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Measurement of development level of digital transformation of banks in Northwest China

Aitong Zhou

Xi 'an University of Architecture and Technology, Shannxi, China

97260645@qq.com

Abstract. In the current era, the digital economy has become an important opportunity for commercial banks. In order to keep up with the pace of The Times, build a solid foundation of science and technology finance, and promote the economic development of the Northwest region, this paper adopts the analytic hierarchy process and fuzzy comprehensive evaluation method to explore the influential factors of the digital transformation of banks in the Northwest region. The analysis shows that net capital, operating income and loan-to-deposit ratio have the greatest impact on the digital transformation of banks. In terms of digital transformation of banks in Northwest China, Shaanxi Province and Gansu Province have a better development level, Qinghai Province and Ningxia Hui Autonomous Region are relatively average, and Xinjiang Uygur Autonomous Region Province is relatively backward. Based on this, the paper puts forward suggestions to improve the level of capital management, optimize the structure of deposits and loans, and promote income diversification.

Keywords: Northwest China, Analytic hierarchy process, Fuzzy comprehensive evaluation method, Digital transformation of banks, Influencing factor.

1. Introduction

Building a digital China is a prominent goal in current societal contexts, aligning with national digital transformation policies and the growing need for contactless financial services. The evolution of online banking is rapidly advancing in response to the demands of the digital economy, prompting the banking sector to hasten its digital adaptation. The emergence of new technologies and business models like the sharing economy, online retail, and mobile payments is reshaping the daily lives of Chinese citizens. Some regions, exemplified by Jiangsu Province, have proactively embraced banking digitalization, resulting in notable financial growth for Jiangsu Bank. Despite the positive outcomes, challenges persist in the digitalization journey, encompassing high initial costs, delayed benefits, technological complexities, and security concerns. Hence, a detailed examination of banks' digital transformation progress is crucial.

This paper introduces a digital evaluation model for banks, comprising 4 secondary indexes and 14 tertiary indexes. The analytic hierarchy process is utilized to assign weights to indicators, with a primary focus on net capital, operating income, deposit and loan ratio, and various factors. A comprehensive evaluation method is applied to assess banks in Northwest China regarding digital transformation, enabling comparison. The study examines the advantages and challenges of digital transformation in banks across Northwest China provinces, aiming to offer recommendations to governmental authorities.

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2. Literature review

2.1. Research on influencing factors of digital transformation of banks

There are differences in the researches on digital transformation of banks at home and abroad. Foreign countries started early, the model construction is mature. Augusto Felicio Jose and Carrilho Tiago [1] analyzed the internal and external factors affecting the success of the bank's digital transformation by using the fsQCA method through semi-structured interviews and questionnaires on the employees of banks in Portugal, and found that the skills of employees were the key. From the perspective of Vietnamese commercial banks, Ariful Hoque et al. [2] used OLS and other models to analyze the impact of digital transformation on various risks of banks, and the results showed that digital transformation reduced credit and solvency risks, but had no significant impact on liquidity risks. Riris Shanti et al. [3] studied the impact of digital transformation of new banks on efficiency, and showed that profit efficiency may be reduced in the short term, but will be significantly improved in the long run. Abdurrahman A et al. [4] used structural equation model to analyze the relationship between the internal dynamic capabilities of the banking sector and digital transformation, emphasizing the importance of capabilities such as perception. The research shows that these activities have a significant impact on digital transformation, and banks should take this opportunity to improve their performance.

Domestic start is late, reference to the previous experience to study the implementation plan. Li Ge et al. [5] used IV-2SLS regression analysis to discuss the impact of digital resource input on business performance and optimal allocation based on the data of A-share listed banks, and reached A conclusion that performance could be significantly improved with threshold points. Zhong Huigong et al. [6] used entropy weight method and benchmark regression model to empirically analyze the relationship between enterprise digital transformation and bank systemic risk, and found that the risk could be reduced. Wang Yucong [7] made a comprehensive analysis of the digital transformation of Jiangsu Bank by integrating various methods and found that it had improved various capabilities. Peng Gang [8] constructed an evaluation system from the perspective of digital ecology and evaluated four large banks, emphasizing internal and external benefits.

These studies show that the digital transformation of banks is complex and multi-dimensional. In the future, banks will focus on customer experience to improve service and management capabilities.

