İKTİSADİ İDARİ VE SİYASAL ARAŞTIRMALAR DERGİSİ
JOURNAL OF ECONOMICS BUSINESS AND POLITICAL RESEARCHES

e-ISSN: 2564-7466 | Cilt:10, Sayı:28, Ekim 2025
https://dergipark.org.tr/tr/pub/iktisad | Vol:10, No:28, October 2025

# The Impact of Economic Policy Uncertainty and Foreign Direct Investments on Renewable Energy Consumption in G-7 Countries

♦♦♦

# G-7 Ülkelerinde Ekonomi Politika Belirsizliği ve Doğrudan Yabancı Yatırımlarının Yenilenebilir Enerji Tüketimi Üzerindeki Etkisi

https://doi.org/10.25204/iktisad.1739234

Fatih Volkan AYYILDIZ*

**Article Info**

**Paper Type:** Research Paper

**Received:** 10.07.2025

**Accepted:** 21.09.2025



**Abstract**

*This study investigates the impact of economic policy uncertainty and foreign direct investments on renewable energy consumption in G-7 (The Group of Seven) countries using data for the period 2000-2023. At the same time, another important purpose of the study is to investigate the multidirectional relationships of causality between the variables. Within the context of the goal, the relationships between variables are analyzed using Gengenbach, Urbain, and Westerlund, Prais-Winsten and Dumitrescu-Hurlin methods. This study fills the gap in the literature by differing from other studies on the subject in terms of the methods used. According to the findings of Gengenbach, Urbain and Westerlund's cointegration test, it was found that there was a cointegration relationship between the variables. According to the findings of the Prais-Winsten regression analysis, a 1% increase in foreign direct investment increases renewable energy consumption by approximately 0.30%, at a statistically significant level. According to the findings of Dumitrescu and Hurlin panel causality analysis suggested for heterogeneous panel data, there is a bidirectional causality relationship between all variables. All the findings obtained from the analysis generally support the findings of similar studies in literature.*

***Keywords:*** *Renewable energy, economic policy uncertanity, foreign direct investment, Prais-Winsten regression, Dumitrescu and Hurlin panel causality.*

**Makale Bilgileri**

**Makale Türü:** Araştırma Makalesi

**Geliş Tarihi:** 10.07.2025

**Kabul Tarihi:** 21.09.2025



**Öz**

*Bu çalışmada, 2000-2023 dönemi verileri kullanılarak G-7 (Yedili Grup) ülkelerinde ekonomi politika belirsizliği ve doğrudan yabancı yatırımlarının, yenilenebilir enerji tüketimi üzerindeki etkisi araştırılmaktadır. Aynı zamanda değişkenler arasındaki çok yönlü nedensellik ilişkilerinin araştırılması çalışmanın bir diğer önemli amacıdır. Bu amaç kapsamında, değişkenler arasındaki ilişkiler Gengenbach, Urbain ve Westerlund, Prais-Winsten ve Dumitrescu-Hurlin yöntemleri kullanılarak analiz edilmiştir. Bu çalışma, kullanılan yöntemler açısından konuyla ilgili diğer çalışmalardan farklılaşarak literatürdeki boşluğu doldurmaktadır. Gengenbach, Urbain ve Westerlund eşbütünleşme testi sonucunda değişkenler arasında eşbütünleşme ilişkisi olduğu bulunmuştur. Prais-Winsten regresyon analizinin bulgularına göre, doğrudan yabancı yatırımlardaki %1'lik bir artış, yenilenebilir enerji tüketimini istatistiksel olarak anlamlı bir düzeyde yaklaşık %0,30 oranında artırmaktadır. Heterojen yapıdaki panel veriler için önerilen Dumitrescu ve Hurlin panel nedensellik analizi bulgularına göre tüm değişkenler arasında çift yönlü nedensellik ilişkisi bulunmaktadır. Analizlerden elde edilen bulgular genel olarak literatürdeki benzer çalışmaların bulgularını desteklemektedir.*

***Anahtar Kelimeler:*** *Yenilenebilir enerji, ekonomi politikası belirsizliği, doğrudan yabancı yatırım, Prais-Winsten regresyon, Dumitrescu ve Hurlin panel nedensellik.*

**Atıf/ to Cite (APA)**: Ayyıldız, F. V. (2025). The impact of economic policy uncertainty and foreign direct investments on renewable energy consumption in G-7 Countries. *Journal of Economics Business and Political Researches, 10*(28), 866-880. https://doi.org/10.25204/iktisad.1739234

*ORCİD Assist. Prof. Dr., Ordu University, Ünye Faculty of Economics and Administrative Sciences, Department of Economics, f.volkanayyildiz@odu.edu.tr

## 1. Introduction

The uncertainty that is associated with policy is considered by economists and those who make policy to be one of the significant aspects that contribute to the overall economic uncertainty. In addition to these arguments on the unpredictability of economic policy, many academics have expressed difficulty in defining the idea of political instability. This is because the degree of political instability in a nation is not readily visible. It could be done to define the same political situation in the country as either stable or unstable, depending on the definition of political instability used in recent years, scholars have seen an increased focus on energy studies. Uncertainty is a primary non-economic variable, while not being a fundamental macroeconomic indicator, particularly in shaping energy policy. Considering the numerous difficulties in the energy sector and the broader context, it is essential to incorporate foreign direct investment (FDI) as a significant factor influencing policy uncertainty and diverse investment decisions while acknowledging the ambiguities in both the data and expert assessments (Baker et al., 2016: 1600-1603). In addition to the uncertainties that are the main motivation source of this study, the other independent variable is FDIs, and the dependent variable is renewable energy (RE).

This study specifically identifies the potential relationship between the variables using various econometric analyses. It is noted that the literature is relatively sparse in studies using Gengenbach, Urbain, and Westerlund's cointegration test, and Prais-Winsten regression analysis, particularly among those using these two variables. This study aims to fill this gap, particularly in terms of methodology

RE is the emerging catalyst for economic progress. In recent years, the economic landscape has become a volatile and intricate reality, and the discourse on clean energy consumption, particularly the momentum of RE, is a crucial element of economic growth. The alteration in economic policy will eventually impact firms' RE investment decisions, which in turn will affect the use of both conventional and RE. The literature indicates that economic policy uncertainty (EPU), conventional energy, and RE are interconnected (Işık et al., 2024).

