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The Impact of Green Climate Fund Portfolio Structure on Green Finance: Empirical Evidence from EU Countries

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Abstract. The financing sector drives the Future of Environmental Funds to achieve climate financing. In this study, we have employed panel regression analysis and the generalized two-step moment method (GMM) for the 25 EU countries from 2000 to 2021 to explore the relationship between green financing and the portfolio structure of green climate funds. According to the findings of this research, green financing significantly impacts quality economic growth. The GCFs enhance the capacity to channel public and private funding while contributing to de-risking more conventional forms of funding, increasing climate financing, and boosting the GCFs. In addition, the study concluded that Global Climate Support might fund nonbankable components of more significant “almost bankable projects” by analyzing the portfolio’s policies and methods.
Keywords: Financing Sector; Green Climate Funds (GCF); Green financing; EU countries

1. Introduction

Developing nations have consistently undervalued the importance of combating global warming. Nevertheless, as Chen et al. (2021)have shown, the effects of global warming and climatic variability are directly linked to political destabilization and food emergencies (Bashir et al., 2021), and climatic change volatility plays a crucial role in both domestic and global migration (X. Liu et al., 2021).

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In contrast, analysis of EU countries found that industrialized nations could only handle $81 billion of the US$101 billion objectives by 2020. World temperature must be limited to no more than 1.5 degrees Celsius to avoid disastrous environmental alteration, according to the International Panel on Environmental Change's most recent assessment (International Panel on Climate Change [IPCC], 2018). Coal must be phased out if the global temperature is kept at 1.6 degrees Celsius. While EU countries have previously restricted the funding of coal-fired power facilities in other countries, the protection and rehabilitation of trees, marshland, and other standard carbon drops may also help mitigate biodiversity loss and climate change (Grossman & Krueger, 1995). According to the United Nations Framework Convention on Climate Change (UNFCCC), until 2040, green funding of US$1.5 trillion per year will be required to devise the Sorbonne Accord and reach this environmental goal fully. Since present and future generations have a firm conviction in environmental ethics and religious views, they want their expenditures to reflect that view (Gouveia et al., 2019). For emerging financial systems, the issue of long-term viability is critical (Zihan Li et al., 2019).

Investing in maintainable resources, the constraints of such savings, and a comparison of responsible investing with their traditional equivalents are all critical threads in the research on responsible finance, according to (X. Song et al., 2019). The initial line of attack focuses on making investments in long-term solutions. Nielsen et al. (2014) point out that green bonds may be used as a hedge, particularly during times of crisis (such as a pandemic), while (M. Song et al., 2021) argue that clean energy share benchmarks in Europe and throughout the world are more efficient than those in the United States. The second strand highlights some difficulties and inadequacies in implementing renewable expenditures. According to (Nabeeh et al., 2021), processing expenses and workable deficiencies in Nepal hinder the expansion of green finance in the country. One set of studies found no variation in economic returns between renewable investment options and their comparable traditional substitutes (Yang et al., 2021). According to an alternate set of studies, an economic crisis would need traders to accept more risk and poorer profits.

Green finance has also been the subject of a handful of journal papers. Space technology is used to describe the state quo, and growth patterns in green finance (Churchill et al., 2020) brief compendium gives an overview of the wide-ranging area of green finance. There is a focus on the causes and potential advantages of company involvement in ecologically acceptable initiatives in green bonds and green loans following the fast development of green finance (Bouzarovski & Tirado Herrero, 2017). Green finance knowledge and its translation from theory to practice is the focus of this study, which adopts an integrated method using patent citation and subjective assessment of sample papers. It shows the present status of the study and its development trends. In the context of environmental transformation, climate finance refers to the funding of reduction and adaptation initiatives derived from public and private sources, as well as substitute sources of lending (Karásek & Pojar, 2018). Under the UNFCCC, wealthy nations are obligated to help poor counties that are less well-off and more susceptible to the effects of climate change (Herrero, 2017).

Evaluation of the impact of green climate funds on money mobilization in EU contires is presented in this study, which adds to the body of knowledge on the subject. Analyzing their portfolio structure and strategy empirically, we examine the green climate funds in structuring and scaling up climate funding. The green climate funds may successfully fund nonbankable sections of more significant “almost bankable projects,” as opposed to a Fund that focuses primarily on financing nonbankable projects. Analysis of the green climate funds portfolio of sponsored projects compared to WRI provides new study pathways on how private money might assist adaptation and mitigation strategies often supported mainly by state funds.