2.2. Research on the development trend of digital transformation of banks

At present, scholars believe that the digital transformation of banks will continue to deepen in the future. Zang Shoufang [9] analyzed the challenges and opportunities faced by commercial banks from a macro perspective, predicted that digital marketing would be strengthened, and stressed the need to change ideas and increase investment. Yangyuan [10] focuses on China Merchants Bank and predicts that digital transformation will promote the development of retail business. Zeng Libin [11] provided the process and driving factors of digital transformation, predicted that the transformation would be achieved by deepening the application of financial technology, and proposed the need to build an ecosystem to strengthen cooperation. Zhang Zhendong [12] focuses on transaction banking and predicts that service model innovation will be realized through the construction of functional centers.

2.3. Literature review

To sum up, foreign research tends to discuss from the perspective of risk management, while domestic research focuses on policy guidance and internal transformation needs. However, few studies cover all aspects of the factors, and the interaction and correlation analysis of various indicators are scarce, so it is difficult to measure the long-term impact. In this paper, the comprehensive evaluation method is adopted to make up for the deficiency and provide more comprehensive transformation strategy suggestions for banks.

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3. Index weight construction

3.1. Preliminary screening of indicators and data sources

This paper constructs 4 secondary indicators and 14 tertiary indicators, as shown in Table 1 below:

Table 1. Indicators affecting digital transformation of banks

Primary indicators	Secondary indicators	Tertiary indicators
Bank digital transformation	Assets	Net Asset income
		Asset size (thousand yuan)
		Weighted asset risk (thousand yuan)
		Asset-liability ratio
		Net interest rate on total assets
	Capital	Net capital (thousand yuan)
		Capital adequacy ratio
	Deposits and loans	Deposit and loan ratio
		Total deposits (100 million Yuan)
		Total loan
	Income	Operating income
		Interest income (thousand Yuan)
		Other income (thousand Yuan)

The data comes from the National Bureau of Statistics (data.stats.gov) and www.cninfo.com. The data in this paper are cross-section data and the time is 2022.

3.2. Analytic hierarchy process construction

Analytic hierarchy Process (AHP) is a decision-making method, which divides the problem to be decided into the level of purpose, standard and solution, and calculates the priority weight of each element to determine the optimal scheme. It is suitable for decision-making problems with hierarchical and staggered evaluation indicators and difficult to describe the target value quantitatively.

3.2.1. Building the analytic Hierarchy analysis model

The hierarchical analysis model of bank digital transformation is shown in Figure 1:

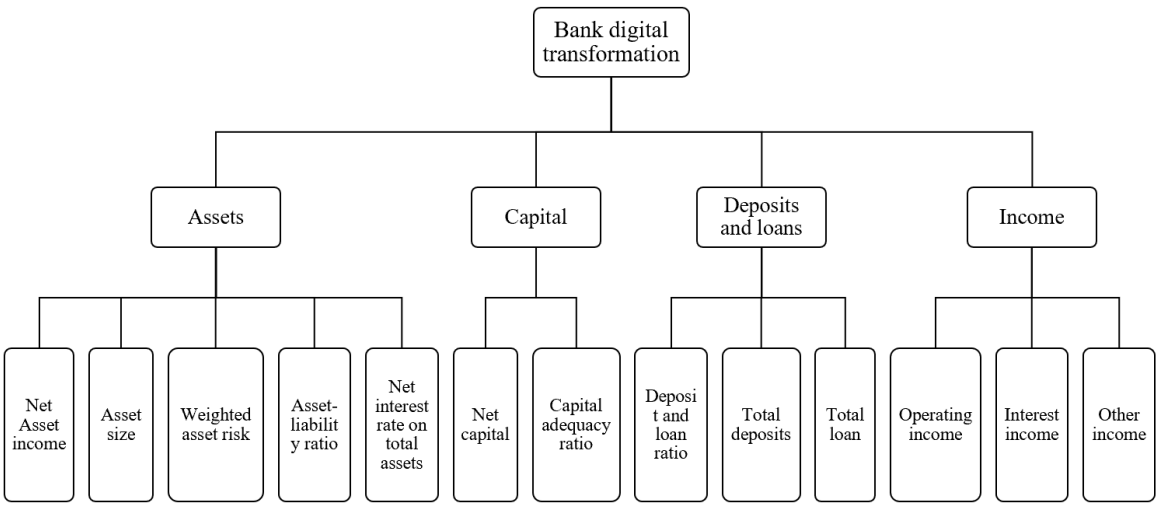

Figure 1. Hierarchical Analysis model of bank digital transformation

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3.2.2. Construct judgment matrix

In the analytic hierarchy process, the judgment matrix is the core calculation tool, and its element value reflects the assessment of the relative importance of each factor, which has a significant impact on the final decision result. Typically, the elements of a judgment matrix are scaled from 1 to 9 and their reciprocal to quantify the relative importance of the factors.

