“Factors affecting bank liquidity during times of crisis: Evidence from European countries”

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FACTORS AFFECTING BANK LIQUIDITY DURING TIMES OF CRISIS: EVIDENCE FROM EUROPEAN COUNTRIES

Abstract

Bank liquidity is a critical determinant of financial stability, particularly during periods of economic and geopolitical uncertainty. It is therefore a significant issue for both policymakers and financial institutions to understand the factors affecting bank liquidity in such circumstances. This study examines the main factors influencing the liquidity of European banks during three major crises: the Subprime crisis, the COVID-19 pandemic, and the Russian-Ukrainian war. The empirical analysis uses a dataset of 196 European banks observed from 2005 to 2022, employing Prais-Winsten regression models with panel-corrected standard errors (PCSE). Based on various liquidity measures, this study finds that both internal bank characteristics and external economic conditions influence liquidity, but their effects vary across crises. At the micro level, credit risk and loan loss reserves consistently have a negative impact on liquidity, which intensifies during the COVID-19 and Russia-Ukraine crises, reflecting banks' increased vulnerability to loan impairments in periods of uncertainty and stress. Market risk has a positive effect on liquidity across all crises, highlighting the growing reliance on interbank markets during times of instability. Bank size consistently shows a negative relationship with liquidity across all crisis periods, indicating that larger banks tend to hold lower levels of liquid assets regardless of the nature of the crisis. Diversification modestly supports liquidity, while capital adequacy is negatively associated with liquidity, indicating a trade-off between capital and liquid asset holdings. At the macro level, inflation enhances asset liquidity but reduces short-term liquidity, whereas GDP growth contributes positively only to short-term liquidity.

Keywords bank liquidity, loan loss reserves, credit risk, market risk, systemic crises, European banks

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INTRODUCTION

Banking liquidity plays a crucial role in maintaining financial stability, particularly during economic crises. It indicates how a bank can meet its short-term obligations without having to liquidate its assets. Effective liquidity management is important in preventing bank crises and maintaining depositors' confidence. In calm periods, banks have traditional short-term lending options to address liquidity problems. A banking crisis can quickly deteriorate the borrowing activities and therefore put much pressure on the entire financial system. It is very important to analyze the determinants of banking liquidity, especially in Europe, for various reasons. Liquidity gives banks the ability to finance their short-term obligations and thereby maintain stability and efficient operations; poor liquidity management can trigger systemic crises, as illustrated by the bankruptcy case of Lehman Brothers in 2008. Secondly, the diversity of banks in Europe – such as universal banks, cooperatives, and investment banks – makes it more difficult to clearly identify the factors affecting liquidity. These factors include the size of a bank, its organizational structure, strategy, funding mod-

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el, profit levels, and asset quality. Thirdly, the post-crisis regulatory environment has created new incentives for banks regarding liquidity risk management. The liquidity ratios set out by Basel III have altered liquidity risk tolerance thresholds. Finally, in an environment of changing interest rates, geopolitical uncertainty, and digital transformation of the sector, it is important to better understand the drivers of liquidity behavior in European banks to inform both supervisors and financial policymakers. Few studies have conducted a comparative and dynamic analysis of the determinants of liquidity in the context of multiple crises. In particular, the differentiated impact of exogenous shocks – financial, pandemic, and geopolitical – on the same liquidity variables has been little explored. Most studies also focus on a limited number of liquidity indicators without analyzing their complementarity. The scientific problem, therefore, lies in assessing the factors that determine liquidity in European banks during major crises. This includes understanding the specific characteristics of each crisis and the resilience of the banking system across shocks of varying types and intensities.

1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

According to the theory of financial intermediation and prudential regulation, banks hold liquidity to meet transaction, precautionary, and speculative needs (Keynes, 1936), to manage liquidity risk (Diamond & Dybvig, 1983), and to comply with regulatory requirements such as Basel III (BCBS, 2013), ensuring a balance between profitability, stability, and compliance.

(i) *The precautionary reason*: The precautionary motive is one component of liquidity demand proposed by Keynes (1936). The demand for liquidity is then observed when banks create liquidity in the event of unforeseen contingencies that require financing or market disruption. Economists have long observed that banks maintain liquidity to protect against sudden shocks. Diamond and Dybvig (1983) show that the mismatch between short-term deposits and long-term loans makes banks vulnerable to unexpected withdrawals. Bhattacharya and Thakor (1993) view liquidity as insurance against market stress. Freixas et al. (2000) highlight liquidity's role in the interbank system, warning that delays can cause broader problems. Allen and Gale (2004) explain how a liquidity shortage in one bank can affect the entire system. Acharya and Merrouche (2013) find that banks with higher liquidity performed better during the 2007–2008 crisis. Basel III now reinforces this precautionary need by requiring banks to hold minimum liquidity levels through measures such as the Liquidity Coverage Ratio (LCR). Recent studies confirm the central role of the precautionary motive in bank liquidity management. Bratsiotis and Theodoridis (2020) show that liquidity shocks can amplify business cycles, whereas Dang (2021) finds that the precautionary accumulation of liquidity is a rational response to market uncertainty. De Bandt et al. (2021) argue that banks adjust their liquidity based on regulatory requirements and their own perception of systemic risk. During the pandemic, Tran et al. (2023) note a considerable increase in liquidity reserves, exemplifying the self-insurance function of the precautionary motive. Nonetheless, Le Coz et al. (2025) caution that excess liquidity can create frictions in credit distribution. Finally, Liu et al. (2025) find that bank competition requires institutions to hold higher liquidity cushions to strengthen resilience to shocks.

