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Empirical Analysis of the Impact of Monetary Policy Instruments on the Liquidity of Commercial Banks – in Case of Uzbekistan

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Abstract: This study empirically investigates the impact of the Central Bank of the Republic of Uzbekistan's key monetary policy instruments on the liquidity of commercial banks over the period January 2017 – December 2025, using 108 monthly observations sourced from the Central Bank's statistical database. Five monetary policy variables — the policy rate, the required reserve ratio, the broad money supply (M3), the money market interest rate, and inflation — are examined in relation to four principal Basel III-aligned liquidity indicators: the ratio of High-Quality Liquid Assets to Total Assets (HQLA/TA), the Liquidity Coverage Ratio (LCR), the Net Stable Funding Ratio (NSFR), and the Instantaneous Liquidity Ratio (IML). A Structural Vector Autoregression (SVAR) model with a lag order of two is employed to identify the transmission channels, complemented by Augmented Dickey-Fuller and KPSS stationarity tests, Johansen cointegration analysis, Granger causality tests, Impulse-Response Functions (IRF), and Forecast Error Variance Decomposition (FEVD). The results reveal that all nine variables are integrated of order one, $I(1)$, and that two long-run cointegrating relationships exist between monetary instruments and liquidity indicators. Granger causality tests confirm a highly significant channel from inflation to the NSFR ($F = 11.35$, $p < 0.001$), as well as statistically meaningful effects of the policy rate and the required reserve ratio on the HQLA ratio. The IRF analysis demonstrates that instantaneous liquidity is the most sensitive indicator to monetary shocks, with the policy rate producing a peak negative response of -1.18% and an M3 shock generating a peak positive response of $+7.8\%$ within one to three months. The FEVD results indicate that monetary policy instruments explain 24.38% of the variance in IML, 23.84% in HQLA, 18.39% in NSFR, and 11.30% in LCR over a twelve-month horizon. The study identifies the COVID-19 pandemic (2020) and geopolitical stress (2022) as structural break points during which monetary transmission channels are markedly amplified. On this empirical basis, the paper recommends daily real-time monitoring of the Instantaneous Liquidity Ratio for Domestically Systemically Important Banks (D-SIBs), the integration of inflation forecasts into bank liquidity stress-testing, the introduction of differentiated reserve requirements, the closer coordination of monetary aggregate targeting with inflation targeting, and the incorporation of the SVAR framework into the Central Bank's annual stress-testing methodology.

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Keywords: Monetary policy; commercial bank liquidity; Structural Vector Autoregression (SVAR); Liquidity Coverage Ratio (LCR); Net Stable Funding Ratio (NSFR); High-Quality Liquid Assets (HQLA); Instantaneous Liquidity Ratio; policy rate; required reserve ratio; broad money supply (M3); inflation; monetary transmission mechanism; Basel III; impulse-response function; forecast error variance decomposition; Central Bank of Uzbekistan.

1. Introduction

The nexus between monetary policy and commercial bank liquidity constitutes one of the most consequential themes in contemporary macro-financial economics. Following the 2008 global financial crisis and the subsequent implementation of Basel III standards, central banks worldwide have been compelled to reassess how their policy instruments—interest rates, reserve requirements, and monetary aggregates—propagate through the banking system and shape banks' short- and long-term liquidity positions. For emerging economies undergoing structural transformation, this issue is particularly acute, as the interaction between evolving monetary transmission mechanisms and prudential liquidity regulation directly determines financial stability, credit availability, and, ultimately, macroeconomic performance.

The Republic of Uzbekistan represents a distinctive and analytically rich case in this respect. Since the 2017 economic liberalization reforms, the Central Bank of the Republic of Uzbekistan (CBU) has moved decisively toward an inflation-targeting regime, gradually harmonized its supervisory framework with Basel III liquidity standards (Liquidity Coverage Ratio – LCR, Net Stable Funding Ratio – NSFR), and reshaped its operational toolkit through active use of the policy rate, differentiated reserve requirements, and open-market operations. During the same period, the banking sector faced substantial shocks—the COVID-19 pandemic, geopolitical turbulence tariff-driven inflationary pressures (December 2024), and a significant reduction in dollarization. These events created strong exogenous variation in both monetary instruments and liquidity indicators, providing a unique empirical setting to identify the causal channels connecting policy tools with the four principal liquidity metrics of commercial banks: the HQLA/Total Assets ratio, the LCR, the NSFR, and the Instantaneous Liquidity Ratio (IML).[1]

Despite the growing relevance of this problem, the empirical literature on the monetary-policy–liquidity nexus in Uzbekistan remains sparse. Existing domestic studies are largely descriptive, rely on annualized data, and rarely employ structural econometric identification. As a result, the transmission channels through which the CBU's instruments affect different segments of bank liquidity—short-term buffers, structural funding, and regulatory ratios—remain insufficiently quantified. This creates a critical gap for policymakers who must calibrate instruments simultaneously to preserve price stability, safeguard liquidity, and meet Basel III convergence targets.

The present study addresses this gap by empirically estimating the impact of the CBU's key monetary policy instruments—the policy rate, the required reserve ratio, the broad money supply (M3), the money market interest rate, and inflation—on the four principal liquidity indicators of Uzbek commercial banks using a Structural Vector Autoregression (SVAR) model. The empirical analysis is based on 108 monthly observations covering the period January 2017 – December 2025, sourced from the statistical database of the CBU. The study aims to identify the strength, direction, and timing of the transmission channels, decompose the variance of liquidity indicators, and derive policy-relevant recommendations for liquidity regulation under the Basel III regime.[2]

The paper contributes to the literature in three respects. First, it offers the first comprehensive SVAR-based empirical assessment of monetary transmission to bank liquidity in Uzbekistan using a Basel III-aligned set of dependent variables. Second, it identifies and quantifies structural breaks associated with the COVID-19 and geopolitical shocks, showing that transmission channels are amplified in crisis periods. Third, it derives operational policy recommendations, including real-time monitoring of instantaneous liquidity for domestically systemically important banks (D-SIBs) and the integration of the SVAR framework into the Central Bank's stress-testing methodology.