**Table 1.** RE Consumption per Capita in G-7 Countries (in Exajoules)

| Country / Years | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|
| Canada | 4.23 | 4.22 | 4.37 | 4.08 |
| France | 0.38 | 0.41 | 0.41 | 0.43 |
| Germany | 1.29 | 1.27 | 1.21 | 1.47 |
| Italy | 1.19 | 1.18 | 1.02 | 1.15 |
| Japan | 1.90 | 2.04 | 2.09 | 2.19 |
| UK | 1.28 | 1.41 | 1.30 | 1.43 |
| US | 9.32 | 9.81 | 10.78 | 10.99 |

**Source:** BP British Petroleum (2025).

According to Table 1, per capita RE energy consumption in G-7 countries is generally on the rise. The highest RE energy consumption among all G-7 countries is expected to occur in 2023. This can be interpreted as a sign of increasing sensitivity to RE and climate change over the years. Among G-7 countries, the US has the highest per capita RE consumption.

Since the 1980s, developed as well as emerging nations have augmented their utilization and production of RE. The growth of RE encompasses four facets. Technological innovation has decreased the expenses associated with investing in RE systems. The second aspect pertains to governmental regulations that have facilitated encouraging policy consequences for RE investments, including the implementation of credit easing and tax deductions for green energy by numerous governments, thereby enhancing certificate and portfolio standards in RE investments The third point pertains to climate change challenges. It is said that the augmented utilization of RE diminishes CO2 emissions, hence enabling RE to alleviate the detrimental impacts of climate change the rise in fossil

fuel prices has stimulated the use of RE. Considering these four elements, RE has the capacity to foster sustained economic growth (Sadiq et al., 2024; Şahin and Ayyıldız, 2020; Danish and Ulucak, 2021).

In particular, the scope of sustainable and secure energy is expanding on a worldwide scale as a consequence of shifting prices for fossil fuels and declining energy sources. Both a decreased reliance on imported fossil fuels for energy production and an enhanced utilization of RE sources that are local to the area provide possibilities that are encouraging. In addition to fossil fuels, certain kinds of energy that are collectively referred to as RE such as hydropower, solar, wind, geothermal, tidal, and waste to energy) have been said to provide a greater number of positive externalities. RE is typically seen as less detrimental due to its negligible greenhouse gas emissions during operation (Mattman et al., 2016).

There are significant consequences for the energy sector's future in the intricate interplay between RE and EPU. In order to create a more sustainable and secure energy system, it is essential for politicians, entrepreneurs, and investors to understand this link. A number of reasons have contributed to RE's meteoric rise in popularity: falling prices, stronger public backing, and supportive government regulations (International Energy Agency, 2021). It is more difficult for firms and investors to make decisions that are informed when there is ambiguity regarding economic policy, which might produce an investment climate that is hazardous to investment (Kammen and Baer, 2012).

According on the outcomes of the empirical research conducted on the topic, the following may be inferred. To begin, a growing number of academics have investigated the impact that RE plays in macro elements such as economic growth, energy efficiency and security, environmental quality, financial development, and FDI inflows. In the second group of findings, the focus was on the factors that determine the increase of RE generation in the economy. As a consequence of this, the study found a number of important factors that determine the incorporation of RE into the economy. These factors include financial development, investment, and FDI. In order to improve the energy mix and strike a balance between the capacity to protect the natural environment and the market conflicts that may arise, RE is an essential component of the energy supply (Aizenman and Marion, 1993; Tiwari, 2011; Gulen and Ion, 2016).

FDI may influence RE demand via two mechanisms. The presence of foreign enterprises in the host country's marketplaces may compel indigenous firms to enhance their competitiveness, especially as energy is generally the most critical, limited, and costly resource for the production of products and services. Domestic companies may seek innovative methods to mandate RE usage to mitigate elevated manufacturing expenses. Secondly, foreign companies may emulate energy-efficient technology if the originating country has compelled them to implement stringent environmental regulations. To far, limited research has examined the correlation between FDI and energy consumption in the literature, with most findings being confusing and yielding inconclusive results. Some writers contend that FDI may foster energy-efficient technology and diminish energy consumption, while others assert that FDI may actually escalate energy consumption when new foreign enterprises engage in these host markets (Polat, 2018).

FDI is one of the key variables affecting RE resources. FDI contributes to the economic and growth of the country that attracts FDI by enabling it to flow out of the country through various channels. FDI is an important catalyst for growth and development in both developed and developing countries (Borensztein et al., 1998). Esty and Gentry (1997) state that FDI is conducted for three different purposes. These are market-oriented, resource-oriented, and production site-seeking FDI. Market-oriented and resource-oriented FDI are considered to be relatively insensitive to environmental factors and relatively insensitive to cost. The third purpose, which is to seek production sites, is FDI that is sensitive to environmental factors. Cost-cutting FDIs aimed at this purpose are

considered to be related to the Pollution Haven Hypothesis (PHH) and have an impact on RE consumption (Aliyu, 2005).

The examination of the topic from a comprehensive viewpoint concerning the influence of FDI on RE is articulated through two distinct theories. These are the pollution halo hypothesis and the pollution haven hypothesis. The pollution haven hypothesis is alternatively known as pollution haven in certain research within the literature. The pollution haven hypothesis states that developing countries have become pollution havens by conducting international trade with developed countries using FDIs, that is, allowing pollution export. The pollution halo hypothesis can be expressed as the international trade in which FDIs play a leading role directs developing countries to clean technology export. Since these companies are based on new technology, it is stated that they contribute to the reduction of carbon dioxide emission levels of the countries they invest in. This situation contributes positively to RE consumption (Hoffman et al., 2005; Shahbaz et al., 2011; Abbasi et al., 2023).

According to the Pollution Haven Hypothesis, a country's pollution level will increase because FDI leads to an expansion of economic activity in industries that ignore environmental factors. This occurs in the long run due to the growth effect of FDI. The basis of this relationship is the long-run inverted-U relationship between output growth and pollution levels, known as the Environmental Kuznets Curve (EKC) (Acharyya, 2009).

The G-7 economies, comprising about 10% of the global population, are responsible for over 25% of worldwide emissions of carbon dioxide, underscoring their unequal impact on the effect of climate change (Chen et al., 2025) In this respect, in this study, the sample of G-7 countries was selected in order to analyze the possible effects of EPU and FDI variables on RE consumption (Doğan et al., 2023: 825).

Taking this into consideration, the sample of G-7 nations was chosen for this study in order to analyze the potential impacts of EPU and FDI factors on RE consumption. Subsequent to this phase of the study, the literature, econometric analysis, and conclusions sections will be examined in that order.

