An Empirical Analysis of Green Finance's Impact on Commercial Banks' Operational Performance

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Abstract

With the financial industry in various countries under strict regulation and interest rates increasingly market-oriented, the rise of the green finance sector has significantly impacted the operations of commercial banks. This influence is particularly evident in green credit, bonds, and insurance, which have emerged as critical components of sustainable finance. As a novel financial paradigm, green finance presents vast development prospects by linking economic growth with environmental sustainability. By actively developing green financial products and services, commercial banks can enhance their operational performance and create new profit growth opportunities. This study conducts an empirical analysis using data from state-owned, joint-stock, and city commercial banks to evaluate the relationship between green finance and bank performance. The findings reveal that green finance positively impacts the operational performance of commercial banks. Notably, green credit emerges as a significant driver, improving profitability while addressing environmental challenges. However, the study also identifies several challenges, such as the need for strategic alignment, product innovation, and enhanced risk management. Commercial banks must improve strategic planning, foster innovation, and strengthen their competitiveness to sustain momentum while maintaining a strong sense of social responsibility. These efforts will contribute to advancing green finance and enable banks to play a pivotal role in promoting sustainable economic development. This research provides valuable insights for policymakers and financial institutions aiming to align economic objectives with environmental goals.

Keywords: green financing, social financing, social sustainability, commercial banks, operations, green lending, profitability, financial regulation

Жасыл қаржыландырудың коммерциялық банктер операциялық қызметіне әсерін эмпирикалық талдау

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Түйін

Әртүрлі елдердегі қаржы индустриясы қатаң реттеуге және пайыздық мөлшерлемелердің нарыққа бейімделуіне байланысты жасыл қаржы секторының өсуі коммерциялық банктердің қызметіне айтарлықтай әсер етті. Бұл әсер әсіресе тұрақты қаржының маңызды құрамдас бөліктері ретінде пайда болған жасыл несиеде, облигацияларда және сақтандыруда айқын көрінеді. Жаңа қаржылық парадигма ретінде жасыл қаржыландыру экономикалық өсуді экологиялық тұрақтылықпен байланыстыру арқылы үлкен даму перспективаларын ұсынады. Жасыл қаржылық өнімдер мен қызметтерді белсенді дамыта отырып, коммерциялық банктер өздерінің операциялық көрсеткіштерін жақсарта алады және пайданың өсуіне жаңа мүмкіндіктер жасай алады. Бұл зерттеу жасыл қаржы мен банк қызметінің арасындағы байланысты бағалау үшін мемлекеттік, акционерлік және қалалық коммерциялық банктердің деректерін пайдалана отырып эмпирикалық талдау жүргізеді. Нәтижелер жасыл қаржыландыру коммерциялық банктердің операциялық көрсеткіштеріне оң әсер ететінін көрсетеді. Атап айтқанда, жасыл несие экологиялық мәселелерді шешу кезінде табыстылықты арттыратын маңызды драйвер ретінде пайда болады. Дегенмен, зерттеу сонымен қатар стратегиялық теңестіру, өнімді инновациялау және тәуекелдерді басқаруды жақсарту сияқты бірнеше қиындықтарды анықтайды. Коммерциялық банктер стратегиялық жоспарлауды жетілдіріп, инновацияларды дамытып, әлеуметтік жауапкершілік сезімін сақтай отырып, серпінді сақтау үшін бәсекеге қабілеттілігін күшейтуі керек. Бұл күш-жігер жасыл қаржыландыруды ілгерілетуге ықпал етеді және банктерге тұрақты экономикалық дамуды ілгерілетуде шешуші рөл атқаруға мүмкіндік береді. Бұл зерттеу экономикалық мақсаттарды экологиялық мақсаттармен сәйкестендіруге бағытталған саясаткерлер мен қаржы институттары үшін құнды түсініктер береді.

