Research on the Risk Spillover Effect of Digital Financial Development on China's Commercial Banks

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Abstract. In recent years, digital finance has been developing continuously, and commercial banks have developed their own digital financial services in order to gain more profits from it in line with the advancement of technology, digital finance has presented commercial banks with unparalleled opportunities, as well as great challenges. To examine the influence of digital finance on the risk spillover among various categories of commercial banks. Theoretical analysis is employed to examine the direct and indirect impacts of digital finance on the risk transmission of commercial banks, as well as to measure the risk spillover effect of digital finance on different types of commercial banks using the GARCH-CoVaR model with skewed t-distribution. The results of the study show that among Chinese commercial banks, nationalized banks have the lowest level of risk, while city commercial banks have the highest risk. By comparing the risk spillover values (%CoVaR), it can also be seen that the highest risk spillover is for nationalized banks and the lowest is for urban commercial banks. This conclusion is of significance for regulating the systemic risk spillover of Internet finance, as well as promoting the sound development of Chinese commercial banks.

1 Introduction

With the deepening of the digital economy and the global outbreak of the New Crown epidemic, the demand for “touch less” or “touch less” financial services is increasing [1]. This type of service shift to the digital environment provides people with easier ways to make payments, manage finances, and other functions [2]. Digital finance refers to the combination of finance and technology, such as big data, cloud computing, block-chain, and artificial intelligence, which can improve the functioning of the financial industry Digital Finance [3]. Promoting green innovation in firms by easing financing constraints, weakening agency conflicts, and improving firm performance [4]. Given the importance of banks in the financial system, it is crucial to study the impact of digital finance on commercial banks. It is uncertain whether digital finance has revolutionized the operation of commercial banks, and academically whether digital finance is effective in increasing the stability of commercial banks remains a controversial topic. But it can be clearly found that digital finance is gradually affecting the traditional business of commercial banks.

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Digital finance is particularly significant in enhancing the information environment of commercial banks and facilitating specialized division of labor [5]. Digital finance offers new opportunities and models for commercial banks, but it also presents unavoidable challenges. From one point of view, digital technology helps commercial banks to push back initial boundaries, giving them more operational management space and creating the conditions needed to enhance operational earnings and minimize operational expenditures [6]. On the other hand digital finance is at its core a constant process of innovation and change [7]. This innovation will generate various uncertainties and challenges that will increase the risk spillover effects the systemic risk posed by commercial banks. There are many factors affecting the systemic risk of commercial banks, such as the size of the bank's assets, the quality of its loans, the rate of bad loans, and its solvency [8]. Commercial banks are pro-cyclical, due to the global economic downturn, pro-cyclical industries are being affected, and the traditional business model cannot adapt to the current economic development, and digital transformation is necessary [5].

This paper provides a theoretical analysis of the risk spillover effect of digital finance on commercial banks, aiming to analyze the underlying reasons for this phenomenon. Secondly, CoVaR analysis mode is proposed, “model selection - smooth root test - autoregressive conditional heteroskedasticity test - mechanism analysis”. In this paper, the closing prices of 9 commercial banks are selected as samples, and the data with missing values and non-overlapping closing price dates in each series are eliminated, and 496 data are finally obtained for each series. In the data on digital finance, this paper explains the variable digital finance, given the short development time of digital finance and the diversity of forms, the use of the Internet finance index is released with the CSI Index Company Limited, which has strong authority and representativeness, and the time is selected from January 3, 2019 to December 29, 2023.

This is how the remainder of the article is organized: In Section 2, theoretical analysis is conducted. The sample and variables are thoroughly explained in Section 3. We go through the empirical procedures and findings in Section 4. The entire text is outlined in the fifth section.

2 Theoretical analysis

Both the technology industry and the financial industry have high risks, and combining the two will inevitably amplify the risks while combining the advantages of both, thus increasing the systemic risk of commercial banks.

First, it will generate technological risk spillover, the swift advancement of digital finance has made online banking and other electronic payment methods increasingly popular, breaking down cross-border barriers, and the application of the Internet and block chain technology has organically connected the global financial system and strengthened business exchanges between different regions, which has led to easier risk spillover between regions [9]. Commercial banks need to constantly upgrade as well as innovate technologically to accommodate to the booming growth of digital finance, but technological risks can spill over to the entire financial sector, especially those involved in Internet financial platforms that could have a serious influence on the entire financial system.

Second, the development of digital finance has promoted financial innovation, which includes new types of financial services such as P2P Internet lending and virtual currencies, and these innovative products have improved the profitability of banks and in turn raised more capital for their development [10]. In order to provide consumers with unique services, banks can use data mining and quantum algorithms to precisely compute preferences, identify customer demands and behavior patterns, create in a variety of digital contexts, and

create clever and sophisticated marketing services [11]. However, these new businesses also bring new risks, including risks of overdue borrowing and lending, broken capital chains, etc., which directly affect the asset quality and profitability of commercial banks, thus leading to credit risk spillovers.

