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Emina Žunić Dželihodžić**, *Mirza Kršo,***

** Central Bank of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina*

E-mail: zunic.emina@gmail.com

*** School of Economics and Business, University of Sarajevo, Sarajevo, Bosnia and Herzegovina*

E-mail: mirza.krso@efsa.unsa.ba

Monetary Policy Effectiveness under a Currency Board Regime: Evidence from Bosnia & Herzegovina

Abstract: This paper examines the effectiveness of monetary policy transmission to bank liquidity in countries operating under constrained monetary regimes, drawing on the case of Bosnia and Herzegovina's currency board arrangement. Using monthly bank-level data (2006 - 2024), we apply a two-step empirical framework combining a Panel Vector Autoregression (PVAR) and a Panel Vector Error Correction Model (PVECM) to analyse the short and long-run effects of reserve requirements and the remuneration of excess reserves on bank liquidity. Our findings indicate that liquidity dynamics are largely driven by banks' internal portfolio decisions, while monetary instruments can influence liquidity in the short term, but their overall impact is modest and considerably outweighed by internal bank-level factors such as lending intensity and foreign asset exposure. A stable long-run relationship is confirmed between liquidity, policy tools, and balance sheet fundamentals. Although the study considers bank size and ownership structure, the estimated effects represent system-wide averages. Nonetheless, the observed patterns are broadly consistent with the hypothesis that large and foreign-owned banks may exhibit lower sensitivity to domestic monetary impulses. The results suggest that in a currency board system, the transmission of monetary impulses is constrained and highly dependent on structural banking characteristics.

Key words: Monetary Policy Transmission, Currency Board, Reserve Requirements, Bank Liquidity.

JEL Code: E52, E58, G21

1. Introduction

Different types of fixed exchange regimes, ranging from conventional pegs to currency boards, impose different challenges in maintaining banking sector liquidity. Such regimes restrict monetary policy autonomy by the obligation to maintain the exchange rate peg, which is a well-known Mundell-Fleming "trilemma" (Obstfeld et al., 2005). That is why these kinds of central banks are frequently dependent on monetary policy tools such as reserve requirements and open-market operations (rather than an independent interest rate policy) in order to influence domestic liquidity. Among such regimes, commercial banks are adjusting their asset-liability strategies to manage liquidity and risk, functioning within the limitations of a fixed exchange rate system.

In 2024, 26 countries, representing 13% of IMF members, had exchange rate regimes classified as hard pegs, such as currency boards or using another country's currency (IMF, 2023). In many of those nations, the banking sector is also largely controlled by foreign-owned banks. Those features could have significant impact on banks` behaviour and effectiveness of monetary policy (Cecchetti, 1999). The role of reserve requirements (RRs), as an instrument of monetary policy that requires from banks to hold a certain part of deposits as reserves at the central bank account, has increased in many emerging markets, especially the ones with a low level of exchange-rate flexibility. By raising or lowering RRs, the central bank can tighten or loosen banks' liquidity without changing the reference rate (which could threaten the maintaining of peg by attracting or discouraging capital flows). Over the past decade, a growing empirical literature confirms that adjustments in RRs materially affect bank liquidity and loans (Alper et al., 2018).

Whether and how central banks remunerate required reserves critically affects the impacts of RRs on bank behaviour and liquidity, especially under fixed exchange rate regimes (Glocker & Towbin, 2012; Khatat & Veyrune, 2019). If the reserves are either non-interest bearing or generate earning below market rates, they are imposing a cost on banks that is commonly called "reserve tax". This means that opportunity cost of holding liquid assets increases. Historically, this mechanism was intentional, and it aimed at discouraging banks from maintaining excess reserves while allowing central banks to have control over credit growth. If required reserves give zero return, increasing the reserve ratio should encourage banks to reduce lending or rise interest rates, resulting in widening the loan to deposit ratio, in order to compensate for the shortfall of income. At the same time, banks do not passively absorb central bank policies but rather actively manage their portfolios to ensure liquidity, especially under the unique constraints in a fixed exchange rate system.

Monetary policy transmission under fixed exchange rate regimes poses distinct challenges, particularly in the context of currency boards where central banks operate with severely constrained policy instruments. Against this backdrop, traditional tools like policy interest rates are unavailable and liquidity management relies heavily on indirect instruments such as reserve requirements and the remuneration of excess reserves (REM). The ability of these instruments to influence bank behaviour, however, remains empirically contested, especially in countries where banking systems are highly concentrated and predominantly foreign owned.

Bosnia and Herzegovina (BiH) offers a compelling case for examining these dynamics. As a small open economy operating under a strict currency board since the late 1990s, it reflects the institutional characteristics typical of constrained monetary regimes. The domestic banking sector is dominated by a handful of large foreign-owned institutions, raising important questions about the effectiveness of central bank tools in shaping liquidity outcomes. In this environment, bank specific factors, particularly asset-liability management strategies, may play an equally, if not more significant role in determining liquidity positions than monetary policy interventions.

Therefore, this paper examines the extent to which RRs reserve remuneration policies influence bank liquidity. Also, in parallel, we explore the role of banks' asset management strategies, such as lending intensity and foreign asset exposure, as alternative determinants of liquidity, potentially rivalling the influence of monetary policy itself. Particular attention is placed on understanding how these internal bank level decisions interact with institutional variables and whether their effects vary depending on bank size and foreign ownership.

By analyzing the interaction between institutional instruments and bank level behaviour, the study contributes to the growing literature on monetary policy effectiveness under constraints of institutional rigidity and external anchoring.

The paper is organized as follows. Section 2 outlines the monetary and financial system in Bosnia and Herzegovina. Section 3 reviews the related literature and conceptual framework. Section 4 describes the data and methodology and section 5 discusses the results. Section 6 presents robustness check and Section 7 concludes.

2. Monetary and financial system of Bosnia and Herzegovina

The Central Bank of Bosnia and Herzegovina (CBBH) operates under a currency board arrangement, which mandates full backing of the domestic currency with freely convertible foreign exchange reserves at a fixed exchange rate of 1 KM = 0.51129 EUR. This framework historically ensured monetary stability but imposes strict constraints on the central bank's policy discretion. The CBBH does not conduct open market operations, set an independent target for interest rate policy or provide lender of last resort option to commercial banks.

As a result, domestic monetary conditions are largely shaped by external developments, primarily those in the Eurozone, which represents a challenge when the country's economic cycle is not aligned with that of the Eurozone.

Given the inherent limitations, the reserve requirement represents the only active monetary policy instrument available to the CBBH in the existing currency board regime. The central bank remunerates required reserves, while excess reserves are neither remunerated nor subject to quantitative limits. Consequently, commercial banks freely manage their holdings of excess reserves based on internal liquidity needs, with no direct cost associated with idle balances. Since its inception, the CBBH has consistently observed substantial volumes of excess reserves in the banking system.

While the money supply in this framework adjusts endogenously to changes in demand and interest rates are aligned with prevailing market conditions, the CBBH can, in principle, influence banking sector liquidity through adjustments to the reserve requirement ratio and the remuneration policy applied to required reserves.

However, the impact of these tools and bank reaction seem to largely depend on structural characteristics of the banking sector, especially ownership structure. These factors condition how banks respond to regulatory changes and ultimately determine the strength of the monetary transmission mechanism.

2.1. Banking sector structure

The banking sector of BiH consists of 22 banks, the majority of which are foreign owned. Total assets of the banking sector at the end of 2024 were 44,82 billion KM. The sector is generally considered stable and well-capitalized. Foreign owned banks play a significant role, not only in terms of their number but also in their substantial share of total assets (Table 1). Most of the capital in these banks originates from the European Union member states. The market is also highly concentrated, with the five largest banks holding 54% of total assets in the system.

Table 1: Asset structure of the banking sector

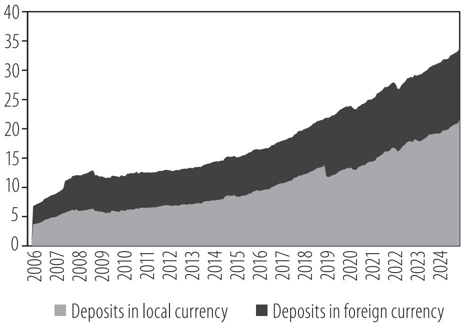
Ownership Type	Number of Banks	Total Assets (KM bn)	Share in Total Assets (%)
Foreign-owned banks	15	33.59	74.9%
Domestic-owned banks	7	11.23	25.1%
Total	**22**	**44.82**	**100.0%**

Source: CBBiH; Data as at 31/12/2024

The primary driver of balance sheet growth continues to be domestic deposits, making locally sourced funds the predominant source of financing. The deposit base has remained stable over time, with all major deposit categories exhibiting a consistent upward trend since 2015 (Figure 1).

