a constant energy supply, to reduce dependence on AF resources and diversify the development of the nuclear reactor.

Russia

Russia is one of the world's leading energy exporters. However, it is vital to realize Russian federal energy policies due to the enormous influence on the international energy market and the development of household GDP. Russia's energy strategy focuses on reliable natural energy sources to ensure growth, a sound economic position and a better quality of life, the safe development of the energy sector, advanced and efficient innovation, the reduction of energy intensity and the emissions, the implementation of the ER system and the guarantee of efficient energy for household consumption.

UK

Globally, the United Kingdom (United Kingdom) is the first country to take action Pre-test record threats of global warming and has become the most prosperous region with the fastest economic growth and emission mitigation. To achieve the goals of the Paris Agreement, the UK is committed to working with other economies and encourages global partnerships to promote clean and sustainable growth, as well as reduce CO2 in the most polluting countries. UK energy strategies support all five the dimensions of the energy union are as follows: ensuring energy security, energy efficiency, decarburization, interconnection with the internal market and innovative and excellent technologies such as renewable energy Resources.

South Korea

South Korea is the eleventh largest economy in terms of nominal GDP and rapid industrialization process. South Korea's economy is dominated primarily by export-dependent manufacturing. Therefore, it is the seventh largest emitter of CO2 worldwide, as increasing pressure to work with others improves environmental performance. The government has established the energy policy to increase the share of renewable energies by 20% in electric power generation, energy security, industrial growth, stable energy supply and clean environment in the future.

Germany

As a member of the European Union, Germany's target of reducing CO2 by 40% by 2020 and 55% by 2030. Garmany's "Energiewende" energy strategies are the ongoing transition based on the "Triangle" of three plans for ecological integrity and energy efficiency. and sufficient power supply. It is the most successful plan in the German energy system to make it more efficient and reliable by renewable energy sources.

China

Globally, China is the largest leader in reducing carbon emissions and investing in households in the energy sector. China has invested around US $ 103 billion in the energy sector. In China, they generally follow the decentralized mode of policy making for renewables, as their clean energy industry is mainly controlled by various government institutes. China's Five-Year Plan is one of the key policy instruments for social and economic development and provides a clear national strategy and intent. China has a five-year energy strategy plan (2016-2020) to improve the use of FF energy in the energy mix by 15% in 2020 and 30% in 2030, to promote the latest innovations, advance Energy Ocean and offshore wind and improve energy efficiency. Solve energy limitations and environmental problems to achieve sustainable development.

Materials and Methods

Data source

The study draws data from British Petroleum's World Energy Statistical Journal and World Development Indicators (WDI). The annual statistics are applied in this article, during a period of (1995-2019), for 24 years. Per capita carbon emission variables in terms of (metric tons), GDP is measured in (constant 2000 US dollars) and foreign direct investment in (% of GDP) is the source (WDI). ER consumption, NE consumptiontaken from BP's statistical review measured in million tons of oil equivalents (MTOE). Variables are converted to natural logarithms in the pragmatic study.

Summarizes the descriptive analysis of the data of the variables for each country during the period 1995-2019. Statistical analysis is based on the mean, standard deviation, Jarque-Bera statistic, and its p-value is analyzed before taking logarithms. . In the statistical analysis, in addition to the mean and standard deviation, the Jarque-Bera test statistics are important to determine the normal distribution of the series. The null hypothesis states that the distribution is normal. If the P-value is greater than 5%, it implies that the series are normally distributed but that a small p-value has led to the elimination of the normal distribution assumption of the null value. Descriptive analysis shows that the United States leads the average (18,789) in carbon emissions per capita, followed by other countries such as Canada, Germany, Russia, Japan and the United Kingdom. The United States also has the highest average consumption of natural gas and natural gas (173,648), (566,300) which indicates a normal distribution. While Germany, Russia, Japan, Korea, China and the United Kingdom follow the United States in terms of NE and GN. In the case of GDP per capita, the United States and China lead the highest average (12,780), 8,994 and GDP is normally distributed equally for all countries. In terms of renewable energy consumption, India and China lead the average of (48.89), (23.286), while Iran has the lowest value (0.981). The variables are normally distributed, except for Japan, Republic of Korea and the United Kingdom, which indicates that the series are not normally distributed. Furthermore, in terms of foreign direct investment, China outperforms all other countries with the highest average of (3.692) while Iran, Korea and Japan have the lowest average of 0.611, 0.885 and 0.148.

