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The Risk-Taking Behavior in Chinese Commercial Banks

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By

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DEDICATION

I would like to dedicate this dissertation to my beloved family: my parents, husband and my lovely sweetie daughter Jiang Yihan. Also my dedication is addressed to all people who helped me through the doctorate time like my supervisor Professor Dr. Zéman Zoltán, respectively.

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LIST OF CLASSIFICATIONS

The list below contains the codes, full names and abbreviations of 16 listed commercial banks in Chinese stock market.

000001	PAB	Ping An Bank
002142	NBCB	Bank of Ningbo
600000	SPDB	Shanghai Pudong Development Bank
600015	HXB	Huaxia Bank
600016	CMBC	China Minsheng Bank
600036	CMB	China Merchants Bank
601009	NJCB	Bank of Nanjing
601166	CIB	Industrial Bank
601169	BOB	Bank of Beijing
601288	ABC	Agricultural Bank of China
601328	BCM	Bank of Communications
601398	ICBC	Industrial and Commercial Bank of China
601818	CEB	China Everbright Bank
601939	CCB	China Construction Bank
601988	BOC	Bank of China
601998	CCB	China CITIC Bank

ABBREVIATIONS

AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
APR	Asset profit ratio
BCPs	Basel Core Principles
BIS	Bank of International Settlements
BRIC	Brazil, Russia, India and China
Buf	Capital buffer
CAR	Capital adequacy ratio
CCAR	Core capital adequacy ratio
CGFS	Committee on the Global Financial System
CI	The consistency index
CIR	Cost income ratio
CR	The Current Ratio
CSMAR	The China Stock Market & Accounting Research Database
D-W	Durbin-Watson
EBIT	Earnings before Interest and Tax
EBITTA	Earnings before Interest and Tax to Total Assets
EPS	Earning Per Share
FASB	Financial Accounting Standards Board
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GGDP	GDP growth rate
GLS	Generalized Least Squares regression
GRA	Grey Relational Analysis
GST	Grey System Theory
IASB	International Accounting Standards Board
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
IPO	Initial Public Offerings
IRB	Internal Ratings Based approach.
ISE	Financial Sector Index of Istanbul Stock Exchange
KMO	Kaiser-Meyer-Olkin

LAR	Loan Allowance Ratio
LDR	Loan to Deposit Ratio
LGD	Lost Given Default Rate
MENA	Middle East North Africa
MR	The American Mathematical Review
NPL	Non-performing Loan
OECD	Organization for Economic Co-operation and Development
PB	Price to Book
PD	Probability of Default
PFC	Provision Coverage Ratio
RI	The Average Consistency Index
ROA	Return on Assets
ROI	Return on Investment
SA	British Science Abstracts
SCP	Structure Conduct Performance
SP	Share Price of listed banks
TDTA	Total Debt to Total Assets

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.

The structure of the dissertation is divided into six chapters. Chapter 1 is the introduction. After the introduction, Chapter 2 addresses the relative literature review. Chapter 3 introduces the research methodology and research materials. Chapter 4 presents the research results and discussions. The Conclusions and suggestions are provided in Chapter 5. And Chapter 6 is the summary.

2. LITERATURE REVIEW

2.1 Risk-taking behaviors and risk management

The word Risk was coined in almost 2000 years ago, according to Milkau (2017), the culture of merchants making decisions under uncertainty and taking the individual responsibility for the uncertain future started with the Roman "Aleatory Society". Knight (1921) made the first accurate definition of the risks and uncertainties and explained the essential differences between risk and uncertainty. His work laid the theoretical foundation for the study of financial risks.

Risks and risk-taking are two co-related while relatively independent concepts. The core proposition of enterprise decision-making is how to maximize the values under the condition of limited internal resources. At the same time companies have to face external uncertainties, which may bring either benefits or losses. And this probability distribution resulting from external uncertainties is called risk (Matt & Shapiro, 1987). The risks of commercial banks refer to the uncertainties that commercial banks face in terms of gains and losses in the business process.

The New Basel Accord II (2003) divides the main bank risks into credit risk, market risk and operational risk. Credit risk refers to the risk of loss caused by the failure of a counterpart to perform the obligations in the contractual agreement; market risk refers to the risk of loss due to changes in the price of financial assets and liabilities; operational risk refers to risk of loss due to imperfect conducts or problems of internal procedures, personnel, systems, or external events.

In the enterprise decision-making, the degree of risk acceptance depends on the decision-makers after their trade-offs with the internal and external factors, which is performed as a game of internal and external stakeholders. And this game raises the question of risk-taking. Wright et al. (1996) defined the risk-taking behavior as a project analysis and selection with a variety of uncertainties for expected and related cash flows. Risk-taking of commercial banks refers to the behavior of commercial banks to take risks or venture capital, which is the total risk of commercial banks in the process of management.

The prerequisite for commercial banks' profitability lies in taking appropriate risks, whose risk-taking is connected with their business development and it is the total risks brought by commercial banks business conducts. The risk-taking is the certain proportion of all risks commercial banks undertaking in their business but it is varied respectively from other risks. Commercial banks will take the initiative to choose the portfolio, which is a dynamic description of the risk selection.

In the wake of outbreak of financial crises in the past few decades, risk-taking behaviors has come to the forefront of academic and policy discussions. Many scholars explored the financial crisis and the mechanism of bank crisis from different perspectives. It is generally accepted that the excessive risk-taking behaviors of commercial banks is the decisive factor in causing the financial crisis.

Kaminsky & Rienhart（1996）pointed out that financial liberalization often precedes banking crises and confirmed that the risk-taking behaviors of banks are increasing with the process of financial liberalization. The financial liberalization has brought about over-risk-taking behavior in commercial banks. Eventually, the financial crisis is inevitable. Demirgüç-Kunt.A (2008) argued that the increase of the risk-taking behaviors of commercial banks is mainly attributed to the moral hazard caused by the deposit insurance system. This can explain that under the background of complete legislation and strict supervision in developed countries, commercial banks still have the motivation of risk-shifting, which could also cause financial crisis and banking crisis. Dewatripont, et al (2010) believed that the underlying reason of financial crisis in 2008 lies in the fact that poor regulatory constraints and the implementation are ineffective, which resulted in the motivation of over risk-taking behaviors of commercial banks. And the over liquidty of commercial banks has stimulated the risk-taking behaviors, eventually leading to the banking crisis. Saldias (2013) explored the mechanism and impact of the subprime mortgage crisis in 2007 on the basis of the U.S. banking system research. He concluded that the contagion effect caused by the risk-taking behaviors of U.S. banks is the main reason for this crisis.

2.2 Literature review on the impact factors of risk-taking behavior

This research identifies and theoretically analyzes the factors that influence commercial banks' risk-taking behaviors from five perspectives, including governance level of commercial banks, the mechanism of the bank's risk-taking channels for monetary policy, market competition of

commercial banks, the operating status of commercial banks and capital regulation. The structure is shown as follow in Figure 2-1:
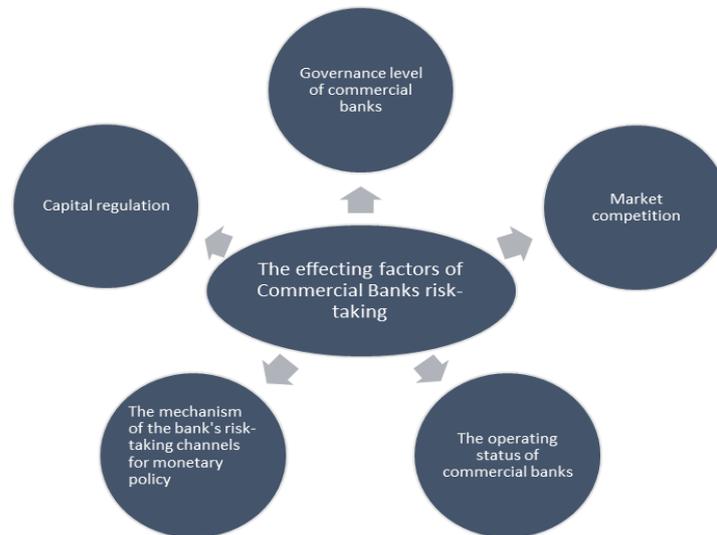
Figure 2-1: The effecting factors of commercial banks risk-taking

Source: The author's construction

2.2.1 The impact of the operating status of commercial banks on the risk-taking behavior

The operating status is the most direct affecting factor of bank risk-taking behaviors, which includes bank size and profitability.

As for bank size, there is one viewpoint regards that the bigger the size, the higher risk-taking of commercial banks will undertake. According to capital asset pricing theory, it usually tends to take a higher risk to obtain higher profits. Meanwhile due to size effect, most banks take higher risks and gain more profits and benefits through the expansion of the size. In addition, due to the role of the government safety net, the bigger the bank get, the more possible the banks would involve in high risk business. Tabak, et al (2013) focused on how bank size and market concentration affect performance and risks in 17 Latin American countries between 2001 and 2008. Tabak, et al (2012) made an analysis on the impact of commercial banks size on their risk-taking in the competitive markets with data from 10 Latin American countries in the period

between the year 2003 and 2008 and found that large size banks have benefited more from their risk-taking behaviors.

On the other hand, the size may also be negatively related to commercial banks' risk-taking. First, under the Basel Capital Accord III, commercial banks can choose standard method or internal rating method to calculate the capital adequacy ratio on the basis of their actual situation, which entitles the big commercial banks to more competitive advantages and their overall risk-taking may be less. Hakenes & Schnabel (2011) analyzed the relationship between bank size and risk-taking under the New Basel Capital Accord with an internal ratings based (IRB) approach. The results show that smaller banks have a higher risk-taking under the frame of Basel Accord II. Second, the large size commercial banks get involved in more businesses. The types and number of their customers are varied, which is favorable for the commercial banks to disperse their risks. Third, one prevailing phenomenon in commercial banks is 'too big to fail'. Large commercial banks can easily attract investors' funds and financing. Their liquidity risk is small. They also have stronger ability to disperse credit and investment risk than the small banks. Fourth, the large-sized commercial banks have staged into the steady development and established a relatively comprehensive corporate governance mechanism. They have comparatively better risk management ability. In contrast, in the fierce market competition, small and medium-sized commercial banks often bear too high risk in order to expand their business, resulting in more overall risk-taking. And relatively incomplete internal control system of these banks could not effectively regulate their risk-taking. Their regulatory systems cannot effectively inhibit their impulse of internal expansion, which also increased the possibility of excessive risk-taking of small and medium-sized commercial banks.

The profitability of commercial banks is related to the risk situation. General investment theories believe that risk is proportional to profit, that is, the stronger the profitability of commercial banks, the higher the risk-taking. It indicates that commercial banks have too much risk-taking. But from another perspective, profitability shows the general effect of the bank assets investment of the commercial banks. Stronger profitability also means the higher investment efficiency of the commercial banks. If the commercial bank's high profitability is achieved through the optimization and perfection of internal management, the efficient operation of assets, effective increase of income and reduction the cost, then the higher profitability of commercial banks does not necessarily mean higher risk-taking. Therefore, the relationship between profitability and risk-taking is also subject to empirical discussion. Liang (1989) examined the relationship

between profits and risks to test whether the estimated effect of market concentration on bank profits is biased when risk is ignored or not. Liang (1989) and Tabak, et al (2013) have proved that the profitability of the bank is the result of their risk-taking behavior and also is the basis of the commercial bank's risk-taking in the next period.

2.2.2 The impact of market competition on commercial banks' risk-taking behaviors

Some researches claim that market competition is an important influencing factor of commercial banks' risk-taking. Matan & Vives (2000) and Boyd & De (2005) empirically analyzed the banking competition and risk-taking of commercial banks. Niinimäki (2004) considered the joint effect of competition and deposit insurance on risk-taking by banks when bank risk is unobservable to depositors.

Generally, the impact of market competition on commercial banks' risk-taking have two aspects. On the one hand, the 'competition - vulnerability' theory suggests that market competition will lead to higher risk-taking of banks. In the competitive environment, the operating costs of commercial banks will rise and the average profitability will decline. To handle this situation, commercial banks may ease the standards of deposit and loan admittance, thus raise the risks of banks. And the increase in default losses may result in the write-off of new profits (Yeyati & Micco 2007).

Boyd and De Nicoló (2005) proposed that concentration in the loan market could lead to increased borrower debt loads and a corresponding increase in loan defaults that undermine bank stability. Sanyal & Shankar (2011) exclaimed that in the post-1998 period, India's private banks have higher risk-taking than state-owned banks under the influence of market competition. Jiang, et al (2017) found that an intensification of competition materially boosts bank risk, reduces bank profits, charter values, and relationship lending and increases banks' provision of nontraditional banking services.

Bushman, et al (2016) provided evidence to prove that greater competition increases both individual bank risk and a bank's contribution to system-wide risk. Furthermore, they found that higher competition is associated with lower underwriting standards, less timely loan loss

recognition, and a shift toward non-interest revenue while higher competition is associated with higher stand-alone risk of individual banks, greater sensitivity of a bank's downside equity risk to system-wide distress, and a greater contribution by individual banks to downside risk of the banking sector.

On the other hand, the "competition - stability" theory claims that the market competition will indirectly reduce the level of bank risk-taking. In a moderate competition environment, commercial banks may strengthen the construction of their internal control and improve their governance structure, thereby enhancing their risk-taking capacity and decreasing the risk-taking level. In addition, commercial banks may extend their profit sources to enhance their profitability in an intense competition market. For example, with the intensification of inter-bank competition in recent years, many commercial banks expanded the intermediary business. It is generally accepted that the risk-taking of such business behaviors will be reduced to a certain extent.

Jayaratne and Strahan (1998) and Beck et al. (2006) argued that intensifying bank competition will reduce bank risks. Zhang, et al (2013) analyzed the relationship among market concentration, risk-taking, and bank performance with a unique dataset of the BRIC (Brazil, Russia, India and China) banks over the period of the year 2003 to 2010, under the framework of SCP (Structure-Conduct-Performance). And they found a negative association between market concentration and performance. Jiménez, et al (2013) empirically examined the relationship of competition and risk-taking of the Spanish banking system. They found that standard measures of market concentration do not affect the ratio of non-performing commercial loans (NPL), while there is a negative relationship between loan market power and bank risk after using Lerner indexes based on bank specific interest rates. Sarkar, et al (2016) analyzed the competition–stability relationship for the Indian banking sector from the period 1999-2000 to 2012-2013. Their results show that market concentration leads to lower levels of default, asset risks and exacerbates the levels of capital and liquidity risks. They all found that the relationship between competition and risk-taking is mixed up - there is a monotonically decreasing relationship between competition and risk.

While, there is another viewpoint on this issue. González, et al (2017) pointed out that there is a U-shaped relationship between competition and banks' risk-taking for MENA (Middle East North Africa) banks. They tested 356 banks operating in the MENA countries during the year 2005 and 2012. And the results not only confirmed the importance of the market structure as an

explanatory factor for financial stability, but also indicated that concentration is not associated with uncompetitive markets.

2.2.3 The impact of corporate governance on commercial banks' risk-taking behaviors

Researchers also studied the impact of corporate governance on its risk-taking from different perspectives. The definition of corporate governance differs in terms of one's view on the world. Looking from a broad perspective on the issues, Gillan and Starks (1998) defined corporate governance as the system of laws, rules, and factors that control operations in a company.

The objectives of the corporate governance mechanism of commercial banks include micro and macro aspects. From the micro perspective, corporate governance is necessary to maximize profits and ensure that the risk is at a lower level thus to be in accordance with the inherent requirements of profitability and security of commercial banks. From the macro point of view, commercial banks play a special role in the financial system and the national economy. Commercial banks are not only the basis of state macro–control but also the implementers of monetary policy and other macroeconomic policies. Therefore, it has the target to maintain financial stability through risk-taking controlling from the macro aspect. Laeven & Levine (2009) firstly made empirical assessment of theories concerning relationships among risk-taking by banks, their ownership structures and national bank regulations. Their findings imply that the same regulations will have different effects on bank risk-taking depending on the bank's corporate governance structure. Barry, et al (2011) employed detailed ownership data for a sample of European commercial banks to analyze the links between ownership structure and risk in both privately owned and publicly held banks. Laeven & Levine (2009) stated that corporate governance has a significant impact on commercial banks' risk-taking behaviors and they pointed out that commercial banks have a high risk-taking when they have large amount of shareholders. Mnasri & Abaoub (2010) put emphasis on the ownership structure, the acceptance of government officials on bank's boards, the capital adequacy requirements and the franchise value to empirically analyze the determinants of risk-taking in Tunisian commercial banks. The results show that capital adequacy is not the most critical factor of risk-taking. Some corporate governance variables also have significant impact on commercial banks' risk-taking.

