# Risk Measurement of Chinese Commercial Banks Based on the Financial Model

*ShuFan Hao**
*A. K. Mabubul Hye***
*Winai Pewkliang****

## Abstract

**The purposes of this article were** 1) to analyze the relevant indicators in operational risk measure value, 2) to analyze the explanatory variables and conduct regression analysis between risk operation measures and independent variables, 3) to analyze the income model to obtain data and explain the corresponding variables, 4) to study OLS, measure the results and use the fuzzy Delphi analysis method, 5) to analyze the correlation among three types of commercial banks and compare them through empirical regression analysis, 6) to analyze the empirical results and provide relevant suggestions for the three types of listed commercial banks. The samples were collected through a combination of theoretical and empirical methods. During this process, key risk indicator points were summarized through relevant data, which was a statement of research technology. The framework theory was then set, relevant literature and research methods were collected, and OLS multiple linear regression was used to conduct regression

* *Ph.D. Candidate, School of Management, Shinawatra University*
** *Advisor*
*** *Faculty of Management, Shinawatra University*

analysis on the samples. The model data were obtained through model setting and hypothesis testing and empirical results analysis.

The results of this study indicated that the relative operational risk of urban commercial bank groups was significantly higher than that of the other two groups. At the end of the paper, the analysis of the empirical results provided relevant suggestions for strengthening the operational risk management of the three types of listed commercial banks. At the same time, after conducting regression analysis to obtain results, ten experts were invited to verify the results through a questionnaire survey by using the fuzzy Delphi method, fully verifying the consistency between the results and the analysis. For commercial banks, some suggested exercising power, being accountable to the people, strengthening supervision, clearly assigning responsibilities, and establishing appropriate organizational structures, having clear and comprehensive regulatory risk management systems with specialized databases to reduce losses. On this basis, the definition of capital regulation, and the strengthening capital regulation, would allow for a comprehensive analysis of the risk management measures of commercial banks.

**Keywords**: Risk Measurement, Chinese Commercial Banks, Financial Model

## Introduction

Before the new Basel Capital Accord included operational risk in the risk category, it did make the national economy truly pay attention to the emergence of operational risk. For China, the economy has experienced rapid development since the reform and opening, but there must be shortcomings behind the rapid economic development, Various events caused by operational risks continue to occur. In the past the president of a branch of the Bank of China committed a large-scale corruption crime, misappropriating customer savings, and later fled overseas due to corruption. The case was announced overseas, with a total amount of 1 billion yuan; another major case broke out within Bank of China, with the Beijing branch of the bank disclosing a credit fraud of 640 million yuan; The Beijing Senhao Apartment 1.56 billion yuan fraudulent loan case, the Beijing Industrial and Commercial Agricultural Bank 460 million yuan fraud case, and Yangzhou 8.5 billion yuan fraud case all warn us that we should strengthen supervision of commercial banking business, Provide appropriate guidance and support for the smooth operation of commercial banking business.

At the same time, the total losses caused by publicly reported operational risk events in China exceeded 7 billion yuan. In recent years, the development of the financial sector has undergone significant changes, with increasing labor mobility in the market, more business lines, more products, and greater operational risk losses. In addition, with the rapid development of financial technology, the transformation of the banking industry and innovation in the service industry have also brought many new operational risks. Even in some financial institutions, operational risk losses have become the largest source of risk losses. Therefore, the banking industry needs to strengthen operational risk prevention and control.

The research topic of this study is to first elucidate the theoretical basis for commercial bank operational risk and its measurement by selecting the revenue model to be measured. Next, we introduced the current situation of operational risks in commercial banks, the internal and external characteristics, and the reasons for their formation. Based on the establishment of income models, we measured

the operational risk values of 13 commercial banks in three major categories, Finally, we propose suggestions for different types of banks to improve operational risk control levels.

The research purpose of this paper is to deepen the theoretical foundation of operational risks in commercial banks and extend the research results to the level of quantitative analysis. Operational risk not only occurs in a department or business but also extends to various aspects of daily banking operations. In addition, there are various reasons for operational risks, whether external, internal, or both, which makes it difficult for banks to manage operational risks in a preventive manner, which is significantly different from other risks faced by commercial banks. To improve the risk management level of commercial banks, it is first necessary to accurately measure risks, control risks based on the measurement results, and study operational risks from a practical perspective.

