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Towards A Political Economy of Renewable Energy: Does Democracy and Globalization Matter for Central and Eastern European Countries (CEECs)

W kierunku ekonomii politycznej energii odnawialnej: czy demokracja i globalizacja mają znaczenie dla krajów Europy Środkowej i Wschodniej (CEEC)

Orhan Cengiz*, Müge Manga**

**Çukurova University, Pozantı Vocational School, Department of Accounting and Taxation, Pozantı, Adana, Turkey,*
E-mail (Corresponding Author): ocengiz@cu.edu.tr, ORCID: 0000-0002-1883-4754
***Erzincan Binali Yıldırım University, FEAS, Department of Economics, Erzincan, Turkey,*
E-mail: mboga@erzincan.edu.tr, ORCID: 0000-0003-2675-2182

Abstract
Renewable energy policy is one of the remarkable parts of the sustainable development path. However, the political-economic dimension of renewable energy policies is not so much widely discussed. Besides, democracy and globalization are essential factors affecting renewable energy. Hence, this paper examines the relationship between renewable energy consumption, democracy, and globalization in the Central and Eastern European Countries (CEECs) during the period 1995-2021. Economic growth and CO_2 emissions are used as control variables in the model. The study employs the panel vector autoregressive (PVAR) estimation technique to quantify the relationship between renewable energy consumption, democracy, and globalization by including economic growth and CO_2 emissions. The findings from the PVAR analysis suggest that participatory democracy and globalization positively affect renewable energy consumption, while liberal democracy, economic growth, and CO_2 emissions have a negative impact on it. Furthermore, the PVAR Granger causality test outcomes indicate an interactive causal relationship between variables.

Key words: renewable energy consumption, democracy, political-economy, globalization, sustainable development, Central and Eastern European Countries (CEECs)

Streszczenie
Polityka w zakresie energii odnawialnej jest jednym z godnych uwagi elementów ścieżki zrównoważonego rozwoju. Polityczno-ekonomiczny wymiar polityki w zakresie energii odnawialnej nie jest jednak tak szeroko dyskutowany. Poza tym demokracja i globalizacja są istotnymi czynnikami wpływającymi na energię odnawialną. Dlatego niniejszy artykuł analizuje związek między zużyciem energii odnawialnej, demokracją i globalizacją w krajach Europy Środkowej i Wschodniej (CEEC) w latach 1995-2021. Wzrost gospodarczy i emisje CO_2 są wykorzystywane jako zmienne kontrolne w modelu. W badaniu zastosowano technikę szacowania PVAR do ilościowego określenia związku między zużyciem energii odnawialnej, demokracją i globalizacją, uwzględniając wzrost gospodarczy i emisje CO_2. Wyniki analizy PVAR sugerują, że demokracja uczestnicząca i globalizacja pozytywnie wpływają na zużycie energii odnawialnej, podczas gdy demokracja liberalna, wzrost gospodarczy i emisje CO_2 mają na nie negatywny wpływ. Ponadto wyniki testu przyczynowości PVAR Grangera wskazują na interaktywny związek przyczynowy między zmiennymi.

Słowa kluczowe: poziom zużycie energii odnawialnej, demokracja, ekonomia polityczna, globalizacja, zrównoważony rozwój, kraje Europy Środkowej i Wschodniej (CEEC)

1. Introduction

Over the past fifty years, global climate change has been sparked by increased CO_2 emissions (Seetanah et al., 2018). Thanks to carbon dioxide and other greenhouse gases as a primary driver of climate change, the global average temperatures have increased by more than 1℃ since pre-industrial times (Ritchie et al., 2020). Therefore, energy transition keeps its vital role in economic development. Achieving clean energy policies has been the most crucial issue in our time and has paid the attention of governments and policymakers in the context of sustainable development goals (SDGs). According to BP (2022), globally, renewable energy consumption increased by 12.6% between 2011 and 2021. For this reason, there has been significant attention to factors affecting renewable energy. Economic growth, foreign direct investment, technological improvement, trade openness, and financial development play an imperative role in renewable energy. In addition to these factors, qualitative factors such as democracy have a vital role in renewable energy for developing countries. In other words, energy policies can not be isolated from institutional factors that remarkably influence environmental policies (You et al., 2015). Romuald (2011) discussed that environmental quality is related to institutional quality. From the angle of democracy, theoretically, more democratic countries are sensitive to a cleaner environment and try to distribute resources toward cleaner production. Also, democratic countries have rigid policies which affect environmental regulation compared to the less-democratic countries (Chen et al., 2021). Therefore, citizens in democratic countries force policymakers to realize their renewable energy agenda (Saadaoui and Chtourou, 2022). Also, firms' lobbying and rent-seeking activities towards non-renewable energy are limited in more democratic countries (Sequeira and Santos, 2018). However, in a democratic country, it is not guaranteed that people always are interested in a clean environment. So, individuals sometimes ignore the demand for renewable energy thanks to the high cost of renewable energy, and it causes them to continue the usage of non-renewable energy sources. In this case, policymakers actualize the voters' preferences for traditional energy sources (Uzar, 2020). Although, it is expected that an increase in democracy rises renewable energy consumption, the political economy of the relationship between democracy and renewable energy consumption presents different views. Therefore, it is necessary to find more precise and robust findings regarding the impact of democracy on renewable energy consumption.

Furthermore, apart from economic growth and democracy, globalization's relevance to renewable energy must be determined, which has not been investigated comprehensively for developing countries. It is assessed that there exist different ways to increase renewable energy through globalization in developing countries. Firstly, well-known renewable energy technology needs massive financial sources to establish the required infrastructure investment for renewable energy. In this stage, foreign direct investment, capital investment, financial inflow, and international trade may contribute to improving renewable energy investment (Awosusi et al., 2022). Based on this approach, it is assumed that globalization improves competitiveness across firms. It ensures the lower costs of generating renewable energy in host countries, increases energy efficiency, and attracts foreign financial to install renewable energy technology. Secondly, a higher degree of globalization causes a rise in the awareness of environmental quality across society and becomes more sensitive to environmental and climate change issues. Hence, globalization may alter the energy consumption patterns and habits of the people and increase renewable energy usage instead of non-renewable energy sources such as fossil fuels (Nan et al., 2022).

Against the backdrop of prior studies, which have ignored the direct effect of democracy by using different indicators on renewable energy consumption, the role of globalization in shaping renewable energy consumption, this study aims to investigate the effect of democracy and globalization on renewable energy consumption for the Central and Eastern European Countries-CEECs (Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, and Lithuania) from 1995 to 2021. In our study, the reasons for including the CEECs are as follows:

- After the Cold War and the collapse of the Soviet Union, most of the CEECs have strived to continue their democratization paths for capturing solid democratic institutions. Thus, it is ambiguous whether democratization contributes to sustainable development by increasing renewable energy consumption in the CEECs.
- Furthermore, the CEECs have started to liberalize their economy for a long time. For this purpose, the impact of the globalization process on renewable energy consumption becomes more crucial in transition economies such as CEECs.

