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Does The Enhancement of Profitability Necessarily Reduce Bank Credit Risk?

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Abstract

Based on the data of China's listed banks from 2010 to 2018, this paper uses panel data model and threshold model to examine the impact of profitability on credit risk of commercial banks. The results show that: (1) After controlling the influence of bank size, the growth rate of net profit is negatively correlated with credit risk; (2) With the same growth rate of net profit, the larger the bank scale, the smaller the credit risk. At the same time, with the decrease of the growth rate of net profit, the influence of bank size on credit risk increases; (3) When the bank scale is large enough, the growth rate of net profit is positively correlated with the credit risk of the bank. This paper discusses the interaction between bank size and profitability and credit risk, which is of guiding significance to banks' risk management.

Keywords: net profit growth rate, asset size, credit risk

1. Introduction

In the 2019 executive report of monetary policy, on the basis of the original monetary policy objectives such as "maintaining reasonable and stable liquidity", the central bank specially proposed that "we should grasp the rhythm and strength of risk disposal, timely resolve the liquidity risk of small and medium-sized financial institutions, and resolutely block the spread and spread of risk". Under the background of great economic downward pressure and the continuous promotion of structural deleveraging, some banks are facing greater pressure. Since 2019, along with the takeover of the Baoshang bank, the reorganization of Jinzhou bank and the capital injection of Hengfeng bank, banking risk events have drawn high attention to commercial banks' credit risk.

Based on existing research, this paper mainly expands in two aspects. Firstly, we describe the relationship between net profit growth rate and bank credit risk in detail by using the data of 16 listed banks. We also test the threshold effect of net profit growth on banks' credit risk because of different size. The rest of this paper is arranged as follows: the second part is literature review and research hypothesis, the third part is research design, the fourth part is empirical results and analysis, the fifth part is conclusions and suggestions.

2. Related Literature and Hypotheses

Existing literature on credit risk is mainly based on the probability of default and the rate of default loss. Probability of default refers to the possibility that the debtor cannot repay the principal and interest in full or perform relevant obligations in accordance with the requirements of the contract in the future. The credit risk analysis method based on default probability is called credit score method. By giving different weights to the key factors that affect the probability of default, a score can be calculated. The score can be interpreted as the probability of default of the company or the credit rating can be divided according to the threshold value. There are four main credit scoring models: linear probability model, such as zeta model, logit model, probit model and discriminant analysis model. Another kind of model is based on the option pricing model of black and Scholes (1973), which regards the company's equity as a call option with the company's debt as the strike price and the company's assets as the target. Later, Merton (1973, 1974), black and Cox (1976) and Ingersoll (1977) made this model more mature. Default loss rate refers to the percentage of the amount of loss caused to the creditor once the default occurs. The size of the loss due to default is not only affected by the qualification of the borrower, but also affected by the specific terms of the contract, such as mortgage and guarantee. According to the state of our country and the data availability of the loss rate of default, it is difficult to use models based on the loss rate of default.

Based on Black Scholes option pricing theory and Merton structure model, Gray, Merton and Bodie (2003) proposed contingent claims analysis to measure risk. In the IMF working report, Chan-Lau, Jobert and Kong (2004) used CCA method to calculate the credit risk of 38 banks, and found that the default distance can predict the credit crisis of banks nine months in advance. Sun Jie and Wei Lai (2010) used CCA method to analyze the systemic financial risk of China's listed banks from 2007 to 2010. They found that the operational risk of China's listed commercial banks is gradually increasing, and the state-owned listed banks have strong anti-risk ability. Ling Jianghuai and Liu Yanmei (2013) verified the applicability of KMV model in credit risk measurement of commercial banks in China based on the financial data and stock transaction data of sample banks in 2012. Gong Xiaolin (2012) used contingent claim analysis method to establish risk financial statements at the level of national economic institutions, and explored the method of measuring systemic financial risk. Li Sheng and Zhang Yuhang (2016) took the default distance of listed commercial banks calculated from 2010 to 2015 as the explanatory variable, and conducted regression analysis on the main influencing factors through panel data. It was found that the non-performing loan ratio, loan to deposit ratio and asset size of commercial banks have a significant impact on bank credit risk. Yang Xiuyun, Jiang Yuanyuan and Duan Zhenzhen (2016) empirically tested the default distance of ST companies and their matched non-ST companies, and found that the comprehensive use of structural model and financial data would make the measurement of credit risk more reliable. Contingent claim method, which combines traditional balance sheet and market data, is more and more used because of its accuracy and forward-looking advantages. This paper chooses the default distance as the proxy variable of credit risk.