The judgment matrix of analytic hierarchy process is shown in Table 2 below:

Table 2. Judgment matrix

Scale	Implication
1	Indicates that two factors are equally important when compared
3	Indicates that one is slightly more important than the other compared to two factors
5	Indicates that one of two factors is significantly more important than the other
7	Indicates that one is more important than the other when comparing two factors
9	Indicates that one of two factors is more important than the other
2,4,6,8	Represents the median of the above two adjacent judgments
Count backwards	If Bij is determined by comparing factor i with j, then Bji=1/Bij is determined by comparing factor j with i

3.2.3. Hierarchical sorting and consistency checking

In analytic hierarchy process, single ranking refers to the order of importance of each factor in a certain level relative to a factor in the previous level. This order is reflected by the eigenvectors of the judgment matrix. Specifically, if there is A judgment matrix A, the solution vector W of the eigenvalue problem AW=λmaxW, after normalization, represents the importance weight of each factor in the hierarchy relative to a factor in the previous layer. This process is called single hierarchy sorting. In order to ensure the reliability of single hierarchical ranking, it is necessary to verify the consistency of the judgment matrix, which involves calculating the consistency ratio.

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{1}$$

λmax is the largest eigenvalue of A.。

Consistency indicators:

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{2}$$

Table 3. Random one-time indicators

Determine the order of matrix n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Consistency ratio:

$$CR = \frac{CI}{RI} = \frac{\lambda_{\max} - n}{RI \cdot (n-1)} \tag{3}$$

Only when CR<0.1, can we think that the result of single hierarchical sorting is satisfactory, otherwise we need to readjust the value of the judgment matrix elements.

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3.3. Hierarchical total sorting and consistency checking

Determine the importance weight of each level factor relative to the top level factor and sort it, which is called hierarchical comprehensive sorting. The process is executed from top to bottom.

Then, the combined consistency ratio of layer p to layer 1 is:

The combined consistency ratio for the first layer is:

$$CR = CR^{(p-1)} + \frac{CI^{(p)}}{RI^{(p)}}, p = 3,4,\cdots,s \tag{4}$$

Only when CR<0.1, the consistency of total hierarchical sorting results can be considered satisfactory. Otherwise, you need to readjust the values of elements in the judgment matrix. If CR<0.1 is obtained through calculation, the decision result is credible and the analytic hierarchy process is completed.

3.4. Index weight table

Based on the construction of the above game analytic hierarchy process indicators, the weight score table obtained in this paper is shown in Table 4 below:

Table 4. Index weight score table of the analytic hierarchy process for digital transformation of banks

Primary index	Secondary index	Three-level index	权重
Bank digital transformation	Assets	Return on equity	0.1332
		Asset size (thousand yuan)	0.3995
		Weighted asset risk (thousand yuan)	0.2851
		Asset-liability ratio	0.0858
		Net interest rate on total assets	0.0965
	Capital	Net capital (thousand Yuan)	0.7500
		Capital adequacy ratio	0.2500
	Deposits and loans	Loan-deposit ratio	0.6370
		Total deposits (100 million Yuan)	0.1047
		Total loan	0.2583
	Income	Operating income	0.6370
		Interest income (thousand Yuan)	0.2583
		Other income (thousand Yuan)	0.1047

The weights of AHP indicators are shown in Figure 2 below:

