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ÖZGÜN ARAŞTIRMA / ORIGINAL ARTICLE

Economic Growth or Environmental Sustainability: Can We Have Both?: An Application in G7 Countries (1974-2023)

Ekonomik Büyüme mi, Çevresel Sürdürülebilirlik mi?: Her İkisine de Sahip Olabilir miyiz?: G7 Ülkeleri Örneği (1974-2023)

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Abstract

Aim: The study aims to investigate the balance between economic growth and environmental sustainability by examining how energy imports, CO_2 emissions, and fossil fuel consumption are influenced by various macroeconomic factors in G7 countries from 1974 to 2023.

Method: The research employs panel data analysis covering the years 1974–2023 for G7 countries. The dependent variables are energy imports, carbon dioxide (CO_2) emissions, and fossil fuel consumption, while the independent variables include inflation, natural gas and oil rents, population growth, patent applications, foreign direct investment, market capitalization, exports, number of listed companies, and military expenditures.

Results: The findings reveal a complex and multifaceted relationship between economic growth and environmental sustainability. Economic activity and energy consumption interact in ways that require careful policy attention, especially regarding carbon emissions and fossil fuel dependence.

Conclusion: The study concludes that environmental policies should not be perceived as barriers to economic growth. On the contrary, when aligned with sustainable development goals, such policies can support long-term welfare. Promoting low-carbon energy sources and reducing fossil fuel dependency are highlighted as key strategies for achieving both economic and environmental objectives.

Keywords

Economic Growth, Environmental Sustainability, Energy Imports, CO2 Emissions, Fossil Fuel Consumption

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Öz

Amaç: Bu çalışmanın amacı, G7 ülkelerinde 1974–2023 yılları arasında enerji ithalatı, CO_2 emisyonları ve fosil yakıt tüketiminin çeşitli makroekonomik faktörlerle ilişkisini inceleyerek, ekonomik büyüme ile çevresel sürdürülebilirlik arasındaki dengeyi analiz etmektir.

Yöntem: Araştırmada, 1974–2023 dönemini kapsayan panel veri analizi yöntemi kullanılmıştır. Bağımlı değişkenler enerji ithalatı, karbondioksit (CO_2) emisyonları ve fosil yakıt tüketimidir. Bağımsız değişkenler ise enflasyon, doğalgaz ve petrol rantları, nüfus artışı, patent başvuruları, doğrudan yabancı yatırımlar, halka açık şirketlerin piyasa değeri, mal ve hizmet ihracatı, toplam halka açık şirket sayısı ve askeri harcamalardır.

Bulgular: Elde edilen bulgular, ekonomik büyüme ile çevresel sürdürülebilirlik arasındaki ilişkinin karmaşık ve çok boyutlu olduğunu göstermektedir. G7 ülkelerinde enerji tüketimi ile ekonomik faaliyetler arasındaki etkileşim, çevresel sonuçlar göz ardı edilmeden değerlendirilmelidir.

Sonuçlar: Çalışma, çevre politikalarının ekonomik büyümeye engel olarak değil, uzun vadeli refahı artıran bir unsur olarak değerlendirilmesi gerektiğini ortaya koymaktadır. Düşük karbonlu enerji kaynaklarına yönelimin artırılması ve fosil yakıtlara olan bağımlılığın azaltılması, sürdürülebilir kalkınma açısından hayati önem taşımaktadır.

Anahtar Kelimeler

Ekonomik Büyüme, Çevresel Sürdürülebilirlik, Enerji İthalatı, CO2 Emisyonları, Fosil Yakıt Tüketimi.

Introduction

In recent years, the relationship between economic development and the concept of environmental sustainability has become a significant topic both in the academic literature and among governments (Stern, 2004; Arrow et al., 1996). In both developed and developing countries, minimizing environmental risks and preserving the natural structure of the environment for future generations are crucial for achieving sustainable development goals. Although the increasing global demand for energy—driven by the removal of market boundaries in the economy, the unrestricted mobility of capital and labor, and changes in consumption patterns—serves as a positive indicator of economic development, it also gives rise to certain risk factors in terms of environmental sustainability. In this regard, the effects of energy policy outcomes on the environment have become a critical subject of analysis across all global economies (Sadorsky, 2010; Grossman & Krueger, 1995).

The primary aim of this study is to elucidate the impact of energy consumption on economic growth and to guide sustainable development policies while considering environmental effects. The relationship between energy supply security and economic development emerges as a determining factor, particularly due to the finite nature of fossil fuels and the ongoing shift toward renewable energy sources (Stokey, 1998). In developed economies like G7 countries, the dynamics between energy consumption and environmental policies directly influence not only national growth strategies but also the trajectory of global energy markets (Acemoglu et al., 2012).

Understanding the potential balance between economic expansion and environmental sustainability will contribute to the formulation of policy options that can be applied for a low-carbon economy. Research has discussed the Environmental Kuznets Curve (EKC) hypothesis, which posits that economic growth initially increases environmental degradation up to a certain point, after which it can support environmental sustainability (Dinda, 2004). However, the generalizability of this relationship across all countries and sectors is still under investigation. The relationship between the Environmental Kuznets Curve and sustainable environment is as shown in Figure 1.