The growth of net profit of banks has both risk effect and income effect on credit risk. Repullo (2004) thinks that the increase of bank's profit will reduce its risk transfer motivation, thus increasing credit risk. In the other hand, Keeley (1990) finds that the increase of net profit will increase the franchise value of banks, making commercial banks adopt more stable operation strategies. Bank size plays an important role in the impact of net profit growth rate on credit risk. The impact of net profit on credit risk may be heterogeneous.

Compared with big banks, small banks have many constraints in operating area, financial business license, historical burden, customer group disadvantage and so on. With the same profit level assumption, the operating cost of small banks is generally higher than that of large banks. In order to achieve high profits, small banks are likely to operate high-risk business. The risk management ability of small banks is relatively weak. As a systemically important bank, big banks often have invisible support from the government, and their risk management methods are more diversified. With the same profit level, the larger the scale is, the smaller the credit risk is. Thus we put forward our first hypothesis.

Proposition 1. the credit risk decreases with the increase of bank scale with the same net profit level.

The income brought by the growth of net profit reduces banks' credit risk. However, when the scale of banks increases, the probability of occurrence of various risk factors such as bad debts also increases, which makes the credit risk increase. Whether there is a possibility that when the scale of bank assets is large enough, the increase of net profit growth rate may increase credit risk instead of reducing it. We call this phenomenon "scale anomaly". From the perspective of banks, given the net profit growth rate, when the bank scale is large enough, it will take more to meet the social financing needs, bringing the potential risk brought by the scale. When risk even exceeds the income brought by the growth of net profit, it will show a positive correlation between the net profit growth rate and credit risk. Thus we put forward our second hypothesis.

Proposition 2. the growth rate of net profit is positive correlated with credit risk when the bank scale is large enough.

The above assumption will become more significant with the decrease of bank profitability. With the decreasing of growth rate of net profit, the possibility of the potential risk brought by bank scale exceeds the income brought by net profit growth will be greater. That is to say, the influence of scale on bank credit risk further increases. Thus we put forward our third hypothesis.

Proposition 3. the smaller the growth rate of net profit is, the greater the impact of bank size on relations between the growth rate of net profit and credit risk is. Specifically, when the bank's profit level is low enough, the bank size will enhance greater positive correlation between net profit growth rate and credit risk.

3. Research Design, Variable Definition and Statistic Description

3.1 Research Design

Taking credit risk as the explained variable, we construct the basic model to examine the effect of bank profitability and credit risk.

$$Risk_{i,t} = \alpha_0 + \alpha_1 * PROF_{i,t} + \alpha_2 * LnA_{i,t} + \alpha_3 * Control_{i,t} + u_i + \zeta_{i,t} \quad (1)$$

where i denotes individual bank, t denotes observation year, $\zeta_{i,t}$ denotes a random interference term.

The significance of α_1 will initially reflect the relationship between bank net profit growth rate and credit risk. Positive α_1 indicates that the growth rate of net profit is positively correlated with default distance, while negative α_1 indicates that profit growth rate is negatively correlated with default distance and positively correlated with credit risk, which indicating the existence of scale anomaly.

In order to study whether bank size has an interactive effect on the growth rate of net profit and the default distance, an interactive item PGR_lnA is added to the model.

$$Risk_{i,t} = \alpha_0 + \alpha_1 * PROF_{i,t} + \alpha_2 * LnA_{i,t} + \alpha_3 * PGR\_lnA_{i,t} + \alpha_4 * Control_{i,t} + u_i + \zeta_{i,t} \quad (2)$$

According to the estimation results of formulas (1) and (2), if the number and sign of coefficient α_1 changes significantly in the two estimates, it indicates that the bank size does have an impact on the relationship between the growth rate of net profit and credit risk. Secondly, if the coefficient of interaction item PGR_lnA is significantly not equal to zero, the size of bank assets in cross-section will significantly affect the effect of net profit growth rate on credit risk. Specifically, if α_3 is negative, it means that with given net profit growth rate, the larger the bank's size is, the smaller the default distance is, which equals greater the credit risk. It proves hypothesis 1 and vice versa. Through further study on relationship of coefficient α_1 and α_3, hypothesis 2 and hypothesis 3 can be proved whether true or false.