From the perspective of stakeholder theory, the main structure of financial institutions includes shareholders, members of the board of director, members of the board of supervisors and executive incentive mechanism. (Hao Chen et al., 2016). Its basic structure is shown in figure2-2.

Fortin, et al (2010) analyzed the bank governance, share ownership, CEO compensation and bank risk-taking. They concluded that different incentives have different impacts on the risk-taking of commercial bank. CEOs with higher base salaries will take less risks, while CEOs with higher bonuses or stock options will take more risks. Uhde (2016) used compensation data provided by 63 banks from 16 European countries to empirically test the impact of excess variable compensation on bank risk. And they stated that there is a risk-increasing impact of excess variable pay for both executive variable cash-based and variable equity-based compensation.

Figure 2-2: The structure of governance level of commercial banks

Source: The author's construction

2.2.4 The mechanism of the bank's risk-taking channels for monetary policy

Macroeconomic conditions have an obvious correlation with risk-taking of commercial banks, and the changes of macroeconomic directly affect the commercial banks' risk-taking behaviors. Gambacorta (2009) made investigations on the link between low interest rates and banks' risk-taking. They found that low interest rates over an extended period cause an increase in banks' risk-taking. López, et al (2011) found a significant link between low interest rates and banks' risk-taking based on the evidences from Colombia from the year 2000 to 2008. It shows that lower interest rates raise the probability of default on new loans, but reduce that on outstanding loans. The transmission of risk in the loan policy is influenced by macroeconomic conditions.

Montes & Peixoto (2014) also referred that monetary policy affects bank's risk perception and thus has impacts on its risk-taking behaviors. Cociuba, et al (2016) pointed out that financial intermediaries increase risky investments when interest rates are low. Dell'Ariccia, et al (2017) used data of banks' internal ratings on loans to businesses for the U.S. banking system over the years from 1997 to 2011 and found that ex-ante risk-taking by banks is negatively associated with increases in short-term interest rates.

The economists have given out different explanations about the mechanism of the bank's risk-taking channels for monetary policy. At early stage Rajan (2005) began to focus on the impact of monetary policy on risk-taking of banks. After the financial crisis in 2008, scholars began to pay attention to the important impact of the banking system in the dissemination and amplification of the economic shock. Substantial empirical evidences suggest that banks tend to expand their credit scale during the economy rise and reduce credit loan during the recession, that is, the bank's risk-taking has a pro-cyclical effect. And this pro-cyclical characteristic of banking system would intensify economic volatility. In fact, economic uncertainty also has a cyclical characteristic, which tend to be lower in the economic boom while higher in the recession. Buch et al. studied the data of 48 countries and found that economic uncertainty has a significantly negative impact on the level of bank risk-taking, and higher economic uncertainty will drive banks to cut credit scale significantly (Ma Zhuntao & Shen Yue, 2016).

Borio and Zhu (2008) firstly brought forward the risk-taking channels of monetary policy and explained the significant correlation between interest rate volatility and bank risk-taking behaviors. They pointed out that monetary policy exerted impacts on the bank's risk-taking through participation in valuation, incomes and cash flows mechanism, profit-seeking mechanism, the central bank's communication and reaction mechanism and leverage mechanism etc. Adjustment of monetary policy firstly affects the risk appetite or risk tolerance of banks, and then has an impact on the bank portfolio, credit risk pricing and loan decision, and ultimately influences the real economy. The risk-taking channel emphasizes the risk appetite and risk tolerance of commercial banks and analyzes the responses of commercial banks to monetary policy from the microcosmic perspective of behavioral decision-making.

(1) The valuation, income and cash flow mechanism

The valuation, income and cash flow mechanism have impact on the risk-taking channel as a

financial accelerator (Adrian & Shin, 2009). For example, from long term, low interest rates will increase the nominal value of assets, collateral, income and profit, which will change the valuation of default risk on bank loan and loan loss reserves. The risk preference and risk tolerability of banks will be changed accordingly, thereby promote the risk-taking willingness and ability for banks. Long-term over-easing monetary policy reduces risk awareness by increasing the value of money (also known as currency illusion), enhancing risk-taking behaviors of banks.

(2) The mechanism of search for yield

The mechanism of search for yield renders from the interaction between the market nominal interest rate and the earnings target. When the nominal interest rate falls, the financial institution tends to increase the proportion of assets with higher risk due to the stickiness of the earnings target, thereby enhancing its risk-taking (Borio & Zhu, 2008). Rajan (2006) pointed out that financial institutions with long-term liabilities need to use their gains from the assets to match their commitment to the debtor. When interest rates remain high, financial institutions can invest in security assets to obtain the necessary profits. While when interest rates remain low, financial institutions are obliged to invest in higher-risk assets to match their debt expenditure. This search for yield mechanism makes commercial banks involve in more high-risk business when the market is under the long-term low interest rate environment, and some market participants who cannot get the bank loan initially, will get loans in this mechanism. That is how expansionary monetary policies affect the real economy through risk-taking channels.

(3) The communication and response of central bank

Central bank will make full use of the anticipated management to achieve objectives when it is in the adjustment of monetary policy position. The fulfillment of anticipated management not only connects with communication effect of the central bank, but also is closely related to the credibility and transparency of central bank. Central bank can eliminate future uncertainties via increasing its transparency and communication, but it will still enhance the bank's willingness to take risks in a long-term low interest rate monetary policy environment (Altunbasetal, 2009). Meanwhile, if market participants anticipate that central bank will help in crisis period, the financial institutions will increase the risk exposure and taking more risks. Diamond & Rajan (2009) suggested that monetary policy should be kept slightly tight even in the booming

macroeconomic period. Ashraf (2017) used an international sample of banks from 98 countries over the period 1998–2007 to examine the impact of political institutions on bank risk-taking behavior and find out that sound political institutions stimulate higher bank risk-taking, political and legal institutions complement each other to influence bank risk-taking behavior.

(4) Leverage mechanism

Adrian & Shin (2009a) pointed out that financial institutions have fixed or pro-cyclical leverage ratios. When portfolio or profits are undergoing a shock, the banks will try to get through with trading assets rather than paying dividends or increasing capital. De Nicolò et al (2010) thought that even the leverage mechanism cares little about the quality of the bank's portfolio, but also shows the working mechanism of the risk-taking channel.

2.2.5 The impact of capital regulation and capital pro-cyclicality effect

In the composition of financial safety net, the capital supervision that can restrict the internal cost of commercial and constraint the bank's risk-taking behavior is particularly important due to the great influence of bank's risk-taking behavior on the real economy,.

Capital supervision refers to the general term for a series of regulations and regulatory review activities, including the actions that the regulatory authorities set requirement of the minimum capital level that financial institutions need to hold; punish financial institutions that actual capital level below the minimum capital level and the supervisory authorities conduct review activities to check the financial institution's capital compliance requirements.

The capital adequacy ratio requirement is the core of capital supervision. Capital adequacy ratio requirements impel the bank to maintain appropriate capital level and reduce business risks. The purpose of supervising the capital adequacy ratio is to restrain excessive expansion of risk assets in banking institutions and protect the interests of creditors. Therefore, the regulatory authority requires banks to hold a certain amount of capital, to withstand the risks posed by financial crisis, agency issues, and safety nets of regulatory agencies.

Capital supervision has evolved from the decentralization of individual countries with a single indicator at the initial stage to the global governance of the Basel Accord. In addition, the capital supervision in the Basel Accord has undergone several revisions, resulting in the multiple level

capital supervision framework in the newly promulgated Basel Accord III in 2010.

Demongüç-Kunt, et al (2008) used data from over 3000 banks in 86 countries to study the relationship between the Basel Core Principles (BCPs) for effective banking supervision and bank risks measured by individual bank Z-scores. Demongüç-Kunt, et al (2008), Laeven & Levine (2009) and Barry, et al (2011) showed that the level of risk-taking lagging one period is significantly related to the current risk level. Simar and Wilson (2007）built the double bootstrapping approach to analyze the relationship between bank efficiency and finance regulatory. Ayadi, et al (2016) applied this double bootstrapping approach to an international sample of listed banks to test the adoption of international capital standards and the Basel Core Principles for Effective Bank Supervision. Jiang, H., & Zhang, J. (2017) indicated that the effect of capital buffer and franchise value on bank risk-taking is heterogeneous across quantiles.

The researches on capital regulation effects in different countries are also varied. Ashraf, et al (2016) studied the impact of risk-based capital requirements on bank risk-taking behavior with a panel dataset of 21 listed commercial banks of Pakistan over the period 2005–2012. Their results suggest that commercial banks have reduced assets portfolio risk in response to stringent risk-based capital requirements. Rahman, et al (2017) found that bank capital adequacy ratios have a positive association with the cost of financial intermediation, whereas a negative association with bank risk-taking variables in 32 Bangladeshi commercial banks over the year of 2000 and 2014. Zheng, et al (2017) suggested that higher capital regulation enhances banks' stability when it combats with credit risk but higher credit risk often persuades abating capital ratio in a developing country over the most recent period between the year 2006 and 2014.

Pro-cyclicality effect of capital adequacy ratio

In 1998, the Basel Committee revised the 1988 Capital Accord and formulated the New Capital Accord (Basel Accord II 2003). The discussions of procyclicality caused by Basel Accord II has widespread concerns and controversies in theory and practice. These correlated discussions on procyclicality of the new Capital Accord made Basel Committee decide to choose smoother risk weight function thus it can encourage banks to use the cycle rating method to ease off a certain degree of its procyclicality. But the negative impact on the procyclicality of the new protocol on economic development may still exist (Gordy& Howells, 2006).

After the worldwide financial crisis in 2008, people have realized that the procyclicality of the financial system has done in-depth harms to financial stability and economic development. The external rules such as Basel Accord II, loan loss provision, fair value criterion and the interaction of internal factors between financial institutions have played certain roles in excessive credit growth and expansion of financial imbalances before the finance crisis as well as the sharp fall of the market, liquidity shortage and credit crunch after the crisis. Especially, the crisis exacerbated the panic selling and market liquidity shortages, hence followed by the formation of vicious circle: prices fall - the market value has shrunk - reduction of capital - sell - prices continue to fall - and liquidity shortage and credit crunch, which promoted the further spread of the crisis.

After a comprehensive analysis of the causes of the crisis the Financial Stability Forum submitted to the G7 finance ministers and central bank governors meeting for the reconstruction of the global financial system package in April 2008. It positioned the solutions of the pro-cyclical issues as an important aspect of strengthening macro-prudential supervision. It appeals to organize the relevant government departments, Basel Committee, Bank of International Settlements, CGFS, IMF, IOSCO, IASB and FASB and other international organizations to set up four specialized working groups to study regulatory capital supervision, loan loss provisions, incentives and pro-cyclical leverage and valuation management respectively. In February 2009, the IMF released IMF (2009), and De Larosiere et al (2009), Turner (2009), Panetta et al (2009) and Brunnermerier et al (2009) all analyzed the source of procyclicality of the financial system and its relationship with the Finance Crisis, then made suggestions on how to release the procyclicality of the financial system.

Demyanyk & Hermert (2008) pointed out that the outbreak of the US sub-prime mortgage crisis in the financial system is the consequence of over procyclicality. And the economic cycle converted into the most important systemic risk for the whole banking system. Aspachs et al (2006) found that in order to meet the regulatory capital requirements of the New Basel Accord, banks will adjust the size of loan more substantial in the face of external shocks, thereby increasing the fluctuations of economic. Heid (2007) also analyzed the capital-induced lending cycles and pro-cyclical effect on the macro-economy and found that the capital buffer plays a crucial role in soothing the impact of the volatility of capital requirements.

Some of researchers analyzed this problem from the perspectives of methodology. Bernanke & Blinder (1988) modified IS-LM model to present the important relationship of money-demand

shocks with credit-demand shocks during the 1980s. Tanaka (2002) developed the modified IS-LM model based on Bernanke & Blinder (1988). By assessing the impact of the New Basel Accord, researchers drew the conclusion that a rise in credit risk may lead to a sharper loan contraction and Basel II may reduce the effectiveness of monetary policy as a tool for stimulating output during recessions. Estrella (2004) built a dynamic model of optimal bank capital in which the banks optimized the costs associated with failure, holding capital, and flows of external capital to examine the procyclicality of bank capital. And she made out several solutions to reduce this problem via the model.

Other scholars empirically studied the impact of procyclicality between economic cycle and capital adequacy ratio. Ayuso et al (2004) applied the panel data of Spanish commercial and savings banks from the year 1986 to 2000 and rendered the result that economic cycles and capital adequacy ratio have a significant negative correlation, and this relationship is asymmetric. Jokipii & Milne (2008) used panel of accounting data from the year 1997 to 2004 to deduce that capital buffers of the banks in the EU15 have a significant negative co-movement with the cycle. For banks in the accession countries there is significant positive co-movement. Bikker & Metzemakers (2004) based their multinational study on 29 OECD countries, which showed that the risk of individual banks have weak relationship with economic volatility. Risk-weighted capital adequacy ratio under the New Basel Accord may not cause significant pro-cyclical effect.

2.3 Literature review on the measurement methods of commercial banks' risk-taking

2.3.1 Financial indicator and market information

Ball, Brown (1968) pioneered into the empirical analysis of correlation between stock prices and financial indicators, in which he found that the empirical results indicated that changes in financial volatility and stock price index appeared to have a significantly positive correlation. For better financial indicators stock, its stock price will rise and vice versa. Beaver and Dukes (1972) implemented empirical experiments of the relevance of financial information and stock prices. Their study found that the correlation of earnings per share and stock price is stronger than the correlation of operating cash flow and the stock price. Earnings per share excel operating cash flow in explaining the stock price. Kevin (2005) examined 28 Finland listed companies operation from the year 1995 to 2004 to explain stock cumulative abnormal return with a relatively simple financial indicators classification method. He also observed whether the

factor classification model has the stability in the same and different phases. The results show the financial indicators have the ability to explain the cumulative abnormal returns of stock, but its explanatory power is not stable in different periods. Fernandez (2008) counted out 38 financial indicators from the financial statements and divided them into seven categories. He found that capital turnover, accounts receivable turnover ratio, financial leverage and the return on investment (ROI) were correlated to stock prices, thus the financial indicators have reference value to stock investors. Michalis, et al (2012) checked over the impact of earnings and book value in the formulation of stock prices on the basis of samples from 38 companies listed in the Athens Stock Market during the year 1996 and 2008. Their research results showed solid evidences that the joint explanatory power of selected parameters in the formation of stock prices increase over time. Holló (2012) developed a system-wide financial stress index (SWFSI) for the Hungarian financial system. And his results show that the system-wide financial stress indicator puts greater emphasis on periods in which stress presents permanently in several market segments at the same time of the stability of the Hungarian financial system.

The research on this issue in China is comparatively late than other countries. The issue if stock prices can reflect the corresponding financial information of listed companies and what kind of relationship is between the two in Chinese stock market gradually attracted more and more academic concerns. Many scholars have probed into the research from different angles.