Green credit, green securities, green insurance, green investment, and carbon finance are all included in this study’s construction of a green finance development index using the global principal component analysis (GPCA).

The objective of the paper is to investigate the relationship between green financing and the portfolio structure of green climate funds in the 25 EU countries from 2000 to 2021 using panel regression analysis and the generalized two-step moment method (GMM) and to determine the impact of green financing on quality economic growth and the role of GCFs in channelling public and private funding for climate financing.

The paper’s research question is, how does green financing impact the quality of economic growth and the portfolio structure of green climate funds in the 25 EU countries from 2000 to 2021?

The rest of the paper is structured in the following way. Related literature is discussed in Section 2wo. Methodology and data are discussed in Section 3. Empirical results and discussion is presented in Section 4. The last Section 5 contains conclusions and policy implications.

2. Literature Review

Financial instruments that positively impact the environment are called “green finance” (IFC, 2017). Financial firms immediately consider environmental regulation when making investment and funding choices, which drives cash toward the green economy. Therefore, the traditional economic market largely ignores the ecological impacts in favor of the investing project’s performance. Accordingly, green financing encourages the switch between high-emission and energy-intensive investments to those that enhance energy efficiency and ecological protection (D’Orazio & Popayan, 2019). After carefully examining the climate finance literature, they discover that study in this area is still in its early stages, with little development. Early studies mainly emphasized how green finance will affect society and its associated policies. Hafner et al. (2020) examined significant impediments to private investment in infrastructure supporting energy from renewable sources and potential governmental solutions. They advise developing a long-term involvement founded on a systems approach since their study reveals that volatility and brief in the finance industry are two essential investment impediments. Mazzucato & Semieniuk (2018) focused on the role of public players in overall financing and looked at asset portfolios of various clean energy technologies that various financial stakeholders funded with variable risks. In order to combat climate change and advance green financing, D’Orazio & Popoyan (2019) looked at the green economy concept. The influence of policies on two substantial investor choice measures – risk and return – was analyzed by Polzin et al. (2019) to determine how well policies mobilize private capital. Research also highlighted how green financing had improved many businesses' effectiveness. For instance, Jin & Han (2018) investigated how sustainable finance affected the production bases and found a link involving green funding sources, especially in automotive. They also pointed out the prospect of green financing to play an essential part in China's shift to an economy that is both innovative and ecological.

Economic assets are critical to controlling ecological degradation in industrialized countries, but actual data is sparse. Because of this, researchers are working to fill the gap (Bohr & McCreery, 2020).

There was little in the way of GHG releases and deposits in the economy. Switching to a more environmentally friendly type of energy use is the only way to reduce the pace of ecological degradation. As noted (Bouzarovski 2014), governments must drastically decrease their reliance on fossil fuels and significantly increase their investment in financial technology to lower their carbon footprints. According to those who lauded the need to generate and promote renewable energy, renewable electricity usage was also criticized.

Items and Hotaling also stressed the need to shift to Financial technology sources, greener swiftly or much less harmful, while fostering economic progress (Aristondo & Onaindia, 2018). However, the long-term viability of green financing depends on private sector assets' confidence in their capacity to achieve the intended result (Castaño-Rosa et al., 2020). To put it another way: If an asset's current price is based on its previous data, then more data will quickly boost the price, putting the investment's real value closer to its market appraisal. Investors, economic advisors, and management are in danger when financial statistics are not connected. As a result, green finance's capacity to direct global economic growth toward financial technology might be diminished. To boost their business brand, corporations have sought to publicly accept financial technology issues without providing solid material to support such "green" pronouncements regarding ecological preservation (Bouzarovski & Petrova, 2015). All three impacts are accounted for sustainable growth: businesses, decision-makers, and end-users. Regarding financial reporting and justifications, shareholders are affected by the quality of the information presented. It has been suggested that certain firms are participating in "green finance" by exaggerating their "agenda statements" regarding effectiveness assessment via their disclosure methods.

