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EXPLORING THE ECONOMIC AND NONECONOMIC DETERMINANTS OF INVESTMENTS IN RENEWABLE ENERGY

Gazi Salah Uddin, Md. Bokhtiar Hasan, Donghyun Park, Md. Sumon Ali, and Christoffer Wadström

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ABSTRACT

Amid a shifting global energy landscape driven by concerns about climate change and fossil fuel depletion, there is a heightened need to move toward sustainable energy sources. Although there has been a significant increase in investments in renewable energy (RE) globally, there is still a considerable shortfall in achieving sustainability goals. This study is the first to explore the determinants of RE investments, considering a range of important economic and noneconomic variables. The research employs a balanced annual panel dataset covering 36 countries from 2000 to 2020. The findings indicate that, in developed economies, industrial growth, environmental taxes, social globalization, and climate vulnerability positively influence RE investments, while inflation and political instability have negative impacts. In developing economies, environmental taxes, social globalization, environmental technologies, and climate vulnerability are beneficial, while industrial growth and oil prices have adverse effects. These factors are significant for policy, providing governments and policymakers with valuable information to create specific strategies to meet global sustainability goals.

Keywords: renewable energy investments, economic and noneconomic factors, developed and developing economies, panel data estimates

JEL codes: C33, F64, Q50, Q42

1. Introduction

Recently, the global energy landscape has undergone profound transformations, driven by a combination of factors, such as growing concerns over the negative impacts of climate change, diminishing reserves of fossil fuels, the urgent need to cut down carbon emissions, and the inherent instability in the markets for fossil energy (Kilinc-Ata and Dolmatov 2023, Omri and Jabeur 2024). In this regard, world leaders have made commitments to lessen the use of fossil energy, acknowledging its substantial contribution to global carbon emissions, which, as estimated by the United Nations (2024), account for approximately 90%. Escalating carbon emissions is a significant driver of the current climate crisis, leading to widespread and severe effects on the global ecosystem (Silva 2008). We thus find ourselves in a situation where fossil fuel reserves are continuously depleting, and the markets for fossil energy, particularly oil and gas, have encountered significant turbulence in recent years due to various geopolitical, economic, and financial uncertainties.

In light of these challenges, the shift toward sustainable and renewable energy sources has become crucial on the global agenda. This transition is essential to address climate change, environmental degradation, and the pressing issues of energy crises and socioeconomic disparities. Despite substantial global renewable energy (RE) investments, currently around \$2 trillion annually, there is a significant gap compared to the \$5 trillion yearly investment stipulated by the International Energy Agency (IEA) until 2030, and beyond to 2050, for net-zero carbon emissions (Lenaerts, Tagliapietra, and Wolff 2021). This shortfall persists despite widespread governmental initiatives. Understanding why renewable investments lag behind the necessary levels to meet global sustainability targets is a crucial and not well-explored topic. This stimulates us to investigate the potential determinants affecting RE investments.

The factors influencing RE investments are complex, involving a combination of economic and noneconomic elements. Previous studies that highlight aspects such as economic growth, government policies, subsidies, incentives, environmental taxation, and fossil fuel prices have a significant impact on additional RE capacity, as noted in research by Bourcet (2020) and Rajendran, Krishnaswamy, and Subramaniam (2023). Additionally, noneconomic factors such as globalization, environmental technologies,

climate vulnerability, and political instability are also found to have an impact on RE deployment (Bourcet 2020; Rajendran, Krishnaswamy, and Subramaniam 2023). Furthermore, recent studies have also indicated that noneconomic factors, although their exact impact is not unanimously agreed upon, could have a greater influence on RE capacity deployment than economic factors, as suggested in the research by Bourcet (2020) and Abban and Hasan (2021). This raises an important question that has yet to be addressed—whether these factors influence RE investments similarly as their impact on RE capacity deployment. The extent to which these factors influence investment decisions and whether they vary across different levels of economic resilience remains unclear. It is a question warranting further investigations.

Furthermore, the differences in RE investments across countries are striking (Reboredo 2015, Abban and Hasan 2021). As shown in Figure 1, investments in clean energy per capita are notably higher in developed economies compared to emerging and developing economies (excluding the People's Republic of China [PRC]). Even within this context, it is important to note that the PRC's investments alone significantly surpass those of other emerging and developing countries. According to the IEA (2022), the PRC led global clean energy investments in 2021 with \$380 billion, followed by the European Union at \$260 billion and the United States at \$215 billion. Hence, it appears that RE investments are growing but their distribution across countries is uneven. Substantial barriers continue to exist, especially in emerging and developing economies (Azarova and Jun 2021). Understanding these disparities and the factors behind them is essential for crafting effective policies aimed at increasing RE investments and achieving emissions reduction targets.

Despite the recognized importance of both economic and noneconomic determinants of RE investments, previous research in this domain has exhibited limitations. Past literature primarily focused on RE deployment, measured by RE consumptions or supply or share in total energy or electricity, to identify influencing factors (Can Şener et al. 2018; Bourcet 2020; Rajendran, Krishnaswamy, and Subramaniam 2023). The majority of earlier studies considered economic, environmental, and energy-related factors of RE use, with few studies addressing political, regulatory, and demographic factors (Can Şener et al. 2018; Bourcet 2018; Bourcet 2020; Rajendran, Krishnaswamy, Network, Sener et al. 2018; Network Studies addressing political, regulatory, and demographic factors (Can Şener et al. 2018; Bourcet 2020; Rajendran, Krishnaswamy, Krishnaswamy, Sener et al. 2018; Bourcet 2020; Rajendran, Krishnaswamy, Krishnaswam

and Subramaniam 2023). Moreover, the findings of these studies, particularly on noneconomic factors, failed to provide robust consensus on the determinants of renewable energy deployment (Bourcet 2020, Abban and Hasan 2021).



Figure 1: Per-capita Clean Energy Investment in Selected Regions, 2020-2022

Furthermore, previous studies mainly focused on the national level, with an emphasis on developed or emerging economies like the PRC, Germany, United States, and European nations, while often neglecting developing economies (Bourcet 2020). Only a limited number of studies have focused on RE from an investment perspective, even though RE investments, measured by installed capacity, are deemed a more appropriate measure for RE development (Abban and Hasan 2021). Although informative, these studies lack comprehensiveness, often examining only a limited number of factors and employing conventional methodologies. For example, Abban and Hasan (2021) explored the influence of government systems (presidential or parliamentary) on renewable energy investments (measured by installed capacity) across 60 countries, revealing significant government nature effects. Similarly, using panel data from 34 Organisation for Economic Co-operation and Development (OECD) countries and the 5 BRICS (Brazil, the Russian Federation, India, the PRC, and South Africa) countries, Kilinc-Ata and Dolmatov (2023) employed installed capacity as a measure of RE investments, indicating a favorable

PRC = People's Republic of China. Source: International Energy Agency. 2022. *World Energy Investment 2022*.

impact from economic growth, renewable policy, and research and development expenditures.

