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The Impact of Digital Transformation on Risk-Taking in Commercial Banks

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Abstract

The digital transformation of commercial banks can enhance the efficiency of financial services, reduce operating costs, and strengthen the banks' competitiveness and stability in the market. With the continuous development of internet technology and artificial intelligence, the potential and scope for digital transformation in commercial banks are expanding significantly. This paper utilizes panel data from 43 Chinese commercial banks from 2011 to 2021 as the research sample and employs stepwise regression to empirically analyze the mechanisms through which digital transformation may affect the risk-taking levels of commercial banks. The study also examines the role of financial innovation in the relationship between digital transformation and risk-taking in commercial banks. The findings indicate that digital transformation significantly increases the risk-taking of Chinese commercial banks. Mechanism analysis reveals that digital transformation promotes financial innovation in commercial banks, which in turn mitigates the extent to which risk-taking levels increase. Heterogeneity analysis shows that the increase in risk-taking due to digital transformation is higher in state-owned and joint-stock commercial banks compared to urban and rural commercial banks. Based on these conclusions, the paper suggests that commercial banks should rapidly embrace digital transformation to reduce operational risks. Additionally, banks of different sizes and characteristics should identify digital transformation paths that align with their operational features and risk management capabilities. Finally, attention should be paid to the inherent risks of digital operations and the risk of low efficiency caused by excessively high input costs.

Keywords: Commercial banks; digital transformation; financial technology; risk-taking

1. Introduction

1.1 Research background and research significance

With the continuous development and maturity of ABCD cutting-edge technologies such as ARTIFICIAL intelligence (AI), blockchain (Blockchain), cloud computing (Cloud Computing) and big data (Data & Data An-alytics), digital technology is also rapidly changing the financial life of residents and impacting the social financial ecology. As an important pillar of the financial sector, the banking industry is facing the great pressure of revenue growth under the impact of increasingly diversified customer financial needs and increasing foreign financial institutions. Digitalization has become one of the important driving forces to promote the business transformation of commercial banks. The digital transformation of commercial banks faces the opportunity of cost reduction and efficiency increase and business transformation, which is an important guarantee to maintain their competitiveness.

However, in the process of seeking new business growth opportunities and innovating new business process models with the help of digital technology, commercial banks are faced with a series of crucial problems, such as the irreversible trend orientation brought by digital transformation and the basic support of banks themselves, as well as the imbalance between risk control and business demand. The partys 20th report clearly stated that we should improve the mechanism for preventing, warning and handling financial risks, and continue to strengthen the ability to prevent and control financial risks. The Central Economic Work Conference has repeatedly highlighted preventing and defusing financial risks, and stressed that "risk prevention" is a strategic and fundamental event for Chinas overall economic and social development. It can be seen that the digital transformation practice of commercial banks urgently needs to be guided by a systematic theoretical framework with realistic insight and strategic guidance. At the same time, it is important to re-examine the relationship between the digital transformation of industrial banks and the risk taking level of banks, and analyze the impact mechanism of digital transformation on the risk taking level of banks, which is of great significance for better promoting the digital transformation process of commercial banks and realizing high-quality economic development and high-level growth.

1.2 Research content and research framework

In this paper, the panel data of 43 commercial banks from 2011 to 2021 are selected, with research hypotheses according to the theoretical basis, and the fixed panel effect model is used to verify whether the assumptions are reasonable. In the robustness test section, the explanatory variables will be replaced with other variables to test whether the results are significant. In the endogenous test link, this paper adopts the instrumental variable method, takes the Internet penetration rate as the instrumental variable, and uses the two-stage least squares method for regression. In addition, in order to further analyze the influence mechanism of the digital transformation of commercial banks, this paper takes financial innovation as a mechanism variable and explores the role of financial

innovation plays between the digital transformation of commercial banks and risk taking of commercial banks. At the same time, for different types of commercial banks, this paper also carries out a heterogeneity analysis to explore the role that digital transformation plays among different types of commercial banks. Finally, according to the above theoretical analysis and empirical test results, the research conclusion is given, and targeted policy suggestions are given.

1.3 Possible innovation and deficiency

1.3.1 Possible innovations in this article

First, research perspective innovation. Most of the previous scholars have studied the impact of digital transformation on the risk taking of commercial banks, but rarely involved in the impact path. There are also scholars who study the path from the perspective of debt and put forward possible mechanisms or channels, but there is still the need to continue to explore. Therefore, based on the research of previous scholars, this paper further explores whether there are other transmission ways for the problem that digital transformation affects the risk taking level of banks.

Second, research content innovation. In order to further study the factors affecting the risk taking of commercial banks, this paper conducts a heterogeneity analysis and divides commercial banks into four categories, namely state-owned commercial banks, joint-stock banks, urban commercial banks and rural commercial banks. It is found that the impact of digital transformation on the risk taking of different types of commercial banks is different. This paper further refines the research on the impact of digital transformation on bank risk taking. According to the research content, targeted policy suggestions can be put forward, reflecting the innovation of the research content.

1.3.2 Shortcomings

Through theoretical analysis and empirical test, this paper verifies that the relationship between digital transformation and the risk taking of commercial banks is a negative correlation. Further, in order to study the role of financial innovation in it, financial innovation is added to the model as a mechanism variable, and it is concluded that financial innovation has a covering effect in the impact of digital transformation on the risk taking of commercial banks. In general, this paper in the digital transformation of commercial bank risk impact research made certain contribution, but there are still many places can be optimized, the explanatory variables selected although can better describe the digital transformation, but because of the digital financial development time is short, academia on how to measure the digital transformation degree did not reach a unified point of view, many scholars still according to their own methods to measure digital transformation degree, the conclusion is different. Therefore, in the later research, if the academic community reaches a unified standard on the measurement index of digital transformation, this standard can be used for empirical research to draw more convincing conclusions.