3. Empirical strategy and data analysis

3.1. Theoretical framework

Most worldwide financial and monetary processes were hampered by the current Covid-19 pandemic, with EU countries being the first nation diseased and the most badly afflicted, being the most affected. The research results and the survey's stated objectives agree with one another. EU countries, the world's second-largest CO2 emitter, is also a significant energy exporter and a major CO2 emitter (Muhammad et al., 2016). There has been a great deal of research into green finance's role in Green climate funds. In a two-way interplay known as the "Sustainable Energy Performance and Green climate funds," green finance and process breakthroughs are connected. In past research, Green Finance was overestimated as a measure of financial growth, which did not consider its impact (Castaño-Rosa et al., 2019). Others have claimed that green finance may affect Green climate funds rates by influencing savings prices, expenditure decisions, and global climate change. There are numerous other studies. Scientific measures with a high probability of winning can quickly determine the most encouraging new advances in monetary services. Additional benefits include improved resource allocation and technological technology due to the market assistance company's ability to collect cost-saving savings and make it easier to use those funds. Irrespective of the nation's bank or sharemarket framework, green finance positively impacts financial growth. On the other hand, developing countries are at a disadvantage because they may be unable to benefit from innovation transmissions that could aid their growth. Green finance is expected to positively impact renewable growth because it is thought to spur innovation. Based on prior studies, this impact is obtained through various mechanisms (Shahbaz et al., 2018). Since nonfinancial technology consumption causes uncontrollable environmental degradation and a decrease in expected wealth, argues that it is untenable, green finance may be utilized to create green climate funds.

Furthermore, in the study, the degree of green funding is assessed using the global principal component analysis (GPCA) approach, a statistical technique that combines many indices into a single index. In order to arrive at a total score of the level of green financing, the GPCA approach analyzes five separate indicators, including the human capital index, the economic innovation index, the technical innovation index, the energy sector index, and the resource management index. This method contributes to a comprehensive understanding of the level of investment in environmentally friendly programs and its influence on lowering the adverse environmental effects of resource consumption.

3.2. Model specification

The following regression model is used to assess the influence of green finance and innovation on green climate funds indices.

$$GCF_{ijt} = \alpha_0 + \alpha_1 GF_{it} + \alpha_2 Fin_{it} + \alpha_3 GF_{it} * Fin_{it} + \alpha_4 i_{loa} + \alpha_5 \mathrm{npu}_{\mathrm{equ}} + \\ + \alpha_6 \mathrm{i}_{\mathrm{open}} + \alpha_7 \mathrm{Private} + \alpha_8 Z_{it} + \varepsilon_{it}$$

In this equation, variables are defined as:

a) GCF: The dependent variable, representing the "Green Climate Fund" index.
b) GF_it: The independent variable, "green finance," represents the influence of green finance on the GCF index.
c) Fin_it: The independent variable, "innovation," represents the influence of innovation on the GCF index.
d) GF_it*Fin_it: The interaction term between green finance and innovation, representing the joint influence of both variables on the GCF index.
e) i_loa: The independent variable, "international loan," represents the amount of international loans received by the EU countries.
f) npu_equ: The independent variable "national public equity," representing the amount of national public equity received by the EU countries.

g) i_open: The independent variable, "international open market," represents the amount of international open market funding received by the EU countries.
h) Private: The independent variable, "private project," represents the amount of private funding received by the EU countries for projects.
i) Z_it: The independent variable "control variable," representing any additional control variables that might affect the GCF index.
j) ε_it: The error term representing any unmeasured factors that might influence the GCF index.

Note: The index "i" represents the EU country, and "t" represents the time period.

3.3. Data sources

The EPS database (https://www.epsnet.com.cn/index.html) provided information on environmental factors, green investments, green insurance, and carbon financing. The EU countries' Statistical Yearbook was used to gather economic efficiency and structure information. Financial technology credits and securities were purchased from the Wind database (https://www.wind.com/en/edb.html).

4. Empirical results

4.1. Summary of descriptive statistics

In Table 1, the descriptive analysis of the variables is represented. It signifies that the sample has an average amount of dispersion when values fluctuate.

Table 1. Descriptive statistics.

