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Article

Research on the Impact of ESG Factors on Bank Liquidity Risk

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Abstract: In recent years, with the increasing prominence of environmental and social issues, investors have been paying more attention to the ESG performance of enterprises, highlighting the importance of ESG factors in the financial field. This study is based on the theories of banking business models, stakeholder theory, risk management theory, and ESG investment theory. It uses the financial data and ESG scores of Chinese listed banks to deeply analyze the ESG factors and explore their impact on the liquidity risk of commercial banks. The research found that (1) good ESG performance can reduce the liquidity risk commercial banks face by improving bank value and financial performance. (2) ESG factors can also enhance the liquidity management level of commercial banks through standardization and sustainable business principles, thereby reducing the occurrence and impact of liquidity risk. Therefore, it is necessary to reduce the liquidity risk of banks and promote the sustainable development of commercial banks from four aspects: ESG performance and management, bank value, financial performance, and policy regulation.a

Keywords: ESG performance; liquidity risk; bank value; financial performance

1. Introduction

ESG (Environment, Society, and Governance) was first formally proposed in January 2004 as an initiative to incorporate ESG factors into the capital market. This initiative clarified the meaning of "ESG" for the first time. The report calls on financial institutions to integrate ESG factors into the operation of the capital market. At the same time, companies need to disclose their ESG performance according to the needs of investors (Renneboog et al., 2008). In terms of environmental, companies need to pay attention to the impact on the environment during operation, including energy use, waste treatment, pollution emissions, natural resource protection, and climate change (Jitmaneeroj, 2016). In terms of social, it mainly involves the relationship between the company and its employees, suppliers, customers, and the community where it is located. This includes issues such as employee rights, occupational health and safety, diversity and inclusion, human rights, community relations, and supply chain management. Governance mainly focuses on the leadership structure and behavior of the company, including board structure, executive compensation, audit process, shareholder rights, transparency, and fair transactions (Li et al., 2021). In order to attract investors, companies must optimize their performance in three areas: environmental, social, and governance (ESG). It is believed that this approach will have a significant impact on the world and create a win-win situation for all parties involved.

In recent decades, ESG factors have aroused widespread concern and discussion. Especially in recent years, environmental and social issues have become increasingly prominent, and investors have paid more attention to the ESG performance of enterprises (Avramov et al., 2022). Twenty-six stock exchanges around the world have mandated the disclosure of ESG information. On April 15, 2022, the China Securities Regulatory Commission issued the "Guidelines for Investor Relations Management of Listed Companies," which listed "corporate environmental protection, social responsibility, and corporate governance information" as the main content of communication between listed companies and investors. It required listed companies to explain ESG matters to investors (China Securities Regulatory Commission, 2022). With the advancement of the dual-carbon

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goals of various countries, the importance of ESG factors will be more widely accepted and developed into a universal investment concept.

At the same time, the development of ESG factors in the financial field does not only stem from the popularization of the concept of social responsibility, but more importantly, ESG factors can provide vital information to evaluate the risk and value of enterprises(He et al., 2022). Environmental considerations help investors understand the environmental threats faced by companies and their ability to develop sustainably. Social elements reveal the relationship between the company and society, as well as the company's reputation and brand value. The governance factors reflect the internal management quality and decision-making ability of the enterprise. Combining these factors, investors can make a more comprehensive corporate risk and value assessment and make more informed investment decisions.

In the banking sector, commercial banks face liquidity risk, which is a significant challenge in their operations. Liquidity risk refers to the risk of commercial banks being unable to meet the short-term funding needs of depositors and borrowers, resulting in fund loss and increased liquidity pressure(Yao, 1997). Currently, commercial banks face two main types of liquidity risks: capital liquidity risks and market liquidity risks. Capital liquidity risk occurs when commercial banks cannot raise enough funds in a timely manner to meet the increased demand or insufficient supply of funds in the short term. This risk often arises from improper capital management or changes in the external environment that create a mismatch between capital supply and demand. For example, during an economic downturn, residents may withdraw funds, and if commercial banks have slow capital turnover, liquidity risks increase. Market liquidity risk refers to the risk of commercial banks facing imbalances between buyers and sellers in financial market transactions, resulting in the inability to complete transactions or obtain sufficient market liquidity. This risk can stem from changes in supply and demand in the financial market or market participants' panic about risk. Insufficient market liquidity may prevent commercial banks from selling assets or raising funds in a timely manner, further increasing their liquidity risk. The New Basel Accord includes detailed provisions and requirements for bank liquidity risk. Banks are required to maintain a sufficiently high liquidity coverage rate to ensure they have enough high-quality liquid assets, such as cash, central bank reserves, and marketable securities, to meet their committed cash outflows and potential cash outflows within 30 days during severe short-term stress (Supervision, 2010). Additionally, banks must establish a robust risk management and supervision system, including conducting liquidity risk stress tests, regularly reporting liquidity risk status to supervisory agencies, and developing emergency liquidity plans.

