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Article

An Econometric Model of Interest Rate Marketization and Diversification Driving the Performance Improvement of Listed Commercial Banks in China

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Abstract: Commercial banks play a crucial role in China's financial markets, and their stability and health are particularly important for the market and national economic development. The study collected a total of 225 balanced panel data sets from 2015 to 2021 as empirical samples, employing both qualitative and quantitative analysis methods. Focusing on the perspective of diversified operations, the study utilized a econometric model based on panel regression to thoroughly examine the relationship between interest rate liberalization and bank operational performance, as well as the moderating effect of diversified operations. The empirical findings indicate that there is a negative relationship between commercial bank performance and the degree of interest rate liberalization, and that diversified operations mitigate this negative impact. Based on these findings, policy recommendations can be proposed from both the bank and government perspectives to improve the quality of diversified operations.

Keywords: panel regression model; econometric model; interest rate liberalization; diversified operations; commercial bank performance

1. Introduction

In recent years, with the continuous development of financial markets and intensifying competition, performance management issues in listed commercial banks have become increasingly prominent [1-2]. Improving the performance of listed commercial banks is not only related to the development and competitiveness of the banks themselves, but also directly affects the stability of financial markets and the sustained healthy development of the economy [3-4].

Currently, the primary factors influencing the performance of listed commercial banks include: (1) Macroeconomic environment factors: The macroeconomic environment is one of the key factors affecting the performance of commercial banks [5]. As China's economy enters a new normal, factors such as slower economic growth and reduced fiscal spending will have a significant impact on commercial banks' performance [6-7]. At this time, commercial banks need to seize opportunities, innovate business models, adapt to market demands, and enhance profitability [8]. (2) Profit management factors: A commercial bank's profit management capabilities are also a key factor influencing performance [9]. Profit management involves commercial banks' asset and liability management, interest rate risk management, credit risk management, and other aspects [10-11]. Only by reasonably controlling risks and implementing meticulous management can commercial banks improve their profitability and performance [12-13]. In addition, asset quality factors and talent management factors are also important factors affecting the performance improvement of listed commercial banks [14-15].

To improve the performance of listed commercial banks, banks need to adopt appropriate strategies.

(1) Improve deposit absorption capacity: An important goal of commercial bank operations is to expand the scale of deposit absorption and enhance capital strength [16-17]. Commercial banks can improve their deposit absorption capacity through measures such as raising deposit interest rates, launching innovative products, and expanding deposit channels [18-19]. (2) Innovate business models: Under the new normal, commercial banks need to innovate business models and launch new products and services that align with market demand [20-21]. Commercial banks should focus on expanding sectors such as investment banking and wealth management to enhance performance [22-23].

Literature [24] analyzed the impact of various internal and external factors on the performance of Indonesian commercial banks. Based on quantitative research methods, it was found that credit risk, operating expenses, and operating income are positively correlated with commercial bank performance, while inflation has a severe negative impact on bank performance. Literature [25] examines the factors influencing the efficiency and performance of Ethiopian commercial banks, emphasizing the important role banks play in national development. The study indicates that management capabilities and surplus quality have a positive impact on bank performance. Literature [26] examines the factors influencing the profitability of Ethiopian commercial banks, emphasizing that capital adequacy ratios and liquidity are significantly positively correlated with bank profitability, while inflation rates and interest rates are negatively correlated with bank profitability. Literature [27] discusses the factors influencing the financial performance evaluation of commercial banks, analyzing the impact of CAR and NIM on commercial bank financial performance. The results indicate that non-performing loans are the most significant factor affecting the financial performance of private banks. Literature [28] assesses the determinants of commercial bank profitability and examines the impact of macroeconomic and internal factors on profitability, revealing that both bank-specific factors and macroeconomic factors influence profitability. Literature [29] aims to identify the factors influencing commercial bank performance, pointing out that commercial bank performance and profitability are constrained by asset return rates, emphasizing that commercial bank performance is primarily influenced by the loan-to-deposit ratio and the total loans-to-total assets ratio, and providing recommendations. The above studies identify the factors influencing commercial bank performance, with inflation and non-performing loans being key factors limiting banks' ability to improve performance, necessitating targeted measures from banks.

Literature [30] explores the cost efficiency and profit efficiency of various types of commercial banks in China from 2002 to 2013, pointing out that the cost and profit efficiency of domestic banks have generally improved, with banks' profit efficiency exceeding their cost efficiency, while foreign banks have the highest cost efficiency but the lowest profit efficiency. Literature [31] investigates the impact of digital financial services on the financial performance of listed commercial banks in Nigeria, aiming to understand the relationship between the dependent variable and the main independent variables. The results indicate that digital financial services have a substantial and significant marginal effect on the earnings per share of the banking sector. Literature [32] analyzed the impact of green credit on bank financial performance from the perspective of heterogeneous regional green development, indicating that green credit can effectively improve the financial performance of commercial banks, and that the level of green development can enhance the economic benefits of banks issuing green credit. Literature [33] aimed to determine the impact of electronic banking on the financial performance of Kenyan commercial banks, emphasizing the effectiveness of electronic banking and suggesting that commercial banks can adopt electronic banking as it can improve bank efficiency and financial performance. Literature [34] explores the impact of corporate governance mechanisms on bank profitability. Based on a multiple regression analysis, the study indicates that banks with effective corporate governance mechanisms can effectively improve financial performance. Literature [35] analyzes the financial performance of Bangladeshi commercial banks in terms of profitability measures before, during, and after financial liberalization, revealing that capital strength and asset quality are the primary drivers of commercial bank profitability. The above studies propose strategies to improve commercial bank performance, including digital financial services, green credit, and electronic banking. The implementation of these strategies not only improves commercial bank efficiency but also promotes overall performance.