3.2 Variable Definition

3.2.1 Credit Risk Measurement

In this paper, we choose the default distance (DD) calculated by KMV model as the proxy variable of bank credit risk. KMV model proposed by KMV company is based on option pricing theory, which considers that the cause of credit risk is the change of companies' asset value.

We use market value, volatility and book value of liabilities are to predict a company's credit risk. From the perspective of options and the value of corporate assets, shareholders hold a call option with corporate debt as the exercise price and corporate assets as the subject matter. If the assets are greater than the liabilities, the shareholders will exercise the call option to repay the debts and continue to operate the company. Otherwise, the company will go bankrupt and the owners will sell the assets of the company to the creditors and thus creditors will own the company. Therefore, asset size and liabilities of the enterprise both determine the probability of bankruptcy.

According to the Black-Scholes-Merton option pricing model, the call option retained by shareholders, namingly market value(E), is determined by the following formula.

$$E = V_a * N(d_1) - B * e^{-rT} * N(d_2) \quad (3)$$

The value of the put option (P) sold by bondholders is determined by the following formula.

$$P = B * e^{-rT} * N(-d_2) - V_a * N(-d_1) \quad (4)$$

d_1 and d_2 in formula (3) and (4) are determined by the two following formulas.

$$d_1 = \frac{\ln(V_a/B) + (r + 0.5\sigma_a^2)}{\sigma_a\sqrt{t}} \quad (5)$$

$$d_2 = d_1 - \sigma_a\sqrt{t} \quad (6)$$

where t denotes remaining maturity of corresponding debt, r denotes risk free interest rate with residual maturity t, σ_E refers to volatility of equity value, σ_A refers to volatility of asset value.

The stock market value follows geometric Brownian motion, we can conclude formula (7) using ito lemma.

$$\sigma_E = \frac{N(d_1)V_a\sigma_a}{E} \quad (7)$$

We can calculate equity market value E and equity value volatility σ_E with public information of listed companies. The two unknown variables V_a and σ_a in the model can be obtained from the following simultaneous equations.

$$\begin{cases} E = V_a N(d_1) - Be^{-rt} N(d_2) \\ \sigma_E = \dfrac{N(d_1) V_a \sigma_a}{E} \end{cases} \tag{8}$$

Distance to default (DD) is the distance between the expected value of the future market value of enterprise assets and the default point. It is expressed as the multiple of the standard deviation by the percentage of decrease in the asset value to reach the default point. A company with large default distance is more likely to repay its debts and less likely to default, which equals a better credit status. Distance to default is calculated as follows:

$$DD = \frac{V_a - DP}{V_a * \sigma_a} \tag{9}$$

When calculating DD, we assume the remaining maturity of debt is 1 year.

As for the risk-free interest rate, we take the interest rate of one-year lumps sum time deposit issued by the people's Bank of China. Since the people's Bank of China has adjusted the benchmark interest rate for many times from 2013 to 2018, we use weighted average method to get the annual risk-free interest rate according to the interest rate duration days. See Table 1 for details.

Table 1. Interest rate of one year lump sum deposit

beginning date	end date	interest rate	time	weighted interest rate
2013.01.01	2014.11.21	3%	2013A	3%
2014.11.22	2015.02.28	2.75%	2013B	3%
2015.03.01	2015.05.10	2.5%	2014A	3%
2015.05.11	2015.06.27	2.25%	2014B	2.95%
2015.06.28	2015.08.25	2%	2015A	2.51%
2015.08.26	2015.10.23	1.75%	2015B	1.73%
2015.10.24	2016.12.31	1.5%	2016A	1.5%
			2016B	1.5%
			2017A	1.5%
			2017B	1.5%
			2018A	1.5%
			2018B	1.5%

Note. A represents the first half of the year and B represents the second half of the year.

After the reform of non-tradable shares in 2007, shares of listed companies in China are divided into tradable shares and restricted shares. Restricted shares cannot be freely traded in the open market and we use the net assets per share to calculate its value. Thus, the equity market value (E) = the average closing price of tradable shares * the number of shares in circulation + the net assets per share * the number of restricted shares.

