Is climate change influencing banks to promote green financing? The case of bank performance in Bangladesh

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Abstract

This study investigates the relationship between green finance and bank performance in the context of Bangladesh. It also aims to examine whether climate change influences banks to promote green financing. Firstly, employing time series data of 2015-2021, this study examines whether climate change influences banks to promote green financing activities. Secondly, analyzing panel data from 22 banks spanning the years 2015 to 2021, this research investigates the impact of green finance on the financial performance of banks utilizing the dynamic panel generalized method of moments technique. Findings indicate that climate change has significant positive influence on green financing activities. Also, robust findings show that there is significant negative correlation between green financing and bank performance. Findings are useful in urging regulators, and policymakers in formulating conducive policies for green financing. The study also contributes to the empirical literature by corroborating or contradicting earlier findings.

Keywords: Green finance, Climate change, Corporate performance, Panel data, Bangladesh

JEL Classification: Q54; E44; G21

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First received, May 27, 2024; Revision received, July 16, 2024; Accepted, August 07, 2024

1 Introduction

Climate change is a very serious threat and a burning topic, and its consequences impact many aspects of our lives. One of the main consequences is threats to businesses such as affecting Agriculture and Forestry, Energy, Insurance, and crosscutting issues for business. The effects of climate change are one of the most urgent issues confronting developed and developing nations. In addition to being highly vulnerable to climate change's effects, most developing countries are also in a transitional period of economic and social development, which makes them greatly reliant on climate finance to sustain their climate safety and alleviation plans. For the economies of developing nations, green financing in the form of an efficient green economy is a crucial alternative and path forward.

South Asian countries, including Bangladesh, have recognized the need for regional collaboration to address shared climate challenges. Initiatives such as the South Asian Association for Regional Cooperation (SAARC) provide a platform for cooperation and knowledge-sharing. Given the interconnected nature of climate impacts, countries in South Asia are increasingly working together to develop joint strategies for adaptation, disaster preparedness, and sustainable development. Having said that, Bangladesh actively participates in global climate negotiations and agreements, advocating for the interests of vulnerable nations. The country's experiences contribute to the global discourse on climate justice and the need for developed countries to support developing nations in their climate resilience efforts.

In Bangladesh, climate change is a serious matter that needs immediate action. Bangladesh is one of the developing nations most susceptible to the effects of climate change and natural disasters, despite being one of the world's least polluting nations. According to Germanwatch's 2021 Global Climate Risk Index (CRI) report, for climate change Bangladesh is the seventh most at-risk nation among all countries and the top most at-risk nation among South Asian countries, despite producing only 0.56 percent of global emissions that are impacting our climate. This is a real and present risk. Between 2000 and 2019, climate change caused 185 extreme weather events and $3.72 billion in economic damages in Bangladesh (Eckstein et al., 2021). Bangladesh's extraordinary economic success is attributable to its

long-standing and consistent investments in climate resilience and disaster preparedness. The nation has achieved global recognition as a leader in disaster preparedness and climate change adaptation; since 1970, cyclone-related fatalities have been reduced by half. Nonetheless, the nation remains confronted with grave and escalating climate-related hazards.

Green finance is a relatively new concept in investment financing. Without a doubt, the Intergovernmental Panel on Climate Change established in its 2007 report the connection between human activity and global warming. A group of Swedish pension funds reassessed their capital allocation in response to the disclosure, considering the escalating incidence of natural calamities. Regarding possible alternatives, they initiated communication with their bank, Sandinaviska Enskilda Banken AB. SEB sought to mitigate investment risks and generate a positive influence by establishing a financial partnership with the World Bank, an organization renowned for its extensive global experience in financing environmental initiatives. The inaugural green bond was issued by the World Bank in 2008, establishing the foundation for ethical investment practices within the capital market. It is now possible to raise funds in support of each of the seventeen Sustainable Development Goals by utilizing the green bond model. The World Bank was capable of providing funding for environmental initiatives, issuing bonds of the highest quality, and reporting on the results of its programs.

The progress of green financing is extremely critical for a country like Bangladesh often ravaged by natural disasters by the impact of climate change. The important purpose of this research is to explore the impacts of green finance on bank performance in Bangladesh. Bangladesh Bank, the country's central bank, initiated a comprehensive program in 2011 to promote and endorse environmentally friendly financing. Banks in Bangladesh are expanding their green financing options to finance green initiatives such as wind and solar farms and green business investments.

Taking into account all of these environmental concerns, we choose to concentrate on how green finance affects Bangladeshi banks' operations and the laws, rules, and incentives that the nation has in place to encourage ecologically responsible and sustainable financial activities. To promote the adoption of environmentally friendly practices in the banking industry and establish a framework that allows for the evaluation of the effects of green financing on banks' performance, the government has started several projects and programs. The world community is interested in Bangladesh's

experience with green financing, particularly if it may be used as a model for other developing countries with comparable environmental issues.

Despite the importance of green finance, the relationship between green finance and financial institutions' performance has received less attention in prior research. This study aims to assist in bridging this divide by empirically investigating the relationship between green finance and the financial performance of banks. This research facilitates the incorporation of green financial policies into operational solutions for financial institutions' sustainability. The research findings can be used to educate policymakers in Bangladesh on the difficulties associated with the innovation and implementation of green finance practices. By adding to the existing literature on green finance and corporate performance, this study may make it easier for academics and business professionals to implement results regarding the effects of green finance on the performance of banks.

This research examines the paradoxical connection between green finance investment and the profitability of banks operating in Bangladesh, and is expected to enrich to what is extant in the literature. First, it may be one of the early works to align climate change, green finance and banks' performances in Bangladesh. It analyzes the development of green banking practices in Bangladesh and investigates how climate change influences banks to undertake green finance projects and the impact of green finance on the bank's performance. Second, the findings will supplement the literatures on green finance and corporate performance, which will help scholars and policy makers. Third, the findings of the research contribute to the green finance policies as an operational solution for corporate sustainability. Overall, the analysis provides useful insights for the academics and formulation of banking regulation and other policies.