In the global financial crisis, although our commercial banks did not trigger a fatal crisis in this financial tsunami, it did not reflect the superiority of our commercial bank business management, but accurately reflected the inconsistency between our commercial banks and the world economy. Our commercial bank management is still very vacant, and China's development is constantly changing, With the acceleration of economic development, the development of financial activities in China is rapid and important. With the improvement and increase of technology, economic development needs to be improved. In this situation, Chinese commercial banks have begun to formulate targeted risk control measures and establish relevant departments according to their own bank development needs, Study relevant risk measurement and quantitative models to correctly manage all operational risks. In this paper, 13 banks were selected from three major categories for operational risk model econometric analysis. Based on operational risk analysis, this paper starts with the concepts of bank regulatory capital and credit risk. By analyzing the current situation of capital constraints, credit risk management, and the interaction mechanism of our banking industry, we identify problems and propose relevant suggestions.

### Research objective

1. To analyze the relevant indicators in operational risk measure value.
2. To analyze the explanatory variables and conduct regression analysis between risk operation measures and independent variables.
3. To analyze the income model to obtain data and explain the corresponding variables.
4. To study OLS measure the results and use the fuzzy Delphi analysis method.
5. To analyze the correlation between three types of commercial banks and compare them through empirical regression analysis.
6. To analyze the empirical results provide relevant suggestions for the three types of listed commercial banks.

## Literature Review

Operational risk was not introduced and included in a wide range of risk categories until the end of 2000, and the measurement and evaluation of operational risk was officially determined in the New Basel Capital Accord in June 2014. China's economy is developing day after day, and global financial instability and the integration of the Chinese economy into the world economy are becoming increasingly close. The significant impact of operational risks on the economy is increasingly valued, The control of operational risk in daily operations of commercial banks, as well as how to measure operational risk and strengthen operational risk management, have become important issues.

The working danger administration of Chinese merchant banks started late, this management means are also relatively backward, there is less systematic and professional research, relatively lack of experience, and the management concept needs to be improved. In terms of management technology and tools, international commercial banks have widely used electronic and chemical tools to manage operational risks. It should also be pointed out that many new businesses have been carried out and new products have been released, but the management system, operation process, and business training can not keep up, and there is no

systematic and electronic tracking and evaluation system to monitor these processes and links prone to operational risk. It is often to formulate and improve the system regulations and business processes after the occurrence of operational risk events.

A relatively detailed analysis of the classification for operational risk by combining financial derivatives and secularization technology, exploring the factors that affect operational risk, and how to accurately and effectively measure operational risk. Based on this, they pursued relatively effective operational risk management. It also made a relatively detailed analysis of the definition of operational risk and some of its causes and made a more introductory analysis of how to apply the loss allocation method to measure the capital allocation requirements of operational risk, what is more worth our reference is that it suggests creating venture capital funds to address operational risks and proposing some relatively feasible strategic recommendations.

Many mathematical methods to measure operational risk through simple analysis, used loss distribution in advanced measurement and other methods to measure operational risk, conducted Exploratory research to measure operational risk, and formed the theory of extreme *smoothness* model, They cannot combine the data for preliminary empirical analysis.[8] In their paper, they proposed a method to calculate the operational risk capital fund, explained the Value at-risk model in detail, and provided more details of the process of calculating the capital allocation requirements of commercial banks' operational risk capital.

The method of measuring and managing operational risk is simpler and lacks explanation. It is mainly about the content of the Basel Accords Accord. This is the research that introduced the Capital Accord before, guiding our next understanding of the Accord. This paper mainly introduces the types of operational risk classification and their relationships with the three pillars of the agreement and discusses in more detail how to use the loss allocation method to measure operational risk.

The average baseline indicator of the bank's total GI revenue and operational risk sensitivity coefficient ($\alpha$ is the return) in the first three years, representing the

manipulation risk capital required by the bank. Based on its experience, the Basel Committee has set alpha at 0.15 to enable banks to adapt to their actual situation. The basic indicator method only requires one total income parameter, requires very little data, and is easy to implement. However, this approach oversimplifies the coordination of risk sensitivity factors, even if a given bank can adjust the ratio appropriately based on its operational risk characteristics, This adjustment cannot fully distinguish the operational risk characteristics of different financial institutions or the different operations of the same institution, thus providing a basis for the optimal allocation of bank capital and the reward and sanction mechanisms of banks.