In addition, the emergence of digital finance has put traditional financial institutions under more intense competitive pressure, which has further pushed commercial banks to innovate and improve their risk management. To maintain their competitiveness in the digital finance era, commercial banks have had to adjust their business models and risk management strategies to adapt to the market demand and risk characteristics under the new situation, which may lead to a decline in their business scale and profitability, thus indirectly increasing the operational risks of commercial banks.

Finally, Banks are using Big Data, artificial intelligence, applying more cutting-edge technology to broaden the scope of risk information collection, creating a risk landscape that is focused on the needs of the client, and shrewdly spotting hidden threats, and catalyzing rapid development within the banking sector. However, the lag in regulation relative to the development of fintech has greatly increased the difficulty of regulation, leading to insufficient regulation and thus further contributing to the adamant risk of the financial system [12].

3 Methodology and Data

3.1 Research method

In this paper, we use the skewed t-distribution in the GARCH-CoVaR model to measure the systemic risk of banks.Var model is a model in which the maximum degree of loss under a particular financial instrument or portfolio depends on the normal future volatility of asset prices [5]. CovaR represents the highest potential risk or loss that other financial institutions or the financial sector as a whole may suffer in the event of an extreme event within a single institution [13]. The "Co" in Covar represents the systemic risk's marginal impact on an individual financial institution during periods of crisis [14]. The GARCH model is a time series statistical model used for financial market analysis.

$$r_x = \alpha + \beta r_m + AR(L)r_x + u \quad (1)$$

$$\sigma_x^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \lambda_2 \sigma_{x-1}^2 \quad (2)$$

△CoVaR applies the value of increase in risk spillover to measure the risk spillover effect, which represents the risk spillover from financial institution *i* to financial institution *j* when financial institution *j* is subjected to a shock, and is expressed as follows:

$$Prob(Xi \leq CoVaR^{j|i}_q | X^j = VaR^j_q) = q \quad (3)$$

$$\Delta CoVaR^{j|i}_q = CoVaR^{j|i}_q - VaR^j_q \quad (4)$$

3.2 Data source

This paper takes listed banks as the object of analysis, and divides commercial banks into nationalized banks, joint-stock banks and city commercial banks. Industrial and Commercial Bank of China (GS), Construction Bank of China (JS) and Agricultural Bank of China (NY) are selected as representatives of nationalized banks, Ping An Bank (PA), China Merchants Bank (ZS) and PuFa Development Bank (PF) are selected as representatives of joint-stock banks, and Changsha Bank (CS), Bank of Chengdu (CD), and Nanjing Bank (NJ) are selected as representatives of city commercial banks. The yield series is used instead of the price series. rt=ln(Pt)-ln(Pt-1). Where rt is the yield and Pt is the closing price of the index on day t. Basic information descriptive statistics are then

performed on the percentage return series of all stock indices. For the data on digital finance, the explanatory variable digital finance (JR) is selected and the Internet finance index is used.

Table 1. Select descriptive statistics of percentage return series of commercial banks

	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera
CD	0.0006	0.0272	0.2189	6.0502	184.3663
JS	0.0004	0.0182	-0.5702	8.6617	647.6511
CS	-0.0006	0.0257	-0.1391	7.2684	355.2426
ZS	0.0003	0.0270	0.1350	4.6587	54.8327
NJ	0.0005	0.0227	-2.4400	30.4267	15067.96
NY	0.0004	0.0152	-0.8930	11.7660	1553.948
PA	-0.0006	0.0313	0.0653	10.2096	1009.566
GS	0.0003	0.0157	-0.1837	9.4197	802.8136
PF	-0.0004	0.0190	-1.4670	20.1609	5873.021
JR	-0.0002	0.0254	-0.7566	12.8134	1914.347

Observation of Table 1, from the skewness coefficients of the percentage returns of the stock indices, the coefficients of CD, PA, and ZS are greater than 0 showing right skewness, and the coefficients of PF, JS, CS, GS, NJ, and NY are less than 0 showing left skewness. All kurtosis coefficients are greater than 3, with obvious spiking phenomenon, at the same time, all kinds of stock index return series do not obey normal distribution.

When performing regression analysis the data should be tested for smooth root, if the data is not smooth the phenomenon of pseudo-regression will occur, so it is required that the data of the time series is smooth.