Chen, et al (2001) examined whether domestic investors in Chinese stock market perceive the accounting information based on Chinese GAAP to be value-relevant. After analyzed the samples of all listed firms in the Shanghai and Shenzhen Stock Exchanges from the year 1991 to 1998, they found that four factors including positive vs. negative earnings, firm size, earnings persistence, and liquidity of stock stand out to function. Their research findings show clear evidence that accounting information is value-relevant to investors in the Chinese market. J. Wang, et al (2013) screened 60 listed companies in Shanghai Stock Exchange in the year of 2011 and empirically analyzed the relationship between accounting information and stock price with a few accounting information indexes. Their research findings unveiled that accounting information and stock price have positive relationship while degree vacillates under different circumstances and there are extraordinary correlations between earnings per share and return on equity. Callen, et al (2016) used data in Chinese equity markets to empirically test the hypotheses that foreign (domestic) investors are more likely to revise their return expectations to cash flow (discount rate) news. And they pointed out that cash flow news and discount rate news are likely

to be uncorrelated when evaluating return revisions by domestic investors, whereas cash flow news and discount rate news are likely to be negatively correlated when evaluating return revisions by foreign investors. Zhu - Niu (2016) analyzed the mechanism behind the effects of investor sentiment and accounting information on stock price on the basis of the residual income valuation model. Their results show that investor sentiment can change both the expected earnings growth and the required rate of return, thus affecting the stock price. They also pointed out that accounting information and investor sentiment can both explain the stock price.

2.3.2 Grey relational analysis method

Generally, the indicators to measure risk-taking are based on the financial information including nonperforming loan ratio, capital adequacy ratio and Z index. Salas & Saurina (2002) firstly introduced nonperforming loan rate (NPL) to be the index to measure risk-taking of commercial banks. After that, The NPL ratio has been the preferred metric for most scholars to measure the risk-taking of commercial banks. Gonzalez, F. (2005) also chose NPL ratio to measure the risk-taking level. They used a panel database of 251 banks in 36 countries to analyze the impact of bank regulation on bank charter value and risk-taking. Hannan & Hanweck (1988) constructed the Z-score value to measure the risk-taking level of the commercial bank. The Z-score value was inversely proportional to the bank's risk-taking -- the higher Z-score value, and the lower risk-taking level. García & Robles (2008) also used the Z-index to measure the risk-taking behavior of Spanish financial intermediaries with a dynamic panel data model in the period from the year 1993 to 2000.

The measurement method of commercial banks' risk-taking based on single financial index has its limitations because it is only evaluated from one point of view. How to make comprehensive consideration to the risk-taking of commercial banks and measure the level of risk-taking becomes a new perspective of researches. Zéman, et al (2013) stated that banking and financial sector controlling is a dynamically growing area of the controlling methods used in organizations. As for the research methods, how to evaluate all kinds of information and evaluate the overall risk of commercial banks is an important issue that researchers need to solve.

The grey relational analysis method stood out to be a better choice to measure the level of risk-taking. Grey relational analysis method is one of the main contents of the grey system theory (GST). The GST was established by Chinese scholar Deng Ju-long in 1982. It is a new method to study the problem of uncertain or poor information. "Incomplete information" is the basic

meaning of "grey". The grey system theory aims at employing small samples, poor information and uncertain system as the research object with partial known and unknown information. It mainly achieves the correct description on the system operation behavior and effective monitoring through developing and exploring on partially known information and decoding valuable information.

In 1982, Deng Julong first published the Grey System Theory on the Journal of Systems & Control. After that, the Grey System Theory has been developing in rapid progress and been applying in many scientific fields with success. The Journal of Grey System, founded in the UK in 1989, has become the core journal of major international digest institutions such as the British Science Abstracts (SA) and the American Mathematical Review (MR) etc.

Camelia (2015) reviewed the application of the grey system in different economic areas such as: the supply chain management, decision-making process, financial performance evaluation, credit risk, energy consumption, investment efficiency, etc. Hamzaçebi & Pekkaya (2011) used grey relational analysis (GRA) for ordering some financial firms' stocks which are in Financial Sector Index of Istanbul Stock Exchange (ISE) to solve multi-criteria decision making problem for the investors. Jin, et al (2012) analyzed the credit risk from the angle of industrial and macroeconomic factor using grey relational analysis method. Their results indicated that the default loan ratio differs by the effect of diverse industry's influence and the macroeconomics. Lin & Wu (2011) constructed a financial crisis warning system by analyzing the credit risks of banking industry based on grey relational approach and stated that GRA is capable of managing financial risks and it has a significant implication for the establishment of early warning models of financial crisis.

Özçelik & Öztürk (2014) evaluated the sustainability performance of banks in Turkey by using grey relational analysis method, the specified ratios for banks' sustainability relating to banks' economic, environmental, and social performance. Duran, et al (2017) focused on the economy policy decision making and applied grey relational method to analyze the degree of relationship between Turkey's domestic savings and selected macroeconomic indicators.

2.3.3 Credit risk and Z-score model

Credit risk has been considered one of the most important risks in the field of risk management.

According to Guption (1997), credit risk refers to the risk of possible losses when debtors are not willing or not able to repay the debt. It comprises the risks probably from the decision of debtors as well as debtors' credit rating migration which may lead to the loss of creditors' assets prices.

A number of researches are keen on credit risk management. The management of credit risk has experienced different periods from the initial decision mode by subjection to modern quantitative risk management across countries for years. A lot of methods are applied to measure and manage credit risk. Based on the requirement of Basel Accord II, banks could adopt the standardized approach or internal rating approach to measure credit risk capital requirement. Beaver (1966) proposed the univariate model for financial early-warning as a transition from expert rating method to multivariate statistics analysis method. The model helps to understand that the cash flow and total debt ratio are the two important factors for relatively successful determination to the enterprises financial status by using the regression analysis of the financial ratios. Kumar, Moorthy and Perraudin(2003) proposed Simple Logit model based on lagged macroeconomic and financial data to forecast currencies crash.

Professor Edward Altman (1968) first introduced Z-score model, a prediction model for enterprise financial position when he was in Leonard N. Stern School of Business in 1968. Professor Altman identified five indicators from initially selected financial ratios, and then gave a certain weight to build a complete weighted average function equation. The final Z score was applied to determine the size of the enterprises' financial status, which can assess the credit risk of loan applicants and classify the default levels. After that, Altman, Haldeman and Narayanan (1977) proposed ZETA model on the basis of Z-score model. Compared with the original Z-score model, ZETA model has seven parameter variables, which could run a better result when classifying different types of enterprises.

Z-score model is one of the most extensively used risk measurement models in developed countries with proven effectiveness. While China, a developing country and still in its primitive stage in this field, has not yet stepped up its efforts to make a proper adjustment of models introduced from foreign countries and fitted into the reality of the country or done such innovative research on quantitative risk model. But some researchers gradually turned to study on this emerging market. Zhang, Altman and Yen (2010) developed a model called Z China score to support identification of potential distress firms in China based on the Z-score. Chen et al, (2006) applied four alternative prediction models to examine the usefulness of several financial

ratios in business failure prediction in China. And from the results, they found significant prediction of these financial ratios, which are Earnings Before Interest and Tax (EBIT) to Total Assets (EBITTA), Earning Per Share (EPS), Total Debt to Total Assets (TDTA), Price to Book (PB), and the Current Ratio (CR). Yi Wang (2012) chose 40 listed real estate companies in China's stock market to estimate the effectiveness of Z-score model on early financial risk warning of listed real estate companies. And their findings show the predicative ability of Z-score model on real estate listed companies. Ligang Zhou (2013) employed the Adaboost method in the prediction of the listed companies which are under special treatment or delisting risk in China' stock market. The results from their test show that Adaboost model is a better alternative method of financial distress prediction. Geng, Bose and Chen (2015) provided a suitable method for prediction of financial distress for listed companies in China. They built a financial distress warning models based on 31 financial indicators and 107 mining firms to a control group of firms and also proved prediction ability of financial indicators on deterioration in firm profitability.

2.3.4 Analytic Hierarchy Process (AHP)

Saaty (1988) firstly introduced the Analytic Hierarchy Process which is a multicriteria decision making approach to arranged different factors in a hierarchic structure. And Saaty (1990) profiled the general background information of the type of measurement employed, its properties and applications of the AHP. Subsequently, Saaty (2004) further developed a generalization of the AHP which is The Analytic Network Process (ANP). According to Saaty (2004), The ANP is an essential tool for articulating our understanding of a decision problem. And AHP with its independence assumptions on upper levels from lower levels and the independence of the elements in a level is offered as a special case of the ANP.

Arbel & Orgler (1990) applied the AHP methodology to the evaluation of bank mergers and acquisitions strategy. It was tested with the assistance of the board of directors of a billion dollar bank holding company and could testify that the AHP approach can provide a useful, simple and powerful tool for dealing with strategic planning in banking. Yurdakul & Ic (2004) focused on manufacturing firms to develop a credit evaluation and decision-making model for the banks to determine the credibility. In their studies, they applied the AHP to the credit evaluation process in the banks and classified the relevant criteria, sub-criteria and measures. A hierarchical decision structure is built to calculate overall credibility scores for loan applicant of manufacturing firms

in Turkey. Stankevičienė & Mencaitė (2012) exploited the AHP to evaluate the performance of banks in Lithuanian market. A system of indicators has been created and an empirical test has been done in different banks. And they concluded that AHP model is appropriate for using in the process of evaluating bank performance.

3. 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.

Table 3-1: **The 16 listed Chinese commercial banks**

Stock code	Bank Name Abbreviation	Bank Full Name
000001	PAB	Ping An Bank
002142	NBCB	Bank of Ningbo
600000	SPDB	Shanghai Pudong Development Bank
600015	HXB	Huaxia Bank
600016	CMBC	China Minsheng Bank
600036	CMB	China Merchants Bank
601009	NJCB	Bank of Nanjing
601166	CIB	Industrial Bank
601169	BOB	Bank of Beijing
601288	ABC	Agricultural Bank of China
601328	BCM	Bank of Communications
601398	ICBC	Industrial and Commercial Bank of China
601818	CEB	China Everbright Bank
601939	CCB	China Construction Bank
601988	BOC	Bank of China
601998	CCB	China CITIC Bank

(Source: The author's construction)

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 to2014 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.

Grey Relational Analysis Method

In 1982, the grey system theory (GST) was established by Chinese scholar Deng Ju-long. And it was first published in the journal of Systems & Control letters. After that, the grey system theory (GST) has been developing at rapid pace and succeeding in the appliances in many scientific fields.

The grey system theory (GST) is a new method to study the problem of uncertain or poor information. The grey system theory aims at employing small samples, poor information and uncertain system as the research object with partial known and unknown information. It mainly achieves the correct description on the system operation behavior and effective monitoring through developing and exploring on partially known information and decoding valuable information. In cybernetics, the clarity of information is often illustrated in terms of colors. For example, Ashby refers to the object with unknown internal information as the Black Box. The grey system theory uses "black" to indicate the unknown information while "white" means the information is completely clear. "Grey" means some information is clear, and some information is uncertain. Correspondingly, the system with complete information is called the white system, the system with unknown information is called the black system, and the system with partially clear and uncertain information is called the grey system. "Incomplete information" is the basic meaning of "grey".

Grey relational analysis (GRA) method is one part of the grey system theory. The basic principle of this method is to distinguish the multi-factors in the system by comparing the geometric relationships of the statistical series. The closer the geometric shapes of the sequence curves are, the greater degree they are related. It is a kind of effective analysis method which is specifically aimed at incomplete information system. Therefore, using this method to study the risk-taking of commercial banks on the basis of financial indicators can make the evaluation results more objective and reasonable.

If we consider commercial bank risk taking as a system with known and unknown information, it has some of the characteristics of "grey system". First of all, for the sake of collection of information and the disclosure limitation of annual report, people have incomplete information about financial and operational information of commercial banks. Because of the trade secrets and the confidentiality of bank client information, it is impossible for banks to fully publish all information relevant to their businesses while most important information is usually disclosed as required by regulatory authorities, so the information we hold is not completed. Secondly, there are many factors that affect the risk-taking of commercial banks, and they are not uniform. For example, some are quantifiable and some are non-quantified. In the analysis, the author can only select limited, quantifiable and representative indicators for comprehensive evaluation. Thirdly, the announcements in the annual report are mainly financial data while the distribution of data is uncertain. For these reasons listed above it can be seen that commercial bank risk-taking system has the characteristics of incomplete information, which is called "grey".

It is difficult to grasp the unknown information of this "grey system" by using the principal component analysis or other evaluation methods. Therefore, this study uses the grey correlation method suitable for "grey system" to synthesize the information of each financial index, then combines the information of each financial index to form the measurement method based on comprehensive financial information.

4. RESULTS AND DISCUSSION

This dissertation focuses on the analysis the risk-taking behavior and relative risk management of the selected 16 Chinese listed banks. As it is stated in the previous chapters, the complete study contains four parts and the research process and results of these four parts are discussed as follows.

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

In accordance with the design of this research, first of all, it focuses on the analysis on one of the main factors that influence the risk-taking behavior of commercial banks -- the constraint effect of capital supervision. In general, higher capital levels can add more safety and soundness to banks. Because main part of commercial bank funds comes from two aspects: one is the bank's own funds provided by its shareholders and the other is the borrowed funds provided by bank creditors, which is also the main source of funds of the bank. The own funds of bank shareholders enable shareholders to have the distribution right of the bank's surplus assets. In addition, shareholders have more information advantages and greater operating rights than creditors. However, when the shareholder's return is zero or negative, it will not have direct adverse consequences for the bank's operations and management. On the contrary, the creditor's rights and interests are stipulated in the creditor's contract and cannot participate in the distribution of the bank's surplus assets.

Therefore, the greater the proportion of banks' own capital, the greater probability that banks will repay borrowed funds when due, and the higher safety and more stable the banking operations will be. However, in order to pursue high returns, the management of banks may prefer to invest in high-risk with high-yield assets. Under the premise that bank shareholders have high debt management and assume limited liability, if the investment fails, bank shareholders will only bear part of the losses; on the contrary, if the investment is successful, bank shareholders relish high returns from investment. Therefore, without the proper supervision of the supervisory authority, bank shareholders who have the advantages of information and operation management right will tend to take excessive risks and high financial leverage to maximize their profits.

However, if the regulatory authority implements the prescribed capital requirements for banks and the necessary regulatory constraints, banks must increase their own capital ratios to meet the requirements of capital supervision. Bank shareholder are required to bear more proportions of losses caused by business failures from taking excessive risks. This would make the bank more cautious in their management, so as to make capital supervision impose more effective restrains on banks from taking excessive risks, thereby reducing the bankruptcy risk of the bank.

4.1.1 The mathematical approach analysis on the constraint effect of capital supervision on commercial banks' risk-taking behaviors

We can also use the following mathematical path to analyze the constraints effect of capital supervision on commercial banks' risk-taking behavior. According to the definition of capital, we can assume the following equation (4-1):

$$E = A \times \frac{RWA}{A} \times \frac{E}{RWA} \qquad (4\text{-}1)$$

Among them, E is the capital of commercial banks; RWA is the weighted risk assets of commercial banks; A is the total assets of commercial banks. RWA/A represents the proportion of risk-weighted assets of commercial banks in total assets, that is, bank portfolio risk, which is abbreviated to P; E/RWA is the proportion of capital and risk assets, that is, commercial bank capital adequacy ratio, which is denoted by C. Equation (4-2) can be expressed as

$$E = A \times P \times C \qquad (4\text{-}2)$$

After transform, it renders as:

$$C = \frac{E}{AP}$$

Inverse the both part of the equation, we can get equation (4-3):

$$\frac{1}{C} = \frac{AP}{E}$$

$$\frac{1}{C} = \frac{A}{E} \times P \qquad (4\text{-}3)$$

In equation (4-3), A/E represents the leverage risk of the commercial bank. It can deduce that the reciprocal of the capital adequacy ratio is equal to the product of the commercial bank leverage risk level and the portfolio risk level. According to the Basel Accord regulatory framework, regulatory authorities require a minimum level of capital adequacy. If regulatory authorities specify a minimum value of C, they will also limit the upper limit of 1/C. Therefore, by regulating the lower limit of the bank's minimum capital standard, the supervisory authority can limit the upper limit of the product of the bank's leverage risk and portfolio risk level.

From this perspective, 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.

4.1.2 The empirical test of pro-cyclical effect on capital adequacy ratio of Chinese commercial banks

According to the mathematical path analysis in the previous parts we could deduce that the capital supervision have constraint effect on commercial banks' risk-taking behavior. And the capital adequacy ratio requirement is the core of capital supervision. A large amount of researches analyzed the pro-cyclicality effect of capital adequacy ratio from different country as discussed in literature review chapter of the dissertation. 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 to be examined is -- Does there exist a pro-cyclicality effect on capital adequacy of commercial banks in China.