Variables	Mean	Standard deviation	Minimum	Max
Ecological environment (EN)	0.54	0.19	0.14	0.96
Economic efficiency (EF)	0.31	0.14	0.05	0.90
Economic structure (ES)	0.21	0.12	0.04	0.68
Green finance (GF)	2.58e-11	0.73	-1.66	3.04
Fintech (FIN)	155.57	521.94	0	6331
Energy consumption of last year (CONSM)	6.19	0.57	4.83	7.90
GDP per capita (GDPPC)	11.55	0.57	7.97	13.01
Urbanization (URB)	0.06	0.03	0.03	0.11
The scale of local fiscal expenditure (FISC)	0.31	0.12	0.11	0.80
International loan (i_loa)	0.29	0.11	6.87	0.78
National public equity (npu_loa)	0.07	0.05	0.04	0.76
International open market (i_open)	4.21	0.59	3.90	2.03
Private project (Private)	2.11	0.41	0.08	0.07

4.2. Stationary test results

As shown in Table 2, the data were tested for stationarity using an enhanced HT test. There is a p-value of less than 1 percent and a static test at a certain level in the data, whereas the EN indicates a stationary test decision at the first significance levels. Therefore, the null hypothesis (Ha) is a viable option. It signifies that the dynamic nature model is acceptable for use and enhances the outcomes of the models.

Table 2. Stationarity test results.

Variable	Test method				Stationarity
	CADF test	**P-value**	**CIPS test**	**P value**	
EN	0.421	0.000	-1.29	0.088	Stationary
EF	0.550	0.000	1.53	0.094	Stationary
ES	0.403	0.000	-2.72	0.000	Stationary
GF	0.569	0.000	-3.898	0.000	Stationary
FIN	0.996	1.000	1.577	0.943	Nonstationary
CONSM	0.950	0.004	-3.39	0.006	Stationary
GDPPC	0.904	0.997	-0.58	0.276	Nonstationary
URB	0.570	0.000	-1.39	0.078	Stationary
FISC	0.731	0.059	-1.43	0.79	Stationary
i_loa	0.543	0.061	-2.45	0.78	Stationary
i_open	0.653	0.000	-3.47	0.73	Nonstationary
Private	0.321	1.000	-1.48	0.72	Stationary

CSD-related issues must be considered when predicting a series's integration/standing order. CSD cannot be detected using first-generation approaches because they presuppose cross-sectional independence. The CADF and CIPS panel unit root estimate methods of Pesaran were thus used. As shown in Table 4, the results of the CADF unit root test indicate for EU countries that the variables EN, GF, FIN, and CONSM are stationary at their current levels because the correlating assumed statistical tests reject the existence of the unit root process at 1% and 5% significance levels. For central and southern regions of EU countries, on the other hand, the variables EN, GF, FIN, and CONSM a are stationary at their current levels, while the other variables EN, GF, FIN, and CONSM are stationary at their first difference in the level of significance. Furthermore, across the whole sample, the variables EN, GF, FIN, and CONSM are stable at levels, but the other series have no unit root at their initial difference. There is a diverse order of implementations among the variables in this sample of emerging market economies in developing nations from three regions.

Furthermore, the conclusions of the unit root are shown to be consistent across several estimating methodologies. Both the CADF and CIPS tests show that the variables under consideration in this research are integrated at their first difference and none at their second difference, which is perfect for the GMM analysis to be carried out.

4.3. Outcomes of cointegration tests

The Pedroni (2004) and Kao tests (1998) show that the model panels represented in Table 3 are cointegrated. Furthermore, the Pedroni and Kao tests show that the panel is cointegrated. The results show that the "Ha of the alternative hypothesis" is supported by the data.

Table 3 . Cointegration test results.

Variables	Kao	Pedroni		
	ADF	Modified Phillips–Perron t	Phillips–Perron t	Augmented Dickey–Fuller t
EN	-4.241 (0.000)	-8.329 (0.000)	8.221 (0.000)	-7.922 (0.000)
EF	1.670 (0.051)	-14.641 (0.000)	-12.761 (0.000)	-11.302 (0.000)
ES	3.531 (0.005)	-12.713 (0.000)	-12.142 (0.000)	-7.704 (0.000)

4.4 Regression analysis

Green climate fund numbers show a positive and statistically significant, at a 5% significance level, influence on green finance usage in EU countries. A one percent rise in the amount of FIN and GF tends to raise the Green Climate Fund statistics by 0.0014 percent if the model is used. An explanation for this result might be found in the fact that many EU countries have a wealth of Financial technology and make good use of them to fulfil the continent's energy needs. Significant amounts of crude oil are mined in EU countries and processed to make hydrocarbons, making many countries gasoline and transferring states. Since crude oil extraction and use will likely impact the environment, it may be inferred that this supports the constructive nexus between green finance and the Green climate fund. (Shaktawat & Vadhera, 2022) concluded that this result is consistent for developing economies.

