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Research on the Impact of Green Credit on Commercial Banks' Profitability

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Abstract: The development of green credit business by commercial banks can not only guide enterprises to establish the concept of environmental protection, but also have an impact on the profitability of commercial banks themselves. This paper takes 20 listed commercial banks as the research subjects and selects data from 2009-2019 to empirically examine the specific impact of conducting green credit business on the profitability of commercial banks in China using a systematic GMM model.

1. Introduction

At present, green development is the main theme of China's economic development, and the green credit business born from it is in line with the mainstream trend and conducive to the sustainable and healthy development of China's economy. By carrying out green credit business, commercial banks in China have made a greater contribution to environmental protection, fulfilled their social responsibility, and improved their ability to coordinate the relationship between their own pursuit of profit maximisation and the transformation and upgrading of the national economy and industrial structure. However, the development of green credit business in China nowadays is relatively backward in terms of both theoretical research and concrete implementation compared with that of developed Western countries. Therefore, how to promote the rapid and stable development of green credit in China requires us to further improve both theoretically and in terms of practical practice.

2. Literature Review

A group of literature related to the study of this paper is the research on green credit. Green credit is a credit policy that commercial banks and other financial institutions implement when lending (He.L and L. Liu, 2018; Zhang, Le, 2020; Wang, Xiaqian and Luo, Yunxuan, 2020) [1-3], which on the one hand aims to limit the amount of loans to corporate projects that do not comply with environmental development strategies as a way to reduce the capital chain of enterprises; on the other hand, it promotes enterprises to constantly take social responsibility, thus contributing to sustainable development of enterprises (Hao Rui, 2017; Marcia Millon Cornett, 2016)[4, 5].

Another set of literature related to the study of this paper is a review of the impact of green credit

on the profitability of commercial banks. Different scholars have conducted studies under multiple perspectives; on the one hand, green credit has a positive impact on the profitability of commercial banks, and many scholars believe that green credit can enhance the profitability of banks by improving their risk control ability, optimizing credit structure, improving financial performance, and fulfilling social responsibility (Ruihong Wang, 2019; Naiwei Chen et al. 2018; Ming Yang 2018)[6-8] On the other hand, green credit may have a negative impact on commercial banks' profitability, mainly in terms of increasing banks' short-term costs, generating crowding-out effects, and increasing opportunity costs (Wang, 2018; Wu, Yingqian, 2017)[9, 10].

3. Empirical Study

3.1. Data Sources and Selection of Indicators

This paper mainly adopts the annual financial reports published on the official websites of 20 listed commercial banks in China between 2009 and 2019, as well as the social responsibility reports as the basis, and combines the data released by the Guotaian database, the Banking Regulatory Commission and the National Bureau of Statistics for analysis.

In terms of the construction of indicators, considering the specificity of commercial banks and the availability of data, this paper will select the following indicators for the construction of the model (see Table 1). The return on total assets (ROA) will be selected as an indicator of profitability in this paper. At the same time, considering the continuity and availability of data, the green credit ratio is selected as the core explanatory variable in this paper, and six control variables are selected: bank size (SIZE), gearing ratio (LEV), loan-to-deposit ratio (LDR), year of enterprise listing (AGE), national economic growth rate (GDP) and non-performing loan ratio (RONA). Among them, the loan-to-deposit ratio is the ratio of all loan balances to all deposit balances. Regulatory requirements indicate that China currently adopts the liquidity coverage ratio, loan-to-deposit ratio, and liquidity ratio as indicators reflecting the liquidity status of banks; the non-performing loan ratio also reflects the liquidity status of enterprises' assets, so this paper adopts two indicators, the loan-to-deposit ratio and the non-performing loan ratio, as control variables reflecting the liquidity status of banks.

Table 1: Selection and description of variables

	Symbols	Variable name	Variable Description
Explained variables	ROA	Return on assets	Net profit/average total assets
Explanatory variables	GLR	Green Credit Ratio	Green credit balance/total credit
Control variables	SIZE	Bank size	Logarithm of total bank assets
	LEV	Gearing ratio	Total liabilities/total assets
	LDR	Loan-to-savings ratio	All loans balance/all deposits Balance
	AGE GDP	Number of years on the market National economic growth rate	Number of years a listed bank has been listed GDP growth rate
	RONA	Non-Performing Loan Ratio	Non-performing loans/total loan balance

3.2. Research Hypothesis and Model Construction

After the above theoretical analysis, this paper puts forward the following hypotheses.