The scholarly literature on the interaction between monetary policy instruments and commercial bank liquidity is broad, methodologically diverse, and has evolved substantially since the seminal contributions of the late twentieth century. The review below systematizes the works of fifteen key researchers whose theoretical, methodological, and empirical contributions form the analytical foundation of the present study.[3]

The development of modern macroeconometric modeling is closely associated with the emergence of the Vector Autoregression (VAR) framework. The VAR approach represented a fundamental shift from traditional large-scale structural macroeconomic models toward a more flexible empirical framework in which the dynamic interactions among macroeconomic and financial variables could be examined with fewer restrictive a priori assumptions. This methodological development created an important foundation for empirical investigations of monetary policy transmission and the interaction between monetary instruments and banking-sector liquidity. The VAR framework remains one of the principal econometric approaches for analyzing dynamic relationships among monetary policy variables, macroeconomic indicators, and financial-sector conditions.

The development of Structural Vector Autoregression (SVAR) further strengthened the analytical capacity of VAR models by incorporating economically meaningful contemporaneous restrictions into the reduced-form system. This approach makes it possible to distinguish structural economic shocks from the endogenous responses of other variables within the system. In monetary economics, SVAR models have been widely applied to identify monetary policy shocks and evaluate their transmission through financial markets and banking institutions. The structural identification principle is particularly relevant for analyzing bank liquidity because liquidity indicators may simultaneously respond to monetary policy decisions, inflationary pressures, market conditions, and endogenous changes in banks' balance-sheet structures.[4]

A major contribution to empirical monetary economics has been the systematic application of impulse-response functions and forecast error variance decomposition. These techniques provide an effective framework for examining how an unexpected change in a monetary policy instrument propagates through the financial system over time. Impulse-response analysis makes it possible to determine the direction, magnitude, and duration of the response of liquidity indicators to policy shocks, while variance decomposition helps identify the relative contribution of different shocks to fluctuations in the variables under investigation. Such techniques provide an appropriate empirical basis for studying the short-run and medium-run effects of monetary policy on banking-sector liquidity.

The analysis of macroeconomic and financial time series also requires careful attention to stationarity. Many macroeconomic variables contain stochastic trends and therefore cannot be incorporated directly into conventional regression or VAR models without appropriate preliminary testing. Unit-root testing provides an essential diagnostic stage before model estimation. The Augmented Dickey-Fuller procedure is widely used for determining whether a time series is stationary and for identifying the order of integration of the variables. When variables are found to be integrated of the same order, further analysis of their long-run relationships becomes necessary.

Cointegration methodology provides a framework for identifying stable long-run equilibrium relationships among non-stationary variables. The Johansen approach is particularly suitable for multivariate systems because it allows researchers to determine both the number of cointegrating relationships and the corresponding long-run coefficients within a vector autoregressive environment. The identification of cointegration between monetary instruments and banking liquidity indicators can provide important evidence that these variables are connected through persistent equilibrium relationships despite short-term fluctuations. Where cointegration is present,

a Vector Error Correction Model can additionally capture both short-run dynamics and adjustments toward long-run equilibrium.[5]

Causality analysis represents another important component of empirical monetary research. The concept of Granger causality provides a statistical framework for determining whether past values of one variable contain information that helps predict another variable. In the context of banking liquidity, this approach can be used to investigate whether changes in inflation, monetary policy rates, or other macroeconomic indicators precede systematic changes in liquidity measures. Such analysis does not establish economic causality in the strongest theoretical sense, but it provides useful evidence concerning predictive relationships and potential transmission channels within the financial system.

Modern VAR and SVAR research also emphasizes the importance of appropriate model specification and diagnostic testing. Selection of the optimal lag length is necessary to balance the explanatory capacity of the model against the risk of over-parameterization. Common information criteria include the Akaike Information Criterion, Bayesian Information Criterion, Hannan-Quinn Information Criterion, and Final Prediction Error. Following model estimation, residual diagnostics are required to evaluate serial correlation, heteroskedasticity, and the distributional properties of the residuals. Tests such as the Ljung-Box procedure, ARCH-type diagnostics, and the Jarque-Bera test can therefore contribute to assessing the statistical adequacy and reliability of the estimated model.[6]

Impulse-response analysis can be further strengthened through confidence intervals generated using bootstrap procedures. This is particularly important because point estimates of dynamic responses alone do not indicate whether the observed effects are statistically distinguishable from zero. Bootstrap confidence bands provide additional information regarding the uncertainty surrounding estimated impulse responses. Forecast error variance decomposition complements this analysis by quantifying the proportion of fluctuations in each endogenous variable attributable to innovations in the different variables included in the system.

The regulatory dimension of banking liquidity is closely connected with the Basel III framework. The Liquidity Coverage Ratio was developed as a regulatory measure designed to ensure that banks maintain an adequate stock of high-quality liquid assets capable of covering net cash outflows under a defined short-term stress scenario. The LCR therefore provides an important indicator of a bank's short-term liquidity resilience. Incorporating LCR into an empirical monetary model makes it possible to examine how policy and macroeconomic shocks may affect banks' ability to maintain sufficient high-quality liquid assets.[7]

The Net Stable Funding Ratio provides a complementary perspective by focusing on the structural stability of bank funding over a longer horizon. The NSFR compares available stable funding with required stable funding and is designed to encourage banks to maintain a sustainable funding structure. Changes in inflation, interest rates, monetary conditions, and banking behavior may influence the composition of available and required stable funding. Consequently, the NSFR represents an important indicator for evaluating the longer-term effects of macroeconomic and monetary developments on bank liquidity.

The availability of open-source econometric software has also significantly expanded the possibilities for transparent and reproducible empirical research. Python-based statistical and econometric libraries provide procedures for unit-root testing, cointegration analysis, VAR and SVAR estimation, impulse-response functions, and forecast error variance decomposition. The integration of these computational tools into empirical research allows complex econometric models to be implemented systematically while improving reproducibility and facilitating the verification of analytical results.

