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Research on the Impact of Green Credit Scale on Commercial Banks' Operating Performance

-- Empirical Analysis based on Principal Component Analysis

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Abstract

With the gradual strengthening of environmental protection awareness, green credit in commercial banks has become the core of green finance development, and more and more banks began to develop green credit. To explore green credit scale of commercial bank on its business performance, this article selects 8 listed joint-stock commercial Banks in 2010-2020 data of principal component analysis, and divided into two classes: class A is the oldest began to implement green credit bank, class B is just starting to implement green credit bank, two kinds of green credit bank scale is large. The results show that the average comprehensive score of class A commercial banks is above that of Class B commercial banks. The scores of the two groups of commercial banks increased from 2010 to 2012, and began to decline in 2012, but recovered steadily after 2013, indicating that green credit has a positive impact on the business performance of commercial banks. However, when the scale of green credit is small, it is greatly affected by the external environment. With the expansion of green credit scale, The performance of commercial banks will continue to improve.

Keywords

Commercial Bank; Green Credit; Business Performance; Principal Component Analysis.

1. Introduction

Since 1978 the implementation of reform and opening up in China, has been more than 40 years of time, in the past 40 years of history, we create the "Chinese miracle", the country has been adhering to the economic construction as the center, the domestic economic development made a global look at the good grades, especially from 1978 to 2006, the rapid expansion in gross domestic product, With an increase of nearly 60 times, China's economy has achieved rapid and steady growth, and its overall national strength has continued to rise, becoming the world's second largest economy. But at the same time, we have appeared in the "growing pains", the traditional extensive economic development mode triggered a complex series of environmental problems, the contradiction between economic development and environmental protection in deepening, which makes the ecological environment in our country is facing unprecedented challenges, has seriously hindered China's economic and social sustainable development, the transformation of the mode of economic development is imperative. In 2016, the People's Bank of China and other seven ministries and commissions jointly issued the Guiding Opinions on The Construction of green Financial System, which strongly supported the innovation and development of green business and achieved remarkable results in green credit business. At the 18th National Congress of the Communist Party of China (CPC), ecological progress was included in the five-sphere Integrated plan of socialism with Chinese characteristics. The fifth Plenary Session of the 18th CPC Central Committee put forward five development concepts for the first time, emphasizing green development. The 19th National Congress of the Communist

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Party of China called for harmonious coexistence between man and nature and firmly advocated the socialist concept of ecological civilization. In 2018, the People's Bank of China issued relevant policy documents, requiring that green credit be included in the performance evaluation system of commercial banks.

The emergence of green credit inclines loans to environment-friendly and resource-saving enterprises and provides them with preferential loans; And raise the loan interest rate and reduce the loan amount for those enterprises with high energy consumption and high pollution, encourage enterprises to save energy and reduce emissions, and develop towards green cycle. In this context, commercial banks will change their previous loan model and favor environment-friendly enterprises with most of their loans, which is bound to affect their operating performance. Then, how will the implementation of green credit affect its business performance? Will different scales of green credit have an impact on its business performance? Is there a short-term and long-term difference in this impact? Answering these questions will make commercial banks realize the significance of developing green credit business.

