



Szent István University  
Doctoral School of Management and Business Administration Sciences

# **The Risk-Taking Behavior in Chinese Commercial Banks**

**The Thesis of the Ph.D. Dissertation**

By

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## TABLE OF CONTENTS

TABLE OF CONTENTS.....	3
1. INTRODUCTION.....	4
1.1 Background and motivation.....	4
1.2 Research objective.....	6
1.3 Design of the research .....	7
1.4 Research hypotheses .....	8
2. RESEARCH MATERIALS AND METHODS .....	9
3. RESULTS AND DISCUSSION.....	11
3.1The constraint effect of capital supervision on the risk-taking behavior of commercial banks.....	11
3.2 The risk indicators selection by factor analysis based on market information.....	13
3.3 The measurement of risk-taking behavior of Chinese commercial bank.....	16
3.4 The management of commercial banks' risk warning.....	20
4. CONCLUSIONS AND RECOMMENDATIONS.....	25
4.1 Conclusions.....	25
4.2 New scientific results and achievements.....	27
4.3 Limitations of dissertation and prospects of further research.....	28
5. SUMMARY.....	29
List of publication.....	32

# 1. INTRODUCTION

## 1.1 Background and motivation

The frequent outbreaks of financial crises worldwide in recent years indicate that the poor management for risk-taking of commercial banks could lead to the bankruptcy of the commercial banks, or even lead to the instability of financial markets and economic recessions.

The banking system, as an important part of the financial market, is the basis for the allocation of all financial resources. The stability of the banking system has an in-depth bearing on the healthy operation of the financial markets and even the whole economy. Once the banking system fall into crisis, a large-scale financial crisis will break out accordingly. And the development of the real economy will also be greatly implicated.

Since the 1980s, as the intensification of financial derivatives and liberalization, the regional and global financial crises triggered by the banking crisis became more and more frequent. In 2008, a global financial crisis ignited by U.S. subprime bonds hit the virtual and real global economy. Analysis on the reasons for the crisis showed that excessive risk-taking behavior of financial institutions was the main cause of the crisis. Under this background, the analysis of the risk-taking behavior of commercial banks has once again become the core concern both in public and academia.

The risk-taking behavior of commercial banks includes the motivations, decision-making and execution of risk-based operations of banks, and is the result of the joint action of banks' participants. These participants include shareholders, creditors, management and government and so forth. They all have different preferences for banks to take risk behaviors from their respective interests and responsibilities. Some of these preferences are mutually compatible and some are mutually antagonistic. The result is the ultimate manifestation of commercial banks risk-taking behavior and is the balance of multiple forces functioning interactively. Risk-taking behaviors of commercial banks is the source of financial and economic vulnerability.

Therefore, there are large numbers of researches to explore the impact factors of risk-taking behaviors of commercial banks from different perspectives. Forasmuch as this, it is meaningful to study the risk-taking behaviors of commercial bank and its relative risk management.

For China, Chinese commercial banks have been undergoing a series of reforms and changes in recent years. Large-scale commercial bank shareholding system reform had been fundamentally completed. Corporate governance, performance appraisal, risk control and other mechanisms and systems have been gradually improving ever since; small and medium commercial banks had to go through the implementation of differentiated and characteristic development strategies to promote innovations in management processes and services hence to maintain a more stable development trend; private banks progressively entered into the market, becoming the new powers in the commercial banking system. Due to the sustained and rapid development of China's economy, commercial banks are now facing a relatively loose macroeconomic environment in their business operations.

However, the global financial crisis had put great pressure on the growth of Chinese macro-economy and its economic growth had been slowing down since the outbreak of crisis. Moreover, with the adjustment of economic structure many enterprises at backward production levels will become obsolete from market. The rapid expansion assets of commercial banks gained in the process of economic growth may encounter the menace of great losses.

While, the risk management development of Chinese commercial banks has a relatively late start, so the risk management methods and technologies could hardly meet the demand of rapid economic development. Under such realistic background, how to better strengthen the risk management of Chinese commercial banks has also become a vitally important research issue.

Traditionally, most researches focus on the research of methodology for a specific risk, such as credit risk, operational risk, interest rate risk or exchange rate risk. However, the study from the overall risk management of the commercial banks is still relatively beyond most researchers' concern. In consideration of the background that the concept of overall risk management is getting more and more attention, this dissertation tries to target at risk-taking behaviors of Chinese commercial banks as the research object. The relative literature works will be reviewed and the affecting factors of commercial banks' risk-taking behaviors will be theoretically analyzed thereupon. On the basis of constructing quantitative models, this dissertation comprehensively analyzes the risk-taking of commercial banks as a whole system in order to provide useful information to risk management and risk regulation to commercial banks and preserve the stability of the economy.

## 1.2 Research objectives

On the basis of the financial enterprise management theory, corporate governance theory and econometrics, the general objective of this dissertation is to analyze the risk-taking behaviors, the countermeasures and management of Chinese commercial banks.

To attain this general objective, four specific objectives are probed into throughout this study.

Objective 1: To theoretically analyze the factors that affect the risk-taking behaviors of commercial banks. And one of the important factors - the capital adequacy ratio was selected to empirically test its pro-cyclical effect. The theoretical analysis of the affecting factors of commercial banks' risk-taking behaviors includes five perspectives, which are the operating status of commercial banks, corporate governance of commercial banks, market competition of commercial banks, macroeconomic environment and capital regulation.

Objective 2: To analyze the financial information and market information of listed commercial banks, some important risk management indicators were selected.

Objective 3: To measure the risk taking level of Chinese commercial banks on the basis of financial information method, the author combined the risk management indicators that selected from the second part of the study. The risk-taking level of Chinese commercial banks will be measured in accordance with the financial information, including the measurement by single indicator which is the nonperforming loan ratio, and Z index. And the measurement by comprehensive risk indicators. A comprehensive model will be constructed via applying the grey correlation method. The model can reflect different types of the financial information and is able to evaluate the commercial banks' risk-taking level.

Objective 4: To evaluate the potential risks of the Chinese listed banks. Z-score model and AHP method will be applied in here.

Objective 5: To propose risk management solutions and development strategies, some strategies are proposed from micro and macro perspectives to manage the risk taking of commercial banks on the basis of theoretical and empirical analysis. On the one hand, making balance business strategies, implementing a comprehensive risk management, improving the warning mechanism of risk and optimization of corporate governance are considered as the micro perspective

management strategies. On the other hand, from the macro perspective, establishing management mechanisms of risk and optimizing financial ecological environment should be taken into full consideration.

### **1.3 Design of the Research**

In order to comprehensively study the risk-taking behaviors of commercial banks, the dissertation is composed of four main parts. The main research samples include 16 listed commercial banks in China and the data selected span from 2004 to 2015. 16 listed commercial banks in China include five large commercial banks, eight joint-stock banks, and three city commercial banks.

Part I: The first step is to select one of the factors affecting the risk-taking behavior of commercial banks, capital supervision for the analysis. Through mathematical calculations, this study analyzes the restraints of capital supervision on the risk-taking behaviors of commercial banks, and then examines the pro-cyclical effect of capital adequacy ratio of commercial banks of China. Via applying the model from Ayuso et al (2004) and Estrella (2004) and based on China's 16 listed commercial banks in 2004-2014 panel data, the dissertation is to analyze the relationship between macro-economic cycle and capital adequacy ratio and to test the pro-cyclical effect of capital adequacy ratio.

Part II: Based on the market information and theory of risk management and using the factor analysis and regression analysis, the author selected the important risk management indicators by analyzing the relationship between the financial indicators and the stock prices of the 16 listed Chinese banks. Finally the author determined to choose NPL, LAR, CAR as an important risk management indicators for follow-up analysis.

