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The Impact of Green Credit on Bank Profitability: Implications for Vietnam

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Abstract

In the context of climate change and the global pursuit of sustainable development, green credit has emerged as a strategic instrument enabling banks to foster both economic growth and environmental protection. In Vietnam, although the State Bank has introduced incentive policies to promote green lending, its implementation remains constrained by an incomplete legal framework and dependence on external capital. Addressing the lack of empirical evidence, this study examines the impact of green credit on the profitability of 18 Vietnamese banks from 2015–2023. Using panel data regression in STATA with diagnostic tests for multicollinearity, heteroskedasticity, and autocorrelation, the study finds that green credit ratio (GCR) significantly enhances return on assets (ROA), while non-performing loans (NPL) reduce it. Bank size also shows a positive but weaker effect, whereas GDP growth is insignificant. The findings highlight green credit's role in sustainable banking and support stronger regulatory and environmental risk management frameworks.

Keywords: *Green credit, bank profitability, sustainable development, non-performing loans, ROA, Vietnam*

1. Introduction

Amidst the contemporary backdrop, wherein the global stage is witnessing unprecedented leaps in economic development and the remarkable prosperity of human civilization, humanity is simultaneously confronted with the unavoidable and adverse consequences of profound environmental shifts. These repercussions manifest primarily as accelerated climate change, the persistent phenomenon of global warming, and a deepening ecological crisis. These multifaceted challenges have evolved into intractable issues, representing a complex conundrum that necessitates the most concerted and comprehensive efforts from individuals and organizations alike for their ultimate resolution. Consequently, in an effort to reconcile the apparent conflict between developmental imperatives and environmental preservation, the "green growth" solution has emerged as a prominent and indispensable global trend. This paradigm is strategically designed to achieve a dual objective: not only to foster continued economic expansion but also to simultaneously alleviate and mitigate the escalating risks of environmental pollution and degradation. The banking sector, in this regard, is no exception; indeed, it is positioned to play a pivotal role in the overarching process of "greening" the economy. Functioning as a primary conduit for capital allocation, the financial industry bears a significant mission to recalibrate its credit flows. This involves the "greening" of loan portfolios by actively prioritizing and promoting projects that are environmentally sustainable and eco-friendly. Specifically, within the Vietnamese context, the adoption of "green credit" mechanisms serves a multifaceted purpose. Beyond its primary function of providing essential financial support for environmental protection initiatives, it concurrently offers tangible benefits to the lending institutions themselves. These advantages include the enhancement of corporate reputation, the fortification of operational transparency, and the crucial alignment with the stringent environmental, social, and governance (ESG) standards increasingly mandated by international investors and regulatory organizations.

In the contemporary academic landscape, a considerable body of research has emerged to investigate the influence of green credit mechanisms on the financial profitability of banking institutions. For instance, a study by Wei and Lin (2023) demonstrated that green credit exerts a positive impact on the profitability of commercial banks within the Chinese context, drawing its conclusions from a focused analysis of the Industrial and Commercial Bank of China (ICBC) over the period 2008-2020. Their findings indicated that the implementation of green credit not only enhances the bank's corporate image but also serves as a catalyst for profit growth by attracting a clientele and investor base that is environmentally conscious. Conversely, offering a different perspective, Ranning (2022) utilized a dataset encompassing 36 listed banks in China from 2011 to 2020. This research uncovered a nuanced relationship, positing

that while green credit initiatives may adversely affect profitability in the immediate short term, they are associated with substantial long-term benefits. The study further differentiated these effects, noting that state-owned banks tended to reap the benefits, whereas their joint-stock counterparts frequently contended with elevated costs and heightened risk profiles. Adopting a distinct methodological approach within the Indonesian market, the work of Furqan (2024) performed an analysis incorporating variables such as capital adequacy, operational efficiency, and credit risk; a key emphasis of this research was the finding that deficient internal environmental management systems possess the potential to significantly diminish the overall efficacy of such green initiatives. Turning to the Vietnamese context, a prominent study conducted by Tuyen (2023) undertook an assessment of the prevailing situation of green credit. The research documented that outstanding loans in this category had reached a significant 451,000 billion VND by the close of 2021, representing an eight-fold expansion compared to the baseline year of 2015. Despite this growth, the study also highlighted that the green credit sector in Vietnam remains heavily reliant on international capital inflows, particularly from organizations like the IMF and ADB, and concurrently faces persistent challenges stemming from an incomplete and still-developing domestic policy framework.

In aggregate, while the extant body of preceding research has furnished valuable insights, it is imperative to acknowledge that certain limitations and scholarly voids persist. A predominant concentration of quantitative studies has been observed, focusing primarily on national contexts distinct from Vietnam, such as the comprehensive analyses conducted in China (Ranning, 2022; Wei & Lin, 2023) or Indonesia (Furqan, 2024; Sutrisno et al., 2024). Consequently, there exists a discernible paucity of empirical investigations specifically examining the nuanced impacts and implementation of green credit within the unique developmental trajectory of Vietnam. This research gap pertaining to green credit in the Vietnamese context is not monolithic; rather, it manifests across several critical domains. Specifically, there is a marked deficiency in granular, quantitative analyses designed to ascertain the precise economic and environmental impacts of green credit initiatives within key strategic sectors, such as the renewable energy transition and the promotion of sustainable agriculture. Concurrently, the existing literature has yet to sufficiently elucidate the intricate, dynamic relationship between the established legal and regulatory frameworks and the practical efficacy of green credit deployment, just as the long-term consequences of these financial policies remain largely unexplored. Furthermore, the prevailing level of corporate awareness and the spectrum of organizational responses to green credit opportunities have not been comprehensively assessed or empirically validated. Most significantly, there is a profound absence of in-depth research dedicated to investigating the viable mechanisms and strategies through which Vietnamese banking institutions might proactively mobilize domestic sources of green capital, a crucial step to mitigate the sector's current, and potentially unsustainable, reliance on capital inflows from international organizations.