We use the historical average method to calculate the daily volatility through the logarithmic return rate of the company's stock historical closing price, and annualize it to obtain the equity volatility σ_E。

According to KMV company’s large number of empirical studies on default, it is found that the most frequent critical point of default is when the company value equals current liabilities plus half of long-term liabilities. However, due to the particularity of commercial banks, it is difficult to distinguish current liabilities from non-current liabilities. We define the default point (DP) as the total liabilities.

3.2 Explanatory Variables Measurement

The core explanatory variable of this paper is the growth rate of net profit (NPR). Control variables are composed of risk indicator, regulatory indicator, liquidity indicator, profitability indicator and capital structure indicator. We finally choose 9 indicators: equity volatility (Vol), capital adequacy ratio (CA), loan to deposit ratio (LDR), total assets (LNA), dividend ratio (ADR), return on total assets (ROA), net interest margin (NIM), asset liability ratio (Lev) and interbank liability ratio (ILR). Table 2 provides detailed variable definitions.

Table 2. Variable definitions

Category	Name	Variable definition
risk indicator	Vol	Annualized fluctuation of logarithmic stock return
regulatory indicator	CA	Ratio of bank capital to weighted risk assets
liquidity indicator	LDR	Total loans divided by total deposits
profitability indicator	ADR	Dividends distributed divided by share price
	ROA	Net profit divided by total assets
	PGR	Growth rate of net profit
	Nim	Net interest income divided by interest-bearing assets
capital structure indicator	lnA	Logarithm of total bank assets
	Lev	Total liability divided by total assets
	ILR	Interbank liabilities divided interest-bearing liabilities

3.3 Statistic Description

3.3.1 Sample Selection

In this paper, we use the semi-annual data of listed commercial banks from 2010 to 2018 as the initial sample, and make the following screening: (1) excluding the samples with missing control variables; (2) excluding the samples whose default distance cannot be calculated due to the uneven financial data. Finally, we get the semi-annual sample of 16 commercial banks. The bank's semi-annual data and financial data are from Wind database. To mitigate the influence of outliers in the data, all continuous variables are winsorized at the 1st and the 99th percentiles.

3.3.2 Summary Statistics

Table 3 reports summary statistics of the main variables used in the study. We find that the fluctuation range of PGR (growth rate of net profit) is from 0.001 to 0.3 and the standard deviation is 0.069, indicating that the profits of different banks are quite different. What is more, the fluctuation range of LnA (logarithm of total bank assets) is from 8.376 to 12.517, and the standard deviation is 1.050, indicating that the scale of listed banks is generally large.

Table 3. Summary statistics

Variable	Mean	SD	Minimum	Maximum
DD	40.843	28.389	-36.098	112.056
PGR	0.089	0.069	0.001	0.300
Vol	1.755	0.768	0.651	3.719
CA	0.125	0.014	0.097	0.157
LDR	0.755	0.117	0.467	1.081
LnA	10.765	1.050	8.376	12.517
ADR	3.576	2.092	0.000	8.365
ROA	0.808	0.271	0.404	1.442
Nim	0.023	0.003	0.014	0.030
Lev	0.933	0.008	0.915	0.949
ILR	0.149	0.072	0.022	0.362

4. Empirical Results

4.1 Correlation Test

Table 4 reports the correlation coefficients of main variables. The result shows that the growth rate of net profit is significantly negative related to the distance of default, significantly positive related to credit risk, indicating that the impact of listed banks' net profit on credit risk is mainly negative.

Table 4. Correlation test

Variable	DD	PGR	Vol	CA	LDR	LnA	ADR	ROA	Nim	Lev
PGR	-0.533*	1								
Vol	-0.746*	0.263*	1							
CA	0.439*	-0.309*	-0.216*	1						
LDR	0.481*	-0.564*	-0.271*	0.091	1					
LnA	0.460*	-0.573*	-0.330*	0.567*	0.287*	1				
ADR	-0.112	0.015	-0.234*	0.108	-0.264*	0.347*	1			
ROA	-0.123	0.079	0.128	0.196*	-0.111	0.163*	0.194*	1		
Nim	-0.573*	0.376*	0.447*	-0.168*	-0.460*	-0.102	0.241*	0.292*	1	
Lev	-0.534*	0.622*	0.288*	-0.693*	-0.564*	-0.657*	0.019	-0.162*	0.306*	1
ILR	-0.333*	0.044	0.250*	-0.638*	0.197*	-0.334*	-0.139	-0.084	-0.106	0.389*

Note. * p-value<0.05.

