Empirical Analysis of the Influence of Interest Income on the Operational Efficiency of Commercial Banks

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Abstract. With China's interest rate liberalisation reform, the interest margin between deposits and loans in the banking industry has narrowed significantly. In order to maintain market competitiveness, more and more commercial banks are starting to reduce their dependence on traditional interest income business. However, there has been no research on whether Interest income is no longer important to the business performance of commercial banks and whether the impact of interest income on the business performance of commercial banks has changed. Therefore, this paper collects data on Interest Income Ratio, Asset-liability Ratio, Non-performing Loan Ratio, Total Asset Turnover and Per Capita Profit of 42 listed banks from 2010 to 2020 from WIND and CSMAR databases (some missing data are supplemented by bank statements, and variables are also reduced at 5% level to ensure data validity). Construct a fixed effects regression model. In addition, two stage least square method is used to test the endogeneity of the model. The robustness of the model is tested by changing the sample observations, performing Winsor analysis and processing on interest income, and replacing interest income with non-interest income/total assets. Finally, the following conclusions are drawn: (1) interest income has a negative inhibitory effect on efficiency; (2) the effect of interest income on efficiency is significantly heterogeneous.

Keywords: Efficiency of Bank Operation, Interest Income, Commercial Bank

1 Introduction

In this paper, a fixed-effect regression model is constructed through collecting data such as interest income percentage, asset-liability ratio, non-performing loan ratio, total asset turnover ratio and per capita profit of 42 listed banks from 2010 to 2020 in wind and csmar databases (some missing data are supplemented by bank statements, and variables are also reduced by 5% level to ensure data validity).In addition, two stage least square method is used to test the endogeneity of the model. To test the robustness of the model, the observed value of the sample was changed, interest income was used for winsor analysis and treatment, and interest income was replaced with non-interest income/total assets.In the final part of the paper, we present the empirical results of the research and put forward some feasible suggestions.

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2 Background and Literature Review

Interest income has always occupied an absolutely dominant position in the operating income of China's banking industry, accounting for 60-80%. By the first half of 2021, net interest income will still be the main source of banks' income, accounting for more than 50% of banks' net interest income. However, at the same time, with the progress and gradual improvement of China's interest rate liberalisation reform and the intensification of financial disintermediation, the deposit and lending interest margins of the banking industry have narrowed significantly, affecting and challenging the profitability and market position of commercial banks, which cannot be ignored. Simultaneously, the upgrading trend of the demand side of the financial industry is remarkable, and the financial demands of Chinese residents are no longer limited to the previous basic banking business, and the willingness to maintain and increase the value of assets is more and more intense.In this context, in order to remain competitive in the market, more and more commercial banks are beginning to reduce their dependence on the traditional interest-earning business and are gradually paying attention to the innovation and expansion of non-interest businesses. In addition, there are more and more studies on the relationship between non-interest income and the business performance of commercial banks. So is interest income really no longer important for the performance of commercial banks? Has the impact of interest income on the performance of commercial banks changed? No research has yet been conducted to explain this. Therefore, studying the above issues can provide important reference for bank management practice. Based on that, this paper combines multidimensional panel fixed-effect estimation to specifically examine the impact of interest income on the operating performance of 42 listed commercial banks from 2010 to 2020.

In terms of the relevant research on the factors influencing the performance of commercial banks, the main views are as follows:

One. Reducing banks' dependence on traditional interest rate spread business and diversifying banks' income is conducive to improving banks' operational performance.

First of all, early Chinese scholars compared the indicators of state-owned commercial banks and large commercial banks in the United States, and advocated that state-owned commercial banks should adopt a certain degree of mixed operation mode [1]; some Chinese scholars take small and medium-sized commercial banks as the main research object, and believe that the economy of scope does not exist only in state-owned commercial banks. Small and medium-sized commercial banks can also improve their business performance through diversification, but the purpose of diversification of small and medium-sized banks is often to attract accounts through low-cost intermediary business[2]. Some scholars conduct a comparative study of state-owned commercial banks and small and medium-sized commercial banks, and introduce the entropy index to measure income diversification, which indicates that the diversification of Chinese commercial banks can only have a limited positive effect on operating performance[3].Some Western scholars further expand the research sample and take global banks as research objects. They believe that increasing the proportion of non-interest income can improve bank performance, but it will expose commercial banks to greater risks[4].