To cope with the impact of interest rate liberalization, commercial banks have continuously improved their diversified business operations, increased innovation efforts, and expanded non-interest income. However, diversified business operations are like a double-edged sword: while they can have a positive impact on performance, they may also bring potential risks. Based on this, this study examines the relationship between interest rate liberalization, diversified business operations, and commercial bank performance. Using data from 30 Chinese commercial banks from 2015 to 2021 as the research sample, this study conducts an empirical analysis of the impact of interest rate liberalization on performance. In the empirical research, three sequential hypotheses are used to test the impact of interest rate liberalization on bank performance and the moderating effect of diversified operations. Finally, heterogeneity analysis was conducted by grouping banks by type, and risk-adjusted return on assets was

used as a proxy variable for operational performance to conduct robustness tests.

2. Research design and data sources

2.1. Hypothesis formulation

Following steady progress in reform, domestic commercial banks have begun to shift away from their previous single business model constraints and move toward diversified business models. In addition, based on financial development theory, changes in China's interest rates will affect the level of financial development of commercial banks.

2.1.1. The relationship between interest rate liberalization and commercial bank performance

During the interest rate control phase, the state would protect banks' net interest margins from a strategic perspective, obtaining deposits at lower interest rates and then issuing loans at higher interest rates, thereby achieving relatively stable net interest margin income. After the implementation of interest rate liberalization reforms, the state no longer protects banks' net interest margins, and the spread between deposit and loan rates has shown a continuous downward trend, meaning that the traditional model of banks relying on net interest margins for profits has been completely disrupted. Therefore, interest rate liberalization severely impacts banks' profitability. Based on the above analysis, the following research hypotheses are proposed:

H1: The higher the degree of interest rate liberalization, the greater the negative impact on the performance of listed commercial banks.

2.1.2. Relationship between interest rate liberalization and the impact of diversified banking operations

Under the guidance of financial innovation and economies of scope theory, banks, as financial institutions, primarily provide banking services and wealth management products to their customers. To better meet customer needs, banks must design diversified wealth management products based on their actual circumstances, which is key to achieving economies of scope. Under this theoretical framework, producing diversified products helps banks achieve greater profitability in their operations, thereby significantly reducing production costs. At this point, banks can leverage this advantage and existing resources to significantly improve their performance levels. This market is an innovative market, and to obtain market resources, it is essential to seize the opportunities presented by product innovation and business development. This is the key to enhancing bank performance. Based on the above analysis, the following research hypothesis is proposed:

H2: The degree of interest rate liberalization promotes the implementation of diversified business strategies by listed commercial banks, and the degree of bank diversification increases accordingly with the rise in interest rate liberalization.

2.1.3. The regulatory role of diversified banking operations

The diversification of bank wealth management product types, customers' implementation of diversified investments, and banks' attainment of economies of scale all hinge on the existence of product substitutability. However, at the current stage, whether the wealth management products launched by banks possess such substitutability requires further investigation. Additionally, factors beyond banking operations and products—such as regulatory policies and economic market fluctuations—can significantly influence the relationship between two variables: diversified operations and bank performance. Therefore, relying on a single theoretical framework cannot yield relatively accurate research conclusions. However, most scholars propose that these two variables have a positive relationship.

To further explore the impact of diversified operations on bank performance, based on the research findings of scholars and in line with the objectives of this study, the following research hypothesis is proposed:

H3: Diversified operations play a moderating role when interest rate liberalization affects bank performance. To some extent, implementing a diversified operational development strategy can mitigate the adverse effects of interest rate liberalization on bank performance.

2.2. Sample Selection and Data Sources

As of now, there are over 30 listed commercial banks in China, including CITIC Bank and Industrial

Bank. The Ministry of Finance has stipulated that new accounting standards will be implemented starting from 2017, which means that the statistical methods for bank financial statements will differ significantly from previous practices. Considering data availability, this study focuses on 30 listed banks, collecting and analyzing their financial data from 2015 to 2021 through channels such as annual reports and Bankscope database, among other sources, to collect and analyze their financial data from 2014 to 2023. A total of 225 balanced panel data points from 2015 to 2021 were collected as the empirical sample.

2.3. Variable Selection

2.3.1. Interest Rate Liberalization

(1) Construction of the interest rate liberalization index

The four primary indicators of interest rate liberalization are loan interest rates, money market interest rates, bond market interest rates, and wealth management product yields. The twelve derived secondary indicators are constructed as shown in Table 1.

Table 1. Internet rate market-oriented index system.