4.2 Default Distance

According to above model settings, we calculate the asset value and asset value volatility of 16 listed banks from 2013 to 2018 to calculate the default distance. Figure 1 shows the average of the banks' default distance in each half year. The default distance of China's major listed banks gradually increased from the low level in 2013-2014 to the high level in 2016-2017, and then fell back in 2018. We can find that credit risk of banks was at a high level in 2013-2014, and then the risk was reduced, and increased again in 2018.

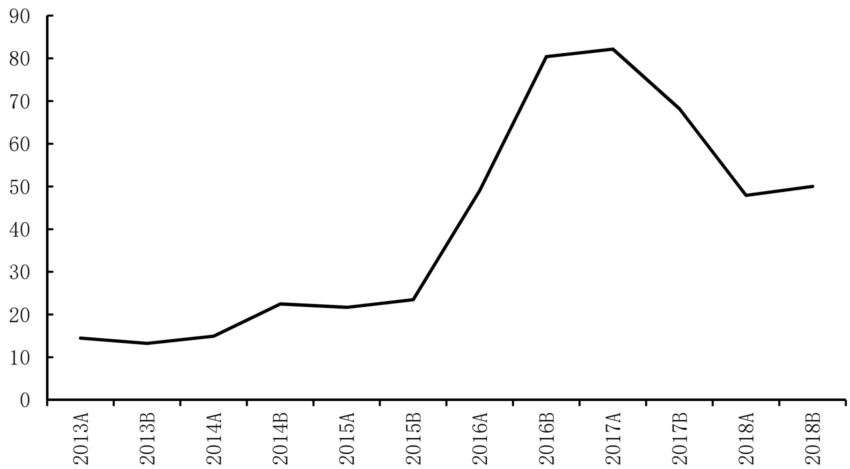

Figure 1. Default distance of mainly listed banks

4.3 The Effect of Net Profit Growth Rate on Credit Risk

Table 5 presents estimates of model (1) and model (2) using fixed effects models. T value was obtained by heteroscedasticity robust standard error estimation.

Table 5. net profit growth rate and credit risk

Variable	(1) fixed effect	(2) interaction term
PGR	-84.956**	555.471**
	(36.038)	(250.015)
Volatility	-17.377***	-17.710***
	(3.008)	(2.964)
CA	86.867	108.283
	(193.380)	(168.319)
LDR	-56.909	-40.700
	(40.443)	(35.059)
LnA	61.427***	64.186***
	(17.505)	(14.325)
ROA	4.057	5.033
	(3.435)	(3.334)
Nim	-623.615	-439.299
	(846.118)	(714.778)
Leverage	-260.633	33.037
	(473.368)	(407.793)
ILR	13.289	-26.517
	(40.769)	(41.860)
pgr_lna		-61.755**
		(22.277)
Constant	-298.070	-615.694
	(520.308)	(479.617)
Observations	192	192
R-squared	0.747	0.756
F	104.35	100.49

Notes. Robust standard errors are in parentheses. * Denotes statistical significance at the 10% level. ** Denotes statistical significance at the 5% level. *** Denotes statistical significance at the 1% level.

The results of model 1 in column (1) shows that the net profit growth rate has a significant negative relationship with default distance, meaning a significant positive relationship with credit risk. This clearly suggests that banks with a high net profit growth rate also have higher default rates and vice for those with low net profit growth rate. The finding implies that the higher the risk effect of high profit outweighs the income effect.

Column (2) in table 5 reports the result of model 2. Surprisingly, the coefficient of PGR changes from negative to positive, suggesting that the net profit growth rate is negative related to credit risk after controlling for asset size to separate the size effect. This methodological choice allows us to suggest that the size effect is important for the level of credit risk.

Results in column (2) show that the estimated coefficient of LnA is positive and the coefficient of interaction term PGR_LnA is negative at the 1% level. The partial derivative of LnA is (64.186-61.755 * PGR), which is positive because of the net profit growth rate's range from (0,1). The results show that larger bank size carry lower credit risk given the net profit growth level. Thus our findings support proposition 1.