The main purpose of this study is to identify and analyze the relationship between green credit and the profitability of banks in Vietnam. At the same time, it aims to evaluate the impact of green credit on banks' operational efficiency, including profitability and other financial indicators. From there, the study seeks to determine the key factors that either promote or hinder the development of green credit in Vietnam, especially in the context of banks shifting toward sustainable financial products. Finally, it proposes practical solutions for banks to enhance profitability through green credit, contributing to the sustainable development goals of both the banking sector and the Vietnamese economy as a whole.

2. Objectives

The objectives of this study are clearly defined and measurable. They can be categorized as follows:

1) Identify the relationship between green credit and the profitability of Vietnamese commercial banks during the period 2015–2023.
2) Evaluate how green credit influences banks' operational performance through key financial indicators such as Return on Assets (ROA) and Return on Equity (ROE).
3) Analyze the internal and external factors (e.g., bank size, credit risk, GDP growth) that affect the implementation and outcomes of green credit in the Vietnamese banking system

4) Determine the main challenges and barriers that hinder the expansion of green credit in Vietnam's commercial banks.
5) Propose practical recommendations and policy implications for enhancing green credit efficiency and profitability, contributing to Vietnam's sustainable financial development goals.

3. Materials and Methods

3.1 Materials

Theoretical foundations: Green credit (GC) is a central concept within the field of sustainable finance and has gained wide recognition globally. According to the definitions provided by the Loan Market Association (LMA) and the Asia Pacific Loan Market Association (APLMA), green credit refers to any type of loan that is exclusively granted to finance or refinance eligible green projects. In essence, it represents credit facilities offered by financial institutions to support production and business activities that have minimal or no adverse environmental impact and pose limited environmental risks, thereby fostering environmental conservation and sustainable economic development. The banking sector, meanwhile, represents a special type of business whose core product is money. Bank profitability (BP) is defined as the net income generated from a bank's main business activities after deducting all relevant expenses. In this study, profitability is measured by the return on assets (ROA), which reflects the overall efficiency of a bank in utilizing its assets to generate earnings.

Regarding the relationship between these two concepts, green credit is theorized to have a significant impact on bank profitability through two main theoretical channels. First, the positive effect arises from the enhancement of corporate image and reputation through green lending, compliance with ESG standards, and the reduction of long-term environmental risks, thereby attracting environmentally conscious investors and customers, which ultimately improves profitability. Second, several scholars have pointed out potential short-term negative effects stemming from high initial appraisal costs and increased risk during the early stages of green project implementation.

Literature Review: The review of existing literature reveals a general consensus regarding the influence of various factors on bank profitability. Quantitative studies conducted in emerging markets, particularly in China, have demonstrated that green credit (GC) positively affects long-term profitability, primarily through enhanced reputation and the expansion of sustainable markets, as confirmed by Wei and Lin (2023). However, some studies also caution that the high initial costs may have short-term adverse effects (Ranning, 2022). In addition, previous research consistently finds that credit risk, represented by the non-performing loan ratio (NPL), has a negative effect on bank profitability. Other internal factors such as bank size (SIZE) in Nguyen et al. (2024) and net interest margin (NIM) in Pham (2024) tend to exhibit mixed or insignificant relationships, while macroeconomic variables such as GDP growth (GDPG) are generally found to correlate positively with bank profitability (Nguyen et al., 2025).

Although there exists a substantial body of literature on green credit globally, a significant research gap remains, particularly in the Vietnamese context. The scarcity of empirical evidence regarding the impact of green credit on bank profitability in Vietnam constitutes a key motivation for this study, as most empirical findings have focused on other markets. This gap also includes the lack of in-depth quantitative analyses to accurately assess the economic and environmental impacts of green credit in strategic sectors (e.g., renewable energy), as well as limited research on feasible mechanisms for Vietnamese banks to mobilize domestic green capital and reduce reliance on international financial institutions. Finally, the relationship between the existing legal and regulatory frameworks and the practical effectiveness of green credit implementation remains insufficiently clarified.

Green Credit in Vietnamese Banks: From 2015 to 2019, Vietnam began to establish the foundation for green credit development under the guidance of the State Bank of Vietnam (SBV). During this period, the SBV introduced several key policy frameworks aimed at integrating environmental and social considerations into the banking system. According to the State Bank of Vietnam (2015), Directive No. 03/CT-NHNN laid the groundwork for promoting green credit growth and managing environmental and social risks in lending activities. This was followed by Decision No. 1604/QD-NHNN, which approved the Development Plan for Green Banking in Vietnam and marked a significant step toward institutionalizing green finance principles (State Bank of Vietnam, 2018). In collaboration with the

International Finance Corporation (IFC), the SBV also developed the Handbook for Environmental and Social Risk Assessment in Credit Activities (2018–2019), which provided detailed guidance for 15 economic sectors. These initiatives helped raise awareness among financial institutions about the importance of sustainable lending and created a more coherent policy environment for green finance.