2 Literature Review and Hypotheses

2.1 Climate change and green financing of banks

In Bangladesh, the probability and intensity of climatic occurrences are varied due to climate change, which is turning into a more pressing problem day by day. The Germanwatch-developed index known as "Global Climate

Risk Index," commonly known as CRI (Climate Risk Index), analyses quantified impacts of extreme weather events, in terms of fatalities and impact of extreme weather events. The index is based on the data from the Munich Re NatCatSERVICE, which is considered worldwide as one of the most reliable and complete databases on this matter. It measures the effects of climate change and its associated vulnerability, concentrating solely on extreme weather events like storms, floods, and heat waves. Climate risk has a moderating impact and a threshold effect on the green finance and energy transaction nexus, according to a study by Lee et al. (2024), suggesting that it has a negative role in facilitating the energy revolution. But, according to (Liu et al. 2024) risks related to climate change significantly mitigate the unfavorable correlation between GF and energy poverty. The greater a nation's green financing, the higher its score on climate risk. So, (Alharbi et al. 2023) found the effect of green finance on renewable energy is more potent in countries with a higher level of climate risk index.

H1: Climate change influences green financing of banks

2.2 Background of Green Finance and Bank Performance

Financial Institutions (FI) are Depository Institutions (DI) like Banks, Credit Unions, and Non-DI like Insurance and Leasing companies, and are considered the lifeline of economic activity as they provide specialized financial services that help to make the overall economy more resourceful. Green financing is a new sector of financing to mitigate the impacts of climate change. As a result, financial institutions are making efforts to combat environmental degradation and climate change by investing more in green technologies and changing their financial flow away from emission-intensive industries and toward environmentally friendly ones. Climate change is already a reality and has thorough financial and non-financial repercussions. Due to the newness of green financing in Bangladesh, the economic sector needs to undertake programs and policies to combat climate change risk and mitigate the impact of adverse climate events. Accordingly, policymakers across the globe are formulating conducive policies in sponsoring the? drive towards a sustainable global economy. The positive impact of green finance can be explained by two distinct theories: the competitive strategy theory, and the environmental risk management

theory.

2.2.1 Competitive strategy theory

The theory of competitive strategy suggests that commercial banks can benefit from green economic growth by adopting green finance strategies, such as expanding into new revenue growth areas and obtaining a competitive advantage. Green finance can help institutions increase their presence in growing economic sectors and expand their operations. According to Russo and Fouts (1997), environmental social responsibility programs can provide a competitive advantage to businesses. Green financing provides a competitive advantage to commercial institutions. There is currently a great deal of competition in the banking industry, and green finance is still a relatively novel business model that has not yet caught on. Therefore, commercial banks actively engaged in green financing can leverage their position as industry leaders to increase green loan revenue, brand recognition, and access to favorable resources for green initiatives and boost green earnings.

2.2.2 Environmental risk management theory

By applying the principles of environmental risk management, green financing enables commercial institutions to reduce costs and manage environmental risks. Financial institutions are at risk due to the legal and societal ramifications of environmental problems (Aintablian et al., 2007). Credit risk is the first of the three principal types of environmental risks. Poor environmental protection performance can result in significant financial and legal penalties, such as fines, suspensions, and even closure orders, all of which can have detrimental effects on a company. Guarantee risk is the second category of environmental risk. If land used as collateral for financing is contaminated with hazardous chemicals, its value may decrease, reducing the banks' ability to collect funds from the sale of the collateral of insolvent businesses and increasing the banks' losses. The third form of liability risk is joint and several. If financial institutions lend money to polluting businesses, they could be held jointly and vicariously liable for any environmental damage that results. Therefore, the establishment of a green loan company by financial institutions may assist in mitigating their

conservational risk. To mitigate their environmental risk, however, financial institutions must conduct a comprehensive review in advance of loan disbursement and continue to closely monitor enterprises' environmental information after loan disbursement.

2.2.3 Previous empirical studies

Researchers noticed a positive relationship between green financing and enterprise performance (Al Mamun and Rana, 2020; Xu et al., 2020) and discussed the moderating effects of business type and geographic location on this relationship. According to Du et al. (2022), green finance encourages innovation and expansion in environmentally conscious businesses. According to Yin et al. (2021), green credit ratio (GCR) has positive effects on profitability. Analyzing data of banks operating in BRIC, Mirza et al. (2023) observed a significant positive association between green SME lending and bank performance, measured by net interest margin. The proportion of green loans has also been found to have a momentous affirmative effect on financial performance (Lian et al., 2022; Xi et al., 2022; Zhang et al., 2022). Al-Qudah et al. (2023), using data of 23 UAE institutions from 2015 to 2020, discovered that green finance is negatively associated with the non-performing loan (NPL) ratio. Hsiao and Wang (2022) analyzed data of 2011-2020 to observe whether there was a correlation between operational risk and financial performance in the green banking sector. Authors found that a higher debt ratio enhanced ROA but had no effect on ROE. Xiliang et al. (2023) surveyed 290 steel employees in China. Using structural equation modeling, researchers found that CSR, green finance, and ICT had a considerable positive impact on the financial performance of China's steel industry. According to He and Liu (2023), obtaining debt financing for eco-friendly businesses is facilitated. The authors did so by analyzing Chinese eco-friendly business data from 2007 to 2020. In the context of Bangladesh, Julia and Kassim (2016) found substantial positive correlations between banks' financial performance, measured by ROA, and their green financing activities. However, when using ROE, they found no such correlations.

Contrary to the positive impacts, some researchers found negative impacts of green financing practices on corporate performance. For instance, Yin (2021) discovered that green loans negatively impacted the short-term profitability of commercial banks. Small and medium-sized commercial

institutions are impacted significantly more severely than their larger counterparts. Analyzing data of 14 Indonesian banks from 2012 through 2018, Karyani and Obrien (2020) found significant negative impacts of green banking practices on bank's profitability. Wanting (2020) investigated the effects of green credit on the financial performance of Chinese banks. Inspecting panel 2012-2018 data of 15 commercial banks, the author observed that green credit has an immediate negative effect on bank performance. A similar study conducted by Galan and Tan (2022) found that green credit has significant negative impacts on bank performance.

