Cuadernos de Economía (2022), Volume 45, Issue 128 Page 1-12

Cuadernos de economía

Asociación Cuadernos de economía

www.cude.es

ARTÍCULO

The Role of Climate Finance in Achieving Cop26 Goals: Evidence from N-11 Countries

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Jel Codes:

M14; N14

Keywords: Climate finance, research, and development, renewable energy, CO2 emissions, environmental quality, foreign development investment, N-11 countries.

Abstract: Recent climate change has become a significant worry for international communities. These alterations' consequences are horrifying, and it is anticipated that they will worsen over time. CO2 emissions are one of the primary factors contributing to the degradation of the environment, among others. Recently, COP26, a UN climate change conference, was convened in the United Kingdom to bring together world leaders to discuss the dire climate situation and propose strategic solutions to reduce environmental concerns. Therefore, this study aims to investigate the impact of Climate financing on environmental quality. The study evaluated climate finance and its impact on CO2 emissions in N-11 nations using three indicators: renewable energy use, foreign direct investment inflows, and R&D expenditure. The information retrieved from WDI spans the years 1990 to 2019. The current study used CS-ARDL and a correlation matrix to determine the relationship between components. The results demonstrated a negative relationship between renewable energy use and R&D spending, and CO2 emissions. However, FDI inflows are found to boost carbon emissions. The current analysis provides credible criteria for the effectiveness of climate finance and concludes with a discussion of repercussions and future directions.

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https://doi.org/10.32826/cude.v1i128.701

1. Introduction

Climate change is one of the most pressing issues that possess a certain trait. This issue is long-term and worldwide in scope; as a result, it incorporates multiple factors, including the environment, institutions, technology, society, economy, and policies, which makes the whole problem more complicated. Since it is widespread, it harms all climate-sensitive industries, including health, agriculture, water, and infrastructure, at domestic and international levels (Ellis et al., 2013; Raza et al., 2020). While the world community is engaged in establishing new goals to eradicate poverty, climate change has become a significant worry in recent years. These alterations' consequences are horrifying, and it is anticipated that they will worsen over time. CO2 emissions are one of the primary factors contributing to the degradation of the environment, among others. The COP26 UN climate change conference was recently conducted in the United Kingdom to bring together world leaders to discuss the dire climate situation and offer strategic initiatives to reduce environmental concerns. The primary objective of the conference is to fulfill the agreement for sustainable climate change progress by reducing "the increase in global temperature to 1.5 degrees Celsius above pre-industrial levels" (Dwivedi et al., 2022; Mahat et al., 2019).

In keeping with this perspective, it is suggested that finance plays a significant role in activating a low-carbon and climate-resilient economy. As previously mentioned, the Paris Agreement also commits to aligning financial flows with actions that reduce GHG emissions, thereby improving climate-resilient development. Multiple studies demonstrate that a considerable financial gap prevents governments from achieving their objectives (Moellendorf, 2012; Steele, 2015). It was recently projected that 1.8 trillion dollars in prospective investments are required to yield 7.1 trillion dollars in benefits. However, according to the most recent estimates, just $30 billion in adaption investments have been identified. This overall scenario indicates that effective public and private climate finance is required to close the budgetary gaps (Bird et al., 2011; UNCTAD, 2015; Z. Wang et al., 2022).

In recent years, experts have viewed climate finance as a credible and effective strategy for combating climate change. It is considered a distinctive form of international aid that encourages green growth and reduces carbon emissions. Additionally, it is anticipated to be particularly effective for low-carbon paths (Westphal et al., 2015). As it is noticed that the need for climate finance is increasing with time, so is the interest of experts in determining whether or not this phenomenon is successful. Emerging and established economies have agreed on climate finance principles at several levels, including international, fund, and institutional. In addition, it encompasses certain public and private flows. Another academic claimed that the quantity of climate funding is, without a doubt, considerable. Therefore, it is crucial to determine how it might be utilized successfully. The reason is that it supports mobilizing climate-friendly investment, assisting governments in achieving the future objective of zero-carbon societies (Dejgaard et al., 2018). This is excellent for people who set the groundwork for public and private climate finance. For instance, stockholders are in climate-focused organizations and taxpayers in developed economies. However, it is equally appropriate for those in emerging economies affected by climate change (Rickards et al., 2014; Terpstra et al., 2013).

However, we cannot conclude that analyzing the effectiveness of climate funding is dishonest. It is suggested that there is now no consensus regarding the activities, interventions, and flows that constitute climate finance. In addition, an understanding of the efficiency of climate finance has been debated at several levels due to the conflicting perspectives of academics and stakeholders. These discrepancies are related to the intervention's financing channels and resources. Also, there are disparities in the evaluation of climate money. Thus, it allows scholars to investigate the phenomena and their impact on environmental quality (Caruso et al., 2013; Y. Wang et al., 2016).

All states are working towards the COP26 aims of improving environmental quality by lowering carbon emissions. To investigate the effects of climate money on environmental quality, we planned to select the Next 11 states (South Korea, Pakistan, Nigeria, Vietnam, Bangladesh, Turkey, Indonesia, Egypt, Philippines, and Mexico) for this study. There are numerous reasons to select N11 nations. First, N11 countries are seen as potential emerging economies with the potential to become the world's largest economies in the future. Because of their potential, they are commonly referred to as the "future BRIC 2 economies."