Part III: To measure the risk taking behaviors of Chinese commercial banks, the dissertation contains measurements by single indicators and measurements by comprehensive indicators. On the basis of previous analysis, this research applied the grey correlation method to establish a comprehensive index based on the comprehensive financial information to measure the risk-taking behaviors of Chinese commercial banks. In the method, four risk indicators include NPL, ROA, CAR and LDR. This approach is based on the comprehensive financial information categories by different risks. Four types of risks are chosen, which are NPL representing credit

risk level, ROA representing operating risk level, CAR representing capital risk level and LDR representing liquidity risk level.

Part IV: Complete risk management not only involves accurate measurements of existing risk-taking but also includes effective early warning and assessment of potential risks in the future. In this study, the Z-score model was initially implemented to evaluate the potential risk of 16 listed commercial banks. By the application of AHP method, the researcher focused on a special type of financial product - the loan of rural land contractual management right, which had been proven to effectively solve out the contradiction between the agricultural enterprise fund raising and credit risk controlling of Chinese commercial banks.

### **1.4 Research Hypothesis**

The research has set the following hypotheses:

Hypothesis 1: There is a pro-cyclical effect on capital adequacy of commercial banks in China.

Hypothesis 2: The financial risk indicators have correlation with stock price of listed Chinese banks.

Hypothesis 3: The indicators with information that bank have high risk prevention ability have positive correlation with stock price in China.

Hypothesis 4: The indicators with information that bank have low risk again ability have negative correlation with stock price in China.

Hypothesis 5: The risk-taking measurement model based on comprehensive financial information is a more effective measurement.

Hypothesis 6: The Z-score model can be effectively applied to measure the credit risk of listed commercial banks in China.

To differentiate this research with previous ones, the author not only chooses normal financial ratio but also focuses on the financial risk ratio of listed banks which can reflect the level of risk management, and these indicators are often used by regulatory requirements and internal risk control system of bank.



## 2. RESEARCH METHODOLOGY

The main objective of this dissertation is to comprehensively analyze the risk-taking behavior, the measurement and risk management of Chinese commercial bank. In order to attain this main objective, the research of this dissertation has been designed into four parts. The main research samples include 16 listed commercial banks in China and the collected data span from the year 2004 to 2015. 16 listed commercial banks in China are made up of five large commercial banks, eight joint-stock banks and three city commercial banks. The detailed information of listed bank are listed in following table. All the data were collected from CSMAR database, Wind database and financial statement of each banks. The statistical softwares used in this dissertation include Excel, Stata, SPSS 19 and Matlab.

In the first part of research, the objective is to analyze the factors that affect the risk-taking behavior of commercial banks and select one of the important factors -- the capital adequacy ratio to test its pro-cyclical effect. By mathematical analysis, this study is meant to analyze the restraints of capital supervision on the risk-taking behavior of commercial banks and then examine the pro-cyclical effect of capital adequacy ratio of commercial banks in China. By applying the model in Ayuso et al (2004) and Estrella (2004), on the basis of China's 16 listed commercial banks in the year 2004 to 2014 panel data, it is to analyze the relationship between macro-economic cycle and capital adequacy ratio and to test the pro-cyclical effect of capital adequacy ratio. There are four variables employed in this part, which are Buf, GGDP, ROA and NPL. The model has been run in the Random-effect Generalized Least Squares Regression (GLS) in STATA statistical software.

In the second part, the objective is to select important risk management indicators by analyzing the financial information and market information of listed commercial banks.

Based on the market information and theory of risk management, the important risk management indicators have been selected by analyzing the relationship between the financial indicators and the stock prices of the 16 listed Chinese banks via using the factor analysis and regression analysis,. Firstly, eight financial indicators including, CAR, CCAR, NPL, PFC, LAR, APR, CIR, and LDR have been chosen to make the analysis. Finally it determines NPL, LAR, CAR as an important risk management indicators for follow-up analysis. The statistical softwares used in this part include Excel and SPSS 19. Program.

The third part is the measurement of risk-taking behaviors of Chinese listed bank, which is the most creative part in this dissertation. In this part, the author also combined the risk management indicators selected in the second part together and measured the risk-taking behaviors of listed commercial banks with the measurements by single indicator and by comprehensive indicators. Among them, the idea of measurement on risk-taking behaviors by comprehensive indicators is an important and creative part in this study.

The measurements by single indicator include non-performing loan ratio and Z-value index, which are tested by SPSS 19. Program. For the measurement by comprehensive indicators, this dissertation uses the grey relational analysis (GRA) method to establish a comprehensive index based on the comprehensive financial information to measure the risk-taking behaviors of commercial banks. The information of GRA method will be demonstrated in the following parts of the dissertation. And four selected risk indicators refer to NPL, ROA, CAR and LDR. Herein NPL in the four types of risks is short for credit risk level, ROA short for operating risk level, CAR short for capital risk level and LDR short for liquidity risk level. This approach is based on the comprehensive financial information categories by difference risks.

The comprehensive risk management not only involves accurate measurement of existing risk-taking but also includes effective early warning and evaluation of potential risks in the future. The objective of final part is to evaluate the potential risks of the Chinese listed banks. The author tried to use the Z-score model to evaluate the potential risk of 16 listed commercial banks in this section. The AHP method used in this part also testified that the loan of rural land contractual management right offers an effective solution for the discrepancy of the agricultural enterprise fund raising and credit risk controlling of in Chinese commercial banks.

### 3. RESULTS AND DISCUSSION

#### 3.1 The constraint effect of capital supervision on the risk-taking behavior of Chinese commercial banks

First of all, the author use mathematical path to analyze the constraints effect of capital supervision on commercial banks' risk-taking behavior and the result show that there is an effective alternative relationship between capital regulatory constraints, leverage risk level of banks and portfolio risk level, that is, under the constraints of capital supervision, an effective capital supervision requirement has complete risk sensitivity. Increased the level of leverage risk of bank has led to a decline in bank portfolio risk. While the rise in the portfolio risk means that the bank must increase its capital level and reduce its own level of leverage risk. Therefore, capital regulation constraints can effectively inhibit banks' risk-taking behavior.

If there is a pro-cyclicality effect of capital adequacy ratio which would also have influence on commercial banks' risk taking. Therefore, the first hypothesis in this dissertation will be examined in this part is -- Does there exist a pro-cyclicality effect on capital adequacy of commercial banks in China.

The test results of random-effects Generalized Least Squares (GLS) regression at 10%, 5% and 1% confidence level has been shown in Table 3-1, Table 3-2 and Table 3-3.

**Table 3-1. The test results of GLS regression in 1% level**

Random- effects GLS Regression			Number of observations = 160			
Group variable: Bank			Number of groups = 16			
R <sup>2</sup> : within = 0.4107			Obs per group: min =10			
between = 0.9314			avg =10			
overall =0.6040			max =10			
Correlation(u <sub>i</sub> , x) = 0 (assumed)			Wald chi-square(4) = 236.41			
			Prob > chi-square = 0.0000			
	Coefficient	Std. Err.	Z	P >  z	99% Confidence Interval	
Buf <sub>t-1</sub>	0.5275485	0.0603546	8.74	0.000	0.3720854	0.6830116
GGDP	0.3794157	0.0878986	4.32	0.000	0.1530038	0.6058275
ROA	3.586031	0.7995008	4.49	0.000	1.526653	5.645408
NPL	-0.0333659	0.0573377	-0.58	0.561	-0.1810581	0.1143264
Constant	-5.350382	1.296441	-4.13	0.000	-8.689792	-0.2010973
Sigma_u	0					
Sigma_e	2.0737077					
rho	0 (fraction of variance due to u <sub>i</sub> )					

(Source: Test result from Stata)