Therefore, although the new Basel Capital Accord provides for three types of measures as a reference. However, due to differences in scale, scope of activities, operating conditions, and financial market environment among banks, they should adjust based on their operational risks, especially the Bazil Committee, which is a board of directors established by 13 developed countries and does not consider underdeveloped countries and regions in its measurement methods, The applicability of the proposed method in China is questionable. Based on the above situation, the income model is more suitable for China's current operational risk measurement than the three types of operational risk measurement methods mentioned in the New Basel Capital Accord.

## Overview of Foreign Research Literature.

The research on operational risk in foreign countries started relatively early, with a relatively mature theoretical level, involving methodological research and empirical analysis for measuring operational risk. Duncan (2015), by creating an operational risk loss event database and further applying risk measurement techniques and loss allocation methods, analyzed in detail the capital requirements needed to measure operational risk, but he was unable to conduct specific empirical research to measure operational risk, Especially due to a lack of data. Michel and Robert (2020) conducted a relatively detailed analysis of the classification of operational risk by combining financial derivatives and securitization technology,

exploring the factors that affect operational risk, and how to accurately and effectively measure operational risk. Based on this, they pursued relatively effective operational risk management. This paper discusses how commercial banks can cope with operational risks by introducing insurance mechanisms, and discusses the substitution between the paid insurance premium and the allocated Economic capital. In his paper, Phihppe (2021) made a relatively detailed analysis of the definition of operational risk and some of its causes and made a more introductory analysis of how to apply the loss allocation method to measure the capital allocation requirements of operational risk, What is more worth our reference is that it suggests creating venture capital funds to address operational risks and proposing some relatively feasible strategic recommendations. Hiwatashi and Hiroshi (2022) introduced some experiences of operational risk management based on the experience of Japanese commercial banks and believed that operational risk management practices are more practical and important than commonly recommended measures of the operational risk scale, Therefore, it is recommended that banking regulatory authorities require banks to pay more attention to improving management measures. John (2014) introduced many mathematical methods to measure operational risk through simple analysis, used loss distribution in advanced measurement and other methods to measure operational risk, conducted much Exploratory research to measure operational risk, and formed the theory of extreme smoothness model, They cannot combine the data for preliminary empirical analysis. In their paper, Reimer and Peter (2015) proposed a method to calculate the operational risk capital fund, explained the Value at-risk model in detail, and provided more details of the process of calculating the capital allocation requirements of commercial banks' operational risk capital. Chornobyl and Rachel (2016) conducted a study on operational risk modeling, recommending the introduction of robust methods to measure operational risk. Gao, Li, and Xu (2016) studied operational risk measurement methods suitable for China, mainly combining operational risk data from Chinese commercial banks. Dobeli (2017) measured operational risk by establishing a dynamic stochastic model, which played an important role in enhancing performance evaluation, employee motivation, risk differentiation, and slow release. Cowell,

Verall, and Yoon (2017) established a nonlinear model for measuring operational risk, known as the Bayesian network model. This model involves simulating scenarios using historical data, modifying model parameters and finally conducting practical validation.

## Overview of Chinese Research Literature.

There is a significant gap in operational risk research between China and foreign countries. Although some books and papers on operational risk management have also been published, there are not many measurement methods that can meet the risk management needs of our bank, Mainly in the following fields: research mainly involves a comprehensive introduction or introduction of foreign theoretical achievements. Chen (2021) explored some operational risk theories in financial risk analysis and briefly introduced the definition and nature of operational risk. At the same time, he studied and analyzed the methods for measuring and managing operational risks in China, as well as the operational risk situation. He also conducted a relatively empirical comparative analysis of operational risk case data in China using media collected over some time. Zhou and Tang (2023) introduced the method of measuring and managing operational risk. This method is simpler and lacks explanation. It is mainly about the content of the Basel Accords Accord. This is the research that introduced the Capital Accord before, guiding our next understanding of the Accord. This paper mainly introduces the types of operational risk classification and their relationships with the three pillars of the agreement and discusses in more detail how to use the loss allocation method to measure operational risk. Wan and Miao (2015) compared the current situation and training reasons of operational risk management both domestically and internationally and introduced foreign research and the current situation of risk management in China. Qi (2015) discussed the role of reasonable utilization of insurance deferred release in reasonably releasing operational risks, proposed a relatively new risk prevention method, and provided a new perspective for scholars and theorists. Guo Lei (2015) studied the legal risks of banks and grouped them with operational risks, taking into account bank management practices. He conducted research and proposed operational risk