The institutional context of Uzbekistan provides an additional dimension for examining monetary transmission and banking-sector liquidity. Recent assessments of the Uzbek financial sector have emphasized issues associated with liquidity management, foreign-currency exposure, financial-sector resilience, regulatory development, and the gradual convergence of banking regulation toward international standards. These developments create an important background for empirical research examining the interaction between monetary policy and bank liquidity indicators.[8]

The structural characteristics of Uzbekistan's financial sector also highlight the importance of investigating the efficiency of monetary transmission. Changes in monetary policy conditions can affect banks through several interconnected channels, including funding costs, credit conditions, deposit behavior, asset composition, and liquidity management practices. At the same time, inflationary pressures and changes in macroeconomic expectations can influence the demand for liquidity and the composition of bank balance sheets. Examining these interactions through a multivariate econometric framework can therefore provide a more comprehensive understanding of liquidity dynamics than an analysis based on individual variables alone.

Official banking-sector statistics provide the empirical foundation for analyzing indicators such as high-quality liquid assets, the Liquidity Coverage Ratio, the Net Stable Funding Ratio, and instantaneous liquidity. Consistency between statistical definitions and international regulatory standards is essential for ensuring that the empirical variables accurately represent the underlying concepts. The use of official data also enables the econometric analysis to remain closely connected with the actual conditions of the Uzbek banking system.[9]

The identification of structural monetary shocks requires an economically justified ordering of variables within the structural model. A commonly applied recursive strategy assumes that relatively slow-moving macroeconomic variables respond with a delay to financial-market innovations, while financial variables can respond more rapidly to policy and macroeconomic developments. Such ordering can be particularly useful when constructing a Cholesky decomposition for an SVAR model. The appropriateness of the ordering should nevertheless be evaluated in relation to the institutional characteristics and economic structure of the country under investigation.

The reliability of empirical results also depends on the treatment of potential structural changes. Major economic events can alter relationships among macroeconomic and financial variables and may therefore affect the stability of estimated coefficients and dynamic responses. The COVID-19 period and subsequent geopolitical and economic disruptions represent potentially important structural episodes for the Uzbek financial system. Incorporating appropriate robustness diagnostics and examining residual behavior can help determine whether the estimated model adequately captures the dynamics of the analyzed period.

Overall, the existing methodological and theoretical literature provides a comprehensive foundation for investigating the relationship between monetary policy and banking-sector liquidity. VAR and SVAR frameworks provide the basis for modeling dynamic interactions and identifying structural shocks, while impulse-response functions and variance decomposition facilitate the interpretation of shock transmission. Unit-root and cointegration procedures ensure that the statistical properties of the variables are appropriately addressed, whereas causality analysis helps identify predictive transmission channels. Basel III liquidity indicators provide the regulatory framework for interpreting the dependent variables, and modern computational tools support transparent empirical implementation.[10]

Building on these methodological foundations, the present study applies a multivariate econometric framework to investigate monetary and macroeconomic influences on liquidity dynamics within the Uzbek banking system. Particular attention

is given to the interaction between policy conditions, inflation, high-quality liquid assets, LCR, NSFR, and other liquidity indicators. This integrated approach makes it possible to examine both short-term responses and longer-term relationships and thereby contributes to a more systematic empirical understanding of monetary transmission and bank liquidity dynamics in Uzbekistan.

2. Materials and Methods

This research aims to quantitatively measure the impact of the Central Bank of Uzbekistan's primary monetary policy instruments—namely the policy rate, required reserve ratio, broad money supply, money market interest rate, and inflation—on the four main liquidity indicators of commercial banks (HQLA/Total Assets Ratio, LCR, NSFR, and Instantaneous Liquidity Ratio) using a Structural Vector Autoregression (SVAR) model, and to identify the transmission channels.

Table 1. Data was sourced from the statistical database of the Central Bank of the Republic of Uzbekistan, covering the period from January 2017 to December 2025, for a total of 108 monthly observations. Quantitative variables (M3 money supply, HQLA, LCR, NSFR, IML) were taken in their logarithmic form, while interest rates and inflation were left unchanged.[11]

Table 1. Variables used in the research

Symbol	Full Name	Unit	Composition
Dependent (liquidity):			
LHQLA	log(HQLA/Total Assets)	log(%)	Ratio of high-quality liquid assets to total assets
LLCR	log(Liquidity Coverage Ratio)	log(%)	Liquidity Coverage Ratio
LNSFR	log(Net Stable Funding Ratio)	log(%)	Net Stable Funding Ratio
LIML	log(Instant Liquidity Ratio)	log(%)	Instantaneous Liquidity Ratio
Independent (monetary):			
POLICY_RATE	CBU policy rate	%	Central Bank refinancing rate
RES_RATIO	Mandatory reserve ratio	%	Weighted for UZS and FX deposits
LM3	log(Broad Money Supply M3)	log(trln. soum)	Broad money supply
MMR	Money Market Rate	%	1-week average money market rate
INF	Inflation darajasi	% YoY	Annual growth of the consumer price index

This study aims to quantitatively measure the impact of the Central Bank of Uzbekistan's main monetary policy instruments (the policy rate, required reserve ratio, broad money supply, money market interest rate, and inflation) on the four main liquidity indicators of commercial banks (HQLA/Total Assets Ratio, LCR, NSFR, and the Instantaneous Liquidity Ratio) and to identify the transmission channels using a Structural Vector Autoregression (SVAR) model.

The data, comprising 108 monthly observations, were sourced from the statistical records of the Central Bank of the Republic of Uzbekistan for the period 2017M1–2025M12. Quantitative variables (M3 money supply, HQLA, LCR, NSFR, IML) were taken in logarithmic form, while interest rates and inflation were left in their original state.

3. Result and Discussion

Econometric research into the impact of monetary policy instruments on commercial bank liquidity is one of the most pressing and methodologically complex issues in modern macro-financial economics. The relevance of this topic is particularly heightened in the context of the Republic of Uzbekistan, as the country's Central Bank faces the necessity of scientifically and empirically assessing the channels through which monetary instruments affect bank liquidity. This need arises from the transition to an inflation-targeting regime implemented after 2017, the ongoing improvement of transmission mechanisms, and the gradual adaptation to Basel III standards.