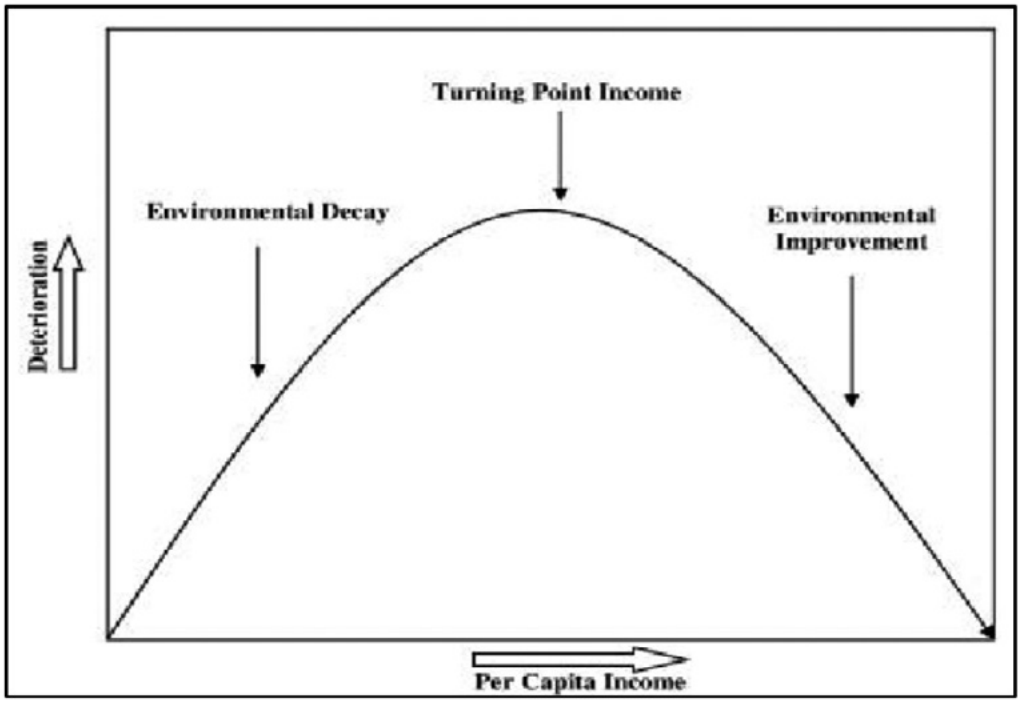


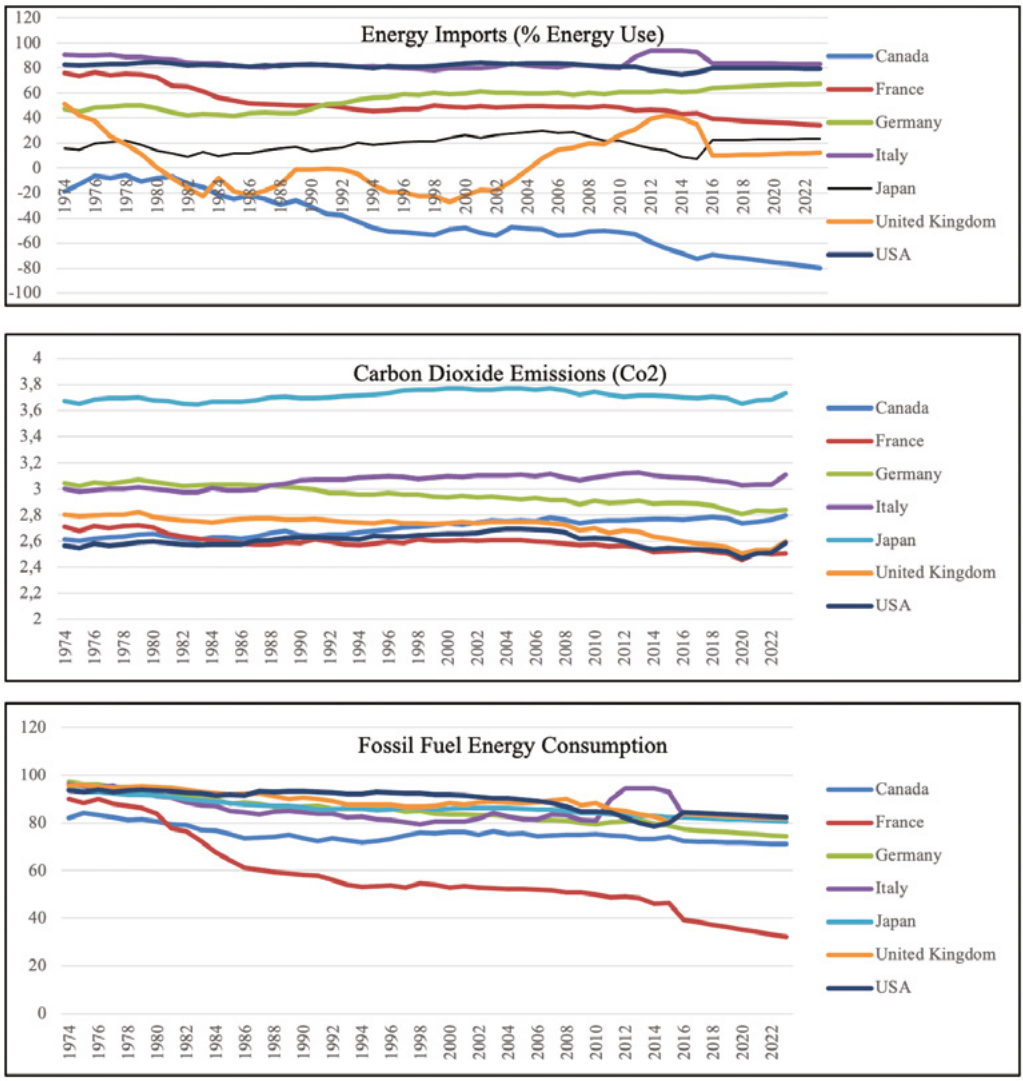
Figure 1. Environmental Kuznets Curves

Source: (Yandle et al., 2004).