Hypothesis I: The higher the green credit ratio is, the lower the return on assets is.

Hypothesis II: The larger the size of the bank, the higher the return on assets, i.e., the SIZE has a positive and significant relationship with ROA.

Hypothesis 3: The green credit ratio has a lagged effect on ROA, which means that the lagged term of green credit ratio has a positive and significant effect on ROA in the dynamic panel regression process.

Combining the above theoretical analysis and the study and selection of dependent and independent variables, and to test the effects of the core explanatory variable, green credit ratio, and the five control variables, namely, capital adequacy ratio, bank size, non-performing loan ratio, non-interest income ratio, and deposit-to-loan ratio, on the explanatory variable, return on assets, respectively, this paper establishes the following model:

$$ROA_{it} = \beta_0 + \beta_1 GLR_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 LDR_{it} + \beta_5 GDP_{it} + \mu_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 GLR_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 LDR_{it} + \beta_5 GDP_{it} + \beta_6 RONA_{it} + \mu_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 GLR_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 LDR_{it} + \beta_5 GDP_{it} + \beta_6 RONA_{it} + \beta_7 AGE_{it} + \mu_{it}$$

Where, ROA denotes the explanatory variable return on assets, GLR, SIZE, LEV, LDR, AGE, GDP, and RONA are the explanatory variables, green credit ratio, bank size, balance sheet ratio, deposit to loan ratio, years of bank listing, national economic growth rate, and non-performing loan ratio, respectively. Variable subscripts i and t denote the data for the i-th individual year t, respectively, βi is the coefficient corresponding to the explanatory variables to be estimated, and εi,t is the random error term.

3.3. Model Testing

In many cases, we want to ensure that the variables are not co-linear with each other, mostly measured by the Variance Inflation Factor (VIF), which indicates the ratio of variance between the explanatory variables and the explained variables, with larger values indicating more serious co-linearity, generally above 10 being considered as having more serious multicollinearity. As can be seen from the test results, the maximum value is 6.98 and thus all indicators are not co-linear.

Table 2: Multicollinearity test

Variable	VIF	1/VIF
GLR	8.020	0.125
GDP	6.980	0.143
LDR	3.190	0.313
LEV	1.560	0.640
AGE	1.520	0.658
SIZE	1.330	0.754
RONA	1.120	0.893
Mean VIF	3.390	

3.4. Empirical Analysis

3.4.1. Descriptive Analysis

According to the descriptive analysis of 220 data of each indicator of the selected 20 listed

commercial banks, as shown in Table 2, most values of return on assets (ROA) do not differ much, and the mean value is about 0.01, which indicates that the changes of the 20 commercial banks in the past ten years are not significant and the differences are not obvious, thus indicating that the profitability level of the selected commercial banks is comparable and in a stable state.

Among the selected banks, due to the late development of green credit in China, as shown in Table 3, the green credit ratio (GLR) has a small difference between banks from the perspective of the maximum value (0.049) as well as the mean value (0.037), which indicates that the implementation of green credit does not vary much among banks.

Looking at other indicators with large variations, such as bank size (SIZE) with a minimum value of 7.310, a maximum value of 31.04, and a mean value of 16.30, the gap is large, and the standard deviation is 7.616, with a large value, indicating that the size varies among banks, and some larger banks may have economies of scale. The non-performing loan ratio (RONA) has a minimum value of 0.665 and a maximum value of 0.004, with a large difference, indicating that the management of non-performing loans across the banks still varies greatly from one another. The maximum value of years of enterprise listing (AGE) is 39 years and the minimum value is 2 years, indicating that there is still a large difference in the order of establishment between different banks.

The difference between the maximum value and the minimum value of both the asset-liability ratio (LEV) and the economic growth rate (GDP) is not large, so it shows that banks can manage their asset-liability ratio well while our economy is growing steadily.