According to the data from Figure 1, renewable energy consumption has an increasing trend between 1995 and 2021. All Central and Eastern European Countries have had upward momentum since 1995. Mainly Slovenia and Latvia are the most renewable energy-consuming countries.

One of the distinguishing features of the CEECs is that while most of these countries belonged to the Socialist Bloc, they adopted policies to integrate with the global economy after the collapse of the Soviet Union. As a result, as can be seen from Figure 2, the KOF globalization index has increased significantly in all of these countries over the last thirty years. In this respect, the change of economic, political, and social structures in these countries with globalization has essential effects on energy policies.

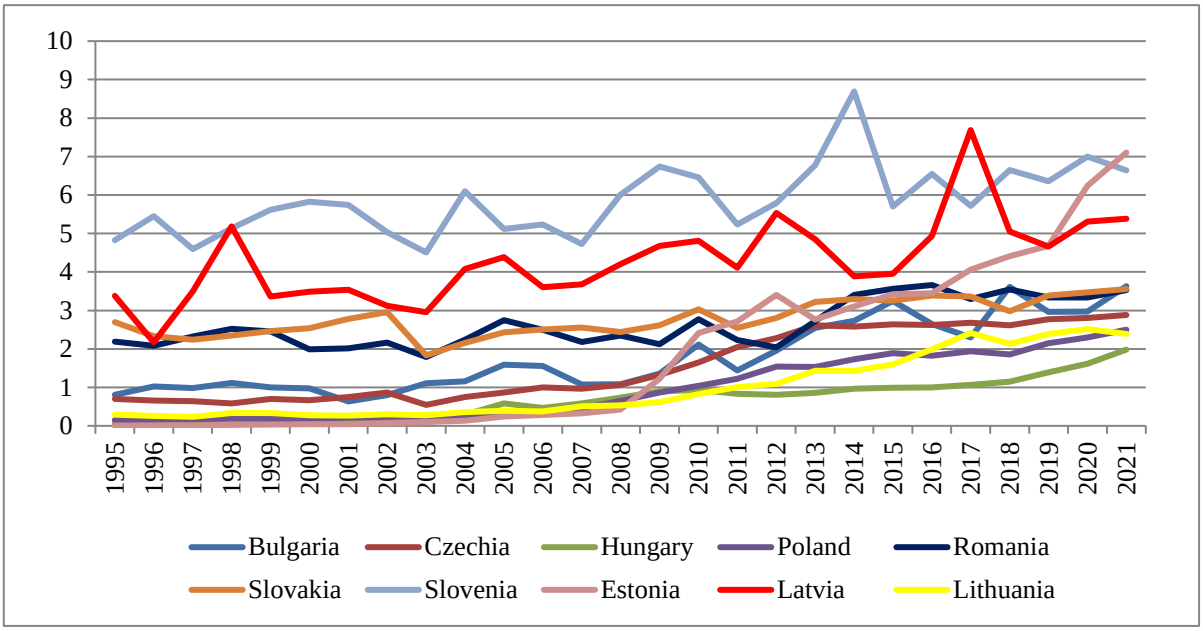

Figure 1. Per capita energy consumption from renewables (MWh), source: Our World in Data, 2023

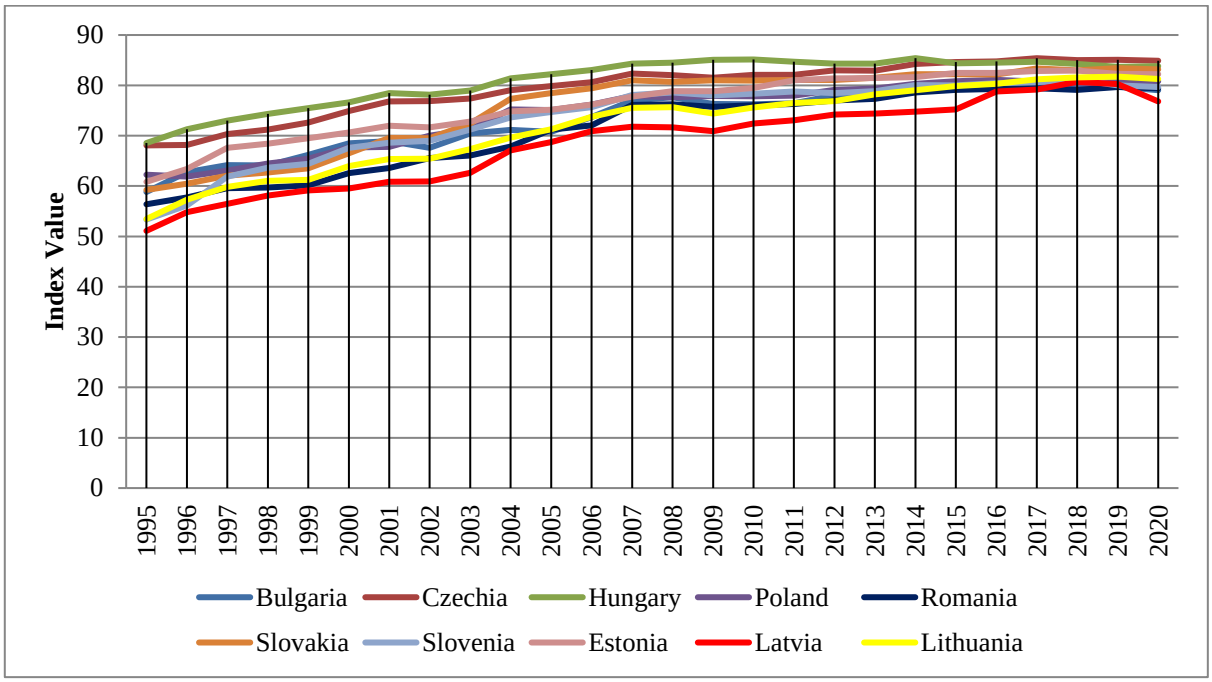

Figure 2. KOF globalization index, source: Gygli et al., 2019

Another prominent feature of the CEECs is that these countries have also started to implement a democratization process for a long time. In this framework, although all of the countries aimed to improve the democratization process as members of the EU, it can be said that this remained at a limited level. Considering the participatory democracy in Figure 3 and the liberal democracy index in Figure 4, limited improvements were seen in certain countries between 1995-2021, while democracy in others worsened. Therefore, the issue of how these developments in the democratization process affect renewable energy consumption gains importance.

Our study differs from another study as follows: (i) To the best of our knowledge, we consider this study to be the first to examine the impact of democracy by using different indicators and globalization on renewable energy consumption, specific to the Central and Eastern European Countries (CEECs); (ii) Unlike previous studies which have employed traditional techniques, our study performs the panel vector autoregressive (PVAR) estimation technique as a multivariate econometric method.