Кілт сөздер: жасыл қаржыландыру, әлеуметтік қаржыландыру, әлеуметтік тұрақтылық, коммерциялық банктер, операциялар, жасыл несиелеу, табыстылық, қаржылық реттеу

Эмпирический анализ влияния зеленого финансирования на операционную деятельность коммерческих банков

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Аннотация

Поскольку финансовая индустрия в разных странах находится под строгим регулированием, а процентные ставки все больше ориентированы на рынок, рост сектора зеленого финансирования существенно повлиял на деятельность коммерческих банков. Это влияние особенно заметно в зеленом кредите, облигациях и страховании, которые стали важнейшими компонентами устойчивого финансирования. Как новая финансовая парадигма, зеленое финансирование представляет огромные перспективы развития, связывая экономический рост с экологической устойчивостью. Активно разрабатывая зеленые финансовые продукты и услуги, коммерческие банки могут повысить свою операционную эффективность и создать новые возможности для роста прибыли. В этом исследовании проводится эмпирический анализ с использованием данных государственных, акционерных и городских коммерческих банков для оценки взаимосвязи между зеленым финансированием и эффективностью банка. Результаты показывают, что зеленое финансирование положительно влияет на операционную эффективность коммерческих банков. В частности, зеленый кредит становится значительным фактором, повышающим прибыльность и одновременно решающим экологические проблемы. Однако в исследовании также выявляется ряд проблем, таких как необходимость стратегического согласования, инновации продуктов и улучшенное управление рисками. Коммерческие банки должны улучшить стратегическое планирование, поощрять инновации и укреплять свою конкурентоспособность, чтобы поддерживать динамику, сохраняя при этом сильное чувство социальной ответственности. Эти усилия будут способствовать продвижению зеленого финансирования и позволят банкам играть ключевую роль в содействии устойчивому экономическому развитию. Это исследование дает ценную информацию для политиков и финансовых учреждений, стремящихся согласовать экономические цели с целями охраны окружающей среды.

Ключевые слова: зеленое финансирование, социальное финансирование, социальная устойчивость, коммерческие банки, операции, зеленое кредитование, прибыльность, финансовое регулирование

Introduction

This paper is dedicated to an empirical analysis of the impact of green finance on the operational performance of commercial banks. The study selects three state-owned banks in China—Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB), and Agricultural Bank of China (ABC)—as its sample. As large state-owned banks, these institutions hold a significant market share and influence in the banking sector, playing a crucial role in maintaining the stability and development of the national economy. Green finance refers to a financial model that promotes sustainable development and environmental protection through financial mechanisms. As global environmental issues become increasingly prominent, green finance plays a crucial role in addressing challenges such as climate change and resource scarcity. In China, relevant authorities are integrating "green" with the new development concepts of "innovation, coordination, openness, and sharing". At this stage, China's economy is transitioning toward green development, moving away from a past focus solely on high-speed growth. [1] This study aims to gain an in-depth understanding of the impact of green finance on the operational performance of commercial banks through empirical analysis. By doing so, it seeks to provide theoretical and practical guidance to encourage commercial banks to accelerate the development of green finance, improve their operational performance, and offer recommendations for achieving sustainable development.

Literature review

This article studies the impact of green finance on the operating performance of listed commercial banks. After reviewing the relevant literature on this topic, it is found that most scholars quantify the green finance and operating performance of commercial banks and then discuss the relationship between them. Therefore, when summarizing the literature, it is divided into the following two categories.

Evaluation of Green Finance
The development of green finance plays an indispensable role in national economic development. For instance, Xu Wenjuan (2011) highlighted that the implementation of green finance is an innovative environmental policy reform. By leveraging financial mechanisms within the market economy, industrial sectors shift from extensive growth to green, energy-saving, and emission-reduction-focused development, thereby adjusting the country's economic structure and promoting a transformation in economic growth patterns [2]. Regarding the evaluation of green finance, some scholars in Asia have adopted single indicators. For example, Li Su, Jia Yanyan, and Da Tanfeng (2017), Tao Xi (2016), Hao Qingmin, Wu Qianyue, and Ge Guofeng (2016) quantified green finance by using the year-end balance of green credit in commercial banks [3, 4, 5]. However, Zhang Xin (2017) disagreed with using the green credit balance as a metric, arguing that it does not effectively reflect the implementation of green finance. Instead, he suggested using a relative measure, such as the ratio of green credit balance to the total loan balance of commercial banks, to assess green finance operations [6]. Similarly, Wu Yingqian (2017) also used the green credit ratio for evaluation [7]. Scholars who rely on single

indicators to evaluate green finance often overlook the need for a comprehensive systematic assessment. Some scholars have emphasized the importance of constructing a green finance framework within the current market economy. They proposed using financial tools, such as green asset securitization, green loans, and green bonds, to address the challenges of high financing costs and difficulties faced by environmental enterprises. Similarly, Zeng Xuewen (2014) systematically built an evaluation system for the green finance operations of banks in China to measure the development level of green finance. The study concluded that since 2010, green finance operations have shown a steadily increasing trend [8].