2. literature review

2.1 Related research on digital transformation

In foreign countries, AGRAWAL 1 and the concept of digitalization (GANS (2018) believe that digitalization is a process for enterprises to use digital technology to improve themselves, but for the concept of digital transformation, the academic research is still relatively scarce, and it is difficult to give a unified definition. Hinings (2018) believes that digital transformation is more about technology itself than how to change an enterprise. Alkhatib (2014) believes that the digital transformation has led to "shifts in key business models and impact on products and processes, as well as organizational structure and management concepts". From the analysis of the above scholars, we can understand that the digital transformation changes the enterprises from the inside to the outside, including the business model, governance structure, etc.

In China, most researchers define it as optimizing traditional financial services with the help of fintech to create new service methods. The Banking Security Committee (FSB) defines it as an Internet financial service technology innovation, that is, to create new service methods for the original financial field with the help of information technology. Huang Yiping and Huang Zhuo (2018) put forward a new view, namely, the traditional banking industry should make full use of digital technology to promote changes in investment, financing, payment and other aspects, and establish a new and innovative financial service model.

2.2 Related research on the risk taking of commercial banks2.2.1 Impact of monetary policy on bank risk taking

After the outbreak of the subprime crisis, scholars focused their research on how monetary policy affected the risk taking of commercial banks. Borio & Zhu (2008) analyzed risk taking from macro factors, and he found that monetary policy would not only affect the level of interest rate, but also indirectly affect the level of risk taking of commercial banks. Adrian & Shin (2009) from the perspective of market psychology, in general, the asset prices and interest rates into the reverse relationship, so when interest rates fall, Banks will be optimism due to the rise in asset prices, underestimate the risk, eventually cause the bank risk level rise, scholars called this phenomenon "valuation effect". Rajan (2005) found that since a large part of the income of commercial banks comes from loans, and the income of loans is mainly determined by the market interest rate, so in the low interest rate, the reduction of loan income will force banks to invest in more risky assets, so as to earn more profits.

2.2.2 Impact of market competition on bank risk bearing

Hauswald & Marquez (2006) believes that the difficulty of obtaining information from banks is positively related to the fierce competition in the industry. The lack of sufficient external information will lead to the decline of the asset quality of commercial banks, the increase of non-performing loans, and the final risk bearing level of banks will also rise. Mar-Miera & Repullo (2010) found that the relationship between market competition and bank risk taking is not simply a simple positive or negative correlation, but a U-shaped relationship. Specifically, when the degree of competition in the banking industry is low, the moral hazard of borrowers will decline with the increase of the degree of competition. Once a certain threshold, the continuous decline of market interest rate will seriously affect the profit level of commercial banks, and the risk bearing of banks will rise.

2.2.3 Impact of fintech on bank risk taking

In theory, external fintech mainly influences the risk taking of commercial banks through competitive effect and crowding out effect, while the research of internal fintech on commercial banks mostly focuses on the profitability, business structure and operational efficiency of banks. Xie Qing et al (2021) believe that fintech will enhance the coverage and experience of financial services and be beneficial to reshape the business; Li Jianjun and Jiang Shichao (2021) believe that they can improve the financial performance; Guo Lihong and Zhu Kodak (2021) constructed the index of employees and users of electronic channels, and found that banks can use fintech means to reduce the risk of inclusive loans and improve the performance. Zhao Jiangshan and Tong Menghua (2023) believe that fintech reduces the risk taking of banks by improving the franchise value from efficiency channels and diversified channels; Xiong Jian (2022) believes that cooperation with external fintech enterprises improves the risk taking willingness of small and medium-sized banks and reduces the risk taking level of small and medium-sized banks, and this influence has long-term sustainability.

In view of the research on the impact of internal fintech on the risk taking of commercial banks, some researchers have also carried out relevant studies. Meng-fei liu (2021) based on 26 listed Banks panel data research found that the rapid development of internal financial technology increased the bank network node and density, will form a complex social network, and broaden the investment of the investors, bank funding sources will be more dependent on interbank lending, increased risk cross infection, this will aggravate the systemic risk of Chinas banking industry. Lepetitetal. (2007) The research content is the impact of the diversification level of banking business products on the risk bearing of banks. The research finds that non-interest income business is closely related to the risk bearing level of banks. The higher the proportion of non-interest income, the more diversified the banking business, the higher the risk bearing level.