Based on China's 16 major commercial banks in the year 2004 to 2014 panel data, the author analyzes the relationship between macro-economic cycle and capital adequacy ratio, as well as probes into the issue whether there exists pro-cyclical effects of the capital adequacy ratio of China commercial banks.

The model of Ayuso, et al (2004) and Estrella (2004) has been proposed to analyze the relationship between macro-economic cycle and capital adequacy ratio. By establishing isostatic adjustment model, it could be assumed that the dynamic adjustment of bank capital follows the formula below (Ayuso, et al 2004).

Firstly, the author assumed:

$$K_t = K_{t-1} + I_t \qquad (4\text{-}4)$$

Here, K_t is the capital of the bank at time t, K_{t-1} is bank capital levels in t-1 period. I_t are changes of the bank's total capital in period T, including retained earnings, the IPO and the number of shares repurchased.

Banks hold capital mainly from three types of motivation: first, to reduce the cost of financial distress; second, to reduce the cost of external financing when capital is insufficient; and third, to reduce the information asymmetry between shareholders and depositors (Berger, et al 1995). We assumed that the holding cost of bank capital contains all these three elements, then it is:

$$Cost_t = (\alpha_t - \gamma_t)K_t + \frac{1}{2}\delta_t I_t^2 \qquad (4\text{-}5)$$

Among the equation （4-5）, α_t represents the risk - reward of capital, γ_t is the bankruptcy costs for banks (or regulatory penalties due to lack of capital), and δ_t is capital adjustment costs.

One important goal of banking operation is the cost minimization. Under the above assumptions, the optimization model is listed as below：

$$MinE_t(\sum_{i=0}^{\infty} \beta^i \cos t_{t+i})$$

$$s.t.K_t = K_{t-1} + I_t$$ (4-6)

$$Cost_t = (\alpha_t - \gamma_t)K_t + \frac{1}{2}\delta_t I_t^2$$

β is the discount rate, i is the year. After calculating the first-order derivative to cost, we can get:

$$I_t = E_t(\frac{1}{\delta_t}\sum_{i=0}^{\infty}\beta^i(\gamma_{t+i} - \alpha_{t+i}))$$ （4-7）

In this case, the bank costs are minimized. Then we substituted the equation （4-7） into equation （4-4）, it is

$$E_t(K_t) = K_{t-1} + E_t(\frac{1}{\delta_t}\sum_{i=0}^{\infty}\beta^i(\gamma_{t+i} - \alpha_{t+i}))$$ （4-8）

After minus minimum regulatory capital requirements in both sides of equation （4-8）, we can get capital buffer. The overall expectations equal to actual observation plus random error term in equation 6:

$$(K - \bar{K})_t = (K - \bar{K})_{t-1} + E_t(\frac{1}{\delta_t}\sum_{i=0}^{\infty}\beta^i\gamma_{t+i}) - E_t(\frac{1}{\delta_t}E_t\sum_{i=0}^{\infty}\beta^i\alpha_{t+i}) + \varepsilon_t$$ （4-9）

Based on the above theoretical analysis, the main empirical test model is listed as follows:

$$Buf_{i,t} = \beta_0 + \beta_1 Buf_{i,t-1} + \beta_2 GGDP_t + \beta_3 ROA_{i,t} + \beta_4 NPL_{i,t} + \varepsilon_{i,t}$$ （4-10）

Here, previously explained variable $Buf_{i,t}$ represents excess capital adequacy ratio of bank i at time t. It is the real bank capital adequacy ratio minus the minimum regulatory capital requirement 8%, which reflects the part of banks holding capital without being subject to regulatory constraints. This part of capital would increase investor's confidence, as well as expand investment opportunities in the future (Jokipii, T.; Milne, A. 2008). In this study, we mainly test how the macroeconomic cycle imposes impact on this variable.

There are 4 explanatory variables,

(1) $Buf_{i,t-1}$ is the first order lag of Buf, which is used to estimate the adjustment costs of capital adequacy ratio. The greater β_1, the higher adjustment costs;

(2) GGDP is GDP growth rate which stands for macroeconomic cycle here. It is the main factor we would test in this dissertation. If the regression coefficient β_2 is greater than 0, it means there exists a pro-cyclical effect between the economic cycle and the capital adequacy ratio;

(3) ROA is bank profitability. The higher profitability means more retained earnings can be converted into capital, it also means higher quality of asset management and the overall risk is small on bank side. So it is assumed that the bank profitability and excess capital are in positive relationship;

(4) NPL is non-performing loan, which is on behalf of the risk of assets here.

In this section, the author collected panel data of 16 major commercial banks in China from the year 2004 to 2014, which covers five large commercial banks, eight joint-stock banks, and three city commercial banks. Data contain capital adequacy ratio, return on assets (ROA), non-performing loan ratio (NPL) of these banks and the annual GDP growth rate of China. All the data are collected from WIND database.

Firstly, the author draw the graph of the trend of annual GDP growth rate of China from 2004 to 2014 as shown in Figure 4-1.

In this research, GDP growth rate are induced to stand for business cycles as mentioned before. From Figure 4-1, we can see the growth rate of GDP in China increased from 2004 to 2007 and decreased sharply after two years, then raised slightly from 2009 to 2010. After that, it declined steady. The changes of GDP growth rate show a movement of business cycle which we can applied in the analysis.
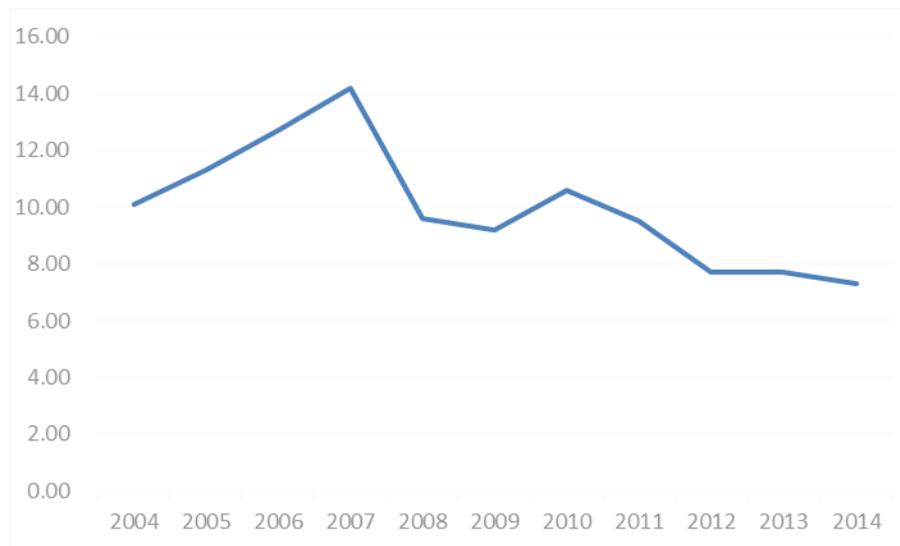
Fig. 4-1. Trend of annual GDP growth rate of China, 2004-2014

(Source: WIND Database)

Table 4-1 shows the basic statistical descriptions of all the variables in equation 4-10 as following.

Table 4-1. Basic statistical description of the variables

Variable		Mean	Std. Dev.	Min	Max	Observations
Buf	overall	3.458977	3.494298	-9.47	22.67	N = 176
	between		2.151305	-0.7745456	7.766364	n = 16
	within		2.801155	-5.236477	18.36261	T = 11
Buf_{t-1}	overall	3.346125	3.62856	-9.47	22.67	N = 160
	between		2.342769	-1.276	8.244	n = 16
	within		2.826404	-4.929875	17.77212	T = 10
GGDP	overall	9.990909	2.048756	7.3	14.2	N = 176
	between		0	9.990909	9.990909	n = 16
	within		2.048756	7.3	14.2	T = 11
ROA	overall	0.9891477	0.3373135	0.02	1.72	N = 176
	between		0.1912601	0.6236364	1.29	n = 16
	within		0.2815853	0.1464204	1.520966	T = 11
NPL	overall	2.504091	4.138635	0.33	26.17	N = 176
	between		2.296214	0.7163636	10.38545	n = 16
	within		3.486688	-6.661364	19.92318	T = 11

(Source: Test result from Stata)

Using Equation 4-10, linear multiple regression analysis has been tested by statistical software Stata, and we can get the following results of the relationships between the bank's excess capital adequacy ratio and GDP growth rates and other variables. The test results of random-effects

Generalized Least Squares (GLS) regression at 1%, 5% and 10% confidence level has been shown in Table 4-2, Table 4-3 and Table 4-4.

Table 4-2. 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^2: within = 0.4107				Obs per group: min =10	
between = 0.9314				avg =10	
overall =0.6040				max =10	
				Wald chi-square(4) = 236.41	
Correlation(u_i, x) = 0 (assumed)				Prob > chi-square = 0.0000	
	Coefficient	Std. Err.	Z	P > |z|	99% Confidence Interval
Buf_{t-1}	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_i)			

(Source: Test result from Stata)

Table 4-3. 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^2: within = 0.4107				Obs per group: min =10	
between = 0.9314				avg =10	
overall =0.6040				max =10	
				Wald chi-square(4) = 236.41	
Correlation(u_i, x) = 0 (assumed)				Prob > chi-square = 0.0000	
	Coefficient	Std. Err.	Z	P > |z|	95% Confidence Interval
Buf_{t-1}	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_i)			

(Source: Test result from Stata)

Table 4-4. 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^2: within = 0.4127				Obs per group: min =10		
between = 0.9294				avg =10		
overall =0.6062				max =10		
				Wald chi-square(4) = 238.64		
Correlation(u_i, x) = 0 (assumed)				Prob > chi-square = 0.0000		
	Coefficient	Std. Err.	Z	P > |z|	90% Confidence Interval	
Buf_{t-1}	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_i)				

(Source: Test result from Stata)

As we can see from the empirical test results in Table 4-2, Table 4-3 and Table 4-4, 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 β_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 2 and Table 3, by 0.383% in Table 4-4 respectively.

In addition, the table 4-2, 4-3 and 4-4 also show that the coefficient of $Buf_{i,t-1}$ 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.

The pro-cyclical effect of the capital adequacy ratio would reduce the constraint effect on the commercial bank's risk-taking behaviors. When the economic cycle is in its rising period, if the regulatory minimum capital requirement remains unchanged, the commercial banks will have more capital buffers, which enables banks to be more confident to undertake more risky business. This would reduce the constraint effect of capital on commercial banks' risk-taking. While in the period of economic decline, the capital buffer will decrease, commercial banks will tighten their credit, and capital resources will not flow smoothly to the real economy. The further recession of the real economy caused by commercial banks tightening credit may leads to a further economic downturn and the overall risk of the commercial banks will increase.

This result has important reference value for improving the effectiveness of China's capital supervision and analyzing the factors that influence the risk-taking behaviors of banks in China.

4.2 The risk indicators selection by factor analysis based on market information

This part focuses on the listed banks in Chinese stock market and aims to find some of the finance risk indicators from the financial statements of listed bank data to establish ties with the stock, mainly through researching the relevance between listed commercial bank share prices and accounting information to verify the feasibility of financial statements in decision-making and risk management, hence to offer banks and investors a guidance in different analyses.

The stock price reflects the performance of listed companies. This part chooses some important finance risk indicators which applied to build risk control system of banks to analyze the correlation between finance risk indicators and share prices on 16 listed banks in Chinese stock market from the perspective of bank's risk management. 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. The results of regression analysis show that significant correlations exist between bank's share prices and financial risk indicators.

Three more hypotheses will be tested in this part. They are:

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

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

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

Indicators Selection

In this part, some key finance risk indicators have been selected for analysis. Based on the general corporate financial indicators evaluation system and financial regulation requirement, it consists of four kind of finance risk indicators: Capital adequacy indicators, Assets security indicators, Liquidity indicators and Sustained profitability indicators (Bao - Zhang, 2016).

(1) Capital adequacy indicators

Commercial banks must meet the minimum capital adequacy ratio which is the 8% minimum capital requirement according to "Basel Accord II"(Basel Accord II, 2003). For listed banks, capital adequacy index plays a very important role throughout the banking industry. The bank capital adequacy ratio is the basic indicator to measure whether banks operations are in stability. The level of capital adequacy ratio of a bank not only affects the ability of the bank issuing the credit, but also affects the ability to bear risk. The higher capital adequacy means the higher ability to against risks for banks. In this study, capital adequacy ratio (CAR) and core capital adequacy ratio (CCAR) are both selected for further analysis.

(2) Assets security indicators

The quality of bank asset comprehensively reflects the security of the banking operation, including the profit earning, the capital loss, the liquidity of the carious assets and the credit level of the bank. The higher the quality of assets of listed banks, the more secure on their operation, which means more profits, less loss and greater investing value of the bank, therefore the stock price of the bank will be higher. Currently, the loan is still the main profitable assets in Chinese listed banks, thereupon, examining the quality of assets basically refers to the analysis of loan quality. Generally, the financial risk indicators that reflect the assets security of listed banks include non-performing loan ratio (NPL), provision coverage ratio (PFC) and loan allowance ratio (LAR), all of which are to be used in this study.

(3) Liquidity indicators

Liquidity demand for banks includes the deposits meet for payment, loan arrangements, maturing debt to pay and other payment requirements. Banks must maintain a certain degree of liquidity to keep the assets and liabilities in balance, which increases the banks' ability to adapt to the changes in the economic environment and to ensure the smooth development of various services. If banks are experiencing liquidity shortage problem, it would lead to the liquidity risk of bank. Theoretically, better liquidity management renders higher share price of bank (Bao - Zhang, 2016). Generally, loan to deposit ratio (LDR) is used to reflect the liquidity in the banking system.

(4) Sustained profitability indicators

Although banks are categorized to special kind of enterprise, but their business objectives are still to chase for the profit maximization, which is the ultimate goal of enterprise mission. In this dissertation, the author also takes this basic requirement of enterprise into consideration and chooses asset profit ratio (APR) and cost income ratio (CIR) to stand the sustained profitability indicators.

Table 4-5 The list of finance risk indicators

Indicator	Code	Formula
Capital adequacy ratio	CAR	= Total capital / Risk weighted assets
Core capital adequacy ratio	CCAR	= Core capital / Risk weighted assets
Non-performing loan ratio	NPL	= Non-performing loan /Total loan
Provision coverage ratio	PFC	= Loan loss provision / Total non-performing Loan
Loan allowance ratio	LAR	= Loan loss provision / Total loan
Asset profit ratio	APR	= Total profit / Average asset share
Cost income ratio	CIR	= Operating cost / Operating income
Loan deposit ratio	LDR	= Total loan / Total deposit

(Source: The author's construction)

To sum up, selected eight financial risk indicators include capital adequacy ratio (CAR), core capital adequacy ratio (CCAR), non-performing loan ratio (NPL), provision coverage ratio (PFC), loan allowance ratio (LAR), asset profit ratio (APR), cost income ratio (CIR) and loan deposit ratio (LDR), which are all shown in Table 4-5.

Firstly, the author made a basic description on the basis of a descriptive analysis on the financial data from listed banks to form a visual impression on the entire industry. Secondly, factor analysis was applied to extract the obvious impact factors on the stock prices of listed companies in banking sectors and impose analysis on the determinants of the share prices of the listed banks. Finally, regression analysis was employed to determine the direction and intensity factors on stock prices.

Until May 2015, there are 16 commercial banks listed in Chinese stock market, and this study selected all of these 16 listed banks as research samples. In this section, the corresponding data of eight financial indicators of 16 listed China banks have been collected from the annual reports in December 2015. As acknowledged, annual financial reports of listed companies have to be published in April of the following year in China. Considering the impact of hysteresis on stock prices of financial statements, the author chose the closing stock price of listed banks from 1st of

April to 10th of May in 2016 and account the average stock price for each individual bank in this period by EXCEL. The last arithmetic average price was used as the stock price of sample, which is the explanatory variables. All the data were collected from CSMAR database of China.