Primary indicator	Secondary indicator
Deposit rate (DR)	RMB deposit rate (DR1)
	Renminbi lending rate (DR2)
	Foreign currency deposit rate (DR3)
	Foreign currency lending rate (DR4)
Money market interest rate (MMIR)	Bill discount rate (MMIR1)
	Interbank rate (MMIR2)
Bond market interest rate (BMIR)	The coupon issue rate (BMIR1)
	Bond repo rate (BMIR2)
	Coupon trading rate (BMIR3)
Yield on wealth management products (YWMP)	Bank wealth yield (YWMP1)
	Trust yield (YWMP2)
	Currency fund yield (YWMP3)

(2) Weighted calculation

Assuming that the secondary indicator weights are w_i , the value assigned to each secondary indicator each year is multiplied by the corresponding indicator weight to obtain the interest rate liberalization index for each primary indicator. Taking the deposit and loan interest rate market as an example, the calculation formula is as follows:

$$DR = DR1 * w_1 + DR2 * w_2 + DR3 * w_3 + DR4 * w_4 \qquad (1)$$

Assuming that the weight of the first-level indicator is w_i , the interest rate marketization index of each first-level indicator obtained from formula (1) is multiplied by the corresponding weight of the first-level indicator to obtain the final interest rate marketization index. The calculation formula is as follows:

$$IRL = DR * w_1 + MMIR * w_2 + BMIR * w_3 + YWMP * w_4 \qquad (2)$$

2.3.2. Diversification Indicators

(1) Diversification of income

From the income statements of listed commercial banks, it can be seen that the income of listed commercial banks can be roughly divided into two categories: interest income and non-interest income. Investment income refers to the gains obtained by commercial banks from buying and selling securities they hold during their operations, including derivative financial instruments and long-term equity investments, etc. Foreign exchange gains or losses refer to the gains or losses incurred when commercial banks convert assets originally denominated in foreign currencies into RMB due to exchange rate differences. Fair value changes refer to the gains or losses incurred by commercial banks from financial assets held in accordance with accounting standards that are measured at fair value with changes in fair value recognized in profit or loss during an accounting period. This refers to the gains or losses arising from changes in the fair value of financial assets held by commercial banks in accordance with accounting standards, which are measured at fair value and whose changes are recognized in the current period's profit or loss, over the course of an accounting year. Other operating income includes revenues from the sale of precious metals by commercial banks.

Based on the above comparison and analysis of various metrics for measuring commercial bank diversification, as well as the actual situation of listed commercial banks, this paper selects the improved Herfindahl Index (HHI) to measure the income diversification (iHHI) level of listed commercial banks. The specific index calculation formula is as follows:

$$iHHI = 1 - \sum r_i^2 == 1 - (NII^2 + NNII^2) \tag{3}$$

Among these, NII represents the proportion of interest income, and NNII represents the proportion of non-interest income. The higher the value of iHHI, the higher the degree of income diversification.

(2) Asset Diversification

The diversification of commercial bank assets is an objective requirement of the current economic situation and also a self-imposed need for commercial banks at their current stage of development. The diversification of listed commercial bank assets refers to the expansion of their asset businesses on the existing foundation, i.e., expanding beyond traditional loan businesses to include interbank deposits, securities investments, and other such businesses. Based on existing research, assets are categorized into three types: customer loans, interbank deposits and loans, and other profitable assets. Among these, other profitable assets primarily include tradable financial assets, held-to-maturity investments, investment properties, and financial derivatives.

Based on the comparative analysis of various indicators measuring commercial bank diversification and the actual situation of listed commercial banks, this paper selects the improved Herfindahl Index (HHI) to measure the asset diversification (aHHI) level of listed commercial banks. The specific index calculation formula is as follows:

$$aHHI = 1 - \sum r_i^2 = 1 - (CL^2 + ISAD^2 + OPA^2) \tag{4}$$

Among these, CL represents the proportion of customer loans, ISAD represents the proportion of interbank placements and deposits, and OPA represents the proportion of other profitable assets.

The higher the value of aHHI, the higher the degree of asset diversification of listed commercial banks.

(3) Diversification of funding sources

The funding sources of listed commercial banks are divided into three categories: customer deposits, interbank deposits, and other funding sources. Other funding sources primarily include the issuance of financial bonds, money market instruments, financial derivatives, financial bonds, and other interest-bearing liabilities.

This paper selects IHHI as the Herfindahl index representing the diversification of funding sources for listed commercial banks, i.e.:

$$IHHI = 1 - \sum r_i^2 = 1 - (CD^2 + DFOB^2 + TOL^2) \tag{5}$$

CD represents the proportion of customer deposits, DFOB represents the proportion of interbank deposits, and TOL represents the proportion of other funding sources.

The calculation method for the diversification index (HHI) in this section is the average of the three.

2.3.3. Performance of Listed Commercial Banks

There are significant differences in performance measurement methods within the academic community. Specifically, analysis can be conducted using metrics such as the Tobin Q ratio, economic value added, and financial indicators. The Tobin Q ratio refers to the ratio of a company's market value to its replacement cost; however, fluctuations in stock prices may affect its accuracy. Economic value added (EVA) is the difference between after-tax net operating profit and the total cost of capital invested. Financial metrics primarily include return on assets (ROA), return on equity (ROE), and return on investment. Considering robustness and simplicity, this paper employs the return on assets (ROA) from financial metrics to measure the performance of commercial banks.

2.3.4. Control variables

The study selects the logarithm of total assets (LnSIZE), cost-to-income ratio (CIR), equity ratio (ER), and the logarithm of regional GDP (LnGDP) as control variables in this paper.