(ii) *The motive for the transaction*: The reason for the transaction is that a bank must maintain sufficient cash to meet customer payments, transfer funds, or repay very short-term loans on a daily basis (Freixas et al., 2000), making this especially important during periods of market stress (Bindseil, 2004). Under normal conditions, if banks have sufficient liquidity, they can settle their short-term obligations (Holmström & Tirole, 1998). If not managed properly, this can create significant liquidity challenges for banks, as demonstrated by the events of the 2008 crisis (Goodhart, 2008; Allen & Gale, 2004). Recent studies have also

raised concerns that the increasing adoption of instant payment systems, alongside innovations in the banking sector, has re-emphasized the need for banks to secure and maintain transactional liquidity, reinforcing the importance of planning and managing liquidity with availability in mind (Korsgaard, 2015; Wuryandani et al., 2014; González et al., 2024).

(iii) The liquidity preference for speculation: Banks may hold liquidity to take advantage of future investment opportunities. Unlike other motives, this is based on expectations about interest rates and market conditions. Tirole (2006) refers to this as "strategic liquidity"– holding cash to act quickly when markets are less liquid. Large banks often adjust liquidity in response to predicted changes in interest rates or credit spreads (Acharya et al., 2011). Shin (2009) observes that banks may hold more liquidity if they anticipate a market downturn. However, waiting too long to invest can result in missed opportunities or reduced value due to inflation or tighter monetary policy (Bernanke & Gertler, 1989).

Recent empirical studies have highlighted the importance of the speculative motive in banks' liquidity decisions. Kick (2022) found that unexpected changes in interest rates lead banks to increase their liquidity holdings as part of a strategy to maximize profits in anticipation of future gains. Huynh (2023) also found that higher competition in banking markets correlates with greater liquidity holdings, indicating that banks hold reserves not only for precautionary reasons but also to remain competitive. Tran et al. (2023) showed that during the COVID-19 pandemic, U.S. banks increased liquidity reserves both as a protective measure and as an opportunity-seeking strategy to prepare for post-crisis investments under conditions of extreme uncertainty. Le Coz and colleagues (2025) used agent-based modelling to show that banks make strategic liquidity decisions when they are interlinked in interbank networks to avoid shocks, clearly illustrating the forward-looking speculative motivation for the management of liquidity. These different reasons for banks to hold liquidity underscore the importance of liquidity to resilience, stability, and risk management; the complexity surrounding these reasons continues to generate tension for banks, regulators, and other stakeholders in balancing safety, efficiency, and growth in a financial landscape that is increasingly unpredictable and fluid (BCBS, 2013; Bernanke & Gertler, 1989).

According to Berger and Bouwman (2009), factors such as funding structure, bank size, and regulatory capital are key to withstanding liquidity crises. Furthermore, the Basel III prudential rules, especially the Liquidity Coverage Ratio (LCR), have positive impacts on banks' capabilities during challenging to turbulent periods (Duffie, 2019; BCBS, 2019). In relation to this reality, the COVID-19 crisis demonstrates instances of severe shocks that go beyond these measures, prompting a stronger response from central banks (BIS, 2010; Cetorelli & Goldberg, 2012). Recent research by Gorton and Metrick (2021) shows that even in stable periods, banks can experience liquidity problems due to severe stress on the whole system. Oino (2021) found that credit and liquidity risks play a major role in banks' solvency and that regulatory capital is an essential buffer for strengthening their resilience to financial shocks. Kolozsi et al. (2022) highlight the effect of liquidity accumulation on interbank demand and short-term rates, describing how liquidity distribution influences banking intermediation. This underscores the importance of proactive management of liquidity and capital buffers as crucial for maintaining the stability and performance of banks in any general economic environment, especially when the economy is characterized by uncertainty. Conversely, Bindseil and Lanari (2020) found that banks with strong connections to central banks and a diverse range of assets can more readily address liquidity issues during a crisis. Nonetheless, despite these valuable contributions, the literature has certain limitations. From this perspective, the present research aims to identify and assess the key determinants of bank liquidity, focusing on the most significant factors affecting it during the three major crises mentioned above. The study will examine how European banks have changed their liquidity risk management practices in response to economic and regulatory changes.