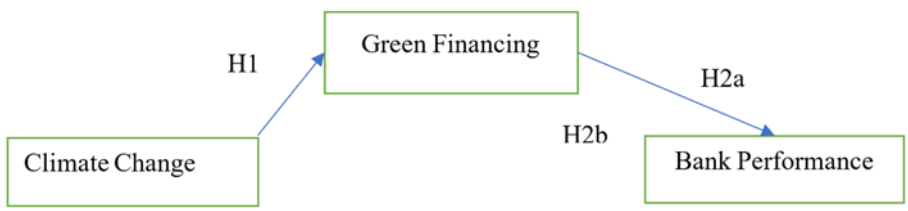
The literature review reveals differing evidence linking green financing with business success. The effects of green finance on the long-term viability of enterprises are mixed, with some studies finding positive effects and others finding negative ones; which creates an avenue for researchers to establish a relationship between green finance and bank performance. In addition, due to the novelty of green financing in Bangladesh, there is a dearth of empirical research examining its effect on business performance. Using panel data from banks functioning in Bangladesh, this study attempts to address these gaps. Thus, the following hypotheses are developed and tested.

H2a: Green finance influences ROE
H2b: Green finance influences ROA

2.2.4 Conceptual model and hypotheses

Figure 1. exhibits the conceptual model and hypotheses of this study.

Figure 1. Conceptual model



3 Materials and Methods

3.1 Sample and data sources

Using available data, we concentrate on whether banks' green funding is impacted by climate change. Based on the climate risk index, Bangladesh is the country most vulnerable to climate change. As a stand-in for climate change, we used the Germanwatch Institute's climate risk index (CRI) score as an independent variable. Based on the data on green finance, available from the central bank's sustainability report, a time series analysis covering the years 2015–2021 is carried out. The study is supported by some control variables, including Broad Money (BM), Population Growth (PM), and Outward Foreign Direct Investment (FDIO). For each of these control variables, yearly data is provided by World Development Indicators. For model 2, panel data were collected from 22 individual websites of different commercial banks in Bangladesh that were operational between 2015 and 2021. Due to a multitude of reasons and difficulties unique to Bangladesh's financial and environmental scenario, the sample size of banks participating in green finance is quite small. There aren't always many banks in Bangladesh that are actively involved in green financing initiatives. This is possible because the country's green financing industry is still in its nascent stage. Many banks are still slow to adopt sustainable finance strategies. Besides, due to worries about project feasibility, a smaller market, economic constraints, regulatory uncertainty, and perceived higher risks, banks may be apprehensive about investing in ecologically sustainable initiatives, which reduces the pool of prospective samples. A list of sample banks is provided in Table 1. Return on equity (ROE) and return on assets (ROA) are the dependent variables that are used to evaluate the financial efficiency of banks. The majority of interest is fueled by green financing (GF). The study controls for a variety of variables, such as the total turnover ratio (TTR), financial leverage (FR), bank size (SZ), equity to total assets (ETA), growth ability (GA), and capital adequacy ratio (CAR). The sample banks' annual audited reports include data for all variables.

Table 1. List of banks, establishment year, and their green finance

Sl No.	Name of Banks	Year of Establishment	Green Finance (2015-2021) Million US $	Green Finance/ Total loans (%)	Net profit/ Green Finance (%)
(1)	(2)	(3)	(4)	(5)	(6)
1	Janata Bank PLC.	1972	318.4826	0.95	40.22
2	Sonali Bank PLC.	1972	15.76764	0.11	504.24
3	Agrani Bank PLC.	1972	144.6475	0.55	24.36
4	BRAC Bank PLC.	2001	759.244	5.01	40.43
5	Eastern Bank PLC.	1992	1018.927	7.78	21.16
6	IFIC Bank PLC.	1976	414.9838	3.09	24.08
7	Islami Bank Bangladesh PLC.	1983	4261.062	7.31	7.16
8	Standard Bank PLC.	1999	252.074	2.81	31.64
9	Shahjalal Islami Bank PLC.	2001	23.38708	0.21	467.28
10	National Bank PLC.	1983	238.488	1.18	101.86
11	Jamuna Bank PLC.	2001	80.85348	0.77	194.01
12	Bank Asia PLC.	1999	41.75906	0.31	337.85
13	Al-Arafa Islami Bank PLC.	1995	1353.154	8.11	12.79
14	Uttara Bank PLC.	1972	79.51067	1.34	1974.13
15	UCB Bank PLC.	1983	47.4376	0.25	397.19
16	City Bank PLC.	1983	94.07214	0.65	241.61
17	Dhaka Bank PLC.	1995	248.6621	2.23	42.41
18	Midland Bank PLC.	2013	18.56911	0.95	210.17
19	NRBC Bank PLC.	2013	103.7526	2.83	70.67
20	Modhumoti Bank PLC.	2013	32.13179	1.60	189.07
21	Dutch Bangla Bank PLC.	1995	2315.927	15.40	10.81
22	Pubali Bank PLC.	1983	410.2683	2.36	38.82

Note: Sl. No. 1, 2 & 3 are State Owned Commercial Banks, and 4 to 22 are Private Banks

According to Bangladesh Bank (BB) policy guidelines, all banks and non-bank financial institutions (NBFIs) are required to disburse funded loans greater than or equal to 5% of total loans in green finance. As provided in column 5 of Table 1, Brac Bank PLC., Eastern Bank PLC., Islami Bank PLC., AL-Arafa Islami Bank PLC., and Dutch Bangla Bank PLC. are a few banks contributing green finance above 5% of total loans. The other banks were left behind to fulfill the required guidelines because longer payback times and significant initial expenses are factors that make green projects less appealing to lenders and borrowers in the short term. Besides, regulations and incentives may not be effective in enticing banks and borrowers to use green financing, therefore banks may not actively promote these possibilities. On the other side, column 6 of Table 1, shows the percentage of net profit

banks are experiencing through green finance. A greater ratio indicates that the corporation is making more profit relative to its green funding, which can be seen as a sign of efficiency and profitability in its sustainability initiatives. A lower percentage, on the other hand, may suggest that the company is not making large revenues from its green activities or is investing extensively in sustainability without immediate reward. Only a few banks earn profits more than the amount invested in green finance; the rest of the banks are inefficient in generating immediate returns when compared to others due to huge investments in greenery. So, Green finance, according to this scenario, shows a detrimental impact on bank profitability.