Table 3: Descriptive analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	220	0.01	0.002	0.005	0.02
GLR	220	0.037	0.01	0.021	0.049
SIZE	220	16.297	7.616	7.31	31.036
LEV	220	0.934	0.011	0.9	0.966
LDR	220	0.713	0.061	0.635	0.839
RONA	220	0.029	0.1	0.004	0.665
AGE	220	17.5	7.584	2	39
GDP	220	0.077	0.013	0.061	0.103

(1) Correlation analysis

Table 4: Correlation analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) ROA	1.000							
(2)GLR	-0.370*	1.000						
	(0.000)							
(3) SIZE	0.047	0.051	1.000					
	(0.485)	(0.449)						
(4) LEV	-0.169*	-0.558*	0.019	1.000				
	(0.012)	(0.000)	(0.784)					
(5) LDR	-0.402*	0.809*	0.042	-0.555*	1.000			
	(0.000)	(0.000)	(0.539)	(0.000)				
(6) RONA	-0.066	0.165*	0.243*	0.000	0.127	1.000		
	(0.329)	(0.014)	(0.000)	(0.999)	(0.060)			
(7) AGE	-0.240*	0.409*	0.414*	-0.162*	0.366*	0.068	1.000	
	(0.000)	(0.000)	(0.000)	(0.016)	(0.000)	(0.314)		
(8) GDP	0.286*	-0.922*	-0.049	0.513*	-0.792*	-0.145*	-0.382*	1.000
	(0.000)	(0.000)	(0.473)	(0.000)	(0.000)	(0.032)	(0.000)	
*** p<0.01, ** p<0.05, * p<0.1								

We conducted correlation analysis on the data information to obtain Table 4: From the results of the correlation analysis, it can be seen that SIZE and RONA are not highly correlated with the explanatory variable ROA, and thus can be used as instrumental variables for the later endogeneity analysis, because these variables are correlated with the core explanatory variables and satisfy the conditions of the instrumental variables of the panel instrumental variables method.

Furthermore, the results show that GLR, CAR, LEV, LDR, and GDP are all significantly correlated with ROA. Moreover the economic growth rate GDP is positively correlated with the return on assets ROA, indicating that when China's economy grows, the earnings of commercial banks will also keep growing.

(2) Regressivity analysis

(i) Baseline regression analysis

For the panel data, there are generally fixed-effects models and random-effects models for us to choose, and to select the appropriate model is commonly judged by Hausman test, the larger the value of the Hausman test chi2, that is, the smaller the corresponding P value, generally its value if less than 0.05, then select the fixed-effects model, and vice versa, select the random-effects model, and finally according to the test results to obtain the fixed-effects panel regressions as shown in Table 5.

Table 5: Fixed effects panel regression analysis

	(1)	(2)	(3)
	ROA	ROA	ROA
GLR	-0.221***	-0.237***	-0.239***
	(-8.16)	(-4.98)	(-4.97)
SIZE	0.002***	0.002***	0.002***
	(5.05)	(4.38)	(4.09)
LEV	-0.101***	-0.101***	-0.101***
	(-8.49)	(-8.32)	(-8.30)
LDR	-0.018***	-0.019***	-0.019***
	(-7.29)	(-5.50)	(-5.48)
GDP	-0.076***	-0.076***	-0.077***
	(-4.32)	(-4.33)	(-4.33)
AGE		0.000	0.000
		(0.41)	(0.46)
RONA			0.000
			(0.32)
_cons	0.094***	0.095***	0.096***
	(7.10)	(7.09)	(6.95)
N	220	220	220
R-Square	0.520	0.520	0.520
Adj.R-Square	0.46	0.46	0.46
Hausman test	24.15 (0.000）	24.40(0.0001）	23.22(0.0003）
F test	6.93(0.000）	6.69(0.000）	6.65(0.000）
Moel select	FE	FE	FE