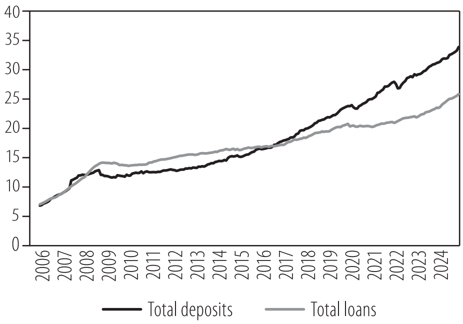
Even though deposit base is stable and growing, the banking sector has not exhibited corresponding credit growth (see Figure 2.) A significant portion of deposits has not been converted into loans and this trend is consistent since 2017. While changes in monetary policy during this period were relatively infrequent, their impact on credit activity appears to have been limited.

Figure 1: Deposit structure (billion KM)



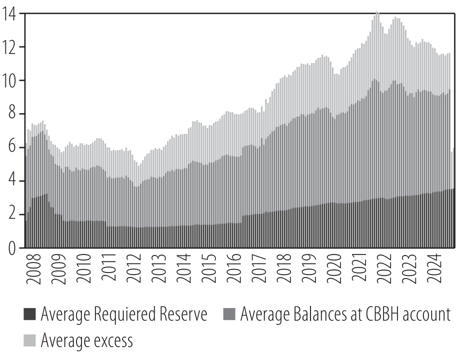
Source: CBBIH data

Figure 2: Total loans and deposits in BiH, 2006-2024 (billion KM)



Source: CBBIH data

Figure 3: Reserve account movements (billion KM)



Source: CBBIH data

Given the limited credit growth despite a stable deposit base, it is evident that banks are not placing adequate funds to the economy. Therefore, an important question arises: where are these funds being allocated? Data from the CBBH suggest that commercial banks have increasingly been placing excess deposits into their reserve accounts at the CBBH (see Figure 3). This trend became particularly pronounced in 2022, driven by the combination of negative markets interest rates and CBBH's reluctance to impose negative Remuneration rate (REM) on excess reserves.

Theoretically, the CBBH should be able to incentivize banks to reallocate excess funds through appropriate calibration of its available monetary policy tools. However, the effectiveness of monetary transmission seems to be significantly constrained by the structure of the banking sector (see Table 1).

High market concentration in combination with stable funding bases means less competitive pressure and greater autonomy in shaping portfolio strategies, which reduces banks' sensitivity to marginal changes in regulatory parameters.

Moreover, foreign owned banks often operate within centralized, group-level liquidity and risk-management frameworks. Therefore, decisions on asset allocation, particularly regarding excess liquidity, may be made at the level of parent banks abroad, rather than in response to domestic monetary signals or market needs. As a result, changes in domestic REM or reserve requirements may have limited influence on their behaviour, especially if alternative placements within the banking group or international markets offer better returns.

Additionally, they may view required reserves as a regulatory cost of doing business, rather than as a strategic monetary signal. This perspective weakens the link between domestic monetary calibration and on-the-ground liquidity or credit decisions, thereby undermining the effectiveness of monetary transmission.

3. Related literature and conceptual framework

This paper contributes to the broad literature on the effectiveness of monetary policy under currency board arrangements. In such regimes, the scope of monetary intervention is inherently limited, and transmission may be further constrained in environments characterized by high banking sector concentration and the dominance of foreign-owned institutions (Claessens & van Horen, 2014).

Theoretical literature suggests that certain types of exchange rate regimes could influence liquidity risk of banks and their behaviour. Chang and Velasco (2000) demonstrated in an open-economy adaptation of Diamond-Dybvig model that a fixed peg without a credible lender of last resort is more prone to self-fulfilling liquidity crises (bank runs). They concluded that currency board regimes with no lender of last resort put initiatives to banks to hold more liquid assets in order to protect their business. On the other hand, more flexible monetary regimes leave more room for bank to hold lower level of liquid assets.

Their findings are supported by Goldstein and Pauzner (2005), who find that the credibility of backstops directly influences banks' incentive to self-insure via liquid assets. Similarly, Jeanne and Wyplosz (2001) highlight that in the absence of a domestic or international lender of last resort, financial systems under currency boards may face systemic vulnerabilities.

Empirically, Bunda and Desquilbet (2008) find a "bank liquidity smile" across exchange rate regimes where banks operating under either hard pegs (such as currency boards) or free floats tend to maintain higher liquidity buffers compared to those in intermediate regimes. This U-shaped relationship is interpreted as a rational response to either the rigidity of monetary conditions (in hard pegs) or high volatility (in free floats). Complementary evidence from Gambacorta and Marqués-Ibáñez (2011) shows that monetary tightening impact on deposits is greatest for small banks, with a high ratio of deposits to lending and well capitalized banks that have greater capacity to raise other forms of external funds. From the macroeconomic perspective, there is an impact of monetary policy on economic growth, and its impact might be different among different monetary regimes. Focusing their analysis on SEE countries, Obradović & Grubišić (2025) showed that the official exchange rate is not a statistically significant factor, while the growth of broad money had a positive impact on the growth of real GDP.

Moreover, Mishra et al. (2012) argue that in less developed financial systems characterized by weak interbank markets, monetary policy transmission is often impaired, which may result in persistent excess liquidity within the banking system. Savluk & Breheda (2023), through analysis of deposit channel of monetary policy in European countries, suggest that central banks can impact on surplus of banks' liquidity by flexible usage of liquidity normative.

An additional constraint on monetary transmission arises from evolving global regulatory standards, notably the Basel III Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR), which have reshaped bank liquidity management practices (see Allen et al., 2011). These rules, while not regime-specific, may interact with the institutional features of currency boards in unintended ways. In such regimes, the supply of high-quality liquid assets (HQLA) denominated in local currency may be structurally limited due to low public debt issuance and the requirement for full foreign reserve backing. As a result, banks often maintain HQLA in foreign assets or deposits abroad, which can become inaccessible during crises, thereby weakening domestic liquidity buffers despite formal compliance (Drehmann & Nikolaou, 2013). Although empirical evidence on this interaction remains scarce, it represents a growing challenge for monetary and regulatory coordination in financially open but institutionally constrained economies.

Alper et al. (2018) analyse the use of reserve requirements (RRs) in Turkey's experience and identify a "quantitative tightening" channel through which RRs influence bank behaviour. They find that increases in RRs lead to a decline in liquid asset holdings and a contraction in loan supply, as banks are forced to lock up a larger share of their funds at the central bank. This compels banks to draw down cash or seek alternative funding sources, thereby depleting unencumbered liquidity and reducing credit creation. While their findings are drawn from a non-peg setting, the underlying mechanism is highly relevant to fixed or quasi-fixed exchange rate regimes, where RRs are often employed countercyclically to influence liquidity without altering the policy interest rate. This practice aligns with what Federico et al. (2014) describe as the "resurrection" of RRs as a policy tool, particularly in emerging markets where conventional monetary instruments are constrained by institutional or exchange rate arrangements.

The theoretical understanding of RRs in a fixed exchange regime has also advanced. Glocker and Towbin (2012) develop a DSGE model comparing different policy regimes. They found out that under a strict peg, usage of RRs as an active policy instrument partially stabilizes output and inflation. However, this is still less efficient than an independent interest-rate policy. According to this framework, if the central bank is hardly maintaining a peg, it needs to passively adjust changes in money demand to defend the peg. This means that any changes in the reserve requirement that would change banks' demand for reserves is compensated by endogenous adjustment in the monetary base.

REM generally gives policymakers an additional degree of freedom and manoeuvring space. In that manner, central banks can adjust the remuneration rate to global or anchor-currency rate, in order to influence banks' liquidity management strategies. Historical experiences (especially the ones with usage of negative rates) suggest that fine-tuning of the REM can help maintain the peg's credibility by adjusting domestic interest rates to the anchor rate. This type of action prevents huge fluctuations in liquidity volumes (Khatat & Veyrune, 2019).

Lastly, competition and market structure can significantly influence liquidity creation under pegged exchange rate regimes. Ali et al. (2022) in their recent study on GCC banks during the period 2012-2018 find that market concentration affects liquidity creation, suggest that the way banks allocate deposits, either into loans or liquid investments, varies with their market power. In highly concentrated banking systems typical of small, fixed-rate economies, the behaviour of a few large banks such as collectively curtailing lending, can exert disproportionate effects on aggregate credit and liquidity conditions. This underscores a promising avenue for further research: analysing how individual bank characteristics shape responses to monetary and exchange rate policies Bilal et al. (2024).

Our analysis draws on two influential theoretical strands: (i) the small open economy framework developed by Glocker and Towbin (2012) with the focus on reserve requirements, and (ii) the Monti-Klein model of imperfect competition in the banking sector (Klein, 1971; Monti, 1972).

In the Glocker and Towbin's model, banks allocate deposits between lending and reserve holdings, facing convex costs for deviating from a required reserve ratio. Changes in monetary policy tools, such as the RRs or REM, affect the marginal return on reserves and thus banks' liquidity management. The model implies that an increase in the reserve requirement raises the opportunity cost of liquidity, potentially discouraging lending and reducing bank liquidity.

The Monti-Klein framework models banks as profit maximizing agents that set interest rates on loans and deposits under monopolistic competition. In this setup, banks' responsiveness to monetary policy depends on market power, measured by the Lerner Index[1]. Banks with greater market power exhibit lower elas-

1 Lerner index = (Product price – Marginal Cost) / Price

ticity in deposit supply and can maintain wider intermediation margins, making them less sensitive to changes in policy variables.