In the period from 2019 to 2023, Vietnam's green credit policies gradually moved from the stage of policy formulation to practical implementation. The SBV continued to work closely with the Ministry of Natural Resources and Environment to submit to the Prime Minister the National Green Classification List, contributing to the establishment of a clearer legal and institutional framework for sustainable economic development. Alongside these regulatory efforts, commercial banks began to play a more active role in promoting green credit. Many banks organized training sessions and capacity-building programs to strengthen their internal management of green credit portfolios. Leading institutions such as Vietcombank, BIDV, Sacombank, TPBank, and MBBank participated in financing renewable energy projects, while others including VietinBank, Agribank, HDBank, and ACB actively supported green agriculture initiatives. These developments indicate that Vietnam's green credit sector has entered a phase of practical application, where both regulatory authorities and commercial banks jointly promote the integration of sustainability into the financial system.

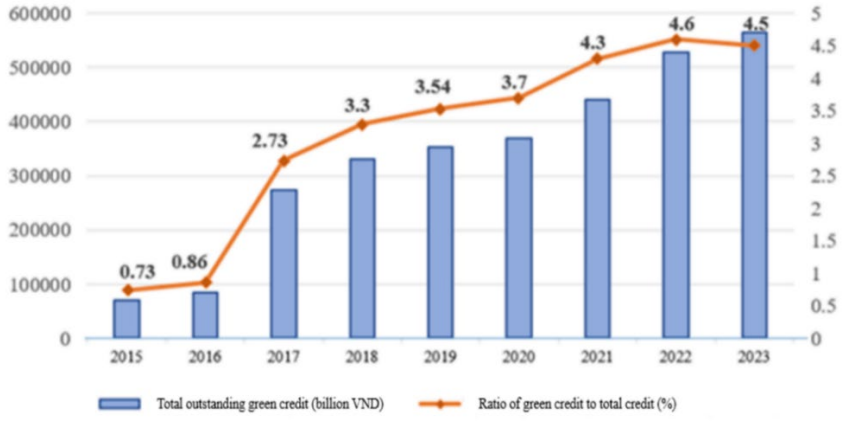

Figure 1 Growth of Green Credit in Vietnam, 2015–2023 by Industry and Trade Journal data

Although still in the early stages of development, green credit has become a major channel for financing environmentally friendly projects in Vietnam between 2015 and 2023. According to the State Bank of Vietnam, the proportion of green credit in total outstanding loans increased from 0.73% in 2015 to approximately 4.5% in 2023. By the end of 2023, total outstanding green credit had reached VND 568 trillion, reflecting the rapid expansion of green project financing in the country.

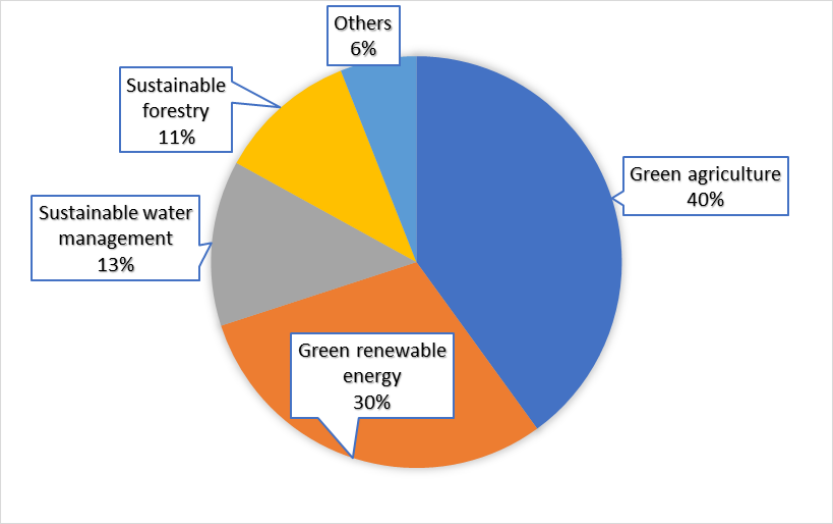

Figure 2 Structure of Green Credit Outstanding by Sector in 2023 by State Bank of Vietnam data

In 2023, the structure of green credit outstanding remained mainly concentrated in two key sectors: green agriculture (40%) and renewable energy (30%). In addition to these major sectors, there were also several emerging projects related to sustainable water management and sustainable forestry, accounting for 13% and 11%, respectively. Banks such as Vietcombank, BIDV, Agribank, and many other financial institutions have also actively participated in clean energy projects. As of March 2024, green credit has continued to maintain stable growth, with total outstanding loans exceeding VND 600 trillion, accounting for 5% of total outstanding credit. In addition, commercial banks have implemented numerous programs and preferential loan packages for enterprises and production facilities engaged in green projects, aiming to encourage and promote the growth of green credit.