Moreover, these nations are anticipated to compete with three of the world's main economies. Despite this, there are no longer any contextual obstacles to growth in these places (Sinha et al., 2020). For instance, Nigeria is currently engaged in a program to eradicate corruption, while Turkey struggles to join the United Nations. Similarly, Pakistan is reorganizing its taxation laws. The second argument is environmental concerns. As we know, environmental quality will be damaged when these nations focus on new sectors to enhance economic growth and compete with established economies (Hao, 2022; Sherif et al., 2022; Zeren et al., 2020). Undoubtedly, Nigeria and Mexico have taken steps to minimize the harmful impact of co2 emissions by enhancing energy intensity. However, there is still a need for an effective plan to address climate change without compromising economic growth. Data fuel the abovementioned issue that N11 and BRIC provide their fair share of carbon emissions relative to other leading economies. Thirdly, regarding technical advancement and R&D, data from chosen economies reveals contradictory evidence (V. C. Nguyen et al., 2021). For instance, in terms of phone penetration, governments like Turkey and Korea compete head-to-head with BRICS members, while other nations display skepticism. In contrast, developing economies demonstrated remarkable economic performance, highlighting the importance of R&D, technology, and infrastructure. However, scant data encourages the author to find the direct relationship between R&D spending, FDI inflows, renewable energy usage, and environmental quality without compromising economic growth (Jiang et al., 2020; L. Wang et al., 2019).

Continuing with the subject, forecasts indicate that by 2050, two-thirds of the size of G7 nations will be divided among the Next 11 economies (Raza et al., 2020). More opportunities will allow N11 countries to experience greater economic growth, increasing their chances of becoming BRICS members. Moreover, due to the strong economic growth rates, these regional economies may need to compete with the existing leading economies and other key markets (Afework et al., 2020). Statistics indicate that N-11 nations are focusing on expanding their economies by relying largely on energy consumption. According to Raza et al. (2020), these regions contributed 30% of global carbon dioxide emissions and 9% of global energy consumption in 2007.

Additionally, they contributed nearly 7% of the world's GDP. Consequently, increased economic growth in N11 nations is associated with a high energy demand, which negatively impacts environmental sustainability. The graph below depicts the primary energy consumption trend of N-11 countries from 1970 to 2015. The rising trend indicates that economic expansion is responsible for increased energy use and increased carbon emissions (Finance, 2019).

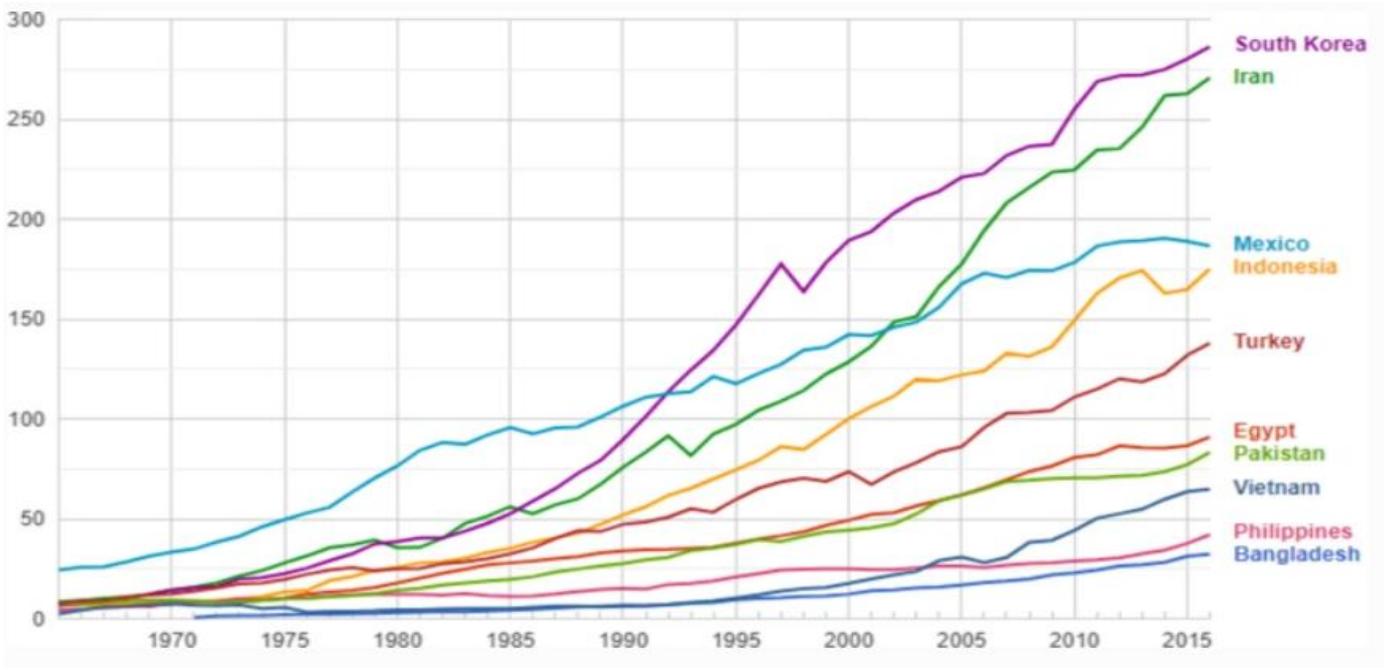

Figure 1. Next-11 Countries' trend of Primary energy consumption (1975-2015)

Concerning environmental challenges, N-11 nations are presently concentrating on developing policies that support the concept of shifting towards renewable and clean energy sources. According to the 2016 Climate Scope Report, Mexico's investment in renewable energy resources reached roughly $4.2 million in 2016. This indicates that the investment in renewable energy sources has increased by 114 percent. In addition, N-11 nations demonstrated in 2018 an increase in the use of clean energy sources, allowing the COP26 aim of mitigating climate change to be realized. In 2018, South Korea reportedly invested $5 billion in clean energy resources, according to argument (Shahbaz et al., 2019). In contrast, Mexico's contribution to renewable energy resources was $3.8 billion. Vietnam's proportion of renewable energy resources was 3,3 billion dollars, while Turkey's investments were up to 2,2 million dollars (Finance, 2019).