prevention measures. Chen (2016) "Risk Management of Comprehensive Commercial Banks: A More Comprehensive Analysis of the Risks Our Banks Face". Gao (2016) conducted an in-depth analysis of operational risk management and measurement, studying capital calculations. Zhong, Wang, and Shao (2016) introduced the methods of quantifying operational risk, including the methods recommended in the Basel Accords Accord and the most popular new methods in the world. Chen (2016) described operational risk management in more detail in the context of Basel but lacked empirical analysis. Zhang and Pan (2017) proposed some principles for establishing risk measurement models and outlined some methods and improvement suggestions for the Basel Program. Qu and Xie (2018) conducted an exploratory analysis of the design of an operational risk management framework and proposed the idea of building an operational risk management framework, but it was only a rough design and could not form an operational risk management system.

## Research Methodology

1. Population and samples of this research

This study is based on the basic operational risk theory of Chinese commercial banks, analyzes different measurement methods, and ultimately selects an income model for regression analysis. This paper selects a sample of 15 representative banks in China and divides them into three categories: nationalized merchant banks, incorporated merchant banks, and town merchant banks. It explains the reasons, background characteristics, trends, and operational risk management status of Chinese commercial banks. Four nationalized merchant banks were selected, and seven incorporated merchant banks were selected. Their initial public offering occurred earlier, while city commercial banks chose two. Four nationalized merchant banks are China Construction Bank, Industrial and Commercial Bank of China, Agricultural Bank of China, and Bank of China, seven incorporated merchant banks are Bank of Communications, Industrial Bank, China CITIC Bank, China Merchants Bank, SPDB, Guangda Bank and Huaxia Bank, and two town commercial banks are Bank of Nanjing and Bank of Ningbo. this paper selected ten experts with more than five years

of experience in commercial banking for interviews during the questionnaire survey. Verify the model results through questionnaire survey data, and conduct expert analysis and verification of the data through the Delphi method.

2. Instrument of this research

This article first uses regression models to analyze the data, uses Eviews to perform OLS regression analysis on the data, and then uses questionnaire survey methods to design a Likert-7 scale for the data, conducts validation analysis on the data, and finally draws relevant conclusions.

3. Data collection

When selecting banks, considering the duration of sample data and whether it conforms to the model, this paper selects the quarterly data of 16 commercial banks with earlier listing dates. However, due to the Bank of Beijing, Ping An Bank, and Minsheng Bank, there are some unpublished quarterly index data to ensure the integrity of empirical data, After 13 commercial banks were listed as samples, they ultimately chose to cancel these three banks. In the panel model data, the net profit comes from the official websites of various banks from 2018 to 2023. The seasonal GDP value comes from the National Bureau of Statistics, and CPI is calculated based on monthly data from the National Bureau of Statistics. The one-year deposit interest rate is calculated by subtracting the one-year basic deposit interest rate from the one-year basic deposit interest rate. The one-year deposit interest rate is calculated based on monthly data published by the People's Bank of China, and the one-year basic deposit interest rate is calculated based on daily data of the one-year basic deposit interest rate. The Shanghai Composite Index is derived from the quarterly data the Shanghai Stock Exchange obtained through the average daily closing point. Quarterly data on non-performing loan interest rates and loan/deposit ratios come from announcements by listed companies of various commercial banks. The quarterly reserve requirement ratio is calculated on average based on monthly data released by the People's Bank of China.

4. Data analysis

Empirical analysis was conducted for qualitative research and quantitative research on three different groups of commercial banks, and empirical results were obtained. Then use explanatory variables for the final sample, root inspection of the device, co-integration inspection, and verify Model Configuration, this way for the further test.

Data Analysis Procedures

4.1 Explanatory variables for the final sample. In the income model, net profit needs to meet the normal distribution of net profit for each bank by the Jarque Bera test.

4.2 Root inspection of the device. If the variable has pseudo regression, the results of test T are invalid relative to test F. About the nonstationarity of the series, the Root of Unity test is usually used to measure whether the Panel data is stable.

4.3 Co-integration inspection. Analyze the results of the Panel data cointegration test to determine whether there is a cointegration relationship between the data.