(1) Asset size (LnSIZE). This study uses the logarithmic value of total assets at the end of each accounting period from the financial statements of listed commercial banks to measure asset size. From the perspective of economies of scale theory, expanding asset size may generate economies of scale, resulting in lower operating costs. Different asset sizes may also lead to varying levels of diversification in business operations.

(2) Cost-to-income ratio (CIR). The cost-to-income ratio measures the operating costs of listed commercial banks. A higher CIR indicates higher operating costs and lower operational efficiency. Improving the management and technological capabilities of listed commercial banks can reduce their operating costs.

(3) Equity Ratio (ER). This refers to the ratio of shareholders' equity to total assets in the financial statements of commercial banks, reflecting their capital structure. Under different conditions, the relationship between the equity ratio and the operational performance of commercial banks is uncertain. On one hand, a higher ratio of shareholders' equity to total assets indicates stronger capital adequacy, enhanced risk-bearing capacity, and greater operational stability, which can improve the bank's performance. On the other hand, a higher ratio of shareholders' equity to total assets is not necessarily beneficial. When a commercial bank lacks sufficient capital, it may be forced to reduce operating expenses to improve performance.

(4) Local GDP. The development of finance and the economy are mutually reinforcing; finance drives economic growth, and in turn, the economy promotes the healthy development of the financial sector. Due to differences in regional economic levels, the performance levels of the banking sector also vary. Therefore, this paper introduces local GDP as a control variable. The definitions of each variable are shown in Table 2.

Table 2. Definition and measurement of various variables of commercial banks.

Variable type	Variable name	Variable symbol
Interpretation variable	Performance of listed commercial Banks	*ROA*
Interpretation variable	Interest rate liberalization	*IRL*
Regulating variable	Diversified operation	*HHI*
Control variable	Equity ratio	*ER*
	Cost income ratio	*CIR*
	Local GDP	*LnGDP*
	Asset size	*LnSIZE*

2.4. Model Construction

Based on the test results, it can be concluded that this paper can be studied using a fixed-effects model with random intercepts [36].

Based on hypothesis H1, model M1 is established:

$$ROA_{it} = \alpha_0 + \alpha_1 IRL_{it} + \alpha_2 ER_{it} + \alpha_3 LnGDP_{it} + \alpha_4 CIR_{it} + \alpha_5 LnSIZE_{it} + \varepsilon_{it} \quad (6)$$

Based on hypothesis H2, model M2 is established:

$$HHI_{it} = \alpha_0 + \alpha_1 IRL_{it} + \alpha_2 ER_{it} + \alpha_3 LnGDP_{it} + \alpha_4 CIR_{it} + \alpha_5 LnSIZE_{it} + \varepsilon_{it} \quad (7)$$

Based on hypothesis H3, model M3 is established:

$$\begin{aligned} ROA_{it} &= \alpha_0 + \alpha_1 IRL_{it} + \alpha_2 ER_{it} + \alpha_3 LnGDP_{it} + \alpha_4 CIR_{it} + \alpha_5 LnSIZE_{it} \\ &+ \alpha_6 HHI_{it} + \alpha_7 IRL_{it} * HHI_{it} + \varepsilon_{it} \end{aligned} \quad (8)$$

In the established model, the target variable selected is ROA, i.e., the return on assets of banks. The interest rate liberalization index and the level of diversified operations of banks are represented by IRL and HHI, respectively; the interaction term between the level of diversified operations of banks and the interest rate liberalization index is represented by IRL*HHI; the logarithm of total assets, the cost-income ratio, the equity ratio, and the logarithm of regional GDP are represented by LnSIZE, CIR, ER, and LnGDP, respectively. ε represents the random error term, accounting for other factors that may influence the target variable. The sensitivity factor of the influencing factors is denoted by α, the number of selected samples by i, and the time span by t. In this study, the time span is from 2015 to 2021, encompassing both time series and cross-sectional data. The panel data model, a relatively typical approach, is employed in the analysis.

3. Analysis of empirical results

3.1. Descriptive statistical analysis

Statistical calculations were performed on each variable, and Table 3 shows the descriptive statistics results for the variables. From the table, it can be seen that the maximum value of return on assets (ROA)

is 1.37%, the minimum value is 0.45%, and the average value is 0.917%. This indicates that there are significant differences in performance among different banks, which may be due to the fact that there are also significant differences in the nature and scale of different banks. The maximum value of interest rate liberalization (IRL) is 3.02%, the minimum value is 1.17%, indicating that as interest rate liberalization progresses, the interest rate spreads among banks also undergo significant changes. The average value of the diversification variable (HHI) is 0.5391, with a small standard deviation, indicating that most banks have implemented diversification strategies. From the perspective of control variables, the differences in the logarithm of total assets (LnSIZE) among banks are not significant, but the differences in indicators such as the cost-to-income ratio (CIR), equity ratio (ER), and the logarithm of regional GDP (LnGDP) are relatively large, indicating that there are significant differences in the operational conditions of banks.

Table 3. Variable descriptive statistics.

