Asian Development Policy Review
ISSN(e): 2313-8343
ISSN(p): 2518-2544
DOI: 10.55493/5008.v12i3.5175
Vol. 12, No. 3, 335-348.

URL: www.aessweb.com

Empirical research on the impact of green credit development on the profitability of commercial banks

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Article History
Received: 26 April 2024
Revised: 6 August 2024
Accepted: 2 September 2024
Published: 23 September 2024

Keywords
Commercial banks
Green credit
Green finance
Profitability.

ABSTRACT

This paper examines empirical research on the impact of green credit development on commercial banks' probability. To promote the green transformation of the economy, the efficient use of resources, and the effective improvement of the ecological environment, it is necessary to vigorously promote the comprehensive development of green finance and the continuous improvement of the green financial system. In terms of improving the green financial system, efforts can start with green credit. This paper uses related data from 10 Chinese listed commercial banks from 2012 to 2020 as panel data, and employs Stata software for empirical research and analysis. The final empirical results show that launching a green credit business may, in the short term, lead to a decrease in the bank's profitability. The reason for this result may be that China has started developing green finance relatively late and for a shorter duration, so the time and number of entities selected for data are very limited. Moreover, the expansion of the green credit business means that while suppressing "two highs and one surplus" enterprises, it also leads to a significant reduction in their loans, thus affecting the profitability of commercial banks. Ultimately, we propose targeted suggestions that align with China's national conditions and enhance the green credit system.

Contribution/ Originality: The paper provides practical and effective targeted suggestions for China to better develop green credit. We propose improving and establishing China's sustainable development mechanism for green finance in accordance with its national conditions. It is critical to achieving the great goals of carbon peaking by 2030 and carbon neutrality by 2060.

1. INTRODUCTION

Population growth has exploded in an era of rapid technological advancement, making environmental pollution and energy conservation more visible to the public. The rocket-like growth of socio-economic development at the expense of the pollution of the natural environment and the excessive consumption of natural resources brings unbearable consequences. Expanding the scope of observation globally reveals the increasingly prominent phenomenon of abnormal climate warming worldwide, caused by the unrestrained excessive emission of greenhouse gases, coupled with the overconsumption of energy. These issues not only impose a huge burden on the ecological

environment but also make the comprehensive development path of future human society much more difficult (Xu & Chen, 2023; Zhu, Fang, Zhang, & Wang, 2024). Making the green financial system better and putting in place related green financial policies is very important for both society and the economy (Hou, Zhu, Wang, & Zhang, 2023; Lyu, Bai, & Zhang, 2024; Wang, 2023) because it leads to a green transformation of socio-economic development. Hence, for China, transforming the traditional economic development model into an innovative, green, and sustainable development model to promote ecological improvement and conserve energy consumption remains an ongoing effort. China needs to strengthen environmental protection and efficient energy use, enhance the ability to conserve energy and reduce emissions, develop a sustainable green economic system, and formulate related green and sustainable development policies, considering the perfection and development of the green financial system as an important strategy for promoting green and sustainable economic development in the future (Nenavath & Mishra, 2023; Song, Gong, & Song, 2024). Green financial products and related policies play a significant role in environmental protection and energy conservation.

With their special status, substantial capital, and excellent ability to regulate resources, commercial banks significantly influence the national economy, intentionally or not, during policy implementation. Therefore, with the goal of perfecting the green financial system, taking the effectiveness of implementing green credit services in the commercial banking industry as a reference is a beneficial approach (He, Ge, Ban, Du, & Sheehan, 2024; Nguyen, Do, Hoang, & Nguyen, 2023). By looking into how green credit services have affected the profits of regulated commercial banks since they started offering them, we can learn a lot that can help us make and change green credit policies in the future, which will help China reach its goals of carbon neutrality by 2060 and carbon peak by 2030.

The targets of reaching a carbon peak before 2030 and achieving carbon neutrality before 2060 have become major goals for China's future. Establishing a concept of green and sustainable development and a perfect green financial system is an inevitable path for China's future development. In 2020, General Secretary Xi Jinping pointed out that if the traditional development model is not transformed, the maladies it brings to human society will not only limit economic development in the near future but could also cause severe destruction to human civilization. Thus, the harmonious and sustainable development of the economy, ecological environment, and social responsibility represent a new trend for the future. As one of the green financial products, the impact of green credit on commercial banks plays a decisive role in the perfect implementation of green credit policies.