In this context, establishing a clear framework that identifies the economic and environmental impacts of factors such as dependence on fossil fuels and foreign direct investments will be a significant step towards filling the gaps in the academic literature. The feasibility of eco-friendly policies in developed economies, along with the effectiveness of renewable energy investments and carbon pricing mechanisms, will determine how the relationship between economic growth and environmental sustainability unfolds in the future (Perman & Stern, 2003).

In this study, energy imports, CO2 emissions, and fossil fuel-based energy consumption are treated as dependent variables. The independent variables under consideration include macroeconomic indicators (inflation, natural gas and petroleum rents, population growth rate), financial factors (foreign direct investments, market value of publicly traded companies, total number of publicly traded companies), trade and innovation indicators (exports of goods and services, patent applications), as well as public expenditures represented by defense spending.

The data utilized in this research reflects the trends of energy imports, CO2 emissions, and fossil fuel consumption in G7 countries from 1974 to 2023. The following graphs visualize the long-term trajectory of these variables. An examination of the information presented in Graph 1 reveals significant differences in energy imports among countries, highlighting the changes in energy dependence over time, particularly in industrialized economies. In terms of CO2 emissions, a decreasing trend is observed in some countries, while more volatile patterns have emerged in others. This variability may reflect differences in the countries' energy policies and their pace of transition to renewable energy. Although fossil fuel consumption shows a long-term decreasing trend, certain periods have experienced increases influenced by factors such as global economic crises and energy transition processes. These trends provide important insights into how countries are shaping their energy policies and the stage they are at in transitioning to sustainable energy.



Graph 1. Overview of Energy Imports, Carbon Dioxide (Co2) Emissions, and Fossil Fuel Energy Consumption in G7 Countries

This study, conducted using panel data from G7 countries over the period from 1974 to 2023, aims to obtain more robust findings by considering the temporal differences among countries. The application of panel data analysis offers significant advantages in examining both the trends in relationships among variables over time and the dynamic structures between countries (Baltagi, 2008).

The significance of this research arises from the increasing global interest in understanding the interactions between sustainable development and economic growth. G7 countries, as critical actors in the global economy, play a pioneering role in shaping environmental policies. In this context, the findings obtained are expected to elucidate the relationship between economic growth and environmental sustainability while providing policy recommendations. In the forthcoming period, during the transition to a low-carbon economy, investments in energy, technological innovations, and international environmental policies will emerge as key elements in maintaining the balance between economic growth and sustainability.

Literature Review

The relationships among energy, finance, and macroeconomic indicators have emerged as a significant area of research, particularly in the context of economics and sustainable development. Energy variables such as energy imports, fossil fuel consumption, and carbon emissions directly influence countries' economic growth, trade balances, and environmental sustainability. Specifically, fluctuations in global energy markets and the impacts of climate policies on economic decision-making processes enhance the importance of this subject within academic discourse.

The interplay between macroeconomic indicators, energy markets, and financial structures is crucial for economic growth and development. Factors such as inflation, natural gas and oil rents, population growth, foreign direct investment, and patent applications play a critical role in shaping economic dynamics, establishing strong connections with energy policies and financial markets. Particularly, financial indicators like the market value and number of publicly traded companies are essential for the development of capital markets and economic stability.

In this regard, a review of the relevant literature reveals a large number of studies encompassing finance, energy, and macro- and microeconomic indicators. However, the growing importance of the concept of energy for all economies in recent years has also brought environmental welfare to the forefront. Therefore, conducting comprehensive and multivariate studies in this field can contribute to the literature while also providing a clearer understanding of how implemented policies impact both the economy and environmental issues. This extensive study aims to address the gap in the literature and serve as a guide for future research. Examples of similar studies in the literature are presented below.

An examination of the literature reveals a significant number of energy-focused studies, yet relatively few have specifically addressed the variable of energy imports. Among the existing studies, Şişeci and Erdem (2023) found a positive and significant relationship between energy imports and foreign direct investment. Similarly, Ürkmez and Okyar (2022) analyzed the factors affecting energy imports and identified a significant relationship with population growth and natural gas prices. The study by Canbay and Pirali (2019), which analyzed the relationship between military expenditures (defense spending) and energy imports, concluded that these variables are significantly related. Furthermore, Şahin et al. (2020) examined the relationship between energy imports and foreign direct investment, finding that these variables exhibit significant long-term associations.

Regarding studies analyzing the factors influencing carbon dioxide emissions, Gündoğdu (2024) found bidirectional causality between foreign direct investment and carbon dioxide emissions. Wu et al. (2023), who examined the relationship between military expenditures and environmental pollution, reported a significant causal relationship between these variables. Kwakwa (2020) demonstrated that population growth and military expenditures have a positive and significant effect on carbon dioxide emissions. In contrast, Chisti et al. (2021) concluded that foreign direct investment negatively affects carbon dioxide emissions, whereas Çelik (2020) found a positive relationship between these variables. Similarly, the findings of Wang et al. (2021) and Azam et al. (2024) indicated that military expenditures positively influence carbon dioxide emissions.

