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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Examining the Relationship Between Climate Change, Energy Consumption, and the Financial System: The Case of E7 Countries

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Abstract
This study aims to investigate the correlation among climate change, energy consumption, and the financial system, using the E7 countries as a case study. The E7 comprises emerging economies including Brazil, China, India, Russia, Turkey, Indonesia, and Mexico, which are the primary focus of this research. The research delves into the factors impacting CO2 emissions over the long term, spanning from 1992 to 2020. Results reveal a positive correlation between economic growth and fossil fuel usage with CO2 emissions, while a negative correlation is identified between CO2 emissions and variables such as renewable energy consumption, temperature changes, and capital investments. The study underscores the significance of sustainability and environmental policies for the E7 nations. Recommendations include increasing investments in renewable energy sources, encouraging the adoption of carbon-neutral transportation technologies, and supporting initiatives for forest conservation and afforestation. In conclusion, this study provides valuable insights into the relationship between climate change, energy consumption, and the financial system within E7 countries, offering policy recommendations for achieving sustainability.
Keywords: Climate Change, Energy Consumption, Financial System, E7 Countries
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I. INTRODUCTION

With the onset of globalization, economies have become integrated with each other in many areas, primarily trade, finance, and technology. Developments in information technology have accelerated this change dramatically. One of the most important elements of economic progress and sustainability worldwide, given advancements in technology, is energy. However, today it is understood that a significant portion of global energy consumption (EC) is not sustainable, considering current technology and general energy sources. At this point, the importance of renewable energy (RE) sources comes to the forefront [1-2].

The use of RE sources plays a central role today in key issues such as economic growth (EG) and global temperature change. RE sources are generally derived from various forms and sources such as solar energy, wind energy, water energy (including river currents, sea and ocean waves), and biomass, biogas, or biochemical energy. These sources, while supporting a sustainable energy supply, also have the potential to promote EG. In particular, increasing investments in RE can bring economic benefits such as creating new job opportunities, transitioning to a green economy, and reducing energy dependency. However, in the face of global issues such as climate change and rising temperatures, the importance of using RE sources is becoming increasingly evident [3]. Investments in RE can also play a critical role in controlling global temperature change by reducing carbon emissions. In particular, reducing greenhouse gas emissions and decreasing the use of fossil fuels are fundamental steps in mitigating the effects of climate change worldwide and ensuring a sustainable future. The Paris Agreement aims to establish a system based on the principles of common responsibilities and differentiated contributions for all developed and developing countries. The agreement aims to establish and strengthen a sustainable system encompassing socio-economic activities globally in the period after 2020 to combat climate change.

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The European Green Deal (EGD) was announced in 2019 with the aim of implementing the global climate change initiatives set forth by the Paris Climate Agreement. The Green Deal aims to reduce greenhouse gas emissions by 55% by 2030 and achieve carbon neutrality by 2050 as part of the EU's growth strategy. Within this framework, the goal is to ensure a transparent, fair, and inclusive transition by reducing pollution, preserving the lives of all living beings, and assisting companies in becoming world leaders in clean products and Technologies [4].

The long-term changes in average surface temperatures worldwide and atmospheric weather conditions are attributed to the increases in greenhouse gas emissions resulting from human activities such as industrialization, fossil fuel use, and deforestation. In particular, increases in the production and consumption of fossil fuels such as coal, oil, and natural gas have led to a rise in global temperatures by approximately 1.1°C compared to pre-industrial levels. The use of fossil fuels in energy production contributes to an increase in carbon dioxide concentration in the atmosphere.. The reduction of this emissions has been identified as a priority and major concern globally. According to the Intergovernmental Panel on Climate Change, it has been stated that the primary cause of the increase in surface temperatures over the past century is the rise in human-induced greenhouse gas emissions. Reducing greenhouse gas emissions is recognized as the most important objective in addressing this issue by the international community [5-6]. Doval and Negulescu [7], demonstrated in their study that green finance and production practices are depicted as a formula for Europe's recovery from crises. Emerging economies, especially those like the E7, exhibit particular sensitivity to climate change threats due to rapidly increasing EC and resulting CO2 emissions (CO2E). Figure 1 shows that among the E7 countries, China has the highest CO2E, while Turkey has the lowest emissions.