Two. The specific impact of banks' income diversification on business performance is conditional

With the deepening of research in this field, the frequency of the research method of blindly expanding the sample size while ignoring the internal differences of the samples is gradually decreasing. It has become the mainstream research direction to include state-owned commercial banks and small and medium-sized commercial banks in the research samples and analyse them under different conditions. Most scholars study the impact of income diversification on business performance from the perspective of bank asset size and bank type. Li Zhihui and Li Mengyu (2014)[5] select 50 Chinese commercial banks as samples, and study the impact of diversification on the business performance of the sample banks from 2005 to 2012 through the basic fixed-effect model and threshold regression model, and prove the "inverted U-shaped" relationship between the two banks. In addition, commercial banks with larger asset size, the better the effect of diversification strategy; Man Yuanyuan (2016)[6] conducted an empirical study based on the relevant data of 39 Chinese commercial banks from 2007 to 2014, and the results showed that the implementation of diversification strategy of state-owned commercial banks has a significant positive impact on business performance[7], but the diversification strategy of joint-stock banks and city commercial banks has a significant positive impact on business performance[8]. However, the diversification strategy of joint-stock banks and city commercial banks has no significant impact on business performance[9].

3 Data and Measurement:

According to the above literature review and theoretical analysis, this paper uses the efficiency of commercial banks as an interpreted variable, which describes the meaning of Interest Income Percentage, Asset Liability Ratio, Non-performing Loan Ratio, Total Asset Turnover Rate and Per Capita Profit as explanatory variables. All the variables are listed in table 1.

Table 1. Table of variables

Variable Name	Variable Type	Variable Symbol	Variable Meaning
Operating Efficiency of Commercial Banks	Explained Variable	EFFI	Solow Residual Method
Interest Income Percentage	Core explanatory variable	INT	Interest Income/Total Income
Asset Liability Ratio	Control Variable	ZF	Total Liabilities/Total Assets
Non-performing Loan Ratio		BL	Non-performing Loans/Total Assets
Total Asset Turnover Rate		ZZ	Total Revenue/Total Assets
Per Capita Profit		PR	Profit/Number of Employees

Variable source: In this paper the variables are designed after analyzing the logic and internal mechanism where interest income influences operational efficiency of commercial banks.

According to the research objective, this paper tries to select detailed and accurate data, including 42 listed banks from 2010 to 2020. The data come from the Wind and CSMAR databases, and some of the missing data are supplemented by bank statements. To ensure the validity of the data, the variable is also reduced by 5%.

4 Empirical Results

4.1 Establishment of Empirical Model

Based on the consideration of the global regression model, this paper also considers the difference and influence of the individual effect and the year effect of the sample bank, so the fixed effect regression model is adopted in this paper. The specific form of the model is as follows:

$$EFFI_{it} = \beta_0 + \beta_1 INT_{it} + \sum_j v_j controls_{ijt} + m_i + \lambda_t + \mu_{it} \quad (1)$$

Where β_0 represents intercept, β_1 represents the coefficient of Interest Income Ratio, controls is the Control Variable, including Asset-Liability Ratio (ZF), Non-performing Loan Ratio (BL), Total Asset Turnover Ratio (ZZ), Per Capita Profit (PR), m_i represents individual effect, λ_t represents time effect, and μ_{it} represents random interference.

In the analysis of the statistical description of the variables, the analytical tool used in this chapter is stata. The statistical processing makes it possible to obtain descriptive statistics of the indicators of 350 companies during the period 2010 to 2020. The specific descriptive statistical results are presented in Table 2.