As noted in the preceding section, some countries have already begun working on climate financing policies and accelerated decarbonization. However, numerous conceptual frameworks for climate financing explain how it operates and which drivers are the most important (Yii et al., 2017). However, the limited empirical evaluation invites scientists to investigate the usefulness of one of these models. To fill the void, the current study investigates the few variables of climate funding and their effect on carbon emissions. These determinants promote green development, so it is important to examine them. However, it is essential to determine which specific factors tend to be more effective in the context of N-11 nations.

In this approach, the current study contributes in several ways. First, it investigates the empirical efficacy of the parameters connected to climate finance in the context of N-11 countries (Buchner et al., 2019; Flåm et al., 2009; Jakob et al., 2015). With the aid of empirical evidence, the study develops a policy that will prove useful to future researchers. The vast majority of work on climate finance centered on climate funding policies or the progress of BRCIS nations. Keček et al. (2019) and Olabi (2019) investigated the relationship between carbon dioxide emissions and economic growth (as a whole). In the context of N-11 countries, scholarly research on climate financing elements like as research and development expenditures, FDI inflows, and renewable energy usage and their effects on environmental quality is minimal (Roberts et al., 2017; Stadelmann et al., 2011).

The investigation is divided into multiple phases. The first step begins with an introduction that outlines the study's motivation and discusses the study gap and significance. In light of earlier literature, the following chapter includes thorough literature assessments on climate financing, environmental quality, and their relationship to one another. The technique phase discusses data collecting for selected constructs and highlights the proposed equations that will be tested in the subsequent study phase. The findings are presented and discussed in previous studies in the following step. The conclusion includes implications and future recommendations to research further facets of climate finance.

2. Literature Review

Climate financing, abbreviated as CF, is sometimes known as "activities related to climate change." The notion is recognized to be various since it lacks a distinct and unique definition; therefore, its scope is well-defined. In recent decades, climate financing has garnered a great deal of interest. It is now regarded as a key vehicle for bringing nations together to explore similar yet distinct methods of addressing the climate challenge individually or collectively (Bendarzsevszkij et al., 2017; Tamazian et al., 2009). While scientists were searching for the correct definition of CF and comparing it to other finance-related activities, which ultimately produced contradictory conclusions, the extra phenomena of climate financing have evolved, adding more layers and making the notion more complex. Climate financing is argued to be a very political and contentious subject during climate change discussions (Schröder et al., 2020; Su et al., 2021). Examples are the United Nations Framework Convention on Climate Change, the Paris Agreement, and the crucial protocol. Both of these parties could not ignore the importance of Climate financing, but they were also unable to offer simple solutions. Notable is that industrialized countries appear to account for the lion's share of global greenhouse gas emissions in the present and prior decades (Shahbaz et al., 2016). This drew the attention of the UNFCCC, which eventually acknowledged the need for "new and extra financing," particularly from emerging economies, to assist established economies in combating climate change and urged parties to work collaboratively to implement the accord. The less developed economies demanded "principle-driven supplementary assistance," sometimes known as climate money, in response to a UNFCCC demand (C.-C. Lee et al., 2022). It is suggested that OECD donors stipulate the similarity between climate finance and official development assistance, emphasizing the need for climate-resilient financing. However, based on prior development finance experiences, experts have determined that climate finance should be more effective and deliver more development benefits while addressing the core demands of climate change (Bird et al., 2011).

According to Anser et al. (2021), the United States has spent a substantial amount on research and development efforts, 2.84 percent of GDP and around 0.834% of GNI over the past year, to minimize co2 emissions. The Indian economy has also contributed significantly to renewable energy consumption, which accounts for 36.021% of total energy consumption. This attracts roughly 1.76 percent of GDP in FDI. Similarly, Brazil has allocated over 1.26 percent of its research and development budget to managing its per capita income, fueled by the rising use of renewable energy sources. To maintain the current inflation rate of 4.47 percent, the Russians have followed suit by limiting population density.

Regarding the United Kingdom, the country could minimize carbon damages equal to 0.4% of GNI. This reduces the inflation rate, enabling the government to increase its per capita income, which is currently $43,711.7 in US dollars. The conversation must be accompanied by relevant statistics, as it strengthens the case for why climate finance is essential for enhancing environmental quality. For this purpose, there are three primary constructs that, according to previous research, can be combined to serve as an indicator of climate finance: R&D expenditures, FDI inflows, and renewable energy use (Anser et al., 2021; Fragkiadakis et al., 2020; Zubair et al., 2020).

