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Research on the Impact of Digital Financial Inclusion on the Operating Efficiency of Rural Commercial Banks

——Empirical Evidence from 67 Rural Commercial Banks in China

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Abstract: Based on panel data from 2016 to 2021 for 67 rural commercial banks in China, a three-stage DEA model is constructed to measure the operational efficiency of these banks. The digital financial inclusion index at the county level is integrated to explore the impact of digital financial inclusion on the operational efficiency of rural commercial banks. The findings indicate a significant effect of digital financial inclusion on the operational efficiency of these banks.

Keywords: Digital Financial Inclusion; Rural Commercial Banks; Operational Efficiency

Introductory

Digital financial inclusion refers to the use of digital technology to promote financial inclusion, with a focus on the alleviation of the financial service gaps of groups traditionally underserved by traditional financial institutions or service modes with the help of digital means to improve their financial accessibility. Given the relatively low efficiency of financial services in rural areas and the failure of traditional finance to fully cover them, rural commercial banks, as a major component of financial institutions in rural areas, must bear the responsibility of promoting financial equity and development in rural areas through digital technology amid the wave of digital financial inclusion. Therefore, it is of practical significance to study the impact of digital inclusive finance on the operational efficiency of rural commercial banks, which will facilitate China's rural revitalization strategy and the high-quality development of the rural economy. Based on panel data from 67 rural commercial banks across China from 2016 to 2021, this paper explores the impact of digital inclusive finance on the operational efficiency of rural commercial banks.

Literature review

Domestic literature related to this paper mainly focuses on two levels: the operational efficiency of commercial banks and the impact of digital finance on these banks. Regarding the research on operational efficiency, scholars commonly use the DEA modeling method. For instance, Yang Wang et al. (2020) combined the DEA model with the Malmquist index to measure the dynamic efficiency of commercial banks across varying time periods with changing circumstances;[1]56 Duan et al. (2019) used a two-stage DEA model to measure service quality efficiency and profitability efficiency; [2] To avoid the influence of environmental factors and random errors of the two-stage DEA model on efficiency values, Huang Xian et al. (2008) applied a three-stage DEA model to measure the X efficiency of 13 commercial banks in China. [3] Regarding the impact of digital finance on the operational efficiency of commercial banks, scholars present two divergent views. One perspective posits that the development of digital finance promotes the operational efficiency of commercial banks. Du and Liu (2022) suggest that digital finance contributes to improved operating efficiency by enhancing credit risk prevention and control capabilities of banks. [4] An opposing viewpoint indicates the development of digital finance poses a hindrance to the improvement of commercial banks' operating efficiency; Feng and Guo (2019) argue that digital finance, by promoting bank competition, reduces profit efficiency. [5]

Based on the above literature review, it is clear that the research on the relationship between digital finance and commercial bank operational efficiency shows three shortcomings: first, most of the existing studies on the impact of digital finance on the operational efficiency of commercial banks tend to be theoretical analyses without empirical ones. Moreover, scholars' views remain inconsistent; second, most of the existing literature is related to large commercial banks or joint-stock banks, with little research on rural commercial banks.

1. Theoretical analysis and research hypotheses

Digital inclusive finance is a new financial service model supported by digital technology, with the primary objective of financial service accessibility. It addresses insufficient financial services in rural areas, where rural commercial banks play an important role in financial services. Therefore, the impact of digital financial inclusion on rural commercial banks is worth studying. The paper will explore the impact mechanism through which digital inclusive finance influences the operational efficiency of rural commercial banks from the perspective of theoretical mechanisms.

Firstly, digital technology enables rural commercial banks to overcome geographical restrictions and expand financial services into rural areas. This expansion can give rise to an increased customer base and market share; secondly, rural commercial banks can employ technical tools such as big data and cloud computing to improve their risk identification capabilities to ensure a more accurate understanding of customer's needs and risk preferences, and, based on the information obtained, provide personalized financial products and services. This, in turn, improves customer satisfaction and fosters greater market competitiveness and profitability; finally, digital inclusive finance makes it possible for rural commercial banks to provide diversified services such as Internet insurance and financial investment, which broadens income sources of income for these banks and thus improves operational efficiency.

In summary, this paper proposes the following research hypotheses:

Hypothesis: overall, digital inclusive finance promotes the operational efficiency of rural commercial banks.

2. Models, Variables and Data

2.1 Econometric modeling

Since the explanatory variables in this paper exhibit variations in the interval [0,1], the Tobit model is selected for panel regression analysis to test Hypothesis 1. Therefore, the following Tobit model is constructed:

$$TE_{i,t} = \alpha_0 + \alpha_1 DIF_{i,t} + \alpha_2 X_{i,t} + \varepsilon \qquad (1)$$

Where, $TE_{i,t}$ is the operational efficiency of rural commercial banks, $DIF_{i,t}$ is the level of digital financial inclusion development in the counties and districts where the rural commercial banks are located, α_0 and ε is the constant term and random error of the model, i denotes different banks, t denotes different time, and $X_{i,t}$ denotes the control variables.

2.2 Selection of variables

（1）Explained variables

The explanatory variable in this paper is the operational efficiency of rural commercial banks. A three-stage DEA model is employed to measure the efficiency value. Drawing on the indicator design proposed by Yuan and Zhang (2009),[6] net fixed assets, total deposits and the number of employees serve as input indicators, while net profit and total loans as output indicators; the environmental variables, namely the number of years since the establishment of the bank, the market share of the bank and the total number of institutions, are considered. Then, the efficiency value is measured for 67 banks in China, with the comprehensive efficiency value chosen as the metric for operational efficiency.