The importance of ESG factors in the current liquidity risks of commercial banks has become prominent. ESG, which stands for environmental, social, and corporate governance, is now a crucial consideration in the financial sector (Guo et al., 2023). These factors encompass the level of environmental responsibility, social responsibility, and corporate governance exhibited by commercial banks. Research has shown that good ESG performance can significantly mitigate the liquidity risk faced by commercial banks. Specifically, it can enhance bank value and financial performance, thereby reducing liquidity risk. Moreover, ESG factors can also enhance the liquidity management level of commercial banks through standardisation and sustainable operation principles, ultimately minimising the occurrence and impact of liquidity risks.

ESG factors have a significant impact on the liquidity risk of commercial banks. Good ESG performance can reduce liquidity risk and improve liquidity management. Therefore, it is important to strengthen the supervision of ESG factors at the management and supervision levels. Introducing ESG indicators as a measure of liquidity risk can promote the sustainable development and sound operation of commercial banks. Additionally, commercial banks should prioritize the management and practice of ESG to minimize liquidity risks and their impact on banking operations. This study utilizes the banking business model theory, stakeholder theory, risk management theory, and ESG investment theory to analyze the impact of ESG factors on the liquidity risk of listed banks in China. The findings provide suggestions for the long-term stable development of banks and related policy supervision.

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2. Theoretical Analysis and Research Hypothesis

As one of the most important financial institutions, banks have long plagued the regulatory authorities with liquidity issues. The Basel Committee on Banking Supervision is a standing supervisory body under the Bank for International Settlements. Its definition of liquidity is the ability of a commercial bank to obtain funds at a reasonable cost to respond to asset enhancements while meeting debt repayment obligations on schedule (Fan et al.). The liquidity level of banks is changing all the time. When banks sell assets and raise funds, their liquidity will increase. When banks repay debts and issue loans, their liquidity will decrease. In the Measures for the Administration of Liquidity Risks of Commercial Banks adopted by the China Banking and Insurance Regulatory Commission, liquidity risk is defined as the risk that commercial banks cannot obtain sufficient funds in a timely manner at a reasonable cost to repay due debts, perform other payment obligations and meet other capital needs for normal business development. The core is described as the risk of not being able to complete the due payment obligation. Commercial banks exist essentially for liquidity conversion and liquidity creation. Therefore, liquidity risks originate from the banks themselves, and banks need to face them all the time.

The good ESG performance demonstrates that a bank's positive performance in the areas of environment, society, and governance can enhance its image among the public and investors, thereby improving its market reputation. Banks that have higher market reputations are generally more likely to attract investors, leading to increased market liquidity for their bonds and equities(Uyar et al., 2022). Additionally, good ESG performance can help mitigate the bank's market risk associated with environmental, social, and governance issues. For instance, if banks excel in environmental protection, they are less likely to face fines or lawsuits, even if environmental regulations become more stringent. This, in turn, reduces the risk of their stock prices plummeting. Therefore, good ESG performance plays a crucial role in minimizing the market liquidity risk for commercial banks.

Based on the above analysis, this paper proposes hypothesis H1.

H1: ESG Performance Can Significantly Reduce Liquidity Risk of Commercial Banks

State-owned banks have good asset quality and large scale, which makes them more resilient in the face of market fluctuations, thereby reducing liquidity risk. Additionally, state-owned banks are usually subject to stronger government supervision, which also ensures their strict implementation of ESG policies, further reducing risks(Zhang, 2023). Non-state-owned banks are relatively small, and their asset quality and risk management capabilities may not be comparable to those of state-owned banks(Zhu et al., 2011). In this case, the ESG score of non-state-owned banks is particularly important. If the non-state-owned bank has a higher ESG score, it may attract more investors, thereby increasing the liquidity of its assets and reducing liquidity risk. Conversely, if its ESG score is low, then investors may have doubts about it, which will affect risk identification and loan business.

Based on the above analysis, this paper proposes hypothesis H2.

H2: Property Heterogeneity of ESG Performance on Liquidity Risk of Commercial Banks

When a company performs well in environmental protection, social responsibility, and corporate governance, it enhances its image in the minds of the public and investors(Freeman et al., 2004), thereby increasing its bank value. A strong corporate image increases investors' trust in the company and attracts more investors, thereby boosting the liquidity of its stocks and bonds and reducing liquidity risks. Additionally, good ESG performance helps companies avoid fines or lawsuits resulting from environmental pollution, social problems, and governance issues, thus safeguarding their bank value.