Table 1 Selected Preferential Programs of Banks for Green Credit Loans by Banking Review Journal data

Bank	Loan Purpose	Interest rate	Loan term
BIDV and Agribank	Clean energy, green agriculture, and projects for pollution reduction or waste treatment	Medium - and long-term: 8.7%/year for the first 3 years; From the 4th year: 12-month savings rate + 4% margin	Minimum 2 years
VietinBank	Projects on energy saving and efficiency under the EIB Environmental Credit Program, GCBF Credit Program, and REDP Renewable Energy Project	Medium- and long-term: 8.1%/year	Minimum 2 years
Sacombank	Strategies, production processes, or loan purposes that are environmentally safe and contribute to ecosystem protection	Medium- and long-term: 8.5%/year in the first year; 9.5%/year thereafter	Maximum 8 years

Bank	Loan Purpose	Interest rate	Loan term
Nam A Bank	Investment, business, or consumption needs that are eco-friendly; projects promoting CO_2 emission reduction and energy savings of at least 20%	Short-term: 7%/year; Medium- and long-term: 8.8%/year for the first 24 months; Preferential package: 7.7%/year	Maximum 2 years
MBBank	Renewable energy sector and inclusion of green products in the loan portfolio (e.g., loans for energy-saving, renewable energy, solar energy, or waste treatment projects)	Medium- and long-term: 2.8%/year margin (normally 3%/year)	Maximum 15 years
HDBank	Renewable energy and high-tech agriculture projects; commercial and rooftop solar power projects	Approved on a case-by-case basis	Maximum 10 years
SHB	Projects related to renewable and clean energy	Preferential rate: 1% –1.5% lower than the regular lending rate	Maximum 10-15 years

Although green credit has received increasing attention and support from banks, it still faces several challenges. First, in terms of policy, the Government and relevant authorities have not yet established a clear legal framework for green credit projects, making it difficult to determine which projects qualify as "green" and what criteria should be used to assess their environmental impact. Second, from the banks' perspective, many institutions encounter difficulties in appraising and evaluating green projects due to limited expertise and experience. Instead of assessing the potential and long-term viability of projects, banks sometimes still rely heavily on the collateral value of enterprises when making lending decisions.

Research scope and subjects

The main research subjects are commercial banks operating in Vietnam, including both state-owned banks (such as Vietcombank, BIDV, and Agribank) and joint-stock banks (such as Techcombank, ACB, and VPBank). These banks provide green credit services, which refer to loans granted for projects related to environmental protection, renewable energy, or environmentally friendly business activities. Bank profitability is evaluated using key indicators such as profit before tax, net profit, return on assets (ROA), and return on equity (ROE). These measures will be analyzed to assess the impact of green credit on bank performance.

The research covers the period from 2015 to 2023, allowing for a comprehensive examination of changes in green credit policies and the development of green credit in Vietnam. This period is particularly important because it marks the time when the State Bank of Vietnam began to place greater emphasis on sustainable development and issued directives to promote green credit and sustainability. During these years, banks also started to introduce green credit products, making this timeframe highly relevant for examining the relationship between green credit and bank profitability, as well as its practical effects in Vietnam.

This study not only addresses the urgent need to promote sustainable development in the financial sector but also contributes to improving the operational efficiency of commercial banks in Vietnam. By combining theoretical foundations with modern quantitative analysis methods, the research provides valuable empirical evidence and proposes practical recommendations for both banks and regulatory authorities. These contributions are expected to help shape strategies for the development of green credit, bringing long-term benefits in economic, social, and environmental aspects in Vietnam.

3.2 Research Methodology

In this research, we use STATA software to perform the regression analysis. After data collection, the information is compiled into a panel dataset in Excel and then imported into STATA 17 for processing. Before conducting the regression, it is necessary to determine the most suitable and optimal model among the three - OLS, FEM, and REM. To select the most efficient model and avoid specification errors, several diagnostic tests are performed, including the Variance Inflation Factor (VIF) test for multicollinearity and the Hausman test to decide between the Fixed Effects Model and the Random Effects Model.

Once the appropriate model is identified, two additional tests - the autocorrelation test and the heteroskedasticity test - are conducted to enhance the reliability of the results. If the model exhibits either of these issues, the Feasible Generalized Least Squares (FGLS) method is applied to correct the problems and obtain more efficient regression estimates. This process ensures that the final model used for analysis provides accurate and consistent results suitable for the study's objectives.

Data collection and description: In this study on the impact of green credit on the profitability of banks in Vietnam, we collected data from 18 banks, including both domestic commercial banks and wholly foreign-owned banks, covering the period from 2015 to 2023. This period was chosen because it marks the time when the State Bank of Vietnam began issuing directives related to green credit, and when the green growth trend became a global movement. Studying this timeframe allows us to clearly observe how green credit has affected banks' operations, thereby assessing the extent of its impact on profitability, along with other influencing factors such as GDP growth and non-performing loan ratios.

The data were collected directly from financial statements and annual reports of the 18 banks, as well as from reputable financial websites such as Vietstock. To ensure the analysis is objective, the banks were divided into two groups. The first group consists of Vietnamese commercial banks (VIB, VPBank, SGB, VietinBank, Bac A Bank, Techcombank, BIDV, Sacombank, TPBank, MBBank, Agribank, ACB, Vietcombank, HDBank, and Nam A Bank). The second group includes wholly foreign-owned banks (HSBC, Shinhan Bank, and Public Bank). Although there are a few more foreign banks operating in Vietnam, their data availability is quite limited, making it difficult to include them in the study.