2. Literature Review

As the development of green finance focuses on green credit, there are many studies on green credit at home and abroad, especially on the impact of green credit on commercial banks. Domestic researches on green credit are basically about whether green credit affects the business performance of commercial banks, and then they are studied from different perspectives. Ma Ping and Jiang Haifeng[1] (2009) believe that commercial banks need to carry out green evaluation of enterprises to increase the loan cost of commercial banks. Dai Xuxian[2] (2013) believes that the implementation of green credit in China's commercial banks is the result of policy promotion, and banks lack confidence in the profitability of green credit, which leads to the inactive implementation of green credit. Ye Weichao[3] (2016) adopted panel model LS-least Squares (and AR) for empirical study, and concluded that credit risk of commercial banks is affected by macro and micro factors and negatively correlated with loan size. Li Su[4] et al. (2017) studied the impact of green credit on the performance and risk of commercial banks and agreed that the implementation of green credit by banks is conducive to improving performance and reducing their risks. Gong Yuxia[5] et al. (2018) made an empirical analysis of the data of 15 commercial banks from 2008 to 2016, and obtained the main factors affecting business performance by using factor analysis method, and regression of dynamic panel model by using system GMM method, and concluded that the implementation of green credit has a positive impact on business performance of commercial banks. And primarily through monetization and security. Song Yawei[6] (2019) took the green credit data of 13 listed national commercial banks as the object of analysis and established a sequential game model for empirical analysis. He believed that green credit policies could help realize energy conservation and emission reduction of enterprises and reduce credit risks, so there was a positive correlation between green credit and financial performance. Wang Jianqiong and Dong Ke[7] (2019) conducted panel regression on the data of 12 banks that issued credit business from 2010 to 2017, and concluded that green credit has different effects on banks of different sizes. Zhang Lin and Lian Yonghui[8] (2020) analyzed the income structure of banks from the perspective of empirical analysis of 33 commercial banks, and concluded that green credit has different impacts on different financial indicators of commercial banks, but the financial performance of small banks with higher liquidity is improved more significantly. Gao Xiaoyan[9] (2020) conducted principal component analysis and panel regression on green credit data of 20 commercial banks, and concluded that green credit can improve bank business performance, but it has different impacts on different types of commercial banks and lags behind. Sun Hongmei and Yao Shuqi[10] (2021) analyzed green business and believed that the performance

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of green business has a lag and negative impact in the short term, but long-term performance can be achieved by reducing risks.

Foreign literature on the study of green credit is mainly on the performance of commercial banks and the adoption of the equator principle. Geaffrey[11] (2005) studied the relationship between environmental awareness and performance of commercial banks and found that although banks would invest part of their costs in environmental risk management, resulting in an increase in bank costs, they would avoid part of the losses caused by environmental risk management in the long run, thus achieving higher asset returns. Mathuva and Kiweu[12] (2016) explored the impact of social and environmental information disclosure on the financial performance of green credit, environmental policy and green operation of 212 savings institutions in Kenya. The results show that thrift institutions with more social and environmental responsibilities have lower returns on assets. Finger[13] et al. (2017) took 78 equatorial banks in the world from 2003 to 2015 as an example and found that roa and interest income of commercial banks in different regions, especially in developed and developing countries, changed differently or even showed a reverse relationship.

Green credit has been analyzed from multiple perspectives at home and abroad, but different scholars have drawn different conclusions on the impact of green credit on the business performance of commercial banks, and there is no consistent conclusion. This paper intends to make an empirical analysis on several commercial banks of the same type but with large differences in green credit scale by using principal component analysis to explore the impact of green credit scale of commercial banks on their business performance and whether it has timeliness.

3. Theoretical Analysis of the Impact of Green Credit on Commercial Banks' Operating Performance

3.1. Green Credit and Business Performance

The concept of green credit originates from green finance, which is an important part of sustainable development and an innovative financial tool that integrates environmental protection into the financial industry. The introduction of green credit has raised the threshold of enterprise loans. In credit activities, environmental testing standards and pollution prevention and control requirements are taken as important indicators, and environmental protection is guided by economic leverage, so that enterprises can internalize pollution and reduce pollution to the external environment. Changes in the credit standards could make loans of commercial Banks from high energy consumption, high pollution enterprise slowly into energy conservation and emissions reduction, environmental protection enterprises, but because this kind of enterprise to implement environmental protection project of response is slow, but also need to public scrutiny, all can lead to the operating performance of commercial Banks affected, therefore, This paper conducts empirical analysis on commercial banks that issue different green credit scales to study whether green credit scales have an impact on their business performance and what are the differences between such impacts in the short and long term.