As previously mentioned, foreign direct investment is one of the most important indicators of climate financing; therefore, it is essential to highlight its relationship with carbon emissions and environmental quality in light of previous research. With the acceleration of economic globalization, foreign capital flows, particularly FDIs, have increased frequently. Foreign direct investment boosts the economic growth of host nations, but it also contributes to an increase in carbon emissions. FDI inflows are the most important international activity due to their critical significance in the economic and environmental spheres (Huang et al., 2022; Ur Rahman et al., 2019). Due to its importance, it has always been regarded as a hot topic in previous literature. It has been suggested that FDI inflows may correlate with global climate change. As a result, numerous scholars in the past have devoted considerable effort to examine its impact on carbon emissions.

In contrast, previous research has made contradictory statements regarding the relationship between FDL inflows and environmental damage. On the other hand, according to the Pollution haven hypothesis, FDI inflows cause environmental damage. The hypothesis explains that enterprises engaged in pollution-intensive industries tend to be located in locations with lax environmental regulations (Al-Mulali et al., 2015). This causes excessive pollution and dangerous emissions. Based on this theory, numerous research studied the relationship and supported the pollution haven effect by presenting empirical evidence that FDI inflows reduce carbon emissions to a greater extent (Ahmad et al., 2019; Cole, 2004; Cole et al., 2011; Kheder et al., 2012).

On the contrary, there are indications that host nations could profit from FDI inflows by employing innovative technology in financial development and enhancing management (Bose et al., 2018; Nair-Reichert et al., 2001). This allows businesses to adopt environmentally beneficial products and technology, ultimately assisting nations in reducing carbon emissions and enhancing environmental quality (Ahmad et al., 2019; Wheeler, 2001; Zeng et al., 2012). In addition, numerous studies emphasize the nonlinear relationship between FDI inflows and carbon emissions. According to the evidence, FDI inflows initially raise carbon emissions, but once a certain threshold is reached, carbon emissions begin to decrease with FDI inflows (Alshubiri et al., 2019; Shahbaz et al., 2016).

Based on the pollution haven theory, research aimed to investigate the direct relationship between FDI inflows and carbon emissions. These studies indicate that foreign direct investment increases carbon emissions. Wealthy economies seek to invest in emerging economies with lower environmental levies and stricter environmental laws to maximize earnings. This activity of theirs pollutes these economies' industries (Aller et al., 2021). Consequently, growing carbon emissions in host countries result from increased FDI activity (Grimes et al., 2003; Mahadevan et al., 2020). Grimes et al. (2003) analyzed 66 emerging economies to investigate the relationship between these two concepts. According to the authors, FDI inflows have led to a large increase in the growth of co2 emissions in developing countries.

Furthermore, developing economies appear more inclined toward permissive regimes to attract foreign investors and achieve economic growth (Bommer, 1999). Cole et al. (2006) investigated the relationship between FDI inflows and severe environmental policies using data from 33 states. The research found that nations with a high perceived level of corruption emit more carbon dioxide. This is because large corporations may influence local government institutions to adopt lenient environmental rules.

Numerous research contradicts the pollution haven idea. Hence we propose the pollution halo hypothesis. According to this idea, FDI inflows bring cleaner and more efficient technical innovation to host countries, assisting them in reducing their carbon emissions (Melane-Lavado et al., 2018; Z. Zhang et al., 2021). According to Z. Zhang et al. (2021), FDI inflows negatively influence carbon emissions; however, when quantiles increase, the effect becomes positive. The pieces of evidence were gathered in the setting of Indonesia, Malaysia, Singapore, Thailand, and the Philippines.

Similarly, a second study concluded that FDI inflows significantly decrease carbon emissions when their output increases over time. The matter was examined in India. In addition, a large body of literature has drawn a complete conclusion regarding the relationship between these two concepts. Alshubiri et al. (2019), for instance, utilized panel data from 32 OECD countries and concluded that FDI inflows and carbon emission shares have a nonlinear relationship. At the left end of the inflection point, FDI inflows are favorable; however, at the right end, they appear to affect carbon emissions negatively.

Similarly, Shahbaz et al. (2016) provide empirical evidence from data collected from 99 nations. It demonstrates that FDI inflows and carbon emissions are unrelated. The variations in national income are the cause. The analysis showed a U-shaped association between FDI inflows and carbon emissions in middle-income nations. FDI inflow and carbon emissions are inversely associated in high-income countries but positively connected in low-income countries.

The urgent need to mitigate climate change by reducing carbon emissions encourages the quick development of current literature by investing funds in research and development. Churchill et al. (2019) investigated the relationship between R&D intensity and carbon emissions. The authors analyzed G7 nations and utilized data from 1870 to 2014. Using both parametric and non-parametric econometric methodologies, researchers determined that these constructs can share positive and negative connections. These insights were shown directly by the fact that R&D affects carbon emissions through controlling elements such as GDP, energy-efficient industry, etc. Fernández et al. (2018) analyzed the significance of research and development on carbon emissions. The study examined 15 EU nations, China, and the United States from 1990 to 2013 and extracted data. The study's specific objective was to give evidence to support the R&D efforts to reduce carbon emissions. The findings demonstrated that R&D investments are beneficial for reducing carbon emissions in emerging economies. Another study analyzed the relationship between innovation in energy research and carbon emission (Shahbaz et al., 2018). The survey was done in France from 1955 to 2016, encompassing the period. The findings indicated a negative association between the two concepts. Y.-J. Zhang et al. (2017) examine the potential relationship between environmental innovation and carbon emissions. The authors considered 30 Chinese provinces, encompassing the years 2000 through 2013. The findings indicated that environmental improvements in China effectively reduce carbon emissions.