Econometrics model for growth

Based on the theoretical structure as presented above, firstly, we develop econometric model I for growth to analyze the effects of independent series on the dependent variable. The equation of Model-I can be written as follows:

$$GDP = f\,(RE, NE, FDI) \qquad (1)$$

Eq. 1 revealed that GDP is a function of renewable energy consumption (RE), nuclear energy consumption (NE) and foreign direct investment (FDI). Eq. 1 is written in panel data form as stated below:

$$GDP = \alpha + ß1RE_{it} + ß2NE_{it} + ß3FDI_{it} + \mu_{it} \quad (2)$$

The above model is expressed in log-linear form as stated following:

$$LnGDP_{it} = \alpha + ß_1\ LnRE_{it} + ß_2\ LnNE_{it} + ß_3\ LnFDI_{it} + \mu_{it} + \varphi i \quad (3)$$

In this study, GDP growth indicates the first-panel model where the subscript i=1,…, N for each state and t=1,…, T indicates time period in a panel, GDP is a gross domestic product, RE is renewable energy consumption, NE is nuclear energy consumption and FDI is foreign direct investment. α is intercept and φi represent an individual effect. µit Indicate an error term and ß1, ß2, ß3, ß4 are parameter estimates of relevant explanatory variables.

Econometrics model for Carbon dioxide Emission

Carbon emission is the II panel model of this article. The impact of GDP, NE and RE consumption on CO2 is another issue of our study. The equation of model-II can be written as follows:

$$CO2 = f\,(RE, NE, FDI) \quad (4)$$

Eq. 4 reveals that CO2 is a function of economic growth (GDP), nuclear energy consumption (NE) and renewable energy consumption (RE). Eq. 5 is written in panel data form as stated below:

$$CO2\ _{it} = \alpha + ß_1RE_{it} + ß_2NE_{it} + ß_3FDI_{it} + \mu_{it} \quad (5)$$

The log transformation of Eq. 5 is as follows:

$$Ln\ CO2\ _{it} = \alpha + ß_1\ LnRE_{it} + ß_2\ LnNE_{it} + ß_3\ LnFDI_{it} + \mu_{it} + \varphi i \quad (6)$$

Here, ln CO2it is the log of per capita carbon emission from FFs measured in metric tons. In addition, we use GDP as a huge amount of investigations have studied the link between CO2 emanation and GDP such as ; lnGDP is a log of gross domestic product.ln NEit is log of nuclear energy and ln REit is log of RE consumption is used in the carbon emission model. α is intercept and φi represent an individual effect. µit indicate an error term and ß1, ß2, ß3 are parameter estimates of the relevant explanatory variables.

Methodology

Panel data is used in this study because of its many advantages, for example, it requires a large number of data points (N, T), eliminates the collinearity problem, and contains more degrees of freedom, which improves capacity. of econometric evaluation. Our empirical research will examine two main questions, explore the influence of renewable energy consumption, renewable energy consumption and direct investment on GDP and analyze the impact of GDP, , the consumption of renewable energy and nuclear nuclear energy on carbon emissions (EC) in the ten most polluting countries. For this, we will use both the GDP and the CE of the models (I-II) to achieve the objective of our research.

Empirical results and discussion

Panel unit root test

The panel unit root test has become famous in the financial community because it contains more power than the normal unit root test established on individual time series. We apply the Unit Root Pretest Log panel to verify the stationarity of the variables before estimating the regression analysis. If the series has a non-constant mean and a variance over time, then we say that it is not stationary, which leads to a false regression. To avoid this problem and ensure the reliability of the results, several unit root tests are used, including.

In this work, we apply the unit root test Im, Pesaran and Shin (IPS) to evaluate the order of integration of series. The panel unit root IPS approach is applied, which allows a heterogeneous estimation of autoregression, it is also the most used method in research. Therefore, a heterogeneous panel unit root test is considered and this survey assumes that there is a process of individual unit root cross sections. The null hypothesis of the IPS test is that the series contains a unit root, while the alternative hypothesis is that it does not have a unit root. The results of the evaluation of the root of the IPS panel unit for each level variable and the first difference with intersection and intersection and trend are presented in Table 2. The result reveals that not all variables are stationary in levels; the null postulate of the unit root cannot be excluded. On the other hand, after taking the first difference, all the variables are stationary, which eliminates the null hypothesis at the 1% level of significance. In conclusion, it was found that the variables are non-stationary and integrated of order one (1). The unit root test of the panel indicates the stationarity of the variables that recommend the possibility of the presence of long-term connection in the middle of variables.