Variable symbol	N	Mean	SD	Minimum	Maximum
ROA	225	0.00917	0.00169	0.0045	0.0137
IRL	225	0.01939	0.00377	0.0117	0.0302
HHI	225	0.5391	0.1076	0.1698	0.6927
ER	225	0.0626	0.01701	0.0218	0.0817
CIR	225	14.6196	1.4938	11.9404	17.3793
LnGDP	225	0.2932	0.06615	0.189	0.6652
LnSIZE	225	0.1361	0.01558	0.1041	0.1797

3.2. Correlation Analysis

An analysis of the correlation between the variables is presented in Table 4. As shown in the table, the correlation coefficients between most variables do not exceed 0.5, indicating that the selected variables in this study exhibit good independence and do not exhibit theoretical multicollinearity issues, thereby enabling further regression analysis. Additionally, there is a significant correlation between the performance indicator ROA, the interest rate liberalization indicator IRL, and the diversification indicator HHI, which to some extent validates the hypotheses presented earlier.

Table 4. Correlation coefficient analysis results.

Variable symbol	*ROA*	*IRL*	*HHI*	*ER*	*CIR*	*LnGDP*	*LnSIZE*
ROA	1						
IRL	0.289***	1					
HHI	0.155*	-0.422***	1				
ER	0.172**	-0.048	-0.0199	1			
CIR	-0.299***	0.245***	-0.301***	0.091	1		
LnGDP	0.177**	-0.185***	0.452***	-0.039	0.17	1	
LnSIZE	-0.211**	-0.121*	-0.025	-0.045	0.016	-0.271***	1

3.3. Regression Results and Analysis

3.3.1. Testing the Impact of Interest Rate Liberalization on Bank Performance

To test Hypothesis 1, which posits that interest rate liberalization has a negative impact on commercial bank performance, this paper conducted an empirical analysis based on Model 1. Table 5 presents the regression results of interest rate liberalization on bank performance.

Looking at the full sample, without controlling for variables (Column 1), the regression coefficient for the interest rate liberalization index (IRL) is -1.522. After controlling for variables (Column 2), the regression coefficient for the interest rate liberalization index (IRL) is -1.228. In both cases, the results are statistically significant at the 1% level. This indicates that interest rate liberalization has reduced the performance of listed commercial banks in China, confirming Hypothesis 1.

Regarding control variables, the regression coefficient for asset size (LnSIZE) is -0.512 and is statistically significant at the 1% level, indicating that the expansion of commercial bank scale does not bring about economies of scale but rather reduces commercial bank performance. The regression coefficient for the equity ratio (ER) is -2.445, and it is statistically significant at the 1% level. This indicates that the stronger the market power of commercial banks, the stronger their pricing power and the higher their performance. The regression coefficient for local GDP (lnGDP) is 1.111, and it is statistically significant at the 1% level. This indicates that economic growth contributes to the improvement of commercial bank performance.

Table 5. The return of interest rate marketization on bank performance.

Variable	(1)	(2)
IRL	-1.522*** (-20.02)	-1.228*** (-7.651)
ER		-2.445*** (7.452)
CIR		1.335*** (10.012)
LnGDP		1.111*** (9.115)
LnSIZE		-0.512*** (-9.022)
Constant	1.055*** (17.49)	-2.552** (-2.552)
R-squared	0.338	0.512
Observed value	225	225

3.3.2. Testing the Impact of Interest Rate Liberalization on Diversified Banking Operations

To test Hypothesis 2, which posits that interest rate liberalization has a positive impact on bank diversification, this paper conducted an empirical analysis based on Model 2. Table 6 presents the regression results of interest rate liberalization on bank diversification. As shown in the table, the explanatory variable, the interest rate liberalization index, is significant at the 5% level, with a coefficient of 0.221. This indicates that interest rate liberalization does indeed have an impact on bank diversification, thereby validating Hypothesis 2. The significant control variables in the regression are the cost-to-income ratio (CIR) and asset size (LnSIZE). The cost-to-income ratio is significant at the 5% level, indicating that banks with higher management efficiency are more likely to adopt a diversified strategy. The positive coefficient of asset size (LnSIZE) also indicates that banks with stronger asset size (LnSIZE) capabilities are more likely to adopt a diversified business strategy. From the analysis of the entire sample, it can be observed that the degree of bank diversification is primarily influenced by two factors: first, the progress of interest rate liberalization reforms from external sources; the higher the degree of interest rate liberalization, the more banks tend to deepen their diversification strategies. Second, management levels from internal sources; banks with higher management levels are more inclined to deepen their diversification strategies.

Table 6. The return of interest rate liberalization to the diversified operations of Banks.

Variable	(1)
IRL	0.221** (2.57)
ER	0.089 (1.22)
CIR	-0.972** (-2.44)
LnGDP	0.158 (0.41)
LnSIZE	0.421** (2.28)
Constant	-0.198 (-0.211)
R-squared	0.538
Observed value	225

3.3.3. Testing the moderating effect of diversification

To test Hypothesis 3, which posits that diversification mitigates the negative impact of interest rate liberalization on commercial bank performance, this study conducted an empirical analysis based on Model 3. Table 7 presents the regression results for the moderating effect of diversification.

Without control variables (Column 1), the regression coefficient for the interest rate liberalization index (*IRL*) is -1.185, which is statistically significant at the 1% level. The regression coefficient for the

interaction term (*IRL*HHI*) is 0.985, which is also statistically significant at the 1% level. After including control variables (Column 2), the regression coefficient for the interest rate liberalization index (*IRL*) is -1.157, which is statistically significant at the 1% level, and the regression coefficient for the interaction term (*IRL*HHI*) is 0.681, which is statistically significant at the 5% level. The regression coefficients for the interaction term (*IRL*HHI*) are all negative and statistically significant. This indicates that increased diversification reduces the negative impact of interest rate liberalization on commercial bank performance, confirming Hypothesis 3.