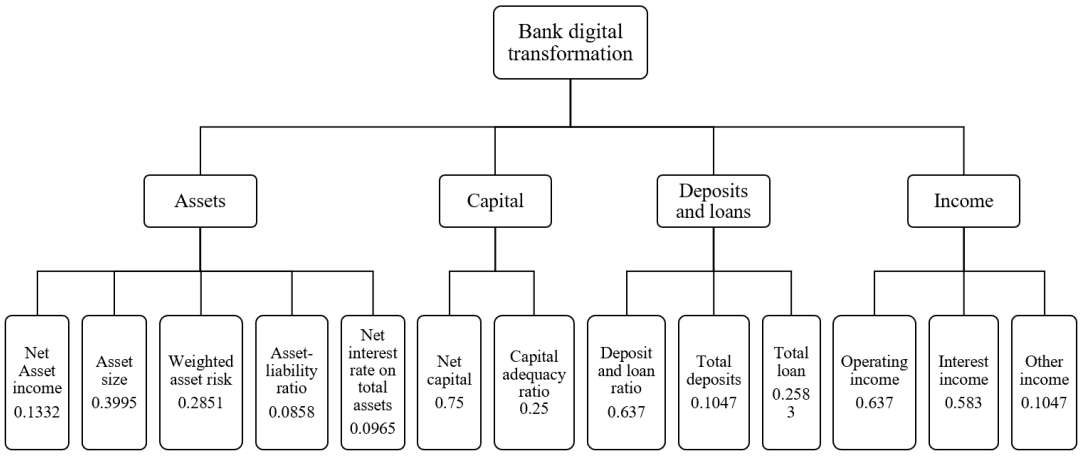

Figure 2. Weight chart of the analytic Hierarchy process for digital transformation of banks

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4. Fuzzy comprehensive evaluation method

4.1. Determine the factor theory domain of the evaluation object

$$U=\{u_1,u_2,L\ ,u_m\} \tag{5}$$

That is to say, there are m evaluation indicators, indicating the aspects from which we evaluate and describe the evaluated object.

4.2. Determine the comment grade domain

The review set is a set composed of various general evaluation results that the evaluator may make on the evaluated object, which is represented by V:

$$V=\{v_1,v_2,L\ ,v_n\} \tag{6}$$

4.3. The fuzzy relation matrix R is established by single factor evaluation

It is called single factor fuzzy evaluation to determine the degree of membership of the evaluation object to the evaluation set V. After constructing the hierarchical fuzzy subset, it is necessary to evaluate the object one by one from each factor ui(i=1, 2,... m) to quantify, that is, to determine the membership degree of the evaluated object to each level of fuzzy subset from a single factor perspective, and then obtain the fuzzy relationship matrix:

$$R=\begin{pmatrix} r_{11} & r_{12} & L & r_{1n} \\ r_{21} & r_{22} & L & r_{2n} \\ M & M & O & M \\ r_{m1} & r_{m2} & L & r_{mn} \end{pmatrix} \tag{7}$$

Where rij(i=1,2,... , m, j = 1, 2,... n) represents the membership degree of a certain evaluated object to the vi level fuzzy subset from the perspective of factor u.

4.4. The fuzzy weight vector of evaluation factors is determined

To reflect the importance of each factor, each factor U should be assigned a corresponding weight ai=(1,2,... ,m), usually requires ai to meet ai$\geqslant$0; Σai=1, then represents the weight of the i th factor, and then A fuzzy set A composed of each weight is the weight set.

4.5. Multi-factor fuzzy evaluation

The model of fuzzy comprehensive evaluation is:

$$B=A\ oR=(a_1,a_2,L\ ,a_m)\begin{pmatrix} r_{11} & r_{12} & L & r_{1n} \\ r_{21} & r_{22} & L & r_{21} \\ M & M & O & M \\ r_{m1} & r_{m2} & L & r_{mn} \end{pmatrix}=(b_1,b_2,L\ ,b_n) \tag{8}$$

Where bj(j=1,2,... n) is obtained by the operation of the JTH column of A and R, and represents the membership degree of the rated object to the fuzzy subset of vj level from the whole perspective.

Based on the fuzzy comprehensive evaluation method, the calculated digital transformation scores of provincial banks are shown in Table 5:

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Table 5. Scores of digital transformation of banks by province

Province	Shaanxi	Gansu	Xinjiang Uygur Autonomous Region	Qinghai	Ningxia
Score	3.773	3.123	1.671	2.689	2.631

5. Conclusion

5.1. Data analysis

(1) The digital transformation of banks in Shaanxi Province scored the highest at 3.773 points. Its advantages are: it has a sense of scientific and technological application and innovation. For example, Bank of Xi 'an uses digital technology to promote business transformation, including product design and other aspects, builds relevant projects, increases investment to strengthen digital team construction, and adjusts organizational structure. It attaches high importance to data governance and application, and establishes a center to play the value of data. It also has policy support and geographical advantages. As the starting point of the ancient Silk Road, the digital economy has developed well, providing a good environment for transformation.