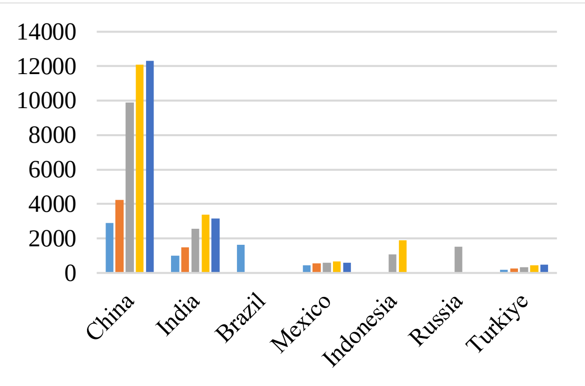

Figure 1. Greenhouse Gas Emissions

The relationship between temperature change and RE production is extremely important. Research indicates that global temperature increase has a positive impact on RE production. For example, high temperatures and longer periods of sunshine can increase the efficiency of solar energy systems, thereby promoting RE production. Similarly, the efficiency of wind energy systems can also vary depending on temperature changes.

The efficient use of resources, especially in production, has become essential in all sectors as part of the fight against climate change. The effects of global environmental changes, particularly evident during the Covid-19 pandemic, have highlighted the need for resource efficiency. The aim of this study is to determine the relationship between climate change, EC, and the financial system in E-7 countries in the long term, and to provide recommendations on sustainability and environmental policies. In this context, the study will begin with a comprehensive literature review, followed by a detailed explanation of the methodology and data employed. Finally, the findings will be analyzed and interpreted.

Studies in the literature provide significant evidence regarding the relationship between climate change and EG.Research in the United States has established the foundational evidence for the relationship between climate change and EG. Strobl [9], conducted a study investigating the impact of hurricanes on EG in 409 coastal regions of the United States between 1970 and 2005. The research revealed that, on average, hurricanes reduced regional EG by 0.45 percentage points. Deryugina and Hsiang [10], employed the EKK method to examine the impact of daily temperature on EG in 48 states of the United States from 1969 to 2011. The study indicates that each 1°C increase in daily temperature above 15°C reduces daily economic productivity by approximately 1.7 percent. Colacito et al. [11], examined the impact of average seasonal temperatures on EG in the United States from 1957 to 2012 using the Panel EKK method. The study found that temperatures, particularly during summer months, have significant effects on EG. It was determined that a 1°F increase in average summer temperature is associated with a decrease in annual growth rate by 0.15-0.25 percentage points.

Research encompassing diverse countries provides strong evidence for understanding the relationship between climate change and EG. Bansal and Ochoa [12], examined the effects of temperature on EG for 147 countries between 1950 and 2007. The study found that a 1°C temperature shock reduced EG by approximately 0.9 percent, with stronger effects observed in countries closer to the equator. Dell et al. [13], investigated the impact of climate change on global economic activity between 1950 and 2006. They found that a 1°C increase in temperature would decrease EG by approximately 1.3 percent, with poorer countries being more adversely affected. According to Burke et al. [14], economic productivity peaks when the annual average temperature is 13°C, with efficiency rapidly declining at higher temperature levels. Azam et al. [15], investigated the impact of environmental degradation on EG using annual data from 1971 to 2013 for China, the United States, India, and Japan. The results of the study indicate that carbon emissions have a significant positive relationship with EG for China, Japan, and the United States, while for India, it exhibits a significantly negative relationship. Sequeira et al. [16], found in their study examining the impact of climate change on economic and industrial outputs in countries that temperature increases do not lead to decreases in per capita income, except in poor countries. Henseler and Schumacher [17], state in their study, utilizing annual data for 103 countries from 1961 to 2010, that temperature is associated with per capita gross domestic product. Additionally, it was found that high temperature levels have strong effects in countries with low EG. Kahn et al. [18], investigated the impact of climate change on economic activities across countries using an ARDL model with a panel dataset covering 174 countries from 1960 to 2014. The study found that a permanent increase of 0.04°C in average global temperature would lead to a reduction of more than 7% in real per capita gross domestic product by the year 2100. Islam et al. [19], found in their study for the period 1990-2019 that in Saudi Arabia, carbon emissions and precipitation have a negative impact on EG, while temperature has a positive effect. Duan et al. [20], investigated the economic impact of climate change in China using the Panel Error Correction Model method. The study found that EG decreases by 0.78% for every 1°C increase in temperature. Additionally, the research indicates that EG will be influenced by a 0.86% increase for every 100 mm increase in precipitation and a 1.34% decrease for every 1% increase in humidity.