Given the background outlined here and considering the identified gaps in the existing literature, this study aims to thoroughly investigate both economic and noneconomic factors that may influence RE investments. This study considers a balanced annual panel dataset encompassing 36 countries for 21 years spanning from 2000 to 2020, further divided into two categories: 21 developed economies and 15 emerging and developing economies. This division is used to examine whether the impact of sample factors differs between these two groups. Several econometric tools are employed: Panel Corrected Standard Errors (PCSE), Feasible Generalized Least Squares (FGLS), and Panel Quantile Regression (QR). The PCSE analysis reveals that in developed economies, factors like industrial growth, environmental tax revenue, social globalization, and climate vulnerability positively affect RE investments, while inflation and political instability negatively impact them. Conversely, in developing countries, environmental tax revenue, social globalization, environmental-related technologies, and climate vulnerability positively influence RE investments, but industrial growth and oil prices have adverse effects. These findings suggest RE investments are shaped by a combination of both economic and noneconomic factors, with clear disparities between developed and developing countries. Similar findings are unearthed by FGLS model estimations. Therefore, these findings are robust as further validated by QR estimates but evidence a noticeable variation in results across quantiles.

Our study contributes significantly to the extant literature in several key aspects. Firstly, it addresses a critical gap by focusing on the determinants of RE investments, bridging a substantial void left by prior studies that predominantly concentrated on RE deployment. By utilizing installed capacity as a proxy for RE investments, this study aligns with the forward-looking aspects of investment decisions, offering a more accurate measure of RE development. Secondly, unlike earlier research, the study also advances the understanding of RE investments by examining a broader set of noneconomic factors, such as social globalization, environmental technologies, climate vulnerability, and political instability, alongside traditional economic variables. Moreover, it extends beyond the conventional focus on developed and emerging economies by including developing

countries, thereby uncovering differences in the impact of the determinants across more heterogeneous economic conditions. This distinction is vital for policymakers as it sheds light on disparities in RE investments, emphasizing the need for tailored strategies based on the economic resilience of each group.

Methodologically, unlike previous relevant studies, this study employs methodologies that encompass both mean-based and quantile-based methods. The use of PCSE as a mean-based technique addresses critical issues associated with data series, including non-normality, heteroscedasticity, serial correlation, and, importantly, cross-sectional dependence. Moreover, this method proves particularly valuable when dealing with a small sample size, especially when *T* is less than *N*. The study also utilizes the FGLS model for robustness. Additionally, the adoption of panel QR as a quantile-based approach offers a nuanced exploration of variable interactions across diverse quantiles, rarely documented in existing literature. Lastly, our findings offer crucial implications for governments and policymakers to formulate effective policies. By uncovering the distinct impact of determinants on RE investments in developed versus developing countries, our research provides actionable insights for crafting targeted strategies. This is particularly pertinent in the context of global sustainability targets, such as the pursuit of net-zero emissions by 2050, underscoring the practical relevance and policy significance of our study.

The remainder of the paper is structured as follows: Section 2 explains the theoretical background and literature, Section 3 describes the methodology and discusses the data and preliminary analysis, Section 4 presents the results and their discussion, and Section 5 concludes the study.

2. Theoretical Background and Literature

As previously discussed, determining RE investments involves a complex interplay of economic and noneconomic factors. Economic drivers, such as industrial growth, government subsidies and incentives, environmental taxation policies, fossil fuel prices, and inflation, collectively shape investment trends in RE. For example, increased industrial activities can lead to higher energy demand, prompting investments in RE to sustainably meet the increasing energy needs, especially in developed economies.

Previous empirical evidence supports a positive correlation between economic growth and RE investments (Yang et al. 2019, Kilinc-Ata and Dolmatov 2023), underscoring the potentially favorable impact of industrial growth in driving RE investments. Likewise, government subsidies and incentives, including tax credits, grants, and attractive financing options, along with environmental taxation policies such as carbon pricing and emission taxes, may have a significant impact on directing RE investments (Yang et al. 2019). These subsidies and incentives can potentially lower the investment costs for renewable projects. Additionally, higher taxes on carbon emissions or non-renewable energy sources may further incentivize investors to choose cleaner and RE alternatives, making them more financially appealing for investors and expediting the adoption of RE technologies (Shahbaz et al. 2022, Sarpong et al. 2023). Moreover, as fossil fuel prices rise and become more volatile, they may decrease in demand while simultaneously increasing the attractiveness of RE options (Buckley and Trivedi 2021). However, it is important to recognize that the impact of higher fossil fuel prices may not always be unequivocally favorable for RE. For instance, an increase in the price of one fossil fuel can lead to greater utilization of alternative fuels as observed when gas prices surged in 2021, resulting in a partial return to coal as a power source in some countries (Jaller-Makarewicz 2021, Gilly and Jørgensen 2022). Inflation can also have adverse effects on RE investments, since inflationary pressures can raise interest rates (i.e., the cost of capital) and project-related expenses, thereby increasing the overall cost of RE projects (Calthrop 2022).

Noneconomic factors, including social globalization, environmental technology, climate vulnerability, and political instability, wield significant influence on RE investments. In specific contexts, the impact of these factors might be more pronounced than that of economic determinants. For example, social globalization, characterized by a heightened awareness of environmental and social issues, can contribute to the promotion of RE investments (Salman, Ahmad, and Alvi 2023). As societies grow more conscious of the implications of climate change and the importance of sustainability, there is a growing demand for RE, resulting in greater support for RE projects (Sinha, Sengupta, and Alvarado 2020; Zafar et al. 2020). Moreover, advancements in environment-related technology can improve the feasibility and appeal of RE investments (Sinha, Sengupta,

and Alvarado 2020; Qin et al. 2021). These technological innovations lead to increased energy efficiency, reduced costs, and improved reliability, rendering RE projects more economically competitive and sustainable (Masini and Menichetti 2013, Sinha et al. 2020). Likewise, regions that are particularly vulnerable to climate-related risks, such as areas prone to extreme weather events or sea-level rise, may drive RE investments as the need to increase resilience and reduce carbon emissions becomes more apparent, prompting greater interest in RE solutions capable of mitigating climate-related risks (Wen et al. 2023). Finally, governments prone to quick destabilization due to unstable politics pose a significant barrier to RE investments. In such precarious political circumstances, the success of RE projects is often compromised, leading individuals and companies to delay investing until political stability is retained (Zhang et al. 2022, Van Song et al. 2023). While heightened geopolitical instability and risk can discourage RE investments, it can also paradoxically increase the demand for RE, particularly in countries that import fossil fuels. This is because these nations may seek to decrease their dependence on fossil fuels and lower import costs, thus potentially boosting investments in RE (Zhang et al. 2022, Wang et al. 2022).