Accordingly, the study proposes the following hypotheses:

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H1: Increased loan loss reserves (LLRR) are likely to reduce bank liquidity in the short term but induce long-term stability, particularly during financial crises.

H2: Increased credit risk (CRISK) has a negative effect on bank liquidity, particularly during crises.

H3: Increased market risk (MRISK) has a negative effect on bank liquidity, especially during periods of high market volatility.

H4: A higher bank capital ratio (ADEQ) improves bank liquidity, but with varying effects across crisis periods.

H5: Bank size (FSize) has a negative effect on bank liquidity, with a more pronounced impact during financial crises.

H6: Bank specialization (SPEC) has a negative effect on bank liquidity, particularly during crises, due to dependence on specific market segments.

H7: Bank diversification (DIVER) has a positive effect on bank liquidity, reducing banks' vulnerability to sectoral shocks and improving their resilience during crises.

2. METHOD

2.1. Sample and data description

During the period from 2005 to 2022, the European banking sector experienced substantial transformations driven by a series of systemic crises: the 2007–2008 financial crisis, the Eurozone sovereign debt crisis (2010–2012), the COVID-19 health crisis (2020), and, more recently, the onset of the Russian-Ukrainian war (2022). A sample of 196 European banks operating in the six countries affected by these crises (Table 1) – France, Germany, Italy, Spain, Great Britain, and Russia – was selected. In total, 3,528 company-year observations were collected across four types of banks: universal, commercial, investment, and public. Bank data were obtained from the BANKSCOPE database, while macroeconomic indicators were sourced from the World Bank website.

According to Table 1, France has 50 banks (25.5%), with a balanced mix of commercial (26), universal (10), investment (8), and state banks (6). The UK has 40 banks (20.5%), dominated by investment (11) and commercial banks (17). Germany has 35 banks (17.85%), primarily commercial (19), reflecting its three-tiered banking model. Italy has 25 banks (12.75%), mostly commercial (13), with some universal or investment banks (5) and a few state banks (2). Spain, with 28 banks (14.25%), shows a similar structure. Russia has 18 banks (9.15%), with a high proportion of state-owned banks (8).

2.2. Variables measurement

This study is based on the following variables:

2.2.1. *Dependent variable*

The liquidity ratio of a bank is a critical financial indicator that measures a bank's ability to meet short-term liabilities. In this study, four different liquidity ratios are used to examine the research hypotheses:

(i) *The Liquid Assets Ratio (LAR)*: This ratio is measured by total liquid assets (TLA) to total assets (TA).

Table 1. Sample composition of banks by type and country

Country	Universal	Commercial	Invest	Public	Total
France	10	26	8	6	50 (25.5%)
UK	8	17	11	4	40(20.5%)
Germany	6	19	6	4	35(17.85%)
Italy	5	13	5	2	25 (12.75%)
Spain	5	17	4	2	28(14.25%)
Russia	0	7	3	8	18(9.15%)
Total	34(17.4%)	99(50.5%)	37(18.87%)	26(13.26%)	196(100%)

$$LAR = \frac{TLA}{TA} \quad (1)$$

According to Aspaches et al. (2005), this ratio measures a bank's ability to meet its short-term liquidity needs. The higher this ratio, the better a bank could be able to meet its immediate obligations without having to sell any assets at a discount or to mobilize for short-term funding.

(ii) *The Current Liquidity Ratio (CLR*) is determined by liquid assets (TLA) to current liabilities (CL).

$$CLR = \frac{TLA}{CL} \quad (2)$$

This ratio helps to measure a company's ability to pay off short-term debts. It represents a company's short-term solvency. According to regulations, this ratio has to be above 100 percent (Vodowa, 2012; Bunda & Desquilbet, 2008; Delechat et al., 2012).

(iii) *The Loan-to-Deposit Ratio (LDR)* shows the relationship between the amount of net loans and overall deposits (Bonfim & Kim 2012; Vodowa 2012)

$$LDR = \frac{Loans}{Deposits} \quad (3)$$

According to prudential criteria, the ideal liquidity ratio (LDR) is between 80 and 90%. If the ratio is too low, banks cannot maximize their returns. If the ratio is too high, banks risk running out of liquidity to meet financing needs or unexpected economic crises.

(iv) *Liquid Assets to Deposit Ratio (LAD*): The predictor of liquidity risk is the ratio illustrating the proportion of liquid assets (LA) in relation to deposits and short-term financing (Tan & Floros, 2012; Acharya & Merrouche 2013).

$$LADR = \frac{LA}{Deposits} \quad (4)$$

The ratio measures a bank's liquidity by assuming it will not be able to borrow from other institutions in the event of a liquidity need. The bank can meet its funding obligations if the ratio is 100% or higher. If the value is lower, the bank is more sensitive to deposit withdrawals.