Li et al. (2017) examined the impact of technology change on carbon emissions in 95 states. The study included information from 1996 to 2007. The authors distinguished between measurement scale and intensity effects. The study's results indicated that technological advancement harms carbon emissions. Similarly, K.-H. Lee et al. (2015) studied the impact of green R&D investment on carbon emissions and financial performance. From 2001 to 2010, the study examined Japanese manufacturing organizations. The results indicate a negative relationship between the two constructs. Garrone et al. (2010) sought to give empirical evidence addressing the relationship between R&D expenditures and carbon emissions in the context of 13 developed nations. The study covered data from 1980 to 2004, indicating no significant relationship between these two constructs.

Academics are compelled to investigate the relevance of renewable energy and its critical role in economic growth due to the rapid expansion of the renewable energy industry on a global scale and the numerous energy transitions undertaken by nations. Renewable and non-renewable consumption are the two primary categories used by scholars to classify energy consumption (Apergis et al., 2012; Menegaki, 2011; Rahman et al., 2020). The objective is to assess the impact of both energy sources on carbon emissions and economic expansion. To date, however, the relationship between renewable energy usage, carbon emissions, and economic growth appears to be inconsistent (Apergis et al., 2012; Bhattacharya et al., 2016; Destek et al., 2017; Farhani et al., 2014; Riti et al., 2017; Sankaran, 2019; Z. Zhang et al., 2021). In recent years, energy consumption has begun to rely on fossil fuels, resulting in a significant increase in GHG emissions worldwide, creating climate change and environmental damage (Ahmed et al., 2018; Hu et al., 2021; Z. Zhang et al., 2021). Riti et al. (2017) used various estimating methodologies, including ARDL, DOLS, impulse response, and FMLOS, to investigate the impact of energy consumption on carbon emissions and economic growth in China. The findings indicate that the rapid and extensive development of China's economy and the rise in energy consumption led to an increase in greenhouse gas emissions (Chontanawat, 2020; Murshed, 2021a). The results, however, contradict the findings of Murshed et al. (2021), which demonstrated that energy consumption in varied circumstances positively affected environmental quality in South Asia. Using this evidence, numerous researchers determined the direct and beneficial relationship between renewable energy and environmental quality (Murshed, 2021b). In the context of African states, Apergis et al. (2018) investigated the impact of renewable energy consumption on CO2 emissions. The study examined data from the years 1995 to 2011. The study revealed a short-term two-way causal relationship between these two constructs, validating the feedback hypothesis. Long-term elasticity measures indicate that the use of renewable energy contributes to the decrease of harmful emissions. This explanation is comparable to the existing energy literature (Brini, 2021; Chen et al., 2019; Z. Zhang et al., 2021).

Nevertheless, the findings collected by Hu et al. (2021) demonstrate a unidirectional causal relationship between these constructs. The study selected India and included data from 1990 to 2018. Similarly, Farhani et al. (2014) investigated the MENA region between 1980 and 2009. The acquired results revealed a favorable correlation between the consumption of renewable energy and carbon emissions. The data also suggest the possibility of causal interaction in both directions between these two concepts. Using this evidence, K. H. Nguyen et al. (2019) employed panel data from 107 nations to investigate the link between these constructs. The data reveal a favorable correlation between low-income states' co2 emissions and renewable energy consumption. In states with a high income, however, the relationship is reversed. Additionally, other experts believe that renewable energy consumption can increase energy self-sufficiency, reduce carbon emissions, and drive sustainable growth to a certain extent. (Gill et al., 2018; Noorpoor et al., 2015).

As we go deeper into the current literature, we uncover much evidence addressing the connection between renewable energy consumption and carbon emissions. Chen et al. (2019) examine the relationship between renewable energy, co2 emissions, GDP, and international commerce in the context of China. The authors used the ARDL and VECM models to determine the association between 1980 and 2014. The findings reveal that renewable energy and trade negatively affect emissions, whereas the relationship between GDP and carbon emissions is U-shaped but inverted. Using the Granger Causality test, the study determined that the relationships between the constructs are bidirectional. Similarly, Y. Wang et al. (2016) investigated the association in China. The authors discovered that meeting renewable energy targets reduced carbon emissions by up to 1.8% from 2010 to 2020. Similarly, Inglesi-Lotz et al. (2018) studied the relationship between RE and carbon emission in the top 10 African electricity-producing nations. The information was collected from 1980 to 2011. The studies revealed a long-term relationship between GDP, RE, and CO2.

3. Methodology

The current study investigates the role of climate finance through renewable energy consumption, FDI inflows, and R & D expenditures on environmental quality in the context of N-11 countries. The study used secondary data, including WDI, from which it extracted the data covering the period from 1990-2020. The study formulates the following equation based on the proposed conceptual framework.

$$CO2_t = \alpha_0 + \beta_1 REC_t + \beta_2 FDI_t + \beta_3 RDE_t + e_t$$

Where,

CO2	=	Carbon dioxide Gas emissions
REC	=	Renewable Energy Consumption
FDI	=	Foreign Direct Investment flows
RDE	=	Research & Development Expenditures

The study measured environmental quality through GHG emissions (% change from 1990). Moreover, the study considered three predictors to investigate Climate finance. The study combined three factors: FDI inflows in terms of GDP, renewable energy in terms of % of total energy demand, and R & D expenditures in terms of % of GDP. The measurement of the understudy variables is mentioned in Table1.