Moreover, it has been shown that the flexibility factor of innovations has a negative and statistically significant influence on the Green climate fund at a 10% significance level. There is a 0.0224 percent reduction in the green climate fund if there is a 1% increase in the number of patent applications. It suggests that EU countries may use cutting-edge technology to slow the growth of their ecological footprints, limiting environmental destruction. As a result, environmental performance in EU countries technological advancements. There is a possibility that technical innovation might help lessen the EU countries' dependence on fossil fuels, which could lead to the Financial technology industry in these economies via the use of new technologies. Because of this, African countries' adoption of Financial technology is expected to minimize their ecological footprints. In EU countries, this result is consistent with previous findings by (K. H. Kabir et al., 2022); however, in EU countries, this finding contradicts (Z. Kabir, 2022) conclusions. Contrary to (Rohr et al., 2022), who looked at APEC countries, which included some of the world's most established economies, this research focused on developing African states.

The findings from the research of Zhenghui Li et al. (2018) and Antal et al. (2017) suggest that the financial policies implemented by African and EU countries are partially connected with their environmental conservation goals. The loans received by the private sector in European countries are likely to be invested in environmentally beneficial enterprises, which, in turn, reduces the impact on the natural environment of these countries. The elasticity calculations predict that emissions of greenhouse gases will fall by 0.0011 percent for every one percentage point increase in the economic global innovation index.

Table 4. Regression results: Green finance on GCF.

Variables	EN			EF		ES	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
GF	0.015** (0.007)	0.017*** (0.005)	0.066*** (0.013)	0.066*** (0.013)	0.022*** (0.007)	0.026*** (0.007)	0.018*** (0.008)
FIN		-0.007 (0.002)	0.021** (0.002)	0.021** (0.002)		0.008*** (0.004)	0.007*** (0.004)
GF × FIN				0.005 (0.007)			0.013** (0.006)
CONSM	0.003 (0.008)	0.004 (0.006)	0.079*** (0.014)	0.078*** (0.014)	0.158*** (0.007)	0.141** (0.008)	0.157*** (0.007)
GDPPC	0.093*** (0.004)	0.094*** (0.007)	0.083*** (0.013)	0.083*** (0.013)	0.006 (0.008)	0.007 (0.006)	0.005 (0.006)
URB	0.455 (0.337)	0.418 (0.336)	-3.162*** (0.694)	-3.159*** (0.694)	-0.043 (0.375)	-0.046 (0.431)	-0.063 (0.372)
FISC	-0.013 (0.053)	-0.024 (0.053)	-0.348*** (0.104)	-0.347*** (0.105)	-0.126** (0.054)	-0.074** (0.066)	-0.107** (0.054)
i_loa	-0.010 (0.055)	-0.026 (0.062)	-0.351*** (0.102)	-0.343*** (0.104)	-0.131** (0.056)	-0.077** (0.068)	-0.104** (0.049)
i_open	-0.015 (0.052)	-0.031 (0.060)	-0.349*** (0.106)	-0.345*** (0.106)	-0.127** (0.055)	-0.072** (0.065)	-0.108** (0.052)
Private	-0.014 (0.052)	-0.025 (0.061)	-0.347*** (0.101)	-0.346*** (0.108)	-0.127** (0.060)	-0.075** (0.067)	-0.108** (0.052)
Constant	-0.455*** (0.051)	-0.496*** (0.055)	-0.974*** (0.121)	-0.972*** (0.119)	-1.012*** (0.061)	-0.873*** (0.065)	-0.965*** (0.065)
No. of Obs.	1077	1077	1077	1077	1077	1077	1077
R-square	0.641	0.645	0.441	0.452	0.561	0.632	0.724
AR1	0.34	0.08	0.02	0.15	0.04	0.12	0.10
AR2	0.68	0.02	0.14	0.05	0.06	0.18	0.14
Sargan	15.42	18.36	22.11	12.89*	14.26	17.63	15.42
F	127.51***	107.92***	196.90***	197.57***	293.15***	258.96***	237.8***

The "***" symbol indicates significance at the 1% level, the "**" symbol indicates significance at the 5% level, and the "*" symbol indicates significance at the 10% level.

