

# A Study on Commercial Bank Liquidity Risk in the Context of Digital Currency Disruption

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**Abstract:** Against the backdrop of the accelerated advancement of digital currencies and their ongoing reshaping of the financial system, commercial banks' liquidity risks are exhibiting new patterns of evolution. Focusing on the mechanism through which digital currency shocks affect bank liquidity risks, this study constructs an analytical framework that incorporates deposit migration pathways. Using panel data from commercial banks, we conduct empirical tests employing two-way fixed-effects models and mediation models. The results indicate that digital currencies significantly weaken deposit stability and elevate liquidity risk levels, with deposit migration playing a partial mediating role in the transmission of shocks. Additionally, banks of different sizes exhibit varying sensitivities to these shocks, with small and medium-sized banks being more significantly affected. Further analysis reveals that capital adequacy ratios have a certain mitigating effect on risk but cannot fully offset structural shocks. This study uncovers the intrinsic evolutionary logic of commercial bank liquidity risk in the context of digital currencies from the perspectives of mechanism identification and quantitative testing.

**Keywords:** Digital currency; Liquidity risk; Deposit migration; Commercial banks; Intermediation effect.

## 1. Introduction

The accelerating evolution of digital currencies is reshaping the structure of money supply and the financial intermediation system. The traditional deposit-based liability foundation of commercial banks faces new pressures for substitution, and liquidity risk is shifting from "scale constraints" to "structural disturbances." While central bank digital currencies CBDCs enhance payment efficiency and access to funds, they also strengthen the ability to instantly convert liquidity, blurring the boundaries between funds inside and outside the banking system and thereby exerting profound impacts on deposit stability and maturity structures.

Against this backdrop, conducting a systematic analysis of the formation mechanisms and transmission pathways of commercial bank liquidity risks under the impact of digital currencies holds clear practical relevance. Based on bank-level panel data, this study introduces deposit migration rates and liquidity indicators to construct a multidimensional measurement system. By combining two-way fixed-effects and intermediation effect models, it quantitatively identifies the impact effects and decomposes their transmission pathways. We expect to reveal the magnitude of digital currency's impact on bank liquidity risk and its structural differences, thereby providing a basis for optimizing risk management and regulatory strategies.

## 2. Literature Review and Research Hypotheses

### 2.1. Literature Review

Existing research has explored the impact of digital currencies and fintech on the commercial banking system from various perspectives. Akhamere, from the perspective of credit creation, points out that central bank digital currencies CBDCs weaken the deposit base of banks, constrain credit expansion capacity, and pose potential shocks to financial

stability [1]. Okaro further analyzes from a macro perspective that digital currencies alter the structure of financial intermediation, enabling direct capital flows between the central bank and market participants, thereby weakening commercial banks' central role in monetary transmission and generating a reallocation effect on sovereign monetary policy [2]. At the micro-banking level, Jailani et al., based on emerging market data, found that while digital currencies enhance payment efficiency, they exert a dual impact on bank profitability and systemic stability through deposit migration and changes in funding structures [3]. Riabushka et al., from the perspective of risk spillovers, point out that under the compounding effects of external shocks such as exchange rate volatility, the volatility of banks' asset-liability structures will be further amplified, making liquidity risks more prone to transmission within the system [4]. Meanwhile, Hussain's research indicates that the development of digital finance generally reshapes bank stability, with the impact pathway depending on the degree of financial innovation and risk management capabilities [5]. Anggraeni et al., focusing on the relationship between liquidity risk and performance, point out that liquidity constraints directly affect banks' operational efficiency and profitability [6]. Regarding moderating mechanisms, Abdul-Wahab et al. argue that while CBDCs enhance financial inclusion, institutional design is needed to guard against shocks to the banking system's stability [7]; Alshouha et al. find that bank size plays a significant moderating role between fintech shocks and liquidity risk, with small and medium-sized banks being more vulnerable to such shocks [8].

Overall, existing literature has revealed the impact of digital currencies on the banking system from both macro and micro perspectives, but two shortcomings remain: first, a lack of systematic characterization of the "deposit migration-liquidity risk" transmission mechanism; and second, a lack of quantitative empirical analysis based on intermediary mechanisms. Therefore, it is necessary to construct an

analytical framework incorporating deposit migration variables to conduct an in-depth examination of the formation mechanism of commercial bank liquidity risk under the impact of digital currencies.