Furthermore, the estimated coefficient of PGR is positive at the 5% level and thus the partial derivative of PGR is (555.471-71.755*LnA). There is a certain value of LnA which makes $\alpha_1 + \alpha_3 * LnA = 0$. When bank size large enough, the partial derivative of PGR will be negative, meaning a positive relationship between net profit growth rate and credit risk. This suggests that the increase of net profit may lead to the increase of credit risk when the scale of the bank is large enough. Thus proposition 2 is proved.

When the bank size is small, the partial derivative of PGR (555.471-71.755 * LnA) will be above zero, which reveals a negative relationship between default distance and the net profit growth rate. In this case, the curve of credit risk on the net profit growth rate inclines downward, which is in line with the expectation of traditional theory.

The asset size of the listed banks selected in this paper is relatively large, thus we find that the growth rate of net profit is positively correlated to credit risk.

Looking back to the partial derivative of LnA (64.186-61.755 * PGR), we can infer that the smaller the growth rate of net profit is, the greater the impact of bank size on the relationship between net profit growth rate and credit risk will be, which is consistent with proposition 3.

4.4 Robustness Check

According to our previous research, we find that when the bank size is large enough, the increase of net profit growth rate will increase banks' credit risk instead of reducing it. To increase the robustness of tour results, we construct a threshold regression model (Hansen 1999) to further study the influence of bank size on the relationship between net profit growth rate and credit risk.

$$DD_{i,t} = \alpha_0 + \theta_1 * PGR_{i,t}I(LnA \leq \gamma_1) + \theta_2 * PGR_{i,t}I(LnA > \gamma_1) + \alpha_3 * Control_{i,t} + \zeta_{i,t} \quad (10)$$

Where I(•) denotes the indicator function, I(•)=1 when the threshold variable meets the conditions in brackets, otherwise I(•)=0.

We test the threshold effect by bootstrapping and find that the threshold effect is significant. Table 6 reports the results of the threshold regression model.

Table 6. The threshold model

Variable	
Volatility	-16.875***
	(2.757)
CA	135.983
	(193.342)
LDR	-77.427**
	(34.201)
LnA	68.673***
	(13.300)
ROA	7.144*
	(3.591)
Nim	-1,229.506*
	(608.230)
Leverage	94.809
	(530.240)
ILR	-43.144
	(53.221)
PGR_Small	40.984
	(26.758)
PGR_Big	-98.168***
	(24.517)
Constant	-680.136*
	(626.303)
Observations	192
R-squared	0.763
F value	142.58
Threshold value	8.994

Notes: Robust standard errors are in parentheses. * Denotes statistical significance at the 10% level. ** Denotes statistical significance at the 5% level. *** Denotes statistical significance at the 1% level.

We report the results in table 6. The coefficient of PGR_Big is negative at the 1% significance level, indicating that large banks whose LnA is higher than the threshold value of 8.994 satisfy the relationship of high profit corresponding high credit risk. Thus it can be seen that risk effect bringing by bank size expands with the scale expansion of commercial banks. Overall, the results of robustness check are consistent with previous conclusions.

5. Conclusion

This study investigates the relation between bank profit and credit risk and how bank size affects their relationship. The findings suggest that the net profit growth rate is negative related to credit risk after controlling for asset size. When bank size large enough, there is a positive relationship between net profit growth rate and credit risk. This suggests that the increase of net profit may lead to the increase of credit risk when the scale of the bank is large enough. The smaller the growth rate of net profit is, the greater the impact of bank size on the relationship between net profit growth rate and credit risk will be. The robustness of the conclusion is proved.

At the regulatory level, regulators need to improve the exit mechanism of the banking industry, guiding the banking industry to develop healthily and stably in the direction of marketization, and promoting banks to complete financing and investment through market-oriented methods. At the level of commercial banks, all banks are facing survival of the fittest. Commercial banks need to give full play to their own advantages and gain their own competitive advantages, finally reducing credit risk.

Notably, the conclusion of this paper does not mean that banks should be timid in order to prevent credit risk. We hold the opinion that commercial banks should operate in compliance with regulations, expand moderately, strengthen risk controlling measures, seize the opportunity of reshuffle of the industry pattern, face the credit risk, and find a balance between risk prevention and development, which is also the starting point of our study.

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