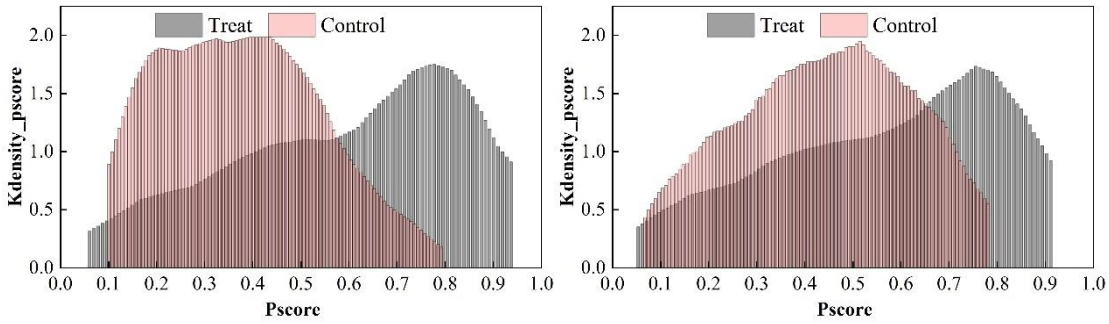
Table 7. The return of the diversified management.

Variable	(1)	(2)
IRL	-1.185*** (-8.846)	-1.157*** (-5.861)
HHI	0.332*** (-3.781)	0.005** (-2.115)
IRL HHI*	0.985*** (-3.885)	0.681** (-2.338)
ER		-1.121** (-3.085)
CIR		1.285*** (7.741)
LnGDP		1.011*** (9.288)
LnSIZE		-0.448*** (-8.784)
Constant	0.925*** (9.115)	-2.595** (-2.345)
R-squared	0.387	0.471
Observed value	225	225

3.3.4. Endogenous testing of interest rate liberalization on bank performance

The performance of commercial banks is influenced by interest rate liberalization, and banks with higher returns and stronger risk management capabilities also have greater capacity to improve interest rate liberalization. To test for potential endogeneity issues, this paper employs the PSM propensity score matching method to validate the selected sample. The propensity scores before and after matching are shown in Figure 1, with (a) and (b) representing the pre- and post-matching scores, respectively.

The matching results in Figure 1 indicate that the re-screened matched samples show significantly improved consistency in terms of control variables, making them more valuable for reference. After matching, the new sample size is 185. The empirical regression results of Model (7) and Model (8) after sample matching are shown in Table 8. After comprehensively comparing the test results of various variables, it can be seen that after propensity matching of the samples, the positive or negative direction and significance of the main variables' impact on performance indicators in Models 1 and 2 are generally consistent. Therefore, the endogeneity issue of the selected samples is not significant and will not have a major impact on the empirical results.



(a) Pre-match (b) Post-match

Figure 1. PSM tends to match scores.

Table 8. The regression results of the trend matching model.

Variable	M2	Variable	M3
IRL	0.038 (1.554)	*IRL*	0.031 (1.38)
HHI	0.2114*** (5.124)	*HHI*	0.211*** (4.44)
		IRL HHI*	-0.0001 (00.38)
ER	-0.0111*** (-4.38)	*ER*	-0.0111*** (-4.255)
CIR	-0.0079*** (-2.11)	*CIR*	-0.0085*** (-2.85)
LnGDP	0.0016 (1.77)	*LnGDP*	0.088 (1.16)
LnSIZE	-0.002** (-1.18)	*LnSIZE*	0.0011 (1.78)
Constant	0.0255*** (2.11)	*Constant*	0.0235*** (2.111)
Observed value	185	*Observed value*	185

3.4. Further analysis

3.4.1. Heterogeneity analysis

Building on the previous analysis of the full sample, we continue to conduct heterogeneity analysis on different types of banks. Table 9 presents the results of the grouped regression under the fixed-effects model. The results show that: (1) After controlling for other factors affecting the operational stability of commercial banks, the impact of interest rate liberalization on the performance of listed banks is not significant for large state-owned banks and joint-stock banks. (2) The regression coefficient for business interest rate liberalization in city commercial banks is -15.221, which is significantly negative at the 1% level. This indicates that interest rate liberalization reforms in city commercial banks are beneficial for improving their operational performance, and that each unit increase in the interest rate liberalization index leads to a 15.221-unit improvement in stability levels. The results of the grouped regression analysis indicate that interest rate liberalization has significantly different impacts on the operational performance of different types of banks.

Table 9. Results of grouping regression.