To study the impact of green credit scale on commercial banks' operating performance, it is necessary to know the measurement indicators of commercial banks' operating performance. As is known to all, the operation of commercial banks is inseparable from the "three principles", namely profitability, safety and liquidity. Profitability is the core requirement of the operation of commercial banks. Commercial banks are also profit-oriented enterprises. Security is the premise of commercial bank operation, that is, to avoid the influence of some uncertain factors such as commercial bank assets; Liquidity is the embodiment of the solvency of commercial banks, that is, the ability to pay to meet the necessary loan needs. Therefore, this paper

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considers the business performance of commercial banks from the principle of "three characteristics" and selects indicators to measure profitability, safety and liquidity for quantitative analysis.

3.2. The Positive Impact of Green Credit on Business Performance

First of all, when commercial banks carry out green credit, they can effectively grasp the various national policies on green development, so that they can carry out credit business with the help of the policies and improve their earnings. The green environmental protection policy, along with our country to develop the enterprise energy saving and emission reduction, reduce energy-consuming enterprises, green credit to commercial Banks provide a huge demand for loans, and most of the emerging environmental protection enterprises are smaller private enterprises, commercial Banks may require a higher risk premium, so as to gain more benefits, improve business performance. Secondly, the green credit of commercial banks can improve the reputation of commercial banks, so as to obtain more environmental credit resources. Under the current social background with such strong awareness of environmental protection, enterprises with a high green reputation will turn to commercial banks to carry out green energy conservation and emission reduction projects, which will increase the credit scale of commercial banks. Finally, there are a series of standards for enterprises to provide green credit, and only those enterprises that meet the standards can make loans. Such a strict audit system reduces the risk of commercial banks' credit, and also reduces the environmental risk of commercial banks compared with loans to high-energy-consuming enterprises.

3.3. The Negative Impact of Green Credit on Business Performance

As green credit business is carried out under the support of policies, it is inevitable that the government will offer interest rate concessions for the implementation of policies, which limits the income of commercial banks and makes it impossible to obtain high returns like traditional loans. In addition, due to the late development of green credit, many enterprises have not achieved obvious results in energy conservation and emission reduction projects, which may lead to a long period of income for commercial banks and the risk of loss. In addition, the qualification examination of green credit issuance is quite strict, and many indicators need to be carefully screened. Therefore, it will increase the business cost of commercial banks and reduce their operating performance.

To sum up, green credit has both positive and negative impacts on bank financial performance, and the final comprehensive impact needs further empirical testing. Existing literature mainly studies the overall impact of green credit on commercial banks' operating performance from net interest rate on total assets and non-performing loan ratio. In fact, the scale of green credit will also affect the operating performance of commercial banks. Based on this, this paper will conduct an in-depth analysis of the impact of green credit scale on the operating performance of commercial banks.

4. Empirical Analysis of the Impact of Green Credit Scale on Commercial Banks' Operating Performance

4.1. Sample Selection

In 2007, the People's Bank of China and the environmental protection administration and other agencies jointly launched the "about the implementation of the views of the environmental protection policies and regulations to prevent credit risk", marked the green credit is launched in our country, and the first green credit business is some joint-stock commercial Banks, therefore, this article selects joint-stock commercial Banks are principal component analysis, Based on the data availability and research purposes, this paper selects the annual data of 8 listed joint-stock commercial banks from 2010 to 2020 and divides them into two groups: Class

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A banks are the four banks that implemented green credit earlier and have higher green credit ratio, namely industrial Bank, China Merchants Bank, Bank of Communications and Shanghai Pudong Development Bank; Class B banks are those with smaller scale of green credit, including China Citic Bank, Huaxia Bank, Everbright Bank and Ping An Bank. The data come from the annual reports and social responsibility reports of each bank.