3. Theoretical mechanism and research hypotheses

3.1 Theoretical basis and research hypotheses

3.1.1 Impact of the digital transformation of commercial banks on their risk-taking level

First of all, in the process of digital transformation, commercial banks face disruptive innovation because almost all the operation processes need to adapt. In the traditional commercial banking business, subject to the acquisition of customer information, banks mainly identify customer risks from the relatively single dimensions such as credit investigation, financial situation and industry attributes, which makes the serious information asymmetry inside and outside of commercial banks. Banks can not only have extensive access to qualified potential customers, but also cannot fully understand the credit status of these groups, so they can only provide products and services to limited customers. However, in the digital background, commercial banks can break the traditional risk data structure and enrich the data dimension, so as to alleviate the problem of information asymmetry, improve the accuracy of bank product sales to customers, and then improve the quality of banking business and optimize the effect of credit risk control. Secondly, the internal responsibilities of traditional commercial banks are subdivided, the business process is complex, the business department and the technical department are difficult to coordinate, and the innovation and iteration ability is weak. The digital transformation of commercial banks has laid a technical foundation for the timely and accurate financial collection and analysis of relevant information, and the increase of data storage is also conducive to strengthening the support of data analysis means for decision-making. By refactoring the organization structure, business mechanism, digital to the traditional commercial bank strategic model and business idea of deep influence, make the financial services and business processes, the bank around digital technology constantly optimize its customer interaction ability, further reduce the management cost and service costs, improve the management efficiency, and effectively resist the impact of emerging science and technology enterprises on their own, reduce the risk taking level. Considering the above analysis, the following assumptions are proposed.

H1: The digital transformation of commercial banks can reduce their level of risk taking.

3.1.2 Digital transformation, operating efficiency and risk-taking level of commercial banks

The digital transformation of commercial banks can improve their operating efficiency. In the context of digitalization, a large number of interpersonal interaction and information transmission begin to be realized through online systems based on digital technology. This transformation can improve the timeliness and accuracy of information transmission, thus reducing the communication cost and improving the coordination efficiency. On the one hand, based on the use of big data, commercial Banks break through the limitation of entity outlets and business hours, reduce the traditional banking business in the process of transaction costs, but also reduce the cost of high costs and a lot of labor costs, thus improving the traditional commercial Banks credit business efficiency. On the other hand, by reducing the organizational level redundancy of banks, digital technology helps to organize them into a more agile and flexible way. Bank

operating synergy between departments will improve, the traditional rigid boundaries are broken, organizational structure tends to be flexible and extensible, help commercial Banks to improve the sensitivity to the external environment change, thus quickly, flexible, effectively develop new strategies and accelerate resource integration and redistribution, and enhance the level of bank services and internal management, efficiency, efficiency and effect of comprehensive improvement and optimization. Therefore, the digital transformation of commercial banks can optimize the traditional business process, reduce the operating cost and service cost of banks, and improve the operating efficiency. The higher the efficiency improvement range of commercial banks, the lower the risk transfer motivation, and the lower the risk bearing level. Considering the above analysis, the following assumptions are proposed.

H2: The digital transformation of commercial banks reduces the risk taking level by improving the operation efficiency of banks.

4. Empirical analysis of digital transformation affecting bank risk taking

4.1 Sample selection

According to the ranking of commercial banks, 43 banks in the top ranking are selected for empirical analysis. The total assets of these banks account for a large proportion of the total assets of the national banks, which can represent the overall situation of the national banks. Among them are 5 large state-owned banks, 10 national joint-stock banks, 18 urban commercial banks and 10 rural commercial banks. The study year interval is selected from 2011 to 2021. The reason why 2011 was chosen as the initial year is that the digital transformation process of commercial banks entered the fast lane starting in this year, and the development speed was significantly faster than before. Although commercial banks have been trying to apply digital technology to their businesses before, it is not comparable to the large-scale integration of digital technology after 2011.

4.2 Data sources

The relevant data of risk taking of commercial banks in the sample comes from the Digital Transformation Index of China Commercial Bank of Peking University, other data are from Guotaiian database, and some data are from the collection and collation of annual reports of banks. Macroeconomic data comes from the data released by the National Bureau of Statistics and the Peoples Bank of China.

4.3 Selection of variables

4.3.1 Interpreted variable

The explained variable in this paper is the risk bearing level of commercial banks. The so-called risk taking level refers to the risk that commercial banks take the initiative to

obtain more profits or make up for the losses caused by various reasons. Different from the risk level, this is the risk that commercial banks take actively. In this paper, we refer to the research of Delis and Kouretas (2011) and Jin Penghui (2014), and choose the proportion of risk-weighted assets to total assets as the index of bank risk taking to represent the overall risk of the bank. The loan provision ratio is the ratio of the bad debt reserve made in advance by the bank manager according to the credit operation condition of the bank to the total loan, which is considered to measure the prior risk of the bank. In order to maintain the robustness of the results, the provision coverage rate (PC) was selected for the robustness test, and the data of the explained variables were obtained from the CSMAR database.

4.3.2 The explanatory variables

In this paper, the Digital Transformation Index of China Commercial Banks (Xie Huali, Wang Shihui, 2023) provided by the Digital Finance Research Center of Peking University is selected to measure the degree of digital transformation of China commercial banks. The index is based on external data such as the text content and patent information of commercial banks from 2010 to 2021. The index system is constructed from the three dimensions of strategic digitalization, business digitalization and management digitalization of commercial banks. Among them, strategic digitalization pays attention to the degree of digital technology in the overall strategic level of banks, and is specifically constructed through the mention of keywords related to digital technology in the text of the annual report of counting banks. Digtize business, focusing on the extent to which banks integrate digital technology into the financial services they provide. Changes in the banking business based on digital technology. Management digitization, focusing on the extent to which banks integrate digital technology into governance structure and organizational management. At the same time, the index uses the principal component analysis method to construct the weight of the index. The characteristic of this method is the strong objectivity, that is, the weight is determined by the characteristics of the data itself, and the factors with large variation will be given higher weight, which is not affected by peoples subjective judgment.