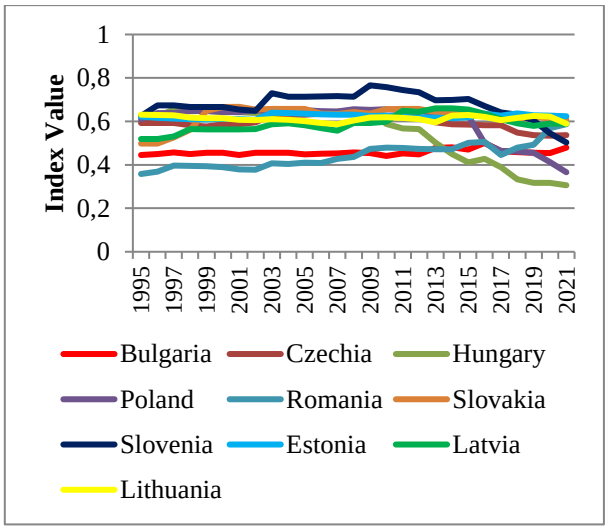

Figure 3. Participatory democracy index, source: Our World in Data, 2023

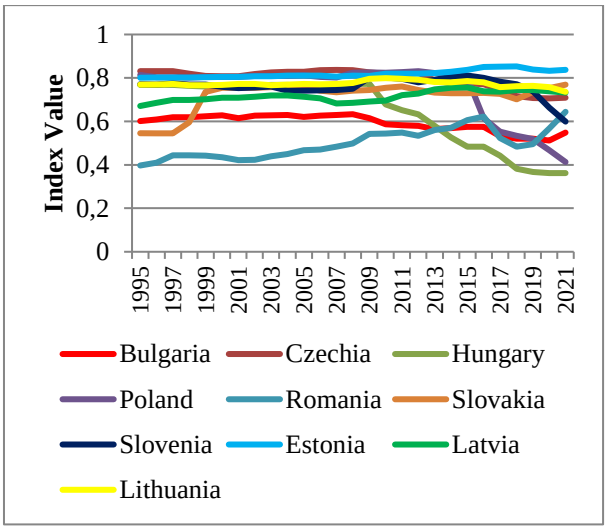

Figure 4. Liberal democracy index, source: Our World in Data, 2023

The rest of the paper is structured as follows: Section 2 explains the importance of renewable energy in the context of sustainable development goals; Section 3 summarizes the empirical literature review; Section 4 summarizes the data, models, and methodology; Section 5 provides empirical findings. Finally, Section 6 presents the conclusion and policy recommendations.

2. Importance of Renewable Energy in the Context of Sustainable Development Goals

United Nations (UN)' Sustainable Development Goals (SDGs) of the 2030 Agenda have excellent attention to achieving comprehensive sustainable policy for all spheres of society. The SDGs consist of 17 goals covering different targets with 169 targets and 230 indicators, from eliminating poverty to ensuring peace and justice (Fleming et al., 2017; Hillerbrand, 2018). The role of renewable energy in ensuring *access to affordable, reliable, and sustainable modern energy for all* as one part of the SDG 7 is crucial. As shown in Table 1 below, SDG 7's targets require a crucial energy transition. This energy transition is mainly based on an increasing share of renewable energy (Büyüközkan et al., 2018).

Table 1. Targets of the SDG 7, source: United Nations, 2015

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix
7.3 By 2030, double the global rate of improvement in energy efficiency
7.A By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
7.B By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

Although the world has experienced remarkable progress in access to energy, it is far from aimed level. The latest data confirms this situation. For example, according to the IEA (2022), almost 770 million people worldwide have no access to electricity. Moreover, 2.4 billion people still use inefficient and traditional cooking sources, which creates pressure on climate change. As of 2019, the share of renewable energy in total energy consumption was only 17.7%. It is also predicted that 679 million people will have no access to electricity by 2030 (United Nations, 2015). Although the investment in renewables was 366 billion dollars in 2021, the fossil fuel subsidies occurred approximately 5.9 trillion dollars in 2020 (Global Status Report, 2022). After years of development in energy technologies, concerns about renewable energy are still high on the agenda. Hence, it encourages all to struggle to achieve clean energy production and consumption in terms of sustainable development.

While countries and international organizations focused on achieving sustainable development goals, the COVID-19 pandemic has disrupted access to modern energy services. As a result, it negatively affected the targets of SDG 7, likewise other SDGs. For instance, the number of people without clean cooking increased by 30 million between 2019 and 2021 due to the COVID-19 pandemic. In addition, the COVID-19 pandemic caused to increase in the number of people without access to electricity by 2% in 2021 (IEA, 2021). Although renewable energy capacity has started to gather strength after the COVID-19 pandemic, just only 18% of total final consumption will be

generated from renewables by 2030. It is considerably below the aimed level-32% needed to achieve net zero (IEA, 2022). More importantly, the COVID-19 pandemic has revealed the importance of renewable energy sources such as electricity in maintaining economic activity, protecting lives, sustaining essential services, etc. (Sherpa et al., 2022).

3. Literature Review

As mentioned above, a vast body of literature emphasizes the importance of several factors. In this paper, we categorized the literature review under four headings in line with the variables used in the empirical model. The summary of the literature review is provided in Table 2.

Table 2. Summary of empirical literature review, source: Authors' compilation

Study	Sample	Period	Findings
Studies on Economic Growth and Renewable Energy Nexus			
Sadorsky (2009a)	G7 Countries	1980-2005	Economic growth and CO_2 emissions positively impact renewable energy consumption.
Sadorsky (2009b)	18 Emerging Market	1994-2003	Economic growth positively affects renewable energy consumption.
Apergis and Payne (2010)	OECD Countries	1985-2005	There is a two-way causality relationship between economic growth and renewable energy consumption.
Pao and Fu (2013)	Brazil	1980-2010	NHREC and TREC positively affect economic growth. There exists one-way causality from NHREC to economic growth, economic growth to NREC, TEC, and feedback causality between economic growth and TREC.
Apergis and Payne (2014)	OECD Countries	1980-2011	Real GDP, CO_2 emissions, and oil prices positively affect renewable energy consumption.
Zhao and Luo (2017)	China	1978-2013	Employment and regulation positively impact renewable energy, whereas economic growth negatively affects it.
Ntanos et al. (2018)	25 European Countries	2007-2016	The correlation between renewable energy consumption and economic growth is more potent in countries with a high level of economic growth.
Eren et al. (2019)	India	1971-2015	Economic growth and financial development have a positive influence on renewable energy consumption.
Chica-Olmo et al. (2020)	26 European Countries	1991-2015	Renewable energy consumption has a positive effect on neighboring countries' economic growth.
Wang et al. (2022)	OECD Countries	1997-2015	In general, renewable energy consumption positively affects economic growth.
Salari et al. (2021)	U.S. States	2000-2016	Renewable energy consumption positively affects economic growth.
Studies on CO_2 Emissions and Renewable Energy Nexus			
Omri and Nguyen (2014)	64 Countries	1990-2011	CO_2 emissions and trade openness have a remarkably positive impact on renewable energy consumption, whereas oil price has a minor impact.
Silva et al. (2018)	Sub-Saharan Africa	1990-2014	Economic growth and energy use positively impact renewable energy. In contrast, the price of fossil fuels, imports, population growth, and CO_2 emissions negatively affects it.
Karaaslan and Çamkaya (2022)	Turkey	1980-2016	Economic growth and non-renewable energy consumption increase CO_2 emissions while health expenditure and renewable energy consumption reduce it.
Sun et al. (2022)	MENA Countries	1991-2019	Economic growth and urbanization increase CO_2 emissions, while renewable energy consumption has a negative impact on CO_2 emissions.
Waheed et al. (2018)	Pakistan	1990-2014	Renewable energy consumption and forest negatively affect CO_2 emissions, although agricultural production has an increasing effect on CO_2 emissions.
Olanrewaju et al. (2019)	Five African Countries	1990-2015	Energy intensity, CO_2 emissions, oil rent, and coal rent negatively affect renewable energy consumption, whereas natural gas rent positively impacts renewable energy consumption.