## 2.2. Research Hypotheses

Based on the aforementioned theoretical analysis and literature review, and to formulate a testable expression of the digital currency shock pathway, the following research hypotheses are proposed:

H1: A digital currency shock significantly increases the level of liquidity risk in commercial banks.

As a highly liquid alternative asset, digital currency undermines the stability of bank deposits, increases volatility on the liability side, thereby reducing liquidity coverage capacity and exacerbating imbalances in the deposit-loan structure.

H2: Digital currency exerts a mediating effect on liquidity risk by increasing the deposit migration rate.

Digital currency drives the transfer of funds from the banking system to digital currency accounts, forming a transmission mechanism of “CBDC → Transfer Rate → Liquidity Risk,” which in turn amplifies liquidity pressures.

H3: The impact of digital currency exhibits significant heterogeneity across commercial banks of different sizes.

Compared to large banks, small and medium-sized banks have more concentrated liability sources and weaker deposit stability, making them more sensitive to deposit migration shocks and resulting in a greater increase in liquidity risk.

H4: Capital adequacy ratios act as a buffer between digital currency shocks and liquidity risk.

Capital adequacy ratios have a significant impact on commercial banks’ liquidity risk and mitigate the rise in risk caused by digital currency shocks to a certain extent.

The above hypotheses provide a theoretical basis for subsequent variable specification and model construction, and constitute the core testing framework for the empirical analysis.

## 3. Research Design

### 3.1. Research Framework

Focusing on the transmission mechanism of digital currency shocks on commercial banks’ liquidity risk, we construct a hierarchical research framework of “shock input—structural transmission—risk characterization—empirical testing” [9]. As shown in Figure 1, first, at the shock input layer, we use the digital currency penetration rate  $CBDC_{it}$  to characterize the intensity of digital currency penetration across regional and temporal dimensions, and reflect its degree of substitution for traditional deposit instruments through the payment substitution rate and holding scale; Second, at the structural transmission layer, we introduce the deposit migration rate  $TransferRate_{it}$  and the liability stability index  $DepositStickiness_{it}$  to characterize the impact of digital currency on the structure of banks’ liabilities, and combine these with the maturity mismatch index  $Mismatch_{it}$  to reflect the process of asset-liability restructuring; Third, at the risk characterization layer, we select the liquidity coverage ratio  $LCR_{it}$ , the net stable funding ratio  $NSFR_{it}$ , and the loan-to-deposit ratio  $LDR_{it}$  to construct a multidimensional liquidity risk measurement system, enabling a joint characterization of short-term and medium-to-long-term risks; Finally, at the

empirical testing level, a two-way fixed-effects model and a mediation model are employed to identify the transmission chain “CBDC → TransferRate → LiqRisk,” and bank size and capital adequacy ratio are further introduced as moderating variables for heterogeneity analysis [10].

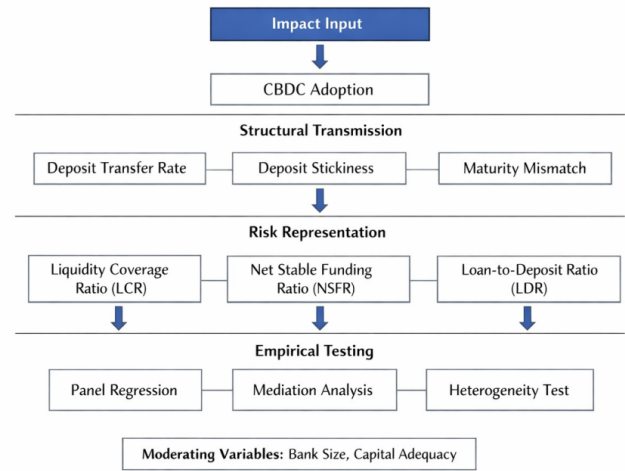


Figure 1. Research Framework Flowchart

### 3.2. Sample Selection

Annual data from commercial banks for the period 2018–2024 were selected as the study interval, with 2018–2019 serving as the pre-shock baseline period and 2020 onwards as the shock period, to cover the stages of digital currency pilot expansion and deepened application. The sample was restricted to listed commercial banks with complete data disclosures, and samples with abnormal fluctuations in asset size or missing key indicators were excluded to ensure data continuity and comparability [11]. To capture differences in the impact, a regional dimension was introduced: banks were grouped based on whether the region where their headquarters is located was included in the digital currency pilot program, creating a treatment group and a control group to identify the marginal impact of CBDC rollout on banks’ liquidity structures [12]. During sample processing, core financial indicators were trimmed at the 1st and 99th percentiles to reduce the influence of outliers, and monetary aggregates were log-transformed to address heteroscedasticity. This resulted in balanced panel data encompassing both the firm-level dimension  $i$  and the time dimension  $t$ , providing a stable data foundation for subsequent two-way fixed-effects model estimation and mediation effect tests.