The social significance of developing green credit includes saving excessive resource consumption, promoting environmental protection, and making enterprises take on their social responsibilities, while its economic significance lies in helping to transform traditional businesses models, promoting sustainable development of banks while driving the development of intermediary business, thereby enhancing their profitability and strengthening the operational flexibility of banks. Therefore, if commercial banks can implement policies related to green credit, it can not only enhance the competitive level of enterprises but also bring them a good reputation, and further promote the transformation of the socio-economic environment towards a green and sustainable direction.

2. LITERATURE REVIEW

Cilliers, Diemont, Stobbelaar, and Timmermans (2010) considered that green credit instruments are the first step towards a multidisciplinary approach to green space planning. They viewed green credit instruments as a communication tools that offers and integrated approach to green space planning, enhances the value of green spaces, and promotes sustainable economic development in urban planning. Knobloch and Mercure (2016) found that firms would not focus on cost-effective green technologies; although barriers of economics can explain part of the gap, even behavioral aspects lead to further underestimation, which may be partly due to a systematic bias in the cognition and normative benchmarks of decision-makers, and partly due to their diversity. Eshet (2017) by using research analysis, proposed feasible recommendations, suggested that central banks should encourage projects like the Equator Principles more, to perfect the risk management process. These projects can show bank managers a better platform

for assessing various risks, thereby selecting the wisest green credit decisions. Scholtens and Dam (2007) found that financial institutions implementing the Equator Principle have a higher CSR (Corporate Social Responsibility) policy score than those that do not. Sun, Wang, and Li (2017) discovered that the development of green credit has a significant negative impact on commercial banks' credit risk, and increasing the scale of green credit of commercial banks can effectively curb the rise in the rate of non-performing loans. Song, Deng, and Wu (2019) used the GMM method to construct a dynamic panel system and empirically explored the impact of green credit on the profitability of domestic and foreign banks. From the final results, they concluded that bank profitability was positively affected by the Equator Principles, confirmed the hypothesis that green credit enhances bank profitability.

He, Li, Wang, Zhang, and Ma (2023) used 18 Chinese A-share listed automobile enterprises from 2012 to 2020 to study the effects and mechanisms of the Dual Credit Policy (DCP) on the Green Technology Innovation Efficiency (GTIE). According to their empirical results reported that the DCP significantly improved the GTIE of automobile manufacturers, but its effectiveness of this improvement diminished over time. Mirza, Umar, Afzal, and Firdousi (2023) used a broad sample of European banks from 2011 to 2021 and examined the relationship between financial technology adoption and bank profitability. By conducting a panel fixed-effects regression model, they found a positive correlation between fintech investments and green loans, owing to enhanced efficiency in search, due diligence, and monitoring processes enabled by new technologies. They also showed that investments in financial technology directly influence risk-adjusted capital returns by lowering costs, expanding product offerings, and reducing economic capital. Their research results highlighted the importance of factors such as firm size, human capital efficiency, and market concentration in shaping bank profitability and green loan decisions.

Wu and Wang (2023) checked the influence of green credit on digital technology innovation in China, by utilizing panel data from 271 prefecture-level cities from 2000 to 2020. The findings indicate that both the availability of green credit and the degree of financialization significantly enhance the relationship between green credit and digital technology innovation. Zhang (2023) choose provincial panel data from China spanning 2006 to 2019 to evaluate Green Total Factor Productivity (GTFP) using the Global-Malmquist-Luenberger technique based on the slack model. They investigated the influence of green credit on GTFP and its underlying mechanisms. They verified that green credit positively influences China's GTFP by facilitating industrial structure upgrades, stimulating green innovation, and optimizing energy consumption patterns.