4.3.3 Control Variables

Selection of the control variables. As can be seen by referring to the relevant domestic and foreign literature, In the selection of the control variables, Roughly divided into two categories: one is the controlling variables that reflect the macroeconomic situation, Including GDP growth (GDP), It reflects the level of economic development; Nominal money supply growth rate (M2), It reflects the tightening of monetary policy; The other category is the control variables that reflect the microscopic situation, Including the log of total assets (SIZE), It reflects the total asset size of commercial banks; Interest spread (NIM), It reflects the banks management capacity, capital adequacy ratio (CAR), It reflects the banks ability to withstand risk; Loan-to-loan ratio (LOD), It reflects the bank liquidity level and the Hepfendal index calculated based on net interest income and non-interest income to measure the degree of business diversification (HHI).

At present, there is no unified standard in the academic community. The main measures include the proportion of non-interest income, the proportion of commission and commission income, and the natural logarithm of the total income of intermediary business income. These indicators all have a common feature, that is, to examine the proportion of non-interest income. Since the commission fees often represent the income of non-traditional business of commercial banks and the level of financial innovation of commercial banks, this paper takes the proportion of commission fees and commission income of commercial banks (FCI) as the agent index to evaluate the financial innovation ability of banks, and the financial innovation ability is directly proportional to this index.

Based on the above analysis, the specific variables involved in the empirical study of this paper are as follows:

type of variable	Variable name	symbol	Variable design
		RISK	Proportion of risk-weighted
explained variable	Bank risk assumption	MISIX	assets
		PC	provision coverage
	Total index of digital		The Digital Transformation
	transformation	LNFI	Index of China Commercial
Como overlanato ev	transformation		Bank of Peking University
Core explanatory			The Strategic Digital
variables	Stuatoria disitization index	71 MEI	Transformation Index of
	Strategic digitization index	ZLINFI	Peking University Commercial
			Bank of China
Mechanism	financial innovation	FCI	Proportion of commission fee
variables			and commission income
	Economic development level	GDP	GDP speed increase
controlled variable	Scale of bank assets	SIZE	Natural logarithm of the total assets
	Bank operation and management ability	NIM	Interest difference
	Banks ability to withstand risks	CAR	capital adequacy ratio
	Bank liquidity levels	LOD	Deposit and loan ratio
	The degree of business	UUI	Proportion of non-interest
	diversification	ппі	income

Table 1: Variables and their definitions

4.4 Descriptive statistics

Variable	observed	average	standard	least value	crest value
name	value	value	error		
ZLNFI	425	140.5	81.48	19.17	335.7
LNFI	425	82.82	35.46	19.27	154.8
LOD	425	71.73	9.785	53.11	96.89
РС	427	189.1	119.2	0.900	442.5
NIM	424	2.344	0.430	1.570	3.455
CAR	422	13.22	1.343	10.86	16.38
SIZE	425	9.114	1.409	6.650	12.18
RISK	425	0.638	0.0566	0.494	0.755
GDP	471	6.970	1.758	2.200	9.551
HHI	425	19.83	8.776	4.160	38.44
FCI	296	218.5	299.7	1.140	1,159

Table 2: Sample descriptive statistics

Table 2 shows the observed values, standard deviations, mean values and the most values of various variables respectively, which reflects the characteristics of the distribution of different variables to a certain extent. The first is the risk-weighted asset ratio (RISK), whose minimum and maximum values are 0.494 and 0.755 respectively, the gap is not large, while the standard deviation is 0.0566, the value is small, indicating that its fluctuation level is also low. The second is the proportion of commission and commission income (FCI). The most special is the minimum and maximum values, which are 1.140 and 1.159 respectively, indicating that some banks have hardly made financial innovation, while some banks the level of financial innovation has reached a very high level. The standard deviation of bank size (SIZE) is 1.409, which is relatively large. We can also see that the difference between state-owned banks and local banks is still very large. The standard deviation of interest difference (NIM) is 0.430, indicating that under the condition of interest rate liberalization, the deposit and loan interest rates of all commercial banks tend to be consistent, with little fluctuation. The average capital adequacy ratio (CAR) is 13.22, with a high level, indicating that the overall risk resistance ability of commercial banks is strong. The maximum loan-to-deposit ratio (LOD) is 96.89, which is an alarming number. More than 100% indicates that some banks have great hidden risks.

In this paper, multicollinearity tests of the regression models were performed using the Stata17.0 software, and Table 3 shows the test results.

~~		01 0110 1110	in commonly	
	variable	VIF	1/VIF	_
	LNFI	4.91	0.203660	
	SIZE	5.31	0.188246	
	FCI	4.91	0.203660	
	ZLNFI	3.91	0.255507	
	NIM	1.90	0.524950	

Table 3. Results of the multicollinearity test

HHI	2.47	0.405065
LOD	1.87	0.533887
CAR	1.64	0.609429
GDP	1.39	0.717155
PC	1.39	0.722018
Mean VIF	2.94	

Table 3 is a multicollinearity analysis of all variables by variance expansion coefficient method. According to the result analysis of multicollinearity test, the VIF value of each variable is below 10, and the tolerance is greater than 0.1, indicating that there is no multicollinearity among each variable, so the model can be constructed for regression analysis.