4.4 Verify Model Configuration. The empirical analysis in this paper is selected for Panel data, avoiding the Multicollinearity problem that may exist in the time series. However, the final results of the model are in line with the actual economic significance and are strongly affected by the configuration accuracy of the Panel data model. Therefore, to build a Panel data model that matches the selected sample, you must first check the model parameters. This paper is based on the Panel data model of 13 banks based on 21 quarters of Panel data.

4.5 Empirical Analysis. Empirical analysis was conducted on three different groups of commercial banks, and empirical results were obtained. This paper uses the income model method for analysis. The income model method belongs to the top-down approach. From the perspective of the fluctuation index of net

income (income), it uses it as an explanatory variable and uses factors that lead to changes in explanatory variables, such as the speed of economic development, market confidence, bank asset quality, etc. as explanatory variables. It also divides the total hazards encountered in banks into trust hazards, fluidity hazards, trade hazards, and procedure hazards. When quantifying the difference in bank net income, the first three measurable risks are considered explanatory variables, while the remaining risks can be considered as the operational risk exposure faced by the bank. The formula is expressed as follows Embrechts, 2013: $Y=C_{+}\beta_1X_{1+}\beta_2X_{2+}\beta_3X_{3+}\ldots\beta_nX_{n+}\mu$ Where Y is the bank's net profit, C is a constant term, $\beta_i$ is risk sensitivity, Xi is the risk factor representing market risk, credit risk, and Liquidity risk, and $\mu$ is a random error term. In the income model, the fluctuation of bank net profit $\delta^2_t$ consists of two parts, one of which is caused by the independent variable, Note that as a part of $\delta^2_{self}$, the other part is to explain unexplained variable fluctuations. Note the $\delta^2_{inc}$, which is: $\delta^2_t=\delta^2_{self}+\delta^2_{inc}$ Therefore, the fluctuation in bank net profit caused by operational risks is: $\delta^2_{oprisk}=\delta^2_t*(1-R^2)$ In the above formula, $\delta_{oprisk}$ is the standard deviation corresponding to operational risk, and $\delta_t$ is the standard deviation corresponding to net profit. The income model assumes that the fluctuation of net income follows the Normal distribution and the business wind is within the 99.9% confidence interval. Risk losses include: $Oprisk=3.1*_{\delta oprisk}$

4.6 Fuzzy Delphi analysis. This paper uses the fuzzy Delphi analysis method to validate the model based on the survey results of experts. The interviewees of this paper are ten senior bankers with more than five years of experience in major banks. By designing a survey questionnaire to analyze the questionnaire data of the experts, the consistency with the model in this paper is verified. In the designed survey questionnaire, a seven-level digital scale was used for analysis, ranging from strongly disagree to strongly agree. 1 to 7 goes from strongly disagree to strongly agree. Analyze and validate using Microsoft Excel. The fuzzy Delphi analysis method first encodes the questionnaire survey data of experts to form a triangular fuzzy number (TEN) and then deblurs the results to establish consistency. The results can be displayed as Gi values. That is to say, the triangular fuzzy number is transformed into

a Gi numerical value for each question, represented by $\alpha$=3.5. If it is greater than 3.5, it indicates that the expert agrees with the questionnaire statement. If it is less than, it indicates that the expert disagrees with the statement and the sentence analysis is incorrect. Please refer to the attached appendix for specific results. The results show that all values are greater than $\alpha$=3.5.

## Results

The Jarque Bera tests of the 13 known banks in Table 1 did not reject the initial assumptions applicable to the income model for the 13 banks. After determining the sample, regression analysis is conducted on the initially selected explanatory variables to ensure that the theoretical variables correspond to the actual meaning of the model establishment. The results obtained using Eviews8.0 software are shown in Table 2.