（2）Explanatory variables

The core explanatory variable is the level of digital financial inclusion. The county-level Peking University Digital Inclusive Finance Index is used to measure the level of digital inclusive finance in the region. The index, compiled by Guo et al. (2020)[7], is currently recognized as the most authoritative measure that can assess the development of digital inclusive finance in the region with greater accuracy.

（3）Control variables

This paper selects the factors affecting the operational efficiency of rural commercial banks as the control variables from the dimensions of external macroeconomics and internal bank management. In the external dimension, provincial per capita GDP and M2 growth rate are selected as control variables. In the internal dimension, asset-liability ratio, capital adequacy ratio, net interest rate, interest income over total loans, deposit and loan ratio and debt-equity ratio are selected as control variables. Refer to Table 1 for the relevant variables and de-

scriptive statistics of this paper.

Table 1 Relevant variables and descriptive statistics

Variable name	Variable symbol	Measurement indicators	Mean	Median	Standard deviation
Operational efficiency	TE	Combined efficiency	0.6550	0.6570	0.2200
Digital Inclusive Finance	DIF	Digital Financial Inclusion Index/100	1.2030	1.2230	0.1200
Macroeconomic level	GDP	Logarithmic provincial GDP per capita	11.4500	11.5190	0.2960
Regulatory level	M2	M2 growth rate	0.0910	0.0900	0.0140
Risk-bearing capacity	CAR	Capital adequacy ratio	0.1480	0.1460	0.0190
Interest rate level	LBD	Interest over total loans	0.0770	0.0730	0.0160
Profit level	ROA	Return on total assets	0.0090	0.0090	0.0040
Liquidity level	LDR	Loan-to-deposit ratio	0.6940	0.6940	0.0970

（4）Data description

In this paper, 67 rural commercial banks in China from 2016 to 2021 are selected as the research object. Data for the research is obtained from the annual reports of the banks, the database of Cathay Pacific, the Oriental Wealth Network, and the Digital Finance Research Center of Peking University. The operational efficiency is measured using the three-stage DEA model. In the first stage and third stages, DEAP2.1 software is used, while the second stage utilizes Frontier4.1 software. The process involves data processing realized through Excel and Stata17.0 software. Empirical tests are conducted by using Stata17.0 pieces for data processing and analysis.

3. Empirical Tests and Analysis of Results

3.1 Baseline analysis

To verify the effect of core explanatory variables and control variables on the operational efficiency of rural commercial banks, a Tobit fixed effect model is constructed, and regression analysis is conducted using Stata17.0 software. The specific results are shown in Table 2.

Table 2 Regression results of digital financial inclusion on operational efficiency

	(1)	(7)
Variables	TE	TE
DIF	0.6508***	0.6766***
	(5.9619)	(5.8097)
Control variables Fixed effect	No Yes	Yes Yes
Observations	402	402

Note: *, **, and *** indicate that the results are significant at the 10%, 5%, and 1% levels of estimation, respectively, and the values in parentheses are z-values. Same below

Table 2 presents the benchmark regression results. Column (1) is the result without control variables added. Column (2) includes control variables. The regression results in column (2) indicate a positive effect of DIF on TE at the 1% significance level, which verifies the validity of Hypothesis 1 in this paper, i.e., on the whole, a rise in the development level of digital inclusive finance promotes the operational efficiency of agricultural and commercial banks. Moreover, a higher level of digital inclusive finance development corresponds to a more positive impact on the operational efficiency of these banks.

3.2 Robustness tests

In this paper, the replacement of the explanatory variables is selected for robustness testing. Drawing on the approach of Zhang and Liu (2022), who chose the total asset turnover ratio of rural commercial banks as a variable to measure operational efficiency,[8]this paper adopts

the total asset turnover ratio of rural commercial banks to measure their operational efficiency. The robustness test results are shown in Table 3, where (1) is the result of the original regression, and (2) is the result of the regression after replacing the explanatory variables. From Table 3, the regression results after replacing the explanatory variables are basically consistent with the original regression results, which indicates a strong robustness in the findings of the paper.

Table 3 Model regression results after replacing explanatory variables

	(1)	(2)
Variables	TE	TAT
DIF	0.6766***	0.0286***
	(5.8097)	(2.6787)
Control variables Fixed effect	Yes Yes	Yes Yes
Constant		-0.2676***
		(-3.9399)
N	402	402
R-squared		0.484

Research findings and policy recommendations

With balanced panel data from 67 rural commercial banks in China from 2016 to 2021, this paper investigates the impact of digital financial inclusion on the operational efficiency of rural commercial banks. The research conducts the necessary robustness tests through a combination of theory and empirical evidence. Finally, it is concluded that, in general, the development of digital inclusive finance can promote the operational efficiency of rural commercial banks.

The above findings have implications for rural commercial banks in China; (i) rural commercial banks should comply with the trend of digital inclusive finance, actively seek cooperation with fintech companies and invest in the introduction and development of talents in digital technology to boost their operational efficiency; (ii) rural commercial banks should establish a risk assessment and early warning system with the help of digital technology to improve their capabilities in risk identification, assessment and control capabilities. Additionally, they should formulate more accurate marketing strategies, optimize banking business processes and service channels, improve service efficiency and quality and explore new fintech and digital products to increase business income and management efficiency.

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