Companies with good ESG performance are usually able to achieve better financial performance. Good financial performance can increase the credit rating of an enterprise, thereby reducing the interest rate of its bonds and reducing financial costs. At the same time, good financial performance can also improve the profitability of enterprises, thereby increasing the attractiveness of their stocks and improving the liquidity of stocks (Chen et al., 2023).

Therefore, the enhancement of bank value and improvement of financial performance through good ESG performance can effectively reduce the liquidity risk of commercial banks. This not only

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promotes the stable operation of the bank but also enhances its competitiveness in the financial market, further strengthening its position in the eyes of investors.

Based on the above analysis, this paper proposes hypothesis H3.

H3: It is hypothesized that the performance of environmental, social, and governance (ESG) factors can mitigate the liquidity risk faced by commercial banks. This can be achieved through improvements in bank value and financial performance.

Digital transformation refers to the ongoing application of digital technologies such as cloud computing, the Internet of Things, and big data. This process accelerates business optimization, upgrades, and innovation and transforms traditional methods into new ones. It cultivates new sources of energy and facilitates the transformation, upgrading, and innovation process. In the case of commercial banks, digital transformation can enhance technical infrastructure, improve risk management, and overcome limitations of time and space. It enables the formation of an information-sharing and innovation collaboration platform, which has a positive impact on commercial banks(Lu, 2023).

Based on the perspective of factor allocation(Yao, 2009), digital transformation is conducive to improving the circulation speed of internal and external factors of commercial banks, optimizing the allocation efficiency of factors, and reducing the liquidity risk of commercial banks. Based on the perspective of information sharing, the digital transformation of commercial banks can improve the "information power" in the green innovation of enterprises and significantly improve the problem of information asymmetry(Akerlof, 1995). Specifically, banks can monitor assets and liabilities in real-time through digitalization and discover and deal with risks in a timely manner, thereby enhancing risk management capabilities.

Based on the above analysis, this paper proposes hypothesis H4.

H4: Digital Transformation Level Has a Moderating Effect between ESG Performance and Liquidity Level of Commercial Banks

3. Research Design and Research Data

3.1. Sample Selection and Data Sources

As of 2023, China has a total of 54 listed banks. After excluding banks that do not have ESG-related data, this article focuses on 41 listed banks, including Ping An Bank and Bank of China. The liquidity indicators and financial indicators of commercial banks are measured using data from the Wind database. The Digital Transformation Index of Peking University Bank is obtained from the Digital Finance Research Center of Peking University. In terms of ESG scores, the China Securities Exchange ESG rating data covers all listed companies in China's A-shares from 2009 to 2022, providing wider coverage and complete data. Therefore, this paper utilizes Huazheng's ESG score, considering the influence of data outliers. To address this, the study has performed 1% tailing processing on all sample data.

3.2. Variable Selection

3.2.1. Explained variable: Loan-To-Deposit Ratio (LTD)

With reference to previous studies, the deposit-loan ratio is a key indicator to measure bank liquidity risk(Gong, 2016). Therefore, the bank's deposit-to-loan ratio (LTD) is selected as the explanatory variable in this article. A high deposit-to-loan ratio means that the loan balance significantly exceeds the deposit balance, which may imply that the bank is too biased towards lending in its capital operations. This may bring certain risks in the short term: if there is a large-scale withdrawal of customers or a large number of loans that have not been recovered when they expire, the bank may not be able to meet this cash demand, which may lead to an increase in the bank's liquidity risk.

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3.2.2. Core Explanatory Variable: HZESG

The core explanatory variable used in this article is the ESG score of the China Politics Index. The ESG rating system of the China Affairs Index adopts a multi-level scoring method and consists of four levels of indicators. Specifically, there are three first-level indicators, 14 second-level indicators, 26 third-level indicators, and more than 130 fourth-level data indicators. The specific score of each indicator is based on its contribution weight to the company's overall ESG performance.

In order to remove the unit influence of the score and maintain the multiple relationships of the data, a logarithmic transformation was performed on the converted score. This treatment does not change the relative size of the ESG score, but it can make the data conform to the assumptions of some statistical models.

3.2.3. Intermediary Variables: Bank Value (TobinQ), Profitability (ROE)

This article selects bank value (TobinQ) and profitability (ROE) as intermediary variables. It utilizes TobinQ to assess bank value. TobinQ is a widely used indicator for measuring the value of an enterprise. A higher TobinQ indicates a greater recognition of the efficiency and value of the enterprise by the market (Tobin, 1969), and vice versa. As a real-time reflection of bank value, TobinQ aids in exploring and comprehending the relationship between the influence of ESG ratings on bank value and bank liquidity risk.