**Table 1** Inspection of Jarque Bera

| Bank Name | JB statistical value | P-value |
|---|---|---|
| China Construction Bank | 2.66439 | 0.26363 |
| Industrial and Commercial Bank of China | 3.27671 | 0.19430 |
| Agricultural bank | 3.25535 | 0.19639 |
| Bank of China | 0.08170 | 0.08170 |
| Bank of Communications | 1.04714 | 0.59240 |
| Industrial Bank | 0.48661 | 0.78403 |
| China CITIC Bank | 1.13006 | 0.56834 |
| China Merchants Bank | 0.43191 | 0.80577 |
| Pudong Development Bank | 0.38742 | 0.82390 |
| Guangda Bank | 1.37533 | 0.50275 |
| Huaxia Bank | 1.60747 | 0.44765 |
| Bank of Nanjing | 0.93481 | 0.62663 |
| Bank of Ningbo | 0.90875 | 0.63484 |

**Table 2** Contains regression results for all explanatory variable

| Explanatory variable | Coefficient | T statistics | P-value |
|---|---|---|---|
| C | 507.4759 | 0.851918 | 0.3952 |
| BL | -5473.207 | -2.327023 | 0.0208 ** |
| G | 2129.233 | 2.809562 | 0.0054*** |
| LR | 139.5224 | 1.780828 | 0.0763* |
| INDEX1 | 0.003849 | 0.0236573 | 0.8132 |
| DR | -1167.553 | -2.769015 | 0.0061*** |
| LD | 8046.565 | 0.352114 | 0.7251 |
| | Adjust R-squared | F Statistics | F statistical probability |
| | 0.913726 | 225.4631 | 0.0000 |

*P<0.5, ** P<0.9, *** P<0.01

By removing the two variables of the one-year loan gap and the Shanghai Composite Index, the final six explanatory variables are changed to four, namely the actual GDP growth rate (G) of market risk and the non-performing loan rate (BL) of credit risk, Loan to deposit ratio (LR) representing Liquidity risk and reserve requirement (DR). After removing the first two variables, the adjusted R-squared value is 0.923597. In contrast, the decisive coefficient after removing the first two variables is higher and the adjustment is better. The calculation results of applying the regression model after removing variables are shown in Table 3.

**Table 3** Interpretation of Variable Regression Results

| Explanatory variable | Coefficient | T-statistic | P-value |
|---|---|---|---|
| C | 507.4759 | 2.539327 | 0.0118** |
| BL | -5437.207 | -2.511549 | 0.0127** |
| G | 2134.657 | 2.829131 | 0.0051*** |
| LR | 144.0307 | 1.898962 | 0.0588* |
| DR | -1201.274 | -3.033420 | 0.0027*** |
| | Adjust R-squared | F Statistics | F statistical probability |
| | 0.923597 | 225.6968 | 0.0000 |

*P<0.5, ** P<0.9, *** P<0.01

**Table 4** Review of non-stationary time series of global data

| Sequence | LLC | IPS | Fisher-ADF | Fisher-PP |
|---|---|---|---|---|
| NP? | 16.3875 | 11.6114 | 16.9227 | 146.716*** |
| ΔNP? | -13.9139*** | -23.5390*** | 156.5560*** | 1221.06*** |
| BL? | -7.2149*** | -3.6422*** | 58.1951*** | 43.8145*** |
| ΔBL? | -5.8144*** | -5.1577*** | 77.7450*** | 100.912*** |
| G | -3.4504*** | -2.64068*** | 10.1027*** | 9.06761** |
| ΔG | -4.9355*** | -4.9610*** | 18.4207*** | 30.8950*** |
| LR? | 1.7942 | 2.0230 | 25.9644 | 50.7664** |
| ΔLR? | -30.6008*** | -25.1629*** | 564.788*** | 1231.53*** |
| DR | 0.31892 | 1.16607 | 0.24452 | 0.25833 |
| ΔDR | -2.0267** | -2.2345** | 8.2008** | 8.1699** |

***,** Significant at the 1% and 5% levels, respectively Δ Indicates the difference in the first order.

The model co-integration test results of Panel data are shown in Table 5. Kao test results show that the probability of accompanying ADF is 0.26%, which is less than 1%, indicating that there is an obvious co-integration relationship in the sequence. In the Pedroni test, the probability of accompanying PP and ADF sequences is 0.0000, indicating a co-integration relationship between the sequences.