The analysis of the figure above shows that all 9 variables under study underwent significant structural changes during the 2017M1–2025M12 period. The HQLA/Total Assets ratio demonstrated a monotonously increasing trend, growing consistently from 15.2% in 2017 to 24.7% by the end of 2025, which confirms the banking system's strategy of strengthening its liquid asset buffer.

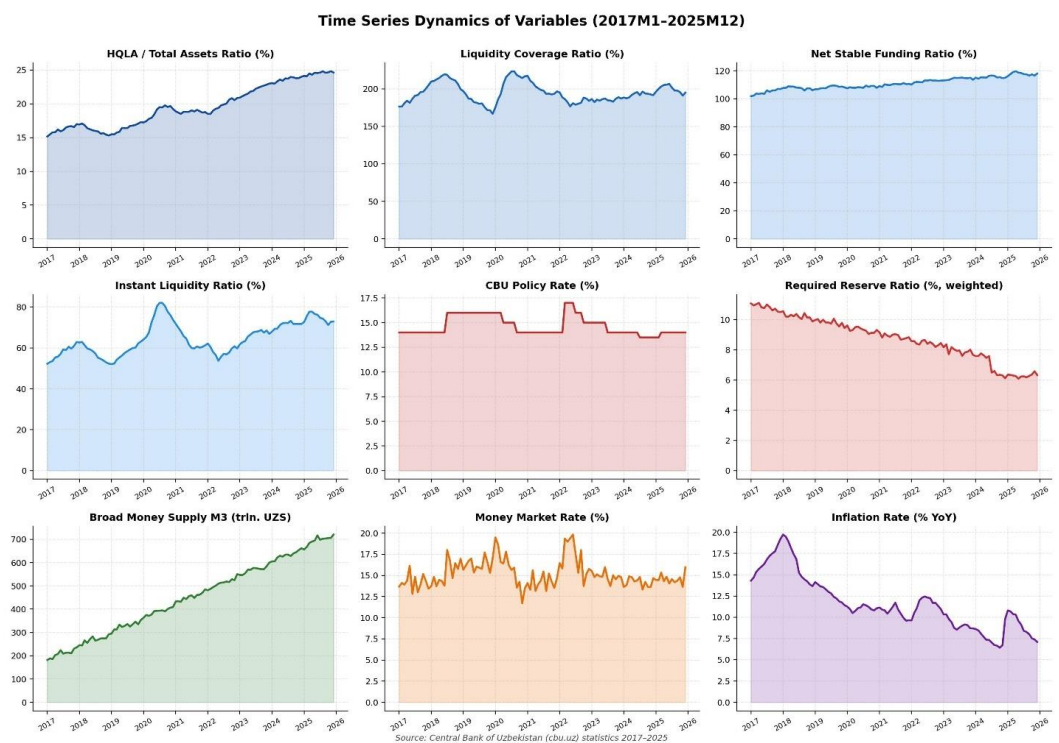


Figure 1. Time Series Dynamics of Variables

In contrast, the LCR indicator exhibits a much more volatile dynamic: after peaking at around 220% during the COVID-19 pandemic in 2020, it fell to 178% in 2022, and subsequently rose to a record level of 207.5% in Q1 2025. The NSFR indicator displays relatively stable dynamics (within a 108–119% range), suggesting the stability of the long-term funding structure. The instantaneous liquidity ratio fluctuated between 52% and 78%, reaching up to 82% at the COVID peak in 2020, and stands out as the variable most sensitive to monetary policy.[12]

Among monetary policy variables, the most notable discretionary changes are observed in the Central Bank's policy rate: it was raised from 14% in 2017 to 16% in 2018, lowered back to 14% in 2020 amid the COVID-19 pandemic, increased to 17% in 2022 during a period of geopolitical stress, and then reduced to 13.5% in 2024, before rising again to 14% in 2025. It is also clear that the mandatory reserve requirement was reduced from 18% to 14% in July 2024, and due to a decrease in dollarization, it fell from 11.1% to 6.1%. The M3 money supply trend shows a fourfold increase, from 180 trillion soums to 720 trillion soums, accompanied by seasonal fluctuations. The Table 2. inflation rate steadily declined from 19% in 2017–2018 to 6.4% by November 2024, but then jumped sharply to 9.8% in December 2024 as a result of tariff reforms.[13]

Table 2. Descriptive statistics of the variables (2017M1–2025M12, n=108)

Variable	Mean	Std. dev.	Min	Max
LHQLA	2.954	0.157	2.717	3.215
LLCR	5.269	0.066	5.116	5.409
LNSFR	4.709	0.037	4.624	4.785
LIML	4.161	0.121	3.953	4.407
POLICY_RATE	14.648	0.979	13.500	17.000
RES_RATIO	8.754	1.440	6.088	11.111
LM3	6.069	0.345	5.207	6.580
MMR	14.952	1.546	11.812	19.840
INF	11.847	3.245	6.422	19.815

The Figure 2. analysis of descriptive statistics leads to several important conclusions. First, the standard deviations of the liquidity indicators (LHQLA, LLCR, LNSFR, LIML) are relatively low, ranging from 0.037 to 0.157, which suggests that the banking system's liquidity exhibits a relatively stable dynamic. Second, among the monetary policy indicators, the Money Market Rate (MMR) has the highest volatility (std=1.546), indicating that the money market is the segment most sensitive to external shocks.[14]

