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Evidence from Bosnia & Herzegovina

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Abstract

This paper examines the pass-through of European Central Bank (ECB) monetary policy to deposit rates in Bosnia and Herzegovina (B&H). We use aggregate and bank-level data to study interest rate pass-through by bank size and ownership for the period 2012-2023. In extensions, we also study pass-through by counterparty and maturity of deposit contracts. Our results suggest that average pass-through is slow and incomplete. We document that pass-through is faster and more complete for banks which are small and foreign-owned, as compared to banks which are large (and foreign-owned), or banks which are small and domestic. This finding suggests that pass-through depends both on domestic market power of banks as well as their access to foreign money markets.

Keywords: monetary policy, transmission mechanism, deposit rates, currency board

JEL: E42, E52, E58, E60

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1. Introduction

A significant number of countries have an exchange rate regime based on a hard peg, i.e. a currency board or no separate legal tender. In 2022, these represented 26 countries or 13% of IMF membership (IMF, 2023: page 7). Many of these countries also have banking sectors which are dominated by foreign-owned banks. The purpose of this paper is to investigate the monetary transmission mechanism in such an environment. We study the effects of monetary policy changes on bank deposit rates in Bosnia and Herzegovina (B&H). We address three research questions: (i) How do Eurozone policy rates (anchor currency) pass-through to bank deposit rates in B&H in general? (ii) Does interest rate pass-through depend on foreign ownership and market power of banks? (iii) Does interest rate pass-through depend on the counterparty (households, non-financial corporations) and contract type (maturity)?

B&H is a prime example of a currency board country with a domestic banking sector dominated by foreign-owned banks. The monetary regime in B&H and its specifics such as domestic currency pegged to euro, financial integration with the euro area (EA) and major foreign ownership of domestic banks (from EU) determines the high relevance of ECB's monetary policy changes for the domestic economy. Investigating the specific channels of European Central Bank's (ECB) monetary policy transmission is fundamental for analyzing domestic economic developments from a historical (pass-through) perspective as well as for assessing the impact of policy changes. In countries where there are no investment options, banks are the key players in the transmission of monetary policy, especially when looking at the impact on interest rates on deposits.

For our analysis we are looking at monthly data on weighted average deposit rates and 3M Euribor. The main data source that we have used is Central Bank of Bosnia and Herzegovina (CBBH) and ECB data on main interest rates. Our analysis relies on the theory of imperfect banking competition, mainly the Monti-Klein model. In order to examine the pass-through of ECB monetary policy on deposit rates in Bosnia and Herzegovina, we have applied the Error Correction Model with a two-step approach.

Overall, we find that the average transmission mechanism of ECB policy rates to deposit rates in B&H is slow and incomplete. However, pass-through does vary by foreign ownership and size of the commercial banks in B&H. We document that pass-through is faster and more complete for banks which are small and foreign-owned, as compared to banks which are large (and foreign-owned), or banks which are small and domestic. This finding suggests that pass-through depends both on domestic market power of banks, as well as their access to foreign money markets.

The paper is organized in the following way: the next section (2.1) reviews the relevant monetary policy transmission channels for a country with a currency board regime from both a theoretical and empirical point of view. Section 2.2 discusses the structural aspects of the B&H financial market focusing on the banking sector and organizational structure. In Section 3, we provided a literature review together with theoretical background. Section 4 provides details on the data and econometric model used for the empirical assessment of the transmission of the ECB's monetary policy to the B&H economy with a focus on the individual transmission channels at bank level (panel data). Model results and conclusions are provided in Section 5, while Section 6 is for robustness checks together with the panel data econometric analysis.

2. Institutional Background

The Central Bank of Bosnia and Herzegovina (CBBH) is organized according to the currency board model, and functions according to the rules of passive monetary policy with no discretionary power. This means that CBBH does not refinance banks, does not set a policy interest rate and nor conducts open market operations. CBBH applies only policy instruments that are consistent with the monetary system under the currency board (i.e. the reserve requirement instrument) to steer domestic liquidity.