Descriptive analysis

The first step of statistical analysis in this part is descriptive analysis. Descriptive analysis describes the basic structure and the overall performance of statistical data in sample banks.

Table 4-6 Descriptive statistics of eight risk indicators

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
CCAR	16	4.70	8.43	13.13	9.9275	1.48454	2.204
CAR	16	4.54	10.85	15.39	12.7025	1.39358	1.942
PFC	16	279.96	150.99	430.95	202.1800	76.50723	5853.357
NPL	16	1.56	0.83	2.39	1.4750	0.34440	0.119
LDR	16	25.58	50.70	76.28	69.4513	6.89153	47.493
APR	16	13.63	0.90	14.53	1.9019	3.36934	11.352
LAR	16	2.18	2.35	4.53	2.8419	0.58887	0.347
CIR	16	13.42	21.59	35.01	28.1844	4.09502	16.769
SP	16	14.72	3.15	17.87	9.4956	5.32970	28.406
(listwise)							

(Source: Test result from SPSS)

Readers can find from table 4-6 that during the sample period, the average stock price of the all listed banks is 9.4956 Yuan. The range between the maximum and minimum value is14.72 Yuan, with the standard deviation of 5.3297 Yuan. The stock price volatility of the sample banks differs greatly during the sample period.

Factor analysis

In this part, factor analysis has been applied to explore the main factors in selected indicators which can explain the most part of information.

Table 4-7 shows the test results of KMO and Bartlett. We can obtain the KMO value of 0.311 from the table and the significant value of Bartlett's Test of Sphericity is 0.000, significantly lower than the level of 0.05, which means there is a correlation between the variables. This indicates that it is suitable for factor analysis.

Table 4-7 KMO and Bartlett's Test of eight risk indicators

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.311
Bartlett's Test of Sphericity	Approx. Chi-Square	99.681
	df	28
	Sig.	0.000

(Source: Test result from SPSS)

The communality of variables is an important index to measure the effect of factor analysis. If the communality of variables is high, it means that the extracted factors can reflect most of the information of the original variables and the result of factor analysis is better. Table 4-8 shows the results of communalities for each variable. It hints in this table that the communalities of most variables in factor analysis are very high except the variables APR and CIR. The results of communalities is 0.263 for APR and 0.271 for CIR, which are very low.

Table 4-9 shows the results of total variance explained. In this table, we can find contribution rate of each factor. In the cumulative of initial eigenvalues, the eigenvalues of first three factors are greater than 1, wherein the sum of the total feature worth 75.718%. This means the first three factors can be extracted to be the main factors.

Table 4-8   Communalities of eight risk indicators

	Initial	Extraction
CCAR	1.000	0.912
CAR	1.000	0.941
PFC	1.000	0.964
NPL	1.000	0.925
LDR	1.000	0.897
APR	1.000	0.263
LAR	1.000	0.885
CIR	1.000	0.271

Extraction Method: Principal Component Analysis.

(Source: Test result from SPSS)

Table 4-9 Total variance explained of eight risk indicators

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.643	33.038	33.038	2.643	33.038	33.038
2	1.921	24.018	57.055	1.921	24.018	57.055
3	1.493	18.662	75.718	1.493	18.662	75.718
4	0.900	11.252	86.970			
5	0.854	10.676	97.646			
6	0.141	1.762	99.407			
7	0.042	0.531	99.938			
8	0.005	0.062	100.000			

Extraction Method: Principal Component Analysis.

(Source: Test result from SPSS)

In consideration of the lower results of communalities for APR and CIR in table 4-8, the author chose to eliminate this two variables from eight variables and run factor analysis again with the remained six variables. The results are as follows:

Table 4-10 shows the test results of KMO and Bartlett with the rest six variables. We can obtain the KMO value of 0.360 from the table which is higher than before, and the significant value of Bartlett's Test of Sphericity is 0.000, significantly lower than the level of 0.05. It indicates that it is suitable for factor analysis.

Table 4-10 KMO and Bartlett's Test of six risk indicators

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.360
Bartlett's Test of Sphericity	Approx. Chi-Square	92.106
	df	15
	Sig.	0.000

(Source: Test result from SPSS)

Table 4-11 shows the results of communalities for each variable. It can deduce from the table that the communalities of most variables in factor analysis are very high, indicating that most of the information can be extracted by variable factors. The result shows that the factor analysis results are valid.

Table 4-11 Communalities of six risk indicators

	Initial	Extraction
CCAR	1.000	0.974
CAR	1.000	0.964
PFC	1.000	0.983
NPL	1.000	0.994
LDR	1.000	0.906
LAR	1.000	0.953

Extraction Method: Principal Component Analysis.
(Source: Test result from SPSS)

Table 4-12 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. This test result without variables APR and CIR is higher than the test with variables APR and CIR before. It shows that the factor analysis is more effective when we choose these six variables including CCAR, CAR, PFC, NPL, LDR, LAR. Thus researchers can extract the first three factors as the main factors from these six variables.

Table 4-12 Total variance explained of six risk indicators

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.542	42.360	42.360	2.542	42.360	42.360	2.200	36.663	36.663
2	1.850	30.838	73.198	1.850	30.838	73.198	1.903	31.711	68.375
3	1.381	23.017	96.216	1.381	23.017	96.216	1.670	27.841	96.216
4	0.171	2.848	99.064						
5	0.046	0.768	99.832						
6	0.010	0.168	100.000						

Extraction Method: Principal Component Analysis.

(Source: Test result from SPSS)

The author also drew a scree plot figure as shown in figure 4-2. The horizon axis is the component number, and the vertical axis is eigenvalue of each factor. The steepness of the slope of the line represents the importance of the factor. The steepness of the straight line corresponds to a larger eigenvalue of the factor, and a flatter line indicates the smaller eigenvalue. It can conclude from the figure 4-2 that the connection line between factors 1, 2, 3 have steep slope, indicating that the first three factors are the main factors. The conclusions is same with the results of table 4-12.
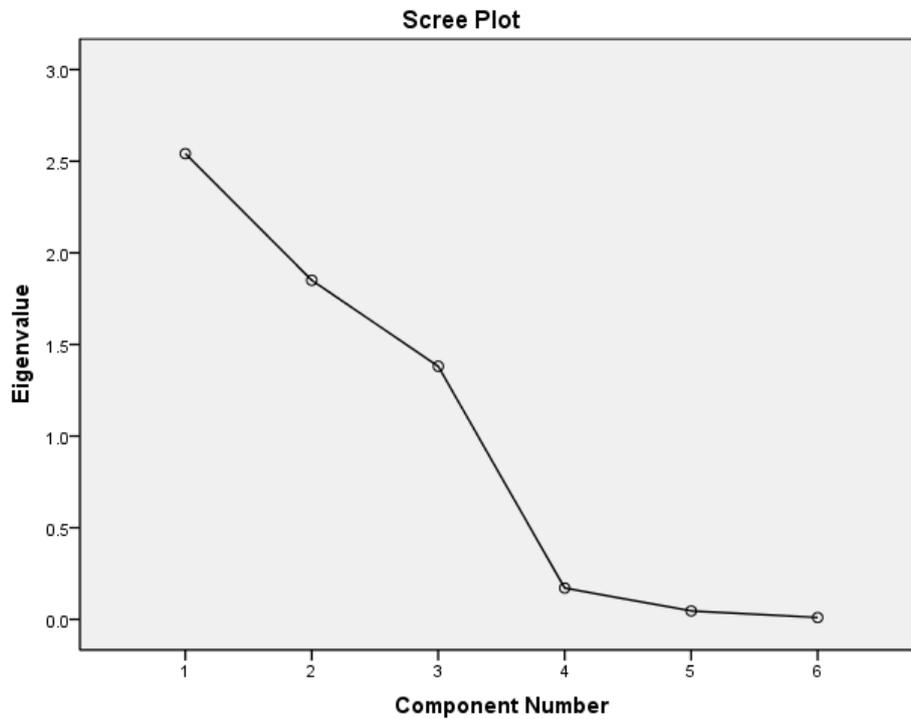
Figure 4-2 Scree plot of six component factors

(Source: Test result from SPSS)

Table 4-13 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.

Table 4-13 Rotated component matrixa

	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)

Regression Analysis

In the following section, this study is to put the principal factor obtained by regression analysis into further exploration of the relationship between the stock prices of listed Chinese banks and its main financial indicators. Resulting from the factor analysis in the previous section, 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 variables to make regression on the dependent variables of the share prices of listed banks. The model could be built as follows:

$$SP = \beta_0 + \beta_1 \times NPL + \beta_2 \times CAR + \beta_3 \times LAR + \varepsilon \qquad (4\text{-}11)$$

SP: Share price of listed banks
NPL: Non-performing loan ratio
CAR: Capital adequacy ratio
LAR: Loan allowance ratio

Table 4-14 shows the results of statistics test of the model. Among them, the adjusted R^2 by the regression model is 0.381, the degree of regression fitness is acceptable and D-W was 2.242, indicating that there is no autocorrelation in model residuals.

Table 4-14   Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.711a	0.505	0.381	4.19250	2.227

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

Table 4-15 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 proves that financial risk indicators have significant correlation with stock prices of listed banks.

Table 4-15   ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	215.161	3	71.720	4.080	.033a
	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 4-16 shows the coefficient value of independent variables in regression model 4-11 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 of the banks. 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 and improve its viability and the stock price of bank will be higher.

While, the correlation between capital adequacy ratio and stock price is insignificant. One possible reason to explain this result is that in China the banking sector is subject to strict supervision by the regulatory authorities. As a result, normally banks are able to meet the capital adequacy ratio requirements of China banking regulatory commission. On the basis of this cognition, stakeholders tend to ignore the capital adequacy ratio when they are making decisions in stock market which resulting in an insignificant correlation between CAR and stock price.

Table 4-16 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		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)

The stock price reflects the performance of listed companies. Researches on the relationship between financial information and stock prices of listed companies provide investors and bank management with decision-making information. Commercial banks function as special enterprises, so the level of risk management is an important part of its business performance.

This part analyzes the correlation between finance risk indicators and share prices of list banks in Chinese stock market from the perspective of risk management. Data of 16 China's A-share listed banks and eight financial indexes from their annual financial reports are cited. On the basis of the result of factor analysis, three main factors LAR, CAR and NPL are employed to explain most information offered by six financial indicators in data of banking industry. Communalities of factor analysis are pretty high, indicating that most parts of the information in variables have been extracted. It verifies the effectiveness of the results of the factor analysis. And regression analyses 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. The results in this part not only provide important information for investors but also for risk regulators and bank risk management, which is of great significance.

4.3 The measurement of risk-taking behavior of Chinese commercial bank

In addition to identifying and analyzing the factors of commercial banks' risk-taking behavior clearly, how to accurately measure risk-taking behavior is also one of the key points to commercial bank risk management and it is also the research focus of this dissertation. In this section, the study will measure it in two ways, including measurement by single indicators and measurement by comprehensive indicators.

4.3.1 The measurement based on single financial information

One method of measurement on risk-taking level of commercial banks is mainly dependent on the financial information of commercial banks. Normally, the financial indicators reflect the risk-taking level of commercial banks from specific angles. Generally, the indictors to measure risk-taking behavior based on the single financial information include nonperforming loan ratio, capital adequacy ratio and Z- value index. In the first section of the dissertation, the author concentrated on capital adequacy ratio to explain its constraint effect on risk-taking behavior of commercial bank by mathematic path and test its pro-cyclical influence. In this section, the author will focus on the measurement of risk-taking level by NPL and Z-value index.

Risk-taking measurement by Non - performing Loan Rate

Loan business is one of the main sources of their profits for commercial banks of China, and the non-performing loan rate in association with the loan business has become one of the main indicators to measure the risk-taking behaviors. Under normal circumstances, the higher NPL ratio means that the commercial banks may take the higher risk. Salas & Saurina (2002) firstly introduced nonperforming loan rate to be the index to measure risk-taking of commercial banks. After that, the NPL ratio has been the preferred metric for most scholars to measure the risk-taking of commercial banks. Gonzalez, F. (2005) also chose NPL ratio to measure the risk-taking level. They used a panel database of 251 banks in 36 countries to analyze the impact of bank regulation on bank charter value and risk-taking.

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 general, the data of non-performing loan rate of commercial banks were collected from annual financial reports of listed banks.
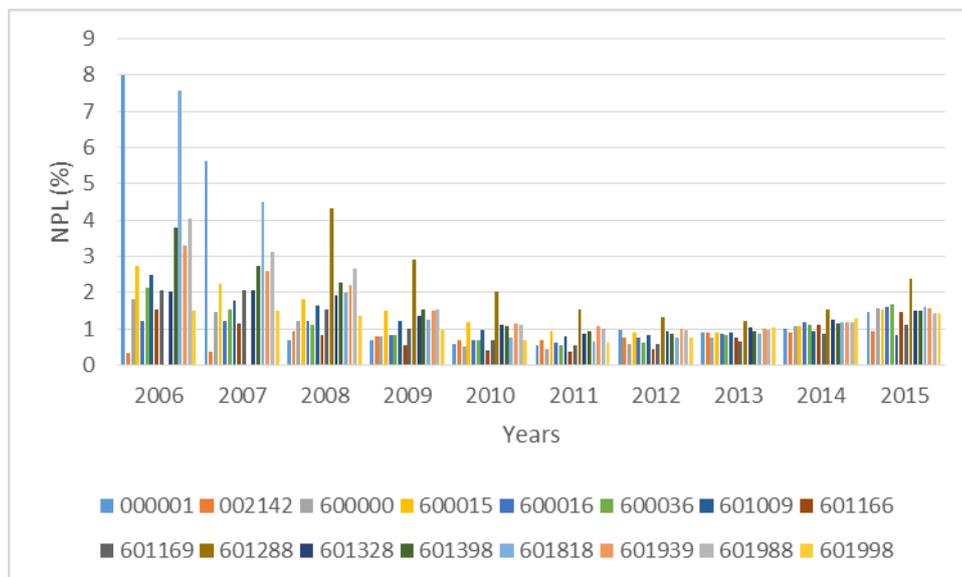

Figure 4-3 The measurement results of NPL on 16 listed banks

(Source: The author's construction)

From the Figure 4-3 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.

Table 4-17 The descriptive statistics of NPL

Stock code	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
000001	0.53	7.98	2.038	2.58435	1.932	2.667
002142	0.33	0.93	0.724	0.2192	-1.105	0.054
600000	0.44	1.83	1.019	0.48257	0.422	-1.19
600015	0.88	2.73	1.479	0.62584	1.012	0.193
600016	0.63	1.6	1.019	0.31007	0.469	-0.559
600036	0.56	2.12	1.106	0.51958	0.898	-0.158
601009	0.78	2.47	1.236	0.55865	1.434	1.406
601166	0.38	1.53	0.86	0.43112	0.426	-1.327
601169	0.53	2.06	1.113	0.58348	0.873	-0.729
601288	1.22	23.57	6.429	9.04424	1.735	1.311
601328	0.86	2.06	1.406	0.45177	0.432	-1.437
601398	0.85	3.79	1.68	0.96876	1.381	1.241
601818	0.64	7.58	2.111	2.23317	2.061	3.928
601939	0.99	3.29	1.658	0.78803	1.228	0.526
601988	0.95	4.04	1.795	1.0873	1.29	0.472
601998	0.6	1.48	1.104	0.34913	-0.316	-1.766

(Source: Test result from SPSS)

Risk-taking measurement by Z-value index

Hannan & Hanweck (1988) constructed the Z value index to measure the risk-taking level of the commercial banks. The Z value was inversely proportional to the measurement of the bank's risk-taking. The higher Z value, the lower risk-taking level. García & Robles (2008) also used the Z value index to measure the risk-taking behavior of Spanish financial intermediaries with a dynamic panel data model in the period from the year 1993 to 2000.

According to Boyd & Al (2006), Laeven & Levine (2009), they all selected the Z-value as a measurement of commercial bank's risk-taking. The calculation formula is shown as follows:

$$Z = \frac{ROA + CAR}{\sigma(ROA)}$$

(4-12)

ROA is the return on total assets of commercial banks. CAR is the equity capital ratio. $\sigma(ROA)$ is the standard deviation of the total return on assets, measuring the volatility of the yield. When ROA obey normal distribution, the probability of commercial bank bankruptcy is Prob (CAR <- ROA). 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.