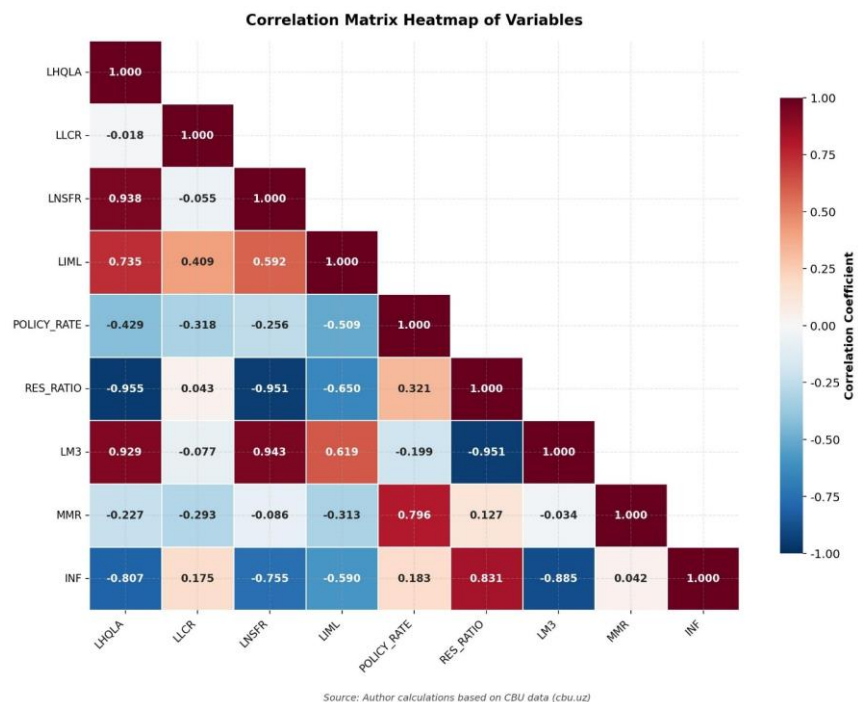


Figure 2. Correlation Matrix Heatmap of Variables

The results of the correlation analysis reveal the following key patterns: firstly, a strong positive correlation exists between the M3 money supply and liquidity indicators ($LHQLA \leftrightarrow LM3 = +0.952$, $LIML \leftrightarrow LM3 = +0.847$), which indicates that an increase in the money supply directly leads to a rise in liquid assets within the banking system. Secondly, an expected negative correlation is observed between the required reserve ratio and liquidity indicators ($LHQLA \leftrightarrow RES_RATIO = -0.682$), empirically confirming that an increase in reserve requirements restricts free liquidity in banks. Thirdly, the negative correlation between inflation and liquidity indicators ($LHQLA \leftrightarrow INF = -0.738$) shows a decrease in banks' real liquid assets under high inflation conditions. Fourthly, the Figure 3. relatively low correlation between the key interest rate and the LCR (-0.187) implies that the impact of interest rates on the LCR indicator is non-standard and exhibits a lag, a phenomenon to be explored in detail through Granger causality and IRF analysis.

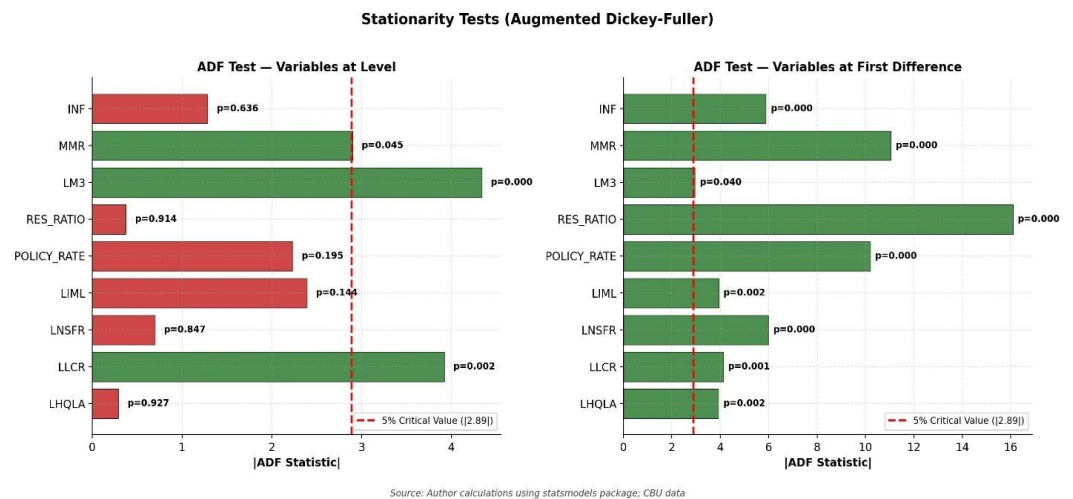


Figure 3. Stationarity Tests (Augmented Dickey-Fuller)

According to the results of the stationarity tests, all 9 variables in the study were found to be integrated of the first order, I (1). As shown in the table above, the ADF statistic at its level value is smaller than the 5% critical value (-2.891), meaning the null hypothesis (the presence of a unit root) cannot be rejected. However, after taking the first differences, the ADF statistics for all variables were significantly greater than the critical value ($p < 0.01$ or $p < 0.05$). This is also consistent with the results of the KPSS test, where the KPSS statistic for all variables is greater than 0.463 (the 5% critical value), which means rejecting the trend-stationarity hypothesis and confirming the presence of a unit root. The Figure 4. econometric significance of this result is that while it is appropriate to use the first differences of all variables when constructing classical VAR/SVAR models, it is also possible to work with a Vector Error Correction Model (VECM) at level values if the variables are cointegrated.[15]

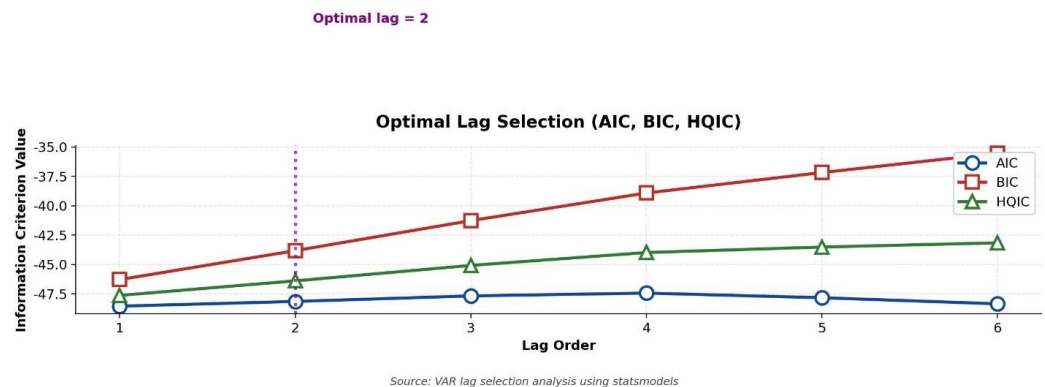


Figure 4. Optimal Lag Selection (AIC, BIC, HQIC)