Table 1: Measurement of Variables

S#	Variables	Measurement	Sources
01	Environmental Quality	CO2 emissions (% change from 1990)	WDI
02	FDI Inflows	% Of GDP (% change from 1990)	WDI
03	Renewable Energy Consumption	% Of total energy demand Natural resources depletion (% of GNI)	WDI
04	R & D expenditures	% of GDP (% changed from 1990)	WDI

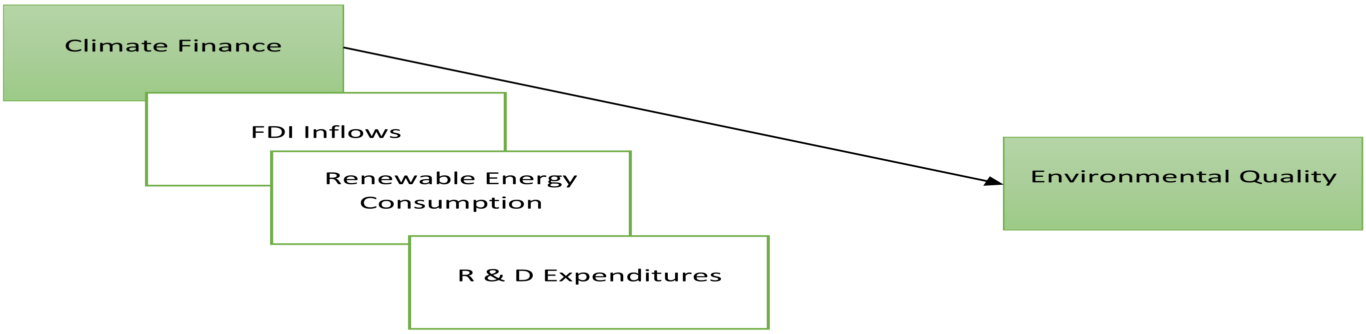

Figure 2: Conceptual Model

4. Research Methods

The paper used descriptive methods, which show the number of observations used in the article and the properties of data such as mean, minimum, maximum, and standard deviation. The study also used a correlation matrix to check the correlation among chosen constructs. In addition, the research chose cross-sectional dependency, abbreviated as the CSD technique, as it appears to be the most appropriate technique when more than one country is selected as a study sample. Below is the CSD expression where $\hat{\bar{\rho}}_T$ represents pair-wise correlation, T represents time, and I represent cross-sections units

$$CSD_{IT} = [\frac{IT(T-1)}{2}]^{\frac{1}{2}} \hat{\bar{\rho}}_T \quad (2)$$

Additionally, the study also aims to evaluate the stationarity of the variables. Therefore, cross-sectionally augmented IPS unit root test was run under the study. The expression for CIPS is outlined below:

$$\Delta W_{i,t} = \emptyset_i + \emptyset_i Z_{i,t-1} + \emptyset_i \bar{Z}_{t-1} + \sum_{l=0}^{p} \emptyset_{il} \Delta \bar{W}_{t-1} + \sum_{l=0}^{p} \emptyset_{il} \Delta W_{i,t-1} + \mu_{it} \quad (3)$$

In equation 3, $\bar{W}$ means cross-section, which is presented below:

$$W^{i,t} = \emptyset^1 \, \overline{CO2}^{i,t} + \emptyset^2 \, REC^{i,t} + \emptyset^3 \overline{FDI}^{i,t} + \emptyset^4 RDE^{i,t} \quad (4)$$

This way, CIPS can be written as

$$\widehat{CIPS} = N^{-1} \sum_{i=1}^{n} CADF_i \quad (5)$$

Where CADF stands for cross-sectionally augmented dickey fuller test in the above expression.

Furthermore, in this study, cointegration was also inspected via Westerlund et al. (2008) cointegration test. The said method is dominant in contrast to the traditional cointegration technique because its CSD and structural break assumptions are durable. Moreover, the said method also helps examine the structure's regime shift and no-shift breaks. The expression of the technique is listed below:

$$llog(L) = \alpha_0 - \frac{1}{2}\sum_{i=1}^{N}\left(Tlog(\sigma_{i.t}^2) - \frac{1}{\sigma_{i,t}^2}\sum_{t=1}^{T} eit^2\right) \quad (6)$$

Lastly, the CS-ARDL technique examined the long and short-run nexus among constructs. The approach deliberates significant assumptions when it comes to endogeneity, CSD as well as heterogeneity. Moreover, the panel ARDL is famous as it is widely considered in heterogeneous panel data estimator. However, it does not have room to identify CSD errors. The study used the CS-ARDL technique as it is novel and established by Chudik et al. (2015) due to its strict assumptions. The expression for CS-ARDL is written below:

$$\Delta Y_{it} = \varphi_i + \sum_{l=1}^{p} \varphi_{it} \Delta Y_{i,t-1} + \sum_{l=0}^{p} \varphi'_{il} EXV_{s,i,t} + \sum_{l=0}^{1} \varphi'_{il} \overline{CSA}_{i,t-1} + \varepsilon_{it} \quad (7)$$

With the help of a general CS-ARDL equation, the article developed an equation according to the study constructs, which is given below:

$$\Delta CO2_{it} = \varphi_i + \sum_{l=1}^{p} \varphi_{it} \Delta CO2_{i,t-1} + \sum_{l=0}^{p} \varphi'_{il} REC_{s,i,t} + \sum_{l=0}^{p} \varphi'_{il} FDI_{s,i,t} + \sum_{l=0}^{p} \varphi'_{il} RDE_{s,i,t} + \sum_{l=0}^{1} \varphi'_{il} \overline{CSA}_{i,t-1} + \varepsilon_{it} \quad (8)$$