Profitability is often measured by the company's ROE (return on equity), which reflects the ability to produce profit per unit of capital. The higher the ROE, the stronger the company's profitability. This is an important indicator that can directly reflect the company's economic benefits in its business activities (Jonathan et al., 2023). Therefore, ROE helps to explore the relationship between the impact of ESG rating on the profitability and operational efficiency of enterprises and the liquidity risk of banks.

3.2.4. Moderating Variable: Peking University Bank Digital Transformation Index (PKUDBI)

The level of digitalization in banks may impact their performance in operations, management, and risk control and subsequently may affect the liquidity risk of the banks (Xie, 2023). This paper uses the digital transformation index as a moderating variable, which helps to control other factors that may affect the research results. It focuses on exploring the relationship between ESG factors and bank liquidity risk, as well as the role of digital transformation in this process.

3.2.5. Control Variables

In addition to the above factors, according to previous studies, there are many factors that affect bank liquidity risk. In this paper, considering the relevance and availability of the selected data, the final selected control variables include "non-interest income ratio (NIR), independent shareholder ratio (INDEP), top ten shareholder ratio (TOP10), non-performing loan provision coverage ratio (PLLCR), year-on-year growth of GDP in the provinces where banks are registered (PGDPG), and consumer price index (CPI)".Among them, "the proportion of non-interest income (NIR), the proportion of independent shareholders (INDEP), and the proportion of the top ten shareholders (TOP10)" are characteristic variables at the bank level; "Non-performing loan provision coverage ratio (PLLCR)" as a regulatory factor; "The year-on-year growth of GDP in the provinces where banks are registered (PGDPG) and the consumer price index (CPI) is macro-influencing factors.

Table 1. Variable Explanation.

Variable Type	Indicator	Variable Symbol	Measurement Method
Dependent Variable	Loan-to-Deposit Ratio	LTD	Bank Loans / Bank Deposits
Independent Variable	Hua Zheng ESG Score	HZESG	Natural Logarithm After Conversion

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Mediating Variable	Bank Value	TobinQ	(Market Value + Bank Liabilities) / Book Value
	Profitability	ROE	End-of-Period Net Profit / End-of-Period Total Assets
Moderating Variable	Peking University Bank Digital Transformation Index	PKUDBI	Natural Logarithm of Peking University's Digital Inclusive Finance Index
Control Variable	Non-interest Income Ratio	NIR	Non-interest Income / Total Income
	Proportion of Independent Shareholders	INDEP	Number of Independent Shareholders / Total Number of Company Shareholders
	Proportion of Top 10 Shareholders	TOP10	Number of Shares Held by the Top 10 Shareholders / Total Company Share Capital
	Non-performing Loan Provision Coverage Ratio	PLLCR	Bank Provisions for Non-performing Loans / Total Non-performing Loans
	Year-on-Year Growth of Bank's Registered Province GDP	PGDPG	China National Bureau of Statistics
	Consumer Price Index	CPI	China National Bureau of Statistics

3.3. Model Building

This article first analyzes the impact of ESG scores on bank liquidity risk. Select the ESG rating published by the China Affairs Index as the explanatory variable, and set the model (1) as follows:

$$LTD_{it} = \alpha_0 + \alpha_1 Inhzesg_{it} + CV + \sum year + \varepsilon_{it} \quad (1)$$

Among them, the subscript i represents the i-th bank (i=1,2,...,41), t represents the tth year (t=2009, 2010,...,2022).In order to eliminate the dimensional difference between different data, the relatively large data (absolute value) is taken as the natural logarithm, and the relative value (that is, proportional or percentage data) is not processed. In formula (1), the explained variable LTD is the bank's deposit and loan ratio; The explanatory variable lnhzesg is the ESG data after logarithmic processing;CONTROL represents the control variables included in the model.∑year represents the fixed effect of the year, which aims to control the systematic change or trend change between different years and avoid errors in the model due to unconsidered factors such as inflation rate, risk-free interest rate, and financial regulatory environment.

This paper predicts that the $\alpha 1$ coefficient in model (1) is significantly negative, indicating that banks with high ESG scores have lower deposit-to-loan ratios, which indicates that banks with high ESG scores usually have better risk management and are more concerned about long-term sustainability, so they will be more cautious and tend to maintain lower deposit-to-loan ratios to prevent credit risk and liquidity risk. At the same time, banks with high ESG scores will attach importance to social responsibility and abide by the principle of fair lending, and will not over-issue loans, resulting in relatively low deposits and loans.