In Western countries, the concept of green finance was explored much earlier than in other regions. For instance, Cowan E. (1999) conducted an in-depth discussion on the basic concept of environmental finance and its outward conceptual expansion [9]. Marcel Jeucken (2001) argued that green finance is not a newly introduced concept but rather an evolution of sustainable finance [10]. Sonia Labatt and Rodney R. White (2002) proposed that the specific implementation of environmental financing involves a social financing behavior aimed at optimizing the natural environment and reducing risks derived from environmental destruction through rational resource allocation [11]. Paul Thompson and Christopher J. Cowton (2004) suggested that implementing green finance is not solely focused on maximizing the economic benefits of commercial banks but involves evaluating enterprises during the loan approval process based on whether they use funds to fulfill environmental responsibilities. Enterprises are assessed against this criterion, and the evaluation results determine the issuance of loans [12]. Regarding the evaluation of green finance, they emphasize comprehensive evaluation methods. For example, E.J. Cilliers, E. Diemont, and D. J. Stobbelaar (2010) suggested that a value matrix method could be used to quantify green finance comprehensively. This is reflected in the value matrix, sets, and green compensation. Economic and environmental win-win outcomes can be achieved through these integrated analytical methods to promote sustainable development [13].

Evaluation of Operational Performance

A comprehensive review of existing literature on the evaluation of bank operational performance reveals that some scholars often employ methods such as factor analysis and principal component analysis when conducting independent studies on commercial bank performance evaluation systems. For example, Gu Haifeng and Li Dan (2013) and Gu Haifeng and Wu Di (2013) used these methods, which have the advantage of providing a comprehensive evaluation. However, the dimensionality reduction process can result in losing the original meaning of variables, making the interpretation of the metrics more challenging [14, 15]. In studies examining the impact of green finance on the operational performance of publicly listed commercial banks, most scholars have chosen single indicators to reflect bank performance. For instance, Zhu Jigao, Rao Pinggui, and Bao Mingming (2012) used the non-performing loan (NPL) ratio as a variable to explain bank operational performance from the perspective of loan management. They found that the NPL ratio negatively correlates with loan quality [16]. Similarly, Li Su, Jia Yanyan, and Da Tanfeng (2017) used the return on assets (ROA) as a reference indicator, arguing that the fluctuation trend of ROA reflects the rise and fall of a bank's operational performance.

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If ROA shows an upward trend, it indicates stable improvement in operational performance; conversely, a downward trend signals poor performance [3]. While the single-indicator approach offers clear and direct advantages, evaluating operational performance solely based on loan quality or asset returns lacks comprehensiveness and systematicity. A multi-dimensional perspective is needed to evaluate the bank's operational performance. For example, Liu Yunlin (2016) analyzed the operational performance of commercial banks from both profitability and risk perspectives. From the profitability perspective, ROA was selected, and from the risk perspective, the NPL ratio was used. This multi-dimensional indicator selection approach ensures that the evaluation method is both comprehensive and systematic [17].