There are numerous studies in the literature addressing the complex relationship between RE consumption, temperature increase, and EG. These studies contribute to understanding the effects of climate change on EG and to the formulation of sustainable development policies. Zhang et al. [21], stated that renewable policies in Brazil and China have long-term positive effects on RE production and consumption. However, they found that Russia's RE policies are inadequate and decrease the growth in RE consumption in the long term. Keleş and Bilgen [2], concluded that Turkey's geographical location offers various advantages for widespread utilization of RE sources, particularly noting sufficient RE potential in terms of both fuel and electricity.

Cetin [22], found in his study, which examined the relationship between RE consumption and EG for E-7 countries during the period 1992-2012, that RE consumption has a positive impact on real GDP in E-7 countries. Marinaş et al. [23], investigated the relationship between EG and RE consumption for ten European Union (EU) member countries from Central and Eastern Europe during the period 1990-2014. The results indicate that in the short term, the dynamics of Gross Domestic Product (GDP) and RE Consumption (REC) are independent in Romania and Bulgaria, while increasing RE consumption improves EG in Hungary, Lithuania, and Slovenia. Klimenko et al. [24], state that in Russia, electricity production efficiency in thermal and nuclear power plants decreases as air temperature rises. According to climate model results, due to temperature increase, electricity production in thermal power plants and nuclear power plants will decrease by 6 billion kWh by 2050. The increase in air temperature during summer months will require higher EC for air conditioning, and by 2050, this figure will increase by approximately 6 billion kWh. Kasperowicz et al. [25], investigated the relationship between EG and RE consumption for 29 countries in Europe during the period 1995-2016. The results indicate that the use of RE as a global commodity is highly significant in the process of EG. Mele et al. [26], investigated the impact of increased RE production on the Brazilian economy, taking into account the periods of the SARS and Covid-19 pandemics. The results of the study indicate that the increasing use of RE sources may sustain economic recovery and create a Gross Domestic Product (GDP) momentum that outperforms other energy variables. Botzen et al. [27], found that under a high warming scenario, their study's results suggest predictions regarding electricity and gas consumption in Mexico. By the end of the century, electricity consumption is projected to increase by 12%, while gas consumption is expected to decrease by 10%, leading to a significant net economic cost of approximately 43 billion pesos per year. Rokicki et al. [3], stated in their study, which examined data from 23 countries in Central and Eastern Europe, that large-scale energy production from renewable sources could lead to a 60% decrease in temperature rise. Additionally, the study shows that such activities could result in a 90% increase in energy efficiency. Saqib et al. [28], revealed that technological modernization helped reduce pollution levels in E-7 countries from 1995 to 2019. Therefore, the study demonstrates that human development, technological innovation, and RE use were the most important variables for reducing carbon emissions during the examined period.