Table 1 Descriptive Analysis of included variables

	China	United state	Canada	Germany	India	Russia	Japan	Korea Republic	Iran	United Kingdom
carbon dioxide emission (CO2)										
Mean	4.176	18.889	16.065	10.185	1.837	11.085	9.405	4.199	6.024	8.715
S. D	1.930	1.209	0.830	0.749	0.295	1.526	0.333	2.446	1.580	0.922
J-B	3.118	5.265	1.599	0.758	2.681	13.056	2.406	3.913	2.212	4.233
P-v	0.210	0.0718	0.449	0.684	0.261	0.001	0.300	0.141	0.330	0.120
Per capita GDP										
Mean	8.994	12.780	2.185	2.168	4.472	6.160	1.740	5.212	3.445	2.147
S. D	2.435	2.383	1.459	1.656	1.865	3.285	1.413	2.663	3.148	1.158
J-B	0.746	2.126	0.882	3.043	1.964	2.062	4.590	1.547	3.653	0.497
P-v	0.688	0.345	0.643	0.218	0.374	0.356	0.100	0.461	0.160	0.779
Nuclear energy consumption (NE)										
Mean	9.484	173.64	19.932	32.796	3.708	31.540	76.14	25.164	0.448	17.896
S. D	8.585	18.336	2.464	6.796	2.066	6.016	31.33	8.640	0.287	2.916

J-B	2.600	3.170	1.121	8.237	2.094	1.876	2.679	2.789	2.397	1.248
P-v	0.272	0.204	0.570	0.016	0.350	0.391	0.261	0.247	0.301	0.535
renewable energy consumption (RE)										
Mean	23.28	5.727	21.899	5.937	48.89	3.608	4.177	1.033	0.981	1.999
S. D	8.413	1.607	0.427	3.836	6.832	0.225	0.477	0.527	0.287	1.880
J-B	3.037	1.750	0.222	2.739	2.169	0.661	8.316	27.657	0.849	11.441
P-v	0.219	0.416	0.894	0.254	0.338	0.718	0.015	0.001	0.653	0.003
Foreign direct investment (FDI)										
Mean	3.692	1.482	2.774	1.824	1.103	1.727	0.148	0.885	0.611	3.628
S. D	1.224	0.767	2.216	2.491	0.885	1.319	0.145	0.540	0.661	2.849
J-B	0.332	2.306	13.091	232.431	5.399	2.075	4.684	1.468	18.98	4.917
P-v	0.846	0.315	0.001	0.000	0.067	0.354	0.096	0.479	0.007	0.085

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and ***(10%)

Table 2: IPS Panel unit root test

	Level		First Difference	
Variables	Intercept	Intercept &Trend	Intercept	Intercept &Trend
GDP	-0.78934	-0.67369	-11.5194	-6.81579*
NE	0.21678	1.09896	-9.07591	-7.60084
RE	1.92339	-0.76848	- 5.38757	-4.36617
FDI	-1.00459	0.84721	-7.33491	-5.48898
CE	2.22467	0.23365	-5.97716	-5.12084

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and ***(10%)

Panel cointegration test

When the series contains a unit root, we use a panel cointegration approach. This technique is applied to confirm whether the variables have a long-term relationship between two or more variables. The Pedroni cointegration panel comprises two types of test; First of all, in the dimension set to (panel cointegration statistics) you have four test statistics: namely, panel v statistics, panel statistics, panel PP statistics, and panel ADF statistics. Second, the cluster test focused on between width (panel cointegration data group) established in three tests, specifically, rho-statistic group, PP statistic group, and FAD group statistics. The null postulate of panel cointegration is that there is no cointegration between the variables, while the alternative assumption is that the presence of cointegration. Tables 3 and 4 report the results of the panel cointegration test for the GDP and CE model.

Table 3: Results of Panel co-integration test for Model-I

	Statistic	Prob.	Statistic	Prob.
Panel v-statistic	1.944261	0.0259*	-0.17115	0.5679**
Panel rho-statistic	-1.01785	0.1544	-0.73444	0.2313

Panel PP-statistic	-6.33153	0	-5.86175	0
Panel ADF-statistic	-6.46736	0	-5.97154	0
Group rho-statistic	0.364997	0.6424	-	-
Group PP-statistic	-9.28019	0	-	-
Group ADF-statistic	-7.28859	0	-	-

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and ***(10%)

In table 3, results of the panel cointegration control on the GDP model, the results show that the statistics and weighted statistics of the PP panel statistics and the ADF panel statistics strongly ignore the zero we postulate at a level of significance of 1% and 5%, whereas, in the cluster cointegration test statistics of the PP group statistics and the ADF group statistics, we strongly reject the null hypothesis at the 1% level of significance. This represents that the variables GNL, lnRE, lnNE and lnFDI are cointegrated with GDP.