Zhang (2023) based on a panel dataset at the enterprise level from 2014 to 2020, researched the link between the development of green finance and the quality of corporate Environmental, Social, and Governance (ESG) performance. The empirical evidence suggests that the development of green finance can effectively motivate ESG performance by mitigating corporate reactions to "greenwashing" behaviors. Shao (2023) utilized data from Chinese A-share listed companies from 2007 to 2020 to systematically analyze the impact of over-indebtedness on Green Technology Innovation (GTI). The empirical results indicate that corporate over-indebtedness significantly constrains their GTI, with excessive debt primarily suppressing corporate innovation by affecting research and development investments and raising the cost of debt. Hasan and Du (2023) used panel data from 30 provinces in mainland China from 1995 to 2020 to study the impact of green finance development and green technological innovation on China's sustainable development goals. The results of endogeneity and other robustness tests support the existence of a causal relationship, highlighting green finance innovation and green technology innovation as important pathways to achieving environmental sustainability.

Zhang, Wu, He, and Hao (2022) utilized data from 1036 Chinese A-share listed companies between 2008 and 2017 to study the impact of Green Credit Policies (GCP) on corporate technological innovation (TI). The study found that GCP significantly promoted TI both in quantity and quality among high-pollution and energy-intensive enterprises (HEE). The impact of GCP on TI of higher-level enterprises is asymmetric, reflecting different effects on enterprises of various ownerships and sizes. Zhang (2021) investigated the causal effect of green credit regulatory policies on green productivity and revisited the Porter hypothesis. By distinguishing R&D (Research and

Development) into environmentally induced R&D and production R&D, it was found that green credit regulatory policies significantly enhanced the growth of green total factor productivity (GTFP) rather than input-output TFP. Hao, Xie, and Liu (2020) studied the impact of China's Green Credit Guidelines on the technological innovation of heavily polluting firms. In their study, the main point is that the Green Credit Guidelines can improve the technological innovation level of heavily polluting enterprises, with a greater effect in regions with a higher degree of marketization, indicating that the Green Credit Guidelines play a positive role in technological innovation of heavily polluting enterprises. Luo, Fan, and Zhang (2017) used a mixed econometric model to figure out what role green credit plays in keeping the economy going. They used research samples from listed companies in China's energy conservation and environmental protection sector from 2007 to 2015 to test their ideas. The empirical results indicate: that financial performance and operational efficiency are below average, suggesting that internal capabilities of enterprises are not yet established; the issuance of green loans did not raise public expectations for green industry enterprises, thus the expectation channel is not supported; Green loans do not necessarily improve the operational efficiency and financial performance of enterprises; hence, the regulatory channel hypothesis does not hold; green loans lead to increased financing costs, management costs, operational costs, and R&D expenditures, partially supporting the capital allocation hypothesis.

Hu, Jiang, and Zhong (2020) looked at the current situation of green credit and industrial structure to explore the mechanism of green credit's impact on industrial structure, using a fixed-effect model constructed with sample data from the eastern, central, and western regions of China from 2006 to 2016. The results found that green credit mainly affects industrial structure through capital and financing, with a significant role of green credit in industrial structure transformation in China, and significant regional differences in the impact of green credit on industrial structure. To effectively promote industrial structure upgrading, establishing a sound green credit legal system, enhancing understanding of green credit, and implementing green credit according to local conditions are effective approaches for relevant stakeholders. Xu et al. (2020) aimed to analyze the relationship between green finance and corporate green performance using a meta-analysis method. To test the proposed hypotheses, the study used Comprehensive Meta-Analysis (CMA) software 2.0 for meta-analysis and applied the Hunter and Schmidt model for statistical analysis to test the proposed hypotheses. The study found a significant positive correlation between green finance and corporate green performance and proved that corporate type and region play a moderating role in the relationship between green finance and corporate green performance. However, profitability did not significantly moderate the relationship between green finance and corporate green performance.