First, the author did the normal distribution test on the ROA data of the sample commercial banks. According to the frequency distribution chart of ROA below, it can be found that the annual ROA obeys the normal distribution. And from the descriptive statistics, the skewness and kurtosis values are all less than 1, which can be approximated as a normal distribution. Furthermore, from Q-Q plot of ROA, we can find that the sample values basically revolve around a straight line, verifying that ROA basically obeys the normal distribution. Therefore, the precondition for calculating the Z value of commercial banks' risk-taking is satisfied.
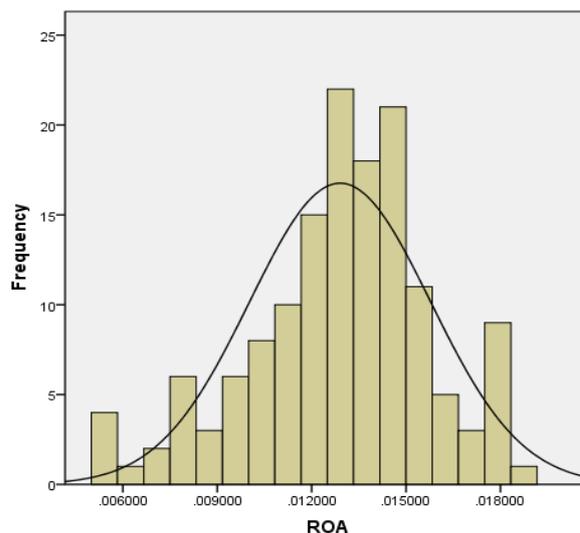
Figure 4-4 Frequency distribution chart of ROA
(Source: Test result from SPSS)

Table 4-18 The descriptive statistics of ROA

			Statistic	Std. Error
ROA	Mean		.01290451	.000238795
	95% Confidence Interval for Mean	Lower Bound	.01243251	
		Upper Bound	.01337651	
	5% Trimmed Mean		.01298521	
	Median		.01315143	
	Variance		.000	
	Std. Deviation		.002875477	
	Minimum		.005419	
	Maximum		.018936	
	Range		.013517	
	Interquartile Range		.003258	
	Skewness		-.460	.201
	Kurtosis		.189	.400

(Source: Test result from SPSS)
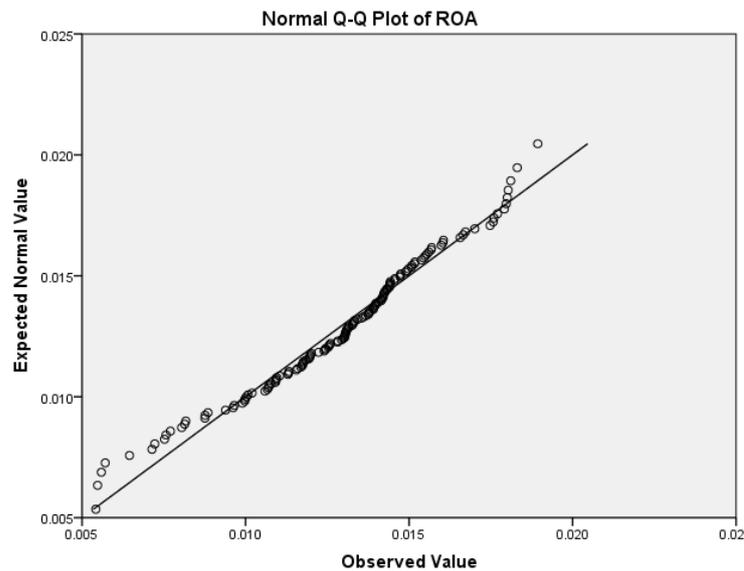
Figure 4-5 Normal Q-Q plot of ROA

(Source: Test result from SPSS)
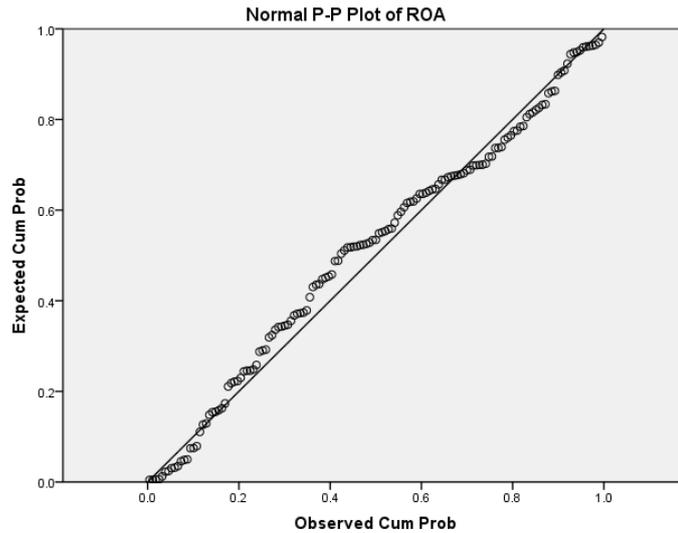
Figure 4-6 Normal P-P plot of ROA

(Source: Test result from SPSS)

According to the Formula 4-12, the Z values of 16 listed commercial banks from 2006 to 2015 are calculated as shown in the following figure 4-7. 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. .
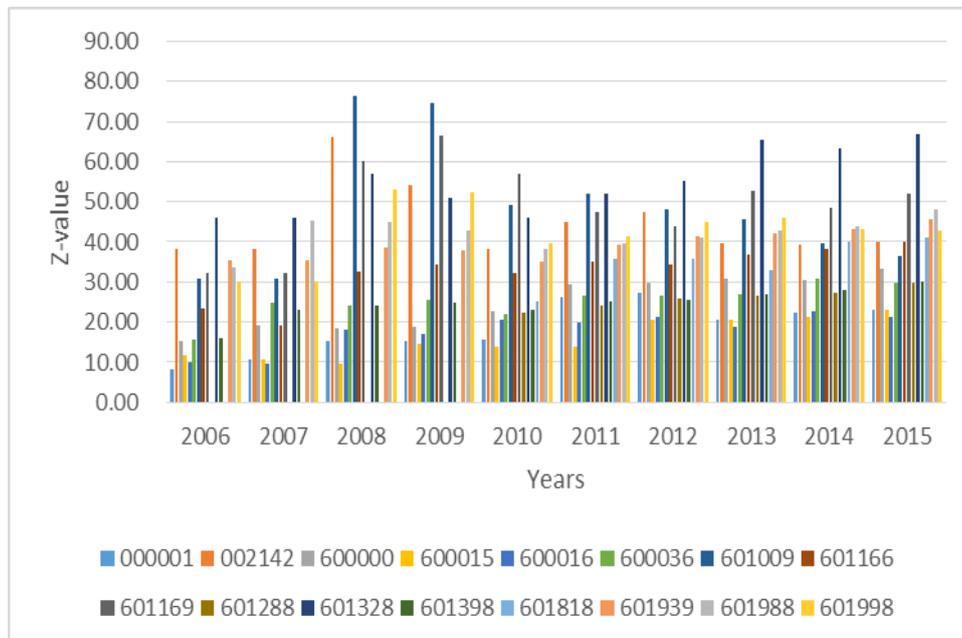
Figure 4-7 The results of Z value on 16 listed banks, 2006-2015

(Source: The author's construction)

Table 4-19 The descriptive statistics of Z value index

| Stock code	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
000001	8.07	27.28	18.437	6.43544	-0.179	-1.089
002142	38.08	66.01	44.622	9.13308	1.736	2.696
600000	15.33	33.46	24.868	6.5731	-0.144	-1.892
600015	9.57	23.04	16.022	4.96273	0.209	-1.756
600016	9.51	22.59	17.955	4.64915	-1.278	0.42
600036	15.61	30.77	25.26	4.28483	-1.183	2.254
601009	30.85	76.24	48.35	16.07373	0.902	-0.081
601166	19.15	39.87	32.609	6.47116	-1.299	1.092
601169	32.24	66.52	49.28	11.09237	-0.316	-0.365
601288	22.39	29.86	26.085	2.6034	-0.029	-0.039
601328	45.91	66.95	54.884	8.05409	0.347	-1.427
601398	16	30.28	24.72	3.79586	-1.139	2.927
601818	25.3	41.09	35.228	5.69728	-1.089	1.379
601939	35.1	45.66	39.382	3.59533	0.373	-0.895
601988	33.49	48.24	42.031	4.16973	-0.743	0.884
601998	30.11	52.96	42.329	7.76536	-0.407	-0.257

(Source: Test result from SPSS)

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.

4.3.2 The measurement applied by Grey Relational Analysis based on comprehensive financial information

The measurement method of commercial banks' risk-taking based on single financial index has its limitations because it only evaluated from one point of view. How to make comprehensive consideration to the risk-taking of commercial banks and measure the level of risk-taking becomes a new perspective of research. As for the research methods, how to evaluate all kinds of information and the overall risk of commercial banks is an important issue that researchers need to solve.

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.

The GRA method stood out to be a better choice to measure the overall level of risk-taking. If we consider commercial banks risk-taking as a system with known and unknown information, it has the characteristics of "grey system".

Selection of Financial Indicator:

The manifestation of risk-taking of commercial banks includes all kinds of risks in commercial banks. This dissertation analyses four major types of risks which are credit risk, operating risk, capital risk and liquidity risk. It also considers the overall risk-taking of commercial banks comprehensively. The author selected four financial indicators representing the four types of risk in commercial banks respectively, and then valuate the degree of grey correlation of commercial banks based on comprehensive financial information risk measurement. According to the result in the section 2, there are three important risk indicators have been selected, thus the author applied these indicators in this section as well. Besides the three indicators, the author also chose one additional indicator ROA for operating risk since four types of risk need to be analyzed. These four indicators 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 non-performing loan ratio is the most common indicator for credit risk, which refers to the proportion of non-performing loans to the total loan in commercial banks. When the banks assess the quality of bank loans, the loans are normally classified into five types , which are normal, concerned, subprime, suspicious and loss. The latter three are collectively referred to as non-performing loans. The non-performing loan ratio of commerical banks is one of the important indicators to evaluate the credit safety of assets in commercial banks. The high non-performing loan ratio indicates that the commercial banks have a high credit risk. The low rate of non-performing loans shows the credit risk of commericial bank is small.

Normally, the calculation of NPL ratio will use the following formula:

NPL ratio = (subprime loans + suspicious loans + loss loans) / total loans × 100% (4-13)

In this study, NPL belongs to the cost index, that is, the negative index. The lowest index value indicate the smallest risk, so the minimum value of NPL in sample data was taken as the benchmark value.

Return on Assets (ROA) is an indicator applied to measure how much net profit is created by per unit of assets. It has wide use in reflecting the operating risk of commercial banks.

Capital adequacy ratio (CAR) as a indicator for capital risk refers to the ratio of total capital to total weighted risk assets. The capital adequacy ratio reflects the extent in which a commercial bank can bear the loss with its own capital after the assets of depositors and creditors have been lost. The objective of requirement on this ratio is to curb the excessive expansion of risky assets, protect the interests of depositors and other creditors and ensure the normal operation and development of commercial banks. Financial authorities in each countries all have regulations on the capital adequacy ratio of commercial banks with the purpose to monitor the banks' ability to against risks.

ROA and CAR are both benifit indicators, that is, positive indicators. The larger the indicator value is, the lower the risk is. Therefore, the maximum value is the optimal indicator which is set as the benchmark value.

LDR is an indicator for liquidity risk referring to the total bank loans to total deposits. From the profitability perspective of banks, the higher the deposit-loan ratio the more profits the banks gain. Because banks need to pay interests to deposits, it is the so-called cost of capital. If a bank has a lot of deposits and a small amount of loans, it means the higher cost and lower income, which will make the banks have low profitability. However, due to the bank liquidity risk, the deposit-loan ratio should not be too high. Because banks also need to deal with the daily cash withdrawal and daily settlement of the vast numbers of customers, this requires the bank to have certain reserves of cash at hand which are from banks' deposits in the central bank or in other commercial banks. If the loan to deposit ratio is too high, this part of funds will be insufficient hence lead to the payment crisis of the banks. And the liquidity risk will spread, which may lead

to the financial crisis and affect the economy in the region or even the whole country. In this research the benchmark value of this indicator is the mean value of LDR in the sample.

There are five steps in the appliacation of GRA method to measure the risk-taking level of commercial banks.

Step 1: Consreucting index data matrix

Specifically, for the evaluation of objective i(i=1,2,...,m), the evaluation indicators were j(j=1,2,...,n), the index data matrix can be expressed as follows,

$$V = (V_{ij})_{mn} \begin{bmatrix} V_{11} & V_{12} & ... & V_{1n} \\ V_{12} & V_{22} & ... & V_{2n} \\ ... & ... & ... & ... \\ V_{m1} & V_{m2} & ... & V_{mn} \end{bmatrix} \qquad (4\text{-}14)$$

After determining the index data matrix, it will be followed by the steps below to measure the commercial bank risk-taking:

Step 2: Identify the benchmark indicators and comparative indicators.

Select respectively the individual indicators based on financial information for the optimal value V0j to compose the benchmark indicators V0, V0=(V01, V02, ..., V0n). Wherein the ratio of non-performing loan ratio and ratio of risk-weighted asset to asset are the cost-type indexes, and the minimum value is the optimal index. While the Z-value index is the benefit-type index, and the maximum value is the optimal index.

Step 3: Normalize the individual risk taking indicators.

Standardization process is to be used in the following step. This process is to make the dimension of sequence data unified and to ensure that each variable can be compared with the same standard. There are usually two methods to standardize the data, that is, the "mean value method" and the "initial value method." In this study, the author uses the "mean value method". Firstly, we need to calculate the mean of the independent and dependent variable, then make

original data be divided by the mean value of the corresponding sequence. The resulting data series is the standardization sequence, which have the characteristics of the curve of data intersecting with each other. One dimension and most of values are greater than 0 and close to 1. The sequence of various factors normalized by "mean value method" will form as a grey correlation coefficient matrix.

After taking all the characteristics of the two types of evaluation indicators into consideration, the cost-type (negative) index and benefited-type (positive) indicator will be normalized respectively:

Positive index indicates that if the value is larger, the risk-taking ability of commercial bank is higher. The standardization formula is

$$X_{ij} = \frac{V_{ij} - b_j}{a_j - b_j} \qquad (4\text{-}15)$$

Negative index indicates that if the value is smaller, the risk-taking ability of commercial bank is higher. The standardization formula is:

$$X_{ij} = \frac{a_j - V_{ij}}{a_j - b_j} \qquad (4\text{-}16)$$

Where i=1,2,...,m; j=1,2,...,n. b_j is the minimum value of item j, and a_j is the maximum value for item j. After the normalization process, the following matrix is obtained:

$$X = (X_{ij})_{mn} \begin{bmatrix} X_{11} & X_{12} & ... & X_{1n} \\ X_{21} & X_{22} & ... & X_{2n} \\ ... & ... & ... & ... \\ X_{m1} & X_{m2} & ... & X_{mn} \end{bmatrix} \qquad (4\text{-}17)$$

Step 4: Calculating the correlation coefficient of commercial bank risk taking.

After normalization, the benchmark index is V0=(V01, V02, ..., V0n), the comparison index is Xi=(Xi1, Xi2, ..., Xin), (i=1,2,...,m), and the correlation coefficient can be expressed as:

$$\delta_{ij} = \frac{\min_i \min_j \left| X_{0j} - X_{ij} \right| + \rho \max_i \max_j \left| X_{0j} - X_{ij} \right|}{\left| X_{0j} - X_{ij} \right| + \rho \max_i \max_j \left| X_{0j} - X_{ij} \right|} \qquad (4\text{-}18)$$

Where ρ is the distinguish coefficient. It is between (0,1), usually take value as $\rho = 0.5$, the smaller ρ can improve the differences between the correlation coefficient.; δ_{ij} is correlation coefficient of the risk assessment indicator of $bank_i$ and the corresponding optimal indicator; and j is the j evaluation indicator of $bank_j$. The coefficient matrix is:

$$E = (\delta_{ij})_{mn} \begin{bmatrix} \delta_{11} & \delta_{12} & ... & \delta_{1n} \\ \delta_{21} & \delta_{22} & ... & \delta_{2n} \\ ... & ... & ... & ... \\ \delta_{m1} & \delta_{m2} & ... & \delta_{mn} \end{bmatrix} \qquad (4\text{-}19)$$

Step 5: Calculating the correlation degree of commercial banks' risk-taking.