4.2. Setting and Variable Selection

Principal component analysis is a mathematical statistics method, which uses the idea of dimensionality reduction to select the important variables of the selected variables through linear transformation. On the premise of minimizing information loss, it transforms multiple index variables into a few comprehensive indexes, and takes the few comprehensive indexes generated by transformation as the main components, in which each principal component is a linear combination of original variables, and each principal component is unrelated to each other. In this paper, STATA15 is used to carry out principal component analysis, which mainly includes principal component estimation, principal component suitability analysis, principal component rotation, prediction, score and so on.

The main steps of principal component analysis are as follows:

①KMO and SMC test. Verify that the data are suitable for principal component analysis.

②Standardize the original index data and eliminate factors such as different units of measurement. Let's say I have P random vectors $X_1,X_2,X_3,\ldots,X_P$ their values in the i-th analysis are $X_{i1},X_{i2},X_{i3},\ldots,X_{iP}$ where I =1,...,n. Expressed by the matrix:

$$X=(X_1,X_2,X_3,\ldots,X_P)=\begin{pmatrix} X_{11} & X_{12} & \cdots & X_{1p} \\ X_{21} & X_{22} & \cdots & X_{2p} \\ \vdots & \vdots & \cdots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{np} \end{pmatrix}$$

③Determine the number of principal components. Combined with the specific situation, the number of principal components M is generally determined according to the cumulative contribution rate ≥70% or the eigenvalue >1.

Table 1. Variable Index Information Table

Target classification	Indicators of detail	Index sign	Index properties
Profitability metrics	Return on total assets	roa	positive
	Cost-income ratio	cir	negative
Asset liquidity indicator	loan-to-deposit ratio	ldr	positive
	Asset-liability ratio	alr	negative
Safety index	Capital adequacy ratio	car	positive
	Non-performing loan ratio	npl	negative
The size of the indicators	Take the logarithm of total assets	ass	positive

④The comprehensive principal component score can be obtained by calculating the weighted sum of M principal components, and the weight of each principal component can be determined by the variance contribution rate of the principal component.

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Based on theoretical analysis of the performance of commercial banks, this paper focused on the "three virtues" of commercial banks and referenced the CAMELS rating system in the US to construct an indicator system that reflects profitability, safety, liquidity and asset size, as shown in Table 1.

4.3. Empirical Results and Analysis

As the data selected in this paper is panel data, the panel data is processed by Excel and the data is arranged in chronological order, which is convenient for principal component analysis and ensures the integrity of the system analysis. Before principal component analysis, stata15 was used to standardize the data according to the situation of the data, denoted as alr_s, roa_s, ldr_s, npl_s, cir_s, car_s, ass_s.

4.3.1. KMO and SMC Test

Before empirical analysis, we conducted KMO and SMC tests on 7 indicators to judge whether the data of each variable is suitable for principal component analysis. KMO is a value between 0 and 1. The higher KMO is, the stronger the commonality of variables is, and the more suitable for principal component analysis. In general, KMO value between 0.60-0.69 is barely acceptable, 0.70-0.79 is acceptable, above 0.8 is a good degree. SMC refers to the square of the negative correlation coefficient between one variable and all other variables, which is also the determination coefficient of the negative regression equation. A higher SMC indicates that the stronger the linear relationship of variables is, the stronger the commonality is, and the more appropriate the principal component analysis is. In this paper, the standardized data were tested by KMO and SMC, and the VALUE of KMO was 0.7472 (see Table 3), which was acceptable. SMC test results (see Table 2) were also suitable for principal component analysis.

Table 2. KMO and SMC Test Table

Variable	KMO	SMC
alr_s	0.8285	0.7786
roa_s	0.6282	0.4503
ldr _s	0.8489	0.7153
npl_s	0.7302	0.7244
cir_s	0.7211	0.5463
car_s	0.6745	0.7358
ass_s	0.7106	0.7806
Overall	0.7472	

4.3.2. The Empirical Test

Table 3. Characteristic Values and Contribution Rates of Each Component

Composition	The eigenvalue	Contribution	Cumulative contribution rate
1	3.9763	56.80%	56.80%
2	1.3318	19.03%	75.83%
3	0.8346	11.92%	87.75%
4	0.3293	4.70%	92.46%
5	0.2485	3.55%	96.01%
6	0.1640	2.34%	98.35%
7	0.1154	0.00%	100.00%