Xie, Ouyang, and Choi (2020) based on urban economic data from 2011-2017 in China's Yangtze River Delta region, empirically explored the characteristics and influencing factors of green finance development through a time-fixed effects Tobin model. The empirical results indicate that green finance development in the Yangtze River Delta region exhibits a significant spatial clustering effect, with considerable regional differences. Regional GDP(Gross Domestic Product), level of innovation, and air quality are the most important factors, whereas the degree of financial development and the level of industrial structure optimization are not significant. Green finance development exhibits a positive correlation with regional GDP, whereas there is a negative correlation between the level of innovation and air quality. The main effects of regional GDP, innovation level, and air quality on green finance development are direct, whereas financial development and industrial structure optimization mainly relate to green finance development through spillover effects. Financial development has a positive spillover effect; in contrast, industrial structure optimization has a negative spillover effect. Wu and Hu (2020) utilized data from high-tech enterprises listed in Shanghai and Shenzhen from 2011 to 2016, testing hypotheses using a negative binomial distribution fixed effects model. The results show that government subsidies, in synergy with unabsorbed slack, effectively enhance corporate green technological innovation, whereas the synergy between government subsidies and absorbed slack negatively impacts corporate green technological innovation. There is an inverted U-shaped curve that shows how ownership concentration affects the relationship between green technological innovation, the synergistic effect of

government subsidies, and unabsorbed slack. The relationship with absorbed slack is not important. Zhou and Cui (2019) focused on Chinese listed companies that issued green bonds, examining the impact of green bond issuance on the companies, including the effect of green bond issuance announcements on stock prices and the impact of green bond issuance on corporate stock prices, profitability, and operational performance. The empirical results show that green bond issuance announcements positively affect stock prices, corporate profitability, operational performance, and innovation capability, enhancing the company's social responsibility.

Corporate green innovation has gained significant attention in both society and academia in recent years, but there has been limited discussions on its relationship with financing conditions. Based on stakeholder theory, they explore whether green innovation can alleviate corporate financing constraints, with empirical tests on non-financial private enterprises listed on the Shanghai and Shenzhen stock exchanges from 2012 to 2017. According to the results, green innovation, including green technological and management innovations, significantly reduces the firm's financing constraints. Meanwhile, the relationship between firm environmental information disclosure and green innovation was positive (Zhang, Xing, & Wang, 2020). Ebrahimi and Mirbargkar (2017) explored the relationship between firm green innovation and the development of SMEs under market turbulence conditions and the role of green entrepreneurship, by using a sample of 112 senior SME managers with Likert scale questionnaires. The results show a significant relationship between green innovation and SME development, where green entrepreneurship plays a significant mediating role. The relationship also holds under market turbulence, with green entrepreneurship acting as a mediator. Hall, Matos, and Bachor (2019) analyzed that proving the technological feasibility of green technologies is necessary but not sufficient; green tech companies must also engage in institutional work, in this case, clarifying the benefits of the technology to regulators to establish legitimacy and avoid potential misuse that could hinder adoption.

Sun, Zhan, and Du (2020) compared VAT preferential policies for different types of new energy companies in China and empirically studied the effects of VAT preferential policies on new energy-listed companies using the Difference-in-Differences (DID) method. The results show that VAT rebates in the new energy sector lower the Return on Equity (ROE) of the experimental group by 4.7 percentage points compared to the control group, primarily due to tax incentives causing industrial chain distortion, overcapacity, and a lack of innovation drive. He et al. (2020) found that the green finance index, which reflects the level of green development and the evaluation of smart cities' green development level have significant practical impacts on economic transformation. Using data from 2013-2019 and constructing a distributed lag model, the study found that green finance promotes the construction of smart cities, with the effects appearing nine months later.

Long, Yang, and Liu (2023) based on data from Chinese listed companies between 2008 and 2021 to conduct an empirical study on the effects of Green Credit Policy (GCP) on the total amount, quality, and quantity of green innovation in renewable energy enterprises (REE) by using a difference-in-differences (DID) model. This study looked at channel effects, moderating effects, and economic effects and found that the GCP made a big difference in the amount, quality, and quantity of green innovation in the rare earth industries. Lin et al. (2023) regarded China's GCP as a quasi-natural experiment and used a difference-in-differences methodology on data from Chinese listed enterprises spanning 2009 to 2020, in order to investigate the policy's impact on firm green innovation (GI). The results show that the GCP can enhance the strategic geographic index of heavily polluting firms while significantly reducing the basic geographic index, implying the absence of the Porter effect; in fact, this suppression is linked to heightened financing constraints, reduced government subsidies, lower enterprise R&D investments, and smaller employment sizes. Xiong, Masron, and Gondo (2023) also studied the impact of China's 2012 Green Credit Guidelines (GCG) on the quality and quantity of green innovation in heavily polluting enterprises as a quasi-natural experiment. According to their research results, they showed that the GCG significantly increased the quantity of firm green innovation but did not significantly improve the quality of such innovations. Their findings suggest that

implementing specific green fiscal policies alongside existing green credit policies could further promote the development of green innovation.