Research hypotheses: Based on the theoretical framework and previous studies on green credit, it is evident that this type of lending can have significant effects on the operational performance of banks. However, existing assessments of its impact remain inconsistent across different research contexts. Therefore, to contribute additional perspectives and empirical evidence to this topic, our study proposes the following hypotheses:

Hypothesis 1: An increase in green credit has a positive impact on the profitability of banks in Vietnam.

Hypothesis 2: The non-performing loan (NPL) ratio has a negative impact on the profitability of banks.

Model specification: Based on previous studies and Hypotheses 1 and 2, our group proposes the following regression model and variables:

$$ROA = \alpha_0 + \beta_0.GCR + \beta_1.CPR + \beta_2.SIZE + \beta_3.NPL + \beta_4.NIM + \beta_5.GDPG$$

Table 2 Variable description in the research model

Dependent variables	Calculation	Code
Return on Asset	The ratio of Net profit to Total assets, measuring bank profitability	ROA
Green Credit Ratio	The ratio of outstanding green credit to total outstanding credit, reflecting the extent of green lending activities	GCR
Credit Risk Provision Ratio	The ratio of credit risk provision expenses to total outstanding credit, indicating the level of risk management	CPR
Bank Size	The size of the bank measured by total assets	SIZE

Dependent variables	Calculation	Code
Non-performing Loan Ratio	The ratio of loans classified in groups 3, 4, and 5 to total outstanding credit, representing credit quality	NPL
Net Interest Margin	The ratio of net interest income to average earning assets, showing interest income efficiency	NIM
GDP Growth	Annual GDP growth rate of Vietnam, representing macroeconomic performance	GDPG

4. Results and Discussion

The data of 18 banks during the period 2015–2023 were collected, resulting in a total of 162 observations. The statistical values, including the maximum, minimum, mean, and standard deviation, are presented in the following table.

Table 3 Descriptive Statistics of Research Variables

Variable	Obs	Mean	Std.dev.	Min	Max
ROA	162	1.356	0.7897	0.03	3.77
GCR	162	0.035	0.017	0.0048	0 .186
CPR	162	-68.757	296.7598	-1858.865	2.5133
SIZE	162	488079.7	544592.2	9724	2300869
NPL	162	0.62337	2.464	0	12.528
NIM	162	0.1023	0.376	-4.482269	0.7058
GDPG	162	0.0607	0.0197	0.026	0.085

The descriptive statistics table shows that banks' ROA ranges from 0.03% to 3.77%, with an average of 1.36%, indicating a relatively stable profitability level. The average proportion of green credit (GCR) is 3.5%, reflecting that green lending activities in Vietnam remain modest and uneven across banks. The average bank size (SIZE) is VND 488,080 billion, with a high standard deviation, indicating significant disparities between large and small banks. The average non-performing loan ratio (NPL) is 0.62%, but with high volatility, suggesting that credit risk remains a concern for some banks. The net interest margin (NIM) shows a relatively low mean, reflecting differences in interest rate management and funding costs. Finally, the average GDP growth rate (GDPG) is 6.07%, consistent with Vietnam's overall economic performance during 2015–2023. Overall, the variables present reasonable values that accurately represent the banking sector; however, variables such as SIZE and NPL show high dispersion and should be normalized before running the regression model.

Table 4 Correlation Matrix of Research Variables

	ROA	GCR	CPR	SIZE	NPL	NIM	GDPG
ROA	1.0000						
GCR	0.1944*	1.0000					
CPR	0.0696	-0.1140	1.0000				
SIZE	-0.0696	0.3770*	-0.4049*	1.0000			
NPL	-0.0866	0.0857	-0.9640*	0.3929*	1.0000		
NIM	0.0908	0.1229	-0.0119	0.1355*	0.0132	1.0000	
GDPG	-0.0483	-0.2907*	0.0155	-0.0839	-0.0102	-0.0690	1.0000

The study conducted a correlation analysis among the variables. The results show that ROA has a positive and statistically significant correlation at the 10% level with GCR (0.1944), indicating that green credit contributes to improving banks' profitability. Meanwhile, ROA shows a slightly negative correlation with NPL and SIZE, implying that higher credit risk and larger bank size may reduce profitability, although these relationships are not statistically significant. Notably, CPR and NPL exhibit a very strong negative correlation (–0.9640), suggesting a potential multicollinearity issue that requires further examination. SIZE is positively correlated with both GCR and NPL, reflecting that larger banks tend to expand green lending but also face higher credit risks. Overall, except for the CPR–NPL pair, all correlation coefficients are below 0.8, indicating that serious multicollinearity is not widespread. However, it is advisable to remove or transform one of the two variables (CPR or NPL) to enhance the reliability of the regression model.

Table 5 Variance Inflation Factor (VIF) Test for Multicollinearity

Variable	VIF	1/VIF
CPR	14.41	0.069413
NPL	14.28	0.070014
SIZE	1.40	0.714863
GCR	1.29	0.777634
GDPG	1.09	0.913281
NIM	1.03	0.972182
Mean VIF	5.58	

Subsequently, to ensure the robustness of the model, we performed a multicollinearity test using the Variance Inflation Factor (VIF). The results show that the VIF values of CPR and NPL are both above 14, exceeding the threshold of 10, which indicates a strong multicollinearity problem between these two variables, because they both reflect the bank's capital adequacy and credit risk situation. This close economic relationship leads to a high linear correlation between the two variables, which results in severe multicollinearity in the regression model. Therefore, the research group decided to remove the CPR variable and retain NPL for further regression analysis.