5. Results

The study employs descriptive statistics to display the number of observations and the specifics of the variables, including mean values, minimum values, and standard deviation. The descriptive statistics of climate finance indicators in a cross-sectional panel of N-11 nations are shown in Tables 2 and 3. The least value of FDI inflows is 0.731% of GDP, while the greatest is 28.346%, with a mean value of 3.711% of GDP, as shown in Table 3. Similarly, the smallest figure for renewable energy consumption is 0.138% of total energy demand, and the largest value is 70.14%. The typical REC value is 22,83 percent of total energy demand. The smallest number for research and development expenditures is 0.15 percent of GDP, while the greatest value is 3.44 percent. While the average value is 0.891%, These parameters serve as a measure of climate funding.

Table 2: Descriptive statistics

Variable	Obs	Mean	Min	Max	Skewness	Kurtosis
CO2	30	124.598%	3.662%	289.772%	0.987	2.973
REC	30	22.83%	0.138%	70.14%	0.991	3.456
FDI	30	3.711%	0.731%	28.346%	3.978	18.306
RDE	30	0.891%	0.15%	3.449%	1.567	4.312

In addition, the current study employed descriptive methods to reveal the year-by-year specifics of variables. The documented results demonstrated that carbon emissions were at their lowest level in 1991, at 3.662%, and their greatest level in 2020, at 278.063%. Similarly, the statistics indicate that the lowest rate of REC was recorded in 2003, with a percentage of 15.037%, while the greatest rate was recorded in 2015. Regarding FDI inflows, the lowest proportion was recorded in 2019, with 6.610 percent, while the highest percentage was recorded in 1991, with 33.258 percent. In addition, the statistics indicate that the percentage of R&D expenditures was highest in 2016 and lowest in 2008.

Table 3: Descriptive year-wise

	CO2	REC	FDI	RDE
1991	3.662	18.471	33.258	5.823
1992	7.188	17.585	32.931	5.110
1993	12.989	18.125	31.678	4.242
1994	18.517	18.088	31.249	3.222
1995	29.534	19.214	29.472	3.200
1996	33.119	17.552	30.537	2.983
1997	31.367	17.512	30.183	2.389
1998	32.079	18.061	29.740	1.744
1999	30.483	16.681	30.506	1.813
2000	30.561	16.639	29.603	2.595
2001	32.185	18.959	28.335	2.483
2002	40.647	17.619	26.978	1.874
2003	59.966	15.037	23.841	1.953
2004	82.821	16.223	20.161	4.662
2005	100.467	16.175	17.441	5.041
2006	120.244	15.593	16.385	5.505
2007	134.390	15.263	14.884	6.376
2008	157.459	17.737	14.138	9.705
2009	172.750	17.864	13.432	3.986
2010	187.304	18.623	12.261	6.299
2011	209.922	16.762	11.338	7.677
2012	219.952	19.966	11.537	4.153
2013	207.811	20.296	11.522	3.025
2014	219.520	22.609	12.061	2.314
2015	231.228	23.927	12.245	1.183
2016	242.937	19.754	12.590	1.047
2017	254.646	19.905	12.864	1.332
2018	266.354	20.056	13.124	1.468
2019	278.063	20.207	6.610	1.255

In addition, the correlation approach was utilized to determine the correlation between variables. The results indicate a negative association between REC, R & D, and CO2 emission. However, there is a positive association between FDI inflows and carbon emissions in the context of the Next 11 countries. Table 4 contains the correlation matrix's particulars.

Table 5: Correlation matrix

Variables	CO2	REC	FDI	RDE
GHGE	1.000			
REC	-0.562	1.000		
FDI	0.659	-0.403	1.000	
RDE	-0.326	0.154	0.882	1.000

As discussed earlier, the study used the CSD test to apply cross-sectional dependency. The findings show that the value of t-statistics is greater than 1.96, whereas the probability value is less than 5%. Hence, the CDS issue does not exist in the proposed model. The details can be shown in Table 6.

Table 6 CSD test

Variable	Test Stat (prob-values)
CO2	3.982*** (0.000)
REC	2.837*** (0.000)
FDI	5.872*** (0.000)
RDE	4.777***(0.000)

Moreover, the Stationarity of variables was also evaluated through the CIPS unit root test. The findings show that CO2 emissions and REC are stationary at the level, whereas RDE and FDI inflows are stationary at the first difference. The details are shown in Table 7:

Table 7: Unit Root Test

	I(0)		1^{st} Difference I(1)	
Variables	CIPS	M-CIPS	CIPS	M-CIPS
CO2	-2.910***	-3.782***	-	-
REC	-1.034	-1.038	3.092***	5.803***
FDI	-5.792***	-5.773***	-	-
RDE	-1.182	-1.162	-5.902***	-6.086***

The present study also checked cointegration via the Westerlund et al. (2008) cointegration test. The results show that the t-values are greater than 1.96, where the p-value is less than 5% (Table 8).