2.2.2. Explanatory variables

we select two dimensions: bank-specific variables and macroeconomic variables (Aspachs et al., 2005).

Loan Loss Reserves (LLRR) are the portion of funds set aside by banks to cover loans that cannot be repaid. LLRR is crucial to the long-term health of the bank. When banks manage their LLRR appropriately, they remain stable, particularly during crises, which typically increase credit risk and reduce liquidity (Gorton & Metrick, 2012; Jiménez & Saurina, 2006).

Credit risk (CRISK) is defined as the possibility that a borrower will be unable to repay a loan or meet another financial obligation. An increase in credit risk can decrease the liquidity of banks due to the need to create credit loss reserves and stricter management of financial resources (Berger & Bouwman, 2009). However, adequate credit risk management can strengthen the financial stability of banks in the long term, reducing the risk of a liquidity crisis and supporting the robustness of the banking system (Jiménez & Saurina, 2006).

Market risk (MRISK) refers to the possibility of losing money due to adverse price changes in financial markets such as interest rates, stocks, currencies, or commodities (Berger & Bouwman, 2009). It affects a bank's liquidity through fluctuations in the value of its assets and can result in potential losses or increased demands for liquidity to compensate for these losses. During crises, market risk becomes quite accentuated as prevailing adverse economic shocks bring highly fluctuated markets, placing banks under pressure. (Gorton & Metrick, 2012; Jiménez & Saurina, 2006).

The Capital Adequacy (ADEQ) measures the relationship involving a bank's capital in relationship to its risk-weighted assets. Higher capital levels enable better liquidity management and the ability to mitigate damage from trust crises or financial market turmoil during such periods (Berger & Bouwman, 2009). However, insufficient capital can worsen liquidity problems, as investors and depositors lose confidence, and it also restricts the bank's ability to raise funds from external sources.

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Table 2. Independent variables and hypotheses formulation

Name	Symbol	Description	Hypothesis
Bank-specific variables			
Provisions for loan losses	LLRR	Ratio of loan loss reserves to total net loans	–
Credit risk	CRISK	Ratio of non-performing loans to total loans	–
Market risk	MRISK	Interbank borrowings are reported to total borrowings	–
Capital adequacy	ADEQ	Ratio of equity to weighted assets	+
Firm size	FSIZE	Total active natural logarithm	–
specialization	SPEC	Net loans to total assets ratio	–
Diversification	DIVER	Ratio of non-interest income to total banking income	+
Macroeconomic variables			
GDP growth rate	GDPG	GDP growth rate	+
Inflation	INF	Inflation rate	–
Crisis	CRISIS	= 1if t is to the Subprime Crisis, COVID-19 pandemic, or Russian-Ukrainian war= 0 otherwise	–

Bank size (FSize): Larger banks generally have better asset diversification, easier access to financial markets, and more funding sources, which help them during liquidity stresses, especially in times of crisis (Klein, 2013). Larger financial institutions can also benefit from their reputation and perceived stability to obtain funding on more favorable terms, strengthening both their short- and long-term liquidity (Acharya et al., 2011). Conversely, smaller banks, with limited resources, are likely to face the greatest difficulties in accessing external funds when the economy is stressed or during a financial crisis.

Specialized banking (SPEC): A bank may focus on a specific area of banking activity (e.g., real estate lending, corporate credit, or investment banking) and is considered specialized banking. In times of crisis, specialized financial institutions may suffer significant shocks to their area of expertise, thereby constraining their liquidity. When a bank becomes highly specialized, its reliance on a particular market segment makes it more vulnerable to risks specific to that market. During a crisis, this specialization can become a disadvantage if market conditions in that area deteriorate rapidly (Stiroh, 2004).

Bank diversification (DIVER) refers to the variety of a bank's operations and assets across various sectors, products, and geographic areas. This approach helps banks diversify risks by not relying on a single sector or region. Greater diversification can strengthen banks' liquidity by providing diversified funding options, even during crises. Diversified banks are better protected against sectoral or geopolitical shocks because they have access to multiple revenue sources and can offset losses in one activity with gains in another (DeYoung & Rice, 2004; Laeven & Levine, 2007).

The macroeconomic variables included in the model are specifically recommended by Rajan and Zingales (2003), Acharya et al. (2011), and Bonfim and Kim (2012).

GDP growth (GDPG): Higher GDP growth rates are expected to improve bank liquidity. Economic growth generally leads to increased business activity and deposits, which enhance banks' access to liquid funds. *Inflation (INF):* Higher inflation rates may reduce bank liquidity. Inflation can increase uncertainty and the cost of holding liquid assets, potentially leading banks to hold fewer liquid assets.

The crisis (CRISIS) is a dummy variable that takes the value 1 during periods of major financial crises, including the subprime period, the COVID-19 pandemic, and the Russian-Ukrainian war, and 0 otherwise. This variable is included to determine whether there are changes in bank liquidity during financial crises.