In Western countries, research on the impact of green finance on the operational performance of publicly listed commercial banks emphasizes comprehensive evaluation methods, including data envelopment analysis, non-parametric analysis, parametric analysis, factor analysis, and principal component analysis. Some scholars introduced the principal component analysis method, which extracts principal components from the original variables through dimensionality reduction to achieve comprehensive scoring. West (1985) analyzed data from 1,900 U.S. banks over two years and used factor analysis to extract four main factors. Based on the characteristics of the variables, these factors were categorized as capital adequacy, asset profitability, asset quality, and asset liquidity, providing an overall evaluation of bank operational performance from these four dimensions [18]. Humphry and Berger (1997) argued that bank operational performance should be measured from an efficiency perspective and proposed using parametric and non-parametric analysis methods for comprehensive quantification [19]. From the perspective of banking operations, Penny Street and Philip E. Monaghan (2001) conducted an extensive analysis of three channels through which banks provide green financial services: electronic devices, online banking, and physical branches. They integrated these green financial service channels with bank operational performance to construct a systematic green finance framework, which was then used as a standard for assessing the operational capacity of banks [20]. Oliver Schmid (2000) examined the types of green financial service products and highlighted the importance of improving the structure of green finance for building a comprehensive evaluation system. He proposed focusing on green financial tools, including green financial products, green insurance, securities, and credit services, as well as their associated environmental benefits and risks. Based on these products and the benefits and risks they generate, he suggested a thorough evaluation of the environmental performance brought about by green finance, aiming to promote the maturity and systematization of green financial operations [21].

Research and Methodology

The data of this study comes from the CSMAR database, and an empirical analysis is conducted around the impact of green finance on the operating performance of commercial banks. Among the research subjects, the large state-owned banks selected are Industrial and Commercial Bank of China, China Construction Bank and Agricultural Bank of China. As large state-owned commercial banks, these three banks not only

occupy an important position in the banking industry, with significant market share and influence but also play a key role in the stability and development of the national economy. In addition, this study selected Ping An Bank, Industrial Bank, China Merchants Bank, and CITIC Bank as samples among the joint-stock banks. These joint-stock banks, known for their flexible operating models and market-oriented operations, have garnered significant attention for their performance in the field of green finance.

In addition, Hua Xia Bank and Ningbo Bank were selected from city commercial banks. City commercial banks play a critical role in local economies, and their operating characteristics and market performance are representative. By selecting banks of different types, this study aims to comprehensively understand the development of green finance among commercial banks in this region and conduct an empirical analysis of their operational performance.

Indicator system construction: To study the impact of green finance on the operating performance of commercial banks, the following indicator system is constructed: the explained variable is ROA (net profit rate of total assets = net profit/total assets); the explanatory variables are (green credit balance scale) green credit balance logarithm Lngreen, total assets Lnassets, capital adequacy ratio car, non-performing loan ratio NPLratio, and liquidity ratio LiquidityRatio. ROA refers to the ability of an enterprise to create net profit using all its assets, and the calculation formula is ROA = net profit/total assets. The green credit balance scale refers to the total amount of green credit outstanding at the current specific point in time. Total assets refer to the total value of all assets of an enterprise, including fixed assets, current assets, etc. Total assets reflect the capital scale and operating strength of an enterprise. Capital adequacy ratio refers to the ratio of a financial institution's capital to its balance sheet assets after deducting risk exposure. The non-performing loan ratio refers to the proportion of non-performing loans in a bank or financial institution to its total loans. The current ratio is an indicator used to measure the relationship between a company's current assets and current liabilities, and the calculation formula is current ratio = current assets/current liabilities.

Model construction: This paper uses a multivariate linear regression model to construct the formula. In this model, the explained variable is ROA (net profit margin of total assets), and the explanatory variable is the logarithm of green credit balance (Lngreen). The control variables include the logarithm of total assets (Lnassets), capital adequacy ratio (car), non-performing loan ratio (NPLratio), and liquidity ratio (LiquidityRatio).

The model formula is expressed as (1):

$$\text{ROA} = \beta + \beta_1 \times \text{Lngreen} + \beta_2 \times \text{Lnassets} + \beta_3 \times \text{car} + \beta_4 \times \text{NPLratio} + \beta_5 \times \text{LiquidityRatio} + \varepsilon \qquad (1)$$

In the formula, β is the intercept, which indicates the expected value of ROA when all explanatory variables and control variables take their baseline values; β_1, β_2, β_3, β_4, and β_5 are regression coefficients, indicating the degree of influence of each variable on ROA: ε is the error term, indicating the influence of other unconsidered factors on ROA.

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Correlation Analysis

As shown in Table 1, correlation analysis can further test and verify the factors that affect the profitability of commercial banks.