Table 4: Results of Panel co-integration test for model-II

	Statistic	Prob.	Statistic	Prob.
Panel v-statistic	-0.346801	0.6356	-0.384683	0.6498
Panel rho-statistic	0.374058	0.6458	-0.120666	0.4520
Panel PP-statistic	-2.103224	0.0177	-2.750741	0.0030
Panel ADF-statistic	-2.249771	0.0122	-2.856029	0.0021
Group rho-statistic	0.941601	0.8268	-	-
Group PP-statistic	-2.801345	0.0025*	-	-
Group ADF-statistic	-2.909810	0.0018*	-	-

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and ***(10%)

The results indicate that weighted statistics from panel PP-statistics, panel ADF-statistics and group PP-statistics group ADF statistics strongly discard the null hypothesis at 1% significance level. This represents that variables lnGDP, lnNE and lnRE, are co-integrated with CO2 means that for both (model I-II), endorses the presence of long run equilibrium association among variables.

3 Fully Modified Ordinary Least Squares

When variables are co-integrated and the presence of long-run liaison is confirmed, the panel fully modified ordinary least squares model is applied to assess long run elasticity of explanatory variables on the dependent series. This study prefers the FMOLS method as it checks the sturdiness of estimates and also keeps more meticulous findings for trivial sample size. FMOLS estimation test removes serial correlation problems and spurious regression Journal Pre-proof portrays by OLS and has gained fully asymptotically efficient estimation in panel data. Table 5, reports the individual countries and panel FMOLS results for GDP Model-I.

Table 5: Long run estimation Model-1 (dependent variable: GDP)

Country	FDI	NE	RE
Canada	0.192 (1.479)	0.188 (0.106)	1.377 (0.783)
USA	0.360 (1.927)	0.723 (6.081)	1.624 (1.860)
India	0.946 (-1.776)	-0.233 (-0.552)	1.264 (0.645)
Iran	1.587 (2.230)	0.062 (0.180)	2.094 (3.125)
Japan	-0.015 (-0.105)	0.081 (0.189)	0.666 (2.662)
Russia	0.274 (0.004)	-4.088 (-2.156)	-0.618 (-0.179)
UK	0.274 (0.004)	0.363 (2.868)	-0.071 (-2.577)
South Korea	0.499 (0.0418)	1.210 (2.552)	4.45 (3.037)
Germany	0.166 (1.5004	-1.415 (-2.479)	4.235 (3.211)
China	0.718 (5.249)	0.021 (2.810)	0.106 (2.070)

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and *(10%)**

The result reveals that NE consumption is an important driver of EG in China, the United States, South Korea and the United Kingdom, but the degree of influence is much higher in the case of Korea compared to the other two countries. A 1% increase in NE leads to economic growth of 0.021%, 0.723%, 1.210% and 0.363%, respectively. However, it is necessary to improve the latest technologies, knowledge and coherence in investments and technological benefits to meet the growing demand for energy and improve energy efficiency consistent with the pace of GDP. Only in three countries, Germany, India and Russia, does NE have a negative influence on GDP. Furthermore, FDI from Japan and India has a negative influence on GDP. This may be due to minimal practices and lower investment management, overflow problems, and local businesses can create positive externalities in the form of productivity. Furthermore, the consumption of renewable energy has a positive long-term influence on GDP; only two countries, Russia and the United Kingdom, have a negative effect on GDP. This means that these countries, Russia and the United Kingdom, have limited investments in the RE sector, resulting in slow deployment of the RE sector. Although the results for each country are mixed.

Since this study used panel data, the policy implications are shaped by the results of the panels. The result of the panel indicates that NE, RE and FDI are statistically significant and have a long-term influence on the GDP of the issuing economies. The results of the FMOLS panel indicate that a 1% increase in NE consumption, RE consumption and FDI would increase GDP by 0.077% and 0.0899% and 0.7783%, respectively.