A review of the literature on fossil fuel consumption, another dependent variable of this study, reveals that Akinola et al. (2024) identified a negative and significant relationship between fossil fuel subsidies and inflation. Mensah (2019) found a causal relationship between economic growth, carbon dioxide emissions, and fossil fuel consumption.

Considering the above-mentioned studies and similar works in the literature, it is evident that while individual study variables have been extensively examined, comprehensive research incorporating a large number of variables remains limited. This study aims to fill this gap in the literature by expanding its scope through a comparison of dependent variables with a broader set of independent variables. Additionally, this research seeks to adopt a holistic perspective by integrating macroeconomic indicators with environmental and financial variables.

Dataset and Methodology of The Study

Dataset

The dependent and independent variables analyzed in the study, along with fundamental information about these variables, are presented in Table 1.

Table 1. Variables of the study

Variables	Abbreviations	Variable Types	Sources
Energy imports	NEI	Dependent Variable	Zhao, Y. (2006); Sarıtaş et al. (2018); Şişeci & Sürekçi Yamaçlı (2020); Murshed et al. (2020); Sürekçi Yamaçlı et al. (2020); Hampp et al. (2021); Damar & Yıldırım (2023)
Carbon dioxide (CO2) emissions	CO2	Dependent Variable	Wang et al., (2011); Kais & Sami (2016); Banday & Aneja (2019); Muhammad (2019); Waheed et al., (2019); Akyol & Mete (2021); Ayla (2022); Yılmaz & Çamkaya (2022); Karaca & Çımat (2023); Türk & Barışık (2024); Shahbaz et al. (2023)
Fossil fuel energy consumption	FFEC	Dependent Variable	Asafu-Adjaye et al., (2016); Zhao et al., (2018); Rehman et al., (2019); Baz et al., (2021); Karaca (2021); Arı (2023); Kılınç (2023);
Inflation	INF	Independent Variable	He et al., (2016); Talha et al., (2021); Khan et al., (2022); Bettarelli et al., (2023); Lu et al., (2023); Ma et al., (2024); Mishra & Sahu (2024)
Natural gas rents (% GDP)	NGR	Independent Variable	Korkmaz (2022); Liu et al., (2022); Adabor (2023); Fu & Liu (2023); Mahmood et al., (2023); Ajayi (2024)
Oil rents (% GDP)	OR	Independent Variable	Davidson (1975); Kemp (1987); Gaddy & Ickes (2005); Andersen et al., (2017); Shobande et al., (2020); Brooks & Kurtz (2022)
Population growth	PG	Independent Variable	Kuznets (1967); Becker et al., (1999); Coale et al., (2015); Hansen (2018); Menike (2018); Rehman et al., (2022)
Patent applications	PAR	Independent Variable	Atun et al., (2007); Özcan & Özer (2017); Tnani (2018); Ben Youssef (2020); Myszczyszyn (2020); Nguyen & Doytch (2022);
Foreign direct investments	FDI	Independent Variable	Amri (2016); Wall et al., (2019); Zhang & Kong (2021); Usta (2023); Nas (2024)
Market capitalization	MCAP	Independent Variable	Loudder (1996); Pham (2015); Brzeszczyński et al., (2019); Büyükyılmaz & Ak (2025)
Goods and services exports	EXP	Independent Variable	Cortés-Borda et al., (2015); Huseynli (2023); Jiang & Gao (2023)
Listed domestic companies	LDC	Independent Variable	Qian et al., (2009); Bianconi et al., (2014); Rejchrt & Higgs (2015)
Military expenditures	MILX	Independent Variable	Ahmed et al., (2020); Elgin et al., (2022); Eregha et al., (2022); Tarczyński et al., (2023); Zhu et al., (2023)

Methodology

This study employs annual data from 38 G7 countries covering the period 1974–2023. The aim is to investigate the determinants of energy imports, carbon dioxide emissions, and fossil fuel energy consumption. Three distinct econometric models are constructed, all analyzed using a panel data framework to account for both cross-country heterogeneity and temporal dynamics.

Variables and Data

The dependent and independent variables used in the study, along with their roles, are summarized in Table 1:

Energy imports (NEI): Dependent variable representing total energy imports as a percentage of total energy consumption.

Carbon dioxide emissions (CO_2): Dependent variable measured in metric tons per capita, capturing environmental impact.

Fossil fuel energy consumption (FFEC): Dependent variable indicating the level of reliance on non-renewable energy sources.

Inflation (INF): Independent variable reflecting macroeconomic conditions affecting energy demand.

Natural gas rents (% GDP, NGR) and Oil rents (% GDP, OR): Represent the economic significance of fossil fuel resources.

Population growth (PG): Captures demographic pressure on energy consumption.

Patent applications (PAR): Proxy for technological innovation, potentially affecting energy efficiency.

Foreign direct investment (FDI): Indicates international capital flows influencing energy infrastructure.

Market capitalization (MCAP) and Listed domestic companies (LDC): Measures of financial market development, possibly affecting energy and environmental outcomes.

Goods and services exports (EXP): Reflect trade activity, which may correlate with energy demand.

Military expenditures (MILX): Captures defense-related energy consumption and economic allocation.