Yu et al. (2022)	Australia, Germany, Japan, Spain, Italy, the USA, South Korea, the UK, France, and China	1991-2018	Renewable energy consumption has a negative impact on CO_2 emissions, except in France.
İnal et al. (2022)	Algeria, Equatorial Guinea, Egypt, Gabon, Congo Republic, Libya, Nigeria, and Sudan	1990-2014	Results show the positive impact of CO_2 emissions on growth for Algeria, Equatorial Guinea, and Egypt.
Omri and Saidi (2022)	MENA Countries	1990-2014	Renewable energy consumption negatively affects CO_2 emissions.
Salahodjaev et al. (2022)	Europe and Central Asia Countries	1990-2015	Renewable energy consumption negatively affects CO_2 emissions.
Adams and Nsiah (2019)	28 Sub-Saharan African Countries	1980-2014	Renewable energy consumption positively affects CO_2 emissions.
Ben Jebli and Ben Youssef (2017)	North African Countries	1980-2011	Renewable energy consumption positively affects CO_2 emissions.
Nguyen and Kakinaka (2019)	107 Low and High-Income Countries	1990-2013	Renewable energy consumption positively affects CO_2 emissions in low income countries, whereas it negatively affects in high-income countries.
Studies on Globalization and Renewable Energy Nexus			
Gozgor et al. (2020)	30 OECD Countries	1970-2015	Economic globalization contributes to an increase in renewable energy.
Ghazouani (2022)	15 Countries	1990-2018	There is a negative relationship between globalization and renewable energy between 2002 and 2011, and it turns a positive relationship after 2014. Furthermore, the impact of globalization on renewable energy differs depending on the renewable energy indicator.
Awosusi et al. (2022)	Vietnam	1984-2019	Economic globalization positively impacts renewable energy in the long run.
Nan et al. (2022)	33 OECD countries	2000-2018	Globalization promotes renewable energy consumption.
Bayar et al. (2021)	11 EU Transition Economies	1995-2015	There is a one-way causality relationship running from trade globalization to renewable energy in Estonia, Latvia, and Slovenia and from renewable energy to trade globalization in Croatia and Lithuania.
Zhang et al. (2022)	36 Belt and Road Countries	2001-2018	The impact of globalization on renewable energy development is positive in high-income, upper-middle-income, and low-income countries, except in lower-middle-income countries.
Liu et al. (2023)	20 Developing Countries	2000-2018	Importing capital goods from China has a negative impact on renewable energy consumption, whereas imports from the EU positively affect renewable energy consumption in developing countries.
Padhan et al. (2020)	30 OECD Countries	1970-2015	Classic globalization has an increasing effect on renewable energy consumption, whereas reconstructed and revisited economic globalization has a decreasing effect on renewable energy consumption.
Yazdi and Shakouri (2017)	Iran	1992Q1-2014Q4	There exists a feedback causality relationship between renewable energy consumption, globalization, financial development, and economic growth.
Zeren and Akkus (2020)	14 Emerging Countries	1980-2015	Non-renewable energy consumption increases trade openness while renewable energy consumption reduces it.
Han et al. (2022)	China	1990-2018	Trade increasingly affects non-renewable energy consumption for all quantiles. However, the positive impact of trade openness exists in some quantiles.
Zhou and Li (2022)	69 Countries	1990-2015	Trade liberalization is positively associated with renewable energy consumption.
Rezagholizadeh et al. (2020)	Iran	1978-2016	FDI and financial development positively affect renewable energy consumption.
Khan et al. (2021)	69 Belt and Road Countries	2000-2014	Technological improvements, economic growth, and FDI are negatively associated with renewable energy consumption, whereas financial development positively influences renewable energy consumption.

Wei et al. (2022)	China	2000-2019	FDI has a substitutional impact on renewable energy.
Qamruzzaman et al. (2022)	13 Top Oil-Importing Countries	1995-2018	FDI and government debt positively affect renewable energy consumption, while economic policy uncertainty is negatively associated with renewable energy consumption.
Akpanke et al. (2023)	15 West African Countries	1990-2021	FDI positively impacts renewable energy consumption.
Elheddad et al. (2022)	Bangladesh	1990-2019	FDI negatively impacts renewable energy consumption.
Studies on Democracy and Renewable Energy Nexus			
Wu and Broadstock (2015)	22 Emerging Countries	1990-2010	Institutional quality and financial development positively impact renewable energy consumption.
Cadoret and Padovano (2016)	26 EU Countries	2004-2011	Lobby activities in the manufacturing sector are negatively associated with renewable energy deployment, whereas the quality of governance positively affects it. In addition, left parties are more aptness to encourage renewable energy policies than right parties.
Uzar (2020)	38 Countries	1990-2015	Institutional quality positively affects renewable energy consumption.
Wang et al. (2022)	32 OECD Countries	1997-2019	Institutional quality and economic growth are positively associated with renewable energy consumption, whereas economic globalization and political risk have a negative impact on renewable energy consumption.
Rahman and Sultana (2022)	19 Emerging Countries	2002-2019	Institutional quality, economic growth, and export are positively associated with renewable energy consumption.
Saadaoui and Chtourou (2022)	Tunisia	1984-2017	Financial development negatively impacts renewable energy consumption. In contrast, economic growth and institutional quality promote renewable energy consumption.
Saidi et al. (2020)	MENA Countries	1986-2015	There exists one-way causal linkage running from renewable energy to bureaucracy quality, democratic accountability, and ethnic tensions.
Amoah et al. (2022)	32 African Countries	1996-2019	Corruption harms renewable energy consumption.
Asongu and Odhiambo (2022)	44 Sub-Saharan African Countries	1996-2016	Political and institutional factors have a negative effect on renewable energy consumption.
Mahmood et al. (2021)	Pakistan, India, Bangladesh, and Sri Lanka	1996-2019	Regulatory quality positively influences renewable and non-renewable energy consumption, except for natural gas. The rule of law and government effectiveness negatively and positively impact all energy sources, respectively. Political stability negatively affects non-renewable energy consumption and positively affects renewable energy sources. Corruption is positively related to natural gas consumption.
MacLean et al. (2015)	53 Countries in Africa	2011-2012	The non-governmental organizations (NGOs) are more effective where high democracy exists, with renewable energy sources lacking for most of the population.
You et al. (2015)	97 Countries	1985-2005	Democracy has a negative impact on CO_2 emissions, while financial openness has no mitigating effect on CO_2 emissions.
Lv (2017)	19 Emerging Countries	1997-2010	Democracy has a negative impact on CO_2 emissions.
Adams and Acheampong (2019)	46 Sub-Saharan African Countries	1980-2015	Democracy and renewable energy consumption negatively affects CO_2 emissions.
Wang et al. (2018)	G20 Countries	2000-2014	Democracy upsurges PM2.5 concentrations in highly-polluted countries compared to less-polluted countries.
Ergun et al. (2019)	21 African Countries	1990-2013	Democracy has no substantial effect on renewable energy consumption.
Sequeira and Santos (2018)	193 Countries	1998-2017	Democracy has a positive impact on renewable energy.
Akalin and Erdogan (2021)	26 OECD Countries	1990-2015	Democracy negatively affects environmental quality.