Table 1. List of correlation analysis results

Variable	code	Year	ROA	Lngreen	car	Lnassets	NPLratio
code	1						
year	0	1					
ROA	-0.210	-0.129	1				
Lngreen	0.209	0.134	0.477***	1			
car	0	0.926***	-0.0620	0.121	1		
Lnassets	0.285*	0.116	0.455***	0.922***	0.103	1	
NPLratio	0.407***	-0.169	-0.231	0.438***	-0.214	0.434***	1
LiquidityRatio	-0.284*	0.429***	-0.282*	0.0370	0.467***	-0.129	-0.00500
Type of bank	-0.234	0	-0.438***	-0.816***	0	-0.949***	-0.376**
L1 ROA	-0.124	-0.154	0.939***	0.539***	-0.146	0.542***	-0.209
L1 Lngreen	0.218	0.117	0.461***	0.995***	0.118	0.923***	0.391**
L1 Lnassets	0.286*	0.0900	0.427***	0.923***	0.0890	0.999***	0.374**
L1 car	0	0.846***	0.0140	0.0730	0.869***	0.0740	-0.211
L1 NPLratio	0.341**	-0.0700	-0.201	0.497***	-0.0810	0.502***	0.884***
L1 LiquidityRatio	-0.362**	0.282*	-0.119	0.00900	0.288*	-0.155	-0.0130
est fe3	0.194	0.354**	0.226	0.542***	0.317**	0.633***	-0.0390
est fe4	-0.117	0.426***	-0.202	-0.0340	0.382***	-0.0880	0.0770

	LiquidityRatio	Typeofbank	L1 ROA	L1 Lngreen	L1 Lnassets	L1 car	L1 NPLratio
LiquidityRatio	1						
Typeofbank	0.115	1					
L1 ROA	-0.410**		1				
L1 Lngreen	0.0160		0.548***	1			
L1 Lnassets	-0.151	-0.507***	0.530***	0.925***	1		
L1 car	0.438***	-0.823***	-0.0430	0.0980	0.0660	1	
L1 NPLratio	0.0180	-0.951***	-0.123	0.506***	0.511***	-0.136	1
L1 LiquidityRatio	0.780***	0	-0.234	0.0190	-0.153	0.338**	0.0100
est fe3	-0.0930	-0.443***	0.361**	0.605***	0.711***	0.108	0.150
est fe4	0.401***	0.105	-0.349**	-0.0710	-0.118	0.133	0.197

	L1 LiquidityRatio	-0.603***	est fe	est RE	est fe3	est fe4	
L1 LiquidityRatio	1						
est fe3	-0.200				1		
est fe4	0.342**				-0.302**	1	

Note: the authors conducted analysis based on data collected from the annual reports of Industrial and Commercial Bank of China, China Construction Bank and Agricultural Bank of China and the CSMAR database.

***$p<0.01$, **$p<0.05$, *$p<0.1$

A positive correlation exists between Return on Assets (ROA) and Green Finance (Lngreen), indicating that commercial banks' participation in green finance activities may

positively impact their profitability. Capital Adequacy Ratio (CAR) is also positively correlated with green finance, suggesting that commercial banks' capital adequacy level is related to their involvement in green finance projects, which may affect profitability. The scale of assets (Lnassets) is positively correlated with green finance, implying that an increase in asset size might be associated with greater participation in green finance activities, thereby positively influencing profitability. Non-Performing Loan Ratio (NPLratio), however, does not exhibit a significant correlation with green finance, indicating that participation in green finance projects may not directly affect the level of non-performing loans in commercial banks. Besides the above factors, the relationship between the Liquidity Ratio and the Type of Bank with green finance also requires further investigation.