Table 2. ADF test and ARCH test

		ADF test statistics	LM order	Prob
	NY	-22.6782	2	0.0074
nationalized bank	JS	-21.9771	1	0.0003
	GS	-22.2637	2	0.0170
	PA	-22.6476	1	0.0023
joint-stock bank	ZS	-22.5320	1	0.0000
	PF	-22.7766	1	0.0032
	CS	-13.2564	1	0.0006
city bank	NJ	-22.0602	2	0.0064
	CD	-22.6104	1	0.0130
Digital finance		-20.3082	1	0.0001

Observation of Table 2 shows that when tested for 1% significance, the ADF test statistic exceeds the critical value of 3.43, and the p-values are all 0. This means that we cannot accept the assumption of the original series, that is, the Internet finance index and commercial bank yields are stable. Because all the series do not conform to the normal distribution and show the aggregation phenomenon of fluctuation, there is a possibility of ARCH effect, so we need to test for ARCH effect. In this paper, the return of SSE index is used to represent the level of total market return, and the return of each commercial bank and the return of Internet finance index are regarded as the explanatory variables, and the return of SSE index is regarded as the explanatory variables to construct the regression equation.

$$r_x = \alpha + \beta r_m + AR(L)r_x + u \quad (5)$$

$r_x$denotes the rate of return of each commercial bank or the rate of return of Internet finance,$r_m$denotes the return of the SSE index,$AR(L)$is the lag factor,u is the residual

The GARCH model is applied to calculate the VaR value of each yield series, and the yield series of digital finance and each commercial bank are taken as the explanatory variables, and the yield series of the SSE index is taken as the explanatory variable to establish the GARCH model respectively.

4 Empirical result

From Table 3, we can find a significant correlation between VaR and %CoVaR in the study of their relationship. Despite the fact that the Construction Bank is the institution with the largest risk spillover in the cyberfinance sector, its VaR ranking is only the 6th, showing a relatively low level of risk. On the contrary, the highest VaR is that of Bank of Chengdu, yet the level of risk spillover it is exposed to is quite weak. This finding reveals the fact that banks that are less risky are more susceptible to cyber risk spillovers, in other words, the overall risk posed by the cyber is more pronounced for these lower-risk banking operations.

Table 3. Digital finance and commercial bank risk

		Model selection	VaR	VaR rank	CoVaR	ΔCoVaR	%CoVaR
	NY	GARCH(1,1)	-0.0050	8	-0.0054	0.0001	1.8181
Nationalized bank	JS	GARCH(1,1)	-0.0066	6	-0.0063	0.0003	4.5434
	GS	GARCH(1,1)	-0.0052	7	-0.0053	-0.0001	1.9231
	PA	GARCH(1,2)	-0.0076	5	-0.0075	0.0001	1.3158
Joint-stock bank	ZS	GARCH(2,2)	-0.0117	2	-0.0112	0.0005	4.2735
	PF	GARCH(1,1)	-0.0082	4	-0.00812	0.00008	0.976
	CS	GARCH(1,1)	-0.0083	3	-0.00823	0.00007	0.8434
City bank	NJ	GARCH(1,1)	-0.0083	3	-0.00831	0.00001	0.12
	CD	GARCH(1,1)	-0.0125	1	-0.01249	0.00008	0.09
Digital finance		GARCH(1,1)	-0.0171				

5 Conclusion

With the continuous development and innovation of digital finance, commercial banks are no longer limited to traditional business and gradually develop online banking services, but the digital financial risks continue to expand, creating a serious risk spillover effect on commercial banks. This paper measures the risk spillover effects of Internet finance on various categories of commercial banks using the GARCH-CoVaR model with skewed t-distribution. First, by comparing the value-at-risk (VaR), it is found that each type of bank has risk differences with Internet finance itself. By comparing the value of risk spillover (%CoVaR), we find that there are substantial variations in the risk spillover of Internet finance to various categories of commercial banks. After the research in this paper, we draw the following conclusions and insights:

The first point: there are non-negligible risks in all types of commercial banks and Internet finance itself. Among commercial banks, nationalized banks have the least risk,

among which the Construction Bank has the lowest risk. This is followed by joint-stock banks, while urban commercial banks are associated with the highest level of risk.

The second point is that, as a whole, there is little difference between the risks of digital finance and those of individual commercial banks, but the risks transferred from digital finance to each commercial bank are very different.It is essential to acknowledge simultaneously that lower-risk banks are more susceptible to risk spillovers from Internet financing, which implies that the spillovers of systemic risk from Internet financing will be more pronounced for these higher-risk banks.

In this regard, this paper put forward some countermeasures and suggestions to deal with the challenge of digital finance development's risk spillover effect on commercial banks. First, commercial banks need to proactively innovate their products and services in order to strengthen their competitiveness to cope with the competitive pressure from digital finance. Second, they should strengthen supervision and monitoring, and establish a sound digital finance risk management system to prevent and control the risks brought by digital finance. In addition, commercial banks should strengthen the construction of internal risk control capacity and improve the level of risk identification and control.

6 References

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