2.3. Model specification

The study examines the economic determinants of bank liquidity using a sample of 196 banks from 2005 to 2022 and estimates a Prais-Winsten regression model with PCSE, following Beck and Katz (1995). This approach accounts for first-order autocorrelation, heteroskedasticity, and contemporaneous correlation across cross-sections.

$$Liquidity_{it} = \alpha + \sum_{k=1}^{7} \beta_k \cdot Z_{it} + \sum_{h=1}^{3} \delta_h \cdot M_t + \varepsilon_{it}, \quad (5)$$

where α refers to the intercept term, which characterizes the average liquidity level when the other components are absent. *Liquidity* is the liquidity ratio (LAR, CLR, LDR, LADR). Z_{it} is a vector of *microeconomic variables* related to bank characteristics (e.g., LLRR, CRISK, MRISK, ADEQ, FSIZE, SPEC, DIVER). M_t is a vector of *macroeconomic factors*, common across banks at time t (e.g., GDP growth, inflation, Crisis). β_k, δ_h are vectors of coefficients to be estimated, ε_{it} the error term is assumed to follow a first-order autoregressive process:

$$\varepsilon_{it} = \rho \varepsilon_{it-1} + u_{it}, \quad |\rho| < 1. \quad (6)$$

To address panel heteroscedasticity and contemporaneous correlation, we use Panel-Corrected Standard Errors with the estimated variance–covariance matrix $\hat{\Omega}$. The following feasible generalized least squares (FGLS) estimator is used to estimate the coefficients:

$$\hat{\theta}_{PW-PCSE} = \left(X' \hat{\Omega} X \right)^{-1} X' \hat{\Omega}^{-1} Y. \quad (7)$$

This approach provides robust and efficient estimators. It is designed for panel data with time dynamics and cross-sectional dependence. Many studies have used panel econometric models to examine bank liquidity alongside internal and external variables and macroeconomic shocks (Berger & Bouwman, 2009; Vodová, 2012; Huong et al., 2021). These studies validate the importance of bank-specific attributes and macroeconomic conditions in understanding liquidity behavior, especially in times of crisis (Chernykh et al., 2023).

3. RESULTS

The analysis covers 196 European banks from France, Germany, England, Italy, Spain, and Russia over the period 2005 to 2022, and reports (Table 3) valuable insights into bank performance during several significant economic periods.

According to Table 3, Liquidity ratios differ significantly: LAR has an average of 0.0873, with a maximum of 0.9365 which means some banks are considerably liquid, likely a result of the 2008 crisis and regulations that followed. CLR, while having a high dispersion (SD 2.3859), has a max of 5.283, also exhibiting a weak average of 0.2281 which means a responsible bank may be at risk with short-term debt. LDR averages 1.000, and LADR confirms the active lending practices typical of commercial banks. Credit risk (CRISK) remains low on average (0.0447), but is higher in some countries affected by sovereign or sectoral crises. LLRR is also low (0.0151), but peaks at 0.0378, indicating cautious provisioning in high-risk cases. The average market risk (MRISK) is at a moderate level of 0.0713, although some banks exhibit high interbank dependence, with a maximum value of 0.2591. The average capital adequacy (ADEQ) is 0.6121, with a maximum of 0.783, reflecting post-2008 regulatory changes and Basel III.

Table 3. Descriptive statistics

Variables	Min	Max	Mean	Std. Dev	VIF test
LAR	0.0029	0.9365	0.0873	0.1158	–
CLR	0.0001	5.283	0.2281	2.3859	–
LDR	0.845	1.151	1.000	0.087	–
LADR	0.118	0.6975	0.4819	0.1493	–
LLRR	0.005	0.0378	0.0151	0.0082	1.31
CRISK	0.0196	0.0675	0.0447	0.0168	1.27
MRISK	0.0211	0.2591	0.0713	0.0628	1.25
ADEC	0.4489	0.783	0.6121	0.078	1.00
FSize	16.203	29.073	23.891	2.3341	1.07
SPEC	0.4061	0.6844	0.4832	0.0778	1.01
DIVER	0.2212	0.4871	0.3484	0.0911	1.32
GDPG	–5.110	6.342	2.374	3.1322	1.35
INF	0.000	9.392	2.3318	2.0461	1.17

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Bank size (FSize) averages 23.891, with wide variation; specialization (SPEC) is stable (avg. 0.4832), and diversification (DIVER) is low (avg. 0.3484), showing reliance on interest income. GDP growth averages 2.374%, with large national variation, while inflation averages 2.33% but fluctuates up to 9.39%, affected by energy crises and post-pandemic shocks. From 2005–2022, European banks showed varied risk and liquidity profiles. Some became stronger post-crisis, especially in capital and liquidity, while others remain fragile due to market dependence and limited diversification. The VIF test results (Table 3) show that there is no significant multicollinearity between the independent variables in the model. All VIFs are below 2, and even well below the critical threshold of 5.