Table 6 Variance Inflation Factor (VIF) Test after Removing the CPR Variable

Variable	VIF	1/VIF
SIZE	1.39	0.718391
GCR	1.28	0.783482
NPL	1.19	0.839860
GDPG	1.09	0.913395
NIM	1.03	0.972781
Mean VIF	1.20	

Table 7 Results of the Fixed-Effects (Within) Regression Model

Fixed-effects (within) regression	Nunber of ods = 162
Group variable: Bank	Number of groups = 18
R-squared:	Obs per group:
Within = 0.1678	Min = 9
Between = 0.0246	Avg = 9.0
Overall = 0.0002	Max = 9
	F(5,139) = 5.60
Corr(u_i,Xb) = -0.5097	Prob > F = 0.0001

ROA	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
GCR	1.835199	2.760518	0.66	0.507	-3.622835	7.293233
SIZE	7.27e-07	1.71e-07	4.25	0.000	3.98e-07	1.07e-06
NPL	-.0987256	.098152	-1.01	0.316	-.2927896	.0953384
NIM	.171466	.1071773	1.60	0.112	-.0404425	.3833745
GDPG	.3094218	1.996412	0.15	0.877	-3.63784	4.256684
_cons	.9619666	.1925944	4.99	0.000	.5811732	1.34276
sigma_u	.78474551					
sigma_e	.46962476					
rho	.73630493	(fraction of variance due to u_i)				
F test that all u_i=0: F(17, 139) = 16.71					Prob > F = 0.0000	

First, it is necessary to compare the Pooled OLS model and the Fixed Effects Model (FEM). The regression results of the FEM with 162 observations show that the model is statistically significant overall (Prob > F = 0.0001). The within $R^2 = 0.1678$, meaning the model explains about 16.78% of the variation in ROA across years within the same banks.

Among the independent variables, SIZE (bank size) has a positive and significant coefficient at the 1% level, indicating that larger banks tend to achieve higher profitability (ROA). Meanwhile, GCR (green credit ratio) and NPL (non-performing loans) show positive and negative signs respectively but are not statistically significant, suggesting that their impacts on ROA are not yet clear. Similarly, NIM and GDPG do not have significant effects on bank profitability.

The F-test (Prob > F = 0.0000) confirms that the individual effects among banks are significant, indicating that the FEM is more appropriate than the Pooled OLS model.

Table 8 Breusch–Pagan Lagrange Multiplier

	Var	SD = sqrt(Var)
ROA	.6236799	.7897341
e	.2205474	.4696248
u	.3712522	.6093047
Test: Var(u) = 0		
	chiba2(01) = 187.61	
	Prob > chibar2 = 0.0000	

Similarly, the group estimated the Random Effects Model (REM) and compared it with the Pooled OLS model. The Breusch–Pagan Lagrange Multiplier (LM) test was conducted to determine which model is more appropriate.

Null hypothesis (H_0): No random effects (Var(u) = 0) → Pooled OLS is suitable.

Alternative hypothesis (H_1): Random effects exist (Var(u) ≠ 0) → Random Effects model is suitable.

The test results show that $chibar^2(01) = 187.61$ and Prob > $chibar^2 = 0.0000 < 0.05$.

Therefore, we reject H_0 and conclude that the Random Effects Model (REM) is more appropriate than the Pooled OLS model for this dataset.

Table 9 Hausman Test Results (FEM vs. REM)

	---Coefficient---			
	(b) FEM	**(B) REM**	**(b-B) Difference**	**Sqrt(diag(V_b-V_B)) Std. err.**
GCR	1.835199	2.760518	0.66	0.507
SIZE	7.27e-07	1.71e-07	4.25	0.000
NPL	-.0987256	.098152	-1.01	0.316
NIM	.171466	.1071773	1.60	0.112
GDPG	.3094218	1.996412	0.15	0.877

Note: the rank of the differenced variance matrix (4) does not equal the number of coefficients being tested (5); be sure this is what you expect, or there may be problems conputing the test. Examine the output of your estimators for anything unexpected and possibly consider scaling your variables so that the coefficients are on a similar scale.

b = Consistent under H0 and Ha; obtained from **xtreg.**
B = Inconsitent under Ha, efficient under H0; obtained from **xtreg.**

Test of H0: Difference in coefficients not systematic
chi2(**4**) = (b-B) ' [(V_b-V_B)^(-1)](b-B)
= **10.87**
Prob > chi2 = **0.0281**
(V_b-V_B is not positive definite)

After estimating both the Fixed Effects (FE) and Random Effects (RE) models, the Hausman test was conducted to determine which model is more appropriate.

The results show $chi^2(4) = 10.87$ with Prob > $chi^2 = 0.0281$, which is lower than the 5% significance level. Therefore, we reject the null hypothesis (H_0) — that "the difference between estimators is not systematic." This means that the Fixed Effects model (FE) is more suitable than the Random Effects model (RE). This finding implies that there are bank-specific characteristics, such as governance structure, risk management capability, and business strategy that significantly influence performance (ROA), making the FE model the more reliable choice for this study.