## 2. Literature

RE and FDIs are among the factors affecting EPU. Recent years have seen a surge in research on EPU, FDI, and RE consumption, resulting in the citation of contemporary academic studies on the topic.

Solomon and Ruiz (2012) examined the Panel GMM analysis method to examine the influence of foreign investments on EPU in 28 developing nations across various regions from 1985 to 2004. Their studies conclude that heightened uncertainty diminishes foreign investment, with this effect being particularly pronounced in African nations.

Gulen and Ion (2016) concluded that a negative correlation exists between future corporate investments and policy uncertainty, as indicated by the policy uncertainty index they developed using data from their compustat analysis files, which encompass quarterly data from January 1987 to December 2013. They found that increases in policy uncertainty lead to precautionary delays in investments.

Çağlar (2020) examined a bootstrap ARDL analysis to examine the interrelationships among energy consumption, FDI, carbon emissions, and economic growth in nine countries, selected based on the Climate Change Performance Index, during the period from 1970 to 2014. The statistics derived from his study suggest that the relationships among the specified variables are significant in the long term, and that short-term causal relationships exist, despite the absence of a long-term relationship to validate the ECC hypothesis. Nevertheless, certain types of causality are observed in the short term. It should be significant in the long term. The empirical analysis yielded no evidence

of an ice term equilibrium relationship, which would enable evaluation of the ECC hypothesis across all countries. Nonetheless, certain types of causality are observed in the short term.

Kang and Ratti (2015) examined the impact of economic and political uncertainty on the oil and stock markets in China from January 2003 to December 2011 using VAR analysis in their research. Their studies conclude that the shocks in the oil market have intensified China's economic policy. Adedoyin and Zakari (2020) examined the correlation among EPU, $CO_2$ emissions, energy consumption, and national income in the United Kingdom from 1985 to 2017 using the Pairwise Granger causality test. Their research indicates that EPU does not significantly impact $CO_2$ emissions in the short term; however, it does lead to elevated carbon emissions in the long term, and a unidirectional causal relationship exists between energy consumption and EPU.

Shafiullah et al. (2021) examined the correlation between policy uncertainty and RE in the United States from 1986 to 2019 using non-parametric decoupling and causality analysis methods. Consequently, their research concludes that prolonged EPU exhibits a renewable inverse relationship. Lu et al. (2021) examined the influence of EPU on RE growth from 1965 to 2019 (with the starting date varying by country based on the dataset) in the USA, Japan, Germany, and Brazil using the VAR model. Studies controlling for EPU indicate that Germany, Brazil, and the USA have not established a bidirectional causal relationship between growth and RE. At the same time, Germany and Japan have similarly struggled to establish a causal relationship between these variables. Tan and Uprasen (2022) examined the influence of foreign investments on RE consumption in BRICS nations utilizing the panel GMM methodology from 1990 to 2015 in their research. Their research concludes that environmentally sensitive FDIs enhance RE consumption. Doğan et al. (2023) examined the relationship between EPU and RE consumption in G-7 countries from 1997 to 2021 using the Han & Phillips method. December. Their studies indicate an inverse relationship between EPU and RE consumption. Athari (2024) examined the correlation between EPU and RE in the Organisation for Economic Co-operation and Development (OECD) countries from 2000 to 2019 using panel quantitative regression analysis, taking into account the stringent environmental requirements in these nations. Their studies indicate that stringent environmental policies significantly mitigate the effects of EPU on RE consumption, while FDIs enhance RE consumption.

Yi et al. (2023) examined the EPU and financial developments in a cohort of 9 developed nations from 2003 to 2012, utilizing monthly data and panel data analysis in their research. Their studies indicate that financial developments enhance RE consumption, whereas economic policy deficiencies exhibit an inverse relationship with the use of RE.

Pata et al. (2023) examined the impact of economic policy uncertainties and geopolitical risks on RE consumption in G-7 countries from 2004 to 2018 using panel data analysis. Their research indicates that economic policy uncertainties and heightened geopolitical risks diminish RE consumption, with the influence of economic policy uncertainties being more pronounced than that of geopolitical risks.

Kapçak (2023) examined the relationship between RE and FDI in the Turkish economy for the period 1980-2019 using a latent error correction model. He concluded that there is an asymmetric causality from FDI to RE consumption.

Sadiq et al. (2024) examined the panel ARDL analysis method to assess the impact of policy uncertainty, RE, and corruption variables on carbon emissions in BRICS-1 countries from 1990 to 2020. As a result of their study, they found that preventing corruption and increasing RE consumption would reduce carbon emissions in the long term, thereby supporting sustainable environmental policy and reducing policy uncertainties.

Dai et al. (2025) examined the impact of energy policy uncertainty on fossil fuel and RE consumption in G-7 countries from 1996 to 2022, employing a panel data analysis method. Their

research indicated that uncertainty in energy policy adversely affects the consumption of both fossil fuels and RE, and they proposed that encouraging FDI could mitigate this uncertainty.

The general results of the studies indicate a relationship between the variables EPU, FDI, and RE. This study specifically identifies the potential relationship between the variables using various econometric analyses. It is noted that the literature is relatively sparse in studies using Gengenbach, Urbain, and Westerlund's cointegration test, and Prais-Winsten regression analysis, particularly among those using these two variables. This study aims to fill this gap, particularly in terms of methodology.

## 3. Data and Methodology

The three main methods used in the model, namely Gengenbach, Urbain and Westerlund cointegration test, Dumitrescu and Hurlin causality test and Prais Winston regression analysis methodology are explained from a theoretical perspective, respectively. The first main method is the cointegration test developed by Gengenbach, Urbain, and Westerlund (2016) is designed for situations where the cointegration relationship is heterogeneous. Unlike traditional cointegration tests, it acknowledges that different long-run relationships might exist for each individual unit. The main goal of the test is not to determine if there is a common cointegration relationship across the panel, but to determine if a cointegration relationship exists for at least one unit.