4.5 Empirical model design

On the basis of the above mechanism analysis, this paper puts forward the research idea that the degree of digital transformation of commercial banks may affect their risk taking through financial innovation channels. In order to better explore the influence mechanism of digital transformation on bank risk taking, this paper adopts the practice of Baron & Kenny (1986) and uses the gradual regression method to test the role of financial innovation in digital transformation on the risk taking of commercial banks. The inspection process is performed as follows:

$$\mathbf{Y} = \mathbf{c}\mathbf{X} + \mathbf{e}_1 \tag{1}$$

$$\mathbf{M} = \mathbf{aX} + \mathbf{e_1} \tag{2}$$

$$\mathbf{Y} = \mathbf{c}' + \mathbf{b}\mathbf{M} + \mathbf{e}_3 \tag{3}$$

In this paper, the dependent variable Y is the bank risk taking variable RISK, the independent variable X is the digital transformation agent variable LNFI, the mechanism variable M is the proportion of commission and commission PCL, and e1, e2 and e3 are the residual items. Model (1) To explore whether the total effect of digital transformation affecting the risk taking of commercial banks exists, If present, the coefficient of c is significant; Model (2) To explore whether the digital transformation has an impact on the financial innovation level of commercial banks, If the coefficient a significantly shows that the digital transformation has a significant, The b in the model (3) is also significant, It shows that the indirect effect of digital transformation affecting the risk bearing of commercial banks through bank financial innovation exists; Model (3) determines whether the direct effect of digital transformation affecting the risk taking of commercial banks through bank financial innovation exists; Model (3) determines whether the direct effect of digital transformation affecting the risk taking of commercial banks after the control variable M exists, According to whether the coefficient cis significant, it can be divided into the following two conditions:

(1) If the coefficient c is significant, the impact of digital transformation on the risk taking of commercial banks will be partially realized through the financial innovation mechanism. In the condition where both c and c are significant, if the sign of ab and c is opposite, then there is a "cover effect". According to the interpretation of "cover effect" by MacKinnon (2000) and Fan Changyu (2016), the so-called "cover effect" refers to the degree of effect of the independent variable on the dependent variable will increase or decrease after controlling the cover variable.

(2) If the coefficient cis not significant, the impact of digital transformation on the risk bearing of commercial banks will all be realized through the financial innovation mechanism.

Based on the above analysis, the following model is constructed for the above test process:

$$RIDK_{it} = \alpha_0 + \alpha_1 LNFI_{it} + \sum_{j=1}^7 \alpha_{2j} Control_{j,it} + \delta_i + \varepsilon_{1it}$$

$$\tag{4}$$

$$FCL_{it} = \beta_0 + \beta_1 LNFI_{it} + \sum_{j=1}^7 \beta_{2j} Control_{j,it} + \delta_i + \varepsilon_{2it}$$
(5)

$$RISK_{it} = \gamma_0 + \gamma_1 LNFI_{it} + \gamma_2 FCL_{it} + \sum_{j=1}^7 \gamma_{3j} Control_{j,it} + \delta_i + \varepsilon_{3it}$$
(6)

4.6 Analysis of the empirical results

The empirical results of the digital transformation on the risk taking of commercial banks are shown in Table 4.

	(1)
	RISK
INEL	0.0006**
LINFI	(0.003)
LOD	0.0026***
LOD	(0.000)
NUM	-0.0131
18110	(0.245)
CAR	-0.0166***
CAR	(0.000)
CIZE	-0.0075*
SIZE	(0.058)
CDD	-0.0041
GDP	(0.198)
11111	0.0000
HHI	(0.994)
_cons	0.7419***

Table 4 Results of the master regression estimation

	(0.000)
N	467

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

The regression analysis of the model (4):

The regression coefficient of digital transformation (LNFI) is significantly positive at the level of 5%, indicating that there is an obvious positive correlation between the digital transformation of commercial banks and their own risk taking. With the advancement of digital transformation, the market competition is increasingly fierce, commercial Banks and development of all kinds of micro, small and medium enterprises loans, supply chain financial products, bank customers from the traditional large and medium-sized enterprise customers gradually extended to the long tail customers, and micro, small and medium enterprises anti-risk ability is weak, easy to produce overdue, aggravate the credit risk of commercial Banks.

The coefficient of GDP growth (GDP) is not significant, which indicates that there is insufficient evidence to prove that a good economic environment will boost the development of investment and lending business of commercial banks, and at the same time can improve the repayment ability of borrowers, thus reducing the risk taking level of commercial banks.

The coefficient of interest spread (NIM) is not significant, which indicates that the relationship between positive changes between interest spread and bank risk taking needs to be further verified. In theory, the larger the interest spread, the greater the ratio of the banks net interest income to all interest-bearing assets. The higher the yield, the more risk the relative commercial banks need to bear.

The regression coefficient of the capital adequacy ratio (CAR) is significantly negative at the level of 1%, which indicates a negative correlation between the banks capital adequacy ratio and the degree of risk it assumes. From a practical point of view, the high capital adequacy ratio of commercial banks indicates that the management is risk-averse. Naturally, in the level of risk taking of commercial banks, the management also tends to reduce risk taking.

The loan-to-deposit ratio (LOD) coefficient is positive at the 1% level, indicating a significant positive correlation between the banks loan-to-loan ratio and the banks risk tolerance. The deposit and loan ratio refers to the ratio of loan and deposit. The deposit and loan are relatively high, indicating that commercial banks use less deposits to carry out more loan business. Once the loan cannot be recovered, the banks are prone to liquidity crisis, so the risk taking level is relatively high.