Table 10 Results of the Hausman Test between Fixed Effects and Random Effects Models

Wooldridge test for autocorrelation in panel data H0: no first – order autocorrelation	
F(1, 17) =	6.173
Prob > F =	0.0237

After comparing the two models, the Fixed Effects Model (FEM) was found to be more appropriate than the Random Effects Model (REM). However, to ensure the model's reliability, two additional diagnostic tests were conducted: autocorrelation and heteroskedasticity tests.

The Wooldridge test for autocorrelation yielded F(1,17) = 6.173 with Prob > F = 0.0237, which is below the 5% significance level. Therefore, we reject the null hypothesis (H_0) of "no first-order autocorrelation," indicating that the model suffers from serial correlation in the residuals. This means that the error terms are correlated over time for the same bank, potentially leading to inefficient estimates. Hence, the model should be corrected using robust (clustered) standard errors to enhance the accuracy and reliability of the regression results.

Table 11 Results of the Modified Wald Test for Groupwise Heteroskedasticity

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model H0: sigma (i)^2 = sigma^2 for all i	
chi2 (18) =	11740.82
Prob > chi2 =	0.0000

The Modified Wald test result shows $chi^2(18) = 11740.82$ with Prob > $chi^2 = 0.0000$, which is smaller than the 5% significance level. Therefore, we reject the null hypothesis (H_0) that the error variances are constant across groups. This indicates that the Fixed Effects Model (FEM) suffers from heteroskedasticity, meaning the variance of the error terms differs among banks. Such a condition can lead to inefficient estimates and biased standard errors. To address this issue, the model should be corrected using robust or feasible generalized least squares (FGLS) estimation to obtain more reliable results.

Table 12 Results of the Feasible Generalized Least Squares (FGLS) Regression Model

ROA	Coefficient	Std. err.	z	P> |z|	[95% conf	.	interval]
GCR	7.679892	2.506265	3.06	0.002	2.767703		12.59208
SIZE	-3.73e-08	9.04e-08	-0.41	0.680	-2.14e-07		1.40e-07
NPL	-.0260138	.0152241	-1.71	0.088	-.0558524		.0038248
NIM	-.0263266	.0824474	0.32	0.749	-.1352674		.1879205
GDPG	2.477575	.6163109	4.02	0.000	1.269628		3.685522
_cons	.9043933	.0746636	12.11	0.000	.7580553		1.050731

Finally, the Feasible Generalized Least Squares (FGLS) model was employed to correct the issues of heteroskedasticity and autocorrelation detected in the previous FEM model. The results indicate that the model is statistically significant at a high level (Wald $chi^2(5) = 24.23$; Prob > $chi^2 = 0.0002$), suggesting that the explanatory variables collectively have a meaningful impact on banks' profitability (ROA). Specifically, the GCR variable shows a positive coefficient (7.6799) and is statistically significant at the 1% level ($p = 0.002$), implying that the expansion of green credit contributes to improving banks' profitability. Similarly, GDPG has a positive and significant effect at the 1% level ($p = 0.000$), reflecting a strong positive relationship between economic growth and banking performance.

Conversely, NPL carries a negative coefficient (–0.026) and is significant at the 10% level ($p = 0.088$), indicating that higher non-performing loan ratios reduce banks' profitability. Meanwhile, SIZE and NIM are statistically insignificant, suggesting that bank size and net interest margin do not have a meaningful impact on ROA during the study period. The research results indicate that green credit has a positive and statistically significant impact on the profitability (ROA) of Vietnamese commercial banks. The positive coefficient and the 1% significance level confirm that expanding green lending helps increase bank profitability. This finding implies that loans for environmentally friendly projects not only contribute to environmental protection but also bring economic value by enhancing the bank's reputation, attracting investors, and reducing long-term risks. In addition, economic growth (GDPG) shows a positive relationship with ROA, suggesting that a stable macroeconomic environment supports banking performance. Conversely, the non-performing loan ratio (NPL) has a negative coefficient, consistent with theoretical expectations, indicating that a decline in credit quality reduces profitability. Other variables such as bank size (SIZE) and net interest margin (NIM) are not statistically significant, implying that they are not the main determinants of profitability during the 2015–2023 period.

After correcting for heteroskedasticity and autocorrelation, the FGLS model was identified as the most appropriate. Overall, the results confirm that developing green credit is a strategic direction for Vietnamese banks to achieve a dual objective — improving profitability while promoting sustainable development and contributing to the transition toward a green economy.

5. Recommendations and Conclusions

5.1 Recommendations

It can be said that the development of the green credit market in Vietnam has made significant progress in recent years, as environmental protection and sustainable development have become increasingly prioritized by the Government, relevant ministries, and international financial organizations. However, during the implementation process, several challenges and barriers still exist. The following are proposed solutions to help overcome these limitations: Currently, definitions and regulations regarding green credit categories are not yet unified nationwide, causing difficulties for commercial banks in monitoring, selecting, and appraising green loans. In addition, this field still lacks standardized criteria, tools to measure environmental impacts, and a complete legal framework. Complicated loan procedures and strict environmental requirements also reduce demand for green credit products. Therefore, the Government and relevant authorities need to develop and unify a comprehensive system of definitions and regulations, providing consistent standards for banks to assess and appraise green projects. Moreover, a specific legal framework for green credit should be established, including environmental impact assessment tools and effective monitoring mechanisms. International standards such as the Climate Bonds Standard or Green Bond Principles can serve as useful references to build a supportive legal environment.