3. Material and Methods

The model described here specifies the dependent variable, namely RE investments, as a function of a set of explanatory variables that encompass both economic and noneconomic factors. The general form of the model is expressed in Equation 1:

$$lnREI_{it} = \alpha + \beta_1 lnIND_{it} + \beta_2 lnTR_{it} + \beta_3 lnIN_{it} + \beta_4 lnOP_{it} + \beta_5 lnGLO_{it} + \beta_6 lnERT_{it} + \beta_7 lnVUL_{it} + \beta_8 PI_{it} + \epsilon_{it},$$
(1)

where, *InREI, InIND, InTR, InIN, InOP, InGLO, InERT, InVUL*, and *PI* represent renewable energy investments, industrial growth, environmental tax revenue, inflation rate, oil price, social globalization, environment-related technology, climate vulnerability, and political instability, respectively. α denotes the intercept, ϵ represents the error term, and β represents the parameters and can be interpreted as elasticities of the dependent variables relative to each explanatory variable. *In* is the natural logarithm of each variable, *i* denotes the cross-sectional unit (i.e., the country), and *t* is time. The analysis starts by testing the cross-sectional dependence (CSD), slope homogeneity test, and stationarity issues inherent in panel data, a critical consideration often encountered in such datasets. Considering the stationarity and CSD issues outlined in subsection 4.1, the study adopts Kao's (1999) test, as recommended by literature (e.g., Camarero and Tamarit 2002; Gengenbach, Palm, and Urbain 2005; Alam et al. 2015), to actively investigate the long-run (equilibrium) association or cointegration among the variables. Kao's test, recognized for its superior performance with small sample sizes, particularly when time (T) is less than cross-section units (N) (Gutierrez 2003), adeptly addresses both stationarity and CSD issues (Kao 1999, Camarero and Tamarit 2002).

Given the identified cointegration, outlined in subsection 4.2, and the inherent dataset challenges mentioned previously, the study selects the PCSE approach, endorsed by existing literature (e.g., Reed and Webb 2010, Millo 2017, Adeleye et al. 2023). This model effectively handles issues such as heteroscedasticity and serial correlation (Adeleye et al. 2023). Empirical testing by Millo (2017) and Reed and Webb (2010) attests to the PCSE model's ability to yield precise standard error estimates with minimal efficiency loss, particularly under large cross-sectional units (i.e., N>T). Additionally, to assess the robustness and consistency of the PCSE estimates, this study also incorporates the FGLS approach. Since both estimators can yield robust estimations in the presence of heteroskedasticity and CSD in the panel datasets (Millo 2017, Le and Nguyen 2019), it would be useful to compare the findings and offer robust and reliable outcomes.

Given the non-normality of all data series across samples and the presence of potential tailed dependence, the study additionally employs the panel QR approach proposed by Koenker (2004). This method captures heterogeneous effects across different quantiles of the conditional distribution, providing robust estimates in the presence of outliers. The panel QR model, less sensitive to tail behavior and outliers compared to traditional models like fixed-effects or random-effects, is deemed superior for handling distributional heterogeneity in panel data (Galvao 2011, Akram et al. 2020). In addition to PCSE and FGLS analyses, the panel QR approach is employed because it captures all significant variations between predicted and observed variables and thus avoids inaccurate regression coefficients (Akram et al. 2020).

3.1 Data and Descriptive Statistics

The dataset consists of annual panel data for 36 economies, 21 developed and 15 emerging and developing countries, between the years 2000 to 2020.¹ The time period and economies are chosen based on the availability of data for variables used, which permits estimations using strongly balanced panel data. Moreover, the countries are ordered according to their income level based on the Atlas method of the World Bank. The dependent variable, RE investments, is represented by the annual global additions in photovoltaic (PV) capacity, particularly new installations. This is chosen because solar PV and new wind power capacity make up over 80% of global renewable energy investments (IEA 2022). In this study, installed PV capacity reflects investment in expanding PV solar energy capacity, signifying commitments to future RE generation (Abban and Hasan 2021). Unlike other metrics such as RE consumption and supply, which assess availability, new PV capacity offers a more forward-looking and investment-focused metric. This more accurately reflects the growth and expansion of RE, making it a more suitable indicator for tracking advancements in the RE sector (Kim and Park 2016, Bourcet 2020, Abban and Hasan 2021).

Furthermore, the study incorporates eight economic and noneconomic factors, encompassing industrial growth (measured by industry value added in constant 2015 United States [US] dollars); environmental tax revenue (measured by environmental taxes, fees, and charges, deposit-refund systems, and tradable permits total value in US million dollars); oil prices (measured by Brent crude price in US dollars per barrel); inflation (measured by consumer price annual percentage); social globalization index (measured by personal contact, cultural proximity, and information flows); environmental-related technology (measured by the number of patent counts for environment-related technologies); climate vulnerability (measured by a country's exposure, sensitivity, and adaptive capacity to climate change's adverse impacts); and political instability

¹ This study covers 21 developed economies (i.e., Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Israel, Italy, Japan, the Republic of Korea, the Netherlands, Poland, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the US) and 15 emerging and developing economies (e.g., Brazil, the PRC, Costa Rica, India, Indonesia, Malaysia, Mexico, Pakistan, the Philippines, Romania, South Africa, Thailand, Tunisia, Türkiye, and Viet Nam).

(measured by the political instability index). Table 1 presents an overview of these variables and their respective sources.

	Variables	Measurement	Short Form	Source
01	Dependent Variable	Renewable energy investments	REI	Bloomberg
02	Economic	Industrial growth	IND	World Bank
	determinants	Environmental tax revenue		Organisation for Economic Co-operation and Development
		Inflation rate	IN	World Bank
		Oil price	OP	investing.com
03	Noneconomic	Social Globalization Index	GLO	Gygli et al. 2019
	determinants	terminants Environment-related technology		Organisation for Economic Co-operation and Development
		Climate Vulnerability	VUL	University of Notre Dame
		Political Instability Index	PI	theglobaleconomy.com

 Table 1: Variables Used in the Analysis and Sources of Data

Source: Authors.