Yu et al. [1], results of the study found that emissions in E7 countries increased with the onset of development but later decreased due to potentially strong environmental regulatory policies implemented. The study also found that renewable energy, green innovations, environmental taxes, and technological innovations in all models had a significant and negative impact on carbon emissions in both the short and long term in E7 countries. Jia et al. [29], investigated the direct and indirect effects of RE consumption on EG using panel data from 90 countries participating in the Belt and Road Initiative between 2000 and 2019. The results of the study demonstrate that RE consumption directly contributes to EG. Germán-Soto et al. [30], investigated the impact of increasing temperatures on electricity consumption and economic development in Mexico between 2003 and 2019. The results of the study indicate that extreme weather conditions increase electricity demand. During extreme weather conditions, electricity consumption further increases due to fluctuations in electricity supply. The study concludes that temperatures have significant effects on economic development and electricity supply.

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II. METHODOLOGY AND DATA

The factors considered for the analysis comprise carbon dioxide emissions, gross domestic product, renewable and non-RE usage, capital investment, and temperature variations in the E-7 countries from 1990 to 2020. Table 1 provides the units of measurement, abbreviations used within the article, and the sources from which the data were obtained.

Table 1. Information on Variables

Variable	Unit/Source	Symbol
CO2 Emission	CO2E from fuel combustion (MtCO2)/World Bank	CO_2
Economic Growth	GDP (constant 2015 US$)/World Bank	EG
Fossil Energy Consumption	Fossil fuel energy cons/mtoe/World Bank	FOSENCONS
Renewable Energy Consumption	RE consumption (% of total final Energy Cons.)/World Bank	RENENCONS
Gross Capital Formation	Gross capital formation (constant 2015 US$)/World Bank	GCAP
Temparature Change	Annual Surface Temparture Change/IMF and Turkish Meteorological Service	TEMP

This research aims to examine the relationship between renewable and non- RE consumption and the financial indicators of countries, such as growth and capital formation, along with climate change in the E-7 countries. In investigating the relationship between CO2E, EG, financial indicators, and temperature changes, the panel ARDL method, which does not require the series to be stationary and enables the analysis of both long-term and short-term relationships, was used. The results of the analysis revealed a long-term relationship between renewable and non- RE consumption and CO2E, which are indicators of climate change. The analysis was conducted using Stata 18 software.

2.1. Method

In the study, a unit root test was initially conducted to prevent spurious regression due to the inclusion of data over time. Researchers working with panel unit root tests are divided into two groups, and the tests they develop are known as first-generation and second-generation tests[1]. First-generation tests assume no correlation between units, and if there is correlation between units, the power of these tests is weak. The most well-known of these tests include Levin, Lin, and Chu (2002) [31], , Harris and Tzavalis (1999) [32], , Breitung (2000) [33], Hadri (2000) [34], , lm, Pesaran, and Shin (IPS, 2003) [35], , Fisher ADF (Maddala and Wu 1999) [36], , Fisher Philips, and Perron (Choi 2001) [37], panel unit root tests. The main characteristic of second-generation panel unit root tests is that they assume correlation between units. The most commonly used tests among these are Pesaran (2004) [38], , Bai and Ng (2004) [39], , Philips and Sul (2003) [40], , Moon and Perron (2004) [41], panel unit root tests.

Consider the standard panel data model where y represents the dependent variable and x represents the independent variable, with i indicating the unit and t indicating the time dimension:

$$y_{it} = \alpha_{i+} \beta' x_{it} + u_{it},\ \text{i:1,2..N, t=1,2…..T} \quad \textbf{(1)}$$

Before estimating this model (1) , to determine which unit root tests are more suitable, cross-sectional dependence was examined. Breusch and Pagan (1980) [42], proposed an LM statistic, which is valid for fixed N(individual) as T(time) →∞ and is given by Equation(2):

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \quad \textbf{(2)}$$

Where $\hat{\rho}_{ij}$ is the sample estimate of pairwise correlation of the residuals:

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} \hat{u}_{it} \hat{u}_{jt}}{\left(\sum_{t=1}^{T} \hat{u}_{it}^2\right)^{1/2} \left(\sum_{t=1}^{T} \hat{u}_{jt}^2\right)^{1/2}} \quad \textbf{(3)}$$

and $\hat{u}_{it}$ is the estimate of u_{it} in the Equation 1. However, this test typically exhibits significant size distortions when N is large and T is finite; therefore, Pesaran (2004) [38], has proposed the CD (Cross Section Dependent) test which can be applied when both T and N are large, was conducted to determine the correlation between units. The statistic for Pesaran's CD test by equation 4.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}\right) \quad \textbf{(4)}$$