The empirical results (Table 4) indicate that both bank-specific and macroeconomic variables significantly affect bank liquidity in Europe, but the nature of this influence depends on the liquidity measure used. (i) From a microeconomic perspective, the LLRR has both positive and negative effects: it reduces liquidity from the asset side (LAR) and from deposits (LDR and LADR), but supports short-term liquidity (CLR). These findings are consistent with Diamond and Dybvig (1983), who highlight the trade-off between short-term flexibility and long-term protection in the presence of risk.

CRISK has a negative effect on liquidity, particularly for some deposit-based ratios and short-term liquidity indicators such as LDR, LADR, and CLR, suggesting that any deterioration in asset quality is likely to impair banks' ability to meet their obligations. This negative effect confirms the earlier study by Acharya and Merrouche (2013), who showed that poor asset quality significantly weakens banks' ability to meet obligations during crises.

Market risk (MRISK) is generally associated with improved liquidity through interbank borrowing. This indicates that access to wholesale markets is typically an important source of liquidity, particularly for larger or more stable banks. This positive impact is supported by Freixas et al. (2000), who demonstrate the importance of access to wholesale markets as a source of liquidity, especially during periods of stress.

Capital adequacy (ADEC), somewhat unexpectedly, shows a slight negative effect on liquidity. This result diverges from traditional expectations but aligns with Berger and Bouwman (2009), who argue that highly capitalized banks may prefer less liquid, long-term assets. Bank size (FSize) reduces liquidity on most measures, except for liquidity relative to deposits (LADR), where larger banks perform better, highlighting scale-related differences in liquidity strategies. This is consistent with DeYoung and Jang (2016), who found that larger banks employ different liquidity strategies, potentially prioritizing efficiency over flexibility. Diversification (DIVER) has a marginal positive effect, suggesting that non-interest income may slightly support liquidity. This finding is consistent with Acharya et al. (2011), who propose that non-interest income can provide an additional buffer in times of stress, thereby slightly enhancing banks' liquidity positions.

Table 4. Determinants of liquidity in European banks before and after the subprime crisis

Variables	Reg 1: LAR	Reg 2: CLR	Reg 3: LDR	Reg 4: LADR
LLRR	– 0.1169**	0.7305***	– 0.2276***	– 0.2862**
CRISK	– 0.0110	– 2.5869***	– 0.6509***	– 0.0558
MRISK	0.5471***	– 0.30913	0.6210***	0.75935***
ADEC	– 0.004**	– 0.0082***	0.02388	– 0.00006
FSize	–0.00405***	–0.14655***	– 4.6533[b]	0.01895***
SPEC	1.40[e]–06	– 0.00031	– 0.00525	0.00001
Diver	0.0031*	0.005012*	– 0.1153	– 0.00083*
Subprime	0.00542	0.387474[b]	– 2.9311	– 0.02229[b]
INF	0.00239***	– 0.04243[b]	0.54255	0.00428*
GDP	– 0.00014	0.061708[b]	– 0.07420	– 0.00032
Constant	0.1331***	0.3759***	0.2806***	–0.0264[b]
R-squared	21.01 %	23.2%	15.97 %	18.72 %
Wald chi2(10)	1269.25	145.46	35.31	254.09
Prob > chi2	0.0000	0.0000	0.0001	0.0000
Nbr. Obs	1176	1176	1176	1176

Note: *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

From a macroeconomic perspective, the Subprime crisis had mixed effects– it improved short-term liquidity, likely due to central bank support, but reduced deposit coverage. Inflation has a conflicting impact: it increases asset-side liquidity but worsens short-term liability coverage. This is consistent with Bernanke and Gertler (1989), who found that inflation may en-

hance nominal values but does not address real funding constraints. GDP growth enhances only short-term liquidity, indicating that broader economic expansion supports banks' short-term obligations more than their long-term liquidity structure. These findings align with Holmström and Tirole (1998), who explain that economic growth is correlated with better liquidity conditions in banking.

This second test examines the determinants of European banks' liquidity over the 2016–2020 period, specifically incorporating the impact of the COVID-19 crisis. The regression results (Table 5) from the COVID-19 crisis show that various bank-specific and macroeconomic factors remained statistically significant for liquidity, in some cases with variation compared to the Subprime crisis. These findings are confirmed by Gorton and Metrick (2021), who assert that systemic shocks can reactivate conventional liquidity concerns even in the presence of regulatory stability. The results suggest that the COVID-19 situation reinforced pre-existing liquidity trends in European banks and that internal factors, including loan loss reserves, credit risk, and interbank borrowing, continued to exert a strong influence on banks' liquidity. This conclusion is supported by Diamond and Dybvig (1983) and Acharya and Merrouche (2013) in earlier crisis contexts. Although the pandemic highlighted the need for sufficient cash or cash-equivalent funds for short-term needs, as shown by a clear positive effect of the COVID-19 pandemic on the LAR and CLR ratios, this is consistent with Holmström and Tirole's (1998) observations regarding the role of liquid assets in times of uncertainty. The negative effect on the LADR ratio indicates that banks have experienced greater distress in managing deposit-related payments, which could be explained by a higher level of withdrawals or a change in deposit behavior. Overall, the evidence shows that banks' liquidity levels during a crisis period depend on a combination of how banks prepare for losses, how they fund themselves, and overall economic circumstances. While banks may remain strong in the short term, they may continue to face additional pressure on their financials in the long term.