To generate more reliable and consistent estimations, we apply natural logarithm transformations to all data (except *PI*), in line with the approach employed by Bhattacharya et al. (2016) and Hasan et al. (2022). To maintain consistency across all variable observations, the missing observations are imputed using the linear interpolation method.

Table 2 presents the descriptive statistics for the entire sample. The mean value for RE investment is higher in developed economies, compared to developing economies. Regarding economic determinants, developed economies show higher average values in industrial growth and environmental tax revenue, whereas developing economies typically have a higher average inflation rate. Concerning the noneconomic determinants, developed economies exhibit higher mean values in environmental-related technology and social globalization. In contrast, developing economies present higher mean values in climate vulnerability and political instability.

Most variables in the samples show negative skewness, pointing to left-sided tail distributions. High kurtosis for most variables (except *InOP*) suggests heavy-tailed

distributions with possible outliers, indicating a deviation from normal distribution. Significant Jarque-Bera statistics further confirm this non-normality.

Variable	InREI	InIND	InTR	InIN	InOP	InGLO	InERT	InVUL	PI
Entire san	nple								
Mean	3.957	25.669	9.007	0.803	4.022	4.243	4.654	-1.029	0.147
Maxi.	10.878	29.383	11.951	4.965	4.591	4.520	9.264	-0.608	1.760
Mini.	-4.906	20.613	4.209	-5.323	3.228	3.163	-1.609	-1.410	-2.810
S.D.	3.182	1.499	1.592	1.119	0.435	0.261	2.355	0.175	0.886
Skew.	-0.151	-0.343	-0.376	-0.890	-0.345	-1.437	-0.143	0.408	-0.806
Kurtosis	2.251	3.894	2.385	5.910	1.955	4.864	2.479	2.683	3.155
JB	20.51***	40.04***	29.76***	366.56***	49.35***	369.52***	11.12***	24.09***	82.67***
Developed	d economies	s							
Mean	4.161	26.032	9.725	0.314	4.022	4.409	5.924	-1.143	0.622
Maxi.	9.830	28.941	11.951	4.965	4.591	4.520	9.264	-0.946	1.760
Mini.	-4.906	24.068	6.211	-5.323	3.228	4.131	1.970	-1.410	-1.630
S.D.	2.999	1.168	1.188	1.049	0.435	0.073	1.681	0.102	0.601
Skew.	-0.348	0.487	-0.481	-1.278	-0.345	-0.969	0.044	-0.058	-1.298
Kurtosis	2.277	2.605	3.346	7.340	1.955	3.644	2.677	3.040	4.879
JB	18.51***	20.33***	19.22***	466.16***	28.79***	76.58***	2.05	0.28	188.76***
Developin	g economie	s							
Mean	3.671	25.160	8.003	1.488	4.022	4.010	2.876	-0.868	-0.518
Maxi.	10.878	29.383	11.689	4.006	4.591	4.425	8.684	-0.608	1.070
Mini.	-3.598	20.613	4.209	-1.671	3.228	3.163	-1.609	-1.040	-2.810
S.D.	3.406	1.747	1.544	0.815	0.435	0.251	1.985	0.123	0.787
Skew.	0.094	-0.231	0.245	-0.363	-0.345	-0.912	0.500	0.622	-0.601
Kurtosis	2.257	3.242	2.193	4.488	1.955	3.847	3.413	2.075	2.998
JB	7.70**	3.58	11.68***	35.95***	20.56***	53.09***	15.36***	31.56***	18.94***

Table 2: Results of Summary Statistics

Notes: *In* is the natural logarithm. *REI, IND, TR, IN, OP, GLO, ERT, VUL*, and *PI* represent renewable energy investment, industrial growth, environmental tax revenue, inflation rate, oil price, social globalization, environment-related technology, climate vulnerability, and political instability, respectively. Max, Min, S.D., Skew, and JB indicate maximum, minimum, standard deviation, skewness, and Jarque-Bera '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

The correlation matrix, presented in Table 3, shows RE investments positively and significantly correlated with most variables (excluding inflation and climate vulnerability), with strong connections evident. Inflation and climate vulnerability are negatively associated with most variables, while other variable pairs display positive interrelationships.

Variables	InREI	InIND	InTR	InIN	InOP	InGLO	InERT	InVUL	PI
InREI	1.000								
InIND	0.143***	1.000							
InTR	0.252***	0.691***	1.000						
InIN	-0.177***	-0.172***	-0.311***	1.000					
InOP	0.076**	0.051***	0.070***	0.033***	1.000				
InGLO	0.089**	0.169***	0.370***	-0.500***	0.215***	1.000			
InERT	0.253***	0.747***	0.816***	-0.432***	0.135***	0.559***	1.000		
InVUL Pl	-0.008 0.020	-0.249*** 0.137***	-0.465*** 0.245***	0.444*** -0.371***	-0.032 -0.071*	-0.823*** 0.632***	-0.536*** 0.398***	1.000 -0.575***	1.000

Table 3: Correlation Matrix

Notes: '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

4. Results and Analysis

4.1. Cross-sectional Dependence, Slope Homogeneity Test, and Panel Unit Root Analysis

Initially, the dataset is evaluated for CSD, a frequent issue in panel data. CSD often arises from common shocks, increasing globalization, economic interconnections among nations at regional and global levels, and other unobserved factors (Abban and Hasan 2021, Naz 2023). Identifying CSD in the sample data is essential before conducting the main analysis, as unaddressed CSD can lead to spurious results (Abban and Hasan 2021). To address this, second-generation methods are employed: the Pesaran (2004) cross-sectional dependence (CD) test and the Breusch and Pagan (1980) Lagrange Multiplier (LM) test. These tests are particularly suitable when the number of time periods (T) is smaller than the number of cross-sectional units (N). In the dataset, T is smaller than N. The results, summarized in Table 4, show that the null hypothesis of no CSD is rejected at the 1% level of significance, hence, evidencing the presence of cross-sectional dependence in all data series across all samples, which implies that a shock in one country can spread to others.