**Table 5** Kao inspection and Pedroni inspection

| Inspection method | Testing hypotheses | Statistical name | Statistical value (p-value) |
|---|---|---|---|
| Kao inspection | $H_0 : \rho = 1$ | ADF | -2.7931*** |
| | | | (0.0026) |
| | | Panel | -1.0899 |
| | | V-statistic | (0.8621) |
| Panel | 0.9302 | | |
| | | Rho-statistic | (0.8239) |
| | $H_0 : \rho = 1$ | Panel | -23.3593*** |
| | $H_1(\rho_i = \rho) < 1$ | PP-Statistic | (0.0000) |
| | | Panel | -12.1019*** |
| Pedroni inspection | | ADF-Statistic | (0.0000) |
| | $H_0 : \rho = 1$ | Group | 1.2377 |
| | $H_1(\rho_i = \rho) < 1$ | Rho-statistic | (0.8921) |
| | | Group | 1.2377 |
| | | PP-Statistic | (0.0000) |
| | | Group | -9.4077*** |
| | | ADF-Statistic | (0.0000) |

***,** Significant at the 1% and 5% levels, respectively

**Table 6** Calculation results

| | numerical value | critical value | Significance level 5% 1% |
|---|---|---|---|
| S1 | 636215.6 | – – | – – |
| S2 | 792645.7 | – – | – – |
| S3 | 13396604 | – – | – – |
| F1 | 1.0655 | 0.669722 | 0.560823 |
| F2 | 69.5299 | 0.696404 | 0.593228 |
| Model Type | – – Variable parameter model | Variable parameter model | |

## Discussion

Through the regression analysis of the above model, this article studied explanatory variables and operational risk loss events, state-owned commercial bank groups typically represent three groups of banks. which are in a leading position in terms of historical risk loss events, number of loss events, and number of loss events, when comparing state-owned commercial bank groups with joint-stock commercial bank groups, urban commercial bank groups can be found together.

In the data of state-owned commercial bank groups, the scale of operational risk events, frequency of losses, and amount are usually representative. There are significant differences in the comparison between the other two groups of commercial banks, indicating that the value of the state-owned commercial bank group is representative.

When commercial banks evaluate their operational risks, they cannot estimate based solely on an absolute or relative operational risk value, but they must combine these two data to analyze the operational risks of commercial banks. Appropriately consider the importance of these two values, fully prepare preventive measures related to operational risk and capital loss reserves, and compare them based on the above data table; When analyzing operational risk, the analysis of the absolute value of operational risk does not allow for accurate differentiation of operational risk in the most complete sense.

Regression analysis results show that there is no direct and obvious correlation between the absolute risk and relative risk of commercial banks, and the large absolute value of risk does not fully correspond to the high value of relative risk, Unlike the regression results of the first three groups of commercial banks, the absolute operational risk of state-owned commercial banks is much greater than that of urban commercial banks, while the relative operational risk of urban commercial banks is much greater than that of state-owned commercial banks.

The operational risk management of three groups of commercial banks should be managed based on their different characteristics, and due to bias, they should serve as directors.

Given that the three groups of commercial banks have different histories, development characteristics, and corresponding banking policies, the potential operational risks faced by commercial banks in their development are also different, Commercial banks should respond with specific operational risk management measures based on their development characteristics, and should not blindly respond based on the existing operational risk management measures of large international commercial banks. They should analyze based on their development reality and describe the operational risk management response of their commercial bank development.

## Conclusion

In the risk regression measurement of commercial banks, we chose the income model regression measurement, which considers risks through regression analysis of commercial bank risk data to obtain opinions on the relevant regulatory value. The income model is a relatively stable and sustainable monitoring method that better considers the risk situation and value at risk, through the correlation regression analysis in this article, and then testing the data to obtain the relevant risk theory. The model design in this article eliminates the roles of credit and market factors in commercial banks, while the remaining factors limit the profitability of commercial banks due to risk factors. Commercial banks verify the importance of risk measurement by analyzing and measuring risk factors, thereby analyzing and testing the generation of risk factors in commercial banks. Emphasized the risk methods and ideas that commercial bank risk management organizations should adopt when measuring risks, as well as the fixed risk measurement structure they should establish.

There are more types of commercial banks with concentrated business. Commercial banks face different risks in specific commercial transactions. The larger the transaction type in actual transactions, the greater the amount of funds involved,

and the greater the risk faced by commercial banks. In actual business, the amount and amount of funds of commercial banks are closely related to their actual operating conditions. Commercial banks with good business development and significant business expansion will inevitably have significant financial transactions and corresponding risk factors. In daily operations, commercial banks should adjust risk management measures based on their situation, monitor risks in real time, and ensure comprehensive and continuous daily risk management.[4] The risk management department of commercial banks should timely adjust their risk management models and strategies to adapt to constantly changing business, validate relevant strategies, and analyze data. The relevant departments of commercial banks should also cooperate and coordinate the implementation of the proposed risk strategy based on the arguments of the risk department, actively report discovered risk issues and properly solve them, timely monitor the traceability and tracking of risk issues, and cooperate with the smooth progress of commercial bank risk work.