3.2 Empirical model

This study relates to the issues of climate change that is drawing the attention of scholars. That is, how much of an influence does climate change have on green financing in the banking sector and does it eventually have a bearing on banks' performance. Specifically, this study's objectives are as follows:

i) Investigate whether and how climate change influences green financing activities

ii) Investigate how green finance affects the performance of financial institutions. To achieve the objectives, we employ the following empirical models:

Model-1: To attain the first objective, we adopt an empirical time series model similar to the works of (Tran, 2022; Guo et al., 2022).

$$GF_t = \alpha + \theta_1 CRI_t + \theta_2 FDIO_t + \theta_3 PM_t + \theta_4 BM_t + \mu_t \quad (1)$$

Where α is constant, $\boldsymbol{\theta_1}$= the coefficient of climate risk index (CRI), $\boldsymbol{\theta_2}$= The coefficient of outward foreign direct investment (FDIO), $\boldsymbol{\theta_3}$ = the coefficient of population growth (PM), $\boldsymbol{\theta_4}$= the coefficient of broad money (BM), $\boldsymbol{u}$= error terms, **t**= time.

Model -2: To achieve the 2nd objective, Grounded on the research of (Du et al., 2022; Xi et al., 2022): we adopt the following model:

$$BP_{it} = \alpha_0 + \beta_i GF_{it} + \lambda_{it} CON_{it} + \varepsilon_{it} \quad (2)$$

In model 2, BP_{it} represents the bank i outcomes for year t (explained variables). Return on equity (ROE) and return on assets (ROA) are used as proxies to evaluate BP. Principal explanatory variable (also known as "green finance" or GF_{it}) is the quantity of money Bank i invested in environmentally friendly initiatives during time period t. CON_{it} is the time-t variable control matrices for the i^{th} bank. The disturbance error term, ε_{it} has a constant variance and a mean of 0. In Table 2, we list the variables, their respective measures, and the consulted data sources.

Table 2. Sources of data, measurements, and variables

Model Number	Variables	Legend	Measurements	Sources of data
	Dependent Variables:			
Model 1	Green finance	GF	The logarithm of the total amount invested in green projects	Annual report
Model 2	Return on equity	ROE	ROE is calculated by dividing pretax profit by equity	Annual report (2015-2021) published in website of each bank
	Return on assets	ROA	ROA is calculated by dividing net profit by total assets	
	Independent variables:			
Model 1	Climate Change	CRI	Climate Risk Index Score: A country's level of exposure and vulnerability to extreme climate events	Germanwatch institute
	Outward foreign direct investment	FDIO	The total amount of cross-border direct investment in a year percentage of GDP	World Development Indicators
	Population Growth	PG	Annual population growth rate	World Development Indicators
	Broad Money	BM	The sum of money supply in an economy, percentage of GDP	World Development Indicators
Model 2	Green finance	GF	The logarithm of the total amount invested in green projects	Annual report (2015-2021) published in website of each bank
	Size	SZ	Log of total assets of banks	
	Financial Leverage	FL	Share of total liabilities to total assets	
	Total turnover ratio	TTR	Total revenue / total asset	
	Shareholders' equity to total assets	ETA	The ratio of Shareholders' equity to total assets	
	Growth Ability	GA	Revenues current year/revenues last year	
	Capital Adequacy Ratio	CAR	A bank's core capital / the bank's risk-weighted assets	

3.3 Variables' Selection

Model-1:

Dependent Variable

This research first endeavors to examine whether climate change has a significant impact on bank green investments in various environmentally beneficial initiatives. So, dependent variable is Green finance, measured by green investments and independent variable is climate change. Similar to (Boitan and Marchewka-Bartkowiak, 2022; Burnell, 2012; Rivera and Wamsler, 2014), we measured climate change by climate risk index (CRI) score.

Control variables

The first control variable, referred to as outward foreign direct investment (FDIO), means the value of the resident investors' equity in and net loans to enterprises in the foreign destination country. A domestic firm can expand its operations to a foreign country through investment competitiveness. A study of (Desalegn et al. 2022) showed Outward foreign direct investment has a negative and significant effect on green finance. This study expects a positive indication.

Population growth (PM) is the rate at which the number of individuals in a population increases in a given period, expressed as a fraction of the initial population.

Broad money (BM) was one of the control variables that we used. The entire quantity of money in circulation, which includes bank deposits and cash, is referred to as the BM. Financial transactions for both green and non-green investments are likely to function well when the money supply across the economy is increased. Accordingly, a thorough analysis by Desalegn et al. (2022) found that a broad money supply significantly and favorably affects green financing.

Model-2:

Dependent Variable

This research intends to learn more about green financing and its impact on the financial performance of banks. Therefore, we have chosen to make

the financial performance of banks as the dependent variable. In the majority of studies, return on equity (ROE) and return on assets (ROA), two essential proxies for financial success, were used to evaluate banking performance. ROE is widely used in the academic community as a measure of a bank's efficacy in returning profits to their shareholders (Hsiao et al., 2022). Similar to the previous studies, this research utilized the return on equity as a metric. In addition to ROE, ROA is frequently used as a performance metric for banks because it indicates how well an organization makes revenues from existing bank assets (Hsiao et al., 2022). Therefore, ROA is used to evaluate the efficacy of these financial institutions.

Independent variables

The purpose of the study is to determine how green financing affects the financial health of banks. The most important independent variable is green finance. Green finance aims to achieve sustainable development objectives by increasing the flow of capital from financial institutions to businesses engaged in environmentally protective initiatives and operations. Banks are investing in green projects such as clean power generation, clean brick production, energy efficient and low-carbon emitting industries, protection of biodiversity, industrial pollution control, water sanitation etc. Several studies (Al Mamun and Rana, 2020; Julia and Kassim, 2016; Xu et al., 2020), among others, have estimated that green financing enhances the financial performance of institutions. To further quantify the green financing variable, the total quantity of money banks have invested in green initiatives is logarithmically computed.

Control Variables

In this analysis, we employ numerous moderators to isolate the effect of green financing on the bank's profitability. The bank size appears first. Muhindi and Ngaba (2018) observed a positive relationship between a company's size and its financial achievement. Other researchers found a similar positive relationship (Du et al., 2022; Xi et al., 2022) between the scale of a bank and its financial performance. On the other hand, opposite relations were also found by (Mirovic et al., 2023; Lian et al., 2022). As a consequence, numerous hypotheses regarding the relationship between company size and the profitability of banks have been proposed. This study aims to ascertain the nature of the relationship between bank performance

and institution size for financial institutions operating in Bangladesh.

We included a control variable referred to as financial leverage (FL), which represents the ratio of liabilities to assets. Consideration is given to the level of financial leverage, or the proportion of a company's assets that are supported by debt. There is evidence that financial leverage negatively impacts the financial performance of banks (Du et al., 2022). Therefore, in this research, we believe that financial leverage is correlated with performance.