The test is based on estimating a separate error correction model (ECM) for each individual unit (i). The core equation of this model is as follows:

$$\Delta yi,t = \alpha iyi,t-1 + \delta ixi,t-1 + \sum k=1p\beta i,k\Delta yi,t-k + \sum k=0p\gamma i,k\Delta xi,t-k + \epsilon i,t \quad (1)$$

This model combines the short-run dynamics and long-run deviations for each unit.i represents the individual units in the panel data (e.g., countries, companies). t denotes the time period, yit and xit represent two variables. The test investigates whether a long-run cointegration relationship exists between them, Δ indicator means the difference operator ($\Delta yi,t=yi,t-yi,t-1$) αi and δi indicators represent the coefficients. The existence of a cointegration relationship depends on αi being non-zero. If $\alpha i\neq=0$, it indicates a long-run relationship for unit i., βik and γik indicators are coefficients that capture the short-run dynamics of the lagged differences of the dependent and independent variables, ϵit is the error term, prRepresents the number of lags (lag order) used in the model.

The Gengenbach, Urbain, and Westerlund (2016) test examines the following hypotheses:

Null Hypothesis (H0): There is no cointegration relationship for all units in the panel. Mathematically, for all units i, $\alpha i=0$.

Alternative Hypothesis (H1): There is a cointegration relationship for at least one unit in the panel. Mathematically, for at least one unit i, $\alpha i\neq=0$.

The test applies individual cointegration tests (e.g., ADF or Phillips-Perron tests) for each unit and then pools these test statistics to create a panel-wide statistic. This provides a more flexible and powerful test by considering the unique dynamics and cointegration relationships of each individual unit.

The second test, the panel causality test established by Dumitrescu and Hurlin (2012), is an adaptation of the conventional Granger causality test for panel data that considers heterogeneity. This assessment acknowledges that the causal link may vary among distinct entities (countries, corporations etc.).

The assessment relies on distinct Granger causality regression equations for each individual unit (i). The equation is as follows:

$$yi,t = \alpha i + \sum k=1K\beta i,kyi,t-k + \sum k=1K\gamma i,kxi,t-k + \epsilon i,t \quad (2)$$

This regression examines the effect of past values of y and past values of x on the current value of y for each individual unit. This index represents the individual units in the panel data (e.g., countries, companies, states). It takes values i=1,2,..,N. t represents the time period (e.g., years, quarters). It takes values t=1,2,..T.; yit and xit are two different variables for unit i at time t. The test investigates whether x Granger-causes yαi represents the constant term for each individual unit. This allows the model to capture the individual differences (heterogeneity) among units, βik is the coefficient of the k-th lag of y for unit i. These coefficients show the effect of y's own past values on its current value, γik is the coefficient of the k-th lag of x for unit i. The Dumitrescu-Hurlin test primarily examines whether these coefficients are equal to zero, k represents the number of lags (lag order) used in the model and ϵit: The error term for each unit and time period.

The Dumitrescu and Hurlin (2012) test primarily examines the following two hypotheses:

Null Hypothesis (H0): x does not Granger-cause y for all units in the panel. Mathematically, for all units i, γi,k=0.

Alternative Hypothesis (H1): x does Granger-cause y for at least one unit in the panel. Mathematically, for at least one unit i, γik≠0.

The test works by calculating a separate Wald statistic (Wi) for each individual unit and then averaging these statistics to create a pooled test statistic (WNT). The test result is obtained using standardized versions of the average Wald statistic ($Z^-$ and Z~). This method ensures that the test provides more robust and reliable results across the entire panel by accounting for the differences in causal relationships among individual units.

The third main method used in the methodology is Prais Winsten regression analysis. In this method, the original model is:

$$Yt = \beta 0 + \beta 1Xt + \epsilon t \quad (3)$$

Autocorrelation of error terms:

$$\epsilon t = \rho \epsilon t - 1 + ut \quad (4)$$

Transformed model:

$$Yt - \rho Yt - 1 = \beta 0(1 - \rho) + \beta 1(Xt - \rho Xt - 1) + (\epsilon t - \rho \epsilon t - 1) \quad (5)$$

To eliminate autocorrelation, the Prais-Winsten method creates a lagged version of the original equation by multiplying it by ρ and then subtracting this lagged equation from the original one. This equation can be rewritten as follows:

$$Yt * = \beta 0 * + \beta 1Xt * + ut \quad (6)$$

Where, the ut terms are the new error terms that are no longer autocorrelated. In conclusion, Prais-Winsten (1954) regression is a powerful tool used to obtain more reliable and efficient estimates of regression coefficients, especially when faced with the problem of autocorrelation in time series data. After detecting the presence of autocorrelation, the Prais-Winsten method uses an approach called Generalized Least Squares (GLS). A key feature of the method is that it retains the first observation (t=1) in the data set, thus avoiding data loss. Unlike the Cochrane-Orcutt method, Prais-Winsten can produce more efficient estimates because it includes the first observation in the equation. This is particularly important for data sets with a small sample size. This method effectively solves the autocorrelation problem in time series analysis, thereby increasing the reliability of regression results.

This study examines the effects of EPU and FDI on RE consumption in G-7 countries from 2000 to 2023 using a panel data methodology and Prais-Winsten regression. The function equation (7) of the model established in this direction is shown below:

$$RE = f(EPU, FDI) \quad (7)$$

The RE notation in the equation indicates RE consumption; the EPU notation indicates EPU and the FDI notation indicates FDI. The EPU monthly index data were rearranged by taking the average of 12-month data and included in the model as annual data. Explanations and data sources for the variables are shown in Table 2.

**Table 2.** Data Set

| Variables | Symbols | Measurements | Data Sources |
|---|---|---|---|
| Renewable energy consumption | RE | Exajoule | BP Statistics (2025) |
| Economic policy uncertainty | EPU | Index | https://www.policyuncertainty.com/ |
| Foreign direct investments | FDI | Current US dollars | Worldbank (2025) |

$$\ln RE_{i,t} = \beta_0 + \beta_1 \ln EPU_{i,t} + \beta_2 \ln FDI_{i,t} + \xi_{i,t} \quad (8)$$

In the model (2), β0 represents the constant parameter coefficient; β1 and β2 represent the parameter coefficients for EPU and FDI, respectively. ξ indicates the error terms; ln indicates the logarithmic form structure of the variables

The findings regarding the summary statistics of the variables are shown in Table 3. According to the findings, the average values of RE consumption, EPU, and FDIs are approximately 0.45, 2.15, and 4.85, respectively. The fact that the variables have small standard deviation values indicates that they tend to be close to the average of the data set, which is the desired situation.