Table 8: Cointegration Test

Test	Without break	Mean shift	Regime shift
Explained Variable: CO2			
$Z_{\varphi}(N)$	-5.092***	-5.066***	-4.137***
P_{value}	0.000	0.000	0.000
$Z_{\tau}(N)$	-6.099***	-4.032***	-5.148***
P_{value}	0.000	0.000	0.000

The results revealed that renewable energy consumption, research, and development expenditures negatively correlate with carbon emissions in N-11 countries. Hence, incorporating these in practices improves the environmental quality, fulfilling these nations to achieve COP26 goals. In contrast, FDI inflows positively correlate with short and longer-run carbon emissions, affecting the climate negatively. Table 9 depicts the situation in detail.

Table 9 CS-ARDL Method

Long Run findings			
Variables	Coeff	t-stat	Prob
Explained Variable: CO2			
REC	-0.676***	-3.802	0.004
FDI	0.793***	5.639	0.000
RDE	-0.654***	-4.873	0.002
CSD-Statistics	-	0.028	0.611
Short Run Results			
REC	-0.574***	-4.812	0.000
FDI	0.786***	3.071	0.022

RDE	-0.657**	-1.983	0.011

6. Discussion

The collected results reveal a negative correlation between renewable energy consumption and carbon emissions. The findings are congruent with those of K. H. Nguyen et al. (2019) and Y.-J. Zhang et al. (2017), who demonstrate that when renewable resources are included in energy production, the use of fossil fuels begins to decline, hence reducing overall carbon emissions. Thus, we may conclude that when the use of renewable energy increases, the total environmental quality begins to improve, allowing for the long-term preservation of the climate. The findings also match the conclusions of Awodumi et al. (2020), which indicate the use of renewable resources such as water, crops, sunlight, and air to create electricity, provide fuel, and cultivate crops to reduce harmful emissions. The results are also consistent with Doğan et al. (2021). They argue that the consumption of renewable energies, such as wind and solar power, is appropriate for meeting energy and economic needs because they help reduce carbon emissions and enhance environmental quality. In addition, the findings are consistent with Anser et al. (2021) assertion that economies that produce renewable energy use much less fossil fuel, hence reducing their harmful emissions. Moreover, with the development of renewable energy resources, RE production appears to be a realistic strategy for mitigating climate concerns by reducing carbon emissions and the planet's temperature. Not only will climatically pattern changes be preserved, but also water surface and oil conditions.

In addition, the studies demonstrated a negative relationship between R&D spending and carbon emissions. The results are consistent with Churchill et al. (2019).'s examination of the relationship between R&D intensity and carbon emissions. The findings demonstrated that investments in R&D aid in the reduction of carbon emissions. The results also support the research by Li et al. (2017), which examined the impact of technology change on carbon emissions. The authors distinguished between measurement scale and intensity effects. The study's results indicated that technological advancement harms carbon emissions. Similarly, K.-H. Lee et al. (2015) studied the impact of green R&D investment on carbon emissions and financial performance. The results indicate a negative relationship between the two constructs.

The data also revealed a favorable correlation between FDI inflows and carbon emissions. According to Cole et al. (2006), FDI inflows cause environmental deterioration. Our findings are consistent with this finding. The findings indicate that enterprises engaged in pollution-intensive industries tend to be located in locations with lax environmental regulations. This causes excessive pollution and dangerous emissions. In addition to the discussion, the findings are consistent with numerous research that explored the direct relationship between FDI inflows and carbon emission and were based on the pollution haven theory. These studies indicate that foreign direct investment increases carbon emissions. Wealthy economies seek to invest in emerging economies with lower environmental levies and stricter environmental laws to maximize earnings. This activity of theirs pollutes these economies' industries (Aller et al., 2021). Consequently, growing carbon emissions in host countries result from increased FDI activity (Grimes et al., 2003; Mahadevan et al., 2020; T.T.H. Nguyen et al., 2022).

7. Conclusion

The study's objective was to assess the impact of climate finance on environmental quality in N-11 nations. The study employed three metrics, including renewable energy usage, R&D expenditures, and FDI inflows, to assess the influence of climate funding on carbon emissions. The study's findings demonstrated a negative correlation between renewable energy consumption and R&D expenditures and carbon emissions, showing that these two resources are the most effective at reducing harmful emissions and assisting nations in meeting COP26 targets. However, the results indicate a positive relationship between FDI inflows and carbon emissions. The model implies that climate funding is a beneficial strategy for reducing carbon emissions in N-11 nations. The study provides several recommendations that would contribute to green literature in light of the findings. It emphasizes the importance of climate finance by demonstrating that one particular green initiative contributes to reducing carbon emissions. As is well-known, carbon emissions are the primary source of environmental degradation, which harms human health and climate. Based on its empirical findings, the report concludes that climate finance must be increased to explore new green energy options and improve overall efficiency. Renewable energy consumption and green technologies are advantageous in this regard because they are ecologically friendly and maintain sustainability over time. The literacy on climate finance would also serve as a "knowledge spillover" for governments, motivating them to create green-related policies to expand the scope of climate finance and increase carbon taxes, particularly on polluting businesses. It also presents the concept of investing appropriately in technology related to renewable energy sources. However, these technologies would only be useful if governments were familiar with green finance tools to combat climate change. It is advised to invest in these technologies so that future societies have reduced carbon emissions.

In addition to the implication, the study suggests a few drawbacks. First, only three metrics were used to evaluate climate financing and its impact on environmental quality. There must be more clues that must be assessed for a deeper comprehension of the phenomenon. Second, the study examined data from N-11 countries to evaluate the constructs. Different samples may produce different results. In addition, there is a lack of control factors or moderating variables in the study model; therefore, it is suggested that these variables be included to achieve more novel results in the literature on climate financing.

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