Chen et al. (2021)	97 Countries	1995-2015	Democratic institutions have a promoting effect on renewable energy consumption.
Ahmed et al. (2022)	G7 Countries	1985-2017	Democracy increases environmental degradation.
Ahmed et al. (2022)	Pakistan	1984-2017	Democracy has a negative impact on the ecological footprint.

NHREC: Non-hydroelectric renewable energy consumption; NREC: Non-renewable energy consumption; TREC: Total renewable energy consumption; TEC: Total primary energy consumption; FDI: Foreign direct investment.

4. Empirical Strategy

4.1. Data and Variable Descriptions

When modeling renewable energy consumption, it is crucial to determine the significant factors influencing it. The main aim of the study is to investigate the impact of democracy and globalization on renewable energy consumption using annual data from Central and Eastern European Countries (Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, and Lithuania) spanning the period 1995 and 2021. The control variables comprised gross domestic per capita and CO_2 emissions per capita. The variables and data sources are described in Table 3.

Table 3. Variable description and source of the dataset, source: Authors' compilation

Variables	Description	Units	Source
REC	Per Capita Energy consumption from renewables	Megawatt-hours	Our World in Data (2023)
Dem_Par	Participatory Democracy	Index (between 0 and 1)	Our World in Data (2023)
Dem_Lib	Liberal Democracy	Index (between 0 and 1)	Our World in Data (2023)
GDP	GDP per capita	Constant at 2015 US$	World Bank (2023)
KOF	Globalization	Index (between 0 and 100)	Gygli et al. (2019)
CO_2	Carbon dioxide emissions per capita	Metric tonnes	World Bank (2023)

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4.2. Empirical Model

Following the previous studies, the functional specification in this paper can be expressed as below:

$$REC_{it} = f(DEMpar_{it}, DEMlib_{it}, GDP_{it}, KOF_{it}, CO2_{it}) \quad (1)$$

The variables are transformed into their natural logarithms, which are shown in the following:

$$lnREC_{it} = \alpha_0 + \alpha_1 lnDEMpar_{it} + \alpha_2 lnDEMlib_{it} + \alpha_3 lnGDP_{it} + \alpha_4 lnKOF_{it} + \alpha_5 lnCO2_{it} + \varepsilon_{it} \quad (2)$$

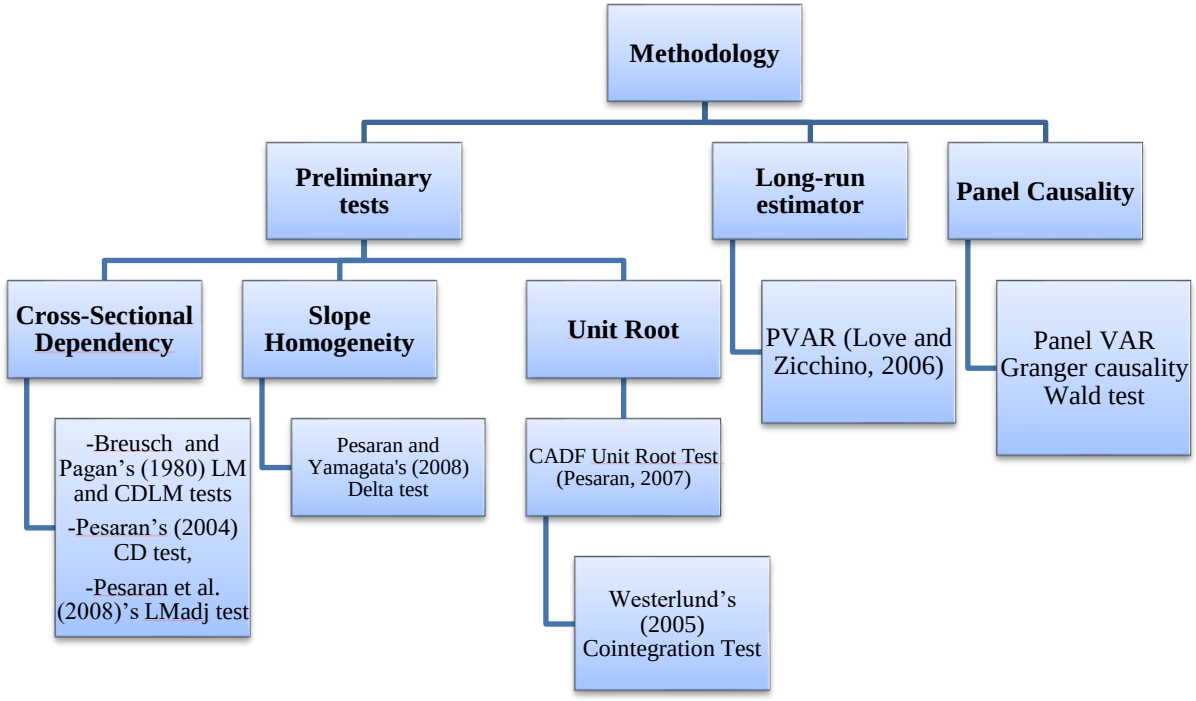

Figure 5. Steps of econometric analysis, source: Authors' compilation

In Equation (2), REC represents per capita energy consumption from renewables (megawatt-hours), DEMpar and DEMlib denote participatory democracy and liberal democracy, respectively. The GDP is the gross domestic product per capita constant at 2015 US$ as a proxy of economic growth. Finally, the KOF is the overall globalization index, and CO_2 represents carbon dioxide emissions (metric tons per capita).