Variable	Large state-owned Banks	Joint-stock bank	City commercial bank
IRL	1.6112 (0.35)	-7.2252 (-0.89)	-15.221*** (-3.81)
ER	2.033** (3.32)	-0.1414 (-0.18)	-2.115*** (-4.85)
CIR	2.12 (3.34)	-3.228** (-3.35)	-2.411** (-2.85)
LnGDP	2.251 (0.95)	1.983 (0.81)	2.012** (1.15)
LnSIZE	7.7581 (1.15)	-3.589 (-0.51)	-4.685** (6.29)
Constant	-264.333** (-2.85)	91.225 (1.48)	288.872** (6.56)
R-squared	0.9558	0.9015	0.8787
Obs	40	70	115

3.4.2. Robustness test

We use risk-adjusted return on assets R_{ROA} as a substitute indicator to measure the level of bank stability. R_{ROA} is an indicator of a bank's risk-adjusted profitability. The significance of R_{ROA} lies in combining a bank's profitability with risk, i.e., the profit generated per unit of risk, making comparisons of profitability more objective and fair. Therefore, it effectively represents the essence of stability, i.e.,

stability and health, safety and profitability, making it a suitable alternative indicator. That is:

$$R_{ROA} = \frac{ROA}{\sigma} \quad (9)$$

Where ROA is return on assets, and σ represents the standard deviation of ROA. The smaller R_{ROA} is, the lower the level of stability. Using R_{ROA} as the dependent variable, the results of the stability regression are shown in Table 10. The regression results indicate that, after controlling for other factors affecting commercial bank performance, the regression coefficient for interest rate liberalization is 2.115, which is significantly positive at the 1% level. This suggests that interest rate liberalization enhances the performance of listed commercial banks, consistent with the prior hypothesis. This significance level is higher than that of the main regression in this empirical study, possibly because the construction of this variable is less detailed compared to the previously mentioned operational stability index, using only ROA and the standard deviation of ROA to consider profitability and risk, without considering liquidity or the bank's capital adequacy. In terms of the completeness of the stability construction, it is inferior to the main regression.

Table 10. Regression results of alternative indicators.

Variable	R_{ROA}
IRL	2.115*** (4.471)
ER	-0.001 (0.000)
CIR	0.681*** (5.225)
LnGDP	0.225 (0.285)
LnSIZE	0.198 (0.851)
Constant	2.751 (0.552)
R-squared	0.9882
Observed value	225

4. Conclusion

This study uses parallel panel data from Chinese listed banks from 2015 to 2021 as its sample and further categorizes the sample to examine the extent to which different types of commercial banks are affected by interest rate liberalization in terms of their diversified operations, as well as the relationship between the operational performance of different types of banks and the implementation of diversified operations. The study conducts empirical regression analysis using logarithms of total assets, cost-to-income ratios, equity ratios, and regional GDP as control variables, and draws the following conclusions.

First, the regression coefficient between the interest rate liberalization index (IRL) and the performance of Chinese listed commercial banks (ROA) is -1.228, which is statistically significant at the 1% level, indicating that interest rate liberalization has reduced the performance of Chinese listed commercial banks. Second, the interest rate liberalization index is significantly correlated with diversified operations at the 5% level, with a coefficient of 0.221. This suggests that interest rate liberalization does indeed have an impact on banks' diversified operations. Third, diversified operations mitigate the negative impact of interest rate liberalization on commercial bank performance.

Additionally, through heterogeneity analysis, it was found that urban commercial banks engaging in diversified operations can significantly improve their operational performance. However, the impact of interest rate liberalization on the operational performance levels of large state-owned banks and joint-stock banks is not significant. Furthermore, the analysis only considered profitability and risk, without accounting for liquidity or capital adequacy, resulting in a less comprehensive assessment of stability compared to the main regression.

In summary, listed commercial banks should avoid blindly expanding their scale during their development phase and should place high importance on enhancing competitiveness, particularly core competitiveness and marginal efficiency.