The differences between the minimum and maximum values of the variables indicate that there is no excessive difference in the data sets. It is observed that the number of observations in the model (N = n*T) is a balanced panel time series consisting of 168 values. Since per capita RE consumption in G-7 countries is between 0 and 1 in exajoules, all of these values are included in the analysis by multiplying by 100. Since per capita RE consumption in G-7 countries ranges from 0 to 1 in exajoules, all of these values were multiplied by 100 and included in the analysis

**Table 3.** Summary Statistics

| Variables | Average | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| lnRE | 4.933309 | 0.9524351 | 2.352327 | 7.002083 |
| lnEPU | 2.154422 | 0.2283953 | 1.575226 | 2.825433 |
| lnFDI | 4.850261 | 0.7374378 | 4.271629 | 6.676135 |

### 3.1. Findings

The findings of Kendall's Tau correlation analysis, which was conducted to make predictions about the direction and degree of possible relationships between data sets, as well as the assumption of multiple linear connections between independent variables, are reported in Table 4. The analysis calculates the relationship between two variables sequentially. When the findings are evaluated, statistical significance levels are seen among all variables. In this direction, it is seen that the relationship between RE consumption and EPU is approximately 0.20, and the relationship between FDIs is approximately 0.59 and exhibits positive correlations. However, it is observed that the relationship between the independent variables is 0.10. The findings are interpreted as the relationships between the variables are not very strong and the assumption of multiple linear connections is met.

**Table 4.** Kendall's Tau Correlation Analysis

| Matrix | lnRE | lnEPU | lnFDI |
|---|---|---|---|
| lnRE | 1.0000<br>- | | |
| lnEPU | 0.3542<br>0.0002* | 0.9999<br>- | |
| lnFDI | 0.5868<br>0.0000* | 0.2105<br>0.0495** | 1.0000<br>- |

**Note**: * symbol is 0.01, ** symbol is 0.05 significance level.

In the first stage of the analysis, to determine the preferred unit root test types and model selection, necessary tests were conducted to examine parameter homogeneity and cross-sectional dependency situations. In this context, the homogeneity of the parameters was first checked using Swamy's (1971) S test. When the findings in Table 5 were evaluated, it was observed that the H0 basic hypothesis was rejected for the variables lnRE, lnEPU, lnFDI and the parameters were not homogeneous, meaning they varied from unit to unit. At the same time, the analysis conducted for the entire panel pointed to the same finding, confirming that the heterogeneity situation should be taken into account in the models to be established.

**Table 5.** Parameter Homogeneity Findings

| Variables | chi2 | Prob > chi2 |
|---|---|---|
| lnRE | chi2(6) = 562.28 | 0.0000 |
| lnEPU | chi2(6) = 39.87 | 0.0000 |
| lnFDI | chi2(6) = 84275.84 | 0.0000 |
| Full panel | chi2(18) = 1.6e+05 | 0.0000 |

After determining that the model is heterogeneous, the Lagrange Multiplier (LM) cross-sectional dependence test, developed by Breusch and Pagan (1980), was performed for the case of T >N, and the findings are summarized in Table 6. The findings showed that the basic hypothesis H0 was rejected at the 0.01 significance level under 21 degrees of freedom, indicating cross-sectional dependence among the variables. In addition, the Breusch-Pagan LM test findings performed at the model scale also supported the existence of cross-sectional dependence in the model.

**Table 6.** Cross-Sectional Dependency Findings

| Variables | Statistics | P-value |
|---|---|---|
| lnRE | 70.44 | 0.0000* |
| lnEPU | 18.68 | 0.0000* |
| lnFDI | 5.62 | 0.0000* |
| Full panel | 72.16 | 0.0000* |

**Note**: p is the probability value and * symbol is 0.01 significance level.

The findings of the CADF (Cross-section Extended Dickey-Fuller) and CIPS (Cross-section Extended Im, Pesaran, and Shin) tests, which are presented in Table 7, have significant implications for the analysis process. They indicate that second-generation unit root tests should be preferred. These results, obtained in the second stage of the analysis, are particularly interesting. They show that the variables of RE consumption and EPU become stationary at I(0) level values, and FDIs become stationary at I(1) first-difference levels, indicating that they do not contain a unit root.

**Table 7.** CADF and CIPS Unit Root Findings

| Variables | CADF | | CIPS | | Result |
|---|---|---|---|---|---|
| | I(0) | I(1) | I(0) | I(1) | |
| lnRE | 2.416 (0.041)** | 3.463 (0.000)* | -2.427** | -5.921* | I(0) |
| lnEPU | 2.613 (0.010)* | 3.186 (0.000)* | -2.487** | -5.164* | I(0) |
| lnFDI | 1.280 (0.880) | 2.378 (0.046)** | -1.341 | -2.779* | I(1) |

**Note:** * symbol, 0.01 significance level; ** symbol, 0.05 significance level; critical values are cv1: -2.57, cv5: -2.33, cv10: - -2.21

In this context, Gengenbach et al. (2016) cointegration test, which allows for heterogeneity, inter-unit correlation, and unequal lag situations in the model, was performed, and the findings are reported in Table 8.When the significance of the panel cointegration test y(t-1) was examined according to the heterogeneous lag length findings, it was found that the basic hypothesis H0 was rejected, thus supporting the existence of a cointegration relationship between RE consumption, EPU, and FDIs.

**Table 8.** Long-term Relationship Findings

| **Test type** | **Cointegration Test** | | |
|---|---|---|---|
| **Panel EC-test** | **Coefficient** | **T-bar** | **P-value** |
| y(t-1) | -0.724 | -3.342 | <=0.01 |

**Table 9.** Tests of Assumptions

| **Assumptions** | **Statistics** | **P** | **Avg.VIF** | **chi2(1)** | **p>chi2** |
|---|---|---|---|---|---|
| Multicollinearity test | - | - | 1.02 | - | - |
| Jarque-Bera normality test | 0.76245 | 0.6631 | - | - | - |
| Breusch-Pagan/Cook-Weisberg heteroscedasticity test | - | - | - | 1.86 | 0.1593 |
| Autocorrelation test | Bhargava et al. Durbin-Watson = 0.35739215<br>Baltagi-Wu LBI = 0.56243518 | | | | |

The Prais-Winsten regression analysis findings for the case where the autocorrelation assumption is not met in the model are summarized in Table 9. According to the findings in table10, it is seen that the EPU variable is statistically insignificant, whereas the FDI variable is significant. In this context, a 1% increase in FDIs increases RE consumption by approximately 0.30%. There are studies in the literature that support this result. There are studies in the literature that support this result. Doytch and Narayan (2016) argue in their study that FDI encourages energy conservation by increasing RE consumption and creates a “pollution halo” effect. Paramati et al. (2016) examine the relationship between FDI and RE consumption in developing economies. Their findings indicate that FDI significantly stimulates clean energy consumption and helps fuel the growth of RE technology.