Based on this theoretical framework, two key implications follow: (i) the liquidity position of banks is expected to respond to monetary policy decisions, such as changes in RRs or REM, with a lagged and diminished effect, particularly in markets where competition is limited, and monetary instruments are constrained; (ii) the magnitude and speed of this response depends on the size and market power of a bank, with larger banks or those with greater market power exhibiting lower sensitivity to policy signals.

Together, these theoretical and empirical contributions suggest that under currency board arrangements, the effectiveness of monetary policy instruments such as reserve requirements may be limited not only by institutional constraints, but also by structural features of the banking sector - such as ownership, capitalization, and access to alternative funding channels.

4. Data and methodology

We use a balanced panel dataset of monthly bank-level observations covering the period 2006-2024. The data for individual banks are provided by the CBBH, which ensures consistent time series on liquidity ratios, loan-to-deposit ratios (LDR), foreign assets (FA), and required reserves, giving bank-level series for 21 banks over the observed period. The dataset captures both balance sheet and behavioural variables, allowing for a dynamic assessment of how bank specific characteristics interact with monetary policy instruments in a currency board regime.

Additional data on Eurozone deposit rates were obtained from the European Central Bank (ECB) to proxy for the opportunity cost of placing excess liquidity abroad.

Based on the share in total asset of banking sector, we have divided banks into three distinct groups: Big Five, Domestic Other, and Foreign Other. Big five includes the biggest banks in system which have the collective market share over 54%. Domestic other group consists of all domestically owned banks not part of the Big Five, with a combined market share of 9%. Foreign Other group consists of foreign-owned banks outside the Big Five and their market share is 38%. This classification allows us to capture heterogeneity in responses to monetary policy, particularly differences associated with ownership structure and market power.

The core dependent variable in the analysis is the Excess Reserve Ratio (ERR), constructed as the ratio of excess reserves to total deposits. It captures banks' relative liquidity positioning in the system and reflects their choice to retain surplus funds rather than allocate them to credit or alternative placements. By focusing on excess reserves rather than total reserves, the ERR offers a clearer view of voluntary liquidity holdings, particularly relevant in a currency board regime where the money supply is largely demand-driven and excess reserves may reflect precautionary motives or strategic behaviour.

To examine the determinants of the ERR, we consider two categories of explanatory variables. The first includes *monetary policy instruments*: the RRs and the REM on excess reserves, both set by the Central Bank. The second comprises bank specific variables: the loan-to-deposit ratio (LDR) and the share of foreign assets in total assets (FA), which reflect internal asset-liability strategies. Additionally, we include the weighted average interest rate (WAIR) on the Eurozone time deposits to proxy for foreign opportunity costs, particularly relevant for foreign-owned banks that may shift liquidity abroad in search of yield. This is particularly relevant given that all foreign-owned banks in Bosnia and Herzegovina have parent institutions based in the EU member states and have been observed to allocate surplus liquidity to the Eurozone markets in pursuit of higher yields.

This structure allows us to capture both institutional policy effects and strategic bank behaviour under constrained monetary conditions

We adopt a two-step empirical framework comprising Panel Vector Autoregression (PVAR) and Panel Vector Error Correction Model (PVECM) techniques to investigate the short and long-run dynamics between monetary policy and bank-level variables influencing the ERR in the banking sector.

The PVAR framework is first applied to capture the dynamic interdependencies among variables in their stationary form, without imposing any long-run equilibrium constraints. This approach is particularly suited for modelling endogenous interactions and estimating impulse response functions (IRFs). This approach allows the evaluation of short-run shocks across the system, as demonstrated by Love and Zicchino (2006) in their application of PVAR to financial sector dynamics. By treating all variables as potentially endogenous, the PVAR accounts for feedback effects and lagged interrelations, making it well suited for analyzing short-term monetary transmission in a multi-bank panel context (Holtz-Eakin et al. 1988).

We employ the panel vector autoregression (PVAR) model to capture the dynamic interactions between monetary policy instruments, banks' asset allocation decisions, and liquidity. The PVAR treats all variables in the system as endogenous and includes bank specific fixed effects to control for unobserved heterogeneity. The model is specified as follows:

$$Y_{y,t} = a_{j,0} + \sum_{i=1}^{p} A_{j,i} Y_{j,t-i} + \sum_{i=1}^{p} B_{j,i} X_{j,t-i} + U_{j,t} \qquad j = 1, \ldots, 21 \qquad (1)$$

The subscript j denotes individual banks. The vector of endogenous variables ($Y_{j,t}$) includes the REM on excess reserves, the required reserve ratio, the LDR, and the share of foreign assets in total assets. $X_{j,t}$ represents an exogenous variable: the WAIR on time deposits in the Eurozone, which serves as a proxy for foreign opportunity costs. The term $U_{j,t}$ implemented through bank specific dummy variables under the Least Squares Dummy Variable (LSDV) estimation technique, allows each bank to have its own intercept. This accounts for unobserved heterogeneity and bank-specific factors, such as size, ownership structure or risk tolerance that could otherwise bias the results.

Before estimation, we address stationarity and lag length. We use a fixed-effects (FE) specification to control for time invariant bank specific characteristics, such as risk appetite or management quality, which are likely to be correlated with the regressors, including both policy instruments and bank-level variables. The FE approach accommodates such correlations, thereby reducing the risk of omitted variable bias. Prior to estimation, we address stationarity and lag structure. Using the Im-Pesaran-Shin unit root test, we verify that the time-series properties of each variable are suitable for VAR analysis (see Appendix 1). Where necessary, variables are transformed to achieve stationarity. Lag length selection is guided by the Akaike Information Criterion (AIC) and the chosen model includes a sufficient number of lags to capture the persistence in bank liquidity dynamics and the delayed impact of monetary policy, without overfitting.

While the PVAR framework is well suited for capturing dynamic short-run interdependencies among variables, it does not account for potential long-run equilibrium relationships that may exist among integrated (non-stationary) series established through panel cointegration testing (Kao, 1999). To address this limitation, we extend the analysis using a Panel Vector Error Correction Model (PVECM) as well, which is appropriate when cointegration relationships are present (Pesaran et al., 1999). The PVECM enables the estimation of both transitory and long-term effects of monetary policy and banking sector structural characteristics on liquidity. Crucially, the model includes an error correction term that captures the speed of adjustment toward long-run equilibrium following short-term deviations, allowing for a more nuanced understanding of the persistence and reversibility of shocks.

Considering the potential heterogeneity in the short-term dynamics of cross-sectional units of observation, and respecting the need to simultaneously give homogeneous long-term coefficients, we employ the Pooled Mean Group (PMG) estimator proposed by Pesaran et al. (1999). The application of this estimator is justified for dynamic heterogeneous panels with a large number of time dimensions and allows short-term coefficients, as well as error variances and their intercepts to differ across groups, while keeping the long-term coefficients unchanged. The general form of the estimated Panel VECM is given as:

$$\Delta ERR_{it} = \phi_i\left(ERR_{i,t-1} - \beta_1' MPV_{i,t-1} - \beta_2' BSV_{i,t-1}\right) + \sum_{j=1}^{p-1} \Gamma_{ij}\, \Delta ERR_{i,t-j} + \sum_{j=1}^{p-1} \Lambda_{ij}^{(1)}\, \Delta MPV_{i,t-j} + \sum_{j=1}^{p-1} \Lambda_{ij}^{(2)}\, \Delta BSV_{i,t-j} + \mu_i + \varepsilon_{it} \quad (2)$$

Where:

$\Delta ERR_{i,t}$ - First-differenced Excess Reserve Ratio for unit i at time t;

$ERR_{i,t-1}$ - Lagged level of the Excess Reserve Ratio; enters the long-run cointegration relationship;

$MPV_{i,t-1}$ - Vector of monetary policy variables (e.g., required reserve ratio, REM);

$BSV_{i\,t-1}$ - Vector of bank-level variables (e.g., LDR, FA-share of foreign assets in total assets);

ϕ_i - Error correction coefficient for unit i; measures the speed of adjustment toward long-run equilibrium. Expected to be negative and significant if cointegration exists;

β' - Cointegrating vector of long-run coefficients (assumed homogeneous across units);

Γ_{ij} - Short-run dynamic coefficient matrices for lagged differences of the dependent variable;

Λ_{ij} - Short-run dynamic coefficient matrices for lagged differences of the explanatory variables;

p - Lag order of the model;

μ_i - Bank-specific fixed effect; controls for unobserved heterogeneity across banks;

ε_{it} - Error term, assumed to be white noise

Although PVAR takes into account the dynamic component of the feedback effect, in order to complement and confirm the findings we also decided to estimate static panel regression models with fixed effects. These models help isolate the average within-bank relationship between liquidity and the explanatory factors, offering a robustness check for the direction of effects observed in the PVAR. The general form of our fixed-effects panel model is:

$$ERR_{i,t} = \alpha_i + \beta_{1,t}MPV_{i,t} + \beta_{2,t}BSV_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where:

$ERR_{i,t}$ denotes the excess reserve ratio for bank i at time t,

α_i represents the bank fixed effect which captures unobserved, time-invariant bank-specific effects,

$MPV_{i,t}$ is a vector of monetary policy variables (e.g., required reserve ratio, REM),

$BSV_{i,t}$ is a vector of bank-level variables (e.g., LDR, share of foreign assets),

$\varepsilon_{i,t}$ is the idiosyncratic error term.