From the table above, it can be seen that the P-values in the Hausman test results of all models are much less than 0.01, thus the fixed effect model is chosen. It can also be seen from the F-test results of all models that their P-values are less than 0.01 and the model rejects the use of mixed effects, so the final model chooses the fixed effect model. From the regression results, at the 1%

significance level, the core explanatory variable GLR has a negative correlation with significant effect on the explained variables in all models; the explanatory variables LEV, LDR and GDP have a negative correlation with significant effect on the explained variables in all models; SIZE has a positive correlation significant effect on the explained variables, and from the fit and goodness of fit of the model, at least 46% of the sample data is explained, thus the overall regression results of the model are quite significant and credible. In terms of the regression results for the core explanatory variables, GLR has a negative significant effect on ROA in all models, indicating that hypothesis one is valid, and SIZE has a positive significant effect on the explanatory variables, indicating that hypothesis two is valid.

(ii) Heteroskedasticity serial correlation robustness test

Although the panel model can effectively reduce cross-sectional data heteroskedasticity and time series autocorrelation problems, however, it does not avoid these problems, thus the paper continues with autocorrelation as well as heteroskedasticity correction for panel regression analysis and the results are shown in Table 6.

Table 6: Heteroskedasticity corrected panel model

	(1)	(2)	(3)
	ROA	ROA	ROA
GLR	-0.221***	-0.237***	-0.239***
	(-3.66)	(-3.77)	(-3.79)
SIZE	0.002*	0.002	0.002
	(1.99)	(1.66)	(1.53)
LEV	-0.101***	-0.101***	-0.101***
	(-5.66)	(-5.23)	(-5.31)
LDR	-0.018***	-0.019***	-0.019***
	(-5.63)	(-3.80)	(-3.75)
GDP	-0.076***	-0.076***	-0.077***
	(-4.57)	(-4.51)	(-4.44)
AGE		0.000	0.000
		(0.28)	(0.31)
RONA			0.000
			(0.57)
_cons	0.094***	0.095***	0.096***
	(6.01)	(6.02)	(5.89)
N	220	220	220
R-Square	0.520	0.520	0.520
Adj.R-Square	0.51	0.51	0.50
Wald test	320.30	327.13	334.70
P	0.000	0.000	0.000

According to the table above: in terms of fit, the adjusted goodness of fit has been significantly improved, from 46% in the panel fixed effects model to over 50% at present, indicating an increase in the strength of sample interpretation. The heteroskedasticity robustness standard error model continues to be used to correct the model, and it is evident from the results of the Wald test that the original hypothesis that there is heteroskedasticity on the surface is strongly rejected, and thus for heteroskedasticity correction is necessary; it is evident from the results that at 1% significance level: the core explanatory variable GLR has a negatively correlated significant effect on the explanatory variables in all models, and the explanatory variables LEV, LDR, and GDP have a negative

significant effect on the explanatory variables in all models, and SIZE has a positive significant effect on the explanatory variables. Hypothesis one is again tested and hypothesis two is also tested.

Similarly, for the heteroskedasticity problem which can take heteroskedasticity correction model, then the solution of autocorrelation problem also needs to pass the serial correlation test, this paper continues to take the heteroskedasticity serial correlation panel correction model for further law analysis, the results are as follows Table 7.

Table 7: Heteroskedasticity serial correlation panel correction model

	(1)	(2)	(3)
	ROA	ROA	ROA
GLR	-0.221***	-0.237***	-0.239***
	(-9.13)	(-6.44)	(-6.42)
SIZE	0.002***	0.002***	0.002***
	(9.59)	(5.96)	(5.64)
LEV	-0.101***	-0.101***	-0.101***
	(-10.22)	(-10.70)	(-10.69)
LDR	-0.018***	-0.019***	-0.019***
	(-5.16)	(-4.14)	(-4.24)
GDP	-0.076***	-0.076***	-0.077***
	(-6.61)	(-6.54)	(-6.66)
AGE		0.000	0.000
		(0.48)	(0.53)
RONA			0.000
			(0.63)
_cons	0.094***	0.095***	0.096***
	(9.05)	(8.22)	(8.48)
N	220	220	220
Autocorrelation test	54.543	61.685	62.781
P	0.000	0.000	0.000