The verification data can be analyzed by principal component analysis, and STATA15 is used to obtain the characteristic value, variance contribution rate and cumulative contribution rate of each component (as shown in Table 3). According to the principle that the characteristic value

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is greater than 1 and the cumulative contribution rate is greater than 85%, the cumulative contribution rate of the first three components is greater than 85%, but the first two eigenvalues are greater than 1. In this paper, the first two components are selected as the main components, that is, the first two components basically cover the content of all indicators, which can explain the business performance of commercial banks.

Table 4. Characteristic Direction Table of Each Component

Variable	Component 1	Component 2
alr_s	-0.4376	0.1165
roa_s	0.1260	0.7540
ldr _s	0.3057	-0.3710
npl_s	0.2283	-0.4803
cir_s	-0.3988	-0.1137
car_s	0.4684	0.1344
ass_s	0.5183	0.1365

Through data rotation denoising, corresponding feature vectors are obtained (Table 4), and the expressions of the two principal components are as follows:

$$F1= -0.4376\ alr\_s + 0.1260\ roa\_s + 0.3057\ ldr\_s + 0.2283\ npl\_s - 0.3988\ cir\_s + 0.4684\ car\_s + 0.5183\ ass\_s$$

$$F2= 0.1165\ alr\_s + 0.7540\ roa\_s - 0.3710\ ldr\_s - 0.4803\ npl\_s - 0.1137\ cir\_s + 0.1344\ car\_s + 0.1365\ ass\_s$$

The comprehensive score of each commercial bank is calculated according to the contribution rate of the two principal components as the weight, and the calculation formula is as follows:

$$F = 56.80\% * F1 + 19.03\% * F2$$

Table 5. Comprehensive Score Table of Class A Commercial Banks

	Industrial Bank	China Merchants Bank	Bank of Communications	SPD Bank	Class A the Average Score
2010	-1.1139	-1.0573	-0.2042	-0.9294	-0.8262
2011	-0.9480	-0.4459	0.1614	-0.2757	-0.3771
2012	-0.2355	-0.1355	0.8971	-0.1028	0.1058
2013	-0.1035	-0.0147	0.4646	-0.1880	0.0396
2014	0.3321	0.2668	1.0286	0.2928	0.4801
2015	0.2413	0.4436	0.8445	0.5951	0.5311
2016	0.3376	0.5880	0.8689	0.4906	0.5713
2017	0.3626	1.5016	0.8494	0.7662	0.8699
2018	0.6181	1.7136	0.8968	1.2340	1.1156
2019	1.1214	1.8249	1.2709	1.4049	1.4055
2020	1.2726	1.9709	1.4840	1.4343	1.5405

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The calculation results are shown in Table 5 and Table 6, and the average scores of the two groups of commercial banks are obtained. According to the scores, Figure 1 is drawn. Some negative scores do not mean negative business performance, which is caused by the standardization of data.

Table 6. Comprehensive Score Table of Category B Commercial Banks

	China Citic Bank	Huaxia Bank	China Everbright Bank	Ping An Bank	Class B the Average Score
2010	-0.8435	-2.9890	-1.4795	-2.5632	-1.9688
2011	-0.0851	-2.0326	-1.0999	-1.2917	-1.1273
2012	0.1380	-1.8713	-0.8670	-1.6589	-1.0648
2013	-0.2528	-1.8824	-0.6278	-1.8655	-1.1571
2014	0.0547	-1.3247	-0.3391	-1.2260	-0.7088
2015	-0.0348	-1.0574	0.0378	-0.7681	-0.4556
2016	0.0269	-0.7198	-0.4554	-0.2400	-0.3471
2017	0.1599	-0.3392	0.2643	-0.4710	-0.0965
2018	0.4111	0.2877	0.3763	-0.2697	0.2013
2019	0.6582	0.7387	0.7229	0.3876	0.6269
2020	0.7238	0.5425	0.8483	0.4521	0.6417