By comparing the regression outcomes with the PVAR findings, we ensure consistency across methodologies.

Finally, we derive IRFs to examine the temporal effects of shocks. One of the key advantages of VAR models is their ability to generate impulse response functions (IRFs), which trace the dynamic effects of a shock to one variable on the others over time. Following the estimation of the reduced-form PVAR, we compute orthogonalized IRFs to evaluate how dynamic effects of shocks, such as a monetary policy tightening or shifts in banks' asset allocations, affect bank liquidity.

This allows for a clear visualization of both the magnitude and temporal persistence of responses across the system.

To complement the impulse response analysis, we also compute Forecast Error Variance Decomposition (FEVD) following PVAR estimation. This technique allows us to quantify the proportion of forecast error variance in the dependent variable (ERR) that is attributable to its own past movements versus those of other explanatory variables, thereby providing insights into the explanatory power of individual monetary policy and bank-level variables over time.

The combined use of PVAR and PVECM thus provides a comprehensive empirical strategy, effectively distinguishing between short-run fluctuations and long-run equilibria within the context of monetary transmission and liquidity management.

5. Discussion of results

The optimal number of lags included in the Panel Vector Autoregression (PVAR) model was determined using multiple lag selection criteria, including the Akaike Information Criterion (AIC), the Hannan-Quinn Information Criterion (HQIC), and the Schwarz Bayesian Information Criterion (SBIC)[2]. Based on these criteria, a three-lag specification was selected for the baseline model. The same choice was applied to the model including only bank-specific variables. On the other hand, the results of the lag selection for the monetary-policy-only model differed. While the AIC recommended six lags, SBIC suggested one, and HQIC indicated that three lags would be most appropriate (see Appendix 1).

Since the HQIC criterion provides a better relationship between model complexity and goodness of fit, penalizing overfitting more than AIC does, but also less restrictive than SBIC, the model specification with three time lags was chosen as a methodologically correct compromise. This choice enables good dynamics of the model without unnecessary burden of estimation or leading to a situation of hyperparameterization, which is especially important in panel settings such as this one. The use of HQIC also aligns with best empirical practices in macroeconomic panel VAR studies where it is commonly preferred when AIC recommends a more complex model and SBIC an overly parsimonious one (Lütkepohl, 2005; Ivanov & Kilian, 2001).

The PVAR estimation results presented in Table 2 provide insights into the short-run dynamics of banking sector liquidity in response to monetary policy instruments and bank-specific variables. Three specifications are presented: a combined model with all explanatory variables, a model including only monetary policy variables, and a model with only bank-specific fundamentals.

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[2] For the combined model based on those criteria's see Appendix 1.

Table 2: PVAR estimation results

Variable	Combined Model	Monetary Policy Only	Bank Specific Only
Excessive Reserve Rate (-1)	0.47 [0.00]***	0.49 [0.00]***	0.47 [0.00]***
Reserve Requirement Rate (-1)	-0.34 [0.05]*	-0.24 [0.17]	-
Remuneration Rate on excess reserves (-1)	-0.00 [0.60]	0.00 [0.65]	-
Loan-to-deposit ratio (-1)	-0.05 [0.00]***	-	-0.05 [0.00]***
Weighted average interest rate on time deposits in Eurozone (-1)	-0.020 [0.77]	-	0.00 [0.81]
Share of foreign assets in total assets (-1)	-0.22 [0.00]***	-	-0.22 [0.00]***
Excessive Reserve Rate (-2)	0.23 [0.00]***	0.23 [0.00]***	0.23 [0.00]***
Reserve Requirement Rate (-2)	0.11 [0.66]	0.04 [0.873]	-
Remuneration rate on excess reserves (-2)	-0.00 [0.37]	0.00 [0.36]	-
Loan-to-deposit ratio (-2)	0.01 [0.37]	-	0.01 [0.32]
Weighted average interest rate on time deposits in Eurozone (-2)	-0.00 [0.29]	-	-0.00 [0.26]
Share of foreign assets in total assets (-2)	0.11 [0.02]**	-	0.10 [0.02]**
Excessive Reserve Rate (-3)	-	-	-
Reserve Requirement Rate (-3)	-	-	-
Remuneration Rate on excess reserves (-3)	-	-	-
Loan-to-deposit ratio (-3)	-	-	-
Weighted average interest rate on time deposits in Eurozone (-3)	-0.00 [0.79]	-	-0.00 [0.76]
Foreign assets share (-3)	0.08 [0.04]**	-	0.07 [0.05]**
R-squared	0.8473	0.8473	0.8473
F-statistics	✓ 1166.09	✓ 1166.09	✓ 888.07

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Across all three model specifications, the lagged dependent variable (ERR) is highly significant at the 1% level. This robust autoregressive pattern indicates a high degree of persistence in bank liquidity, consistent with the previous literature findings that liquidity adjustments in the banking system are gradual and path dependent.

Among monetary policy variables, the required reserve ratio (RRs) exhibits a statistically significant negative coefficient in the first lag (-0.34; $p = 0.05$) in the combined model. This finding suggests that an increase in the RRs leads to a reduction in excess reserves in the short term, consistent with its role as a liquidity-absorbing instrument. However, this effect weakens in the monetary-policy-only specification where it becomes insignificant (-0.24; $p = 0.17$), indicating that its impact is more robust when considered alongside bank-level behaviour. Neither the REM on excess reserves nor the Eurozone WAIR on deposits exhibited statistically significant effects across any specification, indicating limited influence of either channel on domestic bank liquidity, potentially due to institutional or regulatory constraints.

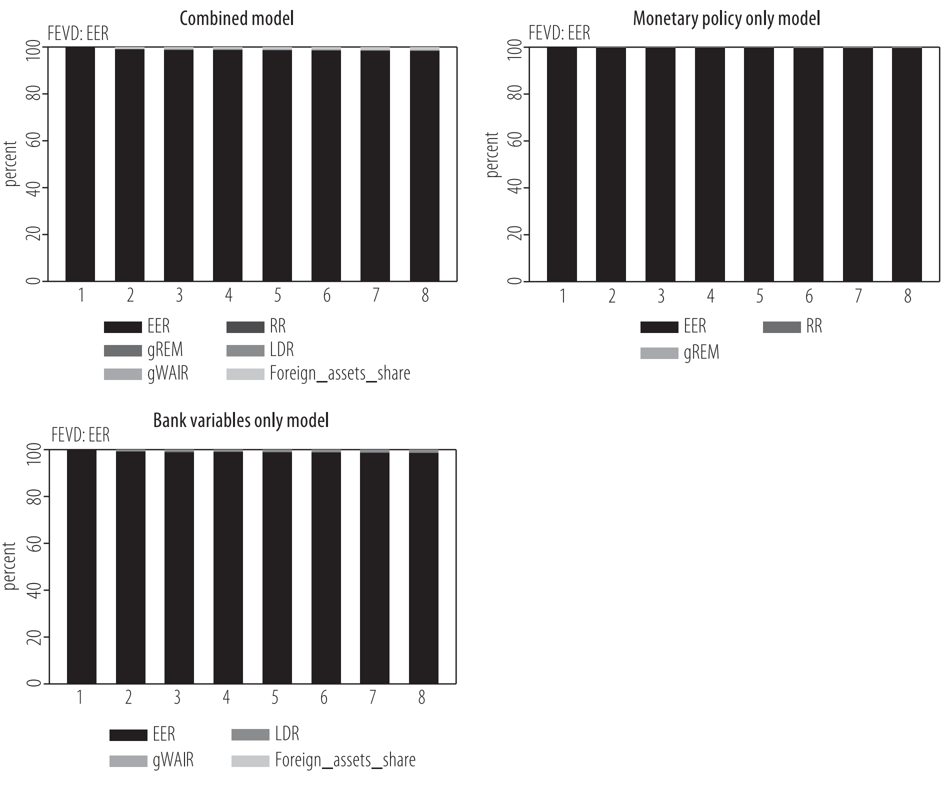
The results highlight the much stronger influence of bank-specific variables. The loan-to-deposit ratio (LDR) is negatively associated with liquidity in both the first and third lags (e.g., -0.05; $p < 0.01$), reflecting the classical trade-off between lending activity and reserve accumulation. This supports the view that aggressive credit expansion tends to reduce excess liquidity holdings. Even more striking is the effect of the share of foreign assets in total assets, which is consistently negative and statistically significant across multiple lags. This suggests that banks with a greater share of externally held assets maintain lower domestic liquidity buffers, likely due to their cross-border portfolio allocation strategies. The persistence of this effect in both the combined and bank-specific models further confirms its importance as a structural determinant of liquidity behaviour.