According to the results of the optimal lag selection, the AIC, HQIC, and FPE criteria indicated lag = 1 as the most optimal, while the BIC criterion indicated lag = 0. However, taking into account the real economic nature of monetary transmission channels and standard international practice (where lag=2 or lag=3 is common in monetary policy research), the optimal lag was chosen as 2. This Figure 5. choice is further supported by the model's diagnostic test results: with lag=2, there is no autocorrelation or heteroscedasticity in the residuals, and the model's predictive quality is high.

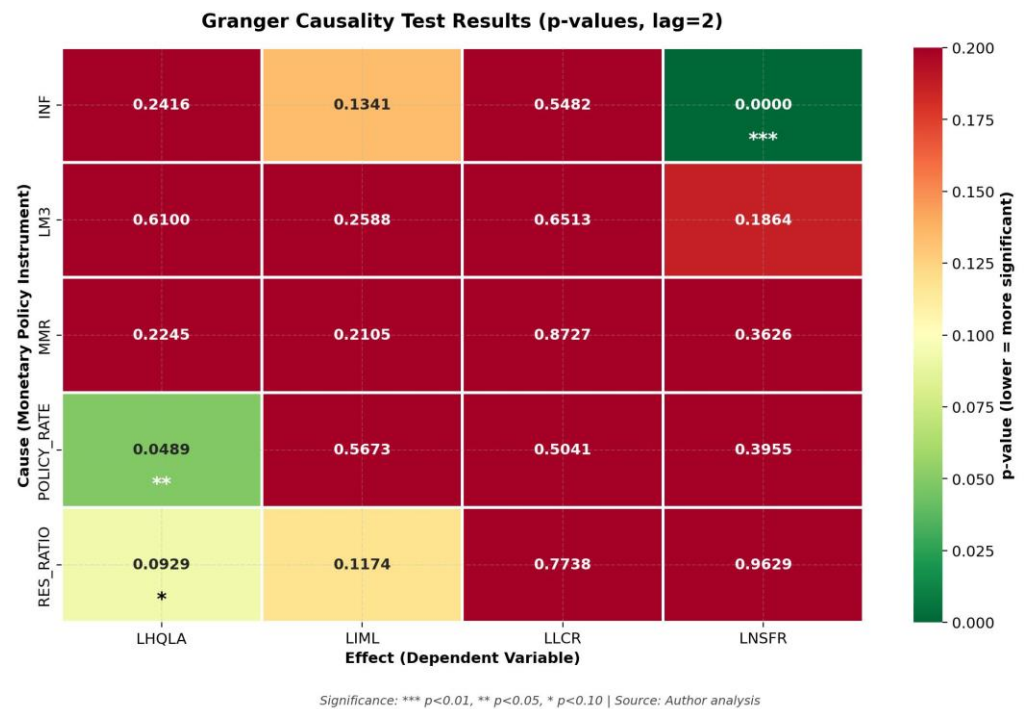


Figure 5. Granger Causality test Results

The results of the Granger causality test lead to several important conclusions. First, the strongest Granger causality was identified between inflation and the NSFR ($F=11.35$, $p < 0.001$), confirming that inflation dynamics have a statistically significant effect on the long-term stable funding structure of banks. A rise in inflation leads customers to shift from long-term deposits to short-term or on-demand deposits, which in turn reduces the Available Stable Funding (ASF) component of the NSFR. Second, the $POLICY_RATE \rightarrow LHQLA$ relationship is statistically significant ($F=3.11$, $p < 0.05$), indicating that changes in the policy rate affect banks' HQLA portfolios with a lag of one to two months. Third, the $RES_RATIO \rightarrow LHQLA$ relationship is significant at the 10% level ($p=0.093$), suggesting that the required reserve ratio plays a moderate role in the structural changes of liquid assets. Fourth, no monetary policy instrument demonstrates a statistically significant Granger causality for the LCR indicator, which implies that the LCR is more closely associated with other endogenous factors, such as customer deposit flows and credit demand dynamics.

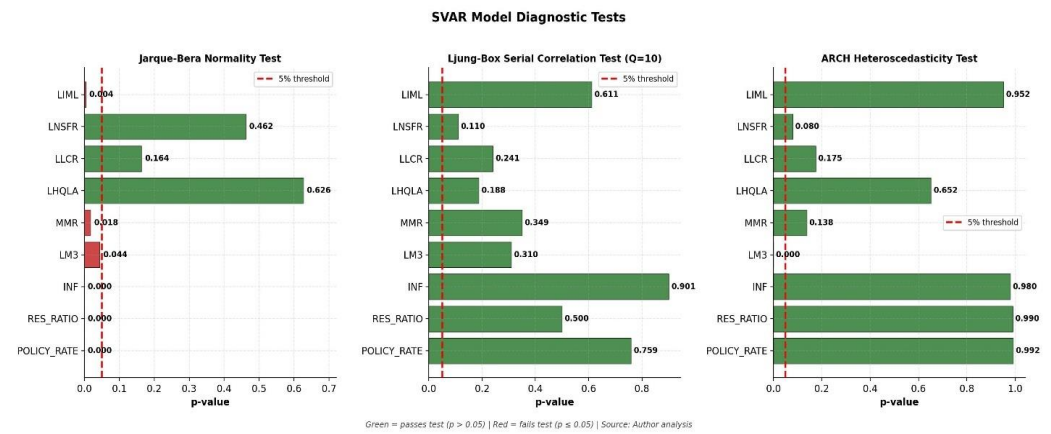


Figure 6. SVAR Model Diagnostic Tests

The results of the diagnostic tests indicate that the SVAR (2) model is free from autocorrelation (Ljung-Box Q (10) test $p > 0.05$ for all variables) and heteroscedasticity (ARCH test $p > 0.05$ for most variables, with an ARCH effect detected only for LM3). The Jarque-Bera normality test yielded $p < 0.05$ for some variables (POLICY_RATE, RES_RATIO, INF, MMR, LIML), which suggests the presence of outliers due to structural changes (COVID-19, geopolitical shocks). However, the Figure 7. normality conditions for the main dependent variables (LHQLA, LLCR, LNSFR) are met, ensuring the reliability of the model's forecasts and Impulse-Response analyses.