### 3.3. Variable Definitions

Focusing on the mechanism through which digital currency shocks affect commercial banks’ liquidity risk, we construct a three-tiered indicator system comprising dependent variables, core explanatory variables, and control variables [13]. The dependent variables consist of liquidity risk indicators, including the liquidity coverage ratio  $LCR_{it}$ , the loan-to-deposit ratio  $LDR_{it}$ , and the net stable funding ratio  $NSFR_{it}$ . These are used to characterize the level of liquidity pressure faced by banks under short-term payment pressures and medium-to-long-term funding stability constraints. Specifically,  $LCR$  reflects the ability of high-quality liquid assets to cover net cash outflows, while  $LDR$  characterizes the degree of tension in the deposit-loan structure [14]. The core explanatory variables are constructed based on two dimensions: the intensity of digital currency

penetration and the substitution effect of funds. First, the intensity of the digital currency shock is defined as

$$CBDC_{it} = \frac{DigitalCurrencyVolume_{it}}{TotalDeposits_{it}} \quad (1)$$

to measure the proportion of the traditional deposit system replaced by digital currency; second, the deposit migration rate indicator is introduced to characterize the capital outflow effect:

$$TransferRate_{it} = \frac{DDeposits_{it}}{Deposits_{it-1}} \quad (2)$$

This indicator reflects the dynamic changes in deposit size and plays a crucial role in identifying liability-side fluctuations triggered by digital currencies. Control variables include capital adequacy ratio  $CAR_{it}$ , non-performing loan ratio  $NPL_{it}$ , bank size  $\ln(Assets_{it})$ , and profitability  $ROA_{it}$ , which are used to control for the confounding effects of bank operational stability and size differences on liquidity risk.

### 3.4. Model Construction

Based on the panel data structure, a two-way fixed-effects model is constructed to identify the impact of digital currency shocks on commercial banks' liquidity risk, and a mediation model is used to depict the transmission mechanism. First, a baseline regression model is established, with the liquidity risk indicator  $LiqRisk_{it}$  as the dependent variable, incorporating bank-specific fixed effects  $\mu_i$  and time-specific fixed effects  $\lambda_t$  to control for unobserved heterogeneity:

$$LiqRisk_{it} = \beta_0 + \beta_1 CBDC_{it} + \beta_2 TransferRate_{it} + \beta_3 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where  $X_{it}$  is the vector of control variables,  $\beta_1$  captures the direct effect of the digital currency shock, and  $\beta_2$  reflects the amplifying effect of deposit migration on liquidity risk. To further identify the mechanism, we introduce a mediation model and first test the effect of the digital currency on deposit migration:

$$TransferRate_{it} = \gamma_0 + \gamma_1 CBDC_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Subsequently, both  $CBDC_{it}$  and  $TransferRate_{it}$  were included in the baseline model. If  $\gamma_1$  and  $\beta_2$  are significant and the coefficient of  $\beta_1$  decreases, this indicates the presence of a significant mediating effect [15]. To enhance the robustness of the model, a lagged term  $CBDC_{it-1}$  was introduced to mitigate endogeneity issues, and cluster-robust standard errors were used for estimation.

## 4. Empirical Analysis

### 4.1. Descriptive Statistics

Based on the constructed bank-level balanced panel data, we conduct descriptive statistical analysis of the core variables to identify the distribution characteristics and structural changes in liquidity risk before and after the digital currency shock. As shown in Figure 2, the box plots illustrate the distribution of the LCR, LDR, and CBDC variables over the sample period. From the overall distribution, the median LCR dropped significantly during the shock period, falling from approximately 1.35 to 1.18, while the interquartile range narrowed markedly, indicating a general decline in banks' liquidity buffer capacity and increased volatility; the LDR, however, showed an upward trend, with the median rising from 0.72 to 0.81, reflecting an intensified expansion of credit issuance relative to the deposit base. Further examination of the CBDC variable reveals that its distribution shifted from high concentration to greater dispersion, indicating

significant regional disparities in digital currency penetration. Combined with the extension of the box-and-whisker plot tails, some small and medium-sized banks exhibited extreme LCR declines during the shock period, corresponding to higher TransferRates, suggesting that deposit migration is more sensitive to their liquidity constraints. Overall, the descriptive statistics preliminarily validate the structural characteristics of digital currency, which, by weakening deposit stability, leads to a right-skewed distribution of bank liquidity risk and an increase in tail risk, providing a data foundation for subsequent correlation and regression analyses.