Li, Zhang, Shen, and Du (2023) checked the impact of the dual credit policy on the quantity and quality of green innovation in automobile firms using a DID model. The findings show that the dual credit policy enhanced corporate environmental responsibility and R&D investment, thereby improving corporate green innovation performance. Additionally, the reduction of government environmental subsidies and the intensification of governmental penalties significantly strengthened the effect of promoting green innovation. Zhou, Sun, Qi, Li, and Gao (2023) also regarded as the 2012 issuance of the Green Credit Guidelines (GCG) as a quasi-natural experiment, used data from Chinese A-share listed enterprises from 2007 to 2016, by applying a difference-in-differences (DID) model to test the effects of the green credit guidelines. Their results showed that GCG improved corporate ESG (environmental, social, and governance), with R&D investment acting as a mediating channel for the effect of GCG on environmental, social, and governance. Hong, Li, and Drakeford (2021) against the backdrop of the 2012 Green Credit Guidelines issued by the China Banking Regulatory Commission, collected panel data from 2825 Chinese listed companies from 2007 to 2018 to construct a double difference model to study the impact of green credit. The empirical results show that the green credit guidelines generally promote corporate green technological innovation and clarify the mechanism through which green credit promotes corporate green technological innovation, mainly by reducing debt financing rather than through financing constraints.

Gao, Mo, Duan, and Li (2022) viewed China's 2012 Green Credit Guidelines policy as a quasi-natural experiment to explore its impact on green innovation in heavily polluting enterprises. The results indicate that implementing green credit policy significantly promotes corporate green technological innovation capacity. Moreover, the mechanism suggests that the green credit policy can promote corporate green innovation by constraining financing space, increasing debt financing costs, and promoting corporate transformation and upgrading, among other channels. Further research finds that green credit policy significantly promotes green innovation in state-owned and large enterprises, but has a less significant effect on non-state-owned and small enterprises. Ling, Han, An, Hunter, and Li (2020) used a DID model to examine the impact of China's 2012 green credit guidance policy on technological innovation in pollution-intensive industries. In their research results, they show that GCG negatively affected both R&D investment and innovation output across enterprises of different ownerships and sizes. Further research indicates that GCG reduced long-term debt in pollution-intensive industries, thereby significantly decreasing R&D investment and innovation output; that is, long-term debt serves as a mediator between GCG and technological innovation.

3. EMPIRICAL STUDY ON THE IMPACT OF GREEN CREDIT ON THE PROFITABILITY OF COMMERCIAL BANKS

3.1. Principle of Indicator Selection

Before conducting empirical research, special attention needs to be given to the selection of indicators, requiring a global awareness and a focus on the overall concept. To ensure the accuracy of the final empirical research results, it is necessary to consider both internal and external indicators and analyze them. The selection of indicators should also be targeted and feasible. After selecting appropriate explanatory and dependent variables, it is also necessary to choose some suitable indicators as control variables, such as Capital Adequacy Ratio (CAR), Provision Coverage Ratio (PCR), Bank Asset Size (AS), and Debt to Asset Ratio (DAR).

3.2. Variable Design

3.2.1. Dependent Variable

The dependent variable selected for this paper is ROA, i.e., Return on Assets. ROA can intuitively show how much net profit can be obtained per unit; hence, it is often used to measure the strength of a bank's profitability.

Generally speaking, a higher ratio signifies that the enterprise has high efficiency in asset utilization and also possesses excellent capability in increasing profits and conserving capital use.

3.2.2. Explanatory Variable

The Green Credit Ratio, the proportion of green credit in the total loan portfolio, serves as the explanatory variable in this paper. Green credit can clearly indicate the level of green credit development of banks of various sizes since the implementation of green credit business.