It is to determine the correlation degree of commercial banks' risk-taking via comparing bank and comparative indicators at each point:

$$\gamma_i = \frac{1}{n} \sum_{j=1}^{n} \delta_{ij} , \quad i=1,2,..., m \qquad (4\text{-}20)$$

Where, γ_i is correlation degree of the comparison indicator Vi and benchmark indicator V0. It is the value of risk taking of commercial bank based on the comprehensive information.

Calculating the degree of correlation. The correlation coefficient is used to find the correlation between the comparison sequence and the benchmark sequence. The degree of association can be calculated with the mean or weighted method. In this research, the author uses the mean method in calculation.

The following graph shows the results of risk-taking measurement by GRA on 16 Chinese listed banks clearly:
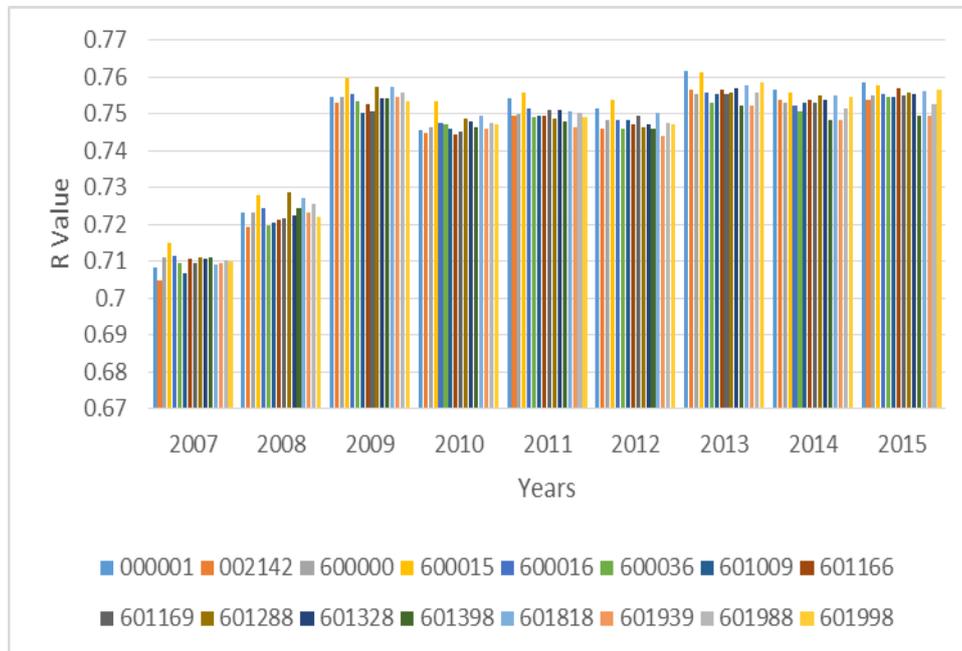
Figure 4-8 The results by GRA method

(Source: The author's construction)

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 .

Table 4-20 Descriptive statistics of risk-taking measurement on 16 listed banks by GRA

Stock code	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
000001	0.7083	0.7616	0.745979	0.0181461	-1.535	1.362
002142	0.7047	0.7567	0.742379	0.0180727	-1.595	1.466
600000	0.7112	0.7553	0.744148	0.0158541	-1.613	1.454
600015	0.715	0.7611	0.748926	0.0160631	-1.684	1.696
600016	0.7116	0.7556	0.744652	0.0157258	-1.652	1.615
600036	0.7096	0.7548	0.742615	0.0162633	-1.589	1.187
601009	0.7068	0.7555	0.742757	0.0171283	-1.652	1.584
601166	0.7107	0.7571	0.743724	0.0164154	-1.472	0.991
601169	0.7096	0.7553	0.743413	0.0163353	-1.619	1.41
601288	0.7111	0.7575	0.745303	0.0155279	-1.696	2.356
601328	0.7105	0.757	0.744402	0.0164555	-1.595	1.334
601398	0.7112	0.7543	0.742221	0.0144625	-1.683	1.91
601818	0.7093	0.7577	0.745876	0.0166066	-1.768	2.375
601939	0.7095	0.7545	0.741506	0.0150555	-1.631	1.778
601988	0.7101	0.7559	0.744085	0.0156342	-1.721	2.141
601998	0.71	0.7585	0.744285	0.0168108	-1.511	1.192

(Source: Test result from SPSS)

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.

These results are in consistence with the following literatures. According to capital asset pricing theory, the bigger banks usually tend to take higher risks to obtain higher profits. Based on the issue of "too big to fail", large financial institutions tend to take excessive risks to gain higher

returns because they do not have to pay the corresponding costs for their risk-taking behavior (Demirgüç-Kunt, & Huizinga, 2013). Meanwhile, due to the role of the government safety net, the bigger the bank get, the more possible the banks would involve in high risk business. Aghion et al. (1999) showed that government safety nets have increased the impulse of large banks to chase high-risk projects. In addition, due to size effect most banks take higher risks and gain more profits and benefits through the expansion of the size. The bigger the size the higher risk-taking of commercial banks will undertake. As Tabak, et al (2012) stated that large size banks have benefited more from their risk-taking behaviors.

Table 4-21 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.

In this section of the dissertation, the author selects the financial indexes that can reflect all kinds of risks in commercial banks from the point of the manifestation of risk-taking behaviors of commercial banks. Based on the comprehensive financial information, the author applied the grey correlation method and established a risk-taking measurement approach to evaluate the level of risk-taking of commercial banks. This approach is based on the comprehensive financial information categories by difference risks. Four types of risks are selected. They are NPL as credit risk level, ROA as operating risk level, CAR as capital risk level and LDR as liquidity risk level. In an empirical study of 16 listed commercial banks in China during the 9-year period from the year 2007 to 2015, it 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 low level of risk-taking. City commercial banks ranked in middle level. This approach provides a new thinking of measurement of risk-taking on the basis of the traditional single financial information risk measurement method.

4.4 The management of commercial banks' risk warning

The complete 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. In this section, the Z-score model was employed to evaluate the potential risk of 16 listed commercial banks. Furthermore, AHP method enable the author to review a special type financial product - the loan of rural land contractual management right in China.

4.4.1 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. China as a developing country though has introduced some risk measurement methods into its banking industry, its use of these risk measurement models is still at very primitive stage. The issues concerning how to apply these methods into their real banking operations, how many

innovations Chinese commercial banks can make to fit into the reality of the country and how to testify the quantitative risk model in theory and so on and so forth are still in need of further researches to prove whether it is applicable to China's listed financial institutions in the emerging market. 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. And the sixth Hypothesis of this dissertation is whether the Z-score model can be effectively applied to measure the credit risk of listed commercial banks in China. It will be tested in this section.

Z-score model was originally proposed by Professor Edward Altman from Leonard N. Stern School of Business in 1968 (Altman, 1968). It basically functions as a prediction model for enterprise financial risk position. Professor Altman selected five indicators from initially chosen financial ratios, then granted a certain weight to establish a complete weighted average function equation. The five indicators which have the sound prediction function in the aspects of liquidity, solvency, profitability, assets operation ability and financial leverage. The final Z score was widely applied to judge the size of the enterprises' financial status, which can evaluate the credit risk of loan applicants and allocate the default levels. Following that, Altman, Haldeman and Narayanan (1977) proposed ZETA model on the basis of Z-score model. Different from the original Z-score model, ZETA model has seven parameter variables while not five which could enable the operators to run a better result in the classification of enterprises.

The Z-score model with these five variables can forecast the operation condition and probability of bankruptcy in enterprises (Altman, 1968). The function of Z-score model is shown as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5 \qquad （4\text{-}21）$$

The Z-score model works well on the early financial warning of international enterprises at the preliminary stage, especially in the manufacturing industry. But the variables cannot be approached in some special industries. In 1977，in order to make the Z-score model applicable to estimated credit risk on borrower without X_5 variable, Professor Edward Altman modified the model again, and established the four variable models b, as follows (Altman, 1977):

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \qquad （4\text{-}22）$$

Where,

X_1 = working capital / total assets

X_2 = (undistributed profit + surplus reserve) / total assets

X_3 = total profit / total assets

X_4 = equity book value / total liabilities

In the second model, sales revenue as industry sensitivity factor X_5 is removed from the original model 1, hence minimizing the impact of industry factor on the results. In this model, the greater the Z value, the higher the corporate credit; the smaller the Z value, the greater the credit risk of corporate. Specific identification range is: when Z<1.23, the credit risk of listed financial institutions are high enough to be carefully considered; when 1.23≤Z<2.675, the listed financial institutions credit risks are large, which should be given certain consideration; when 2.675≤Z<2.9, the credit risk of listed financial institutions is small; when 2.90≤z, the credit risk of listed financial institutions is very small, which means a stable financial status.

The author selected 16 banks listed in Chinese stock market as research samples. And ten years financial data are collected from the published annual financial reports of 16 banks from the year 2006 to 2015. Because the research sample of this study are listed commercial banks whose major businesses are service products, it is difficult to calculate their detailed sales incomes. Therefore, the majority of models used in this part is model 2 presented as in equation 4-22, and all the data are recorded as percentage.

It should be noted that, due to the different operation characteristics of commercial banks, the calculation of their working capital is also different. In this study, variable X_1 includes:

X_1 = cash and deposits in central bank + deposits in other banks + transactional financial assets + net lending funds + Derivative financial assets + net receivables + net investments held to maturity + net available financial assets for sale + net buy back financial assets

In accordance with the equation 4-22, Z-score of 16 listed banks from the year 2006 to 2015 could be calculated respectively and summarized as follows in Table 4-22.

Table 4-22: **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: Calculation result with excel)

From Table 4-22, 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.

The author calculated the average Z-score of 16 listed banks from the year 2006 to 2015 and drew the trend graph as Figure 4-9.

Figure 4-9 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.
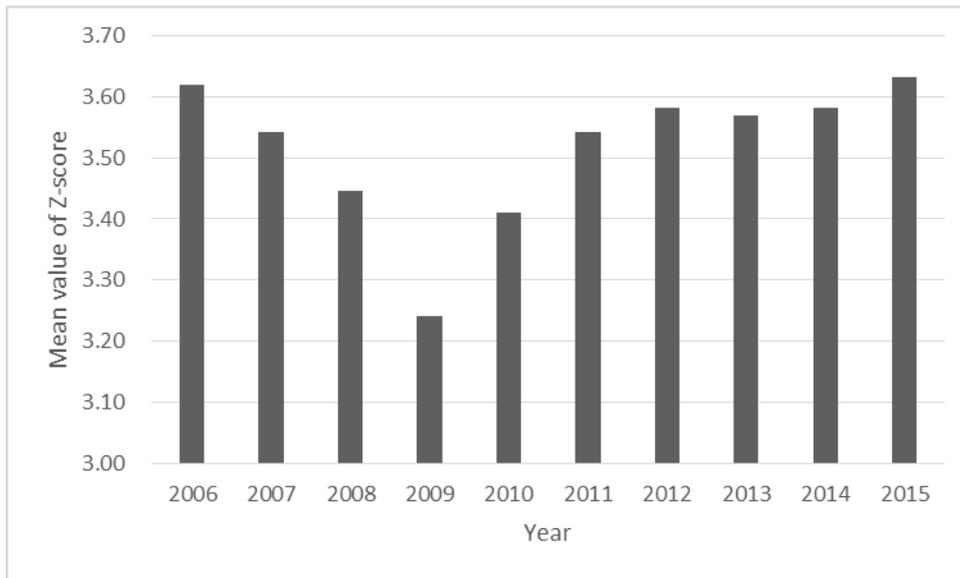
**Figure 4-9: The mean value of Z-score of 16 listed banks**

(Source: The author's construction)
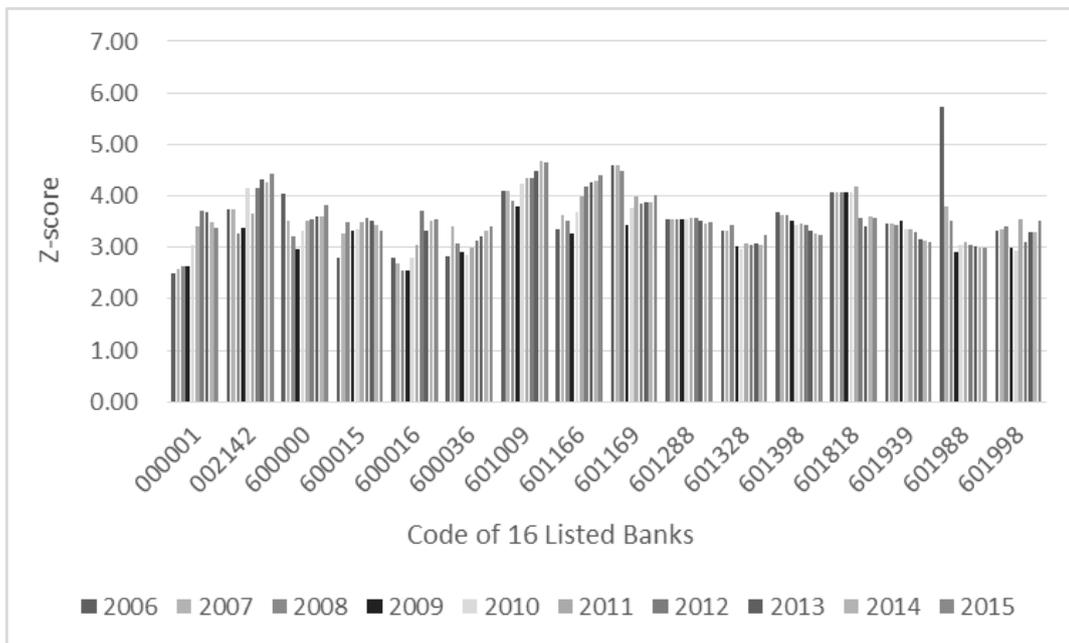
Figure 4-10: The changes of Z-score of 16 listed banks from the year 2006 to 2015

(Source: The author's construction)

At the same time, the Figure 4-10 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.

This section applied Z-score model to process and analyze the credit risk of 16 listed commercial banks in China's stock market. The four-variable Z-score model includes the main financial indicators of commercial banks. The listed commercial banks can measure whether they stagger into the financial instability range through calculating the Z-score with this model. If the management can adjust the business operation and strengthen the internal and external risk management accordingly, it is possible to improve financial situation and reduce the level of credit risk ahead of crucial time. In the selection and calculation of variables in the model, this dissertation takes the characteristics of the research sample into account. Due to the different operating characteristics of commercial banks, it took a different way to calculate their working capital, X_1. The research results verified the sixth Hypothesis that Z-score model can be effectively applied to test the potential credit risk of listed commercial banks in Chinese stock market.

4.4.2 The AHP method applied in credit risk evaluation mode

After establishing effective early warning of potential risk in commercial banks by Z-score model, the following section probes into the risk management in a special financial product with Chinese characteristics - the loan of rural land contractual management right, which has been proved to be an effective solution to the contradiction between the agricultural enterprise fund raising and credit risk controlling of commercial banks. A credit risk evaluation mode that contains 30 risk indicators on the basis of the principle of risk evaluation index system that normally used in Chinese commercial banks was introduced and the analytic hierarchy process (AHP) approach was applied to assess the weight of risk factors. The consistency coefficient test results of all indicators weight are acceptable, which means the AHP is a powerful and useful tool to implement credit risk management of commercial banks in China.