Test	InREI	InIND	InTR	InIN	InOP	InGLO	InERT	InVUL	PI
Entire sample									
CD-tests	30.415***	52.95**	30.29***	115.02***	37.70***	65.91***	109.48***	57.58***	15.15***
p-value	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Breusch-	5498.39***	7501.34***	2467.29***	13230.00***	6989.12***	5991.28***	12009.98***	7441.69***	2504.23***
Pagan LM									
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Developed ecc	onomies								
CD-tests	31.728***	19.95***	36.70***	25.76***	66.40***	62.84***	47.25***	25.82***	11.25***
p-value	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Breusch-	2006.78***	2063.38***	2565.19***	1117.11***	4410.00***	3958.32***	2432.74***	2327.05***	830.14***
Pagan LM									
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Developing eco	onomies								
CD-tests	5.95***	40.83***	4.46***	5.42***	46.95***	45.27***	18.89***	31.79***	3.63***
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Breusch-	816.79***	1688.98***	1079.21***	312.14***	2205.00***	2051.29***	754.40***	1349.67***	426.43***
Pagan LM									
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4: Cross-sectional Dependence Analysis

Note: '***,' and '**,' indicate the significance levels at 1% and 5%, respectively. Source: Authors' estimates.

Table 5 presents the slope homogeneity test results. The outcomes reveal that slope homogeneity tests are highly statistically significant at a 1% level for each of the three models. Therefore, the null hypothesis of slope homogeneity will be turned down and it is concluded that the slope coefficients are heterogenous.

Test statistics	Entire sample	Developed economies	Developing economies
Delta	14.106***	11.461***	2.782***
	(0.000)	(0.000)	(0.005)
Adjusted Delta	19.490***	15.836***	3.844***
-	(0.000)	(0.000)	(0.000)

 Table 5: The Estimates of Slope Homogeneity Test

Note: '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

Given the CSD issue in the panel data, two second-generation unit root tests are employed: The cross-sectional augmented Im, Pesaran, and Shin (CIPS) test and the cross-sectional augmented Dickey-Fuller (CADF) test, both developed by Pesaran (2007). These tests are selected for the robustness and consistency they offer, considering the specific characteristics of the dataset. Notably, in cases of CSD, the conventional Augmented Dickey-Fuller (ADF) test can produce unreliable results (Pesaran 2007, Naz 2023).

The outcomes of both tests, as presented in Table 6, indicate that most of the data series exhibit non-stationarity at their levels for the entire and segregated samples. However, all series become stationary at the first difference at the 1% level of significance, i.e., I(1).

Variables		CIPS	CADF			
	Level	First Difference	Level	First Difference		
Entire sample						
InREI	-1.608	-3.785***	-1.638	-2.907***		
InIND	-1.592	-2.916***	-1.353	-1.946*		
InTR	-2.675***	-4.866***	-2.143***	-2.621***		
InIN	-4.160 **	-4.160***	- 1.945	-2.708***		
InOP	-1.580	-3.252***	-1.580	-3.252***		
InGLO	-2.972***	-5.056***	-2.409***	-2.424***		
InERT	-2.856***	-4.038***	-1.432	-2.027**		
InVUL	-1.314	-4.355***	-2.308	-3.145***		
PI	-1.357	-3.114***	-1.724	-2.910***		
Developed eco	onomies					
InREI	-1.482	-3.666***	-1.848	-2.447***		
InIND	-1.391	-2.804***	-1.931	-2.609***		
InTR	-1.587**	-3.181***	-2.070*	-2.416***		
InIN	-2.217***	-4.925***	-2.126**	-3.646		
InOP	-1.580	-3.252***	-1.580	-3.252***		
InGLO	-2.208***	-4.847***	-2.186**	-3.476***		
InERT	-1.362	-3.406***	-1.848	-2.447***		
InVUL	-1.136	-4.561***	-2.131**	-3.154***		
PI	-2.058***	-4.680***	-1.838	-3.271***		
Developing ec	onomies					
InREI	-1.152	-3.408***	-0.760	-2.839***		
InIND	-1.424	-3.032***	-1.057	-3.095***		
InTR	-0.951	-2.521***	-2.323***	-2.553***		
InIN	-2.349***	-4.907***	-2.385***	-3.408***		
InOP	-1.580	-3.252***	-1.580	-3.252***		
InGLO	-1.472	-4.819***	-2.569***	-3.649***		
InERT	-2.442***	-5.030***	-2.468***	-3.998***		
InVUL	-1.570	-4.177***	-2.085	-3.063***		
PI	-1.674**	-4.084***	-1.957	-2.990***		

Table 6: Results of Unit Root Tests

CADF = cross-sectional augmented Dickey-Fuller; CIPS = cross-sectional augmented Im, Pesaran, and

Shin. Note: '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

4.2. Results of Cointegration Test

Considering the presence of CSD and stationarity issues in the panel data, a cointegration test by Kao (1999) is employed. Although academic literature often recommends the Westerlund (2007) cointegration technique in the presence of CSD, its application is not feasible in this study due to the inclusion of more than six explanatory variables. Therefore, Kao's (1999) test, widely acknowledged in the research community (Gengenbach, Palm, and Urbain 2005), is chosen. This test presents several advantages over traditional cointegration tests. Kao's (1999) test is notably capable of handling both l(0) and l(1) processes and is robust even with limited sample sizes. Additionally, it effectively addresses the CSD in data (Kao 1999). The results, presented in Table 7, unanimously reject the null hypothesis of no cointegration, indicating a cointegrating relationship among the variables under investigation.

Test statistics	Entire sample	Developed economies	Developing economies
Augmented Dickey-Fuller	-2.242**	-3.220***	-1.442*
-	(0.013)	(0.001)	(0.074)

Table 7: The Estimates of Panel Cointegration Test by Kao (1999)

Note: '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

4.3. Results of PCSE Estimates

This study employs the PCSE model to address the inherent issues associated with panel data. This model, as recognized in the literature (e.g., Reed and Webb 2010, Millo 2017, Adeleye et al. 2023), is particularly robust in situations with limited sample size, particularly where T is less than N. The PCSE analysis results in Table 8 show a significant negative coefficient for industrial growth across the entire sample and more markedly in developing countries, suggesting that industrial growth adversely affects RE investments, especially in developing economies. This may be due to rapid industrialization and economic growth in these economies, largely driven by extensive primary energy utilization (Khan and Majeed 2023). The substantial energy demands resulting from industrial growth are not immediately met by RE sources (Cadoret and Padovano 2016), as RE projects entail substantial upfront investment costs and extended

implementation periods, dissuading their adoption in developing countries (World Bank 2024). Moreover, developing economies often prioritize rapid economic development, driven by industrialization, to tackle socioeconomic challenges such as poverty, unemployment, and infrastructure needs (Caglar and Askin 2023). This emphasis on immediate economic goals may result in reduced commitment to RE investments. The findings partially align with Cadoret and Padovano (2016), who observed the negative impacts of manufacturing on RE deployment, and with Chen, Pinar, and Stengos (2021), who noted economic growth's adverse effect on RE consumption in less democratic countries.