References

1. Samal, J. (2019). Effective factors influencing performance management system in commercial bank: an exploratory analysis. International Journal of Management Studies, 5(1), 12-22.
2. Mulwa, M. N., & Weru, J. M. (2017). The influence of performance management system on employee performance in commercial banks in Kitui Town, Kitui County, Kenya. International Journal of Humanities and Social Science, 7(6), 44-55.
3. Kuhil, A. M. (2019). Employee performance management system practices and challenges: A case of commercial bank of Ethiopia. Indian Journal of Commerce and Management Studies, 10(1), 23-33.
4. Ekong, U. M., & Udonwa, U. E. (2015). Banking sector reforms and the performance of commercial banks in Nigeria. Journal of World Economic Research, 4(3), 45-60.
5. Bandaranayake, S., & Jayasinghe, P. (2014). Factors influencing the efficiency of commercial banks in Sri Lanka. Sri Lankan journal of management, 18(1).
6. San, O. T., & Heng, T. B. (2013). Factors affecting the profitability of Malaysian commercial banks. African Journal of Business Management, 7(8), 649-660.
7. Sarkar, S., & Rakshit, D. (2023). Factors influencing the performance of commercial banks: A dynamic panel study on India. FIIB Business Review, 12(1), 85-99.
8. Shukla, A. N., Tewari, S. K., & Dubey, P. P. (2013). Factors Affecting Profitability of Commercial Banks: A Rural Perspective §. Agricultural Economics Research Review, 26(2), 275-280.
9. Obonyo, E. S., & Kerongo, F. (2015). Factors affecting strategic change management and the performance of commercial banks in Kenya: A case study of Kenya commercial bank in Nairobi region. European journal of business and management, 7(15), 109-117.
10. Huynh, B. A., Vo, N. H., & Pham, C. H. (2016). Factors affecting the performances of internet banking: a case of vietnam commercial banks. International Journal of Financial Research, 7(3), 13-27.
11. Mushtaq, M., Hassan, N. U., Yaqub, M. S., & Awan, M. M. H. (2014). Determinants of commercial banks performance: Empirical evidence from Pakistan. Journal of applied environmental and biological sciences, 4(7), 15-21.
12. Teshome, E., Debela, K., & Sultan, M. (2018). Determinant of financial performance of commercial banks in Ethiopia: Special emphasis on private commercial banks. African Journal of Business Management, 12(1), 1-10.
13. LE, D. K., TRAN, T. M. N., & NGUYEN, V. D. (2022). Factors Affecting the Performance of Vietnamese Commercial Banks: Does Basel II Matter?. The Journal of Asian Finance, Economics and Business, 9(3), 43-51.
14. Tuo, M. (2016). An empirical analysis of Chinese commercial banks' efficiency and influencing factors—under the constraint of non-performing loans. American journal of industrial and business management, 6(04), 455.
15. Kristianti, R. A. (2016). Factors affecting bank performance: Cases of top 10 biggest government and private banks in Indonesia in 2004-2013. Review of Integrative Business and Economics Research, 5(4), 371
16. Wang, Y., Xiuping, S., & Zhang, Q. (2021). Can fintech improve the efficiency of commercial banks?—An analysis based on big data. Research in international business and finance, 55, 101338.
17. Nsambu Kijjambu, F. (2014). Factors affecting performance of commercial banks in Uganda a case for domestic commercial banks. International Business Research Conference.
18. Oira, J. K., & Kibati, P. (2016). Influence of innovation on the performance of commercial banks in Nakuru central business district. Journal of Business and Management, 18(10), 102-113.
19. Gizaw, M., Kebede, M., & Selvaraj, S. (2015). The impact of credit risk on profitability performance of commercial banks in Ethiopia. African journal of business management, 9(2), 59.
20. Kolapo, T. F., Ayeni, R. K., & Oke, M. O. (2012). CREDIT RISK AND COMMERCIAL BANKS'PERFORMANCE IN NIGERIA: A PANEL MODEL APPROACH. Australian journal of business and management research, 2(2), 31.
21. Dong, J., Yin, L., Liu, X., Hu, M., Li, X., & Liu, L. (2020). Impact of internet finance on the performance of commercial banks in China. International review of financial analysis, 72, 101579.
22. Kiplangat, K. D., & Tibbs, C. (2018). Financial innovations and financial performance of commercial Banks. International Journal of Innovative Research & Development, 7(5), 36-41.
23. Ahmed, O. N., & Wamugo, L. (2018). Financial innovation and the performance of commercial banks in Kenya. Int. J. Curr. Aspect. Finance (IJCAF), 4(2), 133-147.
24. Akbari, M. I., Yusoff, S. K. B. M., & Azam, F. (2025). Factors Affecting the Performance of Commercial Banks in Indonesia. Devotion: Journal of Research and Community Service, 6(3), 315-325.
25. Dembel, B. (2020). Factors affecting the performance of commercial banks (A case study on commercial banks in Ethiopia): CAMEL ratings. Research Journal of Finance and Accounting, 11(5), 1-11.
26. Abate, T. W., & Mesfin, E. A. (2019). Factors affecting profitability of commercial banks in Ethiopia. International Journal of Research and Analytical Reviews, 6(1), 881-891.
27. Fibriyanti, Y. V., & Nurcholidah, L. (2021, September). Analysis of factors that affect the financial performance of banks. In The 3rd Green Development International Conference (GDIC 2020) (pp. 511-517). Atlantis Press.
28. Shrestha, P. M. (2023). Examining the factors affecting the profitability of commercial banks. Journal of Mathematics Instruction, Social Research and Opinion, 2(2), 105-114.
29. Ulashovich, B. Z., & Ilhomovich, S. E. (2022). Performance of commercial banks in Uzbekistan: Affecting factors. Asian Journal of Research in Banking and Finance, 12(5), 12-19.

30. Dong, Y., Firth, M., Hou, W., & Yang, W. (2016). Evaluating the performance of Chinese commercial banks: A comparative analysis of different types of banks. European Journal of Operational Research, 252(1), 280-295.
31. Isa-Olatinwo, A., Uwaleke, U., & Ibrahim, U. A. (2022). Impact of digital financial services on financial performance of commercial banks in Nigeria. International Journal of Economics and Management Systems, 7, 300-307.
32. Lian, Y., Gao, J., & Ye, T. (2022). How does green credit affect the financial performance of commercial banks?——evidence from China. Journal of Cleaner Production, 344, 131069.
33. Mueni, M. M., & Atheru, G. (2019). Electronic banking and financial performance of commercial banks in Kenya. International Journal of Current Aspects, 3(II), 293-304.
34. Manini, M. M., & Abdillahi, U. A. (2015). Corporate governance mechanisms and financial performance of commercial banks in Kenya. IOSR Journal of Business and Management, 17(3), 25-40.
35. Robin, I., Salim, R., & Bloch, H. (2018). Financial performance of commercial banks in the post-reform era: Further evidence from Bangladesh. Economic Analysis and Policy, 58, 43-54.
36. Gopal K. Basak & Samarjit Das. (2017). Intercept Homogeneity Test for Fixed Effect Models under Cross-sectional Dependence: Some Insights. Journal of Econometric Methods,6(1),20150004-20150004.