Econometric Models

Three econometric models are specified to analyze the determinants of the dependent variables. Each model follows a panel data framework:

Model 1: Energy Import

$$NEI_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 NGR_{it} + \beta_3 OR_{it} + \beta_4 PG_{it} + \beta_5 PAR_{it} + \beta_6 FDI_{it} + \beta_7 MCAP_{it} + \beta_8 EXP + \beta_9 LDC_{it} + \beta_{10} MILX_{it} + v_i + \epsilon_{it} \quad (1)$$

This model examines how economic, demographic, innovation, financial, trade, and defense factors influence energy imports across G7 countries.

Model 2: Carbon Dioxide Emissions

$$CO2_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 NGR_{it} + \beta_3 OR_{it} + \beta_4 PG_{it} + \beta_5 PAR_{it} + \beta_6 FDI_{it} + \beta_7 MCAP_{it} + \beta_8 EXP + \beta_9 LDC_{it} + \beta_{10} MILX_{it} + v_i + \epsilon_{it} \quad (2)$$

This model investigates the determinants of per capita carbon dioxide emissions, reflecting the environmental consequences of economic and demographic developments.

Model 3: Fossil Fuel Energy Consumption

$$FFEC_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 NGR_{it} + \beta_3 OR_{it} + \beta_4 PG_{it} +$$

$$\beta_5 PAR_{it} + \beta_6 FDI_{it} + \beta_7 MCAP_{it} + \beta_8 EXP + \beta_9 LDC_{it} + \quad (3)$$

$$\beta_{10} MILX_{it} + v_i + \epsilon_{it}$$

This model captures factors affecting fossil fuel energy consumption, highlighting the interplay between economic, demographic, and policy variables.

Panel Data Framework and Estimation

A panel data approach is used to control for unobserved heterogeneity across countries. The term viv_ivi captures country-specific effects, while ϵit\epsilon_{it}ϵit represents idiosyncratic errors. A Hausman test is applied to determine whether fixed or random effects are appropriate. Robust standard errors are employed to address potential heteroskedasticity and autocorrelation.

Model Diagnostics

All models are tested for multicollinearity, heteroskedasticity, and serial correlation to ensure the reliability of the results. Panel unit root tests are conducted to verify the stationarity of the series. These procedures guarantee that the estimated coefficients provide robust and consistent insights into the relationships under investigation.

Summary statistics of the variables analyzed in the study are presented in Table 2.

Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	350	1998.5	14.45153	1974	2023
NEI	294	36.93341	43.03714	-72.52817	93.98126
CO2	343	2.905057	.3722027	2.456881	3.772995
FFEC	294	82.4911	11.7062	46.22592	97.18269
INF	350	3.957813	4.269565	-1.352837	24.20729
NGR	336	.2249116	.4848688	0	3.220839
OR	336	.4504025	.7486447	.0007108	5.019822
PG	350	.4976413	.4993264	-1.853715	2.932274
PAR	273	4.463435	.6614465	3.216957	5.588119
FDI	350	1.485931	1.818302	-2.64546	12.60853
MCAP	314	69.22488	4617924	.0231188	213.4806
EXP	350	11.58461	.420742	10.56782	12.48465
LDC	317	3.100775	.4484647	2.120574	3.907949
MILX	343	2.344304	1.36804	.8620683	6.814057

Findings

The model findings and interpretations of the results regarding the question of whether economic growth or environmental growth should be prioritized, or whether it is possible to improve both simultaneously, are presented below.

Unit Root Test and Evalutaion of the Findings

In time series analyses, ensuring the stationarity of variables is a crucial assumption for the reliability of the results obtained in the study. In this regard, the stationarity of the variables included

in the study has been examined, and if any non-stationary variables were identified, they were transformed into stationary forms before conducting the analyses.

In the study, the stationarity status of the utilized variables has been tested, and the following results have been obtained:

- The variables NEI, CO_2, FFEC, PAR, LDC, and MILX are not stationary at level. This indicates that the means and variances of these variables change over time. However, it has been observed that they become stationary when their first differences are taken.
- The variables INF, NGR, OR, PG, FDI, MCAP, and EXP are stationary at level. This result indicates that these variables possess a stable structure over time and may be utilized as they are in the model.

Taking the differences of non-stationary variables to make them stationary is essential to enhance the reliability of the model. Thus, misleading correlations and spurious regression problems in model predictions can be prevented.

Following these analyses, the results of the model formed with stationary variables have become more reliable, providing an appropriate structure for econometric analysis.

Table 3. Unit Root Tests

Variables	Statistics Value	Stationarity	Stationary Value
NEI	-0.8516	Not Stationary	-5.0374
CO2	-0.756	Not Stationary	-7.2652
FFEC	-1.1445	Not Stationary	-5.4891
INF	-3.5209	Stationary at Level	
NGR	-2.3192	Stationary at Level	
OR	-2.6306	Stationary at Level	
PG	-2.3833	Stationary at Level	
PAR	-1.4002	Not Stationary	-4.9041
FDI	-3.7763	Stationary at Level	
MCAP	-2.1553	Stationary at Level	
EXP	-2.3087	Stationary at Level	
LDC	-1.5431	Not Stationary	-6.5944
MILX	-1.2174	Not Stationary	-5.9191

Once the stationarity conditions of the study variables were satisfied, suitable model selection and assumption deviation tests were applied to analyze the relationships between the variables, leading to the identification of the appropriate estimators that would yield the best results. The results for each model are presented in Tables 4, 5, and 6 below.