Conversely, in developed economies, the results differ: industrial growth positively correlates with RE investments. Developed economies, having achieved their economic targets, now focus more on environmental sustainability and climate change mitigation, reducing fossil fuel dependence in line with global commitments like the Paris Agreement. Moreover, these countries have the necessary technology and infrastructure for effective RE integration. Factors such as strong environmental regulations, sustainability objectives, accessible capital, advanced technologies, and increased environmental consciousness collectively push industries toward cleaner energy sources. This makes RE investments more viable and efficient. The findings concur with studies by Yang et al. (2019); Chen, Pinar, and Stengos (2021); and Kilinc-Ata and Dolmatov (2023), which all report a positive link between economic growth and RE consumption.

Turning to the impact of environmental tax revenue, the study finds a significant and positive effect on RE investments at the 5% significance level across all samples, with a stronger coefficient observed in the sub-sample containing developed economies. This result is consistent with expectations, as environmental taxes internalize the external costs of environmental pollution and provide economic incentives for individuals and businesses to embrace cleaner technologies and reduce their environmental footprint (Sarpong et al. 2023). By taxing activities such as carbon emissions, pollutants, and nonrenewable resource use, environmental taxes encourage a shift toward more sustainable and environmentally friendly behavior, while generating revenue that can be reinvested in environmental conservation and sustainable initiatives (Abban and Hasan 2021, Doğan et al. 2022, Sarpong et al., 2023). The findings are also in line with Fan, Li, and Yin (2019),

who underscore the favorable role of environmental taxes in promoting green development. Nevertheless, the results differ from certain previous studies, such as Abban and Hasan (2021), who reported an insignificant relationship between environmental tax and RE investments, albeit with a positive direction. Furthermore, the findings challenge the results of Bashir et al. (2021), who observed a negative linkage between environmental tax and RE utilization.

Conversely, inflation shows a negative impact on RE investments for both the entire sample and developed economies. Inflation's detrimental influence operates primarily through two mechanisms. Rising inflation leads to increased interest rates, thus escalating the cost of capital (Calthrop 2022, Akan 2023). Additionally, inflationary conditions contribute to widespread increases in prices, including project costs, raising the total costs of RE projects. Secondly, inflation brings uncertainty to the business environment, deterring investment and innovation in the RE sector (Akan 2023). This reluctance may be related to the risks associated with the considerable upfront costs of RE investments. However, in developing countries, the results show no significant link between inflation and RE investments.

Regarding oil prices, a significant negative link with RE investments is found exclusively in samples from developing economies. This suggests that the typical substitution effect, where rising oil prices lead to reduced oil utilization and increased RE use, does not apply in these developing countries (Salim and Rafiq 2012, Abban and Hasan 2021, Mukhtarov et al. 2022). In developing countries, rising oil prices can strain budgets, leaving fewer funds for RE projects. The high initial costs of RE infrastructure are often seen as prohibitive, especially compared to the immediate affordability of fossil fuels. Additionally, an increase in the price of one fossil fuel may result in the higher utilization of alternative fuels. For example, the rise in gas prices in 2021 led to a partial shift back to coal for electricity generation in some countries (Jaller-Makarewicz 2021, Gilly and Jørgensen 2022). These factors could account for the negative relationship between oil prices and RE investments in developing countries, aligning with findings by Abban and Hasan (2021) and Mukhtarov et al. (2022). Interestingly, the oil price coefficient lacks statistical significance for the entire and developed economies samples, suggesting that RE investments in these nations are becoming less influenced by oil

prices. Instead, in developed economies, RE investments are increasingly motivated by international pressure to prioritize environmental sustainability and climate change mitigation, as highlighted by Salim and Rafiq (2012) and Abban and Hasan (2021).

For noneconomic determinants, social globalization significantly and positively impacts RE investments in both developed and developing countries. Social globalization acts as a catalyst for global environmental awareness and climate change recognition, encouraging individuals, businesses, and governments to prefer cleaner energy sources to reduce carbon emissions (Sinha et al. 2020, Zafar et al. 2020, Urom et al. 2022). Additionally, the interconnectedness and information exchange promoted by social globalization enhance international collaboration in RE technology and policy (Urom et al. 2022), aiding the adoption and investment in these technologies. These results partly align with Nan, Huo, and Lee (2023), who emphasized globalization's role in advancing RE adoption.

Similarly, a positive effect of climate vulnerability on RE investments is observed across all samples, highlighting the increased awareness in both developed and developing countries of their susceptibility to climate-related challenges and risks. This awareness motivates these countries to increase RE investments as a strategic response to mitigate carbon emissions and proactively address climate-related threats. These findings align with Wen et al. (2023), who also noted a positive correlation between physical vulnerability and green investments.

Accordingly, environmental-related technology also demonstrates a positive association with RE investments for the overall sample and developing countries. This suggests that advancements in environmental technology are associated with increased RE investments. The underlying rationale is likely the instrumental role these technologies have in improving the viability and efficiency of RE solutions (Sinha et al. 2020, Qin et al. 2021), leading to greater energy efficiency, lower costs, and enhanced reliability. These advancements make RE projects more economically viable and sustainable (Sinha et al. 2020). These observations are somewhat in line with Nosheen, Iqbal, and Abbasi (2021), who highlighted the impact of climate change technology on green growth.

In contrast, developed economies show a statistically insignificant negative relationship between environmental-related technology and RE investments. This may

suggest a different dynamic in these economies, perhaps due to already substantial investments in RE infrastructure and technology, indicating sectoral maturity. The focus in these economies might be on optimizing and maintaining existing RE systems, not on continued expansion, hence the lack of a statistically significant positive correlation between ongoing technological advancements and further RE investments.

Lastly, it is noted that political instability significantly hampers RE investments in developed economies due to the risks and uncertainties of unstable political climates. Deviations from presumed political stability in these nations can deter investors and stakeholders, as political conflicts or policy changes add unpredictability to the business environment (Zhang et al. 2022, Wang et al. 2022). This uncertainty makes investors wary of committing to long-term, capital-intensive RE projects with extended payback periods. Wang et al. (2022) partially confirm this with their findings of a negative link between political risk and RE utilization.