Table 5. Impact of the COVID-19 crisis on bank liquidity determinants

Variables	Reg 1: LAR	Reg 2: CLR	Reg 3: LDR	Reg 4: LADR
LLRR	– 0.1258**	0.68721***	– 0.2453***	– 0.3085**
CRISK	– 0.0234	– 2.9104***	– 0.7274***	– 0.0647
MRISK	0.6012***	– 0.3475	0.6710***	0.8081***
ADEC	– 0.0005**	– 0.0089***	0.0265	– 0.00008
FSize	– 0.0445***	– 0.1593***	– 5.0127**	0.0213***
SPEC	2.00e–06	– 0.00029	– 0.00461	0.00002
Diver	0.0038**	0.00547*	– 0.1289	– 0.0091*
COVID-19	0.10842**	0.5054**	– 0.082	– 0.444***
INF	0.00152**	– 0.0492**	0.4678	0.00291c
GDPG	– 0.00021	0.0647**	– 0.0708	– 0.00035
Constant	0.13042	3.896***	2.874***	–0.0293b
R-squared%	22.3	16.8	17.5	20.9
Wald chi2(10)	1302.14	158.25	38.97	275.64
Prob > chi2	0.0000	0.0000	0.0001	0.0000
Numb. Obs	980	980	980	980

Note: *** indicates significance at the 1% level, ** at 5%, and * at 10%.

For the Russian-Ukrainian war, the results (Table 6) indicate that European banks experienced increased stress on deposit-based liquidity, despite efforts to maintain or improve short-term liquidity coverage. Loan loss provisions, credit risk, and bank size continued to negatively affect liquidity, while interbank borrowing emerged as a key channel for maintaining liquidity access, confirming the findings of Allen and Gale (2004) on the systemic role of interbank markets. The war's impact is most evident in the deterioration of LADR, suggesting a vulnerability in banks' ability to cover deposits during geopolitical crises. This is consistent with Cetorelli and Goldberg (2012), who emphasized the fragile nature of deposit bases under external shocks. Some research, such as Bindseil and Lanari (2020), points to the ability to mitigate these deposit stresses through robust relationships with the central bank and asset diversification, providing a more optimistic view of bank resilience. However, the observed impact on short-term liquidity (CLR) may be the result of effective monetary interventions or injections of liquidity. In contrast, Gorton and Metrick (2012) caution that, while regulatory protections exist, systemic shocks can greatly impair liquidity, indicating enduring weaknesses. Overall, although these findings confirm that external shocks such as wars amplify existing weaknesses, especially in

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deposit funding structures, they illustrate the necessity of diversified income and interbank markets for liquidity provision under uncertainty.

Table 6. Impact of the Russian-Ukrainian war on bank liquidity determinants

Variables	Reg 1: LAR	Reg 2: CLR	Reg 3: LDR	Reg 4: LADR
LLRR	– 0.130**	–0.115***	–0.2501***	– 0.320**
CRISK	– 0.010	– 3.000***	–0.8011***	– 0.0607
MRISK	0.650***	0.750***	0.7040***	0.850***
ADEC	–0.0005**	–0.0009***	0.025	– 0.0008
FSize	– 0.0045***	– 0.150***	– 4.727**	0.020***
SPEC	1.5.00e–06	– 0.00035	– 0.0055	0.00002
Diver	0.00032*	0.0051*	– 0.120	– 0.00085*
Russian-Ukrainian war	0.110*	0.125**	– 0.090	– 0.450***
INF	0.0025***	– 0.045**	0.555	0.0045*
GDP	–0.00015	0.065**	– 0.080	– 0.00037
Constant	0.135***	3.800***	2.8541***	–0.030**
R-squared	17.5 %	15.5%	16.0 %	29.1 %
Wald chi2(10)	1300	150	36.02	260.01
Prob > chi2	0.0000	0.0000	0.0001	0.0000
Nbr. Obs	392	392	392	392

Note: *** indicates significance at the 1% level, ** at 5%, and * at 10%.