(2) The digital transformation score of banks in Gansu Province is relatively high, at 3.123 points. First of all, the strategic layout is sufficient. Bank of Gansu attaches importance to digital transformation and puts forward the strategy of "retail priority" to drive innovation with digital technology. Second, continue to increase financial technology investment, and build 5G smart financial business hall. In addition, we actively develop digital financial products to meet the financing needs of enterprises, and launch a number of online loan products. Finally, adhere to the optimization of channels and processes, and build a mobile terminal service system.

(3) The digital transformation scores of banks in Qinghai Province and Ningxia Hui Autonomous Region are relatively low, with 2.689 and 2.631 points respectively. First of all, the construction of technical infrastructure is insufficient, including high-speed Internet, data centers, etc., some banks have poor technology application foundation, and the localization of core key technologies and low security guarantee. Secondly, the level of digital transformation of banks is related to the development level of regional economy, which is dominated by traditional industries and has limited power and application scenarios for digital transformation. Finally, there are problems in the business system architecture. Based on the traditional microservice architecture, it cannot meet the requirements, so it is necessary to build a cloud management platform and container environment.

(4) The score of digital transformation of banks in Xinjiang Uygur Autonomous Region Province is relatively the lowest, with 1.671 points. In addition to the above problems, first of all, there is a lack of professional talent, geographical location, lack of resources caused by the lack of talent, especially in the field of financial technology. Secondly, there are risk management and security issues, and data security and other aspects may be insufficient. In addition, the internal culture of the bank is conservative, and the attitude of management and employees towards new technologies is conservative, which slows down the pace of transformation.

5.2. Suggestions

(1)Sufficient capital boosts confidence

In the digital transformation of banks, the net capital has the greatest impact, and the level of capital management is closely related to it. To improve the level of capital management, first, optimize the capital structure, increase the proportion of core tier 1 capital, issue stocks and bonds to enhance strength, and strengthen capital adequacy ratio management. The second is to strengthen the control of risky assets, control the non-performing loan ratio, improve asset quality, use the risk assessment model to rationally allocate credit resources, and reduce the proportion of high-risk assets. The third is to promote capital saving business, develop non-credit business, such as financial management, payment and settlement, and promote asset-light operation model to improve efficiency

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(2)Balance deposits and loans to promote stable development

The loan-to-deposit ratio has a significant impact on the digital transformation of banks. First of all, we should optimize the structure of deposits and loans, adjust the investment of loans to key areas of support, and expand the sources of deposits. Secondly, pay attention to the efficiency of the use of funds, and optimize the loan approval process with digital means such as intelligent advisory. Third, strengthen liquidity management, build a perfect system, and use digital tools to monitor the flow of funds.

(3)Multiple income increases efficiency

Operating income is an important indicator. Banks need to diversify their revenue sources, such as wealth management, increase non-interest income and provide personalized services through digital platforms. Improve the added value of services, provide one-stop services with digital means, improve customer experience. Optimize cost structure, reduce operating costs through digital transformation, improve business processing efficiency, and optimize network layout.

(4)Identify customer needs to increase revenue

Deepen the insight analysis of customer needs, portrait and analyze behavior with big data technology. Build a data analysis platform to understand needs, provide personalized recommendations based on portraits, segment markets, update preferences in real time, track marketing effects and adjust strategies, carry out precision marketing, popularize financial knowledge, enhance cognition, comply with regulations, and strengthen risk management.

(5)Innovative products to enhance the driving force

Scientific and technological innovation is an important driving force. Banks should increase financial technology innovation, develop new products, such as blockchain supply chain finance, build innovation laboratories, cooperate with technology companies to introduce cutting-edge technologies, develop characteristic financial products, open banking services and third-party cooperation, participate in or build e-commerce platforms to integrate financial services and scenes.

(6)Knowledge renewal drives development

Banks should build a talent training system, clarify goals and requirements, focus on the cultivation and introduction of financial technology talents, cooperate with colleges and universities, strengthen on-the-job staff training and knowledge update, cultivate compound teams, implement continuing education programs, build innovation teams, and build career development channels for talents.

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