Analysis Results

Upon examining the results presented in Table 4;

it is observed that in the first model, inflation (INF) has a negative and significant effect on the NEI ($\beta = -0.319874$, $p = 0.032$). This finding indicates that inflation tends to create economic uncertainty, adversely affecting the investment climate and leading to a weakening of economic indicators. High inflation can particularly limit economic growth by increasing volatility in financial markets.

The results indicate that natural gas rents (NGR) have a statistically significant and positive effect on net energy imports (NEI) ($p = 0.006 < 0.05$). This suggests that an increase in revenues from natural gas is associated with a rise in net energy imports among G7 countries. Given the coefficient value of 1.416, a one-unit increase in natural gas rents leads to an approximate 1.42-unit increase in net energy imports. This finding implies that as revenues from natural gas increase, G7 countries become more reliant on energy imports or that natural gas revenues may contribute to economic conditions that incentivize greater energy imports.

Population growth (PG) exerts a statistically significant and positive influence on net energy imports (NEI) (p = 0.015 < 0.05). With a coefficient of 2.01, the findings suggest that a one-unit increase in population growth results in an approximate 2.01-unit increase in net energy imports. This outcome highlights the direct relationship between rising population levels and increasing energy demand, indicating that as the population grows, G7 countries are compelled to import more energy to meet rising consumption needs.

Table 4. Model 1 Results

NEI	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
INF	-.319874	.1433709	-2.23	0.032	-.6112387	-.0285092
NGR	1.416331	.4811982	2.94	0.006	.4384185	2.394243
OR	-.0073601	.8577015	-0.01	0.993	-1.750419	1.735699
PG	2.010688	.7806122	2.58	0.015	.4242936	3.597083
PAR	-.9522323	762811	-0.12	0.901	-16.45442	14.54995
FDI	.1475639	.1692754	0.87	0.389	-.196445	.4915728
MCAP	-.0003364	.009777	-0.03	0.973	-.0202058	.0195329
EXP	.2868533	1.141838	0.25	0.803	-2.03364	2.607346
LDC	6.160599	3.528074	1.75	0.090	-1.00931	13.33051
MILX	-.1643735	1.540354	-0.11	0.916	-3.29475	2.966003

According to the analysis results of the PCSE model presented in Table 5, military expenditures (MILX) have a negative and significant effect on CO_2 emissions (β = -0.0181372, p = 0.004). This finding indicates that as military expenditures increase, there is a corresponding decrease in emission levels. One possible reason for this may be the energy efficiency of the technologies used in the defense industry, or it could be that military expenditures redirect economic activities towards environmentally friendly sectors. On the other hand, the approach that the lower number of motor vehicles put on the market due to military expenditures would lead to lower emission emissions (reducing the national income per capita) may also have led to such a result.

Nonetheless, the effects of other variables on CO_2 emissions were found to be statistically insignificant. This situation suggests that the direct determining factors of environmental sustainability cannot be explained solely by macroeconomic variables, highlighting the need for further sectoral analyses.

Table 5. Model 2 Results

CO2	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
INF	-.0012558	.0006436	-1.95	0.051	-.0025173	5.70e-06
NGR	.0037895	.0024174	1.57	0.117	-.0009486	.0085276
OR	.0016041	.002113	0.76	0.448	-.0025373	.0057455
PG	-.0014233	.0022037	-0.65	0.518	-.0057425	.0028958
PAR	.066369	.0371909	1.78	0.074	-.0065237	.1392618
FDI	.0001218	.0006732	0.18	0.856	-.0011977	.0014413
MCAP	.0000352	.0000255	1.38	0.167	-.0000147	.0000852
EXP	-.0061551	.0043114	-1.43	0.153	-.0146053	.0022952
LDC	.0234588	.0151322	1.55	0.121	-.0061997	.0531173
MILX	-.0181372	.0062902	-2.88	0.004	-.0304658	-.0058087

According to the results presented in Table 6 regarding the model for fossil fuel energy consumption (FFEC), it has been determined that inflation has a negative and significant effect on the dependent variable (β = -0.1512701, p = 0.001). This finding indicates that price instability exerts pressure on

energy consumption and shows that energy demand declines during periods of economic stagnation. In an inflationary environment, consumers and firms may adopt more conservative energy usage behaviors.

Moreover, foreign direct investments (FDI) exhibit a positive and significant effect on energy consumption (β = 0.1009972, p = 0.016). This finding suggests that foreign investments support industrial and infrastructure development, thereby increasing energy demand. Particularly, investments in the manufacturing sector can lead to a rise in energy consumption.

The results suggest that the number of listed domestic companies (LDC) has a statistically significant and positive effect on fossil fuel energy consumption (FFEC) (p = 0.012 < 0.05). The coefficient value of 1.418 indicates that a one-unit increase in the number of listed domestic companies is associated with an approximate 1.42-unit increase in fossil fuel energy consumption. This finding implies that as more companies are publicly listed, fossil fuel consumption tends to rise, potentially due to increased industrial and economic activities associated with corporate expansion. The positive and significant relationship highlights the potential link between capital market development and energy demand, emphasizing the role of corporate growth in shaping fossil fuel consumption patterns.