Conversely, in developing countries, political instability has an insignificant, yet positive, impact on RE investments. This indicates that in less stable political environments, such instability might actually encourage RE investments. This counterintuitive effect could be due to efforts in these countries to diversify energy sources and reduce fossil fuel reliance for energy security and environmental sustainability. Additionally, international aid and cooperation promoting RE in these regions may alleviate the negative impact of political instability on investments.

In summary, the study's analysis shows that both economic and noneconomic factors significantly affect RE investments, with the impact's direction and significance varying depending on whether countries are developed or developing. For developed economies, factors like industrial growth, environmental tax revenue, social globalization, and climate vulnerability positively influence RE investments, while inflation and political instability act as deterrents. In contrast, in developing countries, positive drivers of RE investments include environmental tax revenue, social globalization, environmental-related technologies, and climate vulnerability, while industrial growth and oil prices negatively affect these investments. These results highlight the complex interplay of various factors on RE investments across different national contexts, enhancing understanding of the diverse dynamics in the RE sector.

The FGLS method, whose results are shown on the right side of Table 8, is also estimated to corroborate the estimates from the PCSE model. Overall, the FGLS results align robustly and consistently with the PCSE estimates, except for social globalization in the entire sample.

	Dependent variable: InREI					
	PCSE			FGLS		
Variables	Entire sample	Developed economies	Developing economies	Entire sample	Developed economies	Developing economies
	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
InIND	-0.349***	0.589***	-0.531***	-0.349***	0.589**	-0.531***
	(-2.69)	(3.11)	(-4.16)	(-2.82)	(2.16)	(-3.52)
InTR	0.479***	0.522**	0.396***	0.479***	0.522**	0.396**
	(4.14)	(2.33)	(3.30)	(3.80)	(2.56)	(2.31)
InIN	-0.333***	-0.432***	0.228	-0.332***	-0.432***	0.228
	(-3.10)	(-3.22)	(1.11)	(-2.84)	(-3.59)	(0.93
InOP	-0.19	0.136	-1.583***	-0.190	0.136	-1.583***
	(-0.30)	(0.21)	(-2.76)	(-0.67)	(0.41)	(-3.20)
InGI O	1.84	13.650***	2.718**	1.840**	13.650***	2.718**
	(1.59)	(3.54)	(2.39)	(1.98)	(5.45)	(2.26)
InFRT	0.344**	-0.048	0.362*	0.344***	-0.048	0.362**
	(2.32)	(-0.23)	(1.78)	(3.01)	(-0.25)	(2.26)
InVUI	6.151***	8.710***	8.650***	6.151***	8.710***	8.650***
	(5.21)	(5.03)	(4.69)	(5.18)	(5.45)	(3.65)
PI	-0.226	-0.664***	0.333	-0.226	-0.664***	0.333
	(-1.23)	(-3.42)	(1.16)	(-1.39)	(-3.12)	(1.15)
Constant	6.626	-66.217***	15.951***	6.626	-66.217***	15.951***
Constant	(1.11)	(-3.84)	(3.03)	(1.35)	(-5.12)	(2.73)
Observations	756	441	315	756	441	315
R-squared	0.13	0.30	0.12			
Wald						
statistics						
Chi-squared	472.63	661.45	199.61	113.85	189.58	41.61
(P-value)	0.00	0.00	0.00	0.00	0.00	0.00

Table 8: Panel Corrected Standard Errors and Feasible GeneralizedpLeast Squares Estimates

Notes: The table reports the results of panel corrected standard errors (PCSE) and feasible generalized least squares (FGLS) estimates. The values in the parenthesis are z-statistics. '***,' ind '*' indicate the significance levels at 1%, 5%, and 10%, respectively.

Source: Authors' estimates.

4.4. Results of Quantile Regression

Addressing the non-normality and potential tailed dependence in the dataset, panel quantile regression was employed to estimate the complex relationships between various variables and RE investments across different quantiles. The results in Table 9 indicate that industrial growth negatively impacts RE investments for the entire sample, with significant effects in most quantiles, especially between 0.20–0.40 and 0.60–0.70. This pattern is even more pronounced in developing countries. In contrast, in developed economies, industrial growth positively affects RE investments, showing statistical significance in lower to middle quantiles (0.10–0.50). Regarding environmental tax, a positive impact on RE investments is observed across all samples. This significance spans most quantiles for the entire sample, middle to higher quantiles (0.30-0.90) in developed economies, and lower (0.10–0.20) and higher (0.80–0.90) quantiles in developing countries. Conversely, inflation negatively affects RE investments in the entire sample and developed economies across most quantiles. In developing countries, inflation's positive influence on RE investments is not statistically significant in most quantiles. Oil prices show mixed effects, varying across quantiles and country categories. They negatively impact RE investments at higher quantiles in the entire sample and at middle to higher quantiles in developing countries. However, in developed economies, oil prices have a positive, albeit insignificant, impact across most quantiles. Social globalization positively influences RE investments in most quantiles for all samples, with significant positive coefficients in lower and lower-middle quantiles (0.10-0.50) for the entire sample, but negative and insignificant in higher quantiles (0.60–0.90). In developed economies, the effect is significant in all but the 0.90 quantiles, while in developing countries, it is statistically insignificant in most quantiles. Environment-related technologies positively impact RE investments in higher quantiles for the entire sample and in developing countries, albeit without statistical significance. In developed economies, they have a negative, significant impact in lower quantiles.

Climate vulnerability shows a consistently positive and significant effect on RE investments across most quantiles for all samples. Political instability negatively affects RE investments in lower and lower-middle quantiles for the entire sample. A comparable negative effect is observed in both developed and developing countries across most

quantiles. Statistically significant impacts are noted in the lower and lower-middle quantiles (0.20–0.40) for developed economies and in the upper quantiles (0.80–0.90) for developing countries.

Overall, the quantile regression estimates generally align with the baseline model estimates (PCSE and FGLS), but exhibit variations across quantiles, indicating quantile dependence, highlighting the diverse dynamics within different segments of RE investments.