3.2.3. Control Variables

3.2.3.1. Capital Adequacy Ratio (CAR)

The Capital Adequacy Ratio is usually applied to judge a bank's ultimate ability to repay debts. The Capital Adequacy Ratio can be used to determine whether a commercial bank has enough capital to cover losses when depositors and creditors lose assets. If a bank has a high CAR, it indicates that the commercial bank has a strong ability to resist risks and repay bonds, thereby enabling the commercial bank to develop steadily. At the same time, significantly increasing its CAR also means that the commercial bank's expansion capability is weakening, and its profitability will become weaker.

3.2.3.2. Provision Coverage Ratio (PCR)

The Provision Coverage Ratio is an indicator that can measure the risk level of a commercial bank's loans. Analyzing a commercial bank's Provision Coverage Ratio can determine its financial robustness and ability to control risks. An increase in the bank's PCR signifies that its strength to resist risks is also increasing, meaning the profit-generating assets will decrease as this ratio climbs.

3.2.3.3. Bank Asset Size (AS)

Bank Asset Size is an indicator to measure the overall size of a bank. The logarithm of the total assets of the commercial banks selected in this paper serves as a control variable for bank asset size, given their large total assets.

3.2.3.4. Debt to Asset Ratio (DAR)

The Debt-to-Asset Ratio is an indicator that can measure the strength of a bank's debt repayment level, as well as the safety level of loans issued by the bank. If a bank has a relatively high Debt-to-Asset Ratio, it reflects that the proportion of funds from debt is high in the total sources of funds, implying higher financial risks. The enterprise might face bankruptcy due to insufficient cash flow utilization and the disruption of the capital chain, unable to repay the debt on time before maturity. Table 1 presents all variable explanations.

Table 1. Variable definitions.

Variable	Abbreviation	Variable name	Variable formula
Dependent variable	ROA	Return on assets	Net profit/Average total assets*100%
Independent variable	GLR	Green loan ratio	Green credit balance/Total loan*100%
Control variable	CAR	Capital adequacy ratio	Total capital/Assets at risk*100%
	PCR	Provision coverage	Reserve for loan losses/Non-performing loans*100%
	LnAS	Bank assets size	Log of bank's total assets
	DAR	Asset-liability ratio	Total liabilities/Total assets*100%

3.3. Data Sources

This paper selects listed commercial banks in China as research subjects and conducts empirical research based on appropriate data regarding their green credit and bank profitability. Due to the relatively late start of green finance in China and the lack of an authoritative statistical system, it is difficult to find relevant data through publicly available channels on official websites. To ensure the authenticity and accuracy of the final empirical research results, the indicators used in this paper are obtained from statistical yearbooks, the official website of the China Banking Regulatory Commission, bank annual reports, the CSMAR (China Stock Market & Accounting Research) database, and social responsibility reports of related commercial banks, among other sources.

3.4. Empirical Model Analysis

This paper explores the changes in profitability brought to commercial banks under the implementation of green credit policies in China, amidst the vigorous development of green credit and the annual increase in the total amount of green credit. Therefore, it is necessary to comprehensively analyze factors such as the green credit ratio as explanatory variables in the base model of this paper and conduct empirical research to observe their impact on the profitability level of commercial banks. The empirical research model, which is based on the selection of variables and research analysis, is presented below:

$$ROA_{it} = c + \alpha_1 GLR_{it} + \beta_1 CAR_{it} + \beta_2 PCR_{it} + \beta_3 LnAS_{it} + \beta_4 DAR_{it} + \varepsilon_{it} \quad (1)$$

In the above equation, i represents the individual banks selected for the study, t denotes different time periods, c stands for the intercept term, α_i and β_i refer to the regression coefficients for different variables, and ε represents the error term.

4. REGRESSION RESULTS

4.1. Descriptive Analysis

Table 2 displays the results of a descriptive analysis of the study's variables. Analyzing the results of the descriptive analysis, the average value of the Green Loan Ratio (GLR) is 4.863, with a maximum value reaching 10.014 and a minimum value of 0.365. This indicates that the scale of green credit in various commercial banks is relatively small and there is a significant difference in the balance of green credit among different banks. The minimum value of the Capital Adequacy Ratio (CAR) is 9.8%, which exceeds the minimum capital adequacy ratio of 8% explicitly defined in the Basel Accord. This represents that Chinese banks possess a strong ability to withstand risks and repay debts.

Table 2. Analysis of statistics of variables.