In summary, a comprehensive internal analysis of the randomness and degree of loss of risk events on previous commercial bank risk events may indicate that due to a high proportion of risk events caused by human factors, the risk factors that play a dominant role in risk events account for a significant portion of the human environment. Human issues are reflected in the process of commercial bank activities. Therefore, we are encouraged to effectively manage the risk personnel of commercial banks, select excellent personnel in risk positions, fully understand risk operations, apply excellent risk monitoring methods to manage risks, and truly choose personnel with risk awareness, foresight, and risk prediction, Able to understand all risk calculation models and methods for entering risk positions in different departments.

## References

Anurag, G., & Bing, L. (2015). Do hedge funds have enough capital? A value-at-risk approach. *Financial Economics, 77*(5), 219–253.

Ba, S. (2013). Research on the New Basel Capital Accord. *China Financial Publishing House, 52*(12), 25-28.

Ba, S., Wang, S., & Jin, L. l. (2017). Measurement and regulatory framework of bank operational risk under Basel III [J]. *Journal of Dalian University of Technology (Social Science Edition), 38*(1), 36-42.

Bin, J. C., & Wu, J. (2023). Fitting and Diagnosis of the Distribution of Operational Risk Losses, *Chinese Commercial Banks Investment Research, 14*(3), 20-32.

Cai, Z. X., & Sun, Q. (2007). Bank Operational Risk Estimation Based on Partitioned Multi objective Risk Model (PMRM) *Economic issues, 15*(11), 86-89.

Chen, X. H., Yang, H. Y., & Huang, X. Y. (2013). The Application of POT Model in Operational Risk Measurement of Commercial Banks. *Management Science, 16*(2), 49-52.

Dang, J. Z, Chen, H. M., & Wang, Q. H. (2017). Design of a Comprehensive Risk Management System for China Postal Savings Bank. *Banker, 13*(11), 69-72.

Eddie, C. (2014). Bank Risk Management (Translated by Wang Songqi). *Beijing: China Financial Publishing House, 15*(10), 33-34.

Fei, L., & Deng, M. R. (2007). Statistical Characteristics of Operational Risk in Commercial Banks and Empirical Capital Simulation. *Financial forums, 15*(8), 3-11.

Gu, J. P. (2015). Operational risk management of Chinese commercial banks. *Beijing: China Financial Publishing House, 13*(5), 12-15.

Han, W. Y. (2023). An Empirical Study on the Fertility Intention of Workplace Women in Taiyuan City: A Comprehensive Application Based on Fuzzy Delphi Method. *Finance and Economics, 137*(15), 47-52.

Huang, H. F., Wang, G. J., & Wang, Q. Z. (2006). Research on the Causes and Countermeasures of Operational Risk in Chinese State-owned Banks. *Finance and Economics, 35*(1), 27-30.

Ji, N. F. (2005). Research on Operational Risk Management Methods for Commercial Banks, *Economic Issues, 56*(11), 69-70.

Joshua, V. R., & Til, S. (2016). A general approach to integrated risk management with skewed, fat-tailed risks. *Financial Economics, 79*(10), 569–614

Li, G. (2001). Preliminary Exploration of Internal Control System. *Journal of Capital University of Economics and Trade, 13*(6), 68-70.

Paul, E., Hansjorg, F., & Roger, K. (2013). Quantifying Regulatory Capital for Operational Risk. *Derivatives Use [J]. Trading & Regulation. 12*(9), 217-233.

Qian, H. H., & Xu, X. F. (2011). Analysis of Operational Risk Management Issues in Commercial Banks in China. *Zhejiang Finance, 18*(12), 27-33.

Sun, Y., Shang, Z. Y., & Pan, H. (2017). Commercial Bank Operational Risk Assessment – CVaR Model Based on EVT Theory. *Industrial Technology Economy, 45*(7), 126-129.

Xu, X. F. (2009). A New Theory on Operational Risk Management in Commercial Banks. *Beijing: China Financial Publishing House, 23*(12), 72-75.

Yu, C., & Zhou, W. (2014). Commercial banks are exploring ways and methods to measure risk losses. *Economic Theory and Economic Management, 35*(2), 78-84.