	(1)	(2)	(3)
	RISK	RISK	RISK
INTEL	0.0010***	0.0009***	0.0007***
LINFI	(0.000)	(0.000)	(0.000)
CDD		-0.0046	
GDP		(0.199)	
LOD			0.0026***
LOD			(0.000)
NIM			-0.0142
INTIM			(0.208)
CAD			-0.0166***
CAR			(0.000)
SIZE			-0.0083**
SIZE			(0.035)
TITI			-0.0001
HHI			(0.930)
200	0.5369***	0.5773***	0.7148***
_cons	(0.000)	(0.000)	(0.000)
Ν	471	471	467

Table 5 The estimated results after removing the control variables

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

Table 5 presents the results of the regression analysis of the three different models on the impact of digital transformation on commercial banks. First, model (1) did not include any control variables in model (1), while model (2) included only macro control variables. Finally, model (3) included only micro control variables. In model (1), the regression coefficient of digital transformation (LNFI) is at the significance level of 1%, which is close to twice the coefficient shown in Table 4. This result indicates that, without considering any control variables, with the increasing degree of digital transformation, the risk taking of commercial banks will also increase significantly due to various macro and micro factors. This finding highlights the importance of considering other relevant factors when exploring the impact of digital transformation on risk taking of commercial banks. In model (2) and model (3), the regression coefficient of digital transformation (LNFI) is still at the significance level of 1%, and numerically the values of model (3) are closer to those shown in Table 4. This result shows that both macro and micro factors will significantly interfere with the impact of digital transformation (LNFI) on the risk taking of commercial banks. And the interference and influence of micro factors is greater. Therefore, when studying the impact of digital transformation on the risk taking of commercial banks, these potential interference factors should be fully considered, so as to more accurately evaluate the actual impact of digital transformation on the risk taking of banks.

4.7 Robustness test

4.7.1 Change the robustness test of the explained variable

This paper first chooses to replace the proxy index of the explained variable of commercial banks with provision coverage (PC) to test the robustness of the regression results. The master regression results are shown in Table Table 6.

variables			
	(1)		
	РС		
INIEI	0.6183**		
LINFI	(0.013)		
LOD	-1.2792**		
EOD	(0.037)		
NIM	105.6561***		
N1M	(0.000)		
CAP	0.1834		
CAR	(0.961)		
SIZE	18.5783***		
SIZE	(0.000)		
CDD	5.1404		
GDr	(0.199)		
	0.8138		
HH1	(0.337)		
	-235.5294**		
_cons	(0.004)		
Ν	467		

Table 6 Principal regression results after changing of explained

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

As can be seen from Table 6, the relationship between digital transition and provision coverage of the explained variables is significant at the level of 5%, indicating that there is a significant positive relationship between digital transition and bank risk taking, which is consistent with the results of the master regression before changing the explanatory variables. This demonstrates the robustness of the regression results.

4.8 Endogeneity test

This paper draws the ideas of Tang Song et al. (2020) and Liu Mengfei (2021), and takes the Internet penetration rate (www) as the tool variable that digital transformation affects

risk taking. The digital development of commercial banks cannot be separated from the Internet. It can be said that the process of digitalization of commercial banks is the process of the development of the Internet. At the same time, it has little correlation with other explanatory variables and random disturbance terms at the bank level. Therefore, the Internet penetration rate meets the requirements as a tool variable. Reregression using a two-stage least squares method (2 SLS).

	(1)
	RISK
INEI	0.0654***
LINFI	(0.016)
SIZE	-0.0187***
SIZE	(0.004)
NUM	2.724***
INTIM	(1.002)
CAR	-1.285***
CAR	(0.209)
LOD	0.255***
LOD	(0.027)
CDD	-0.00426
GDP	(0.201)
	-0.108***
HHI	(0.053)
	0.887***
_cons	(0.097)
N	467
R2	0.455

Table 7 Principal regression results of instrumental variables

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

The regression results showed that the digital transformation index (LNFI) was significantly and positively correlated with bank risk taking, and the master regression results remained robust after the adoption of instrumental variables.

5. Impact mechanism analysis and heterogeneity analysis5.1 Analysis of the impact mechanism

From the regression results, we can conclude that the degree of digital transformation is positively correlated with the level of risk bearing of commercial banks, that is, the higher the degree of digital transformation of commercial banks, the higher the level of risk bearing. As for the influence mechanism, this paper puts forward the hypothesis of financial innovation, believing that financial innovation may affect the risk taking level of commercial banks by innovating business model and improving operating efficiency. Table 8 shows the results of the regression of models (4), (5) and (6) in order to study the impact mechanism of financial innovation.

	(1)	(2)	(3)
	RISK	FCI	RISK
INTEL	0.0006**	-0.2614	0.0007***
LNFI	(0.003)	(0.537)	(0.000)
LOD	0.0026***	-3.4611***	0.0015**
LOD	(0.000)	(0.001)	(0.002)
NIM	-0.0131	163.8318***	-0.0158
181191	(0.245)	(0.000)	(0.249)
CAR	-0.0166***	80.0136***	-0.0107**
CAR	(0.000)	(0.000)	(0.005)
SIZE	-0.0075*	210.6602***	-0.0015
	(0.058)	(0.000)	(0.825)
CDD	-0.0041	2.6272	-0.0009
GDP	(0.198)	(0.701)	(0.777)
TITI	0.0000	0.3136	0.0003
HHI	(0.994)	(0.846)	(0.687)
ECI			-0.0000
ГСІ			(0.222)
	0.7419***	-2.94e+03***	0.6639***
_cons	(0.000)	(0.000)	(0.000)

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

Table 7 shows the results of the whole sample regression. The regression coefficient of digital transformation (LNFI) in Model 1 is significantly positive at the level of 5%, indicating that there is an obvious positive correlation between the digital transformation of commercial banks and their own risk taking.