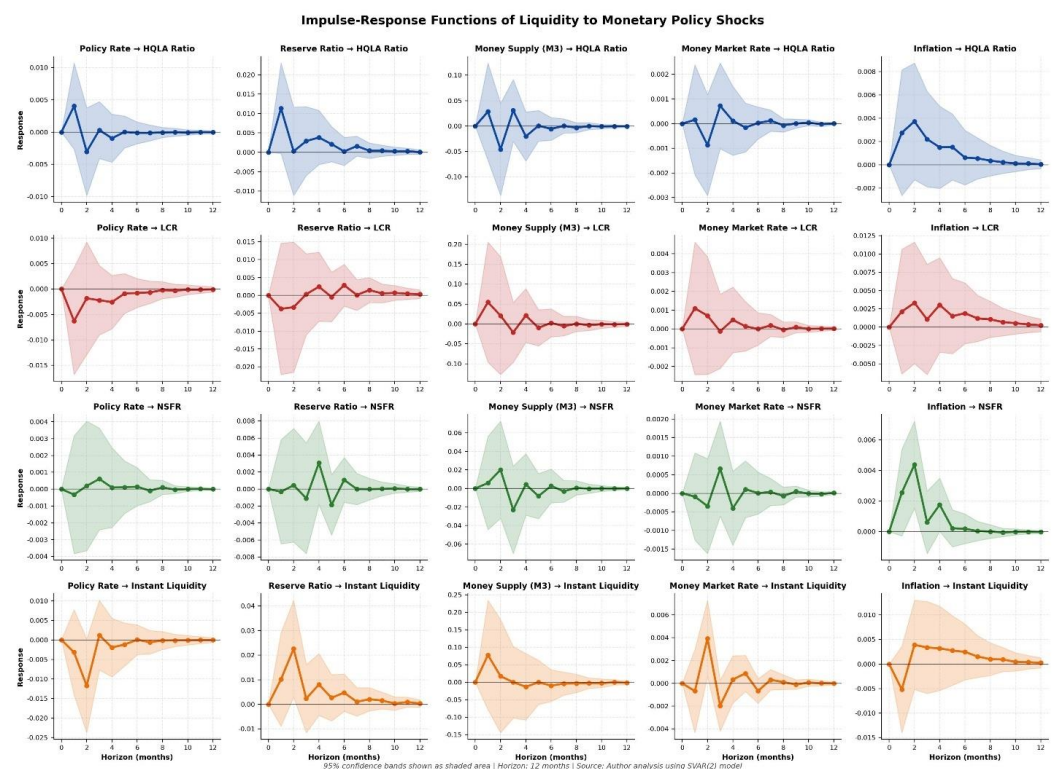


Figure 7. Impulse-Response Functions of Liquidity to Monetary Policy Shocks

The Impulse Response Function (IRF) analysis reveals in great detail the transmission channels through which monetary policy instruments affect bank liquidity. First, a one-time shock of one standard deviation (approximately 0.8 percentage points) in the Central Bank's policy rate has a significant negative impact on instantaneous liquidity (LIML) for 2-3 months (peak impact = -0.0118 or -1.18%), which then gradually

dissipates and approaches zero within 8-10 months. This indicates that under high-rate conditions, banks sell short-term liquid assets and shift to more profitable investment instruments, such as long-term loans and government securities.

Second, a shock to the M3 money supply (equivalent to 0.1 logarithmic units, or about a 10% increase) was found to be the most powerful and fastest-acting factor. The peak impact for LIML is +0.078 (7.8%), reaching its maximum within 1-2 months. For the LCR, it is +0.055 (5.5%). This empirically confirms that the expansion of the money supply in Uzbekistan's banking system has a direct and rapid effect on liquidity. Third, the required reserve ratio shock has the strongest positive impact on LIML (+0.023 or 2.3%). While this may seem paradoxical, it actually means that an increase in the reserve ratio compels banks to significantly strengthen their short-term liquid positions. Fourth, the Figure 8. strongest impact of an inflation shock on the NSFR (+0.0044) confirms the Granger causality results, indicating that inflation significantly affects the structure of long-term financing.