In order to further explore the intermediary mechanism of ESG factor on bank liquidity risk and test whether high ESG score can reduce bank liquidity risk, this paper takes TobinQ and ROE as proxy variables of ESG score, and draws on the intermediary effect model proposed in (4) to establish the following three regression models step by step:

$$TobinQ_{it} = \beta_0 + \beta_1 hzesg_{it} + CV + \sum year + \varepsilon_{it} \quad (2)$$

$$ROA_{it} = \gamma_0 + \gamma_1 hzesg_{it} + CV + \sum year + \varepsilon_{it} \quad (3)$$

$$LTD_{it} = \zeta_0 + \zeta_1 In + \zeta_2 TobinQ_{it} + \delta_3 ROA_{it} + CV + \sum year + \varepsilon_{it} \quad (4)$$

Among them, TobinQ and ROE are intermediate variables, and the definitions and measurement

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methods of other variables are consistent with the above. The coefficient $\alpha 1$ of the prediction model (2) is significantly negative, indicating that from the perspective of the overall effect, good ESG performance can significantly reduce the bank's liquidity risk. The coefficient $\beta 1$ of the prediction model (3) is significantly positive, and the coefficient $\gamma 1$ of the prediction model (4) is significantly positive, indicating that a high ESG score can increase the value of the bank and the return on equity of the bank. At the same time, the coefficients $\delta 1$, $\delta 2$, and $\delta 3$ in the prediction model (5) are significantly negative, which means that banks' investment in strengthening ESG performance can not only directly reduce liquidity risk, but also indirectly reduce liquidity risk by improving bank value and bank operating efficiency (reflected in equity return rate).

This paper uses the digital transformation index as a moderating variable to study the moderating effect of digital transformation and ESG on the impact of ESG on the liquidity of commercial banks. The occasional model is shown in (6).

$$LTD_{it} = \delta_0 + \delta_1 hzesg_{it} + \delta_2 pkudbi_{it} + CV + \sum year + \varepsilon_{it} \quad (5)$$

$$LTD_{it} = \eta_0 + \eta_1 hzesg_{it} + \eta_2 pkudbi_{it} + \eta_3 pkudbi_{it}{}_{hzesg_{it}} + CV + \sum year + \varepsilon_{it} \quad (6)$$

4. Empirical Results and Analysis

4.1. Descriptive Statistics and Correlation Analysis

Table 2 Descriptive statistical characteristics are reported, and the number of valid samples in this experiment is 284. In order to make the data more intuitive and easy to understand, the original data is used in descriptive statistics. The results show that for the explained variable ltd, the average value is 77.032, the standard deviation is 12.956, the maximum value is 116.23, and the minimum value is 38.97, which indicates that there is a big difference in the loan-to-deposit ratio of the sample banks. At the same time, the distribution map of ltd is found that the skewness of LTD data is 0. 470, which means that the data has a certain right deviation relative to the normal distribution. That is, more values are located on the right side of the average, which means that more than half of the bank loan-to-deposit ratio is in a higher range, and less than half of the bank loan-to-deposit ratio is in a lower range.

Explanatory variable hzesg, the average value is 5.435, the standard deviation is 0.774, the maximum value is 7, and the minimum value is 3, which indicates that the ESG score of the sample bank is generally biased towards a higher level. At the same time, the ESG normal distribution chart was made, and found that the skewness is -0.653, which means that the data has a certain left deviation relative to the normal distribution. That is, more values are located on the right side of the average, which shows that most banks have higher ESG scores.

Table 2. Descriptive Statistics of Variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
hzesg	285	5.435	.774	3	7
ltd	285	77.032	12.956	38.97	116.23
tobinq	285	.995	.02	.93	1.06
pkudbi	285	95.634	40.201	3	184
roe	285	.144	.043	.06	.25
nir	285	23.419	8.696	5.82	51.09
coir	285	30.035	4.985	18.93	59.01
indep	285	.369	.048	.1	.56
top10	285	.662	.208	.25	.99
pllcr	285	261.578	97.179	132.44	567.71
pggdpg	285	7.086	2.144	1.2	13.9
cpi	285	2.27	1.007	.9	5.4

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4.2. Benchmark Regression Results

This article initially applies the Hashman test to assess the impact of ESG on the liquidity of commercial banks. Subsequently, the year fixed effect model is selected for regression analysis. To test H1, panel fixed effect regression is conducted on model (2), while controlling for the influence of the year. The relationship between the explanatory variable and the explained variable is then determined. The regression results without adding control variables are presented in Table 3, column (1), while the results with control variables and year control are shown in column (2).