Banks should also design customized green credit packages for enterprises implementing environmentally friendly projects, such as carbon emission reduction, renewable energy development, or forest protection. At the same time, they can offer green loan products for individuals—such as loans to purchase electric vehicles, eco-friendly homes, or solar power systems. Banks need to ensure transparency and public disclosure of their green loan portfolios and investments, providing clear information to build trust among customers and investors.

Table 13 Legal Framework for Green Project Classification by ASEAN Taxonomy Board in 2021 data

Sector	Examples of Eligible Activities	Preliminary Quantitative Criteria
Renewable Energy	Wind power, solar power, biomass energy, small hydropower projects	≥ 95% of total output generated from renewable sources
Energy Efficiency	Equipment upgrading, green lighting systems, certified green buildings	≥ 20% reduction in energy consumption
Green Transportation	Electric vehicles, public transportation infrastructure, green logistics	≥ 25% reduction in CO_2 emissions per km
Sustainable Construction	Buildings certified by EDGE/BREEAM/LEED standards	Energy consumption < 70% compared to the standard level
Water & Waste Management	Wastewater treatment, recycling projects	Recycling rate ≥ 50%
Green Agriculture & Industry	Cleaner production processes, organic farming	≥ 15% reduction in greenhouse gas emissions
Green Finance	Issuance of green bonds, preferential green loans	Regular capital monitoring and reporting mechanisms

The research results confirm that green credit has a positive and statistically significant impact on the profitability (ROA) of Vietnamese commercial banks. This indicates that expanding green lending not only supports environmental protection but also enhances economic efficiency by improving banks' reputation, attracting investors, and reducing long-term risks. Therefore, promoting green credit should be considered a strategic direction to achieve both profitability and sustainable development in the Vietnamese banking sector.

First, the preferential mechanism should be improved. The Government needs to establish preferential interest rate policies for green credit projects to reduce borrowing costs for businesses, thereby minimizing risks and shortening payback periods. Banks can also cooperate with the Government or international organizations such as the World Bank (WB), Asian Development Bank (ADB), and Global Climate Fund (GCF) to develop green credit guarantee programs. These programs would help reduce risks and enable banks to offer more favorable interest rates for environmentally friendly projects.

Second, to ensure effective implementation and maintain a strong position in green finance, it is essential to train and enhance the capacity of bank staff regarding green credit criteria and evaluation methods. Banks should establish comprehensive training programs on green finance, environmental risk management, and green credit reporting aligned with international standards. This will help improve internal expertise and ensure that lending decisions support both profitability and sustainability objectives.

In summary, the findings reaffirm that developing green credit significantly contributes to bank profitability, as shown by its positive effect on ROA, while also generating environmental and social benefits. By improving preferential policies, establishing risk-sharing mechanisms, and strengthening human resource capacity, Vietnamese commercial banks can build a distinct competitive advantage, fostering both economic growth and sustainable development in the transition toward a green and resilient economy.

5.2 Conclusion

The study highlights the crucial role of green credit in promoting sustainable development not only in the banking and financial sectors but also across the national economy. The research findings confirm that green credit has a positive impact on bank profitability, particularly through the Return on Assets (ROA) indicator. Loans that finance environmentally friendly projects not only enhance the bank's image and reputation but also attract investment from international organizations, contributing to long-term benefits. However, the study also points out several major challenges faced by banks in implementing green credit, such as the lack of a clear legal framework and difficulties in assessing the risks and effectiveness of green projects. These issues highlight the urgent need to improve policy mechanisms, enhance transparency, and apply modern technologies to support the evaluation and appraisal process. By implementing practical solutions, such as establishing clear standards, offering preferential interest rates, fostering international cooperation, and strengthening human resource training, Vietnamese banks can maximize the benefits of green credit. More importantly, these efforts will help accelerate the country's transition toward a sustainable economy, mitigating the impacts of climate change and protecting the environment for future generations.

This research is expected to serve as a foundation for policymakers, banks, and other stakeholders to further develop appropriate policies and strategies that promote green credit, thereby generating long-term economic, social, and environmental value. In addition to the positive findings obtained, this study still has several limitations. First, regarding the research period and scope, the study was conducted within a relatively short timeframe, and the dataset was collected from only 18 out of 49 commercial banks in Vietnam. Therefore, the generalizability of the research results remains limited and may not fully reflect the overall picture of the Vietnamese banking system. Second, as green credit is still a relatively new concept in Vietnam, data related to this area are often insufficient or lack consistency. This limitation may affect the accuracy of the analysis and the validity of the conclusions. Third, the study focuses primarily on examining the overall impact of green credit on bank profitability without distinguishing between short-term and long-term effects, which may restrict a more comprehensive understanding of this relationship over time.

Based on these limitations, several directions are suggested for future research. Subsequent studies could address the existing shortcomings of this research to develop a more comprehensive understanding of the topic. Expanding the research sample to include more banks or the entire banking system in Vietnam would improve the representativeness and practical relevance of the findings. Furthermore, future studies should analyze the short-term and long-term impacts of green credit, helping banks design more effective strategies for green credit development in different time horizons. In addition, future research could also explore the influence of green credit on interest rates,

monetary policy, or total assets of Vietnamese banks to provide a broader perspective on the role of green credit in banking operations and in promoting sustainable economic development.

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