**Table 3-2. The test results of GLS regression at 5% level**

Random- effects GLS Regression		Number of observations = 160				
Group variable: Bank		Number of groups = 16				
R <sup>2</sup> : within = 0.4107		Obs per group: min =10				
between = 0.9314		avg =10				
overall =0.6040		max =10				
Correlation(u <sub>i</sub> , x) = 0 (assumed)		Wald chi-square(4) = 236.41				
		Prob > chi-square = 0.0000				
	Coefficient	Std. Err.	Z	P >  z	95% Confidence Interval	
Bu <sub>t-1</sub>	0.5275485	0.0603546	8.74	0.000	0.4092557	0.6458413
GGDP	0.3794157	0.0878986	4.32	0.000	0.2071375	0.5516938
ROA	3.586031	0.7995008	4.49	0.000	2.019038	5.153023
NPL	-0.0333659	0.0573377	-0.58	0.561	-0.1457458	0.0790141
Constant	-5.350382	1.296441	-4.13	0.000	-7.891359	-2.809405
Sigma_u	0					
Sigma_e	2.0737077					
rho	0 (fraction of variance due to u <sub>i</sub> )					

(Source: Test result from Stata)

**Table 3-3. The test results of GLS regression at 10% level**

Random- effects GLS Regression		Number of observations = 160				
Group variable: Bank		Number of groups = 16				
R <sup>2</sup> : within = 0.4127		Obs per group: min =10				
between = 0.9294		avg =10				
overall =0.6062		max =10				
Correlation(u <sub>i</sub> , x) = 0 (assumed)		Wald chi-square(4) = 238.64				
		Prob > chi-square = 0.0000				
	Coefficient	Std. Err.	Z	P >  z	90% Confidence Interval	
Bu <sub>t-1</sub>	0.5343186	0.0602455	8.87	0.000	0.4352235	0.6334137
GGDP	0.3834441	0.0878248	4.37	0.000	0.2389852	0.5279029
ROA	3.575044	0.7946035	4.50	0.000	2.268038	4.882051
NPL	-0.0342572	0.0572449	-0.60	0.550	-0.1284168	0.0599023
Constant	-5.412109	1.293269	-4.18	0.000	-7.539348	-3.28487
Sigma_u	0					
Sigma_e	2.0683356					
rho	0 (fraction of variance due to u <sub>i</sub> )					

(Source: Test result from Stata)

As we can see from the empirical test results in Table 3-1, Table 3-2 and Table 3-3, the macroeconomic indicators GDP growth rate (GGDP) has significant impact on the commercial bank's excess capital adequacy ratio at confidence level 1%, 5% and 10%. The coefficient  $\beta_2$  is positive, indicating that the capital adequacy rate of China's commercial bank have pro-cyclical effect. As we discussed before, pro-cyclical effect on the capital adequacy ratio means that, when the economic cycle goes up, the borrower's financial situation improved, their credit rating increases, resulting in lower probability of default (PD), higher collateral prices and lower lost given default rate (LGD) of loan, the risk capital requirement decreases comparatively. With a

constant capital holding in one period, the excess capital increases comparatively. This part of excess capital adequacy of commercial banks would be improved to support more substantial credit expansion, which will promote an upsurge of further economic development (Kashyap, A. K.; Stein, J. C. 2004). While during the economic downturn, the level of capital adequacy would be reduced. Meanwhile, the financing cost of banks equity is higher, commercial banks have to shrink their balance-sheets and reduce the supply of credit which would exacerbate the cyclical fluctuations of the real economy (Estrella 2004). We could hereby reach the conclusion that when GDP growth increase per 1%, the average excess capital adequacy ratio will accordingly be increased by 0.379% in Table 3-1 and Table 3-2, by 0.383% in Table 3-3 respectively.

In addition, the results also show that the coefficient of  $Bu_{i,t-1}$  is significantly positive at confidence level 1% ,5% and 10%. It demonstrates that the specification on dynamic adjustment model of capital adequacy ratio is reasonable. There is a significant positive correlation between the return on assets (ROA) and excess capital as well, which indicates banks with higher profitability would have higher capital adequacy levels. NPL ratio increase would reduce excess capital ratios. It also shows that there is a negative correlation between the explanatory variables and NPL but the result is not significant here. Hereby we can draw the conclusion that the hypothesis 1 is proved to be true. It demonstrates that there is a pro-cyclical effect on capital adequacy of commercial banks in China.

### **3.2 The risk indicators selection by factor analysis based on market information**

This part aims to find some of the finance risk indicators from the financial statements of listed bank data to establish ties with the stock. Eight financial indicators have been selected from their annual financial reports. On the basis of the results of factor analysis, three main factors have been employed to explain nearly 96% information offered by eight financial indicators in data of banking industry and the results of regression analysis show that significant correlations exist between bank's share prices and financial risk indicators.

Table 3-4 shows the results of factor contribution rate, among which the eigenvalues of first three factors are greater than 1. And the cumulative eigenvalues worth 96.216%, which means the first three factors can explain 96.216% information instead of overall six indicators. Thus researchers can extract the first three factors as the main factors from these six variables.

**Table 3-4 Total variance explained of six risk indicators**

Component	Initial Eigenvalues		Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings	
	Total	% of Variance	Total	% of Variance	Total	% of Variance
		Cumulative %		Cumulative %		Cumulative %
1	2.542	42.360	2.200	36.663	2.200	36.663
2	1.850	30.838	1.903	31.711	1.903	31.711
3	1.381	23.017	1.670	27.841	1.670	27.841
4	0.171	2.848				
5	0.046	0.768				
6	0.010	0.168				

Extraction Method: Principal Component Analysis.

(Source: Test result from SPSS)

Table 3-5 shows the values of factor after rotation, and the rotation is orthogonal rotation method in compliance with Kaiser Standardization. By rotating factor, each main factor have a relatively clear meaning. The first main factor is most relevant with the variables LAR and LDR, therefore we chose LAR that value is 0.937 as an explanation index for the first factor. The second main factor is most relevant with CAR and CCAR, therefore CAR with value is 0.974 as a representative of the second factor. The third main factor is the most relevant factor with NPL which value is 0.991. And these three factor, LAR, CAR and NPL will be used in regression analysis in next part to test their correlation with stock price of sample banks.

Resulting from the factor analysis before, we could find three main factors LAR, CAR and NPL can explain more than 96% of the information. Therefore, these three factors could function as the independent variable to make regression on the dependent variable of the share prices of listed banks. The model could be built as follows:

$$SP = \beta_0 + \beta_1 \times NPL + \beta_2 \times CAR + \beta_3 \times LAR + \epsilon \quad (3-1)$$

Table 3-6 shows the results of variance analysis. F value of regression portion is 4.08. Accordingly, P value is 0.033, which is significantly lower than the level of 0.05. This result

means the three financial indicators have significantly correlation with stock price of listed banks. According to the factor analysis before, this three index are main factors that can replace other indicators to explain almost 96% information. Hereby we can make the conclusion that the Hypothesis 2 is true. It demonstrates that financial risk indicators have significant correlation with stock prices of listed banks.

**Table 3-5 Rotated component matrix<sup>a</sup>**

	Component		
	1	2	3
LAR	0.937	-0.125	0.244
LDR	-0.910	-0.110	0.257
CAR	0.118	0.974	-0.043
CCAR	-0.174	0.953	0.186
NPL	0.082	0.071	0.991
PFC	0.666	-0.116	-0.725

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.  
 (Source: Test result from SPSS)

**Table 3-6 ANOVA**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	215.161	3	71.720	4.080	.033 <sup>a</sup>
	Residual	210.925	12	17.577		
	Total	426.086	15			

a. Predictors: (Constant), NPL, CAR, LAR  
 b. Dependent Variable: SP  
 (Source: Test result from SPSS)

Table 3-7 shows the coefficient value of independent variables in regression model 3-1 and relative statistic results. In this table, we could find the coefficients of three independent variables respectively. The coefficient value of NPL is -8.347 and significant of T value is 0.026 which is lower than 0.05. It indicates that the ratio NPL has significant negative correlation with dependent variable stock price and when NPL increase per 1%, the stock price will decrease

8.347 accordingly. NPL is non-performing loan ratio, which was allocated to asset security indicator as introduced in the previous section. Higher non-performing loan ratio of a bank indicates higher level of asset risk which is not good for the risk control for the bank. The statistic result here verified the Hypothesis 4.