2.1 Monetary policy regime

The Central Bank of Bosnia and Herzegovina (CBBH) maintains monetary stability by issuing domestic currency according to the currency board arrangement with full coverage in freely convertible foreign exchange funds under a fixed exchange rate 1 Bosnian and Herzegovinian

convertible mark (KM): 0,51129 Euros (EUR). The fixed KM exchange rate against the euro and the very limited instruments that national monetary authorities have (to influence monetary policy conditions within the currency board regime), suggest that domestic monetary conditions should be largely determined by the monetary environment in the Eurozone (EA). Economic credibility, low inflation and low interest rates are obvious advantages of a currency board. The currency board (like any peg) has disadvantages as the CBBH cannot conduct independent monetary policy. This is an issue if the business cycles are not synchronized.

The monetary transmission mechanism in the currency board is based on the anchor role of the exchange rate. There is no independent target of the central bank regarding the interest rate, nor any other variable, whereby interest rates are adjusted in accordance with the terms which dominate at the markets. Under a currency board arrangement, the money supply is endogenous, so it automatically adjusts to the demand for money when it changes. In other words, in the currency board, there is no change in the money supply, nor a change in interest rates caused by domestic monetary policy actions. Both variables are adjusted to current economic trends as well as conditions prevailing on the domestic financial market. In Bosnia and Herzegovina (B&H), the convertible mark is pegged to the euro, where any changes in ECB policy rates, such as the refinancing rate or deposit facility rate, can directly influence interest rates offered by banks in B&H. If the ECB raises its rates, banks in B&H may follow suit to maintain the peg, resulting in higher interest rates on deposits. Competition among banks in B&H also plays a role. Banks may adjust deposit rates based on market conditions and competition with other financial institutions.

As a reaction to reduced uncertainty regarding the exchange rate, there should be a joint movement of domestic and foreign interest rates (in the country of the currency board). The currency board arrangement, however, does not automatically ensure full convergence of domestic interest rates with foreign interest rates.

2.2 Banking sector structure

The banking sector of Bosnia and Herzegovina (B&H) consists of 22 banks, with majority foreign ownership. Total assets of the banking sector at the end of 2023 were 39,04 billion KM[1]. The banking sector is stable and well capitalized. The key role of foreign banks is noticeable not only in regard to the number of banks, but also in their share of total assets (see Table 1 below). Origins of those banks' capital are mostly from Austria or Turkey. The banking sector is also concentrated since 50% of total assets are held by the 5 biggest banks in the system (the "Big 5" foreign banks).

Table 1: Asset structure of the banking sector

Total assets of banking sector		39,04 billions KM*
Number of banks		22
Wich of:		
	foreign banks*	13
	domestic banks	7
Share in total assets:		
	foreign banks	74.10%
	domestic banks	25.90%
Share in total assets:		
	5 biggest banks**	50%

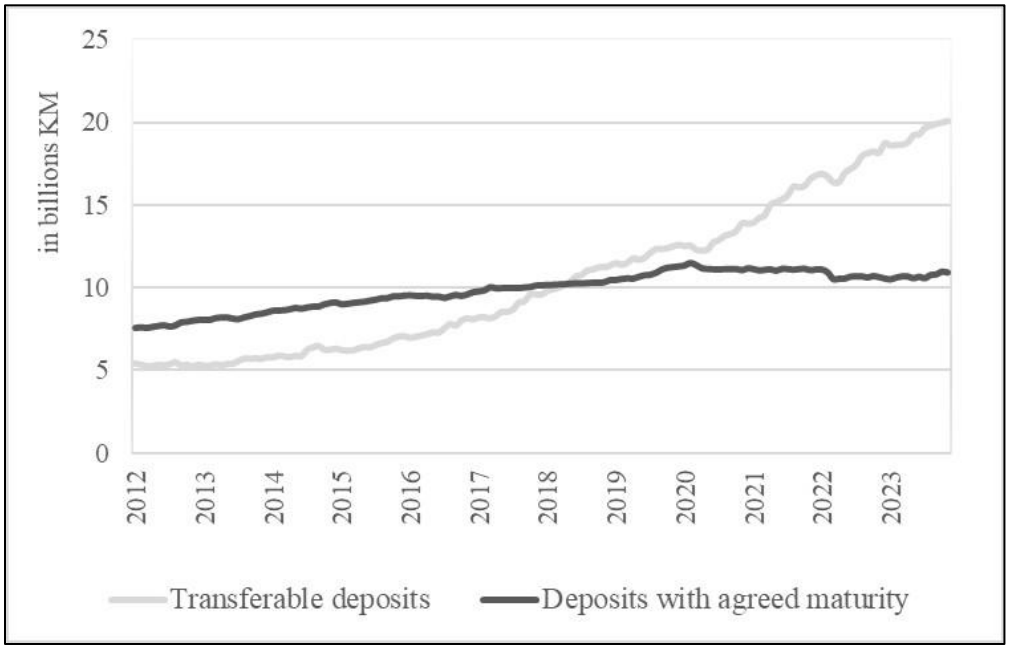
Source: CBBH data (as of 31.12.2023)
*Major banks with Austria or Turkey capital
** 35% off assets is held by 14 other banks (not big) with individual share of assets less than 5%