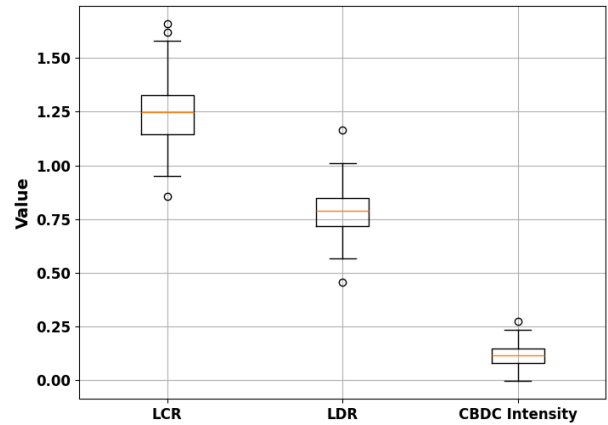


Figure 2. Box-and-whisker plot of liquidity indicator distributions

### 4.2. Correlation Tests

To test for linear relationships among variables and potential multicollinearity issues, Pearson correlation coefficient analysis was performed on the main variables, and a correlation heatmap was plotted. As shown in Figure 3, CBDC exhibits a significant negative correlation with LCR (approximately -0.42), indicating that higher digital currency penetration is associated with weaker bank liquidity coverage capacity; CBDC shows a positive correlation (approximately 0.37), suggesting that the deposit substitution effect drives imbalances in the credit and deposit structure. Further analysis of the mediating variables reveals that TransferRate exhibits a strong negative correlation with LCR (approximately -0.51) and a positive correlation with LDR (approximately 0.46), validating the key role of deposit migration in the transmission of shocks. Regarding the control variables, CAR shows a positive correlation, reflecting the mitigating effect of capital adequacy on liquidity risk, while NPL shows a negative correlation, indicating that deteriorating asset quality exerts pressure on liquidity. Overall, correlation coefficients are all below 0.7, indicating no severe multicollinearity issues, which suggests that the model variables have good discriminatory power. The clear color gradient changes in the heatmap clearly characterize the strength of variable relationships, further supporting the hypothesis that digital currency affects bank liquidity risk through the deposit migration channel, and providing directional guidance for subsequent regression model estimation.

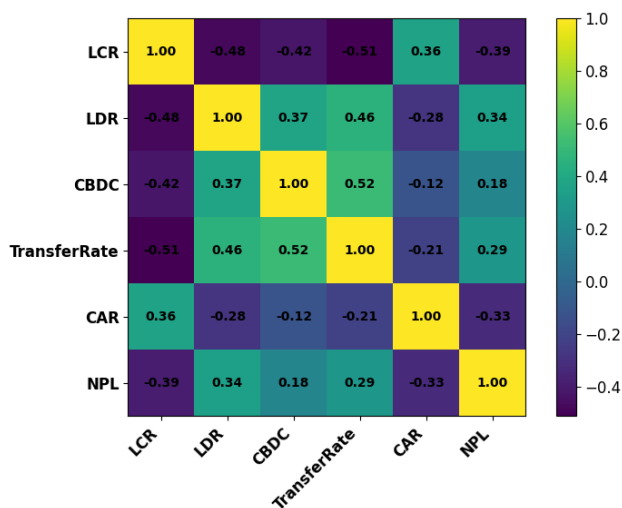


Figure 3. Heatmap of the Correlation Structure of Key Variables

### 4.3. Regression Analysis

Based on the correlation tests, a two-way fixed-effects model was employed to estimate the impact of digital currency shocks, and multiple models were constructed to compare the regression results. Table 1 presents the core regression results.