Fan and Hao (2020) state in their studies that FDI in China facilitates the transfer of clean technologies and provides financing for RE projects. The results highlight that FDI increases RE use and that these investments are vital for the region's energy transition.

**Table 10.** Prais-Winsten Regression Analysis Findings

| **Variables** | **Coefficient** | **Standard Error** | **t** | **P>\|t\|** | **[95% Confidence interval]** |
|---|---|---|---|---|---|
| lnEPU | 0.0035287 | 0.0312942 | 0.11 | 0.907 | [-0.0573674 0.0652783] |
| lnFDI | 0.3024957* | 0.1425558 | 2.13 | 0.034 | [0.02242361 0.5845218] |
| Constant | -1.035852 | 0.7091575 | 1.46 | 0.145 | [-2.4358274 0.3672616] |

**Note:** * symbol is 0.05 significance level.

In the final stage of the analysis process, Dumitrescu and Hurlin's (2012) panel causality test was conducted to determine the causal relationships between the variables and the direction of these relationships. The test, which allows balanced and unbalanced panel time series, is recommended for heterogeneous panels (Şahin, 2022).

**Table 11.** Causality Analysis Findings

| Basic hypotheses | W-statistic | Z-statistic | P-value |
|---|---|---|---|
| lnRE ≠ lnEPU | 18.5874 | 9.6138 | **0.0000*** |
| H0 = lnEPU is not the cause of lnRE | | | |
| lnEPU ≠ lnRE | 16.2844 | 7.8548 | **0.0000*** |
| H0 = lnRE, is not the cause of lnEPU. | | | |
| lnFDI ≠ lnRE | 22.2174 | 12.3862 | **0.0000*** |
| H0: lnFDI is not the cause of lnRE. | | | |
| lnFDI ≠ lnRE | 10.0921 | 3.1254 | **0.0018*** |
| H0 = lnRE, is not the cause of lnFDI. | | | |
| lnEPU ≠ lnFDI | 36.5326 | 23.3197 | **0.0000*** |
| H0 = lnFDI, is not the cause of lnEPU | | | |
| lnFDI ≠ lnEPU | 10.8552 | 4.8988 | **0.0000*** |
| H0 = lnEPU is not the cause of lnFDI. | | | |

**Note:** The optimal lag length is 6, the information criterion is the Akaike information criterion, the * symbol, the significance level is 0.01.

When the findings in Table 11 are evaluated, it is seen that the H0 basic hypothesis is rejected in all causality relationships between RE consumption, EPU, and FDIs, thus reflecting two-way causality relationships that indicate feedback effects

The findings of a two-way causality between variables are visualized and presented in Figure 1.

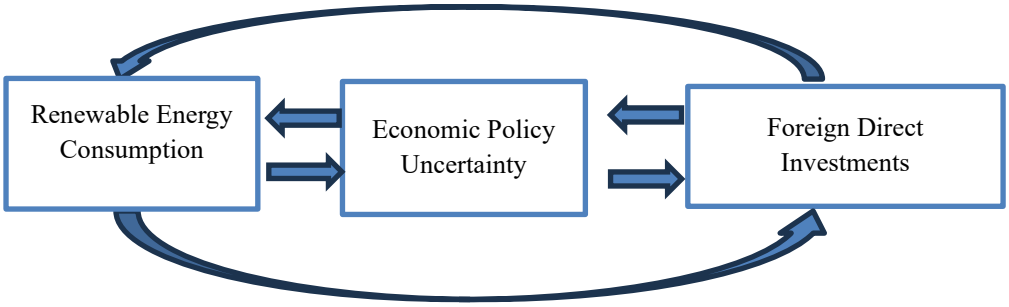


**Figure 1.** Dumitrescu-Hurlin Panel Causality Test Findings
**Source:** The figure was created by the author.

There are studies in the literature that reach similar findings. Shafiullah et al. (2021) compellingly demonstrated a bidirectional causality between economic EPU and energy consumption, indicating that fluctuations in one significantly impact the other. Moreover, the research by Mert and Bölük (2016) found in their study that the relationship between RE and FDI variables was statistically significant in the panel causality period. These findings highlight a crucial understanding of how these variables interrelate, emphasizing the need for comprehensive approaches in policy-making and investment strategies.

## 4. Conclusion

This study analyzed the effects of EPU, FDI on RE in G-7 countries from 2000 to 2023 period. The methodologies employed Gengenbach, Urbain and Westerlund cointegration test, Prais-Winsten regressions test, and Dumitrescu -Hurlin panel causality test offer a robust framework for examining the intricacies of these relationships across various stasis levels. The results obtained in the study indicate that preventing policy uncertainty is a factor that fosters direct investments, and this situation will contribute to RE consumption holistically. The results of the study are generally similar to those

of Doytch and Narayan (2016), Paramati et al. (2016), Shafiullah et al. (2021), Yi et al. (2023), Sadiq et al. (2024), and Dai et al. (2025).

Various incentives associated with renewable assistance policies, such feed-in tariffs, RE certificates, and renewable portfolio criteria, significantly influence FDI in RE (Keeley and Matsumoto, 2018). Governments must also reform national finance rules to oversee and limit direct dirty FDI inflows. In this instance, both unclear FDI government officials may misappropriate funds for personal gain rather than for developmental purposes (OECD, 2014).

Based on the analysis findings of the study, here is a detailed and expanded conclusion section, including a discussion, policy implications, and a summary of the findings The G-7 countries should consider the following recommendations to effectively promote RE consumption and foster a more stable economic environment.