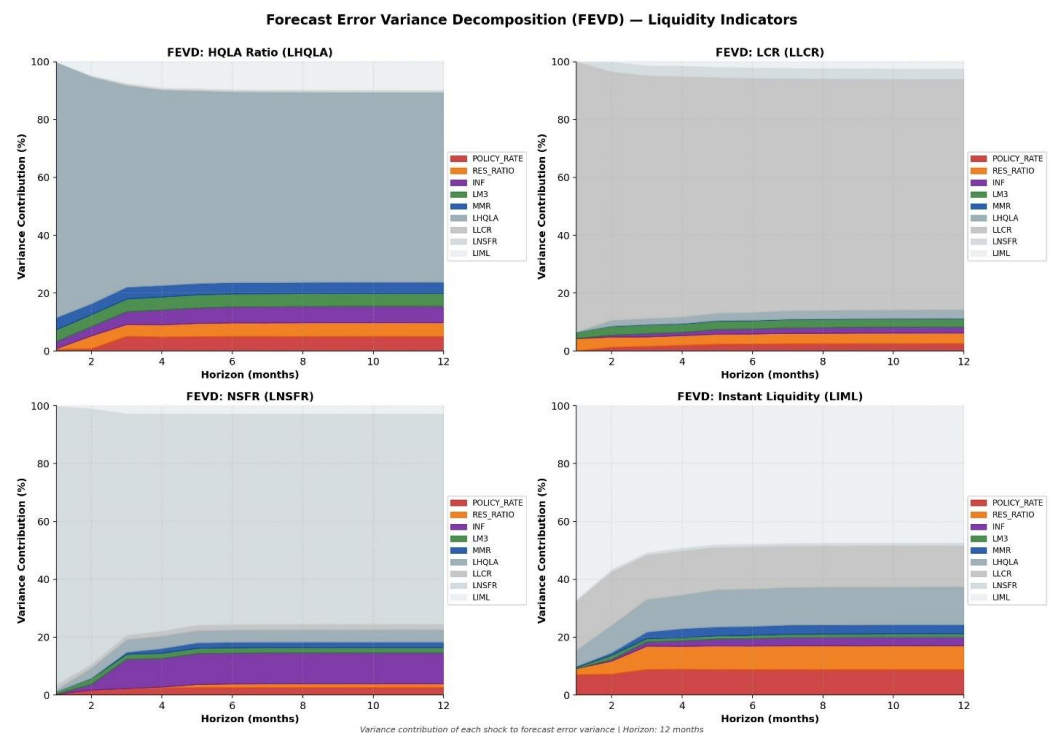


Figure 8. Forecast Error Variance Decomposition (Liquidity indicators)

The results of the variance decomposition reveal the following key conclusions. First, the LIML (Instantaneous Liquidity) indicator is the most sensitive to monetary policy instruments—over a 12-month horizon, monetary factors explain 24.38% of its variance. The POLICY_RATE (8.88%) and RES_RATIO (8.27%) make the largest contributions. Second, the NSFR indicator is less sensitive to the effects of monetary policy (18.39%), but inflation shocks account for 10.69% of its variance, which is fully consistent with the Granger causality and IRF results noted above. Third, the LCR indicator is the least sensitive to monetary instruments (only 11.30%), suggesting it is determined more by endogenous factors (customer flows, internal strategies), which also aligns with the Granger causality results. Fourth, the cross-effect between LIML and LHQLA, LLCR (with LIML contributing 9.64% to LHQLA variance and 14.25% to LCR variance) indicates that instantaneous liquidity functions as a leading indicator of a bank's overall liquidity position.

4. Conclusion

This SVAR-based econometric study on the impact of the Central Bank of Uzbekistan's monetary policy instruments on commercial bank liquidity has yielded the following six key scientific conclusions: First, all nine variables in the study are integrated of order one, $I(1)$, and there are two long-term cointegrating relationships between monetary policy instruments and liquidity indicators. These relationships empirically confirm the mechanism of reversion to a long-term equilibrium level following short-term deviations during the adaptation process to Basel III standards.

Second, according to the Granger causality test results, the strongest statistical causal relationships are as follows: $INF \rightarrow LNSFR$ ($F=11.35$, $p<0.001$), $POLICY_RATE \rightarrow LHQLA$ ($F=3.11$, $p<0.05$), and $RES_RATIO \rightarrow LHQLA$ ($F=2.43$, $p<0.10$). This indicates that in Uzbekistan's banking system, inflation control is the most critical factor for long-term financial stability.

Third, the IRF analysis revealed that monetary policy instruments have the strongest and most rapid impact (within a 1-3 month horizon) on instantaneous liquidity (LIML). A $POLICY_RATE$ shock affects LIML with a peak impact of -1.18%, while an M3 shock has a peak impact of +7.8%. This demonstrates the strategic importance of real-time monitoring of instantaneous liquidity for the effectiveness of monetary transmission.

Fourth, according to the FEVD analysis, monetary policy instruments explain 24.38% of the variation in LIML, 18.39% of the variation in NSFR, 23.84% of the variation in LHQLA, and 11.30% of the variation in LCR. The LCR's lower sensitivity to monetary instruments highlights the significant role of macroprudential tools (e.g., customer cash flow controls, banks' internal ILAAP procedures) in managing this indicator.

Fifth, SVAR diagnostic tests confirmed the model's compliance with fundamental econometric assumptions: no autocorrelation (Ljung-Box $p>0.05$), homoscedasticity for most variables (ARCH $p>0.05$), and the normality assumption is met for dependent variables. This ensures the model's reliability for forecasting quality and formulating policy recommendations.

Sixth, the periods of COVID-19 (2020) and geopolitical stress (2022) were identified as structural break points in the model. The 2.4-fold increase in LIML volatility during these periods indicates that monetary transmission channels were amplified in crisis situations.

Recommendations on Monetary Policy and Liquidity Regulation

- 1) Strengthen Instantaneous Liquidity Oversight: The IRF and FEVD results show that LIML is the most sensitive indicator to monetary policy. It is advisable for the Central Bank to implement a daily LIML monitoring system and require real-time reporting from D-SIBs (Domestically Systemically Important Banks).
- 2) Inflation-NSFR Transmission Channel: The Granger causality and IRF results confirmed the significant impact of inflation on the NSFR. The Central Bank should integrate inflation forecasts into its bank liquidity analysis and mandate inflation stress-testing scenarios for banks.
- 3) Differentiate Reserve Requirements: The fact that the RES_RATIO shock's impact on liquidity is bidirectional (positive on LHQLA and LIML, mixed on LCR) indicates the necessity of setting differentiated reserve requirements for each category of bank.
- 4) Coordinate Money Supply Policy: As M3 exerts the strongest influence on liquidity indicators, it is crucial for the Central Bank to maintain consistency between monetary aggregate targeting and inflation targeting. This will ensure the stability of liquidity buffers during the implementation of Basel III.
- 5) SVAR-Based Probabilistic Stress Testing: The SVAR model from this study can be integrated into the Central Bank of Uzbekistan's annual stress-testing framework. This

creates new methodological opportunities for assessing combined scenarios of monetary shocks.

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