Model two can see that the regression coefficient of the digital transformation is significantly negative. It shows that digital transformation has a negative impact on bank financial innovation. In the case of increasingly fierce market competition, banks have been seeking digital transformation, trying to enhance the core competitiveness of banks through financial innovation, broaden the ways of non-interest income in order to reduce the negative impact of the narrowing of deposit and loan spreads on their profitability, and effectively reduce the risk taking level of banks.

Model 3 is the regression result after adding the financial innovation variable (FCI) and the bank digital transformation index as the core explanatory variable. It can be seen that the fee and commission income ratio (FCI) is significantly negative, and γ 2 is negative. The Bank Digital Transformation Index (LNFI) is significantly positive, and γ 1 is positive. Therefore, the product of β 1 and γ 2 is opposite to γ 1, indicating that the lending rate has a "concealment effect" rather than an "intermediary effect". According to the interpretation of "cover effect" by MacKinnon (2000) and Fan Changyu (2016), the total effect of digital transformation on the risk bearing of commercial banks is 0.0006, which is 0.0007 less than the direct effect of digital, that is, after controlling the proportion of commission and commission income (FCI), the improvement effect of digital transformation can reduce the risk taking level of banks by improving the level of financial innovation.

This paper believes that the possible reason is that the digital transformation makes the risk of information technology and network security more prominent, the credit rating of customers is sunk, the scope of long tail customers is expanded, the capital leverage ratio of commercial banks is increased, and the credit risk of commercial banks is increased. The development of Internet business can easily lead to maturity mismatch and increase the compliance risk of banks. At the same time, digital transformation strengthens the connection between the businesses of commercial banks, which easily leads to the risk transmission of the whole chain. Therefore, generally speaking, digital transformation improves the risk taking of commercial banks. In terms of financial innovation mechanism, digital transformation has promoted the transformation of the business model of commercial banks, improved the operating efficiency, enhanced the ability of risk identification, and improved the possibility of risk transfer, thus reducing the level of risk taking. Embodied in the model, the total effect of digital transformation on the risk bearing of commercial banks is 0.0242, which is less than 0.0269 than the direct effect.

5.2 Heterogeneity analysis

Different types of commercial banks will have heterogeneous reactions due to the differences in their asset size and total business categories. Due to the small number of samples in this paper, it is impossible to analyze the differences of different types of commercial banks separately. Therefore, we find a new way to eliminate the four banks in the sample and divide them into four subsamples. Then, four subsamples excluding a certain type of commercial banks were substituinto the model (4), and the regression results were analyzed with the regression results of the whole sample to analyze the heterogeneity of different types of commercial banks, the sub-samples exclude the data of state-owned banks, the sub-samples exclude the data of joint-stock banks, the subsamples exclude the data of urban commercial banks, and the subsamples exclude the data of rural commercial banks.

It can be seen from Table 9 that the regression coefficients of digital transformation in subsample 1 and subsample 2 are 0.0008 and 0.0007, respectively, compared with the regression coefficient of 0.0006, which is obviously larger. This shows that after excluding the state-owned banks and joint-stock banks, the influence of the digital transformation on the risk bearing level of commercial banks has increased, that is, the digital transformation has a stronger influence on urban commercial banks and rural commercial banks. However, the regression coefficients of the digital transformation of subsample 3 and subsample 4 were 0.0006 and 0.0005, respectively, showing little difference of 0.0006 from the regression coefficient of 0.0006 in the whole sample. This shows that after excluding urban commercial banks and rural commercial banks, the influence of digital transformation on the risk bearing level of commercial banks has decreased, that is, the influence of digital transformation on state-owned banks and joint-stock banks is weak. Then the sub-sample 1 and sub-sample 2 are compared, and the sub-sample 3 and sub-sample 4 are compared to compare the differences between these state-owned banks and joint-stock banks, as well as the differences between urban commercial banks and rural commercial banks. First, the regression coefficient in subsample 1 is greater than that in subsample 2, indicating that digital transformation has a greater impact on joint-stock banks. However, the regression coefficient of subsample 3 is greater than that of the regression coefficient of subsample 4, indicating that the degree of digital transformation has a greater impact on rural commercial banks.

	(1)	(2)	(3)	(4)
	RISK	RISK	RISK	RISK
	0.0008***	0.0007***	0.0006***	0.0005***
LINFI	(0.000)	(0.000)	(0.000)	(0.000)
LOD	0.0022***	0.0015**	0.0020***	0.0018***
LOD	(0.000)	(0.013)	(0.000)	(0.000)
NUM	0.0149*	0.0119	0.0079	0.0018***
181191	(0.089)	(0.0119)	(0.459)	(0.000)
CAD	-0.0095***	-0.0079**	-0.0119***	-0.0114***
CAK	(0.000)	(0.038)	(0.000)	(0.000)
SIZE	-0.0117**	-0.0068*	-0.0077**	-0.0113***
	(0.001)	(0.053)	(0.005)	(0.000)
CDP	-0.0005	-0.0027	-0.0026	-0.0017
GDP	(0.793)	(0.317)	(0.289)	(0.425)
TITI	0.0004	0.0000	-0.0007	0.0008*
нні	(0.392)	(0.977)	(0.216)	(0.084)
_cons	0.6125***	0.6267***	0.6871***	0.7017***
	(0.000)	(0.000)	(0.000)	(0.000)
N	233	113	157	211