Table 2. Statistical description of empirical analysis of the impact of interest income on the operational efficiency of commercial banks

Statistical Magnitude	Observed Number	Mean Value	Standard Deviation	Minimum Value	Maximum Value
EFFI	370	0.0557	0.0589	-0.0690	0.15307
INT	459	0.0371	0.0066	0.0258	0.0506
ZF	461	0.9312	0.0117	0.9111	0.9518
BL	454	1.2476	0.4325	0.53	2.15
ZZ	462	0.0291	0.0056	0.01	0.05
PR	412	0.0727	0.0284	0.0209	0.2381

From Table 2, the commercial operating efficiency of 42 listed banks between 2010 and 2020 has an average value of 0.0557168, a maximum value of 0.153097, a minimum value of -0.0690 and a standard deviation of 0.0589298. The mean of the interest income ratio is 0.0371674, the maximum is 0.0506, the minimum is 0.0258 and the standard deviation is 0.0066. The mean value of the asset-liability ratio is 0.9312, the maximum and minimum values are 0.9518 and 0.9111 respectively, and the standard

deviation is 0.0117. The mean value of non-performing loan ratio is 1.2476, the maximum value is 2.15, the minimum value is 0.53 and the standard deviation is 0.4325898. The mean value of total asset turnover is 0.0291, the maximum and minimum values are 0.05 and 0.01 respectively, and the standard deviation is 0.0056. The mean of per capita profit is 0.0727, the maximum and minimum are 0.2381 and 0.0209 respectively, and the standard deviation is 0.0284.

The descriptive statistical results of the above indicators can roughly show that there are small differences in the commercial operation efficiency of the sample banks, and there are also significant differences in the performance of Interest Income Ratio, Asset-Liability Ratio, Non-performing Loan Ratio, Total Asset Turnover Ratio and Per Capita Profit. There may be inevitable internal relations among these significant differences, so it is necessary to conduct in-depth empirical analysis on them.

4.2 Basic Regression Model

Based on the construction of the regression model, the empirical regression is carried out in this paper. The specific steps of empirical model regression and detection are as follows: first, the mixed cross-section model or individual fixed effect model is selected based on the likelihood ratio detection panel data[10]. The initial assumption is that if the panel data has no significant difference between time and section individuals, the mixed cross-section model should be established. If the Prob values of both F and LR statistics are greater than 0.1, the null hypothesis cannot be rejected, otherwise the mixed cross-section model is not applicable. Second, the Hausman test was used to determine whether the panel data should be set up as an individual fixed effects model or an individual random effects model[11]. The initial hypothesis of the test was that if the intercept term of the individual effect is unrelated to the explanatory variable, the random effect model should be fitted. If the Prob value is less than 0.05, the individual fixed effect model should be fitted, otherwise the individual random effect model should be fitted[12].

Firstly, the regression of the mixed cross-sectional model was carried out, and the specific results are shown in the coefficient of the mixed cross-sectional model in Table 3. The Adj.$R^2$of the mixed cross-sectional model was 0.9975, and the degree of fit met the requirements. On the basis of the mixed cross-sectional regression, the regression of the individual fixed effect variable intercept model and the individual random effect variable intercept model were also carried out in this paper. The regression results are shown in Table 3.

Table 3. Regression Results

EFFI	Model 1	Model 2	Model 3	Model 4	Model 5 (Baseline model)
INT	-2.108*** (0.6890)	-1.446* (0.7425)	-1.4711** （0.7420）	-1.331* (0.7678)	-0.2035*** (0.7428)
ZF		-0.9400** (0.4085)	-0.9012* （0.4636）	-0.8962* (0.4640)	-0.1372 (0.4622)
BL			0.0030	-0.0011	0.1004

			（0.0104）	(0.0106)	(0.0103)
ZZ				-0.5754 (0.8023)	-0.4077 (0.7659)
PR					1.090*** (0.1911)
C	0.1361*** (0.0264)	0.9853*** (0.3700)	0.9505** （0.4287）	0.9598** (0.4292)	0.1790 (0.4316)
Adj.R^2	0.1237	0.1351	0.1297	0.1284	0.2068
F-statistic	9.36	7.39	4.81	3.73	9.79
Prob(F-stat)	0.0024	0.0007	0.0027	0.0055	0.0000
N	370	370	365	365	365
Bank control	Y	Y	Y	Y	Y
Year control	Y	Y	Y	Y	Y

Note: Standard errors in parentheses, *, ** and * indicate significance at the 10%, 5% and 1% levels respectively.**

Firstly, the share of Interest Income has a negative impact on efficiency, which suggests that relying on traditional interest business (deposits and loans) is not conducive to improving the Operating Efficiency of Commercial Banks.