This analysis employs the asset turnover ratio (or total asset turnover ratio, TTR) as a control variable. The TTR metric quantifies a bank's capacity to monetize its holdings. This ratio is calculated by dividing sales revenue by the bank's total or average assets. (Du et al., 2022) states that a higher turnover rate is indicative of strong financial performance. We anticipate that TTR will have a comparable impact on the productivity of financial institutions.

Another variable namely, equity to total assets (ETA) which represents the ratio of shareholders' equity to total assets of banks, measures the fraction of the banks' assets that are funded by equity, has been included in this study. Lian et al. (2022) found a negative relation of ETA with profitability. We also expect a negative sign between ETA and bank performance.

Growth ability (GA), the ratio of the current year's revenue to last year's revenue, has been incorporated in the study that depicts the banks' income over the period compared to the past. Xi et al. (2022) argued that higher growth ability fosters the banks' financial performance. Arguing similarly, we expect a positive relation between GA and bank performance.

Finally, the capital adequacy ratio (CAR), which measures a bank's financial soundness by comparing the amount of total capital to its risk-weighted assets, determines whether funds are available to customers and protects the bank from going out of business, has been included in the present study. In general, the greater the capital adequacy ratio, the more secure the bank and the more the variety of deposit options available to clients. However, it's not always that the greater CAR is good. Because, the greater a bank's capital adequacy ratio, the more expensive it will be to raise capital, which will subsequently reduce its profitability. (Xi et al., 2022; Hsiao and Wang, 2022) observed a positive association between the profitability of banks and CAR. Arguing similarly, we expect positive sign between CAR and bank performance.

4. Empirical Results and Their Discussions

4.1 Descriptive statistics

Table 3-a represents Descriptive statistics for model 1. According to the table, there was a range of 2.81 to 3.75 and an average of 3.26 for green finance, with a standard deviation of 0.40. The mean value of the CRI was 1.43%, with a range of 1.20 to 1.93, and the standard deviation was 0.23. The average FDIO, PG, and BM values, together with their corresponding standard deviations, were found to be -1.96, 0.02, and 0.03 in the result.

In Table 3-b, the sample institutions' average return on equity (ROE) was 0.10%, with a range of 0.22 to -0.19 and a standard deviation (SD) of 0.05. The average ROA was 0.009 percent, and the standard deviation was also 0.005 percent. GF, the primary variable of interest, was found to have an average of 1.14 and a standard deviation of 0.89. We found that the mean values for SZ, FL, TTR, ETA, GA, and CAR were 3.43, 0.91, 0.05, 0.08, 1.09, and 0.14 with standard deviations of 0.40, 0.09, 0.02, 0.03, 0.20, and 0.03 respectively.

Table 3-a. Descriptive findings for Model-1

Variable	Obs	Mean	Std. Dev.	Min	Max
logGF	7	3.26	0.40	2.81	3.75
logCRI	7	1.43	0.23	1.20	1.93
logFDIO	7	-1.96	0.52	-2.89	-1.37
logPG	7	0.02	0.02	-0.01	0.05
logBM	7	1.76	0.03	1.74	1.81

Table 3-b. Descriptive findings for Model-2

Variable	Obs	Mean	Std. Dev.	Min	Max
ROE	154	0.1039	0.0527	-0.1906	0.2216
ROA	154	0.0092	0.0059	-0.0112	0.0381
GF	154	1.1356	0.8908	-1.0306	2.9583
SZ	154	3.4252	0.4000	2.3454	4.2484
FL	154	0.9077	0.0926	0.1346	0.9660
TTR	154	0.0461	0.0250	0.0020	0.1384
ETA	154	0.0800	0.0336	0.0034	0.2325
GA	154	1.0997	0.1989	0.5679	2.2946
CAR	154	0.1365	0.0323	0.0755	0.3526

4.2 Multicollinearity test

Model-1: With time series data from 2015 to 2021 that is specific to a nation to quantify the multicollinearity problem. Using pairwise correlation metrics, the multicollinearity between the variables is investigated. Multicollinearity can be detected if the correlation coefficient is over 0.7, as stated by Wooldridge (2015). The result shows that because of the poor connection between the variables, multicollinearity is not a significant problem. Lastly, using VIF 10.00 as a suitable threshold, this study performed a variance inflation factors (VIF) test following Nachane's (2006) recommendation. In the end, the Table 4-a displays a VIF range of 1.34 to 2.27, indicating that multicollinearity had no impact on the present study.

Table 4-a. Correlation Analysis for Model-1

	logGF	logCRI	logFDIO	logPG	logBM	VIF
logGF	1.00					
logCRI	-0.21	1.00				2.27
logFDIO	0.59	-0.70	1.00			2.47
logPG	0.85	-0.37	0.50	1.00		1.50
logBM	0.28	0.06	0.23	0.37	1.00	1.34
		Mean VIF				1.90

Model-2: Using bank-wise panel data of 22 banks for 2015-21 with 6 specified variables; multicollinearity may become an issue. We check the multicollinearity among variables, first of all, by examining pairwise correlations among the explanatory variables. According to Wooldridge (2015), multicollinearity is present if the correlation coefficient is found to be higher than 0.7. As can be seen in Table 4-b, the association between variables is weak, demonstrating that multicollinearity is not a severe problem in the analysis. Also, Table 4-b demonstrates that multicollinearity is minimal, with the maximum VIF value being 4.46. Consequently, Multicollinearity does not appear to affect this study.

Table 4-b. Correlation matrix for model-2

	ROE	ROA	GF	SZ	FL	TTR	ETA	GA	CAR	VIF
ROE	1.000									4.46
ROA	0.459	1.000								3.08
GF	0.089	-0.129	1.000							2.64
SZ	-0.404	-0.716	0.279	1.000						2.54
FL	0.301	0.008	0.218	0.179	1.000					1.64
TTR	0.467	0.499	0.134	-0.492	0.053	1.000				1.53
ETA	0.417	0.807	-0.196	-0.803	-0.070	0.490	1.000			1.3
GA	0.227	-0.062	0.477	-0.370	-0.105	0.143	0.428	1.000		1.18
CAR	0.334	-0.120	0.647	-0.600	-0.089	0.213	0.686	0.420	1.000	4.46
				Mean VIF						2.43