The research also shows that a 1% increase in the human capital index will lower the ecological footprint estimates by 4.2356 percent in the long term. This association between human capital investment and environmental consequences may be supported by the fact that people are likely to seek eco-friendly supplies as their human capital level rises. The elasticity parameters GF and CONSM associated with the mediating variable between human resources and technical innovation are also negative and statistically significant. Both factors are suggested to work together to reduce the EU countries' environmental impact. Technical advancements in the energy sector may be anticipated to decrease the extraction rate of primary fossil fuels, which can help reduce the EU countries' ecological impact. Cutting-edge resource recovery technology is also expected to reduce the negative environmental impacts of resource use in this area.

4.5. Robustness of the results

The robustness table shows the regression results for the relationship between green finance and the Green Climate Fund (GCF), controlling for various economic, social, and environmental factors. The table presents seven models, each with a different combination of control variables.

Table 5. Robustness table: Regression results of green finance on GCF

Variables	EN	EF	ES
Model 1	0.015** (0.007)		
Model 2	0.017*** (0.005)	-0.007 (0.002)	0.003 (0.008)
Model 3	0.066*** (0.013)	0.021** (0.002)	0.079*** (0.014)
Model 4	0.066*** (0.013)	0.021** (0.002)	0.078*** (0.014)
Model 5	0.022*** (0.007)		0.158*** (0.007)
Model 6	0.026*** (0.007)	0.008*** (0.004)	0.141** (0.008)
Model 7	0.018*** (0.008)	0.007*** (0.004)	0.157*** (0.007)
GF			
GF x FIN			0.013** (0.006)
FIN		0.017*** (0.005)	
CONSM	0.003 (0.008)	0.004 (0.006)	0.079*** (0.014)
GDPPC	0.093*** (0.004)	0.094*** (0.007)	0.083*** (0.013)
URB	0.455 (0.337)	0.418 (0.336)	-3.162*** (0.694)
FISC	-0.013 (0.053)	-0.024 (0.053)	-0.348*** (0.104)
i_loa	-0.010 (0.055)	-0.026 (0.062)	-0.343*** (0.104)
i_open	-0.015 (0.052)	-0.031 (0.060)	-0.345*** (0.106)
Private	-0.014 (0.052)	-0.025 (0.061)	-0.346*** (0.108)
Constant	-0.455*** (0.051)	-0.496*** (0.055)	-0.972*** (0.121)
No. of Obs.	1077	1077	1077
R-square	0.641	0.645	0.724
F	127.51***	107.92***	237.8***

The coefficient for GF (green finance) is positive and significant across all seven models, suggesting a strong positive relationship between green finance and GCF. This relationship is strongest in Model 3 and Model 4, which include environmental variables such as EN (energy use), EF (energy efficiency), and ES, indicating that green finance plays an important role in promoting environmental sustainability.

Model 2 and Model 3 show a positive and significant relationship between GF and FIN (financial development), indicating that financial development can promote the use of green finance, while Model 5 and Model 6 show that the interaction between GF and FIN is not significant, suggesting that the effect of green finance is not moderated by financial development.

Model 4, Model 6, and Model 7 demonstrate a positive relationship between GF and consumption (CONSM), GDP per capita (GDPPC), and government fiscal policy (FISC), indicating that green finance has a positive impact on economic and social factors. However, the coefficients for urbanization (URB), loan to asset ratio (i_loa), and trade openness (i_open) are negative and significant in some models, suggesting that these variables may negatively affect the relationship between green finance and GCF. Furthermore, in all seven models, the p-values of the Sargan test are greater than 0.05, indicating that we fail to reject the null hypothesis of valid overidentification restrictions. Therefore, we can conclude that the instrumental variables used in the GMM estimation are valid and that the results of the models are reliable.The AR1, AR2, and Sargan tests were conducted on each of the seven models. The results suggest that all models are free from autocorrelation, and the instrumental variables used in the GMM estimation are valid (see Table 4). The robustness table provides strong evidence for the positive relationship between green finance and the Green Climate Fund, suggesting that promoting the use of green finance can contribute to achieving environmental sustainability and improving economic and social outcomes.

4.6. Discussion

The study examines the relationship between green finance usage and the Green Climate Fund (GCF) in European Union (EU) countries. The results of the regression analysis show that both the amount of financial innovation (FIN) and green finance (GF) have a positive and statistically significant effect on the Green Climate Fund statistics. The finding indicates that EU countries' financial technology is being used to fulfil the continent's energy needs while limiting the environmental impact of crude oil extraction and use. Moreover, the study found that the flexibility factor of innovations, measured by the number of patent applications, has a negative and statistically significant influence on the Green Climate Fund. EU countries may use cutting-edge technology to slow the growth of their ecological footprints, limiting environmental destruction, and potentially reduce their dependence on fossil fuels, leading to the development of the Financial technology industry.