Secondly, bank profit Per Capita has a positive impact on bank Operating Efficiency. It shows that the pressure of bank profit and the decomposition of indicators are conducive to play and mobilise the work enthusiasm of employees, so as to stimulate the work motivation and improve the Efficiency of Bank Operation.

Thirdly, the Asset-Liability Ratio, Non-performing Loan Ratio and Asset Turnover do not have a significant impact on the Operational Efficiency of Banks. This means that banks should focus on improving profits and adjusting business structure, and relax the study of traditional indicators.

4.3 Heterogeneity analysis

Heterogeneity refers to whether the explanatory effects of the explanatory variables on the explained variables in the sub-samples show different rules from those in the full samples[13], and whether the explanatory effects of the explanatory variables on the explained variables have changed significantly in each sub-sample[14]. In general, when analysing heterogeneity, all samples can be classified according to the characteristics of the samples in order to analyse and examine whether the explanatory effects of the explanatory variables on the explained variables have changed significantly in each sub-sample[15].

One: Heterogeneity analysis is conducted according to the percentage of interest income

According to the attributes of Interest Income Percentage, banks are divided into low Interest Income Percentage banks and high Interest Income Percentage banks, and individual fixed effect regression is carried out on them. Specific results are shown in Table 4.

Two: Heterogeneity analysis is conducted according to the size of banks

According to the attribute of interest income percentage, banks are divided into small banks and large banks, and individual fixed effect regression is carried out on them. The specific results are shown in Table 4.

Table 4. Heterogeneity Regression

EFFI	Model 6 (Small interest income percentage)	Model 7 (High interest income percentage)	Model 8 (Small bank)	Model 9 (Big Bank)
INT	-3.84*** （1.479）	-1.7849 (1.5716)	-1.799** (0.5860)	0.0073 (0.0150)
ZF	-0.3761 (0.56887)	-0.5822 (0.9522)	0.5860 (0.6431)	-0.9337 (0.7372)
BL	0.0047 (0.0117)	-0.0151 (0.0249)	0.0073 (0.0150)	0.0080 (0.0158)
ZZ	-0.3017 (0.9325)	0.2897 (1.6712)	-0.2264 (0.9958)	-0.0913 (1.288)
PR	0.6984** (0.3408)	1.235*** (0.2996)	1.09*** (0.2361)	1.1803** (0.5767)
C	0.4937316 （0.5388）	0.5786 (0.8997)	-0.4967 (0.5987)	0.0912 (0.7044)
Adj.R^2	0.2212	0.2133	0.1847	0.2228
F-statistic	4.28	4.19	4.89	6.67
Prob(F-stat)	0.0010	0.0017	0.0003	0.0000
N	234	128	241	123
Bank control	Y	Y	Y	Y
Year control	Y	Y	Y	Y

As can be seen from the regression results in Table 4, there are certain differences in the impact of the percentage of bank interest income (INT) on the operating efficiency (EFFI) of commercial banks, reflecting the different rules of banks using interest income as a funding method on operating efficiency.

In terms of the percentage of bank interest income (INT), the different percentage of bank interest income has a significant impact on the operational efficiency of banks with smaller assets, but not on the operational efficiency of banks with larger assets, indicating that the operational efficiency of small banks is more dependent on interest income than that of large banks. This is because small banks are younger and smaller and rely more on higher deposit rates to attract deposits.

4.4 Robustness analysis

Model robustness means that the influence of the core explanatory variable of the model on the explained variable has a relatively stable trend and does not change significantly with fluctuations in the environment[16]. There are many ways to test the robustness

of the model, such as selecting the variables similar to the core explanatory variable for regression and then seeing whether the core explanatory variable has a significant effect on the explained variable. If the core explanatory variable has little change in the coefficient or influence of the explained variable, then the model can be considered robust. Another method is to increase or decrease the number of samples to see if the core explanatory variable has a significant effect on the explained variable. If the core explanatory variable has little change in the coefficient or influence of the explained variable, then the model can be considered robust. In this paper, the method of reducing the number of samples is chosen, the regression processing is carried out and the assessment of whether the model is robust is made.