The coefficient value of LAR is 3.754 and significant of T value is 0.045 which is lower than 0.05 too. It indicates that the ratio LAR has positive correlation with dependent variable stock price. When LAR increase per 1%, the stock price will increase 3.754 accordingly. This result verified the Hypothesis 3 since LAR is loan allowance ratio which is equal to loan loss provision to total loan. The higher of LAR, the more easily banks can digest the potential losses, improve its viability and the stock price of bank will be higher.

**Table 3-7 Coefficients**

Model	Unstandardized		Standardized			
	B	Std. Error	Beta	t	Sig.	
1	(Constant)	30.779	11.576		2.659	0.021
	NPL	-8.347	3.293	-0.539	-2.535	0.026
	LAR	3.754	1.925	0.415	1.950	0.045
	CAR	-1.546	0.777	-0.404	-1.990	0.070

a. Dependent Variable: SP  
(Source: Test result from SPSS)

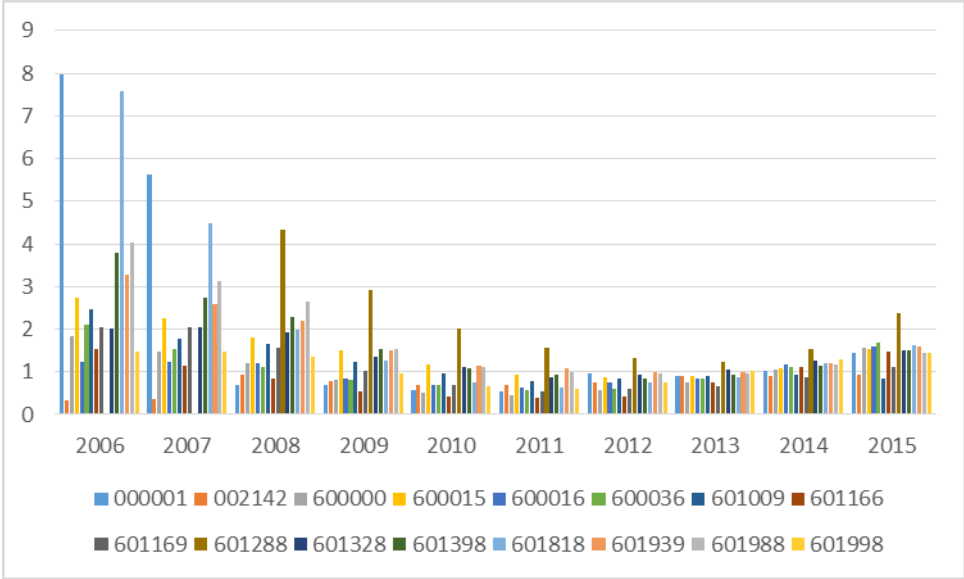
**3.3 The measurement of risk-taking behavior of Chinese commercial bank**

*Risk-taking measurement by Non - performing Loan Rate*

From the test results in the second section about the selection of risk indicators, NPL and another two factors LAR, CAR could be deployed to explain most information of banking industry. And regression analysis on stock prices and three main finance risk indicators show that the stock prices of the listed banks are significantly influenced by finance risk indicators. Therefore, the author first selects NPL to measure the risk-taking level of Chinese 16 listed commercial banks from the year 2006 to 2015 in this section.



From the Figure 3-1 we can find out that the NPL annual change trends of the 16 listed commercial banks are similar. During the whole sample period, the overall trend of the NPL has gradually decreased. In the first three years of 2006 to 2008, NPL was generally high, and the differences among banks were relatively large. Subsequently, NPL gradually declined, and it dropped to a low point around 1% in the year 2011. With the exception of individual banks, the differences of NPL between banks were also gradually narrowed, and the basic levels were kept the same. From the year 2014 to 2015, the NPL increased slightly.



**Figure 3-1 The measurement results of NPL on 16 listed banks**  
(Source: The author’s construction)

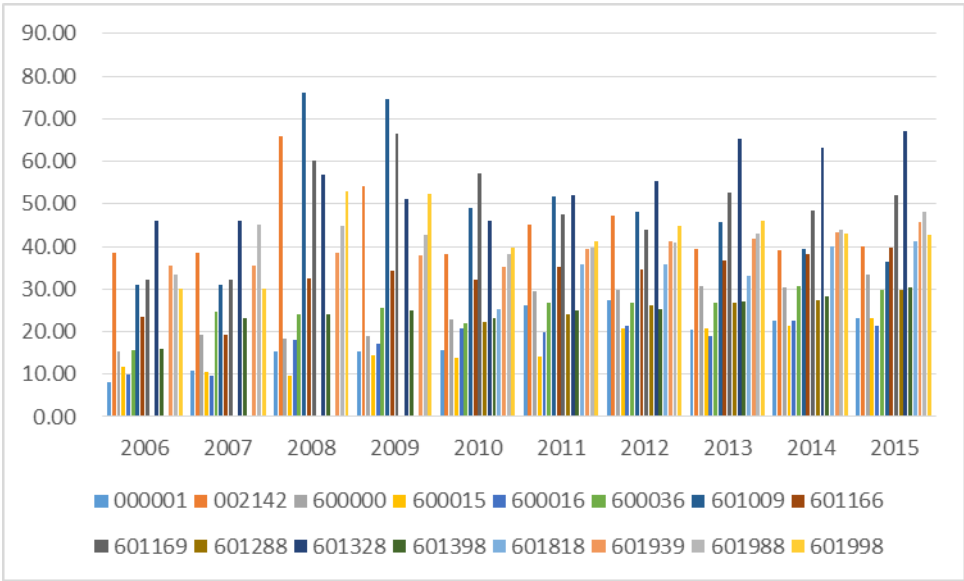
***Risk-taking measurement by Z-value index***

Z value index is the proxy variable of commercial bank bankruptcy risk. The higher Z value, the smaller bankruptcy risk, and the corresponding risk taking level is lower.

The Z values of 16 listed commercial banks from 2006 to 2015 are calculated as shown in the following Figure 3-2. From the overall results, the Z values of the 16 commercial banks are all greater than 0. Some of the banks have high Z values in individual years, indicating that the listed banks have very small bankruptcy risk, and the overall risk fluctuates from year to year. .

The risk-taking measurement by NPL index and Z value index both belong to the single indicator measurement. By comparing the two results, we can see that in the annual change trend of the risk-taking level, both indicators reflect the gradual decrease trend after the year 2006; among

them, the Z value can more clearly describe the differences and subtleties variety between banks risk-taking level.