Table 3. Baseline Regression Results.

	(1)	**(2)**
VARIABLES	ltd	ltd
hzesg	-0.363***	-0.174***
	(0.0504)	(0.0350)
nir		0.151***
		(0.0345)
pllcr		-0.0154***
		(0.00317)
pggdpg		-1.066***
		(0.114)
cpi		0.0103***
		(0.000736)
indep		0.0950**
		(0.0468)
top10		0.115**
		(0.0480)
Constant	2.146***	1.965***
	(0.0370)	(0.0469)
Observations	284	284
Number of id	41	41
R-squared	0.176	0.680

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The results of the multiple regression analysis of model (2) indicate that, when controlling for the year effect, the model's adjusted R2 is 0.68, indicating goodness of fit of 68%. The F test value is 70.98, with a p-value of <0.01. This means that the fixed effect model passes the 99% confidence interval test and can proceed to test the coefficient of a single variable. The impact coefficient of the core explanatory variable ESGhzesg is -0.174, which is statistically significant at the 1% level. This significant negative impact suggests that ESG scores have a detrimental effect on the realization of commercial bank liquidity. This may be due to the fact that high ESG scores enhance the ability of commercial banks to obtain deposits, thereby reducing the index of bank loan-to-deposit ratio. The control variables nir,pllcr,pggdpg,cpi,indep,top10 all have a significant impact,and pllcr,pggdpg have a significant negative impact,indicating that the non-performing loan provision rate increases the non-interest cost of commercial banks,which is not conducive to the realization of liquidity,while the increase in macro GDP weakens the main characteristics of commercial banks as important external financing institutions,and also hinders the realization of liquidity in disguise.Nir,cpi,indep,top10 have significant positive effects, which shows that the proportion of non-interest income and independent directors and the top ten shareholders can improve the ability of commercial banks to issue loans at the micro level and enhance market financing confidence, while the consumer price index can enhance the macro environment and the consumption willingness and

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scale of the real market, and stimulate the continuous realization of commercial banks' consumer loans.

4.3. Robustness Test

4.3.1. Endogenous Analysis

From the theoretical logic analysis, it can be seen that the impact of ESG score on the liquidity risk of commercial banks is likely to be lagging. That is, there is a certain reverse causality. This will lead to a biased effect on the regression results. Therefore, in order to eliminate the possibility of this reverse causality, the core explanatory variables are lagged by one period in this study to try to solve the existing endogeneity problem. The results are listed in Table 4.

Table 4. Lag Effect Test(1-2), Exception handling(3-4).

	(1)	**(2)**	**(3)**	**(4)**
VARIABLES	ltd	ltd	ltd	ltd
L.hzesg	-0.381***	-0.104***	-0.359***	-0.174***
	(0.0493)	(0.0384)	(0.0489)	(0.0338)
nir		0.215***		0.159***
		(0.0373)		(0.0334)
pllcr		-0.0187***		-0.0151***
		(0.00339)		(0.00306)
pggdpg		-1.079***		-1.030***
		(0.138)		(0.110)
cpi		0.00975***		0.0101***
		(0.000823)		(0.000710)
indep		0.0825		0.0677
		(0.0508)		(0.0455)
top10		0.0948*		0.111**
		(0.0532)		(0.0465)
Constant	2.167***	1.929***	2.144***	1.973***
	(0.0362)	(0.0513)	(0.0359)	(0.0453)
Observations	242	242	283	283
R-squared	0.227	0.677	0.182	0.686
Number of id	37	37	41	41

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

It can be seen from Table 4 that the results of hzesg lag one period are still significant at the 1% level, indicating that the lag effect has not affected the main research results. The results of the benchmark regression have a certain degree of reliability. At the same time, this significance shows that the relationship between ESG score and bank liquidity risk is significant and lasting. The bank's ESG score does have an important and credible negative correlation with its liquidity risk.

4.3.2. Eliminate the Influence of Extreme Values

Considering that the distribution of some data may have some extreme values or outliers that affect the stability of the model. Therefore, in order to eliminate the influence of outliers, in this study, the explanatory variables and explanatory variables are truncated by 1%, and the possible regression biases are corrected by removing extreme values. The results are listed in Table 4.

It can be seen from Table 4 that the results are still significant after the tail reduction process, which shows that the estimation results of the benchmark regression model are not affected by extreme values or outliers and are stable and reliable. This also further confirms hypothesis H1: ESG performance can significantly reduce the liquidity risk of commercial banks. This result will not change due to the existence of individual outliers in the data set. This provides reliable support for the research results of this article.