Table 6. Model 3 Results

FFEC	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
INF	-.1512701	.0437632	-3.46	0.001	-.2402077	-.0623325
NGR	.0279319	.1270276	0.22	0.827	-.2302193	.2860831
OR	.0574344	.2084707	0.28	0.785	-.3662291	.4810979
PG	-.4632471	.4039607	-1.15	0.259	-1.284194	.3576998
PAR	3.999401	2.331217	1.72	0.095	-.7382021	8.737003
FDI	.1009972	.0396548	2.55	0.016	.020409	.1815854
MCAP	-.0046013	.0046591	-0.99	0.330	-.0140697	.0048671
EXP	.5972332	.4156313	1.44	0.160	-.2474312	1.441898
LDC	1.418504	.532292	2.66	0.012	.3367568	2.500252
MILX	-.1811269	.3477659	-0.52	0.606	-.8878723	.5256184

Conclusion and Overall Evaluation

This study provides insights for policymakers, investors, and academics by examining the determinants of energy imports, CO_2 emissions, and fossil fuel-based energy consumption in G7 countries. The analysis includes macroeconomic indicators (inflation, natural gas and petroleum rents, population growth rate), financial factors (foreign direct investments, market value of publicly traded companies, total number of publicly traded companies), trade and innovation indicators (goods and services exports, patent applications), as well as public expenditures represented by defense spending. The findings are instructive in terms of ensuring macroeconomic stability, developing sustainable energy policies, and minimizing environmental impacts.

Firstly, it has been determined that inflation has adverse effects on energy consumption and economic indicators. This finding aligns with the results of Akinola et al. (2024), who suggest that inflation increases volatility in energy prices, leading to market instability. Similarly, AlShafeey and Saleh (2024) and Ullah et al. (2023) indicate that high inflation rates amplify greenhouse gas emissions, further linking macroeconomic instability with environmental degradation. Therefore, implementing strict monetary policies and effective fiscal decisions is crucial, particularly in combating high inflation and ensuring a more stable economic outlook. For developing countries and those heavily dependent on energy imports, keeping inflation under control is vital for efficient resource utilization.

The impact of population growth on energy demand and economic development is a crucial indicator for countries. Studies in the literature, such as Ürkmez and Okyar (2022) and Kwakwa (2022), also emphasize that population is a significant variable affecting energy demand. However, recent

studies such as “The Impact of Renewable Energy Consumption on Environmental Quality in Central European Countries” highlight that population growth alone is insufficient; it must be complemented by policies on education, labor market participation, and digitalization to achieve sustainable growth. Particularly, supporting investments in renewable energy is essential for achieving economic development while preserving the environment.

The significant effect of natural gas rents (NGR) on energy imports is consistent with the findings of Narayan & Smyth (2009). This result indicates that G7 countries may face energy price fluctuations, leading to increased energy costs and negative impacts on households. Moreover, studies on fossil and renewable energy consumption (e.g., “Energy imports as inhibitor of economic growth”) reinforce that reliance on fossil fuel rents elevates vulnerability to external shocks, highlighting the need for domestic renewable energy promotion. In this context, promoting renewable energy investments is crucial for reducing energy dependence.

It has been found that foreign direct investments (FDI) contribute to increased energy consumption. Similarly, the study by Şişeci and Erdem (2023) and Shahbaz et al, (2023) states that FDI boosts energy consumption and supports economic growth. However, cross-country evidence (e.g., “The effect of financial development and economic growth on ecological footprint”) suggests that FDI can have differential impacts depending on whether it is channeled into energy-efficient or environmentally detrimental sectors. Therefore, directing FDI within the framework of policies that promote energy efficiency would be beneficial. Expanding incentive mechanisms for clean energy investments can help manage energy consumption more sustainably.

An important finding of this study is that military expenditures have a reducing effect on CO_2 emissions. There are mixed results in the literature on this topic. While studies such as Wang et al. (2021) suggest that military spending increases CO_2 emissions, our findings indicate that the military sector in G7 countries may have shifted towards environmentally friendly technologies. This aligns with research emphasizing technological modernization in defense sectors as a pathway to carbon neutrality. This result highlights the potential for increasing incentives for sustainable energy investments in the defense sector, thereby mitigating the environmental impact of military spending and supporting carbon-neutral policies.

The positive and significant effect of listed domestic companies (LDC) on fossil fuel energy consumption (FFEC) aligns with the findings of Sadorsky (2010). An increase in the number of firms stimulates industrial production, encourages economic activities, and consequently plays a role in increasing fossil fuel consumption. Recent evidence (e.g., “The effect of carbon dioxide emission and the consumption of electrical energy, fossil fuel energy, and renewable energy, on economic performance”) underscores that financial markets play a pivotal role in shaping energy use patterns, reinforcing the need to integrate sustainability considerations into capital market regulations. This finding underscores the importance of capital markets in shaping sustainable energy policies.

Policy Recommendations

1. Controlling Inflation: Enforcing monetary and fiscal policies to maintain stable inflation levels is critical for stabilizing energy markets and mitigating environmental risks.
2. Promoting Renewable Energy Investments: Incentivizing renewable energy projects can reduce dependency on fossil fuels, mitigate price volatility, and enhance environmental sustainability.
3. Directing FDI Toward Energy Efficiency: Policies should guide FDI to environmentally sustainable projects and energy efficiency initiatives, supported by green financing mechanisms.
4. Encouraging Environmentally Friendly Defense Technologies: Investments in green defense technologies and R&D in the military sector can reduce CO_2 emissions and promote carbon-neutral objectives.
5. Integrating Financial Market Development with Sustainability Goals: Developing financial instruments like green bonds and sustainability-linked financing can align market growth with sustainable energy consumption.