**Figure 3-2 The results of Z value on 16 listed banks, 2006-2015**

(Source: The author’s construction)

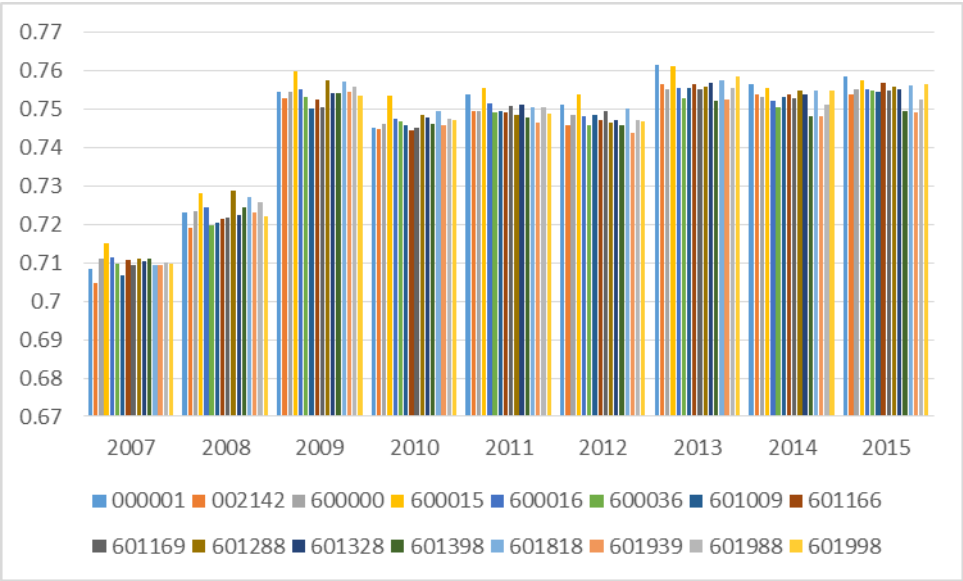
***Risk-taking measurement by Grey Relational Analysis***

This dissertation probes into the comprehensive considerations to the various risks in commercial banks on the basis of the traditional measurement on single indicators, then chooses four major risks including credit risk, operating risk, capital risk and liquidity risk. The corresponding financial indicators of these four risks have been selected respectively, and the author also tries to apply grey relational analysis (GRA) method to establish a risk-taking measurement approach based on risk categories and comprehensive financial information.

These four indicators based on results of analysis before are the non-performing loan ratio (NPL) representing credit risk, return on asset (ROA) representing operating risk , capital adequacy ratio (CAR) for capital risk and loan to deposit ratio (LDR) for liquidity risk.

The Figure 3-3 shows the results of risk-taking measurement by GRA on 16 Chinese listed banks clearly. From the overall trend of change, we can see that all 16 listed commercial banks showed a high level of risk-taking during the year 2007 to 2008. One of the reasons was that under the influence of the global financial crisis in 2008, the changes in real economy and consumer demand at home and abroad led to the increase of risk-taking of commercial banks in China. After the year 2009, the levels of risk-taking of 16 banks began to decrease and maintain a stable

trends between the year 2009 and 2015. The values of risk-taking of all banks have been fluctuating between 0.74 and 0.76. One of the reason is that Chinese government implemented the economic stimulus plan, the enterprises were more active and the demand for capital started to increase. On the other hand, it also reflected that Chinese commercial banks have consciously strengthened their risk management and improved their risk-taking ability after the financial crisis. According to the annual changes of each banks, although the values of risk-taking for each banks change very slightly, the risk-taking levels were not so different, which means that even there are some differences in the scale and business of each banks, while their risk management level is close.



**Figure 3-3 The results by GRA method**  
(Source: The author’s construction)

The author also ranked the level of risk-taking according to the mean value of each bank's R value. The first three are bank 600015, bank 000001 and bank 601818, all of which appeared to make the lowest risk-taking. All these three banks are medium-sized joint-stock commercial banks. Among them, the standard deviation of bank 000001 is comparatively larger, indicating that its volatility is slightly higher than that of other banks and its risk-taking has changed more during the sample period. The last two in the ranking are bank 601398 and bank 601939 who have a high level of risk-taking. These two banks are allocated to large state-controlled commercial banks. Among them, bank 601398 has the smallest standard deviation, indicating that its operations are in stability and the changes of risk-taking is more fluent. Another interpretation of the figure is that some medium-size city commercial banks such as bank 601009 and bank 601169 have comparatively moderate level of risk-taking.

**Table 3-8 Risk-taking rank of 16 listed commercial banks in China**

Stock code	Bank Name	Mean Value of R	Rank
600015	Huaxia Bank	0.748926	1
000001	Ping An Bank	0.745979	2
601818	China Everbright Bank	0.745876	3
601288	Agricultural Bank of China	0.745303	4
600016	China Minsheng Bank	0.744652	5
601328	Bank of Communications	0.744402	6
601998	China CITIC Bank	0.744285	7
600000	Shanghai Pudong Development Bank	0.744148	8
601988	Bank of China	0.744085	9
601166	Industrial Bank	0.743724	10
601169	Bank of Beijing	0.743413	11
601009	Bank of Nanjing	0.742757	12
600036	China Merchants Bank	0.742615	13
002142	Bank of Ningbo	0.742379	14
601398	Industrial and Commercial Bank of China	0.742221	15
601939	China Construction Bank	0.741506	16

(Source: The author's construction)

If we compare the results with measurement by single risk indicators, the risk-taking measurement based on comprehensive financial information by GRA method shows more detail information about the level of risk-taking in listed banks. It can not only describe the overall change trend of sample banks risk-taking, but also give the accurate assessment about risk-taking level and show the differences between banks. More importantly, this risk-taking assessment model is based on comprehensive information and take different kinds of risks into consideration in commercial banks. Thereby, it is in compliance with the fifth hypothesis: the risk-taking measurement approach based on comprehensive financial information is a more effective measurement.

### **3.4 The management of commercial banks' risk warning**

#### *The analysis of Z-score model on risk warning*

Z-score model is one of the most widely acknowledged risk measurement models in developed countries and its effectiveness in weighting risks has been proven for years. In this section, the

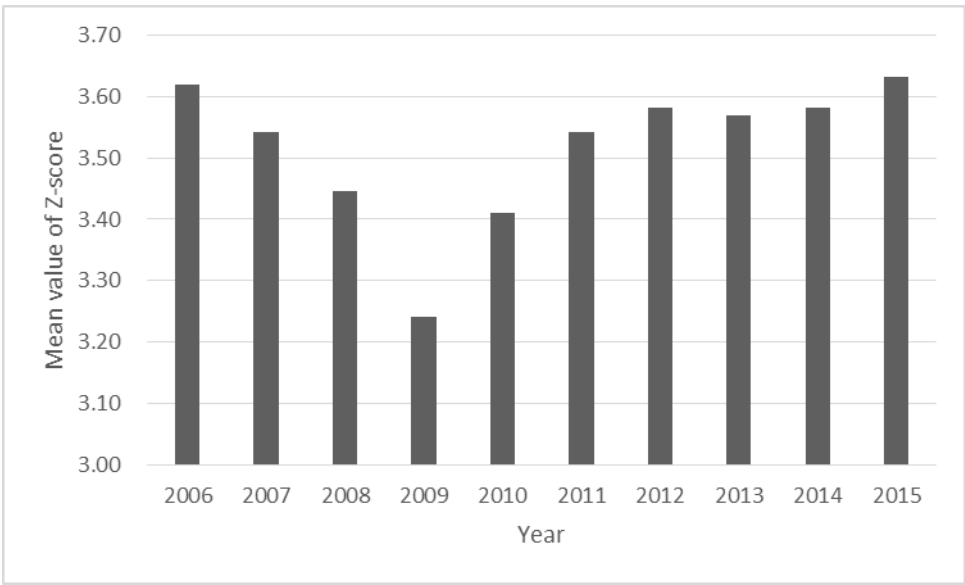
author selects 16 listed banks in China’s stock market as research samples and Z-score model is adopted to process and analyze the annual financial data from the year 2006 to 2015.

From table 3-9, we can find that Z-score of the listed banks increases yearly from 2006 to 2015. And the average level of annual Z-score in each bank is higher than 2.675, which means the credit risk of each bank is small. From the overall level, the overall Z-score of listed bank is lower between the year 2006 and 2009; and after 2010, the overall Z-score of listed banks are higher except several individual banks. The Z-score of most listed banks are higher than 2.9 which illustrates the credit risk is very small and their financial status are stable.