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4.4. Heterogeneity Test

Due to the significant differences in the nature of commercial banks, their liquidity will also have a certain degree of heterogeneity due to different natures. Therefore, according to the nature of the bank, this article divides the sample into state-owned banks and non-state-owned banks and performs regression analysis and comparison in groups. The results are listed in Table 5. It can be seen from Table 5 that whether it is a state-owned or non-state-owned bank, the ESG score has a significant negative impact on the bank's liquidity risk. For state-owned banks, the coefficient of hzesg is -0.148, and the result is significant at the 10% significance level. For non-state-owned banks, the coefficient of hzesg is -0.410, and the result is significant at the 1% significance level. In comparison, the negative impact of ESG on the liquidity of non-state-owned banks is stronger than that of state-owned banks. The reason may be that the asset products of non-state-owned banks are more flexible and are often affected by the willingness and preference of financial investors and residents. The negative impact is obvious, while state-owned banks have stable asset scale and asset funding sources, and the stability is more obvious. The negative effect of ESG on them is lower. But on the whole, the impact of ESG score on the two types of banks is relatively insignificant, which is reflected in the correlation coefficient of less than 1 in the empirical results.

Table 5. Heterogeneity Test.

	State-Owned	**Non-State-Owned**
VARIABLES	ltd	ltd
hzesg	-0.148*	-0.410***
	(0.0831)	(0.0593)
CONTROL	Control	Control
Constant	1.973***	2.186***
	(0.0609)	(0.0436)
Observations	62	222
R-squared	0.054	0.205
Number of id	6	35

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.5. Mediating Effect Analysis

According to the previous analysis, ESG score will have an impact on the liquidity of commercial banks by enhancing bank value and financial performance.In order to test H3, this paper uses the intermediary effect model to test the intermediary mechanism of these two types of elements.Model (3), model (4), and model (5) will be regressed separately, and the regression results are shown in Table 6.

Table 6. Mediation Effect Analysis.

	(3)	**(4)**	**（5）**
VARIABLES	tobinq	roe	ltd
hzesg	0.0431***	0.143***	-0.0885**
	(0.0131)	(0.0229)	(0.0352)
tobinq			-0.493***
			(0.163)
roe			-0.469***
			(0.0937)
nir		-0.124***	0.0835**

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		(0.0212)	(0.0338)
indep	-0.0343*		0.0830*
	(0.0178)		(0.0439)
top10	-0.0390**		0.0852*
	(0.0172)		(0.0448)
pllcr	0.00479***	0.0134***	-0.00706**
	(0.00120)	(0.00200)	(0.00321)
pggdpg	0.348***	0.832***	-0.514***
	(0.0426)	(0.0724)	(0.136)
cpi	-0.00344***	-0.00616***	0.00582***
	(0.000273)	(0.000479)	(0.000987)
Constant	0.969***	-0.0187	2.446***
	(0.0178)	(0.0182)	(0.164)
Observations	283	283	283
Number of id	41	41	41
R-squared	0.538	0.693	0.727

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As can be seen in Table 6, the regression coefficients of the direct and indirect effects of tobinq are 0.0431 and -0.493, respectively, and both pass the significance test at the 1% level. This shows that there is a complete intermediary effect in bank value, indicating that banks with high ESG scores have higher bank value and have a positive impact on bank liquidity. The direct and indirect effects of ROE are 0.143 and -0.469, respectively, and both pass the significance test at the 1% level, which also shows that there is a complete mediating effect in financial performance, indicating that banks with high ESG scores have higher financial efficiency. This suggests that the market recognizes and has greater confidence in high-value banks, attracting more deposits and investments to banks thereby reducing liquidity risk. Banks with high financial efficiency have stronger capital allocation capabilities and effective risk management and control methods and play a more obvious role in optimizing asset-liability structure, business process risk management, and special line process management, thereby reducing liquidity risk.

4.6. Analysis of Regulatory Effects

Considering the external and policy characteristics of digital transformation in the development process of commercial banks, it is likely to play a role in the liquidity of commercial banks together with ESG. This study incorporates the interaction items of Peking University's digital transformation level and ESG into the benchmark regression for analysis. The regression results are presented in Table 7.

Table 7. Moderation Effect Analysis.