The high R^2 values (0.85) across all specifications demonstrate strong explanatory power, and the significance of the F-statistics affirms the joint relevance of the included variables. Overall, the findings highlight a dual mechanism in the transmission of monetary policy under a currency board regime. It suggests that while regulatory instruments like the reserve requirement can influence liquidity in the short run, structural factors at the bank level, particularly lending intensity and foreign asset exposure, play a dominant role in shaping liquidity outcomes. That underlines the importance of accounting for bank heterogeneity when evaluating policy effectiveness.

The Forecast Error Variance Decomposition (FEVD) analysis provides insights into the relative contribution of structural shocks to the variation in bank liquidity over time. Specifically, it quantifies the proportion of the forecast error variance in the excess reserve ratio (ERR) that is attributable to its own past movements versus those of other explanatory variables.

FEVD results confirm the strong autoregressive nature of liquidity dynamics across all three model specifications. In each case, the vast majority of the variance in ERR is explained by its own past shocks, even at the eight-month horizon. This dominance suggests high inertia in ERR and bank liquidity behaviour, while shocks in other variables have limited impact and contribution in explaining its fluctuations over time (Figure 4).

Figure 4: Forecast variance decomposition of ERR at 8-month horizon, for combined vs. sub-models



Source: Authors` calculations

These findings are consistent with the PVAR impulse response results and reinforce the interpretation that bank liquidity under a currency board regime is overwhelmingly shaped by its own historical path, rather than by exogenous shocks. This may reflect institutional rigidities, precautionary liquidity buffers or the limited traction of indirect monetary instruments.

To further examine the dynamic effects of structural shocks on bank liquidity, we estimate impulse response functions (IRFs) using an 8-period forecast horizon. Given the monthly frequency of the data, this window is sufficiently long to capture adjustment dynamics within the banking sector. For each identified shock, we report the point estimate of the IRF along with its confidence intervals (see Appendix 2 for the complete set of IRFs).

Figure 5: IRF of bank liquidity on 1 standard deviation change in REM on excess reserves

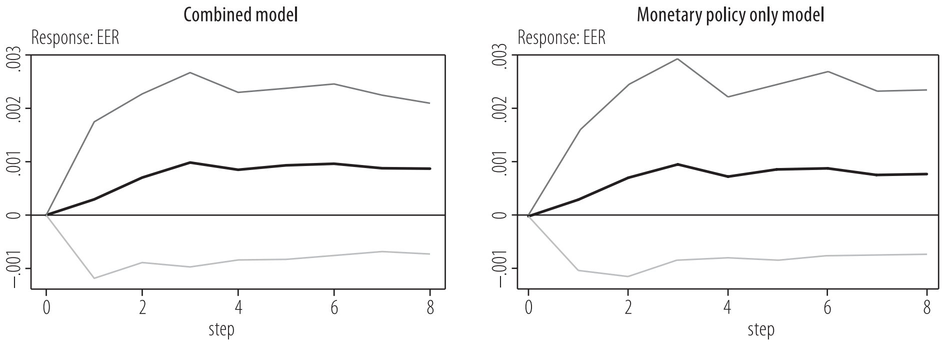


Figure 5 illustrates the response of the ERR to a one standard deviation shock in the REM on excess reserves. The results indicate a clear positive, albeit temporary, response across all model specifications. This finding highlights the short-term effectiveness of REM on reserves as a liquidity management tool under a currency board regime.

Post-estimation tests of the Panel VAR model estimated using the Least Squares Dummy Variable (LSDV) approach revealed the existence of heteroscedasticity in the residuals (Appendix 1). The determined heteroscedasticity of the residuals does not affect the estimation of coefficients, but it can affect the reliability of standard errors as well as confidence intervals and their statistical significance.

Accordingly, interpretations of the IRFs and Forecast Error Variance Decompositions (FEVD) should be made with caution. These findings remain valuable for assessing the direction and relative importance of policy shocks, but the quantitative precision may be influenced by non-constant residual variance. Robust standard errors were employed where applicable to mitigate these concerns; nonetheless, the results should be viewed as indicative rather than conclusive. Future research could explore alternative estimation methods - such as system GMM or Bayesian VAR - to enhance the robustness of inference. Although the

GMM approach is widely used for dynamic panel analysis, it was not suitable for our purposes. There are several reasons, including the low frequency of changes in monetary policy (GMM approach requires more dynamic in data in order to capture dynamic relationship), problem with validity of instruments (Hansen and Sargan test were failing) and the Arellano-Bond test for autocorrelation indicates to autocorrelation among residuals.

5.1. Panel VECM results

Table 3 presents the estimated short-run and long-run coefficients from the Panel VECM specification for the liquidity ratio as the dependent variable.

Again, three model specifications are compared. The error correction term (ECT) is negative and highly significant in all specifications (-0.21, $p < 0.01$), confirming the existence of a long-run cointegration relationship and a stable adjustment mechanism. In all three models, the magnitude implies that approximately 21% of the deviation from long-run equilibrium is corrected each month.

In the combined model, key short-run findings include:

- a statistically significant negative impact of the reserve requirement rate (-2.13, $p = 0.07$), suggesting that tighter reserve policies reduce liquidity in the short term,
- a strong negative effect of the LDR (-0.25, $p < 0.01$), in line with theoretical and practical concepts meaning that higher lending reduces liquidity reserves,
- the share of FL also has significant negative effects (-0.39, $p < 0.01$), indicating that banks are reallocating liquidity to higher-yield foreign investments.
- no significant short-run effects are found for REM on excess reserves and WAIR.

The monetary policy only and bank-only confirm the robustness of these findings with similar signs and significance. Both the LDR and FL remain significant in the bank-only specification, while the monetary policy-only model confirms a weak short-run effect of the RRs.

In the long run, the combined model reveals several statistically significant relationships. The RRs has a strong negative association with liquidity (-1.55, $p < 0.01$), confirming its enduring restrictive effect on liquidity. The loan-to-deposit ratio and the foreign assets also show persistent negative effects (-0.26 and -0.45, respectively; both p < 0.01), indicating that structural balance sheet strategies significantly shape liquidity outcomes. The REM on excess reserves shows no significant long-run influence, suggesting limited long-term impact of these interest-based tools under the currency board regime. In both monetary policy-only and bank-only models, the magnitude and significance of the coefficients are preserved, particularly for structural bank indicators. Together, the results highlight that both regulatory tightening and aggressive loan expansion are the key drivers of liquidity constraints in the banking sector, while calling into question the effectiveness of remuneration policy in a rigid monetary environment.

Table 3: Panel VECM Estimation Results

	ΔLiquidity ratio	Combined model	Combined model: Big five banks	Combined model: Domestic banks other	Combined model: Foreign banks other	Model monetary policy only	Model bank variables only
Short-run coefficients	Error correction term (speed of adjustment)	-0.21 [0.00]***	-0.20 [0.01]***	-0.23 [0.10]*	-0.23 [0.00]***	-0.21 [0.00]***	-0.21 [0.00]***
	ΔReserve requirement rate	-2.13 [0.07]*	-1.05 [0.00]***	-2.11 [0.27]	-1.04 [0.00]***	-1.33 [0.12]	-
	ΔRemuneration rate on excess reserves	0.04 [0.24]	0.00 [0.94]	0.03 [0.46]	0.01 [0.19]	0.01 [0.253]	-
	ΔLoan to deposit ratio	-0.25 [0.00]***	-0.23 [0.00]***	-0.08 [0.55]	-0.30 [0.00]***	-	-0.23 [0.00]***
	ΔWeighted average interest rate on deposits with agreed maturity Eurozone	-0.02 [0.28]	0.00 [0.92]	-0.03 [0.47]	0.030 [0.40]	-	-0.01 [0.32]
	ΔShare of foreign assets in total assets	-0.39 [0.00]***	-0.51 [0.00]***	-0.40 [0.04]**	-0.45 [0.00]***	-	-0.39 [0.00]***
Long-run coefficients	Reserve requirement rate (-1)	-1.55 [0.00]***	-1.53 [0.00]***	-2.26 [0.04]**	-1.77 [0.00]***	-0.27 [0.29]	-
	Remuneration rate on excess reserves (-1)	0.04 [0.00]***	0.04 [0.00]***	0.02 [0.43]	0.05 [0.00]***	0.01 [0.01]**	-
	Loan to deposit ratio (-1)	-0.26 [0.00]***	-0.32 [0.00]***	-0.30 [0.00]***	-0.29 [0.00]***	-	-0.17 [0.00]***
	Weighted average interest rate on deposits with agreed maturity Eurozone (-1)	-0.02 [0.00]***	-0.01 [0.00]***	-0.01 [0.30]	-0.02 [0.00]***	-	-0.01 [0.00]***
	Share of foreign assets in total assets (-1)	-0.45 [0.00]***	-0.52 [0.00]***	-1.14 [0.00]***	-0.58 [0.00]***	-	-0.35 [0.00]***

* p < 0.10, ** p < 0.05, *** p < 0.01

6. Robustness check

To verify the robustness of the Panel VAR results, we additionally estimate a fixed effects (FE) regression using the *areg* estimator, with the same set of explanatory variables and lags. The findings from the FE model closely mirror those from the Panel VAR (LSDV) specification.