1. Promote Stable and Transparent Economic Policies: The established bidirectional causality between EPU and RE consumption suggests that political and economic stability is a prerequisite for a thriving clean energy sector. G-7 nations must create and maintain clear and transparent economic policies to reduce uncertainty. A stable environment will encourage both domestic and foreign investors, who are risk-averse, to commit to long-term RE projects. This is crucial for avoiding the precautionary delays in investments caused by high policy uncertainty.
2. Attract FDI with Targeted Incentives: Given the significant positive impact of FDI on RE consumption (a 1% increase in FDI leads to a 0.30% increase in RE), governments should implement policies that specifically attract "green" FDI. This can include financial incentives like tax breaks and grants, as well as simplified regulatory processes for RE ventures. By attracting environmentally conscious investments, G-7 countries can leverage external capital and expertise to accelerate their energy transition and reduce their reliance on fossil fuels. This approach supports the pollution halo hypothesis, ensuring that FDI contributes positively to environmental goals.
3. Encourage Consistency and Continuity: The study's findings on the reciprocal relationship between EPU and RE emphasize the need for consistent and continuous policies. For instance, a policy shift like a country leaving the Paris Climate Agreement could increase climate policy fragility and negatively impact RE consumption. Policymakers should therefore prioritize long-term policy frameworks that are resistant to short-term political changes, as a stable policy environment is a key factor in attracting investments.
4. Strengthen Global Collaboration: The G-7 countries are responsible for over 25% of global carbon emissions, so collaborative strategies are essential for a successful transition to RE. Governments should work together to standardize green finance regulations and support international initiatives that facilitate the flow of green FDI across borders. This will not only promote a greener future but also ensure long-term economic and environmental benefits
5. In conclusion, this study provides a comprehensive analysis of the complex interplay between EPU, FDI, and RE consumption in G-7 countries. The results highlight that preventing policy uncertainty is a factor that fosters direct investments, and this situation will contribute to RE consumption holistically. The findings suggest that a unified approach—one that combines stable economic policies with strategic incentives for green FDI—is the most effective way to promote a robust and sustainable energy transition

**References**

Abbasi, M. A., Nosheen, M., and Rahman, H. U. (2023). An approach to the pollution haven and pollution halo hypotheses in Asia countries. *Environmental Science and Pollution Research*, *30*(17), 49270-49289. https://doi.org/10.1007/s11356-023-25548-x

Acharyya, J. (2009). FDI, growth and the environment: Evidence from India on CO2 emission during the last two decades. *Journal of Economic Development*, *34*(1), 43-58. https://jed.cau.ac.kr/archives/34-1/34-1-3.pdf

Adedoyin, F. F., and Zakari, A. (2020). Energy consumption, economic expansion, and CO2 emission in the UK: The role of economic policy uncertainty. *Science of the Total Environment*, *738,* 140014. https://doi.org/10.1016/j.scitotenv.2020.140014

Aizenman, J., and Marion, N. P. (1993). Policy uncertainty, persistence and growth. *Review of International Economics*, *1*(2), 145-163. https://doi.org/10.1111/j.1467-9396.1993.tb00012.x

Aliyu, M. A. (2005, June 9-11). Foreign direct investment and the environment: Pollution haven hypothesis revisted. In *8th Annual Conference on Global Economic Analysis*. Lübeck, Germany. https://ageconsearch.umn.edu/record/331376/?v=pdf

Athari, S. A. (2024). Global economic policy uncertainty and renewable energy demand: Does environmental policy stringency matter? Evidence from OECD economies. *Journal of Cleaner Production*, *450*, 141865. https://doi.org/10.1016/j.jclepro.2024.141865

Baker, S. R., Bloom, N., and Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593-1636. https://doi.org/10.1093/qje/qjw024

Borensztein, E., De Gregorio, J., and Lee, J. W. (1998). How does foreign direct investment affect economic growth?. *Journal of International Economics*, *45*(1), 115-135. https://doi.org/10.1016/S0022-1996(97)00033-0

BP British Petroleum. (2025, March 15). *2025 Statistical Review of World Energy*, *March 2025.* https://www.bp.com/en/global/corporate/energy-economics.html

Breusch, T. S., and Pagan, A. R. (1980). The lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, *47*(1), 239-253. https://doi.org/10.2307/2297111

Çağlar, A. E. (2020). The importance of renewable energy consumption and FDI inflows in reducing *environmental* degradation: Bootstrap ARDL bound test in selected 9 countries. *Journal of Cleaner Production, 264*, 121663. https://doi.org/10.1016/j.jclepro.2020.121663

Chen, H., Zhang, L., Pinzon, S., Chen, H., and Chen, B. (2025). Decarbonizing the G7: Renewable energy, economic growth, globalization, and policy pathways to sustainability. *Renewable Energy, 244,* 122671. https://doi.org/10.1016/j.renene.2025.122671

Dai, J., Farooq, U., and Alam, M. M. (2025). Navigating energy policy uncertainty: Effects on fossil fuel and renewable energy consumption in G7 economies. *International Journal of Green Energy*, *22*(2), 239-252. https://doi.org/10.1080/15435075.2024.2413676

Danish, D., and Ulucak, R. (2021). Renewable energy, technological innovation and the environment: A novel dynamic auto-regressive distributive lag simulation. *Renewable and Sustainable Energy Reviews*, *150*, 111433. https://doi.org/10.1016/j.rser.2021.111433

Doğan, B. Ö., Williams, A., and Williams, A. (2023). Economic policy uncertainty and renewable energy-Is there a relation? Case study- G7. *Sinop Üniversitesi Sosyal Bilimler Dergisi*, *7*(1), 823-843. https://doi.org/10.30561/sinopusd.1267695

Doytch, N., and Narayan, S. (2016). Does FDI encourage energy conservation? The case of the pollution halo hypothesis. *Renewable and Sustainable Energy Reviews*, *54*, 1481–1488. https://doi.org/10.1016/j.eneco.2015.12.010

Dumitrescu, E. I., and Hurlin, C. (2012). Testing for granger non-causality in heterogeneous panels. *Economic Modelling*, *29*, 1450-1460. https://doi.org/10.1016/j.econmod.2012.02.014

Esty, D. C., and Gentry, B. S. (1997). Foreign investment, globalisation, and environment. In T. Jones (Ed.), Globalisation and environment: Preliminary perspectives (pp. 141-172). Organisation for Economic Co-operation and Development.