In equation 4, $\hat{\rho}_{ij}^2$, i,j represents the residual correlation coefficient between i and j. The test statistic is distributed as χ^2 with d= $\frac{N(N-1)}{2}$ degrees of freedom. Under the null hypothesis of no correlation between units, as N approaches infinity and T is sufficiently large, CD converges to N (0,1).

The first step in the study was to investigate whether the series contained unit roots. For this purpose, correlations between units were initially examined. To determine the correlation between units, the Pesaran CD test and LM tests were conducted. The test results are summarized in Table 2.

Table 2. Cross Section Dependence Test's Results

Variables	Pesaran CD	LM	LM adj*	LM CD*
CO2E	15.84***	27.23	1.55*	-1.38
EG	23.51***	40.15	6.67*	-1.12
FOSENCONS	15.72*	34.02**	4.17***	-0.36
RENENCONS	15.11*	45.71***	8.92***	-.13
TEMP	11.07*	59.35***	14.02***	3.97***
GCAP	9.25*	29.99*	2.70***	1.54*

*** ,**,* 1%, 5%, and 10% significance levels.

Upon evaluating Table 2, the Pesaran CD and LM adj* tests yield statistically significant results for all variables, indicating the presence of cross-sectional dependence. The LM test shows significant results for the variables EG, FOSENCONS, RENENCONS, TEMP, and GCAP, while the LM CD* test indicates significant results for the variables TEMP and GCAP. Particularly, the Temp and Renencons variables consistently show significant results across all tests, suggesting strong cross-sectional dependence in these variables.

In summary, the results of all conducted tests indicate that the null hypothesis, Ho: There is no cross-sectional dependence, is rejected for many variables. This implies that cross-sectional dependence is generally present. Considering this dependence is crucial for the reliability of modeling and results.

Pesaran (2007) [43], developed a simple method to eliminate cross-sectional correlation instead of estimating factor loadings. The Pesaran CADF(PESCADF) test is designed to check for the presence of unit roots (stationarity) in time series data within a panel data framework. In this method, he utilizes an extended version of the ADF regression with lagged cross-sectional averages, and the first difference(Δ) of this regression eliminates cross-sectional correlation. This generalized Dickey Fuller regression across cross-sections is referred to as the simple Cross-sectionally Augmented Dickey-Fuller regression. (CADF) regression:

$$\Delta Y_{it} = \alpha_i + \rho_i^* Y_{it-1} + d_0 \bar{Y}_{t-1} + d_1 \Delta \bar{Y}_t + \varepsilon_{it} \quad (5)$$

In this regression model, ΔY_{it} represents the first difference of the dependent variable, Y_{it-1} represents the one-period lag of the dependent variable, and, $\bar{Y}_t$ is the average of all N observations at time t. The presence of lagged cross-sectional averages and first differences accounts for inter-unit correlation through factor structure. If there is autocorrelation in the error term or in the factor, the regression in the univariate case with the addition of lagged first differences of Yit and Ȳt can be extended as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i^* Y_{it-1} + d_0 \bar{Y}_{t-1} + d_1 \Delta \bar{Y}_t + \sum_{j=0}^{p} d_{j+1} \Delta \bar{Y}_{t-j} + \sum_{j=0}^{p} c_k \Delta \bar{Y}_{i,t-k} + \varepsilon_{it} \quad (6)$$

For this equation**,** the degree of extension can be selected using an information criterion or consecutive tests.

Pesaran (2007) introduces the CIPS(cross- sectionally augmented IPS) test, which remains robust in the presence of cross-sectional dependence among individual series in the panel. After estimating the CADF regression, the averages of the t-statistics of lagged variables are taken to obtain the CIPS statistic:

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF_i \quad (7)$$

For the CIPS statistic expressed as above, the combined asymptotic limit is not standard, and critical values have been calculated for various T and N values. In the test, the null hypothesis is that the variables are not stationary.