For Chinese commercial banks, several major problems exist in agricultural enterprises loans: high transaction costs, lack of collateral and high credit risk etc. As the overall level of rural economic development in China is far from satisfaction; the turnovers of agricultural enterprises are low and very few of them have enough fixed assets. Meanwhile, when commercial banks evaluate the safety of the loan they still emphasize the necessity of mortgage and collateral. Low income and lack of collateral led to insufficient repayment ability of agricultural enterprises and most of agricultural enterprises cannot get financing support from the formal financial channels. In addition, the credit system in rural China is still under construction and imperfect, and the occurrence of intentional default from some agricultural enterprises is still unavoidable. This also made the agricultural enterprises cannot get loans, and then difficult to enhance profitability hence fall into a vicious cycle of poverty (Zeng & Wang, 2010). Therefore, how to solve the problem of high cost and high risk has become the key to the development of fund raising of agricultural enterprises.

The situation of low income of agricultural enterprise is difficult to change in short term, but the valuable "assets" of farmers at hands are the housing and land. In China, the ownership of rural land is collectively owned. Individual peasants only have the right to contractual management of rural land but have no ownership, and therefore they cannot directly use land as collateral to obtain loans from financial institutions. The contractual management right of rural land refers to the right of the rural land contractor to possess, use, earn and dispose of the contracted land according to the law. As one of the most valuable assets of peasants, the contractual management right of rural land is an applicable way to settle the financing problem between peasant households and banks (Gao et al, 2009). "Land contract management right mortgage" is labelled to be the Chinese characteristics product during the economic development. The rural land contract management right mortgage can solve the problem of lack of collateral, which reduce the loan risk of the financial institution. With the enhancement of the credit concept of the agricultural enterprises, the whole rural social credit environment could be improved (Zeng & Wang, 2010).

In the process of credit risk management of commercial banks, normally a risk evaluation index system will be established. Usually the frequency statistics methods, theoretical analysis methods and factor analysis in multivariate analysis methods are applied to complete the selection of indicators in the evaluation index system. When the relevant indicators are selected, there is

another important problem to be solved, that is to determine the weight of each risk indicators. At present, the universally implemented methods to determine the weight include the expert evaluation method, principal component analysis, analytic hierarchy process and so on.

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.

The risk evaluation index system of commercial banks is usually composed of three layers: target layer, criterion layer and program layer. The value in target layer is the comprehensive value of risk assessment, which is reflected by the criterion layer; the criterion layer is reflected by specific evaluation index and the program layer includes specific implementation methods.

Table 4-23 shows a credit risk evaluation mode generally used in Chinese commercial banks. From table 4-23 we can see, criterion layer is divided into three levels and the first level includes three indicators reflecting the borrower risk, guarantor risk and industry risk respectively. The sub-level is divided into nine indicators on the basis of first level indicators, such as the borrower risk is separated into three items including moral hazard, business risk and financial risk in the second-level. The total three levels include 18 indicators, in which the industry risk is no longer divided into the three-tier. There are three operation modes of the loan in the program layer: first, the operation right to the mortgage plus guarantee of natural person; second, the operation right to the mortgage plus enterprise guarantee; third, the operation right to the mortgage plus guarantee of guarantee institution.

All the data in this section are collected from questionnaire by rural commercial banks in Jiangxi province in China in August 2016.

Table 4-23 The mode of the rural land contract management right loan

1st criterion layer	2nd criterion layer	3rd criterion layer	4th program layer
Borrower risk	Moral hazard	Repay willingness	1 (MP) the operate right to the mortgage plus guarantee of natural person; 2 (ME) the operate right to the mortgage plus enterprise guarantee; 3 (MI) the operate right to the mortgage plus guarantee of guarantee institution.
		The real use of the loan	
		Credit record in past 5 years	
	Business risk	Operation cost	
		Other cost	
		Labor cost	
	Financial risk	Total liabilities	
		External guarantee amount	
Guarantor risk	Source of Benefits	Net profit of main business	
		Net profit of other business	
		Real estate collateral amount	
	Proof of guarantee ability	External guarantee amount	
		Credit record in past 5 years	
		Margin payment amount	
	Joint and several liability	Guarantee rate	
		Counter - guarantee collateral	
	Substitution Solvency willingness	Legal representative willingness	
		Liability guarantee agreement	
Industry risk	Seasonal cycle		
	Price fluctuation		

(Source: The internal report of Chinese commercial bank)

With the AHP approach, we can calculate the weights of all the indicators in each level of rural land contractual management rights mortgage guarantee.

Table 4-24 Weights of indicators in the 1st criterion layer

Indicators	Borrower risk	Guarantor risk	Industry risk
Weights (%)	62.50	23.85	13.65

(Source: Calculation result with AHP approach)

And after the consistency test, the results are shown in Table 4-25:

Table 4-25 The results of consistency test

Consistency index	1st criterion layer	2nd criterion layer	3rd criterion layer	4th program layer
CI	$CI_{11}= 0.0457$	$CI_{21}=0.0529$ $CI_{22}=0.0007$ $CI_{23}=0.0000$	$CI_{31}=0.0492$ $CI_{32}=0.0517$ $CI_{33}=0.0000$ $CI_{34}=0.0282$ $CI_{35}=0.0433$ $CI_{36}=0.0000$ $CI_{37}=0.0000$	$CI_{41}=0.0139$ $CI_{42}=0.0524$ $CI_{43}=0.0282$ $CI_{44}=0.0560$ $CI_{45}=0.0329$ $CI_{46}=0.0265$ $CI_{47}=0.0578$ $CI_{48}=0.0527$ $CI_{49}=0.0217$ $CI_{410}=0.0454$ $CI_{411}=0.0220$ $CI_{412}=0.0567$ $CI_{413}=0.0042$ $CI_{414}=0.0114$ $CI_{415}=0.0244$ $CI_{416}=0.0047$ $CI_{417}=0.0073$ $CI_{418}=0.0403$
CR	$CR_{11}= 0.0788$	$CR_{21}=0.0913$ $CR_{22}=0.0011$	$CR_{31}=0.0849$ $CR_{32}=0.0892$ $CR_{34}=0.0486$ $CR_{35}=0.0746$	$CR_{41}=0.0240$ $CR_{42}=0.0903$ $CR_{43}=0.0487$ $CR_{44}=0.0966$ $CR_{45}=0.0568$ $CR_{46}=0.0456$ $CR_{47}=0.0997$ $CR_{48}=0.0908$ $CR_{49}=0.0374$ $CR_{410}=0.0783$ $CR_{411}=0.0379$ $CR_{412}=0.0977$ $CR_{413}=0.0073$ $CR_{414}=0.0197$ $CR_{415}=0.0421$ $CR_{416}=0.0081$ $CR_{417}=0.0127$ $CR_{418}=0.0695$

(Source: Calculation result with AHP approach)

From Table 4-25, we can see that the consistency coefficient of all indexes is less than or equal to 0.1, which means the consistency results of all the indicators are acceptable. Through AHP method we can calculate the weight of all indicators of the mode. The results are shown in Table 4-26.

From the analysis above, we can see there does exist some problems in the development of China's rural economy. On the one hand, the development of agricultural enterprises needs a large amount of financial capital support; on the other hand, commercial banks classify agricultural enterprises into the high risks type in risk evaluation thus cannot give credits to them, which lead to a difficult predicament in finance for agricultural enterprises. This study focuses on a special kind of loan type - rural land contract management right mortgage loan which can effectively solve this contradiction. Combining with the credit risk evaluation index system of commercial banks, this section applied analytic hierarchy process (AHP) to solve how to assess the weight of risk factors when the financial institutions measure this special kind of loan.

Table 4-26 Weights of indicators in all layers

1st criterion layer		2nd criterion layer		3rd criterion layer		4th program layer
Indicators	Weights	Indicators	Weights	Indicators	Weights	Weights
Borrower risk	62.50%	Moral hazard	41.67%	Repay willingness	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 in past 5 years	5.84%	MP=25.84% ME=13.38% MI=40.78%
		Business risk	33.15%	Operation cost	14.96%	MP=33.25% ME=13.97% MI=52.78%
				Other cost	13.54%	MP=47.31% ME=24.50% MI=8.19%
				Labor cost	51.50%	MP=36.95% ME=2.38% MI=40.67%
		Financial risk	25.18%	Total liabilities	70.00%	MP=47.42% ME=13.39% MI=19.19%
				External guarantee amount	30.00%	MP=35.85% ME=13.49% MI=30.66%

Guarantor risk	23.85%	Source of Benefits	23.49%	Net profit of main business	30.19%	MP=57.41% ME=3.40% MI=19.19%
				Net profit of other business	52.26%	MP=35.85% ME=13.49% MI=30.66%
				Real estate collateral amount	17.55%	MP=57.41% ME=3.40% MI=19.19%
		Proof of guarantee ability	30.25%	External guarantee amount	14.40%	MP=35.85% ME=13.49% MI=30.66%
				Credit record in past 5 years	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 rate	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 willingness	19.97%	Legal representative willingness	44.45%	MP=57.41% ME=3.40% MI=19.19%
				Liability guarantee agreement	55.55%	MP=35.85% ME=13.49% MI=30.66%
Industry risk	13.65%	Seasonal cycle	44.45%			
		Price fluctuation	55.55%			

(Source: Calculation result with AHP approach)

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 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 these 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.

5.2 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.

5.3 Policy recommendations

This dissertation finds some basic characteristics and rules of risk-taking in Chinese commercial banks through theoretical and empirical research. According to these characteristics and laws, this section puts forward some policy recommendations and strategies for commercial banks' risk-taking and risk management. Some feasible measures are given below.

(1) Establishing a comprehensive governance mechanism for board of directors in commercial banks

First, banks can internalize the possible loss brought by the board of directors' appetite toward risks through the establishment of an incentive-constraint contract, that is, the loss is linked to their own income so that the directors bear the corresponding risk. In this process, it is necessary to scientifically evaluate the work of the board of directors and continuously improve the efficiency of the board of directors through the scientific board performance appraisal. At the same time, banks should strengthen the obligations and responsibilities of directors;

Second, banks should establish the position of a chief risk officer. In China, only small parts of listed commercial banks have appointed the chief risk management officers, while in contrast, most mature commercial banks in the world have appointed their chief risk officers. The chief responsibilities of the chief risk management officer include: formulating a risk management strategy; supervising the implementation of risk management policies and establishing a risk management system; implementing relevant measures for risk management and internal control; suggesting risks in the operational process, the corporate environment and strategies; regularly reporting the risk report to the board of directors etc.

Third, banks must clarify the position of independent directors and give full play to the role of independent directors. It is representing and safeguarding the interests of the entire company to emphasize the independence of independent directors as third parties. Banks should pay special attention to the interests of depositors and small and medium shareholders. They should highlight their roles in safeguarding stakeholder interests, improve corporate governance and balance the powers of major shareholders, board of directors, and senior management.

Reviewing the status quo of China's listed commercial banks, we would find that the proportion of independent directors is low, and their role is also quite limited. Hence it is very important to give independent directors sufficient power and to increase the proportion of independent directors to enhance the independence of the board of directors. Therefore, an appropriate increase in the proportion of independent directors plays an important role in strengthening the independence of the board of directors and safeguarding the interests of the majority of small and medium shareholders and the sound management of the banks.

(2) Improve and optimize management incentives.

A good salary incentive mechanism should be able to motivate employees to invest in their work with greater enthusiasm. At the same time, they should also constrain employees' "profit-taking behavior" which will do harms to the interests of the company. Specific methods include the following conducts:

First, link management's remuneration with risk management performance to effectively reduce the possibility of excessive risk-taking caused by "profit-taking behavior"; second, implement equity incentive plans based on executive-to-commercial banks contribution and use the equity incentives to reduce the risk of excessive risk-taking; the third is to improve the information disclosure system. Without perfect, accurate and detailed information disclosure, it is impossible to judge the level of salary, whether the salary system is reasonable, or whether the interests of shareholders, the public etc. are guaranteed and protected. The fourth is that banks should have a strict punishment system to the top management who violates the law and regulations hence to prevent their excessive risk-taking behaviors at work in the bank.

(3) Perfection of Risk Warning Mechanism

The effective management of commercial banks' risk-taking lies in the accurate assessment of the current risk-taking situation of commercial banks. And at the same time, they must precisely make the prediction toward future risks.

The first measure is to enhance the development of risk early warning technologies. Risk early warning technologies include overall risk early warning and subdivided risk early warning. When it comes to the reference to the overall risks of commercial banks, it could be referred to

the risk-taking measurement method proposed in this dissertation. Its practical appliance relies on the characteristics of commercial banks themselves. As for subdivided risks, banks should improve their internal rating system from the "standard method" to the "higher law" in risk assessment and early warning methods.

The second measure is to enhance the early warning to the correlation effect of the risk-taking of commercial banks. The correlation effect of commercial banks reflects the contagion of risks. The accurate judgement of correlation effect of risks enables the banks to achieve much more effective management of risks.

The third measure is to enhance the stress testing and management of emergency capital. The risk status of commercial banks should be comprehensively reviewed and banks should set up different scenarios to make the stress test to the risk-taking of the commercial banks. It helps to determine the losses of commercial banks in different situations and the emergency capital under extreme conditions, thereby enhancing the risk handling capacity of commercial banks in crisis.

(4) Improve the comprehensive risk management system

The comprehensive risk management framework is compatible with the Basel Capital Accord II and Basel Capital Accord III. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) systematically proposed and released it in the Enterprise Risk Management integrated framework in 2004.

Comprehensive risk management can be expressed as a process in which the corporate body including board of directors, management, and other personnel formulate and implement an overall corporate strategy. It is to identify potential risks that may affect the achievement of the objectives so that risks can be managed within the company's risk appetite. It is to provide reasonable protection for the realization of the company's goals."

Comprehensive risk management emphasizes the integrity of risk management and includes the following measurements:

First, to accurately assess the overall risk-taking of commercial banks, it is possible to use evaluation methods based on comprehensive financial information in this dissertation;

The second is to clarify the objectives of comprehensive bank risk management and formulate feasible risk management policies. Combining the banking business development strategy with the risk management strategy, we must consider whether the risk response measures are consistent with commercial banks' risk strategy and risk tolerance.

Third, to implement risk control in compliance with key risk indicators and to implement risk accountability in accordance with risk management performance. The management is responsible for the implementation of risk policies and the control of risks as a whole;

The fourth is to implement all aspects of risk management such as risk identification, assessment, and risk control. In the process of improving risk identification with multiple technology combinations, China's commercial banks must learn from advanced experiences all around the world and use core risk measurement tools to establish a comprehensive risk management system with an internal rating system.

(5) Enhance the restraint effect of capital supervision on banks' risk-taking.

Commercial banks need to improve the efficiency of bank's capital supervision, effectively reduce the excessive risk-taking, reduce the supervision costs of regulatory agencies and strengthen the bank's capital supervision to effectively suppress bank's excessive risk-taking behaviors.

First, to implement strict supervision to commercial banks to enforce the minimum capital adequacy ratio. Regulatory authorities should impose strict regulations on high-risk banks, constrain their incentives of risk-taking, conduct loose supervision to low-risk banks and encourage their profitability hence to optimize their capital structure. Second, to establish a countercyclical mechanism for capital supervision. In the previous chapters, we have empirically tested that the capital adequacy ratio has a procyclical effect. Therefore, when abnormal changes occur in the economic cycle, appropriate counter-cyclical adjustment measures should be taken to improve the effectiveness of capital supervision.

(6) Enhance the supervision and punishment of high-risk bank capital

Regulators should enhance their supervision, especially the punishment and supervision of high-risk banks. On the one hand, they should increase the supervision and punishment of high-risk banks, and on the other hand, they should increase incentives for low-risk banks. There should have explicit stipulation that when the capital adequacy ratio of a commercial bank falls out of regulatory requirements, the regulatory authority must take measures to punish banks, such as strictly controlling the bank's asset growth rate, adjusting its asset structure, dismissing and replacing its senior management personnel, or even implementing takeovers or reorganization. Only when regulatory punishment becomes a credible threat, capital will become a hard constraint for the development of commercial banks, thereby enhancing the motivation of banks to control risks to meet regulatory requirements.

5.4 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.

6. 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 pro-cyclicality 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.

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