Table 6 shows the FMOLS results for Model II CO2. For the long-term elasticity of CO2 in some income statements, of the ten most polluting countries, 5 denotes that the use of NE consumption will benefit efforts to reduce carbon emissions. Also, GDP is statistically significant in CO2 in 5 countries. Also, the magnitude of the coefficient relative to GDP has an effect on Korea and Russia. NE has a negative influence on CO2 in China, Canada and Korea, but in other NE regions it does not contribute to the mitigation of CO2 emissions. A 1% increase in NE reduces CO2 by -0.164%, -0.188% and -1.071%, respectively. South Korea produces 26% of total electricity in 2019 and becomes the fifth largest producer in the world. Likewise, the impact of larp is negative in Germany and South Korea, but in other countries the results are mixed. The ER coefficient has a negative effect on CO2 in China, the United States, Canada, Germany, India, Japan, South Korea, Iran, and the United Kingdom. This implies that an increase in RE would improve environmental performance in these most polluting countries, but in Russia RE have a positive and significant influence on CO2. Depending on the importance of RE sources and nature, results may vary from country to country. Sometimes, fluctuations in the development of renewable energy technology can cause problems due to lack of operational skills, lack of policies and regulations, and less information about the destination or failure of plant installation. The result of the FMOLS panel shows that a 1% increase in NE and RE will reduce CO2 by 0.012% and 0.19% and a 1% increase in GDP will increase CO2 by 0.063%, respectively. This study is aligned with the surveys by et sanglim et al. Another critical finding is that the economic growth of coffee is positive and statistically significant means that CO2 is mainly influenced by GDP. the results show that EN and RE would contribute to reducing carbon emissions; On the other hand, meet the constant increase in energy demand in these selected countries of the future. These natural energy sources are indispensable for other regions, especially in developing economies, because these regions are endowed with well-established, huge and abundant sources of energy.

Table 6: Long run estimation Model-II (dependent variable: CO2)

Country	GDP	NE	RE
Canada	0.245 (2.983)	-4.71 (-1.106)	0.226 (-4.519)
USA	0.002 (0.935)	-0.188 (-2.043)	-1.002 (-1.936)
India	0.0021 (0.186)	-0.013 (-0.480)	-1.201 (-8.015)
Iran	0.035 (20.05)	0.001 (0.117)	-0.002 (0.936)
Japan	0.026 (10.77)	-0.017 (-1.276)	-0.253 (-2.286)
Russia	0.130 (-1.747)	1.666 (4.772)	0.676 (1.785)

UK	2.346 (4.542)	-0.095 (-3.530)	0.117 (-5.486)
South Korea	0.284 (-1.680)	-1.070 (-1.843)	-0.571 (0.003)
Germany	0.0004 (0.086)	0.028 (1.300)	-0.095 (-11.42)
China	0.122 (1.866)	-0.164 (-2.934)	-1.001 (-8.376)

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%).(5%),and ***(10%)

4 Causality Test

Our study uses the latest causality approach of Dumitreschu and Hurlin which has two advantages over the traditional Granger causality test: first, it is suitable for panel data and second, it assumes that all coefficients are different in cross-sections. There are two different statistics according to this approach 1) Wbar statistics and 2) Zbar statistics. The first Wbar statistic takes an average of the test statistics; however, another denotes the standard normal distribution. Table 7 shows the results of the Dumitrescu and Hurlin paired causality method.

The results of the paired causality test indicate that there is bidirectional causality between the feedback hypothesis that informs the consumption of GDP, FDI and GN. Also, one-way causality shapes NE consumption relative to GDP, supporting the growth postulate. Another important finding of the RE is the conservation hypothesis that found a unidirectional causality from GDP to the RE. In the case of carbon emissions causality, the results show that the one-way causality lies between carbon emissions and GDP. On the contrary, there is the bidirectional connection between NE and CO2. However, a unidirectional causal link from ER to CO2 was determined, revealing the growth hypothesis. The results represent that an increase in ER and NE can affect carbon emissions.

In conclusion, renewables and renewables increase economic growth and mitigate climate change for long-term sustainability and environmental performance. The potential for renewable energy consumption is greater than the NE and any increase in the use of renewable energy will not hurt the economy. Furthermore, carbon emissions are mainly influenced by GDP and economic growth in most economies requires more energy. High emissions, i.e. traditional energy, drive GDP, but growth can be achieved using other productive decarburization activities, which means that GDP is slowly decoupling from carbon emissions.