The model was again corrected for autocorrelation, and from the results of the autocorrelation test, it can be seen that the p-value is much less than 0.01, which strongly rejects the original hypothesis, indicating the existence of autocorrelation in the panel data of this paper, and thus it is necessary to further conduct the regression analysis using the panel correction model. From the results, it can be seen that at the 1% significance level: the explanatory variables LEV, LDR and GDP have a negative significant effect on the explanatory variables in all models, and SIZE has a positive significant effect on the explanatory variables, hypothesis one is again verified, and hypothesis two is also verified. Overall, the models used in this paper and the hypotheses are robust, then these conclusions are from static panel data, want to obtain a more complete analysis, need to further consider the core explanatory variables or lags of the explanatory variables to carry out a step dynamic panel analysis, the more popular in academia is the system GMM and differential GMM model, then use these two models to further stepwise regression, and the results are as follows.

Table 8: System GMM model

	(1)	(2)	(3)
	ROA	ROA	ROA
L.ROA	0.692***	0.699***	0.691***
	(11.58)	(11.61)	(11.30)
GLR	0.038	0.033	0.037
	(1.08)	(0.92)	(1.02)
SIZE	0.000***	0.000***	0.000***
	(3.73)	(3.72)	(3.48)
LEV	0.035***	0.033***	0.032***
	(2.94)	(2.70)	(2.62)
LDR	-0.002	-0.002	-0.002
	(-0.18)	(-0.23)	(-0.19)
GDP	-0.031	-0.030	-0.029
	(-0.44)	(-0.42)	(-0.41)
L.GLR	-0.076	-0.080	-0.082
	(-0.92)	(-0.96)	(-0.99)
L2.GLR	-0.214***	-0.209***	-0.207***
	(-3.15)	(-3.05)	(-3.03)
L3.GLR	0.236**	0.240**	0.241**
	(2.07)	(2.09)	(2.10)
RONA		0.001	0.001
		(1.61)	(1.46)
AGE			-0.000
			(-0.69)
_cons	-0.027	-0.025	-0.024
	(-1.57)	(-1.42)	(-1.37)

As can be seen from the results of the systematic GMM regression, this paper uses dynamic panel regression analysis with lags one to three of the core explanatory variables. The previous static panel regression results have concluded that GLR has a negatively correlated significant effect on ROA, however the results in table 8 above show that lag one GLR does not have a significant effect on ROA, lag two GLR still has a negatively correlated significant effect on ROA, while the positive significant effect of GLR on ROA with three lags suggests that banks with higher green credit ratios do not earn high returns in the current period, but rather reflect them in future years, thus meeting the expectations of hypothesis three.

4. Conclusions and Recommendations

4.1. Conclusion of the Study

The empirical study in this paper shows that conducting green credit business can improve the profitability of commercial banks. In the empirical analysis, it is found that the green credit ratio is positively related to the return on assets, indicating that an increase in the green credit ratio will lead to an increase in the bank's return on assets, and thus the bank's profitability will be enhanced.

From the analysis of relevant indicators, five control variables, such as the return on net assets rate and non-performing loan rate, all have an impact on the profitability of commercial banks, therefore, commercial banks should take all aspects into consideration when carrying out green

credit business. From the results of the empirical analysis, the non-performing loan rate has a negative and significant impact on the return on assets, and its coefficient is high, which will affect the profitability of banks to a greater extent, so banks should also pay attention to the control of risk when carrying out green credit business.

4.2. Research Recommendations

First, from the bank's own perspective, commercial banks should establish an awareness of green credit risk management and effectively enhance their ability to bear and live up to the risks; at the same time, it is necessary to set up special institutions for business operations, train professional talents, study and learn from successful experiences at home and abroad, and continuously promote the professionalization of green credit business; Finally, they should increase technological research and development, and continuously innovate and launch green credit products to meet market demand.

Second, from the government's perspective, the government should establish and improve green credit laws and regulations, so that green credit can be carried out in accordance with the law; it should also establish a credit support system such as financial subsidies, tax breaks and cost subsidies to substantially promote the development and progress of commercial banks' green credit business; and it should also continuously improve the construction of an environmental protection information communication and sharing platform to ensure that commercial banks make effective credit decisions.

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