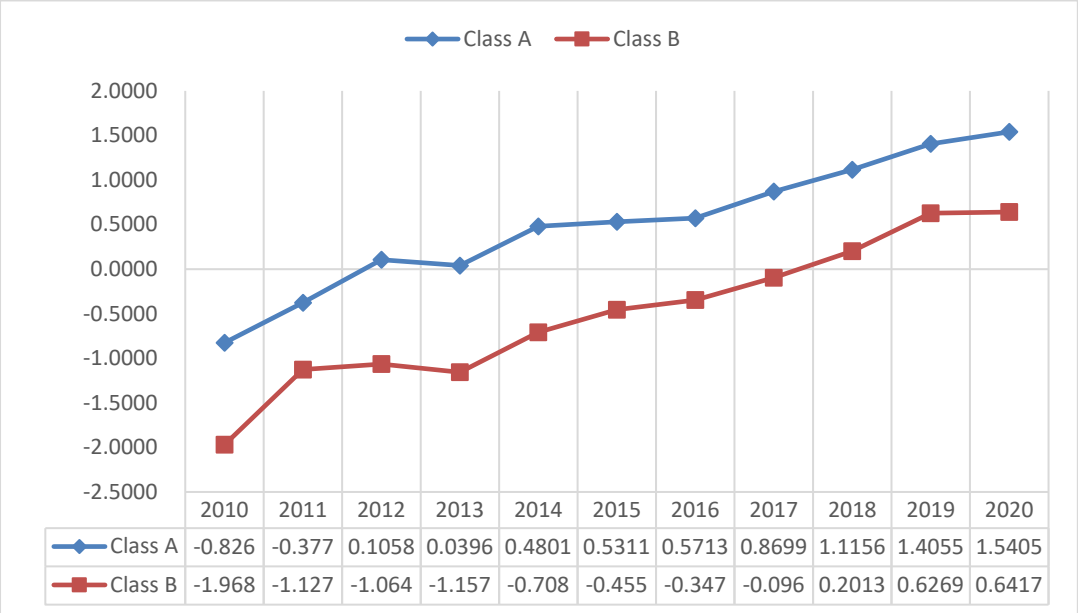

Fig 1. Comparison of Scores Between the Two Groups of Banks

4.3.3. Results Analysis

According to the comprehensive score results of principal component analysis, it can be clearly seen that the operating performance of the two groups of joint-stock commercial banks has improved in the 11 years from 2010 to 2020, but the changes are different. The average comprehensive score of B-type commercial banks has increased significantly from -1.9688 in 2010 to 0.6417 in 2020. The average comprehensive score of Class A commercial banks also increased significantly, from -0.8262 in 2010 to 1.5405 in 2020, but the range was smaller than that of Class B commercial banks.

Although class A commercial bank's comprehensive scoring average growth is slow, but every year the value of the above class B commercial Banks (as shown in figure 1), this is because in 2007 after the green credit business, bank, China merchants bank first opened up the road of

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green credit, and in constant exploration and improvement of green credit scale of commercial bank to 2010 are on the increase, Capital allocation is also being optimized. From the scores of the principal component analysis, concrete is mainly the second principal component contribution is more, the corresponding is profitability indicators, mainly after the implementation of green credit, commercial Banks for loans to credit procedures standardized treatment, in some of the loan process for effectively control cost and risk, makes business performance has improved, However, b-type commercial banks have just started green credit at this time, and their operating costs will increase.