Variables		Quantiles									
variables	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90		
Entire sample	е										
InIND	-0.251	-0.450***	-0.254***	-0.134*	-0.070	-0.327**	-0.300*	-0.133	-0.102		
InTR	0.580***	0.609***	0.502**	0.625***	0.683***	0.490***	0.589***	0.416***	0.525***		
InIN	-0.750**	-0.791***	-0.816***	-0.716***	-0.441***	-0.194	-0.070	0.045	0.231***		
InOP	0.373	0.038	0.330	0.045	-0.295	-0.695	-0.862***	-0.868***	-1.203***		
InGLO	3.664**	5.647***	5.559***	6.420***	5.688**	-1.153	-1.929	-2.262	-0.833		
InERT	0.182	0.298***	0.206	0.132	0.162	0.474***	0.460***	0.498***	0.260		
InVUL	7.597***	8.775***	8.465***	9.215***	7.105***	2.670	2.236*	1.889	1.785		
PI	-0.461	-0.813***	-0.888***	-0.899***	-0.914***	-0.326*	-0.071	0.013	0.205		
Developed e	conomies										
InIND	2.486***	1.212***	0.849**	0.757**	0.807*	0.610	0.325	-0.104	-0.641		
InTR	-0.140	0.572	0.893***	0.986***	0.913***	1.040***	0.975***	0.951***	0.720**		
InIN	-0.833***	-0.883***	-0.730***	-0.568***	-0.385***	-0.219**	-0.088	-0.037	0.194**		
InOP	1.421***	0.756*	0.199	0.002	0.152	-0.141	-0.341	-0.478	-1.084**		
InGLO	8.696*	16.070***	19.853***	21.072***	22.385***	18.846***	15.858***	11.302***	-0.443		
InERT	-0.996***	-0.625*	-0.577**	-0.438	-0.375	-0.313	-0.093	0.221	0.668**		
InVUL	7.829***	12.630***	14.169***	12.085***	10.527***	9.296***	7.187***	6.250***	0.342		
PI	-0.455	-1.151**	-1.036**	-0.844**	-0.526	-0.562	-0.366	-0.291	0.044		
Developing e	conomies										
InIND	-0.817***	-0.469***	-0.353	-0.322	-0.589***	-0.434**	-0.461**	-0.295*	-0.354*		
InTR	0.510**	0.452*	0.125	0.273	0.452*	0.447	0.408	0.713***	0.847***		
InIN	0.075	-0.489	-0.690	0.103	0.192	-0.002	0.060	0.345	1.226**		
InOP	-0.096	-0.023	-0.305	-2.247***	-2.041***	-1.712*	-1.834**	-2.066***	-1.993***		
InGLO	3.783	3.602	4.500	4.714*	1.612	-1.016	-2.943	0.732	4.979***		
InERT	0.387	-0.181	-0.005	0.205	0.293	0.416	0.680**	0.375	0.292		
InVUL	10.328**	9.641**	7.968*	8.766*	9.196*	4.757	1.436	6.228**	13.588***		
PI	0.015	-0.641	-0.737	-0.362	-0.004	-0.063	0.132	0.748**	1.726***		

Table 9: Results of the Panel Quantile Regression Estimation

Note: '***,' '**,' and '*' indicate the significance levels at 1%, 5%, and 10%, respectively. Source: Authors' estimates.

5. Conclusion and Policy Implications

It is a global imperative to transition to sustainable and renewable energy sources to address climate change and energy crises, requiring substantial investments in RE infrastructure. Despite escalating global RE investments, a considerable gap persists between the current investment levels and what is required to meet global sustainability goals. Bridging the gap demands massive and collective initiatives worldwide. Developed economies exhibit significant RE investments while developing economies face a considerable shortfall. Understanding the factors behind this shortfall is critical and still unexplored in extant literature. Our study addresses the critical gap by focusing on the potential determinants of RE investments. Unlike previous research, our study concentrates on RE investments, measured by installed capacity, offering a more forward-looking perspective and comprehensively exploring both economic and noneconomic factors.

Utilizing a 21-year, 36-country annual panel dataset and advanced econometric tools—PCSE, FGLS, and QR, the research, based on baseline models (i.e., PCSE & FGLS), reveals a nuanced interplay of economic and noneconomic variables in shaping RE investments, with notable disparities between developed and developing countries. In developed economies, industrial growth, environmental tax revenue, social globalization, and climate vulnerability positively impact RE investments, while inflation and political instability exhibit adverse effects. In contrast, developing countries experience a negative impact of industrial growth and oil prices on RE investments, while environmental tax revenue, social globalization, environmental-related technologies, and climate vulnerability exert favorable influences. QR analysis further validates these findings, albeit showing variations across quantiles.

The study's findings hold significant policy implications for stakeholders in both developed and developing countries. For developed economies, aligning industrial growth with sustainability is crucial. Policies should incentivize eco-friendly industrial practices, balancing economic growth with environmental conservation. Concurrently, a robust environmental taxation framework is key to internalizing environmental costs and channeling funds toward RE projects. Policymakers should refine these policies to fortify the financial instruments underpinning sustainable energy transitions. Social

globalization's role in facilitating RE investments highlights the importance of international collaboration in knowledge exchange, collaborative research, and technology transfer. Also, addressing climate vulnerability through climate change-resilient RE infrastructure is essential, alongside controlling inflation and ensuring political stability to attract long-term RE investments.

For developing countries, sustainable industrialization and cleaner technologies should be encouraged. Strengthening environmental taxation policies can generate funds for RE projects. Leveraging social globalization for collaborative RE initiatives and prioritizing investments in environmental technologies are important. Given the observed negative impact of oil prices, diversifying energy sources and strategic partnerships are recommended to mitigate vulnerability to oil price fluctuations. Investing in climate-resilient infrastructure is also vital in this regard. Overall, our study emphasizes the need for a coordinated global effort, urging international collaborations, information sharing, and joint initiatives to accelerate the transition to sustainable energy worldwide.

However, acknowledging our study's limitations, future research could enhance comprehensiveness by incorporating various RE capacities beyond PV solar, e.g., wind, hydrogen, etc. Additional factors, such as government policies, market structure (e.g., feed-in tariffs, tax credits, and grants), and access to financing could be explored to better understand their impacts on RE investments. Moreover, our study relies on annual panel data and focuses on a select group of developed and developing countries due to data deficiency. Extending the time frame and expanding the sample size, if available, would contribute to the generalizability of future research in this critical study area.

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Exploring the Economic and Noneconomic Determinants of Investments in Renewable Energy

This paper explores the determinants of renewable energy investments along with other economic and noneconomic variables in both developed and developing economies. The findings of this paper indicate that industrial growth, environmental taxes, social globalization, and climate vulnerability positively influence renewable energy investments in developed economies, while inflation and political instability have negative impacts. In developing economies, environmental taxes, social globalization, environmental technologies, and climate vulnerability are beneficial, while industrial growth and oil prices have adverse effects. These factors are valuable information for policymakers to create specific strategies to meet global sustainability goals.

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