4.3 Cross-sectional Dependency test

Cross-sectional Dependency (CD) test is employed to scrutinize the correlation in residuals in panel data. Negligence of the Cross-sectional Dependency test in panel analysis might lead to distorted and unreconciled findings. Therefore, to determine the existence of CD in the models, Pesaran's (2004) CD test and Bias-corrected scaled LM test, formulated by Baltagi et al. (2012), are applied in this treatise.

$$CD = \sqrt{\frac{2T}{(N-1)N}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}\text{ij}$$

In the above equation, T epitomizes time, N refers to panel index, and $\hat{\rho}$ij denotes the relationship between the ith and jth error components. Furthermore, the average value for the fixed values of N and T is zero. In this case,

$$\hat{\rho}\text{ij} = \sum_{t=1}^{T} \frac{\mu_{it}\,\mu_{jt}}{\left(\sum_{t=1}^{T} \mu_{it}^2\right)^{1/2} \left(\sum_{t=1}^{T} \mu_{jt}^2\right)^{1/2}}$$

μ_{it} provides clarification for the OLS residual error components based on T observation for each i = 1,……., N. The null hypothesis, which construes that there is no correlation in residuals, is resolutely putative by the Pesaran (2004) CD test result. In addition, the outcome of bias-corrected scaled LM test tenaciously corroborates the result of the Pesaran (2004) CD test. Results indicate no cross-sectional dependence of any variables. The findings are depicted in Table 5.

Table 5. Results of Cross-sectional Dependency Test

	Model 1		Model 2	
Test	**Stat.**	**Prob.**	**Stat.**	**Prob.**
Pesaran CD	-0.516	0.605	0.222	0.823
Bias-corrected scaled LM	1.415	0.157	0.274	0.783

4.4 Unit root test

Model-1: The modified Dickey-Fuller t test, known as the DF-GLS, was performed by Elliott et al. (1992). A regression model is fitted to test the null hypothesis H_0: $\beta = 0$

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \cdots + \zeta_k \Delta y_{t-k} + \varepsilon_t$$

Where Y_t is a random walk, testing the null hypothesis possibly with drift. Other optimistic alternative hypotheses: y_t is stationary about a linear time trend or y_t stationary with a possibly nonzero mean but with no linear time trend.

Findings are presented in Table 6-a. According to Table 6-a, all the variables are stationary at level, except green finance and population growth with intercept, and outward foreign direct investment with intercept plus trend. When it comes to the first difference, all variables are stationary with intercept, and intercept plus trend.

Table 6-a. DF-GLS unit root test results for Model-1

	Level		First Difference	
	Intercept	Intercept + Trend	Intercept	Intercept + Trend
logGF	-1.059	-3.389**	-3.041**	-2.849
logCRI	-3.524**	-5.741**	-4.669**	-7.790**
logFDIO	-2.306**	-4.516	-4.261**	-4.562**
logPM	1.070	-3.533**	-1.714*	-2.766*
logBM	-5.200**	-4.100**	-4.750**	-4.175**

Note: ** and * signify 5% and 10% level of significance, respectively.

Model-2: The application of the proverbial LLC unit root test is frequent, devised by Levin et al. (2002), (Janjua et al., 2023; Zhao et al., 2018). Considering the ADF test statistic to determine whether a unit root is

present or not in the panel, the alternative hypothesis is tested against the null hypothesis (Westerlund, 2013). According to Augmented Dickey–Fuller (ADF) regression, this test permits serially correlated heterogeneous error:

$$\Delta y_{it} = \beta_i + \theta_t + \pi_i t + \rho_i y_{i,t-1} + \sum_{j=0}^{\rho} \beta_i \Delta y_{t-j} + \omega_{it} \quad (i = 1,..,N; t = 1,.....T)$$

In the above-mentioned Equation, Δy_{it} indicates the exogenous variable; the parameters are β_i; θ_t; $\pi_i t$; the regress of Δy_{it} on Δy_{t-j}; ρ denotes lag length and ω_{it} is a stochastic error, whereas panel index is signified by i = 1, . . . , N; index of time is specified by t = 1, . . . , T. Henceforth, all series for unit root test are H_a: $\rho_i < 1$ and H_0: $\rho_i = 0$. Following the assumptions of the LLC unit root test, the null hypothesis might be rejected for either one or all series.

The exhibition of the results of the LLC and Fisher-ADF unit root test is in Table 6-b. According to the findings of the LLC unit root test, all variables, except for bank size, are stationary at level, indulging in both intercept and trend plus intercept. It is conspicuous that after implementing the first deference – considering intercept plus trend and intercept – entire series becomes stationary. Moreover, the outcome of the Fisher-ADF accentuates that it is tantamount to the LLC unit root test, which persistently validates the probity of the LLC unit root test.

Table 6-b. Results of LLC and Fisher-ADF Unit Root Test for Model-2

Variable	LLC				Fisher-ADF			
	Level		1st Deference		Level		1st Deference	
	Intercept	Intercept + Trend	Intercept	Intercept + Trend	Intercept	Intercept + Trend	Intercept	Intercept + Trend
	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ROE	-20.78*	-15.67*	-15.79*	-19.30*	91.55*	125.94*	146.58*	136.47*
ROA	-17.51*	-18.31*	-18.25*	-21.43*	82.17*	124.10*	165.12*	131.99*
GF	-2.49*	-6.66*	-8.63*	-13.39*	41.74	58.32***	86.46*	79.32*
SZ	3.90	-5.44*	-9.66*	-17.91*	21.10	60.00**	99.18*	118.69*
FL	-2.84*	-10.49*	-11.37*	-40.48*	103.39*	96.20*	103.00*	161.37*
TTR	-4.01*	-11.72*	-13.05*	-20.25*	49.05	90.98*	130.29*	136.84*
ETA	-2.90*	-11.06*	-12.63*	-40.28*	101.87*	107.40*	114.67*	162.20*
GA	-15.83*	-14.01*	-17.31*	-20.87*	128.63*	150.70*	175.80*	126.62*
CAR	-8.30*	-14.40*	14.85*	-17.46*	65.39*	126.72*	140.74*	90.19*

Note: *,** and *** indicate 1%, 5% and 10% level of significance

4.5 Results of regression studies and their discussions

Model-1: We deployed (Newey and West 1987) method for time series regression analysis to reduce the autocorrelation. Results from Table 7-a, CRI shows a significant positive correlation with green financing indicating climate change influences to promote more green investment. A chunk of studies (Lee et al., 2024; Alharbi et al., 2023) reveal similar results. Higher vulnerability to climate risks often requires more significant investments in adaptation and mitigation measures and puts pressure on governments and policymakers to implement stronger climate policies and regulations. That's how banks' green financing is influenced to use this assessment to identify areas where climate-related risks are most severe. Other controls show the same positive signs of green financing. Considering no institutional barriers of the host country has a direct impact on outward foreign direct investment and affects the development and execution of foreign direct investment that fosters green financing. A place with advancement in population growth and broad money supply is a major concern to government and authorities for higher demand of resources and economic activity that heavily leads to environmental degradation. To improve in environmental scenarios banks are promoting green financing in eco-friendly projects.