In conclusion, this study presents comprehensive findings on financial, energy, and environmental sustainability in G7 countries. The results are largely consistent with existing literature, while also highlighting nuanced differences and the importance of policy frameworks in moderating impacts. Future research could expand on these findings by incorporating additional sectors, renewable energy adoption rates, and cross-regional analyses to further elucidate the interplay between economic growth, energy consumption, and environmental quality.

Declarations

Declaration of Research and Publication Ethics: This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement: The authors declare that they have contributed equally to the article.

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Özet

Bu çalışma, sürdürülebilir kalkınma ile ekonomik büyüme arasındaki ilişkiyi, enerji odaklı çevresel değişkenler temelinde incelemeyi amaçlamaktadır. Çalışmada G7 ülkelerinin 1974–2023 dönemine ait verileri üzerinden enerji ithalatı, karbon emisyonları (CO_2) ve fosil yakıt tüketimi gibi çevresel bağımlı değişkenler; makroekonomik göstergeler, finansal yapılar, dış ticaret ve inovasyon faaliyetleri ile kamu harcamaları gibi bağımsız değişkenlerle ilişkilendirilmiştir. Çalışmada odak noktası, ekonomik büyümenin çevresel sürdürülebilirlik üzerindeki etkilerini analiz etmek ve bu bağlamda politika yapıcılara yol gösterici politikalar üretmek olarak belirlenmiştir.

Çalışmanın ilk aşamasında, enerji tüketiminin ekonomik büyüme üzerindeki etkisi ve bu etkilerin çevresel sonuıçları ele alınmıştır. Artan enerji talebi, bir yandan ekonomik kalkınmanın bir göstergesi olarak değerlendirilirken, öte yandan çevresel baskıları artırarak sürdürülebilir kalkınma hedeflerini tehdit etmektedir. Bu yönüyle, çevre ekonomisi literatüründe önemli bir yere sahip olan Çevresel Kuznets Eğrisi (Environmental Kuznets Curve – EKC) hipotezi doğrultusunda, büyüme ile çevre arasındaki etkileşim tartışılmıştır.

Çalışmadan elde edilen sonuçlar, enflasyonun enerji tüketimi ve ekonomik dinamikler üzerinde olumsuz etkiler yarattığını ortaya koymaktadır. Bu sonuç, literatürde yer alan enflasyonun enerji fiyatlarındaki dalgalanmaları artırarak ekonomik istikrarsızlığa yol açtığı yönündeki değerlendirmelerle uyumludur. Aynı şekilde, nüfus artış oranının enerji talebi ve ekonomik büyüme üzerinde etkili olduğu tespit edilmiş; ancak bu etkinin pozitif sonuçlar doğurabilmesi için eğitim ve istihdam politikalarıyla desteklenmesi gerektiği ifade edilmiştir.

Doğal gaz gelirlerinin (natural gas rents – NGR) enerji ithalatı üzerindeki etkisi ise ülkelerin enerji bağımlılığına işaret eden kritik bir gösterge olarak öne çıkmaktadır. Bu bulgu, yenilenebilir enerji yatırımlarının artırılması gerekliliğini bir kez daha ortaya koymaktadır. Diğer taraftan, doğrudan

yabancı yatırımların (foreign direct investment – FDI) enerji tüketimini artırıcı etkisi olduğu tespit edilmiş; ancak bu yatırımların çevresel etkilerinin göz ardı edilmemesi gerektiği vurgulanmıştır. Bu kapsamda, çevresel sürdürülebilirliği dikkate alan yatırım teşviklerinin yaygınlaştırılması önerilmektedir.

Çalışmanın dikkat çekici bulgularından biri de askeri harcamaların CO_2 emisyonları üzerinde azaltıcı bir etkisinin tespitidir. Bu sonuç, savunma sanayisinde çevreci teknolojilere yönelmeyle ilişkilendirilebilir. Her ne kadar literatürde farklı bulgular yer alsa da, bu sonuç savunma alanında sürdürülebilir politika uygulamalarının geliştirilebileceğine işaret etmektedir.

Son olarak, halka açık işletme sayısındaki artışın fosil yakıt tüketimi ile pozitif ilişki içinde olduğıu tespit edilmiştir. Bu ilişki, kaynak bulmanın kolaylaşması neticesinde sanayi üretiminin genişlemesi ve ekonomik faaliyetlerin yoğunlaşmasıyla açıklanabilir. Bu durum, sermaye piyasalarının çevresel sürdürülebilirlik üzerindeki etkilerine odaklanan politika yaklaşımlarının gerekliliğine dikkat çekmektedir.

Genel hatlarıyla bu çalışma, G7 ülkeleri bağlamında enerji, ekonomi ve çevre etkileşimini çok boyutlu bir şekilde analiz ederek, hem kuramsal hem de ampirik düzeyde literatüre katkı sağlamaktadır. Elde edilen bulgular, düşük karbonlu ekonomik sisteme geçiş sürecinde hangi ekonomik, finansal ve politik değişkenlerin etkili olabileceğini ortaya koymakta ve gelecekte yapılacak sektörel ve ülke karşılaştırmalı çalışmalara sağlam bir temel sunmaktadır.