Table 1. Regression Results of the Digital Currency Shock on Commercial Bank Liquidity Risk

| Variable      | Model (1) LCR | Model (2) LCR | Model (3) LDR | Model (4) LDR |
|---------------|---------------|---------------|---------------|---------------|
| CBDC          | -0.128***     | -0.092**      | 0.084***      | 0.061**       |
| TransferRate  | —             | 0.214***      | —             | 0.173***      |
| CAR           | 0.056**       | 0.049**       | -0.031*       | -0.028*       |
| NPL           | 0.073***      | 0.065***      | 0.052**       | 0.047**       |
| ln(Assets)    | 0.021         | 0.018         | -0.015        | -0.013        |
| Fixed effects | Control       | Control       | Control       | Control       |
| R2            | 0.41          | 0.48          | 0.37          | 0.44          |

Note: \*, \*\*, and \*\*\* denote significance levels of 1%, 5%, and 10%, respectively.

The regression results show that the CBDC coefficient is significantly negative in the LCR model and significantly positive in the LDR model, indicating that digital currency significantly weakens banks' liquidity safety margins and exacerbates structural imbalances. Further testing of the transmission channels reveals that CBDC has a significant positive impact on TransferRate, suggesting that digital currency shocks significantly increase deposit migration rates, thereby providing the preconditions for the transmission mechanism to hold. After introducing TransferRate, the absolute value of the CBDC coefficient decreases significantly, while TransferRate significantly influences liquidity indicators, indicating that deposit migration plays a partial mediating role in the transmission of shocks. The direction of the control variables aligns with expectations, validating the rationality of the model specification. Overall, the results indicate that digital currency exerts a systemic impact on bank liquidity risk by altering liability structure and liquidity characteristics.

### 4.4. Robustness Tests

To verify the robustness of the regression results, tests were

conducted from two dimensions: variable substitution and model specification. As shown in Figure 4, the coefficient comparison bar chart illustrates the variation in the core CBDC coefficient under different model specifications. After substituting the dependent variable with the NSFR, the CBDC coefficient remains significantly negative, indicating that the conclusions are not sensitive to the choice of liquidity indicators; after introducing the lagged term  $CBDC_{it-1}$ , the coefficient remains significant with a slight decrease in value, suggesting that the digital currency shock exhibits a certain lag effect but does not alter the overall direction. In the subgroup regression, the absolute value of the coefficient for the sample of small and medium-sized banks is significantly higher than that for large banks, reflecting their weaker liability structure stability and greater susceptibility to deposit migration shocks. In the bar chart, different colors distinguish the model specifications; the coefficient ranges are stable with no significant fluctuations, indicating that the model possesses strong robustness. Based on the comprehensive robustness test results, it can be confirmed that the impact of digital currency shocks on commercial banks' liquidity risk is consistent and reliable.

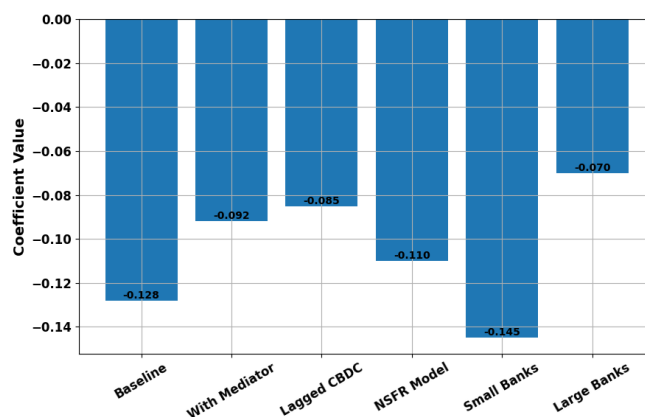


Figure 4. Bar Chart Comparing CBDC Coefficients

## 5. Conclusions

Based on panel data models and mediation effect tests, this study conducted a systematic analysis of the mechanism through which digital currency shocks affect commercial banks' liquidity risk. Empirical results indicate that digital currency significantly weakens the stability of bank deposits, exacerbates liquidity risk exposure by increasing deposit migration rates, and exhibits greater sensitivity in small and medium-sized banks; capital adequacy ratios have a certain mitigating effect on this shock, but cannot fully offset structural pressures.

This study also has limitations: first, the penetration of digital currency is characterized using a proxy variable, which may introduce measurement bias; second, the sample time span is limited, making it difficult to capture long-term dynamic effects; third, external shock factors such as cross-border capital flows were not included. Future research could combine higher-frequency data with multi-level models to deepen the dynamic characterization of the linkage mechanism between digital currency and banking risks, and explore differentiated regulatory tools and liquidity management strategies.

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