Table 7-a. Regression results with Newey-West standard errors (Model-1)

Variable	Coef.	Newey-West Std. Err.	t	P>t
logCRI	0.908*	0.232	3.910	0.060
logFDIO	0.464*	0.154	3.010	0.095
logPM	15.199**	1.973	7.700	0.016
logBM	-3.218	1.822	-1.770	0.219
intercept	8.201	3.126	2.620	0.120
F		116.59		
Prob > F		0.008		

Note: ** and * indicates variables significant at 5% and 10% level of significance respectively.

Model-2: We choose to use the Arellano-Bond (1991) method for estimating dynamic panel data to address the endogeneity issue. Due to the latent dependent variable, the endogeneity problem with all explanatory factors is mitigated when using the dynamic panel GMM estimator. Findings indicate that green finance (GF) has significant negative impacts on both return on equity (ROE) and return on assets (ROA), as shown in

Table 7-b. In other words, investments in green finance have had a significant negative impact on the financial performance of banks operating in Bangladesh. These findings are similar to the findings of (Galan and Tan, 2022; Wanting, 2020). Our findings are not promising at this stage in terms of bank's profitability. One of the probable reasons for the negative impacts of green finance is that in Bangladesh, green finance is a relatively new awareness for the banks that started to begin in 2011. Since 2011, Bangladeshi banks have increased funding for environmentally friendly initiatives, with positive outcomes. However, earnings from these environmentally friendly investments haven't yet given the desired positive bottom-line profits to foster banks' performance because commercial banks just started paying priority to green financing following the implementation of the Green Financing Guidelines in 2011. Rather, green credit merely makes up a small portion of the entire bank wealth; on the other, the expenditure of pre-assessment, process tracking, as well as additional links in the allocation of green loans by scheduled banks are relatively inadequate making it tough to have a substantial effect on the way it performs. Another reason why green credit has an unfavorable impact on profit efficiency is that the net returns of long-term green initiatives do not produce enough money to cover the greater costs incurred by banks.

This means that banks in Bangladesh must develop comprehensive financial plans for all existing and future green finance initiatives if they want to benefit financially. A portion of the money invested in green financing is used to increase R&D spending, but we anticipate that bank expenditure is relatively low compared to the increase in operational expenses and decline in financial performance. Though we have found negative effects, our research signifies increasing awareness of climate change and green finance among corporate cultures.

Table 7-b displays a significant negative relation of bank size with ROE and ROA. Economies of scale influences bank size. Large bank's assets are negatively impacted by the size variable, but small banks are significantly benefited. Average earnings may decrease from a level of size upward due to bureaucratic procedures and diseconomies of scale which Bangladesh's developing banks experience. Therefore, we conclude that the performance of banks in Bangladesh is negatively affected by their size.

Table 7-b. Results of regressions for Model-2

Variable	ROE				ROA			
	Coef.	Std. Err.	z	P-value	Coef.	Std. Err.	z	P-value
ROE L1., ROA L1	-0.145***	0.023	-6.29	0.000	-0.007	0.031	-0.24	0.811
GF	-0.007***	0.003	-2.66	0.008	0.004	0.001	-0.12	0.908
SZ	-0.103***	0.026	-3.90	0.000	-0.010***	0.001	-6.98	0.000
FL	0.377***	0.008	45.50	0.000	0.027***	0.001	47.48	0.000
TTR	0.260	0.279	0.93	0.351	0.064***	0.024	2.69	0.007
ETA	-0.765**	0.378	-2.02	0.043	0.023**	0.012	1.96	0.050
GA	0.047***	0.013	3.66	0.000	0.004***	0.001	4.72	0.000
CAR	0.320*	0.175	1.82	0.068	0.037***	0.009	4	0.000
intercept	0.090	0.123	0.73	0.466	0.006	0.005	1.23	0.219
No. of Obs		110				110		
No. of Groups		22				22		

Note: ***, ** and * indicates variables significant at 1%, 5% and 10% level of significance respectively.

When utilizing financial leverage, we noticed that FL significantly increases both ROE and ROA. Greater leverage increases the profitability of Bangladesh's banking sector inciting businesses to be more financially sound to meet their obligations and lowering the chance of insolvency. The conclusion reached by Obia (2020) is consistent with our findings. Du et al. (2022) divulged that after the implementation of green credit guidelines, the total loans of green firms increased also uplifting the financial leverage. We found that increasing the TTR insignificantly increased ROE and ROA. This implies that banks are able to generate sales revenue by effectively utilizing their assets. A rapid increase in the aggregate turnover ratio has the potential to improve the banking industry's financial health. Du et al. (2022) achieved similar outcomes to ours. Mostly, TTR represents firms' efficiency and our findings interpreted that the management of banks is able to properly utilize the banks' assets to generate revenue and therefore the bank's profitability is reduced in Bangladesh. On the other hand, ETA shows a significantly negative association with ROE but a positive association with ROA. The higher value of this ratio shows that banks have assets via issuing debt rather than equity. So, the banks being less leveraged has a significant detrimental effect on performance. This finding is consistent with the findings of (Lian et al., 2022). Consistent with the findings of Xi et al. (2022), this study finds that growth ability has statistically significant positive impacts on bank performance. Higher revenue growth is fostering earnings

of banks and shareholders' revenue indicating a sound and noticeable bank performance in Bangladesh. Findings also show that CAR significantly increases the banks' ROE and ROA. A high CAR ratio always guarantees that the banks have enough capital accessible to deal with any unanticipated losses and viz. versa. This result is consistent with the findings of (Xi et al., 2022; Hsiao and Wang, 2022). However, it is of interest for the readers to be aware that Bangladeshi banks maintained the lowest capital adequacy ratio of 11.83 percent among the South Asian countries, according to the Bangladesh Bank's Financial Stability Report 2022.