Fan, W., and Hao, Y. (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. *Renewable Energy*, 146, 598-609. https://doi.org/10.1016/j.renene.2019.06.170

Gengenbach, C., Urbain, J-P., and Westerlund, J. (2016). Error correction testing in panels with common stochastic trends. *Journal of Applied Econometrics*, *31*(6), 982-1004. https://doi.org/10.1002/jae.2475

Gulen, H.,and Ion, M. (2016). Policy uncertainty and corporate investment. *The Review of Financial Studies, 29*(3), 523-564. https://doi.org/10.1093/rfs/hhv050

Hoffmann, R., Lee, C. G., Ramasamy, B., and Yeung, M. (2005). FDI and pollution: A granger causality test using panel data. *Journal of International Development: The Journal of the Development Studies Association*, *17*(3), 311-317. https://doi.org/10.1002/jid.1196

International Energy Agency. (2021, December 01). *Renewables 2021*. https://www.iea.org/reports/renewables-2021

Işık, C., Ongan, S., Ozdemir, D., Jabeen, G., Sharif, A., Alvarado, R., Amin, A., and Rehman, A. (2024). Renewable energy, climate policy uncertainty, industrial production, domestic exports/re-exports, and CO2 emissions in the USA: A SVAR approach. *Gondwana Research*, *127*, 156-164. https://doi.org/10.1016/j.gr.2023.08.019

Kang, W., and Ratti, R. A. (2015). Oil shocks, policy uncertainty and stock returns in China. *Economics of Transition*, *23*(4), 657-676. https://doi.org/10.1111/ecot.12062

Kapçak, S. (2023) Türkiye'de doğrudan yabancı yatırımlar ile yenilenebilir enerji tüketimi arasındaki ilişkinin incelenmesi. *İstanbul Aydın Üniversitesi Sosyal Bilimler Dergis*i, *15*(3), 401-420. https://dergipark.org.tr/tr/pub/iausos/issue/78931/1243953

Keeley, A.R., and Matsumoto, K. (2018). Investors' perspective on determinants of foreign direct investment in wind and solar energy in developing economies-review and expert opinions. *Journal of Cleaner Production*, 179, 132-142. https://doi.org/10.1016/j.jclepro.2017.12.154

Lu, Z., Zhu, L., Lau, C. K. M., Isah, A. B., and Zhu, X. (2021). The role of economic policy uncertainty in renewable energy-growth nexus: Evidence from the rossi-wang causality test. *Frontiers in Energy Research*, 9, 750652. https://doi.org/10.3389/fenrg.2021.750652

Mattmann, M., Logar, I., and Brouwer, R. (2016). Hydropower externalities: A meta-analysis. *Energy Economics*, *57*, 66-77. https://doi.org/10.1016/j.eneco.2016.04.016

Mert, M. and Bölük, G. (2016) Do foreign direct investment and renewable energy consumption affect the CO2 emissions? New evidence from a panel ARDL approach to Kyoto Annex countries. *Environmental Science and Pollution Research, 23*, 21669–21681. https://doi.org/10.1007/s11356-016-7413-7

Organisation for Economic Co-operation and Development (OECD). (2014). *OECD Foreign Bribery Report: An analysis of the crime of bribery of foreign public officials*. OECD Publishing. https://www.oecd.org/en/publications/oecd-foreign-bribery-report_9789264226616-en.html

Paramati, S. R., Ummalla, M., and Apergis, N. (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. *Energy Economics*, *56*(C), 29–41. https://doi.org/10.1016/j.eneco.2016.02.008

Pata, U. K., Alola, A. A., Erdoğan, S., and Kartal, M. T. (2023). The influence of income, economic policy uncertainty, geopolitical risk, and urbanization on renewable energy investments in G7 countries. *Energy Economics*, *128*, 107172. https://doi.org/10.1016/j.eneco.2023.107172

Polat, B. (2018). The influence of FDI on energy consumption in developing and developed countries: A dynamic panel data approach. *Yaşar Üniversitesi E-Dergisi*, *13*(49), 33-42. https://doi.org/10.19168/jyasar.340938

Prais, S. J., and Winsten, C. B. (1954). *Trend estimators and serial correlation* (Cowles Commission Discussion Paper No. 383). Chicago. https://cowles.yale.edu/sites/default/files/2023-05/s-0383.pdf

Sadiq, M., Hassan, S. T., Khan, I., and Rahman, M. M. (2024). Policy uncertainty, renewable energy, corruption and CO2 emissions nexus in BRICS-1 countries: A panel CS-ARDL approach.

*Environment, Development and Sustainability*, *26*(8), 21595-21621. https://doi.org/10.1007/s10668-023-03546-w

Şahin, G. (2022). Kömür ihraç eden ülkelerde STIRPAT modeline dayalı çevresel etki analizi. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, *73*, 196-216. https://doi.org/10.51290/dpusbe.1113499

Şahin, G., and Ayyıldız, F. V. (2020). Climate change and energy policies: European union-scale approach to a global problem. In H. Qudrat-Ullah & M. Asif (Eds.), *Dynamics of energy, environment and economy*. *Lecture Notes in Energy, vol 77*, (pp. 295–320). Springer. https://doi.org/10.1007/978-3-030-43578-3_14

Shafiullah, M., Miah, M. D., Alam, M. S., and Atif, M. (2021). Does economic policy uncertainty affect renewable energy consumption?. *Renewable Energy*, *179*, 1500-1521. https://doi.org/10.1016/j.renene.2021.07.092

Shahbaz, M., Nasreen, S., and Afza, T. (2011). Environmental consequences of economic growth and foreign direct investment: Evidence from panel data analysis. *Munich Personal RePEc Archive*. MPRA Paper No 32547.

Solomon, B., and Ruiz, I. (2012). Political risk, macroeconomic uncertainty, and the patterns of foreign direct investment. *The International Trade Journal*, *26*(2), 181–198. https://doi.org/10.1080/08853908.2012.657592

Swamy, P. A. V. B. (1971). *Statistical inference in random coefficient regression Models*. Springer. https://doi.org/10.1007/978-3-642-80653-7

Tan, Y., and Uprasen, U. (2022). The effect of foreign direct investment on renewable energy consumption subject to the moderating effect of environmental regulation: Evidence from the BRICS countries. *Renewable Energy*, *201*(Part 2), 135-149. https://doi.org/10.1016/j.renene.2022.11.066

Tiwari, A. K. (2011). A structural VAR analysis of renewable energy consumption, real GDP and CO2 emissions: Evidence from India. *Economics Bulletin, 31*(2), 1793-1806. http://www.accessecon.com/Pubs/EB/2011/Volume31/EB-11-V31-I2-P164.pdf

Worldbank (2025, October 10). *FDI inflows*. *October,2025* https://data.worldbank.org/indicator/

Yi, S., Raghutla, C., Chittedi, K. R., and Fareed, Z. (2023). How economic policy uncertainty and financial development contribute to renewable energy consumption? The importance of economic globalization. *Renewable Energy, 202*, 1357-1367. https://doi.org/10.1016/j.renene.2022.11.089