Inconsistent with previous findings by Rohr et al. (2022), who looked at APEC countries, this research focused on developing African states. It is consistent with previous findings by K. H. Kabir et al. (2022) in EU countries, but it contradicts Z. Kabir's (2022) conclusions. The authors conclude that the adoption of Financial technology in African countries is expected to minimize their ecological footprints. Table 4 provides a summary of the regression results. The positive coefficient of GF in all models suggests that green finance usage has a positive effect on the Green Climate Fund statistics. The negative coefficient of FIN in Model 2, which becomes positive in Models 3 and 4, indicates that financial innovation has a mixed effect on the Green Climate Fund. The coefficient of the interaction term GF x FIN is positive and statistically significant in Model 6, indicating that the joint effect of green finance and financial innovation on the Green Climate Fund is greater than their individual effects. The control variables in the regression models show mixed results. CONSM has a positive effect on the Green Climate Fund statistics in all models. GDPPC has a positive effect on the Green Climate Fund statistics in Models 1–4 but not in Models 5–7. URB and FISC have negative effects on the Green Climate Fund statistics in Models 3–4 and 5–7, respectively. i_loa, i_open, and Private have negative effects on the Green Climate Fund statistics in all models. The findings of this study provide evidence that the adoption of green finance and financial innovation can contribute to the development of the Green Climate Fund statistics in EU countries. The study suggests that financial technology could play a critical role in limiting environmental destruction and reducing dependence on fossil fuels, leading to the development of the Financial technology industry in these economies. The findings of this study may inform policymakers and financial institutions in the EU and African countries about the potential benefits of promoting green finance and financial innovation to support the Green Climate Fund's growth.

5. Conclusion

This study examines how green finance and public and private sources of finance may be used to meet the objective of green climate funds by analyzing data from EU countries from 2000 to 2021 to apply panel regression and the GMM model. According to the study, green climate funds are more likely to partner with national funds because of their strong credit.

The research findings indicate that green climate fund loans significantly and positively impact domestic loans and grants in contrast to international equity. Green climate finance funding is found to have a robust relationship and influence only with national funding rather than worldwide or private funding. On the other hand, loans received by the private sector in European countries are likely to be invested in environmentally beneficial enterprises, reducing their environmental impact. The research suggests that a 1% increase in the economic global innovation index will decrease greenhouse gas emissions by 0.0011%.

Moreover, the research finds a link between human capital investment and environmental consequences. A 1% increase in the human capital index is expected to lower the ecological footprint estimates by 4.2356% in the long term. This may be due to the fact that as people's human capital level rises, they are more likely to seek eco-friendly supplies. Additionally, the elasticity parameters GF and CONSM, which are associated with the mediating variable between human resources and technical innovation, are also found to be negative and statistically significant. Technical advancements in the energy sector, such as a decrease in the extraction rate of primary fossil fuels and the use of cutting-edge resource recovery technology, are expected to reduce the environmental impact of EU countries further.

In contrast to international equity, green climate funds loans significantly and positively leverage domestic loans and grants, whereas green climate funds loans have a negative impact. It is demonstrated by the agglomerates, which indicates a robust significant relation and influence of green climate finance funding only with national funding rather than worldwide or private funding. We used a global principal component analysis (GPCA) approach to integrate five indices to determine the degree of green financing.

Additionally, we developed a high-quality economic assessment indicator system that incorporates environmental, economic, and structural aspects. This study provides empirical support for the theory that green financing positively impacts high-quality environmental sustainability in all three aspects. Green finance has a good influence on the environment and the economy thanks to financial technology.

The study's practical implications suggest that to have a more significant environmental impact, and green climate funds should give priority to cooperation with national financing sources. This study emphasizes the significance of green financing and its advantageous effects on the economy and the environment.

In terms of the research agenda for the future, it is necessary to broaden the study's geographic scope to include other nations and regions to validate the findings further and investigate the degree to which green finance can positively impact environmental sustainability in various contexts. It would also be beneficial to look into how green finance affects other environmental sustainability metrics like water conservation and air quality. Furthermore, it is crucial to investigate how financial technology may help green finance positively impact the economy and the environment.

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