4.6 Robustness test

To verify that the findings of our baseline model provided in Equation 1 are robust, we employ two methods. First of all, alternative proxy of green finance, namely green projects to total assets ratio (GF/TA) have been considered in the model and regressed accordingly. Data on GF/TA throughout 2015-2021 on the same 22 banks was collected from banks' annual audited reports. As shown in Table 8, we find that green finance has negative but insignificant impacts on ROE and ROA which is similar to the findings of the original model of this study. Secondly, based on the established year of banks, we divide sample periods from 1972–1992 and 1993–2013 and perform the regressions separately. The results observed,

Table 8. Results of robustness check by alternative proxy method

	ROE				ROA			
	Coef.	Std. Err.	z	P-value	Coef.	Std. Err.	z	P-value
ROE L1., ROA L1.	-0.117	0.080	-1.460	0.144	0.027	0.078	0.35	0.729
GF/TA	-0.068	0.125	-0.540	0.586	-0.009	0.010	-0.990	0.322
SZ	-0.070*	0.038	-1.820	0.069	-0.010***	0.003	-3.110	0.002
FL	0.382***	0.041	9.410	0.000	0.027***	0.003	8.260	0.000
TTR	0.535	0.412	1.300	0.194	0.078**	0.031	2.460	0.014
ETA	-0.189	0.466	-0.410	0.685	0.018	0.032	0.560	0.576
GA	0.057***	0.021	2.760	0.006	0.005***	0.002	3.140	0.002
CAR	0.446*	0.261	1.710	0.088	0.035*	0.020	1.720	0.086
intercept	-0.126	0.163	-0.770	0.440	0.005	0.014	0.330	0.739
No. of Obs	110				110			
No. of Groups	22				22			

Note: ***, and ** indicates variables significant at 1%, and 5% level of significance respectively.

Table 9. Results of robustness checks by dividing the sample into two periods

	Sample of banks established in 1972–1992						Sample of banks established in 1993–2013					
	ROE			ROA			ROE			ROA		
	Coef.	Std. Err.	P-Value	Coef.	Std. Err.	P-Value	Coef.	Std. Err.	P-Value	Coef.	Std. Err.	P-Value
ROE L1. ROA L1.	-0.218**	0.092	0.018	-0.016	0.109	0.882	-0.024	0.150	0.872	-0.123	0.114	0.280
GF	-0.017**	0.008	0.039	-0.001	0.001	0.298	-0.002	0.008	0.811	0.005	0.001	0.919
SZ	0.019	0.082	0.816	0.001	0.006	0.885	-0.060	0.051	0.236	-0.016***	0.005	0.001
FL	0.341***	0.038	0.000	0.024***	0.003	0.000	-1.311	13.568	0.923	-0.178	0.958	0.852
TTR	0.362	1.379	0.793	0.112	0.110	0.311	0.922**	0.434	0.034	0.070**	0.033	0.035
ETA	2.149**	1.017	0.035	0.198**	0.082	0.016	-2.805	13.735	0.838	-0.238	0.967	0.805
GA	0.059*	0.034	0.085	0.004	0.003	0.175	0.027	0.032	0.398	0.003	0.002	0.112
CAR	-0.643	0.528	0.223	-0.035	0.042	0.402	0.696**	0.292	0.017	0.060***	0.022	0.006
intercept	-0.396	0.323	0.220	-0.034	0.026	0.184	1.581	13.649	0.908	0.230	0.966	0.812
No. of Obs		55			55			55			55	
No. of Groups		11			11			11			11	

Note: ***, ** and * indicates variables significant at 1%, 5% and 10% level of significance respectively.

shown in Table 9, are very similar to those obtained during the whole study period. Thus, we conclude that our results are robust.

5 Conclusions

Bangladesh hopes to graduate from the LDC category in 2026 to be a middle-income country and aspires to be a high-income nation by 2041, therefore tackling climate change is of great importance. Climate change profoundly affects Bangladesh in her trajectory of economic development. According to a report published by PBS[2] of USA, "The low-lying nation of Bangladesh emits just one-half of 1 percent of the world's carbon emissions. But it suffers disproportionately from the climate change that's caused by that pollution". Not only is it a serious threat to the people of Bangladesh, but climate change is also endangering the world economy. This problem needs public-private sector collaboration to drive the development of sustainable economic growth. This research examines whether climate change is influencing banks to foster green financing activities in Bangladesh.

[2] https://www.pbs.org/newshour/show/driven-by-necessity-bangladesh-develops-innovations-to-fight- climate-change

Analyzing time series data of 2015–2021, this study explores that climate change has significant positive impacts on green financing activities of banks.

Regulators in both developed and developing countries like Bangladesh have been updating policies that will allow banks to play a vital and active part in resolving climate issues since they are aware of the importance of banks in the global economy. Policymakers have to recognize that climate change is a long-term problem and by facilitating green financial solutions targeted at reducing energy use, banks may greatly contribute to sustainable development. The study aimed to evaluate whether banks in Bangladesh are contributing to solving this problem through investing in green projects.

This research examines the paradoxical rapport between green finance investment and the profitability of banks operating in Bangladesh. Through an examination of data spanning the years 2015 to 2021, this study assesses the financial performance of 22 distinct banks in Bangladesh in relation to green financing. This study's key finding is that green financing is negatively associated with bank performance. In other words, green finance has negative impacts on return on equity and return on assets, according to our research, but it answers the very vital question we raised earlier, that is if banks in Bangladesh are influenced by climate change to promote green financing. Though findings on profit performance may not be heartening for now, the trend is very promising in that awareness is growing and obvious with a gradual increase in green finance. It is conceivable that early investments in green projects are answerable for these divergent outcomes. After a certain interval of time has elapsed, banks' investments in environmentally friendly initiatives will yield a substantial, long-term return. To become a completely green society, we therefore advocate for investors to implement green initiatives. The primary objective of this study is to encourage banking authorities and regulators to adopt strategies that will expedite financial institutions' incorporation of green finance, although the overall financial leverage, size, growth ability, and capital adequacy ratio are significantly associated with a bank's financial success.

The dearth of readily accessible data was our greatest hindrance. Once the awareness for more green financing by banks is undertaken and more data are available, other research could include additional measures for analysis and relate them to the broader banking industry to make results more comparable.

Conflict of Interest

The authors declare that there exists no conflict of interest in this work.

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