Table 3. Panel Unit Root Test Results

Variables	The Pesaran Cross-sectionally Augmented Dickey-Fuller regression (PESCADF) Results	
	Level	
	Constant[1]	Constant and Trend[2]
CO2E	-2.246*	-2.737*
EG	-2.101	-1.835
FOSENCONS	-2.255	-2.461
RENENCONS	-1.472	-1.600
TEMP	-4.024**	-3.695***
GCAP	-2.160*	-2.622
	First Difference	
	Constant	Constant and Trend
CO2E	-2.942***	-2.898**
EG	-2.579*	-2.588
FOSENCONS	-2.687***	-2.732*
RENENCONS	-3.055***	-3.134***
TEMP	-5.651**	-3.965***
GCAP	3.628***	-3.796***
	Results	
CO2E	I(1)	
EG	I(1)	
FOSENCONS	I(1)	
RENENCONS	I(1)	
TEMP	I(0)	
GCAP	I(1)	

[1]shows the result of the model estimated with the constant parameter.[2] shows the the result of the model estimated with the constant parameter and trend. *** ,**,* 1%, 5%, and 10% significance levels.

According to Table 3, the PESCADF results test the null hypothesis that the series have a unit root, indicating non-stationarity. For CO2E, EG, FOSENCONS, RENENCONS and GCAP, the null hypothesis cannot be rejected at levels, implying these series are non-stationary. However, after taking the first difference, the null hypothesis is rejected, indicating these series become stationary (I(1)). In contrast, for the TEMP serie, the null hypothesis is rejected at levels, indicating it is stationary (I(0)) without needing differencing. This means TEMP does not have a unit root and is stable over time, unlike the other variables. After determining the stationarity levels of the series, cointegration tests are conducted to identify the presence of a long-term relationship between them.

The Mean Groıup (MG) estimation method, proposed by Pesaran and Smith (1995) [44], obtains the long-run parameter by averaging the long-run parameters of autoregressive distributed lag models created for each unit. Thus, it allows for the valuation of long-run parameters according to units. The Pooled Mean Group estimation method, proposed by Pesaran, Shin, and Smith (1999) [45], consists of a mixture of the MG estimator, which allows both slope and intercept parameters to vary across units, and the fixed effects estimator, which imposes that the slope parameter is constant while allowing the intercept parameter to vary. PMG keeps the long-run parameters fixed while allowing short-run parameters and error variances to vary across units [45], :

$$\Delta Y_{it}=\emptyset_i(Y_{it-1} - \beta_i' X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}\, \Delta Y_{it-j} + \sum_{j=0}^{q-1} \delta_{ij}\, \Delta X_{it-j} + \varepsilon_{it} \quad (8)$$

where: Y_{it} is the dependent variable for unit i at time t X_{it} is a vector of independent variables for unit i at time t , β_i are the long term coefficients. λ_{ij} and δ_{ij} are short run coefficients and ε_{it} is error term. $\emptyset_i$ is the error correction parameter, and the calculation of the $\emptyset_i$, and β_i' parameters is as follows :

$$\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right) \quad (9)$$

$$\beta_i = \left(\sum_{j=0}^{p} \delta_{ij}\right) \quad (10)$$

Here, if ϕi is significant and negative, there is a long-run relationship between the dependent and independent variables. [46-47].

III. RESULTS AND DISCUSSION

Table 4 shows the PMG and MG estimates for the variables CO2, GDP, RE consumption, non- RE consumption, temperature increase and gross capital formation for E-7 countries.