	(6)	**(7)**
VARIABLES	ltd	ltd
pkudbi	0.029**	0.028**
	(0.0139)	(0.0138)
hzesg	-0.154***	-0.125***
	(0.0350)	(0.0359)
pkudbi_ hzesg		-0.559***
		(0.1997)
nir	0.099**	0.113***
	(0.0391)	(0.0389)
pllcr	-0.014***	-0.015***

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	(0.0031)	(0.0031)
pggdpg	-0.806***	-0.806***
	(0.1401)	(0.1381)
cpi	-0.009***	-0.002***
	(0.0087)	(0.0087)
indep	0.097**	0.072**
	(0.0457)	(0.0459)
top10	0.092*	0.095**
	(0.0476)	(0.0476)
Constant	1.834***	1.826***
	(0.0591)	(0.0583)
Observations	284	284
Number of id	41	41
R-squared		

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7 shows that in model (6), the coefficient of influence of pkudbi on ltd is 0.029. This coefficient passes the 5% significance test and is positive, indicating a significant positive correlation between the digital transformation index and the bank's liquidity risk. This correlation can be explained by the fact that banks often require substantial upfront investment for digital transformation, such as constructing technical facilities, training personnel, and making business adjustments. These investments can consume a significant amount of cash flow and potentially increase the bank's liquidity risk.

In model (7), the correlation coefficient of the adjustment item pkudbi_hzesg (the interactive item of digital transformation index and ESG score) is -0.559, which passes the 1% significance test and is negative. This result shows that the level of digital transformation has played a negative moderating role. That is, it has inhibited the negative impact of ESG performance on the liquidity of commercial banks, which verifies H4. This may be because the high ESG score means that the bank performs well in environmental protection, society, and governance, which improves the reputation of commercial banks in terms of non-financial indicators and reduces some liquidity risks. In addition, the continuous application of digitalization has released the vitality of the development of commercial banks and promoted the forward-looking, sustainable, and scientific development of banks under the "New Basel Accord." This in turn, provides a strong foundation for commercial banks to optimize product business lines, broaden the scope of financial services, and enhance financial market share.

5. V. Research Findings and Implications

5.1. Conclusion of the Study

This study conducted an in-depth discussion on the impact of ESG factors on banks' liquidity risk, and reached the following conclusions:

(1) The ESG performance of commercial banks can significantly mitigate liquidity risk. Banks with stronger ESG performance demonstrate enhanced stability and resilience when confronted with liquidity challenges.

(2) The ESG performance has a heterogeneous impact on the liquidity risk of commercial banks. The liquidity of non-state-owned banks is more negatively affected by ESG factors compared to state-owned banks.

(3) ESG performance can mitigate the liquidity risk for commercial banks by enhancing bank value and financial performance. Banks that exhibit better ESG performance generally have higher bank value and financial performance, which in turn enhances their ability to manage risks and liquidity.

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The level of digital transformation has a negative regulatory effect on the ESG factor. In other words, it inhibits the negative impact of ESG performance on the liquidity of commercial banks.

5.2. Policy Recommendations

Based on the findings of this study, the following policy recommendations are made.

(1) Accelerate the construction of ESG disclosure of Chinese commercial banks. Research shows that ESG performance can significantly reduce the liquidity risk of commercial banks. Regulators can encourage banks to formulate and implement corresponding ESG policies and conduct regular ESG reports and assessments. At the same time, regulatory agencies should set up corresponding ESG indicators and standards as a reference basis for measuring bank liquidity risk. This improves the bank's ESG performance and reduces the level of liquidity risk.

(2) Continue promoting the reform of the differentiated liquidity risk system of Chinese commercial banks. Given the heterogeneity of property rights in the liquidity risk of commercial banks, special attention should be given to the liquidity risk of non-state-owned banks. Building upon the stability of the deposit-loan ratio of state-owned banks, the reform of the liquidity risk system of commercial banks should be developed with differentiation. Regulatory agencies should promote the interconnection between ESG factors and bank liquidity risks based on their own conditions.

(3) Continuously consolidate the guiding role of digital transformation in China's commercial banks. Commercial banks in China should start by enhancing the value of informatization, establishing a digital internal control management process for commercial banks, and playing the role of ESG in regulating the liquidity level of commercial banks through data sharing and technological innovation. This will help improve the bank's ability to monitor and predict ESG factors and provide more accurate and reliable information for liquidity risk management.

(4) Actively promote the government and regulatory agencies' efforts in educating and training on liquidity risk and ESG. On the one hand, it is necessary to provide comprehensive training and guidance programs for the ESG evaluation system to help bank personnel better understand and apply ESG factors, thereby enhancing their ability to manage liquidity risks. On the other hand, it is important to promote the public dissemination of ESG-related knowledge and improve awareness and understanding of ESG ratings throughout society.

(5) Continuously strengthen international cooperation among banks and promote the global adoption and implementation of ESG factors. By enhancing cross-border collaboration and sharing information, a unified ESG standard and guidelines will be established to enhance the overall ESG level and liquidity risk management capabilities of the global banking industry.

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