Regression Analysis

The regression model results show that the F-statistic of the model is 11.00, with a p-value less than 0.001, indicating that the model is overall significant. The R-squared value is 0.5851, suggesting that the model explains 58.51% of the variance in the dependent variable, ROA. Controlling for other variables, the LnGreen variable positively impacts ROA, with a coefficient of 0.0006714 and a p-value of 0.009. The variables Lnassets, CAR, and LiquidityRatio do not significantly affect ROA. In contrast, the NPLRatio variable has a negative impact on ROA, with a coefficient of -0.0029223 and a p-value less than 0.001. Overall, the regression model is significant, and it has passed the Variance Inflation Factor (VIF) test, indicating that there is no strict multicollinearity. (Table 2)

Table 2. List of regression analysis results

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	
Lngreen	0.0006714	0.0002451	2.74	0.009	0.0001756	0.0011672
Lnassets	-0.0000583	0.0004592	-0.13	0.900	-0.0009873	0.0008706
car	-0.0005438	0.0004032	-1.35	0.185	-0.0013594	0.0002718
NPLratio	-0.0029223	0.0005942	-4.92	0.000	-0.0041241	-0.0017204
LiquidityRatio	-0.0000419	0.0000236	-1.78	0.083	-0.0000897	5.80e-06
Constant	0.0193842	0.0057009	3.40	0.002	0.0078531	0.0309153
R-squared	0.5851		Root MSE		0.00109	
Adj R-squared	0.5319		Number of obs		45	
F-test	11.00		Prob>F		0.0000	

Note: The author conducted an analysis based on data collected from the annual reports of banks such as the Industrial and Commercial Bank of China, China Construction Bank and Agricultural Bank of China, and the CSMAR database.

Year Fixed Effects Model Regression Analysis

Based on the given regression results, the impact of green finance on the profitability of commercial banks can be analyzed (Table 3).

Table 3. Summary of fixed effect output model results

Variable	y		
Lngreen	0.001** (3.05)	Observations	45
Lnassets	0.002 (0.73)	Number of code	9
car	-0.001 (-1.42)	R-squared	0.567
NPLratio	-0.000 (-0.32)	Company FE	YES
LiquidityRatio	-0.000*** (-3.48)	Year FE	YES
2016	-0.002** (-2.80)	F test	9.69e-06
2017	-0.001*** (-3.40)	r2_a	0.470
2018	-0.000*** (-3.85)	F	41.99
2019		Observations	45
Constant	0.005 (0.35)		

Note: The author conducted an analysis based on data collected from the annual reports of the Industrial and Commercial Bank of China, China Construction Bank and Agricultural Bank of China, and the CSMAR database. ***$p<0.01$, **$p<0.05$, *$p<0.1$

First, the regression results include a sample size of 45, with 9 different groups (codes) participating in the empirical analysis. The R-squared value of the regression model reflects the extent to which the model explains the dependent variable (ROA, i.e., profitability). In this model, the overall R-squared is 0.3007, indicating that the linear combination of all explanatory variables accounts for 30.07% of the variation in ROA. When only considering within-group variation (Within), the R-squared increases to 0.5666, meaning that the explanatory variables in the model account for 56.66% of the variation in ROA within groups. In addition to within-group variation, the model also considers between-group variation (Between), which explains 31.68% of the variation in ROA.

Next, the focus is on the coefficients and significance of the explanatory variables. The coefficient for Green Finance (Lngreen) is 0.0013088, with a standard error of 0.000429. This indicates that holding other explanatory variables constant, each unit increase in Lngreen will lead to an increase of 0.0013088 units in ROA. This coefficient is statistically significantly greater than zero (p-value = 0.016), meaning that Lngreen has a statistically significant positive impact on ROA.

The Lnassets (total assets) coefficient is 0.00121, with a standard error of 0.0022594 and a p-value of 0.488. This suggests that holding other explanatory variables constant, each unit increase in Lnassets will lead to a rise in 0.00121 units in ROA. However, statistically, this coefficient does not significantly differ from zero, as its p-value is relatively significant (greater than 0.05).

The coefficient for the CAR variable is -0.0013927, with a standard error of 0.0009817 and a p-value of 0.194. Thus, holding other explanatory variables constant, each unit increase in CAR will result in a decrease of 0.0013927 units in ROA. However, the difference between this coefficient and zero is insignificant from a statistical perspective.

The NPLratio (non-performing loan ratio) coefficient is -0.0002374, with a standard error of 0.0007324 and a p-value of 0.754. This indicates that each unit increase in NPLratio will lead to a decrease of 0.0002374 units in ROA. However, statistically, it

cannot be determined whether this coefficient significantly differs from zero, as its p-value is quite significant.