Table 9 points the sample estimation results

p-values in parentheses

* p<0.1, ** p<0.05, *** p<0.001

With the continuous development of Chinas economy, the scale of banks is also expanding, and all kinds of emerging banks are springing up like mushrooms. Finally, the structural system of four types of banks is state-owned commercial banks, joint-stock banks, urban commercial banks and rural commercial banks. These banks cover customers at the national level and are an indispensable force for Chinas economic development. Specifically, state-owned commercial banks and joint-stock banks have a wide range of business and can meet the needs of different customers. Urban commercial banks and rural commercial banks are rooted in the local area and are universal benefits. These banks are greatly different internally because of their different management systems. Therefore, the extent to which the digital transformation affects its risk taking is also different.

6. Conclusions

6.1 Study Conclusion

Through the past literature, first of all, this paper expounds the digital transformation of commercial bank risk bearing level and its influence mechanism, then from the perspective of empirical selection 2011-2021 43 commercial Banks in China panel data, empirical test the digital transformation on the influence of commercial bank risk bearing level, and for different types of commercial Banks points sample heterogeneity analysis. Finally, the gradual regression method is used to verify the influence path of digital transformation to affect the risk bearing level of commercial banks through financial innovation. The study conclusions are summarized as follows:

(1) First of all, from the perspective of the main regression model, the regression coefficient of the digital transformation is significantly positive at the level of 1%, indicating that there is an obvious positive relationship between the degree of digital transformation and the level of risk taking. On the one hand, digital technology has optimized the institutional structure of commercial banks and improved the operating efficiency, but on the other hand, it also makes the operation and management of commercial banks more complicated.

(2) Digital transformation reduces the positive impact on the risk bearing level of commercial banks through the financial innovation mechanism. On the one hand, digital transformation makes the risk of information technology and network security more prominent, the credit rating of customers sinks, expands the scope of long tail customers, improves the capital leverage ratio of commercial banks, and increases the credit risk of commercial banks. The development of Internet business can easily lead to maturity mismatch and increase the compliance risk of banks. At the same time, digital transformation strengthens the connection between the businesses of commercial banks, which easily leads to the risk transmission of the whole chain. Therefore, overall, digital transformation improves the risk taking of commercial banks.

(3) The heterogeneity of the impact of the development of digital finance on the risk taking of different types of banks is very obvious. The risk of large and medium-sized banks such as state-owned banks and joint-stock banks is more obviously affected, while the impact of small banks such as urban commercial banks and rural commercial banks is relatively small.

6.2 Policy recommendations

From the conclusion of the research, the digital transformation has indeed increased the risk-taking level of commercial banks. However, this is more due to the fact that they are still in the early stage of digital transformation, and commercial banks are not mature enough in the application of digital. In the long run, as commercial banks become more proficient in the use of digital technology, banks can weaken or even eliminate the disadvantages brought about by digital transformation, and fully enjoy the fruits brought about by digital transformation. Taking the historical opportunity of digital transformation, we can better contribute to the people, the country, and this society. According to the three conclusions drawn in this paper, from a practical perspective, we advise commercial banks and regulatory authorities to help commercial banks better promote digital transformation, help regulatory authorities better maintain the order of the financial market, and promote the healthy and sustainable development of the financial market.

First, formulate clear digital strategies and development plans: commercial banks need to formulate a clear digital strategy and clarify the goals, paths and key areas of digital transformation. In addition, banks should establish a complete digital development plan to ensure that their business and technology investments are aligned with their strategic objectives. Specifically, banks should implement the digital transformation plan in stages, starting from the construction of infrastructure and technology platform, gradually expand to the innovation of financial products and services, and finally achieve comprehensive business process optimization and management mode upgrading.

Second, invest in innovative technologies and infrastructure: Banks should actively introduce emerging technologies, such as artificial intelligence, big data, blockchain, etc., to improve business processing efficiency and customer service quality. In this process, banks need to establish close cooperation with technology companies, fintech companies, universities and research institutions to jointly explore the application scenarios and business models of fintech. At the same time, banks need to invest in infrastructure construction, such as data centers and cloud computing platforms, to support the development of digital businesses. These investments can be made through partnerships, internal research and development, or mergers and acquisitions.

Third, combined with the actual differentiated digital transformation layout: on the one hand, banks should conduct differentiated digital transformation layout according to their own actual situation and development. For example, state-owned commercial banks and those located in high economic level should make full use of their advantages in

capital, market and technology to actively carry out digital transformation; non-state-owned commercial banks and those located in low economic level should not be confined to capital and technology, but use digital transformation to enhance risk identification ability. On the other hand, banks can use network technology, big data, cloud computing and artificial intelligence to improve the risk pricing and control model, transform and upgrade the risk early warning system, and improve the efficiency of financial services and risk identification ability. At the same time, they should clarify their positioning, differentiate competition and build core competitiveness.

Fourth, change the risk management system and mechanism: the banking industry should pay attention to the combination of digital technology and its own risk management system, and change the risk management system and mechanism. Commercial Banks should as soon as possible to data management into the long-term development planning and strategic layout, strengthen the construction of data standards, data model, data architecture management, efficient use of massive multidimensional data, realize discrete information integration and characteristics, clear their own risk appetite, in the process of promoting digital transformation firmly hold the bottom line.

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