**Table 3-9: The Z-score of 16 listed banks from 2006-2015**

CODE	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Mean-value
000001	2.49	2.59	2.62	2.64	3.04	3.40	3.71	3.67	3.50	3.38	3.10
002142	3.75	3.75	3.27	3.39	4.16	3.66	4.16	4.33	4.27	4.42	3.91
600000	4.05	3.51	3.22	2.98	3.33	3.51	3.53	3.61	3.59	3.82	3.51
600015	2.81	3.26	3.48	3.32	3.35	3.50	3.57	3.53	3.44	3.31	3.36
600016	2.81	2.70	2.56	2.56	2.79	3.06	3.71	3.34	3.52	3.54	3.06
600036	2.84	3.40	3.07	2.92	2.85	2.99	3.14	3.21	3.31	3.42	3.11
601009	4.10	4.10	3.91	3.79	4.24	4.34	4.34	4.48	4.68	4.66	4.26
601166	3.35	3.62	3.53	3.27	3.67	4.00	4.19	4.27	4.30	4.39	3.86
601169	4.60	4.60	4.47	3.43	3.77	3.98	3.86	3.88	3.88	4.02	4.05
601288	3.53	3.53	3.53	3.53	3.53	3.57	3.57	3.51	3.46	3.50	3.53
601328	3.32	3.32	3.43	3.03	2.97	3.06	3.04	3.07	3.05	3.24	3.15
601398	3.69	3.62	3.62	3.51	3.42	3.46	3.44	3.32	3.27	3.25	3.46
601818	4.08	4.08	4.08	4.08	4.08	4.17	3.58	3.40	3.61	3.57	3.87
601939	3.46	3.46	3.44	3.51	3.35	3.35	3.30	3.16	3.14	3.09	3.33
601988	5.74	3.80	3.51	2.90	3.05	3.10	3.05	3.01	3.00	3.00	3.42
601998	3.31	3.35	3.40	2.99	2.95	3.54	3.11	3.29	3.28	3.50	3.27
Mean-value	3.62	3.54	3.45	3.24	3.41	3.54	3.58	3.57	3.58	3.63	3.52

(Source: The author’s construction)



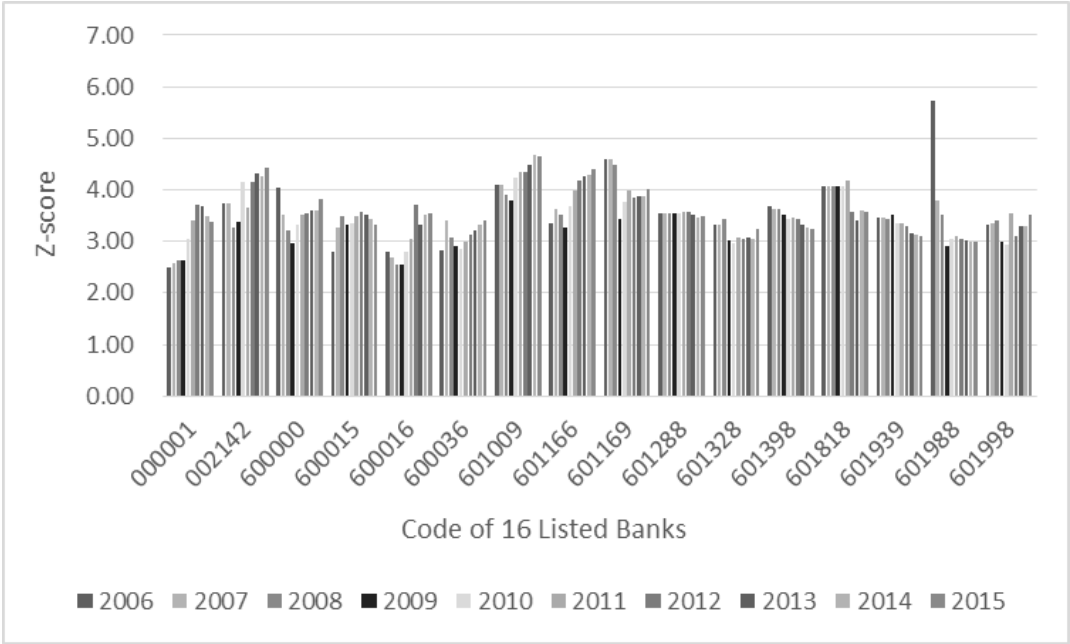
**Figure 3-4: The mean value of Z-score of 16 listed banks**

(Source: The author’s construction)

Figure 3-4 illustrates in clear way that the average Z-score of the 16 listed banks decreased from

the beginning of the year 2006 and dropped to the lowest point in 2009, after that it continued to rise, that is, the credit risk of China's listed banks showed a curve from first fall to the following ascending trend. Taking the global financial crisis in 2008 into account, this trend corresponds to the changes in the macroeconomic environment.

At the same time, the Figure 3-5 below also analyzes the changes of the Z-score of each listed bank. Although the Z-score of each bank have highs and lows from 2006 to 2015, but generally the range keeps at above 2.5 level. And the changing trend of most listed banks is consistent with the overall average level, which shows decreasing first and then rising thereafter. However, the listed bank 601288 was a little different, its Z-score remained around 3.5. Bank 601939 has a persistent decline which is opposite to the overall trend, but the Z-score level is still high. Even at the lowest point in 2015, it still reached 3.09 which was higher than the critical value 2.9, which means the credit risk of bank 601939 is low. The Z-score of bank 601988 anomalies as high as 5.74 in the interval of sample year 2006, then drop down to the average level.



**Figure 3-5: The changes of Z-score of 16 listed banks from the year 2006 to 2015**

(Source: The author’s construction)

*The AHP method applied in credit risk evaluation mode*

This section focuses on the loan of the rural land contract management right mortgage from the perspective of credit risk management of financial institutions and applies analytic hierarchy process (AHP) to solve how to assess the weight of risk factors when the financial institutions evaluate this special kind of loan.

We can conclude the weight of all indicators of the model. All specific calculation process are same as the above and results are shown in Table 3-10.

**Table 3-10 Weights of indicators in all layers of mode**

1st criterion layer		2nd criterion layer		3rd criterion layer		4th program layer		
Indicators	Weights	Indicators	Weights	Indicators	Weights	Weights		
Borrower risk	62.50%	Moral risk	41.67%	Profile Interviews	21.58%	MP=42.85% ME=27.35% MI=9.80%		
				The real use of the loan	52.58%	MP=11.14% ME=38.88% MI=49.98%		
				Credit record	5.84%	MP=25.84% ME=13.38% MI=40.78%		
		Business situation	33.15%	Energy Bill invoice for past six months	14.96%	MP=33.25% ME=13.97% MI=52.78%		
				Transportation Bill	13.54%	MP=47.31% ME=24.50% MI=8.19%		
				Packaging worker's salary	51.50%	MP=36.95% ME=2.38% MI=40.67%		
		Financial risk	25.18%	Liabilities	70.00%	MP=47.42% ME=13.39% MI=19.19%		
				External guarantee	30.00%	MP=35.85% ME=13.49% MI=30.66%		
		Guarantor risk	23.85%	Source of Guaranteed Payout	23.49%	Net profit of main business	30.19%	MP=57.41% ME=3.40% MI=19.19%
						Direct income of natural persons	52.26%	MP=35.85% ME=13.49% MI=30.66%
Real estate collateral	17.55%					MP=57.41% ME=3.40% MI=19.19%		
Substitution Solvency ability	30.25%			Amount of external guarantee	14.40%	MP=35.85% ME=13.49% MI=30.66%		

		guarantee		Credit record	19.57%	MP=57.41% ME=3.40% MI=19.19%
				Margin payment amount	46.03%	MP=35.85% ME=13.49% MI=30.66%
		Joint and several liability	26.29%	Guarantee coverage	44.45%	MP=35.85% ME=13.49% MI=30.66%
				Counter - guarantee collateral	55.55%	MP=60.00% ME=0.00% MI=0.00%
		Substitution Solvency will	19.97%	The Substitution Solvency agreement of natural persons	44.45%	MP=57.41% ME=3.40% MI=19.19%
				The Substitution Solvency agreement of guaranty enterprise	55.55%	MP=35.85% ME=13.49% MI=30.66%
Industry risk	13.65%	Planting subsidies	44.45%			
		Price protection	55.55%			

(Source: Calculation result with AHP method)



## 5. CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusion

The risk-taking behavior of commercial banks is an important issue in the field of bank research. New perspectives and new factors have constantly given this issue new research directions. As an important part of economy, the risk management of banking system is closely related to the stability and healthy operation of the financial markets and even the whole economy of a country. Commercial banks are risk-taking financial institutions in nature. In the process of engaging in risk business, commercial banks receive corresponding rewards for taking risks. While if risks are improperly taken or poorly managed, commercial banks will face greater risks and may even fall into bankruptcy, which would affect the whole economy. After the global financial crisis in 2008 hit the global virtual and real economy, large amount of researches analyzed the reasons of the crisis and pointed out that excessive risk-taking behavior of financial institutions is the main cause of the crisis.