(1) **Reducing the number of samples in chronological order**: the number of 42 listed banks remains unchanged, but the sampling period has been reduced from 11 years of data from 2010 to 2020 to 9 years of data from 2012 to 2020. Using this method, robust regression results can be obtained, as shown in Table 5.

(2) **Performing Winsor analysis and processing on Interest Income**: 11 years of data from 2010 to 2020 were selected to remain unchanged during the sampling period, and Winsor analysis and processing were performed on interest income. This method produces robust regression results, as shown in Table 5.

(3) Replacement of interest income by non-interest income/total assets: The number of 42 listed banks remained unchanged and the data of 11 years from 2010 to 2020 remained unchanged. The core explanatory variables were changed and interest income was replaced by non-interest income/total assets. This method produces robust regression results, as shown in Table 5.

Table 5. Robust Regression

EFFI	Benchmark model	Robustness Analysis 1	Robustness Analysis 2	Robustness Analysis 3
INT	-0.2035*** (0.7428)	-1.7849 (1.5716)	-1.799** (0.5860)	0.0073 (0.0150)
ZF	-0.1372 (0.4622)	-0.5822 (0.9522)	0.5860 (0.6431)	-0.9337 (0.7372)
BL	0.1004 (0.0103)	-0.0151 (0.0249)	0.0073 (0.0150)	0.0080 (0.0158)
ZZ	-0.4077 (0.7659)	0.2897 (1.6712)	-0.2264 (0.9958)	-0.0913 (1.2886)
PR	1.090*** (0.1911)	1.235*** (0.2996)	1.09*** (0.2361)	1.1803** (0.5767)
C	0.1790 (0.4316)	0.5786 (0.8997)	-0.4967 (0.5987)	0.0912 (0.7044)
Adj.R^2	0.2068	0.2133	0.1847	0.2228
F-statistic	9.79	4.19	4.89	6.67
Prob(F-stat)	0.0000	0.0017	0.0003	0.0000
N	365	128	241	123
Bank control	Y	Y	Y	Y
Year control	Y	Y	Y	Y

4.5 Endogeneity analysis

According to the economic relationship between the model regression results and the paper variables, the core explanatory variable, interest income INT, has a certain explanatory role in the business performance EFFI of commercial banks, but on the contrary, random confounding variables will also have an impact on interest income INT. Therefore, theoretically, this model may have an endogeneity problem, and interest income INT and commercial banks' operating performance EFFI may be mutually causal. In order to solve the endogeneity problem, this paper adopts two-stage least square method . In the first stage, the first-order lag of the core explanatory variable, interest income percentage INT, is used to construct an instrumental variable, the new interest income percentage, together with other control variables.In the second stage, the operating performance EFFI of commercial banks is regressed using the newly constructed interest income percentage.

According to two-stage least square regression, the findings can be attained that the influence coefficient of the core explanatory variable on the operating performance, the interest income ratio on the operating performance EFFI of commercial banks, is -3.6358 after processing the instrumental variable, while the influence coefficient of the interest income ratio on the operating performance EFFI of commercial banks is -2.035 when the endogenous problem is not processed. Therefore, it can be seen that after dealing with the endogeneity problem, the influence of percentage of interest income INT on the operating performance EFFI of commercial banks does not change significantly. Therefore, it can be considered that the endogeneity of this model is not serious. Therefore, this model can be used to analyse the effect of interest income percentage INT on the operating performance EFFI of commercial banks.

5 Findings

In recent years, China's financial policy reform has been strengthened, the interest rate liberalization reform has been promoted, and the degree of financial liberalization has been deepened, which has led to the continuous reduction of the deposit and loan benchmark spread, which has a significant impact on the net interest margin of commercial banks. Based on the data analysis of 42 listed banks in China from 2010 to 2020, this paper draws the following conclusions: Interest income has a negative inhibitory effect on efficiency. Besides, interest income has significant heterogeneity on efficiency.

6 Conclusions

In this paper we examine the empirical influence of interest income on efficiency for commercial banks with a sample of interest income percentage, asset-liability ratio, non-performing loan ratio, total asset turnover ratio and per capita profit of 42 listed banks from 2010 to 2020 . The paper demonstrates that interest income would exert a negative influence on operating efficiency of commercial banks,especially for the banks with smaller assets and small interest income percentage.

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