Table 4: Panel ARDL Long Run Estimation

Dependent Variable: CO2E	Coefficients	
	PMG	MG
Long Run		
EG	0.055*	0.103*
FOSENCONS	0.997***	0.843***
RENENCONS	-0.0011*	-0.003
TEMP	-0.055**	-0.062
GCAP	-0.003***	-0.0008
EC Coefficient	-0.259***	-9.92***
Short Run		
EG	0.1089*	0.047
FOSENCONS	0.537***	0.323***
RENENCONS	-0.005***	-0.002
TEMP	0.007	0.026
GCAP	0.0004	0.0006
Hausman	3.78 (0.5817)	

t statistics in paranthesis:* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Before interpreting the results in Table 4, we first examined the error correction coefficient and found it to be statistically significant at the 1%, 5%, and 10% significance levels. In terms of indicating how quickly the series reach equilibrium, this parameter is important. Accordingly, approximately 25% of the imbalances occurring in one period will be corrected in the next period, leading towards approaching the long-term equilibrium. After conducting PMG and MG estimations, a Hausman test was performed to determine which estimator is consistent to use, and based on the test results, it was decided that using the PMG estimator is appropriate.

The estimated PMG model finds that all parameters are statistically significant. According to the results, a 1% increase in EG leads to a 0.055% increase in CO2E while a 1% increase in FOSENCONS results in a 0.99% increase in CO2E. Looking at other long-term parameters, a 1% increase in RENENCONS leads to a 0.0011% decrease in CO2E, while a 1% increase in TEMP results in a 0.05% decrease in CO2E emissions. A 1% increase in GCAP leads to a 0.003% decrease in CO2E emissions. In this context, Table 6 summarizes the long-term effects of all variables on the CO2E variable.

Table 5: Summary of the long-term effects of variables on CO2E emission

Variable (%1 increase)	**Effect on C02E Emissions in the long term**
Economic Growth (EG) ↑	0.055% increase ↑
Fossil Energy Consumption (FOSENCONS) ↑	0.99% increase ↑
Renewable Energy Consumption (RENENSONS) ↓	0.0011% decrease ↓
Temperature Change (TEMP) ↓	0.05% decrease↓
Domestic Investment in Fixed Capital Formation ↓	0.003% decrease↓

Upon a detailed evaluation of the results, it is known that there is a relationship between growth, one of the most important economic indicators of a country, and CO2E, and this relationship is also complex depending on the country's EC and production structure. While previous literature has shown a positive relationship between EG and CO2E, recent studies suggest that this relationship may vary. Given that the E-7 countries are developing economies, it is expected that there would be a positive relationship between EG and CO2E. The relationship between fossil EC and CO2E is also complex, but existing literature indicates that as fossil EC increases, CO2E also increase, which is consistent with the findings in our model.

When examining studies on RE consumption, it is observed that there is a negative relationship between CO2 and RE consumption. RE technologies such as solar panels and wind turbines do not rely on the combustion of fossil fuels, hence they do not contribute to CO2E, or they minimize these emissions significantly. Our model also exhibits a similar effect, as the relationship between RE consumption and CO2E is found to be negative as the relationship between RE consumption and CO2E is found to be negative.

Gross fixed capital formation represents the total value of new fixed capital investments made in an economy during a specific period, typically involving the construction and expansion of production facilities, infrastructure projects, and other long-term asset investments. Such investments often occur in energy-intensive sectors, which can contribute to CO2E. Existing literature suggests that the relationship between fixed capital and CO2E tends to be positive in countries experiencing rapid EG and industrialization processes. However, in the PMG estimation conducted for these E-7 countries, this relationship was found to be negative. Nevertheless, it is well known that several E-7 countries, particularly China, Brazil, India, and Mexico, also prioritize sustainable development and environmental protection. China, for instance, makes significant investments in RE to reduce greenhouse gas emissions and implements various environmental protection policies. India takes measures to combat air and water pollution and invests in renewable energy. Brazil makes efforts to protect the Amazon rainforest, reduce deforestation, and conserve biodiversity. Mexico implements various policies to increase energy efficiency, improve waste management, and protect natural resources. Additionally, Russia also conducts studies on the conservation of natural resources, environmental laws and regulations, and industrial waste control. Similarly, Turkey engages in activities related to waste management, clean energy production, forest conservation, and afforestation. Therefore, it is not surprising that the relationship between gross fixed capital formation and CO2E appears negative in the model, as it can be influenced by the environmental policies implemented by these countries. In conclusion, the relationship between gross fixed capital and CO2E in E-7 countries is complex, with policies varying from country to country. However, the small magnitude of this effect compared to other coefficients indicates that the impact of this variable on E-7 countries is minimal. The model estimations revealed a negative correlation between temperature change and CO2E. While literature studies provide sample evidence that temperature change influences CO2E, the general expectation is for this relationship to be positive. However, the negative relationship observed in the predictions for E-7 countries can be explained by their active engagement in environmental protection and sustainability efforts, particularly highlighted in countries like Brazil, China, India, and Mexico, as mentioned above. Additionally, each country has its own unique policies. Understanding this relationship necessitates taking into account the specific circumstances and policies of each country.