Therefore, commercial banks, regulators and stakeholders hold an increasingly high opinion of the risk-taking of commercial banks. Enhancing the researches on commercial banks' risk-taking behaviors will help commercial banks to better manage their risks and it will also help supervisors to formulate more effective supervision measures and better implement financial regulatory innovation.

The dissertation focus on the risk management of Chinese commercial banks. It takes commercial bank risk-taking behaviors as the research object and comprehensively uses a variety of methods to measure the risk-taking of commercial banks on the basis of theoretical researches. In addition to systematic theoretical research, empirical research and countermeasure research also compose the solid foundation of the research. Some valuable and constructive conclusions are elaborated below.

First, this dissertation is based on the latest research findings on risk-taking behaviors of commercial banks. On the basis of relative researches, the author identifies and summarizes the five major factors that affect the risk-taking behaviors of commercial banks through theoretical analysis. The five factors are the operating status of commercial banks, market competition, corporate governance level of commercial banks, the mechanism of the bank's risk-taking channels for monetary policy and capital regulation and capital pro-cyclicality effect.

Second, through theoretical deduction and mathematical derivation the author concludes that capital supervision can restrict commercial banks risk-taking motivation, optimize risk-taking behavior and prevent risk-taking consequences. In other words, capital supervision can achieve the goal of standardizing commercial bank risk-taking behaviors. The empirical test result of pro-cyclical effect on capital adequacy ratio of Chinese commercial banks indicated that there is a pro-cyclical effect on capital adequacy of commercial banks in China.

Third, the author used market information to filter risk indicators for risk measurement, including CCAR, CAR, PFC, NPL, LDR and LAR. Among them, three risk indicators can replace other indicators to explain almost 96% of the total information, which are NPL, CAR and LAR. We can conclude that the risk indicator with information that bank have high risk prevention ability have positive correlation with stock price while the risk indicator with information that bank have low risk prevention ability have negative correlation with stock price in China.

Fourth, the author constructed the risk-taking measurement approach on the basis of risk category and comprehensive financial information. This approach is based on single financial indicator. It combines several single indicators which represent different risks respectively and uses grey relational analysis (GRA) method for comprehensively measuring the risk-taking level of commercial banks. This method can comprehensively reflect various types of financial information and can fully reflect the risk-taking level of commercial banks. From the empirical analyses on 16 listed commercial banks in China, it showed that the major large state-controlled commercial banks have a higher level of risk-taking, while the majority of medium-sized joint-stock commercial banks have a low level of risk-taking. The current risk-taking level of Chinese commercial banks is reasonable.

Fifth, The Z-score model can be effectively applied to measure the credit risk of listed commercial banks in China and the AHP method is a powerful and useful tool to implement credit risk management of commercial banks in China. The effective early warning of potential risk in commercial banks can be tested by Z-score model, and the application of AHP method for a special type financial product - the loan of rural land contractual management right in China with the hope of improving the internal control of credit risk management in Chinese commercial banks.

## 4.2 New Scientific results and Achievements

Based on the study in previous chapters, the following new scientific results were explored.

(1) Through the empirical study of 16 listed commercial banks in China during the 9-year period from the year 2007 to 2015, the result shows that the major large state-controlled commercial banks have a higher level of risk-taking, while the majority of medium-sized joint-stock commercial banks have a comparatively low level of risk-taking. Cities commercial banks ranked in middle level.

(2) During the process of risk indicators selection by factor analysis, six variables were chosen out of eight variables and be proved to be more effective. The six variables include CCAR, CAR, PFC, NPL, LDR and LAR.

There are three risk indicators that can replace other indicators to explain almost 96% information, which are NPL, CAR and LAR. And the result of regression analysis on these three variables with stock price indicates that Hypothesis 2 is true. That is financial risk indicators have significant correlation with stock prices of listed banks.

(3) On the basis of the comprehensive financial information categories by difference risk, this research probes into the comprehensive considerations to the various risks in commercial banks for risk-taking measurement. According to the author's research findings, four types of risks are selected. They are NPL short for credit risk level, ROA short for operating risk level, CAR short for capital risk level and LDR short for liquidity risk level. This approach provides a new thinking on measurements of risk-taking on the basis of the traditional single financial information risk measurement method.

(4) When the author was constructing the risk-taking measurement approach based on risk category and comprehensive financial information, there was a technical problem - how to combine the different risks together and obtain the comprehensive financial information? This research applied grey relational analysis (GRA) method to establish the measurement model. This method is proved to be effective in measuring the risk-taking of sample banks and it provides a new perspective to measure the risk taking of commercial banks.

### **4.3 Limitations of dissertation and prospects of further research**

The remained issue needs to be pointed out is that in this dissertation due to the limits in research experience and data collection there still exist some limitations and issues for further researches left as the future research directions.

(1) Commercial banks need to take a certain degree of risk based on business operations, their own characteristics, and their external economic environment. However, when the certain degree of risk-taking do not match the appropriate risk-taking standard, commercial banks will experience excessive or insufficient risk-taking. Excessive risk-taking is that commercial banks' risk business operations exceeds the actual risk level of bank acceptance, while 'insufficient' refers to that commercial banks do not make full use of resources to carry out risk business. This dissertation measures the overall level of risk-taking of Chinese listed commercial banks. While, how can we distinguish the portion of the excessive and insufficient risk-taking in Chinese commercial banks? This is another important issue about risk-taking behavior of commercial banks. It is worth exploring the relevant variables and establishing appropriate methods of analysis in future research.

(2) Under the context of globalization, the risks of different financial systems have a correlate effect, that is, risk-taking transmit among different banks and different countries, or wave up and down for some common factors at the same time. It is a form of risk-taking linkage. In terms of the form and the causes of the risk taking effect of commercial banks, it is believed that bank risks will spread from individual banks to the entire banking industry, and may even cause large fluctuations in the banking system, and then lead to the fluctuation of the global financial system. Therefore, in the future research, the authors will focus on the comparison between banks and international comparisons between countries.

(3) As it is the first time to applied GRA method to comprehensive measure the overall risk of Chinese commercial banks, the author intended to select the most commonly used risk indicators in commercial bank financial statements which are available in financial reports with the hope of fully implementing the research idea. However, the indicators could be possibly selected in more sophisticated way. The ROA indicator here is not the typical choice for operational risk. And some other indicators with the Basel expectation could be more accurate at describing the different kind of risks in commercial banks. Those indicators will be considered in the author's future research.

## 5. Summary

The banking system is an important part of the financial market in a country. Its stability concerns the healthy operation of the financial market and even the entire economic system. Therefore, the risk management of commercial banks has been always positioned at the research hotspot. The risk management of Chinese commercial banks has always been the top concern of bank management in China.