As seen in Appendix Table A2 (page 31), the banking sector in B&H has maintained a high degree of financial stability (strong profitability growth, improvement of asset quality, high liquidity and good capitalization). The main generator of banks' balance sheet growth is still determined by local sector deposits (main source of funding is domestic), with a recent decrease in foreign liabilities. With a mild increase in interest rates and credit activity, rising interest rates in the Eurozone affected banks' interest revenues (by increasing foreign assets). The majority of deposits (75%) are below 3 months of maturity.

[1] 1 KM=1,95583 EUR

The deposit base of the banking sector has been stable throughout the years. All categories of deposits, mainly transferable deposits, experienced an upward trend from 2015 (see Graph 1 below). From 2017, transferable deposits in the local currency have displayed a strong increasing trend while the deposit rates for these deposits are near zero.

Graph 1: Deposit structure



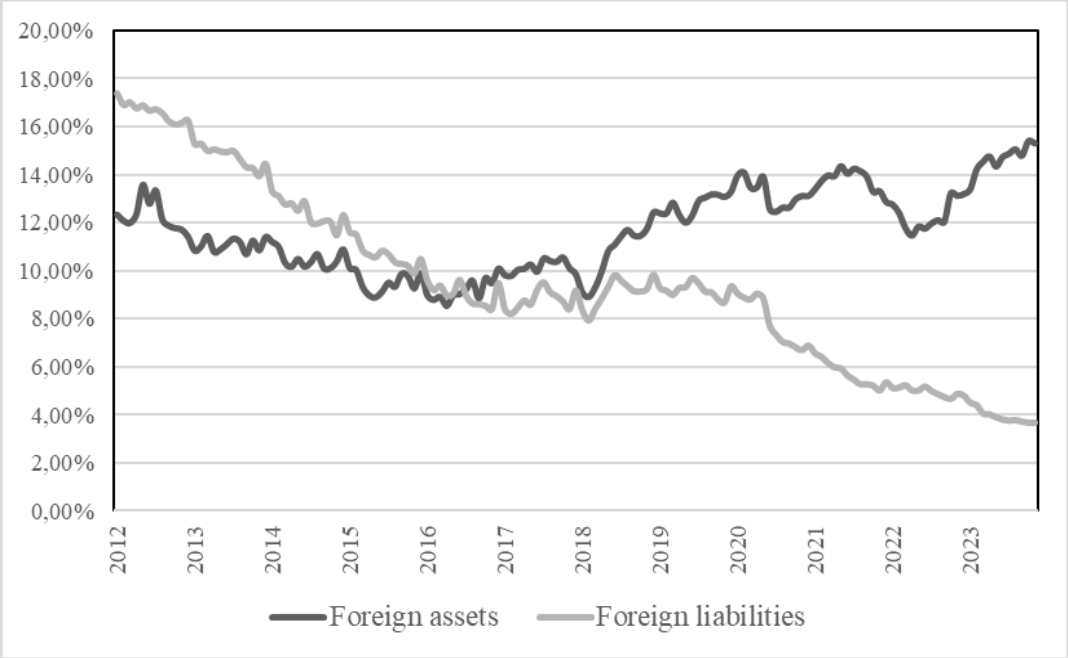
Source: CBBH data

The structure of the bank financing sources is mainly based on domestic sector deposits. Although this structure of sources in current conditions of strong growth of interest rates in the global environment is favorable for banks, unfavorable maturity structure of deposits is a risk for a more significant credit growth in the private sector. After a short-lasting liquidity shock which brought about the withdrawal of deposits, mainly those of households, in the first quarter of 2022, an upward trend continued in the following years. Transferable deposits have been dominating the deposit structure during the observed period, but as we mentioned, with deposit rates near zero (see Appendix Graph A1 on page 30). Consolidated balance sheet data (see Appendix Table A1 on page 31) is showing a share of more than 65% in total deposits, with the domination of transferable deposits in the domestic currency. Thus, these types of deposits are playing an

important role in the interest rate policies of commercial banks. From the pass-through point of view, this deposit structure can be a potentially limiting factor.

Since the majority of banks operating on the B&H market are foreign-owned, they can influence the transmission process between ECB monetary policy and Central Bank of Bosnia and Herzegovina (CBBH) in a significant way. After a period of negative interest rates on financial markets, changes in the structure of commercial banks' balance sheets (foreign assets) have been observed in line with the increase of the reference market rate (see Graph 2 below). These changes, in favor of foreign assets are influencing the pass-through effect of ECB monetary policy on interest rates in B&H.

Graph 2: Share of foreign assets and foreign liabilities in total bank assets



Source: CBBH data