4.3. Empirical Methodology

This study applies several econometric procedures step by step. We tested the cross-sectional dependency (CSD) and slope homogeneity in the first step. After testing the cross-sectional dependency and slope homogeneity, we tested the stationary properties of data through the panel unit root test, then co-integration, long-run parameters estimates, and causal relationships between variables. The process of econometric analysis is picturized in Figure 5.

5. Empirical Results

5.1. Preliminary Tests Results

In the first stage of our empirical findings, it is critical to test the cross-sectional dependency and slope homogeneity in the model. Therefore, our empirical analysis starts with testing cross-sectional dependency and slope homogeneity among variables. The results of cross-sectional dependency and slope homogeneity are reported in Table 4.

Table 4. Cross-sectional dependency and slope homogeneity test results, source: Authors' compilation

CS Dependency	**lnREC**	**lnDem_Par**	**lnDem_Lib**	**lnGDP**	**lnKOF**	**lnCO_2**
LM	256 (0.000)	346 (0.000)	418.76 (0.000)	218.2 (0.000)	417 (0.000)	172.3 (0.000)
CD_{LM}	62.27 (0.000)	91.23 (0.000)	39.398 (0.000)	51.5 (0.000)	110.6 (0.000)	38.17 (0.000)
CD	13.7 (0.000)	15.68 (0.000)	2.818 (0.000)	5.963 (0.000)	18.92 (0.000)	9.402 (0.000)
LM_{adj}	26.96 (0.000)	2.79 (0.000)	39.206 (0.000)	33.90 (0.000)	34.07 (0.000)	10.70 (0.000)
Slope Homogeneity	**lnREC**	**lnDem_Par**	**lnDem_Lib**	**lnGDP**	**lnKOF**	**lnCO_2**
Delta ($\tilde{\Delta}$)	30.57 (0.000)	10.16 (0.000)	19.037 (0.000)	30.57 (0.000)	27.10 (0.000)	13.15 (0.000)
Delta $(\tilde{\Delta})_{adj}$	32.43 (0.000)	10.78 (0.000)	20.192 (0.000)	32.43 (0.000)	28.74 (0.000)	13.95 (0.000)

Note: Numbers in brackets denote p-values.

The outcomes from Table 4 reject the null hypothesis of no cross-sectional dependency among variables and confirms that the variables are heterogeneous in the panel at the 1% significance level. Therefore, after validating the presence of cross-sectional dependency and slope heterogeneity, second-generation unit root tests must be used to assess the stationarity of the variables. Thus, we have employed the CADF unit root test, and the results are reported in Table 5.

Table 5. The CADF unit root test results, source: Authors' compilation

Variables	**lnREC**	**lnDem_Par**	**lnDem_Lib**	**lnGDP**	**lnKOF**	**lnCO_2**
CADF Test Statistics (Level)	-1.871 (0.359) [4]	-1.181 (0.970) [1]	-0.970 (0.995) [1]	-1.898 (0.326) [2]	-1.879 (0.350) [3]	-0.697 (1.000) [1]
CADF Test Statistics (First Differences)	-2.723 (0.001) [3]	-2.931 (0.000) [1]	-2.477 (0.010) [1]	-2.525 (0.006) [2]	-3.576 (0.000) [3]	-3.764 (0.000) [1]
Order of Integration	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Note: Numbers in () and [] are p-values and lag-length, respectively. The critical values at 1%, 5%, and 10% level of significance are -2.570, -2.330, and -2.210, respectively.

Table 5 illustrates that all variables are stationary at first difference. In other words, they are integrated with first-order [I(1)]. Since cross-sectional dependency, slope heterogeneity, and the order of integration of the variables have been verified, we have performed Westerlund's (2005) cointegration to investigate the long-run relationships among renewable energy consumption, democracy, economic growth, globalization, and CO_2 emissions. Westerlund' (2005) cointegration test outcomes are reported in Table 6.

Table 6. The cointegration test result, source: Authors' compilation

	Cointegration Test	
Variance ratio	**Statistics**	**p-value**
	-1.637	0.050

The results of the Westerlund cointegration test in Table 6 demonstrate that the null hypothesis of no cointegration could be rejected at a 5% significance level, implying that lnREC, lnDem_Par, lnDem_Lib, lnGDP, lnKOF, and $lnCO_2$ are cointegrated and move together in the long run.

5.2. PVAR Model Results

Before estimating the long-run parameters using the PVAR technique, the current step is determining the lag period suitable for constructing the PVAR model. The results of the lag length criteria are documented in Table 7.

Table 7. Results of lag selection criteria, source: Authors' compilation

Lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	0.309	167.69	0.086	-595.267	-120.31	-312.518
2	0.639	117.82	0.243	-454.393	-98.175	-242.313
3	0.731	83.121	0.174	-298.357	-60.878	-156.982
4	0.734	41.850	0.231	-148.889	-30.149	-78.201

Note: CD means the overall coefficient of determination, and J is Hansen's J statistics. MBIC, MAIC, and MQIC represent the Modified version of Bayesian Information Criterion, Modified version of Akaike Information Criterion, and Modified version of Hannan and Quinn Information Criterion, respectively.

According to the MBIC, MAIC, and MQIC, the optimal lag of the PVAR model is one. After deciding the optimal lag length, we estimated the long-run parameters by performing PVAR based on the GMM equation. The PVAR regression results are offered in Table 8.

Table 8. The PVAR regression results, source: Authors' compilation

Response of	Response to					
	lnREC	**lnDem_Par**	**lnDem_Lib**	**lnGDP**	**lnKOF**	**$lnCO_2$**
$lnREC_{(t-1)}$	0.880***	0.022**	0.319**	0.003	1.181	0.753***
$lnDem\_Par_{(t-1)}$	2.774***	1.004***	-0.671***	-0.286***	0.435***	-0.420***
$lnDem\_Lib_{(t-1)}$	-0.984**	0.208**	1.349***	0.145***	1.977**	0.276***
$lnGDP_{(t-1)}$	-1.040**	0.429***	0.652***	1.215***	1.074***	1.083***
$lnKOF_{(t-1)}$	0.005*	-0.005***	-0.005***	-0.004***	0.654***	-0.004***
$lnCO_{2(t-1)}$	-0.488**	0.100	-0.081*	-0.303	4.493*	0.636***

Note: Asteriks *,**, and *** denote significance level at 10%, 5%, and 1%, respectively.
Test of overidentifying restriction: Indeed, this specification produces a Hansen's J statistics connected with a chi2 (108) = 111.785* at 10% levels, which in this context refers to the case where we with confidence can not reject the null hypothesis which states that the overidentification restrictions are not valid, thus making the specification valid.