A large number of studies have shown that the global financial crisis triggered by the US subprime mortgage crisis in 2008 originated from the excessive risk-taking by commercial banks. It has shown in full scale that the excessive risk-taking of financial institutions and the inadequate supervision have a significant negative impact on the global economy. As for China, the second largest economy of the world, Chinese financial market is currently relatively close, but according to the conditions for China's entry into the WTO, Chinese financial market will be gradually open to the world. In this process, if the over-all risk-taking of the Chinese banking sector has excessive fluctuations, there is possibility that it will cause the systematic risks, which would inevitably affect the stability of the global economy for the chain effect of financial risks among countries. At current stage, the risk management level of Chinese institutions is still in its infancy. Therefore, in the process of gradual opening, China must learn from advanced economies such as the US, Japan and the European Union. At the same time, China should gradually improve the risk management mechanism of Chinese financial system on the basis of China's national conditions and strive to maintain its healthy development.

Maintaining the stability of the banking system is of great significance to the healthy operation of the economic and financial system. The risk-taking level of commercial banks is closely related to the sustained and healthy development of the entire banking industry and the safety and growth of the entire financial industry. At the same time, the credit scale of commercial banks is also influenced by banks' risk-taking behaviors, which in turn affects the macro economy and has a major impact on Chinese economic development.

The risk management of commercial banks is not to completely avoid risks, but to effectively manage risks. Bank management creates value for shareholders through the development of business and successful risk management. The failure of risk management in commercial banks would lead to its bankruptcy. Then how to achieve the goal of maximizing shareholder value? On

the one hand, banks can actively take reasonable risks and achieve the expansion of banking business, on the other hand, how to avoid unreasonable risk-taking is the focus of risk management of commercial banks. In recent years, China's commercial banks have undergone a series of reforms and changes. However, are they still exposed to risks? Under this background, how to better strengthen the risk management of commercial banks in China has become an important research issue.

This research comprehensively analyzes the risk-taking behavior, the measurement and risk management of Chinese commercial banks. 16 listed Chinese commercial banks had been chosen as research samples including five large commercial banks, eight joint-stock banks and three city commercial banks. Combining theoretical analysis with empirical test and using a variety of research methods and measurement models, the author conducts a comprehensive study of the risk-taking behavior of commercial banks. The statistical analyses include Random-Effects Generalized Least Squares (GLS) regression, factor analysis, linear multiple regression analysis, grey relational analysis (GRA) and Analytic hierarchy process (AHP) method. The statistical softwares used in this dissertation rang from Excel, Stata, SPSS 19 to Matlab. There are 6 hypotheses had been tested and proved in this dissertation. The author established a risk-taking measurement model by GRA method based on the thinking of comprehensive considerations to the various risks in commercial banks.

In the beginning of this research, the author identifies and summarizes the five major factors that affect the risk-taking behavior of commercial banks through theoretical analysis on the basis of studying related literatures. The five factors are composed of the operating status of commercial banks, market competition, corporate governance level of commercial banks, the mechanism of the bank's risk-taking channels for monetary policy and capital regulation and capital procyclicality effect.

The main part of the research consists of four sections, which established a complete research process. First, an important factor on risk-taking of commercials banks is selected, that is, the capital supervision and capital adequacy ratios. Through theoretical deduction and mathematical derivation, it deduces the constraint effect of capital supervision on commercial bank risk-taking behaviors. Then the author empirically tests the procyclical effect of capital adequacy ratio applied model in Ayuso, et al (2004), and random-effects GLS regression was employed.

Considering about the samples are all listed banks, the author selected the risk management indicators required for the research on the basis of market information, and six key risk indicators were finally selected by using factor analysis, including CCAR, CAR, PFC, NPL, LDR and LAR. And the author selected the three most representative indicators --NPL, CAR, LAR and applied regression analysis to test its relationship with the market price information stated by the stock price.

Combined with the risk management indicators selected in the second part, the risk-taking behaviors of listed commercial banks are measured, including the measurements by single indicator and comprehensive indicators. Risk indicators NPL and Z value index are employed as single indicator to measure the risk-taking level. The result showed similar changing trends on risk-taking level of 16 listed banks. For comprehensive measurement, this dissertation established a risk-taking measurement model on the basis of comprehensive financial information and it contains different kinds of risks. The grey relational analysis method was introduced in the dissertation and tested by statistical software Matlab. The result indicates that the major large state-controlled commercial banks have a higher level of risk-taking, while the majority of medium-sized joint-stock commercial banks have a comparatively low level of risk-taking. From the general review, we can judge that the risk-taking level of Chinese commercial banks are reasonable. The risk-taking measurement model based on comprehensive financial information is a more effective measurement.

Moreover, this research not only examines the existing risks in Chinese commercial banks but also evaluates the potential risks in their future. The Z-score model by Altman (1977) was put in use for such an examination. The result shows that the changing trend of most listed banks is consistent with the overall average level, which appears to decrease first and then rise thereafter. And generally the fluctuation range keeps at above 2.5 level.

## List of Publication

### Journal Articles:

- 1 **Jing, L.**, & Zeman, Z. (2016). Pro-cyclical effect on capital adequacy of commercial banks in china. *VADYBA Journal of management*, 2(29), pp.77-83. ISSN 1648-7974
- 2 Li, M., Zéman, Z., & **Li, J.** (2016). The Impact of CSR on Chinese Economic Development. *Public Finance Quarterly*, 61(4), pp. 500-515. ISSN 1552-7530
- 3 Emese B., Judit B., & **Jing, L.** (2016). Investments and funds under crisis. *VADYBA Journal of management*, 2(28) ISSN 1648-7974
- 4 **Jing Li**, Maohua Li, Márk Tóth, Judit Bárczi. (2017). AHP approach in the credit risk evaluation of the rural finance in China. *MODERN SCIENCE / MODERNI VEDA 2017* :( 2) pp. 57-69. ISSN 2336-498X.
- 5 **Jing Li**, Maohua Li, Bernadett Almadi, Judit Bárczi. (2017). The factor analysis of share price for chinese listed banks from the angle of risk management control. *MODERN SCIENCE 2017* :( 3) pp. 62-76. ISSN 2336-498X.
- 6 **Jing, Li.** (2017). The Application of Z-score Model on Financial Early Warning of Chinese Listed Companies. *Journal of Shanxi Radio & TV University*, 2 (107), pp.48-50. ISSN1008-8350
- 7 Maohua Li, **Jing Li**, Bernadett Almádi, Judit Bárczi, Tibor Pál Szilágyi. (2017). The study on employee corporate identity based CSR. *MODERN SCIENCE / MODERNI VEDA 2017* :( 4) pp. 93-108. ISSN 2336-498X.
- 8 Gan Quan, Maohua Li., **Jing Li.** (2017): Compare of economic conditions for some developing countries with China. *Economics & Working Capital*. 1-4 Issues. pp. 56-65. ISSN 2398-9491
- 9 Maohua, Li., Pál, szilágyi, Tibor., **Jing, Li.** & Bernadett, Almádi. (2017). A vállalati társadalmi felelősségvállalás viszonya az alkalmazotti identitás kapcsolatrendszerében. Tanulmánykötet Vállalkozásfejlesztés a XXI. században VII, pp. 368-379. ISBN 978-963-449-028-9

### Conference Paper:

- Jing Li.**, & ZY Jiang. (2015). The empirical research on the herd effect in China's medium and small enterprises board based on CCK model. *STRUCTURAL CHALLENGES – CYCLES IN REAL BUSINESS*, International Scientific Conference on the occasion of Hungarian Science Festival, SOPRON, Hungary 2015. November 12. pp. 566-573. ISBN 978-963-334-264-0



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**Jing Li.** (2017). Theoretical analysis of affecting factors of risk-taking behavior of commercial banks. "Geopolitical Strategies in Central Europe" International Scientific Conference, Sopron - Hungary, 09.11.2017. University of Sopron Press. pp. 741-755. ISBN 978-963-359-091-1