In both models, the first lag of the ERR is positive and highly statistically significant, indicating strong persistence in bank liquidity. Similarly, the first lag of the LDR exhibits a consistently negative and significant effect, confirming that increased lending activity is associated with reduced liquidity levels. The FL also shows significant effects in both specifications.

The FE model additionally yields a high R-squared value for the liquidity ratio equation (0.849) and reports low multicollinearity among regressors, as indicated by a mean VIF of 1.29. Furthermore, Breusch-Pagan and Shapiro-Wilk tests conducted under the GMM specification confirm the presence of heteroskedasticity and non-normality in residuals, supporting the application of robust standard errors.

Table 4: Panel regression, FE model results

Variable	Combined Model (t-stat)	Monetary Policy Only (t-stat)	Bank Specific Only (t-stat)
Const	0.03 [1.12]	0.02 [1.78]*	0.02 [1.10]
Excess Reserve Rate (-1)	0.47 [4.27]***	0.92 [4.34]***	0.47 [4.28]***
Excess Reserve Rate (-2)	0.23 [14.61]***	0.23 [9.42]***	0.23 [14.18]***
Excess Reserve Rate (-3)	0.19 [4.05]***	0.18 [0.02]***	0.19 [3.93]***
Reserve Requirement Rate (-1)	-0.34 [2.45]**	-0.24 [1.86]*	-
Reserve Requirement Rate (-2)	0.11 [1.07]	0.04 [0.41]	-
Reserve Requirement Rate (-3)	0.20 [1.53]	0.14 [1.22]	-
Remuneration Rate on Excess Reserves (-1)	0.00 [0.83]	0.00 [0.68]	-
Remuneration Rate on Excess Reserves (-2)	0.00 [1.73]	0.00 [1.78]*	-
Remuneration Rate on Excess Reserves (-3)	0.00 [2.42]	0.00 [2.16]**	-

Loan to Deposit Ratio (-1)	-0.05 [1.61]	-	-0.05 [1.54]
Loan to Deposit Ratio (-2)	0.01 [1.17]	-	0.01 [1.26]
Loan to Deposit Ratio (-3)	0.04 [1.74]	-	0.03 [1.73]
WAIR on Deposits Eurozone (-1)	0.00 [0.39]	-	0.00 [0.33]
WAIR on Deposits Eurozone (-2)	0.00 [2.24]**	-	0.00 [2.47]**
WAIR on Deposits Eurozone (-3)	0.00 [0.47]	-	0.00 [0.56]
Share of Foreign Assets in Total Assets (-1)	-0.22 [4.00]***	-	-0.22 [3.87]***
Share of Foreign Assets in Total Assets (-2)	0.11 [3.05]***	-	0.10 [2.99]***
Share of Foreign Assets in Total Assets (-3)	0.08 [1.80]*	-	0.07 [1.78]*
Shock in RR	-0.29 [0.64]	-	-
Observations	3 825	3 825	3 825
R-squared	0.85	0.85	0.85

Note: Robust t-statistics in brackets. Standard errors are adjusted for clustering at the bank level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Even though this study focuses on Bosnia and Herzegovina, we found it meaningful to compare our findings with similar studies among currency board countries. Although a currency board formally removes the central bank's ability to conduct active monetary policy through interest rate setting or open market operations, the research reviewed explores whether and how certain institutional and structural factors allow for indirect monetary influence. The cases of Lithuania, Estonia, Bulgaria, and Bosnia and Herzegovina illustrate both similarities and country-specific differences in the monetary transmission mechanisms and the role of instruments such as reserve requirements, institutional credibility, and commercial banks behaviour.

Table 5: Comparison of results with similar studies

Country	Analysis	Conclusion
Lithuania and Estonia	Monetary Policy Under a Currency Board (Jurgilas, 2007)	Although a Currency Board regime severely limits traditional monetary policy tools such as interest rate setting or open market operations, the central bank can still exert **indirect influence on monetary conditions**. The paper concludes that administrative measures, like **conversion fees and reserve requirements, can produce limited but measurable effects on aggregate liquidity and economic flows** even within the constraints of a currency board.
Bulgaria	Effectiveness of Specific Monetary Policy by the Currency Board Regime (Assenova, 2013)	Although the Currency Board regime formally eliminates discretionary monetary policy, **certain measures can still influence economic activity**, especially through expectation channels. The paper concludes that **monetary policy under a currency board can affect aggregate supply indirectly**, primarily through structural credibility, fiscal discipline, and public trust.
Bosnia and Herzegovina	This analysis	This study finds that under the currency board regime in Bosnia and Herzegovina, monetary policy, particularly reserve requirements, has a limited but measurable short-term impact on bank liquidity, while bank-specific structural factors such as lending behaviour and foreign asset exposure play a dominant role. The results emphasize the strong autoregressive nature of liquidity, the limited effectiveness of interest-based tools like REM, and highlight the need for macroprudential measures and coordinated policy responses tailored to bank heterogeneity.

Source: Authors` compilation

The comparative overview shows that while currency board regimes limit monetary policy autonomy, there remains some scope for influence through administrative tools and indirect channels. The key finding across all studies is that the impact of monetary instruments in such regimes is often limited and gradual, but not negligible. The most significant transmission appears to originate from structural characteristics of the banking sector, including lending intensity, exposure to foreign assets, and bank size and ownership structure. The effectiveness of monetary policy under a fixed exchange rate regime depends not only on regulatory discipline but also on macroprudential oversight and coordination with fiscal policy.

7. Conclusion

This study provides empirical evidence of monetary policy effectiveness in countries operating within limited monetary regimes, examining the case of the currency board in Bosnia and Herzegovina. It shows that under a currency board, reserve requirements have a modest impact on bank liquidity, while bank-specific factors dominate the liquidity trajectory.

A two-step empirical framework comprising Panel Vector Autoregression (PVAR) and Panel Vector Error Correction Model (PVECM) techniques were used to analyse the short and long-run dynamics between monetary policy and bank-level variables influencing the ERR in the banking sector. Particular attention is placed on understanding how these internal bank-level decisions interact with institutional variables and whether their effects vary depending on bank size and foreign ownership.

Our findings indicate that monetary policy under currency board regime has a limited but not negligible influence on liquidity. Still, the findings corroborate existing literature indicating that EER (as measure of liquidity) has very pronounced autoregressive component, meaning that that liquidity adjustments in the banking system are gradual and path dependent. By analyzing the interaction between institutional instruments and bank-level behaviour, the study contributes to the growing literature on monetary policy effectiveness under constraints of institutional rigidity and external anchoring.

The results highlight the much stronger influence of bank-specific variables. This further confirms its importance as a structural determinant of liquidity behaviour. Overall, the findings highlight a dual mechanism in the transmission of monetary policy under a currency board regime. It suggests that while regulatory instruments like the reserve requirement can influence liquidity in the short run, structural factors at the bank level, particularly lending intensity and foreign asset exposure, play a dominant role in shaping liquidity outcomes. That underlines the importance of accounting for bank heterogeneity when evaluating policy effectiveness.

The Forecast Error Variance Decomposition (FEVD) results confirm the strong autoregressive nature of liquidity dynamics across all three model specifications. In each case, the vast majority of the variance in ERR is explained by its own past shocks, even at the eight-month horizon. This dominance suggests high inertia in ERR and bank liquidity behaviour, while shocks in other variables have limited impact and contribution in explaining its fluctuations over time.

The REM on excess reserves shows no significant long-run influence, suggesting limited long-term impact of these interest-based tools under the currency board regime. In both monetary policy-only and bank-only models, the magnitude and significance of the coefficients are preserved, particularly for structural bank indicators. Together, the results highlight that both regulatory tightening and aggressive loan expansion are key drivers of liquidity constraints in the banking sector, while calling into question the effectiveness of remuneration policy in rigid monetary environment.

The implications of this study for monetary decision makers are twofold. First, the reserve requirement remains an influential instrument even in regimes where interest rate autonomy does not exist. Second, the limited effectiveness of the REM and the strong influence of banks' asset management decisions suggest the need for complementary macroprudential regulation, as well as better coordination with fiscal policy. This research could be extended in the future by introducing additional liquidity indicators or by testing heterogeneity of effects by bank size or ownership.

Declaration of AI Use

During the preparation of this manuscript, the authors did not use AI tools.