The coefficient for the Liquidity Ratio variable is -0.0000669, with a standard error of 0.0000192 and a p-value of 0.008. This indicates that holding other explanatory variables constant, each unit increase in the Liquidity Ratio will lead to a decrease of 0.0000669 units in ROA. The statistical results show that this coefficient is significantly different from zero. Lastly, attention should be given to the effect of years (year) on ROA. The regression results show that the logarithmic differences for 2016, 2017, and 2018 (2019 is not provided) all have negative coefficients with high significance levels. This suggests that commercial banks' profitability may have declined over time. In summary, based on the given regression results, The study concluded that green finance (Lngreen) has a positive impact on the profitability (ROA) of commercial banks; the impact of variables such as bank assets (Lnassets), capital adequacy ratio (CAR) and non-performing loan ratio (NPLratio) on the profitability of commercial banks have not reached statistical significance; the liquidity ratio has a negative effect on profitability; in addition, the year variable has an impact on the profitability of commercial banks, especially in 2016 and 2017.

Results

This study combined the results of model analysis to conduct an empirical study on the impact of green finance on the operating performance of commercial banks and drew the following conclusions. First, green finance has a significant positive impact on the operational performance of commercial banks. The empirical results indicate that commercial banks adopting green finance strategies perform better in terms of operational performance. This finding is consistent with other related research, confirming the positive role of green finance in commercial banking. Second, green credit positively influences the operational performance of commercial banks. The empirical results show that by allocating funds to green projects that meet environmental and social sustainability standards, commercial banks not only fulfill their social responsibilities but also achieve higher operational performance. Therefore, commercial banks should vigorously promote expanding the green credit business. Third, diversifying green financial products improves commercial banks' operational performance. The study reveals that providing various green financial products enables commercial banks to attract more customers and expand their market share, thereby enhancing operational performance. As a result, commercial banks should continuously innovate and launch more green financial products. Fourth, green finance plays a positive role in improving the risk management capabilities of commercial banks. The empirical results demonstrate that commercial banks adopting green finance strategies perform better in managing environmental and social risks, which reduces risk management costs and improves their risk management capabilities.

Based on the research conclusions, the following recommendations are proposed. Commercial banks should promote the implementation of green finance strategies by actively integrating environmental and social factors into their business decision-making processes. This includes formulating and implementing policies and measures related to

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environmental and social responsibilities to maximize the positive impact of green finance on operational performance. Additionally, they should further promote the development of green credit businesses by allocating funds to green projects that meet environmental and social sustainability standards, which not only helps fulfill social responsibilities but also enhances their operational performance. Commercial banks should also innovate and launch diversified green financial products to attract more customers and expand their market share. These products can include green loans, green bonds, and green investment funds, catering to the diverse needs of customers and providing new growth opportunities for the banks. Furthermore, commercial banks should optimize their green finance talent systems by establishing green finance research think tanks, encouraging experts and scholars to conduct green finance research, creating talent incentive mechanisms, and forming interdisciplinary research teams to integrate professional resources from different fields.

Conclusion

The rapid development of green finance has profoundly impacted commercial banks' business models and performance. This study highlights that green finance not only provides a platform for developing innovative financial products and services but also offers opportunities for banks to address climate change, sustainable resource utilization, and environmental protection. The development of green finance strengthens banks' sense of social responsibility, encouraging them to incorporate more environmental elements into financial services, thereby enhancing public trust and market competitiveness. However, the current development of green finance still faces numerous challenges, including incomplete policy incentive mechanisms, unstable market demand, and the lack of unified green standards. These challenges limit the comprehensive improvement of commercial banks' performance through green finance. Thus, commercial banks need to play a more significant role in improving the green finance ecosystem by aligning with policies, enhancing business innovation, and increasing financial support for green projects to promote green finance's widespread and in-depth development. In the future, commercial banks should actively optimize the structure of green financial products, explore more diversified green finance models, and strengthen risk management to ensure the sustainable development of green finance. By advancing green finance, commercial banks can contribute to the harmonious development of the economy, society, and environment while securing a more advantageous position in global competition and becoming leaders in responsible and sustainable development within the international financial market.

In conclusion, green finance presents significant potential and development opportunities for commercial banks, but its full realization requires collaborative support from policies, markets, and industries.

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