There are six results in the PVAR model. Therefore, we can summarize the findings of the PVAR as follows:

- Considering renewable energy consumption as the explanatory variable, renewable energy consumption positively affects all types of democracy (participatory and liberal) and CO_2 emissions. A 1% increase in renewable energy consumption improves participatory democracy, liberal democracy, and CO_2 emissions by 0.022%, 0.319%, and 0.753%, respectively.
- Considering participatory democracy as the explanatory variable, participatory democracy positively affects renewable energy consumption and globalization while negatively affecting liberal democracy, economic growth, and CO_2 emissions. A 1% increase in participatory democracy increases renewable energy consumption and globalization by 2.774% and 0.435%, respectively; decreases liberal democracy, economic growth, and CO_2 emissions by 0.671%, 0.286%, and 0.420%, respectively.
- Considering liberal democracy as the explanatory variable, liberal democracy has a positive impact on participatory democracy, economic growth, globalization, and CO_2 emissions. In contrast, it has a negative impact on renewable energy consumption. A 1% increase in liberal democracy increases participatory democracy, economic growth, globalization, and CO_2 emissions by 0.208%, 0.145%, 1.977%, and 0.276%, respectively; decreases renewable energy consumption by 0.984%.
- Considering economic growth as the explanatory variable, economic growth positively impacts participatory democracy, liberal democracy, globalization, and CO_2 emissions, whereas it negatively impacts renewable energy consumption. A 1% increase in economic growth increases participatory democracy,

liberal democracy, globalization, and CO_2 emissions by 0.429%, 0.652%, 1.074%, and 1.083%, respectively; decreases renewable energy consumption by 1.040%.

- Considering globalization as the explanatory variable, globalization positively affects renewable energy consumption. On the contrary, it negatively affects participatory democracy, liberal democracy, economic growth, and CO_2 emissions. A 1% increase in globalization increases renewable energy consumption by 0.005%; decreases participatory democracy, liberal democracy, economic growth, and CO_2 emissions by 0.005%, 0.005%, 0.004%, and 0.004%, respectively.
- Considering CO_2 emissions as the explanatory variable, CO_2 emissions positively affects globalization, whereas it negatively influences renewable energy consumption and liberal democracy. A 1% increase in CO_2 emissions increases globalization by 4.493% and decreases renewable energy consumption and liberal democracy by 0.488% and 0.081%, respectively.

5. 3. Panel VAR Granger causality test results

Further, this study employs the causality test to check the causal relationships among variables. The results of the PVAR Granger causality (Wald) test are provided in Table 9.

Table 9. The PVAR Granger causality Wald test results, source: Authors' compilation

Causal direction Lag(1)	**lnREC**	**lnDem_Par**	**lnDem_Lib**	**lnGDP**	**lnKOF**	**lnCO_2**
lnREC	-	4.107	6.522***	7.673***	6.281*	30.025***
lnDem_Par	11.890***	-	8.195**	12.068***	13.422*	9.406***
lnDem_Lib	4.194 *	7.012**	-	2.897	4.710***	6.505***
lnGDP	33.184***	23.633***	21.378***	-	25.219***	26.794***
lnKOF	4.792***	21.486***	7.465***	21.119***	-	8.913***
lnCO_2	9.097**	2.246	3.629	1.462	3.787	-

Note: Asterisks *, **, and *** illustrate significance level at 10%, 5%, and 1%, respectively.

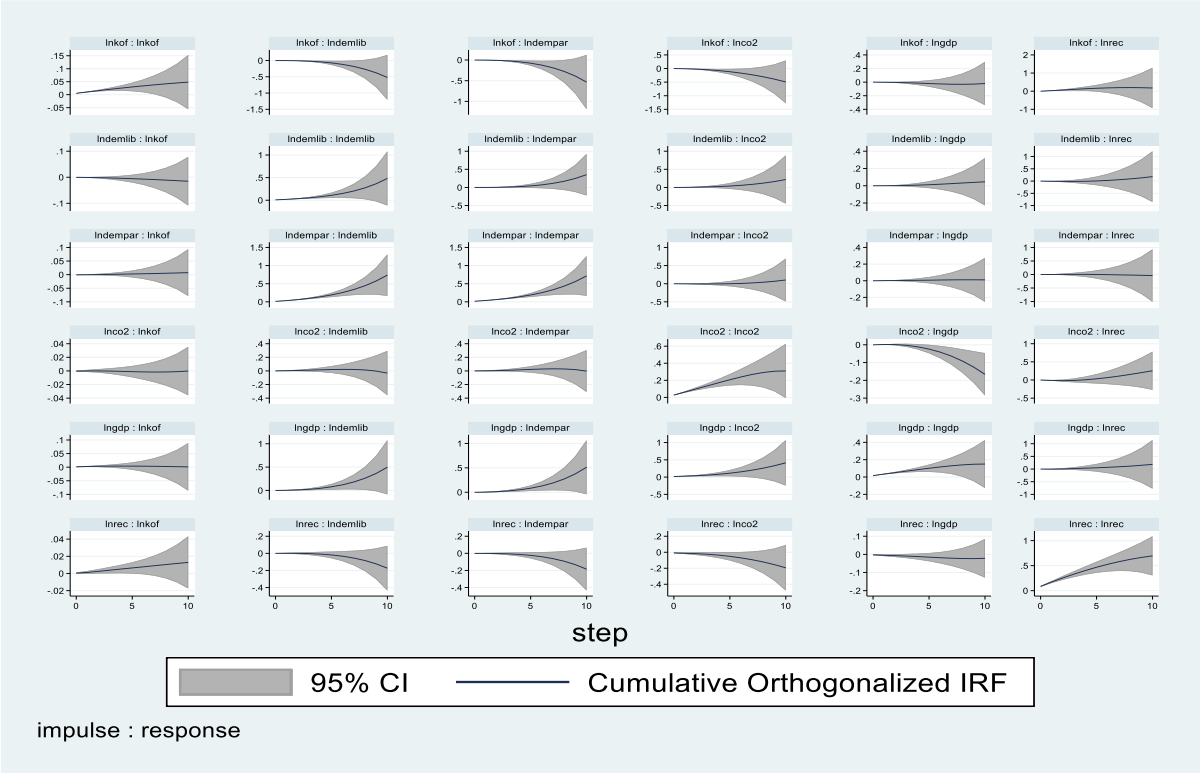

Figure 6. Impulse-response analysis results, source: Authors' compilation

- The panel VAR Granger causality outcomes provide a two-way causal relationship between renewable energy consumption-liberal democracy, renewable energy consumption-economic growth, renewable energy consumption-globalization, and renewable energy consumption-CO_2 emissions.