Variable	Mean	Std.	Min.	Max.
ROA	1.038	0.212	0.657	1.467
GLR	4.863	2.637	0.365	10.014
CAR	0.146	0.019	0.098	0.174
PCR	2.346	0.908	1.316	5.234
LANS	10.938	1.221	8.236	12.718
DAR	0.895	0.011	0.921	0.954

4.2. Correlation Analysis

To ensure the accuracy of the empirical research results, it is necessary to perform a correlation test on the selected variables. If there is no correlation between the dependent variable, explanatory variable, and control variables, then proceeding with regression analysis would be meaningless. According to the analysis results shown in Table 3, there is a positive and significant correlation between the Return on Assets and both the Provision Coverage Ratio and Bank Asset Size. The Capital Adequacy Ratio and Debt-to-Asset Ratio, Bank Asset Size, Green Loan Ratio, Capital Adequacy Ratio, and Debt to Asset Ratio have correlation coefficients with absolute values

reaching 0.5. This suggests that multicollinearity is likely to distort the model. To prevent this situation, the Variance Inflation Factor (VIF) is used to conduct a multicollinearity test on the selected samples to measure the degree of collinearity among the explanatory variables.

Table 3. Pearson correlation analysis.

Variable	ROA	GLR	CAR	PCR	LANS	DAR
ROA	1					
GLR	0.041	1				
CAR	0.154	0.384***	1			
PCR	0.339***	-0.239**	0.092	1		
LANS	0.241**	0.615*	0.576***	-0.295***	1	
DAR	0.083	-0.325***	-0.812***	0.227**	-0.648**	1

Note: *** p<0.01, ** p<0.05, * p<0.1 represents 1%, 5%, and 10% significant level.

4.3. Multicollinearity Test

Table 4 presents the results of the multicollinearity test analysis. The Variance Inflation Factor (VIF) values for the explanatory variable and the four control variables did not exceed 10, and the average VIF value is 2.901. The selected samples show no multicollinearity, indicating the suitability and potential use of the variables for subsequent regression analysis.

Table 4. VIF test.

Variable	VIF	1/VIF
CAR	4.243	0.234
DAR	4.292	0.233
LANS	2.635	0.383
GLR	1.758	0.569
PCR	1.586	0.627
Mean	2.901	

This paper takes 10 listed commercial banks from 2012 to 2020 as the objects of research analysis. Based on these 10 listed commercial banks, an individual fixed effects model is established. After establishing the model, regression is conducted. Table 5 shows the results obtained from the regression.

Table 5. Results of regression analysis.

Variable	ROA
GLR	-0.015***
	(-3.487)
CAR	-3.234***
	(-3.391)
PCR	0.082***
	(-8.281)
LANS	-0.364***
	(-9.881)
DAR	-5.234***
	(-2.938)
Constant	10.212***
	(-5.091)
Observations	90
R^2	0.859
Company FE	Yes

Note: *** p<0.01, represents 10% significant level

Based on panel data from 10 listed commercial banks from 2012 to 2020, empirical research analysis was conducted. The analysis of the results obtained from the regression shows that the coefficient of determination of the regression equation is 0.859, indicating that the regression line is quite close to the observations, signifying that the model fits well. The F-statistic is infinitely close to 0, meaning the regression equation is highly significant.

The empirical study's final results indicate a negative correlation between the profitability of banks and the explanatory variable, the green credit ratio. Similarly, bank profitability also has a negative correlation with control variables such as bank asset size, capital adequacy ratio, and debt to asset ratio, while it has a positive correlation with the provision coverage ratio, indicated by a positive coefficient. The coefficient of the explanatory variable, the green credit ratio, is -0.015, signifying that for every unit increase in the green credit ratio, the return on assets of commercial banks decreases by 0.015 units. This suggests that engaging in green credit business over time may not be conducive to improving the profitability of commercial banks, contradicting the expected outcome that implementing green credit business would enhance bank profitability.