IV. CONCLUSION

Climate change and energy consumption are pivotal issues dominating global agendas, profoundly shaping the economic policies of nations. The objective of this study is to explore the long-term interrelationships among climate change, EC, and the financial system within the E-7 countries, and to offer recommendations for sustainability and environmental policies. The E-7 countries, which include Brazil, China, India, Russia, Turkey, Indonesia, and Mexico, are recognized as the seven major emerging economies. Given their substantial populations and growth potential, the development strategies implemented by these nations play a pivotal role in addressing climate change. To underscore this significance, the study analyzed factors influencing CO2 emissions over the period from 1992 to 2020. The analysis identified that variables such as EG, Renewable EC, Fossil EC, fixed capital, and temperature changes have a significant impact on CO2 emissions in the long run. This research highlights the critical importance of integrating sustainable energy practices and robust environmental policies to mitigate the adverse effects of climate change. Additionally, the findings underscore the necessity for tailored policy measures that address the unique developmental and environmental challenges faced by emerging economies.

The study's findings highlight a clear connection between CO2 emissions (CO2E) and economic growth (EG), as well as fossil fuel consumption. Conversely, CO2E shows an inverse relationship with RE consumption, temperature changes, and capital investment variables. A broad evaluation of the results confirms that they meet the expected outcomes. The E-7 nations present substantial potential for growth, and targeted investments in renewable energy sources—such as solar, wind, hydroelectric, and biomass—tailored to the specific needs of each country, could effectively reduce CO2E. Additionally, adopting carbon-neutral transportation solutions, including public transit and electric vehicles, is promising for further CO2E reduction. Strategies for forest conservation, reforestation, and the advancement of clean energy and environmental technologies would also be advantageous. E-7 countries can also cut CO2E by investing in carbon-free transportation and enhancing public transit systems. Shifting to clean transportation technologies like electric vehicles will improve air quality and lower greenhouse gas emissions. Moreover, the growth and widespread adoption of clean energy and environmental Technologies will not only boost economic growth but also advance environmental sustainability. Additionally, the positive correlation between EG and fossil fuel usage with CO2E suggests that financial support in these sectors mirrors their environmental impact. Considering the role of financial systems in addressing climate change, it is crucial to assess how financial institutions in E-7 countries handle environmental risks and opportunities, and how they can channel resources into sustainable projects. Sustainable finance, known for its pivotal role in combating climate change through green finance practices, necessitates that policymakers and financial institutions collaboratively develop and implement strategies to manage environmental risks and prioritize sustainability in investments.

Considering the study's limitations, it is important to acknowledge that the analysis is based on data available up to the end of 2020. This data constraint regarding renewable and fossil energy sources may affect the scope and depth of the findings. While this timeframe allows for a comprehensive examination of trends and relationships up to 2020, developments in energy consumption and policy changes occurring after this period are not included. Future research could gain valuable insights by integrating more recent data, providing an updated perspective on the dynamics between renewable and fossil energy sources and their impact on CO2 emissions. Additionally, detailed analyses for each country within the E-7 group could further enhance these findings. Expanding the study to include neighboring countries could also help identify which variables are influenced by climatic factors.

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