4. DISCUSSION

Liquidity determinants showed varying impacts from the Subprime Crisis, COVID-19, to the Russian-Ukrainian war (Table 7). Loan loss reserves initially supported short-term liquidity but became fully negative during the Russian-Ukrainian war, indicating the need to balance provisioning with operational liquidity. Credit risk consistently reduced short- and deposit-based liquidity, particularly during the Russian-Ukrainian war, highlighting the need to tighten credit controls. Market risk remained a positive driver throughout all periods, reinforcing the importance of access to wholesale funding. Capital adequacy had a persistent but slight negative impact, calling for better alignment between capital and liquidity strategies. Larger banks consistently had lower overall liquidity but stronger deposit coverage, indicating the need for size-specific regulation. Diversification slightly improved liquidity in all periods, supporting broader income sources. Specialization showed no major influence, suggesting limited policy focus is required. Crisis conditions generally improved short-term liquidity but reduced deposit coverage, especially during the Russian-Ukrainian war, underlining the importance of central bank support and robust deposit insurance. Inflation improved asset liquidity but strained short-term coverage, while GDP growth consistently supported short-term liquidity, recommending buffer-building during economic upturns.

Table 7. Bank liquidity determinants during major crises in Europe (2005–2022)

Variables	Subprime Crisis	COVID-19	Russian-Ukrainian War	Policy and Managerial Recommendations
Loan Loss Reserves (LLRR)	(–) Total and deposit liquidity (+) Short–term liquidity	(–) Overall liquidity (+) Short–term buffers	(–) All liquidity ratios	Manage reserves to keep enough cash for daily needs
Credit Risk (CRISK)	(–) Short–term and deposit liquidity	(–) Reduces liquidity	(–) Strong negative effect	Strengthen credit risk controls, reduce bad loans
Market Risk (MRISK)	(+) Improves all liquidity	(+) Same positive effect	(+) Supports all liquidity	Improve wholesale and interbank market access
Capital Adequacy (ADEC)	(–) Slight negative effect	(–) Same pattern	(–) Slightly negative	Hold some capital in liquid assets; follow Basel III
Bank Size (FSize)	(–) Reduces LAR, CLR, LDR (+) Improves LADR	(–) Bigger banks less liquid overall	(–) Overall liquidity (+) Better deposit coverage	Adjust rules by bank size; support smaller banks
Diversification (DIVER)	(+) Slightly improves LAR, CLR	(+) Modest positive effect	(+) Small positive effect	Encourage diverse income to stabilize cash flow
Crisis Dummy Variable	(+) Improves short–term liquidity (–) Worsens LADR	(+) LAR, CLR improved (–) LADR worsened	(+) CLR improved (–) LADR declined	Strengthen emergency liquidity and deposit insurance
Inflation (INF)	(+) Increases LAR (–) Reduces CLR	(+) Improves LAR (–) Lowers CLR	(+) Boosts LAR (–) Reduces CLR	Hedge inflation risks; adjust liabilities
GDP Growth	(+) Improves CLR only	(+) Same effect	(+) CLR improved	Use growth to build buffers

Note: (+) means a positive effect on liquidity, (–) means a negative effect. *LAR* = Liquid Assets Ratio, *CLR* = Current (short-term) Liquidity Ratio, *LDR* = Loan-to-Deposit Ratio; *LADR* = Liquid Assets to Deposits Ratio.

CONCLUSION

This study examines the main factors affecting bank liquidity in Europe during three crises: the Subprime crisis of 2008, the COVID-19 pandemic of 2020, and the Russian-Ukrainian war of 2022. The analysis adopts various liquidity measures and demonstrates that both bank-specific factors (loan loss reserves, asset risk, access to financial markets, capital, size, and income diversification) and macroeconomic conditions (inflation rates, GDP growth, crisis shocks) are relevant in establishing liquidity profiles. Loan loss provisions and credit risk negatively affected liquidity in all periods, particularly as indicated by deposit-based liquidity measures. In contrast, access to the interbank market (market risk) had a positive effect, especially during periods of stress, highlighting the interbank market's role in liquidity stability. Capital adequacy and bank size tended to correlate negatively with liquidity, reflecting trade-offs between stability and flexibility. Diversification provided a small but positive contribution to liquidity. The shocks of the three crises differed considerably. The subprime crisis led to higher liquidity but increased pressure on deposit funding. The pandemic enabled banks to accumulate liquidity with policy support, but at the cost of higher deposit utilization. The Russo-Ukrainian war showed banks that they are not exempt from massive deposit withdrawals during crises, which creates a need for liquidity reserves. In a word, a sound and sustainable liquidity position can be maintained only through the balanced management of micro- and macroprudential factors. Proper supervisory mechanisms would allow financial institutions to establish adequate provisions against credit default risk, enhance their credit risk management systems, provide access to market funding as an alternative to deposits, and help in the stabilization of the macroeconomic environment. Such measures are critical to building a more resilient banking sector in Europe that can withstand future economic shocks.

AUTHOR CONTRIBUTIONS

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Funding acquisition: Monia Chikhaoui.
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