There are three main reasons for the negative correlation observed in the empirical results. The first reason is that compared to other countries, China's development in the green finance sector has a shorter history and a later start, with more restrictions on data retrieval. Therefore, the sample data both in terms of time and the number of entities is very limited, leading to a negative correlation between the explanatory and dependent variables in the final empirical results. The second reason is the short development duration of green credit business in China and the lack of professional knowledge in green credit, as well as the absence of a well-established internal operating mechanism and related policies for green credit compared to other countries. Information asymmetry issues have always made communication between banks, the government, and enterprises difficult, resulting in credit losses for banks. The third reason is that the implementation of green credit business has impacted the development of "two highs and one surplus" enterprises, while the main source of bank profits comes from loans to these enterprises. The implementation of green credit not only incurs costs for banks but also loses many customer resources, significantly reducing bank revenues. Investments in green-related projects have long investment cycles and slow capital return flows, unable to quickly compensate for the losses caused by banks' implementation of green credit business.

5. CONCLUSIONS

This paper first elucidates the importance and necessity of green credit for the development of green finance in China, then introduces the impact mechanism of green credit on the profitability of commercial banks and the current state of green credit development in China, and conducts theoretical analysis. It discusses the content of China's green credit policies and, after referring to the advanced experiences and early problems encountered by developed countries in green credit development, points out the persistent issues in China's development of green credit.

Based on targeted and feasible selection principles, relevant data from 10 listed commercial banks from 2012-2020 were chosen to construct a panel data model for empirical research, analyzing whether there is a relationship between green credit and bank profitability. The empirical results indicate that, at the current stage, green credit business is negatively correlated with the profitability of Chinese commercial banks. There may be multiple objective reasons for this result, such as a mismatch of maturities and limited sample data available. Therefore, although green credit has not yet significantly improved the profitability of Chinese commercial banks at this stage, based on the above analysis, it can be considered that the deep and effective implementation of green credit business will be beneficial for the long-term revenue of banks. To improve the green financial system, China has a long way to go in promoting the development of green credit.

In summary, judging by the effectiveness of the implementation of green credit-related policies, green credit can not only improve environmental quality and promote the green transformation of industrial structure but also has significant benefits for the healthy and sustainable development of banks and enterprises. The research in this paper

aims to provide practical and effective targeted suggestions for China to better develop green credit, hoping to offer some experiential reference and value for the deep implementation of green credit.

To smoothly achieve the great goals of carbon peaking by 2030 and carbon neutrality by 2060, it is necessary to have a deep understanding of the significance of these goals during the "14th Five-Year Plan," an important time for achieving these "dual carbon" targets. The 14th Five-Year Plan begins in 2020, and based on its requirements and implementation of dual carbon targets, we propose suggestions that are suitable for China's national conditions while also enhancing and establishing China's sustainable development mechanism for green finance.

(1) Establish and Perfect the Green Credit Legal System. Currently, most of China's green credit-related policies are of a principled nature and lack strong binding force. Thus, to foster a positive green financial environment, the state should formulate and improve related laws and regulations for green credit as soon as possible. The legal system should clearly define the social responsibilities that the banking industry and enterprises need to undertake, making it clear that their operations are not only about economic aspects but also about assuming corresponding social responsibilities to promote rapid and harmonious social development. The government should also work on perfecting incentive policies for green credit, rewarding banks that actively undertake social responsibilities and grant loans to environmentally friendly enterprises, and adopting incentive policies such as tax incentives and fiscal subsidies for banks that proactively respond to green credit policies to encourage the active participation of commercial banks.

(2). Strengthen the Reserve and Training of Related Professional Talents. One of the difficulties China faces in promoting green finance is the lack of professional talent, unlike foreign banking industries that have dedicated institutions and personnel for operating green credit. Having a professional green credit team can not only save the cost of hiring professional green credit teams from abroad but can also effectively reduce the credit risk that commercial banks may encounter when implementing such business according to the industry situation of our country. Therefore, it is suggested that commercial banks should first organize talents from multiple fields to form a professional green credit team, training and guiding related professionals while compensating for the lack of green credit professionals in China, and continuously cultivating new blood for the research path of green credit in the future. Professional talents can also be introduced from abroad to fill the gap in professional personnel during green credit training. China can also benefit from foreign experiences related to green credit to advance the progress of green financial credit business in China.

Funding: This study received no specific financial support.
Institutional Review Board Statement: Not applicable.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Upon a reasonable request, the supporting data of this study can be provided by the corresponding author.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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