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Appendix 1: Panel pre- and post-estimation test and measurements

Table 5: Panel descriptive statistics

Panel	Mean	Min	Max	Sd	Obs
Variables:					
Excess Reserve Ratio (EER)	0.131	0.001	1.799	0.110	4780
Reserve requirement rate	0.1053	0.085	0.1800	0.0242	4788
Excess reserves remuneration rate	0.4918	-0.75	4.1700	1.3203	4788
Loans to deposits ratio	0.8902	0	37.3992	0.5925	4762
Foreign assets	0.1156	0.0045	0.9405	0.0869	4760
Weighted average interest rate on deposits corporation with maturity up to 1 year - EU	1.2170	-0.36	4.5200	1.4373	4683

Table 6: Unit root test results

	Im-Pesaran-Shin unit-root test	Im-Pesaran-Shin unit-root test
	p-value (level)	p-value (first difference)
Excess Reserve Ratio (EER)	0.0000	-
Reserve requirement rate	0.0000	-
Excess reserves remuneration rate	0.8142	0.0000
Loans to deposits ratio	0.0000	-
Share of foreign assets in total assets	0.0000	-
Weighted average interest rate on deposits corporation with maturity up to 1 year - EU	1.0000	0.0000

Table 7: Lag-order selection Combined model

Sample: 2006m8 thru 2024m7 **Number of obs = 216**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1527.71				3.1e-14	-14.0899	-14.0520	-13.9961
1	2585.25	2115.1	36	0.000	2.4e-18	-23.5486	-23.2835	-22.8923*
2	2653.81	137.12	36	0.000	1.8e-18	-23.8501	-23.3577*	-22.6313
3	2713.66	119.70	36	0.000	1.4e-18*	-24.071*	-23.3513	-22.2896
4	2748.11	68.893	36	0.001	1.4e-18	-24.0566	-23.1096	-21.7126
5	2783.21	70.2	36	0.001	1.5e-18	-24.0482	-22.874	-21.1418
6	2816	65.587*	36	0.002	1.5e-18	-24.0186	-22.6171	-20.5495

* optimal lag

Endogenous: EER, RR, D_REM_E,

Exogenous: _cons

Table 8: Lag-order selection Monetary Policy Only model
Lag – order selection criteria
Sample: 2006m8 thru 2024m7 **Number of obs = 216**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	744.377				2.1e-07	-6.86461	-6.84567	-6.81773
1	1377.4	1266	9	0.000	6.5e-10	-12.6426	-12.5668	-12.4551*
2	1389.42	24.037	9	0.004	6.0e-10	-12.6706	-12.5368	-12.3424
3	1413.19	47.544	9	0.000	5.3e-10	-12.8073	-12.6179	-12.3385
4	1424.71	23.044	9	0.005	5.2e-10	-12.8102	-12.5847	-12.2212
5	1445.25	22.272	9	0.008	5.0e-10	-12.8525	-12.5704	-12.1044
6	1446.94	22.174*	9	0.008	5.0e-10	-12.8698*	-12.5099	-11.9791

* optimal lag
Endogenous: EER, RR, D_REM_E
Exogenous: _cons

Table 9: Lag-order selection Bank Specific Only model
Lag – order selection criteria
Sample: 2006m8 thru 2024m7 **Number of obs = 216**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	820.12				2.5e-10	-7.5918	-7.5742	-7.5489
1	1368.55	1096.86	16	0.000	1.2e-13	-12.6110	-12.5654	-12.4950*
2	1415.70	94.31	16	0.000	9.6e-14	-12.9989	-12.9253	-12.8099
3	1472.91	114.42	16	0.000	6.9e-14	-13.5171*	-13.4155	-13.2550
4	1493.81	41.80	16	0.001	6.7e-14	-13.4700	-13.3404	-13.1348
5	1510.62	33.61	16	0.005	6.8e-14	-13.3913	-13.2336	-12.9820
6	1524.10	26.96*	16	0.043	7.1e-14	-13.3340	-13.1483	-12.8506

* optimal lag
Endogenous: EER
Exogenous: _cons

Table 10: Model stability test

Eigenvalue		
Real	Imaginary	Modulus
0.9758745	0.0038699	0.9758821
0.9758745	-0.0038699	0.9758821
0.9095058	0	0.9095058
-0.2949518	-0.6059351	0.6739094
-0.2949518	0.6059351	0.6739094
-0.3742135	-0.5561771	0.6703497
-0.3742135	0.5561771	0.6703497
0.6429398	0	0.6429398
-0.6342168	0	0.6342168
0.0592317	0.5967506	0.599683
0.0592317	-0.5967506	0.599683
0.5764247	0	0.5764247
-0.3078075	0	0.3078075
0.3026906	0	0.3026906
-0.0340792	-0.2357218	0.2381725
-0.0340792	0.2357218	0.2381725
-0.0579975	-0.0888889	0.1061364
-0.0579975	0.0888889	0.1061364

All the eigenvalues lie inside the unit circle
PVAR satisfies the stability condition.

To ensure the absence of multicollinearity among explanatory variables, Variance Inflation Factors (VIFs) were computed after the estimation. All VIF values were below the commonly accepted threshold of 5, with the mean VIF being 1.10, indicating no multicollinearity concerns.

Table 11: Multicollinearity test

Variable	VIF	1/VIF
Foreign assets L1.	1.21	0.826750
LDR L1.	1.15	0.868860
RR L1.	1.10	0.908055
gWAIR L1.	1.01	0.989945
gREM L1.	1.01	0.989970
Mean VIF	1.10	

Table 12: Heteroscedasticity test

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (17) = 3883.12

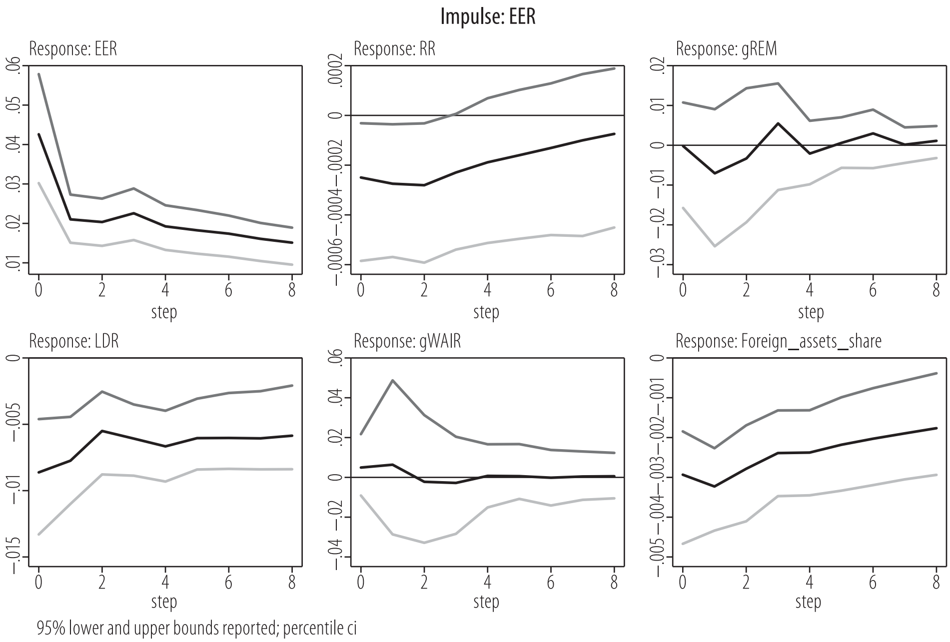
Prob > chi2 = 0.0000

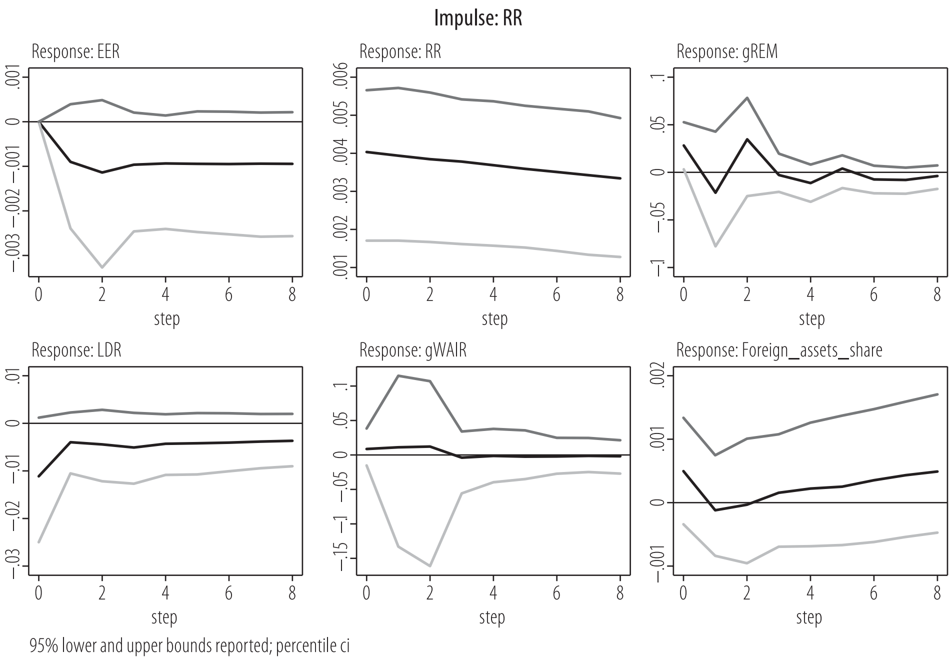
Table 13: Kao test of cointegration results