- There is a two-way causal relationship between participatory democracy-liberal democracy, participatory democracy-economic growth, participatory democracy-globalization, and a one-way causality relationship running from participatory democracy to renewable energy consumption and CO_2 emissions.
- There is a two-way causal relationship between liberal democracy-globalization and a one-way causality relationship running from liberal democracy to CO_2 emissions.
- There is a two-way causal relationship between economic growth-globalization and a one-way causality relationship running from economic growth to liberal democracy and CO_2 emissions.
- There is a one-way causal relationship running from globalization to CO_2 emissions.

The PVAR model does not only analyze the coefficient estimators among variables. In addition, it allows us to follow the dynamic response of variables to one another. This technique is called the impulse-response function, and our impulse-response analysis result is provided in Figure 6.

According to the results of the impulse-response analysis, where renewable energy consumption is a dependent variable; renewable energy consumption increases due to a one-unit change in globalization and economic growth. On the other hand, due to a one-unit change liberal democracy, participatory democracy, and in CO_2 emissions, renewable energy consumption does not reflect any change in the first period. Then, however, it starts to decrease in the next period.

6. Conclusions and Policy Directions

As a crucial determinant of environmental quality, renewable energy has taken great attention from policymakers and researchers. Although the factors affecting renewable energy have been extensively investigated, no significant body of literature focuses on the effects of democracy and globalization on renewable energy. In the relevant literature, mainly the determinants of renewable energy have been analyzed in the context of quantitative factors. However, there are several qualitative factors, such as democracy, affecting renewable energy policies in developing countries. Therefore, the possible impacts of democracy and globalization on renewable energy are needed to reveal clearly for developing countries. For this purpose, this study examines the impact of democracy and globalization by controlling the role of economic growth and CO_2 emissions for a panel of 10 Central and Eastern European Countries (CEECs) (Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, and Lithuania) from 1995 to 2021. We used the PVAR estimation technique and the PVAR Granger causality tests to check for the long-run parameters' estimate and examine the direction of causalities between variables.

Considering renewable energy consumption as the dependent variable, participatory democracy and globalization positively affect renewable energy consumption, while liberal democracy, economic growth, and CO_2 emissions negatively affect it. Our positive impact of democracy on renewable energy consumption is in line with the results of You et al. (2015), Sequeira and Santos (2018), Ahmed et al. (2022), Uzar (2020), and Chen et al. (2021) who concluded that democracy has a promoting effect on environmental quality and renewable energy. Furthermore, the negative impact of liberal democracy on renewable energy is in line with the results of Wang et al. (2018), Ahmed et al. (2022), and Akalin and Erdogan (2021) found that democracy causes to increase in environmental degradation. The opposite effects of participatory and liberal democracy on renewable energy consumption are required to explain. As Lv (2017) emphasized that the relationship between democracy and environmental quality offers controversial views. The impact of democracy on environmental quality and renewable energy is heterogeneous in the relevant literature. In the CEECs as a whole, the quality of democracy is still far from maturity compared to developed countries. Thus, if individuals can participate much more in the decision process related to the environment and energy policy, the energy transition will be easy and more substantial. Participatory democracy means citizens have a more significant say in decision-making than in liberal democracy. Particularly in the decisions to be taken on societal issues, the fact that there is a more participatory process ensures the empowerment of individuals and citizens.

The impact of economic growth on renewable energy consumption is negative. It indicates that an increase in GDP per capita decreases renewable energy consumption instead of increasing it. This finding is consistent with Cadoret and Padovano (2016), Zhao and Luo (2017), and Uzar (2020), who obtained that economic growth has a negative impact on renewable energy. However, this finding is different from Sadorsky (2009a), Sadorsky (2009b), Apergis and Payne (2014), and Eren et al. (2019), who found that economic growth positively influences renewable energy. In our model, the negative impact of economic growth on renewable energy can be caused by some reasons. An increase in economic growth causes to rise in energy demand. In this case, with the high cost of stock and establishment for renewable energy, individuals tend to consume more non-renewable energy sources accessible to people. Thus, the impact of economic growth on renewable energy becomes negative (Uzar, 2020). According to the findings, globalization positively affects renewable energy consumption. This finding is consistent with the results of Gozgor et al. (2020), Awosusi et al. (2022), Nan et al. (2022) and Zhang et al. (2022). Finally, CO_2 emissions decrease renewable energy consumption. It means that increasing CO_2 emissions decreases renewable energy consumption and vice-versa for all countries. This is consistent with the study of Silva et al. (2018), Nguyen and Kakinaka (2019), and Olanrewaju et al. (2019). However, it contradicts the study of Omri and Nguyen (2014),

Murshed (2020), and Chen et al. (2021). Generally, an increase in CO_2 emissions is expected to enhance renewable energy consumption in terms of cleaner and sustainable environmental policies. However, the empirical findings can be differed depending on the countries' development level. Notably, the commitment of international agreements such as the Kyoto protocol and the Paris Agreement should care little about renewable energy consumption in developing countries. Hence, CO_2 emissions do not cause to increase in renewable energy consumption as expected. Based on our empirical findings, the following policy suggestions are proposed:

- Economic growth reduces renewable energy consumption. As Uzar (2020) mentioned, if people focus on the cost of renewable energy consumption, economic growth may not promote environmental quality through increasing renewable energy consumption. Because, in this case, people prefer to consume cheap non-renewable energy sources. Thus, policymakers should promote renewable energy consumption through some incentives (for example, taxes exemption and credit loans).
- Participatory democracy promotes renewable energy consumption, while liberal democracy negatively affects renewable energy consumption. This means that if people participate actively in the decision-making process, which is associated with the public interest. Thus, policymakers should establish policies to increase democratic institutions that allow for deciding options in terms of environmental policies. In this regard, ensuring democratic awareness can play a key role in ensuring environmental quality.
- Globalization positively affects renewable energy consumption. Globalization offers new views regarding environmental quality and attracting renewable energy through foreign investment and trade. Therefore, removing bureaucratic barriers and tariffs and promoting foreign direct investment in renewable energy is crucial for sustainable development. Furthermore, international cooperation between developed and CEECs in the contexts of technology transfer and technological improvement through globalization can be strengthened to support and expand renewable energy resources in the CEECs.
- The COVID-19 pandemic showed us that clean energy systems are vital for all spheres of life. Hence, it is necessary to make an effort to transiting toward renewable energy systems to capture the SDG 7 target. More coordinated and comprehensive domestic policies and international cooperation can be convenient options to ensure SDGs in this framework.
- Policymakers in these countries should implement more stringent environmental regulations and increase the environmental awareness of individuals.

Although this study contributes to the literature, it has some limitations. Firstly, we use the overall KOF globalization index, which includes economic, social, and political globalization dimensions. As a result, future studies can investigate the effects of different dimensions of globalization separately. Secondly, we used gross domestic per capita and CO_2 emissions as control variables. Future studies can also examine the impact of environmental taxes and renewable energy costs.

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