Table 7: Results of Pairwise Dumitreschu and Hurlin Panel causality

Null Hypothesis	W-Stat	Zbar-Stat.	Prob.
FDI does not consistently cause GDP GDP does not consistently cause FDI	2.71248 2.87661	2.99780 3.30394	0.0027 0.0010
NE does not consistently cause GDP GDP does not consistently cause NE	2.43373 1.33603	2.47788 0.43042	0.0132 0.6669
RE does not consistently cause GDP GDP does not consistently cause RE	2.50987 4.09006	0.32210 2.28075	0.7474 0.0226
NE does not consistently cause FDI FDI does not consistently cause NE	2.78719 4.73513	0.66584 3.08031	0.505 0.0021

RE does not consistently cause FDI FDI does not consistently cause RE	6.75938 4.02390	3.05945 0.52171	0.0022 0.6019
RE does not consistently cause NE NE does not consistently cause RE	4.04906 4.04471	2.22993 2.22454	0.0258 0.0261
GDP does not consistently cause CO2 CO2 does not consistently cause GDP	2.44919 3.60123	0.24689 1.67484	0.8050 0.0940
NE does not consistently cause CO2 CO2 does not consistently cause NE	7.75439 9.13704	2.08076 3.05455	0.0375 0.0023
RE does not consistently cause CO2 CO2 does not consistently cause RE	9.96423 5.88177	3.63714 0.76188	0.0003 0.4461

Notes: Probability values are shown in brackets. Significance thresholds * (1%), ** (1%), (5%), and *** (10%)

Conclusion

In recent years, climate change and global warming have been the main problems facing many states. These new apprehensions have encouraged many countries to find an alternative energy source that can meet their pent-up energy demand and deal with the problem of increasing GHG radiation. However, these alternative energy sources contribute significantly not only to energy security, but also to an effective and deliberate solution to reduce carbon emissions and improve economies. Simultaneously, along with the benefits of reducing emissions, these alternative energies provide a stable and low-cost energy supply, reducing dependence on foreign energy. Therefore, the main intention of this work is to examine the effect of NE on GDP and carbon emissions in the ten countries with the highest CO2 emissions, namely China, United States, Canada. , Germany, India, Russia, Korea. , Iran and the United Kingdom. However, the two-panel model GDP and CO2 growth achieved during the period 1995-2019 using an FMOLS panel and a heterogeneous frame panel causality model.

The empirical results of this study can be summarized as follows. First,based on heterogeneity. The result of the panel cointegration method reveals that all series have a long-term equilibrium association. Second, the FMOLS panel for the GDP I model indicates that nuclear energy, FDI, and renewables have a statistically positive long-term influence on GDP. Likewise, nuclear and renewable energy have a negative long-term influence on the EC, which means that these clean energy sources play an important role in reducing energy carbon emissions.

Third, in Model I, there is short-term two-way causality between FDI and GDP that supports the feedback hypothesis. The results specify that the consumption of NE a has a short-term causality relative to GDP; the growth hypothesis is valid for the emitting countries, the results of our study revalued that energy conservation strategies could harm GDP. On the other hand, there is a short-term unidirectional causal link between GDP and renewable energy consumption that supports the conservation hypothesis. Renewable energy consumption could help expand access to energy in emitting countries; on the other hand, energy conservation policies may not harm GDP and energy consumption in the short term. ER has a positive and dynamic influence on GDP in the long term. Finally, in the CO2 II NE and RE model, consumption plays a fundamental role in reducing carbon emissions.

The empirical results of this study revealed that policies that encourage both RE and RE consumption forms helped increase GDP and mitigate carbon emissions. This pre-test Journal may occur due to the development of new power plants in the short term. Accelerated development of renewable energy sources (solar, wind, biomass and hydroelectric) and NE will enhance economic growth and emit minimal carbon emissions when used. To increase the share of green and sustainable energy in the entire energy structure, it is necessary to increase investment in RE and NE infrastructures that could contribute to improving energy efficiency.

In conclusion, both energy consumption and renewable energies are crucial for economic sustainability and ecological aspects.; therefore, the government should improve infrastructure projects and develop long, medium, and short-term energy strategies that can improve private sector companies, including subsidies, tax incentives, and sales tax for uninterrupted power generation. Each country is in a different situation, therefore renewable, the option of nuclear energy must remain within the framework of the Paris Agreement for the parties who wish to take them into account and also strengthen the profitability of their actions to reduce climate change.

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