From 2010, the scores of B-type commercial banks increased rapidly, and from 2010 to 2012, the scores of A-type commercial banks also increased significantly, because in 2010, the CBRC and the People's Bank of China jointly issued the "Opinions on Further Supporting Financial Services for Energy Conservation and Emission Reduction and Eliminating Backward Production capacity", and the government strongly supported the development of green credit. Other commercial banks have also started green credit business. After 2012 years the average scores of two groups of commercial Banks have appeared a downward trend, from all the scores of the principal component analysis, mainly is the first principal component scores declined, belong to the liquidity indicators, mainly to cut interest rates for the second time in a row, after a series of monetary policy, and market liquidity overall belong to the state of tight, This has led to the overall decline in the liquidity of commercial banks.

In terms of long-term development, although liquidity is tight in the overall environment of the market, the overall scores of the two groups of commercial banks showed an upward trend after 2013, and the increase of category A was slightly larger than that of Category B, which became more obvious after 2019. On the one hand, the scale of green credit of all commercial banks has been improved. A-type commercial banks have more reasonable allocation of funds in green credit, resulting in A steady increase in business performance. Developed on the other hand is the national policy, vigorously develop green credit, from the "green credit guide" to "green credit statistical system" to "green credit implementation key evaluation indicators", such as green credit system perfecting, makes commercial Banks on the development of green credit business running smoothly, not only to improve the business performance, also increase the effects the reputation of the bank itself.

Therefore the author believes that commercial Banks in implementing green credit business, it will increase cost lead to lower profits in a short time, but in the long run, with the increase of green credit scale, the loan system, process, gradually standardized and capital allocation under the condition of continuous optimization, will steadily improve the operating performance of commercial Banks. Under the background of positive response to environmental protection, the state strongly supports the development of green economy. Commercial banks should seize the opportunity to vigorously implement green credit and improve the operating performance of commercial banks.

5. Conclusions and Recommendations

5.1. Conclusion

The development of green credit business of commercial banks not only contributes to environmental protection, energy saving and emission reduction, but also reduces the environmental risks of commercial banks, thus promoting sustainable economic development. This paper makes an empirical analysis of joint-stock commercial banks in China by using principal component analysis method and finds that the average comprehensive score of the two groups of commercial banks is always higher than that of the b-type commercial banks. Since 2010, the comprehensive scores of the two groups of commercial banks have been improving, but in 2012, there was a slight decline; After 2013, the two groups of commercial

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banks showed a steady upward trend, but the rising speed was different. The main reason is that after 2010, major commercial banks began to implement green credit one after another, while the a-type commercial banks that took the lead in implementing green credit in 2007 had advantages in scale and capital, so their scores were always higher than b-type commercial banks. Interest rate cut and a series of monetary policies in 2012 reduced market liquidity and affected the liquidity of commercial banks. However, after 2013, a series of national policies were introduced to strongly support the development of green business, and the scale of green credit of commercial banks has been expanding. Therefore, in the long run, With the support of policies, the continuous improvement of credit system and the rational allocation of funds, the expansion of green credit scale of commercial banks can steadily improve the operation performance of commercial banks.

5.2. Put Forward the Proposal

In order to promote the effective implementation of green credit in commercial banks and improve the operating performance of commercial banks, this paper puts forward the following suggestions:

First, commercial banks can expand the scale of green credit in a planned way, or innovate other green products, and build a comprehensive system of green financial products, so as to improve business performance. At present, many commercial banks have a certain reputation and customer resources for green credit, but they mainly use green credit with a single product form. In order to improve the performance of commercial banks, some additional products can be added on the basis of green credit to improve their earnings.

Second, commercial banks need to improve their internal audit system and improve efficiency. When issuing green credit loans, it is necessary to make clear the situation of energy conservation and emission reduction of enterprises to invest funds reasonably and reduce credit risks. Formulate the corresponding risk monitoring system, and give real-time tracking feedback to each green loan issued, so as to effectively prevent risks.

Third, relevant government departments should also establish a sound system. As mentioned above, in the early stage of implementing green credit, commercial banks' profitability will be reduced due to imperfect institutional systems. Therefore, relevant departments should establish a sound green credit examination and supervision system and corresponding incentive mechanism to encourage commercial banks to carry out green credit.

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