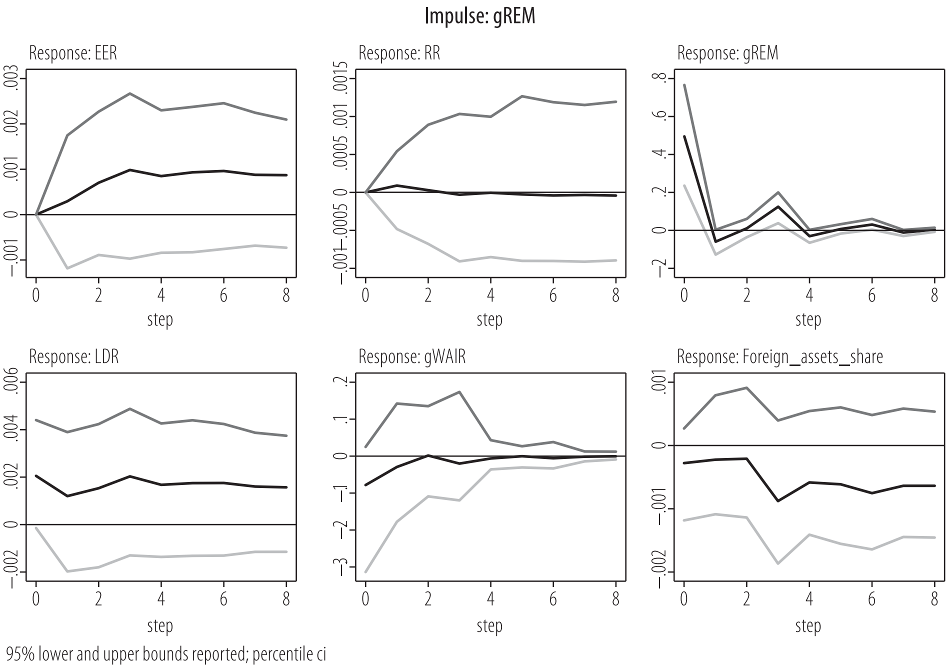
	t statistics					
	Combined model		Model with only monetary policy		Model with only bank variables	
Modified Dickey-Fuller	-180.000 [0.000]	H0 rejected; Cointegration exsists	-140.000 [0.000]	H0 rejected; Cointegration exsists	-180.000 [0.000]	Cointegration exsists
Dickey-Fuller	-42.932 [0.000]		-41.363 [0.000]		-42.876 [0.000]	
Augmented Dickey-Fuller	-30.359 [0.000]		-29.312 [0.000]		-30.210 [0.000]	
Unadjusted modified Dickey -Fuller	-180.000 [0.000]		-180.000 [0.000]		-180.000 [0.000]	
Unadjusted Dickey-Fuller	-42.909 [0.000]		-41.552 [0.000]		-42.879 [0.000]	

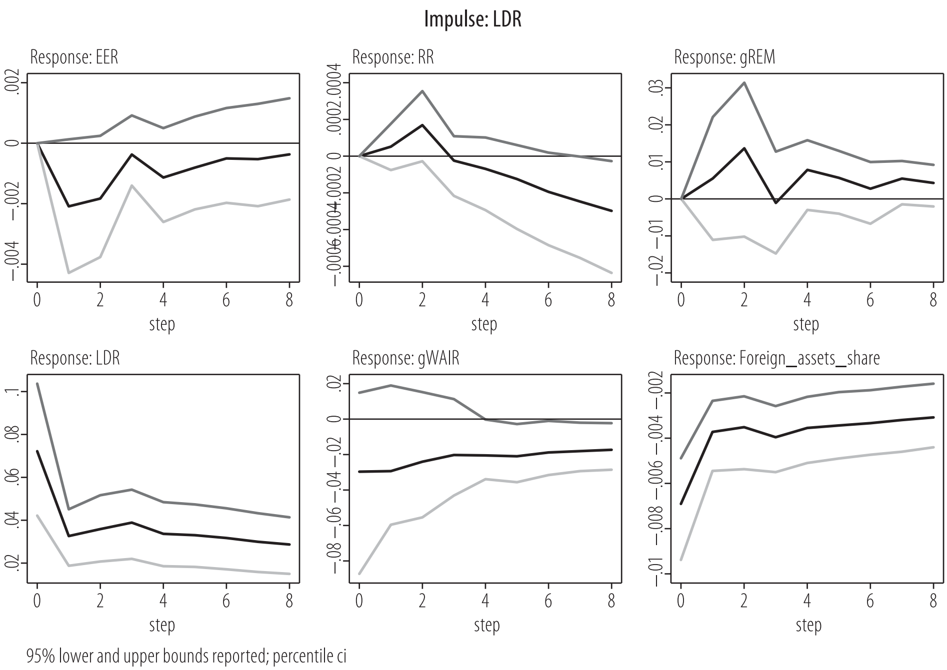
Note: p-values denoted in []

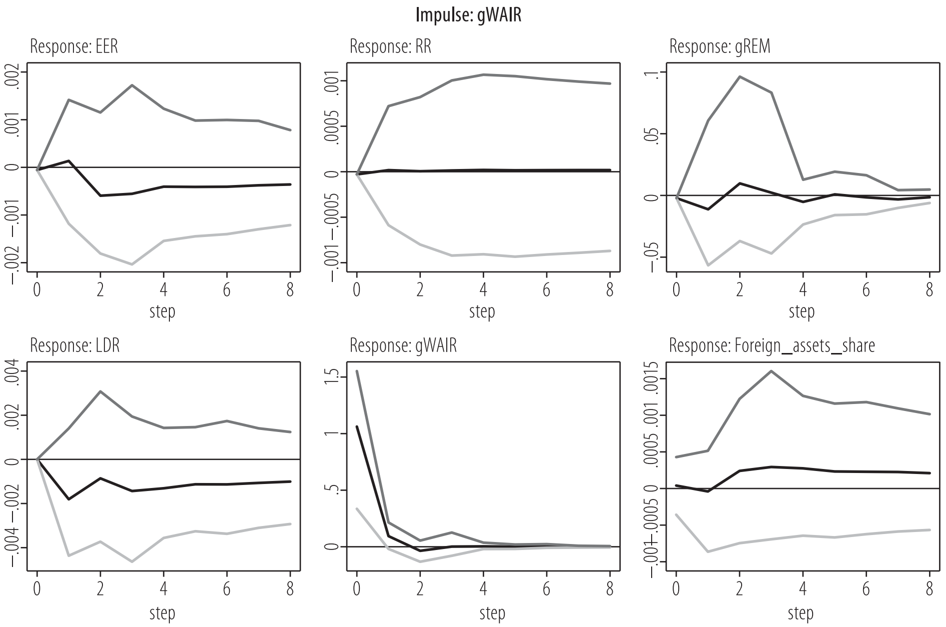
Appendix 2: Complete IRFs



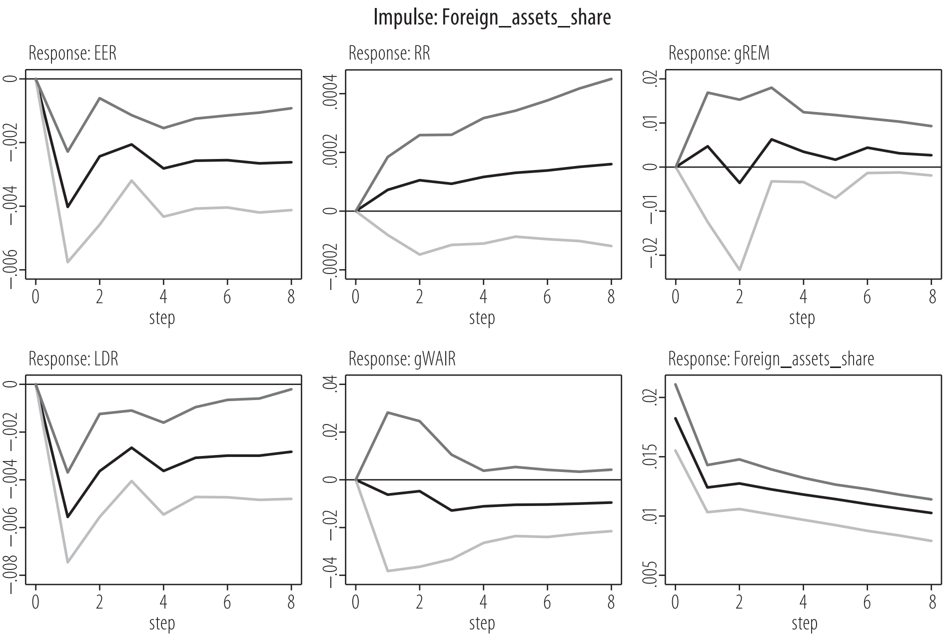



Impulse: gREM
Response: EER
Response: RR
Response: gREM
Response: LDR
Response: gWAIR
Response: Foreign_assets_share
step
95% lower and upper bounds reported; percentile ci


Impulse: LDR
Response: EER
Response: RR
Response: gREM
Response: LDR
Response: gWAIR
Response: Foreign_assets_share
step
95% lower and upper bounds reported; percentile ci



95% lower and upper bounds reported; percentile ci



95% lower and upper bounds reported; percentile ci