3. Related literature and hypotheses

This paper contributes to the broad literature examining the pass-through of monetary policy to bank deposits and lending rates in a country with a currency board. Due to the high trade and financial sector integration and capital mobility in the EU, we might expect significant interactions between domestic and foreign economic developments.

The existing literature documents four key facts about interest rate pass-through. The first one is that pass-through of the policy rate to deposit rates is imperfect (Hannan & Berger, 1989). The second one is that weak inter-banking markets, as a key symptom of a low level of financial development, can result in excess liquidity in the banking system (Mishra & Montiel, 2012). The third one is that comparing the effects of a monetary tightening on different kinds of banks, authors find that the impact on deposits is greatest for banks with the following characteristics: 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 (Gambacorta & Marques-Ibanez, 2011). And the last one is that small banks are not more sensitive to monetary policy shocks than large banks (Kishan & Opiela, 2000).

A large body of research studies the pass-through equation by an error correction mechanism, which drives the rates back toward their long-run equilibrium relationship. Examples of such studies are (Sander & Kleimeier, 2000), (Mojon, 2000), (Opiela, 1999), (de Bondt, 2002), and (de Bondt, Mojon, & Valla, 2003). The main reference of interest rate pass-through studies is (Cottarelli & Kourelis, 1994) with an autoregressive distributed lag specification model.

Hannan and Berger (1991) show that the degree to which banks' deposit rates are sticky depend on the elasticity of deposit supply and the costs of changing the price. The elasticity of supply may depend on structural factors, such as market concentration and the depositor base of the bank. They find that banks adjust deposit rates in an asymmetric fashion, as rates tend to be more rigid in the case of interest rate increases than in periods of decreasing interest rates. Similarly, Mester and Saunders (1995) find that commercial loan rates tend to be more rigid in the upward direction. Mojon (2001) finds similar results for six euro area countries and notes that the asymmetry in the pass-through process partly hinges on the degree of competition.

Differences in financial market structures among countries, in terms of banking competition and financial market development, also explain part of this heterogeneity. The degree of competition in the banking sector, the size of the bank, ownership of the banks, the types of clients and the level of credit risk, among other financial factors, were found to be the main determinants of deposit interest rate flexibility in studies of (Bernstein & Fuentes, 2003). Bank interest rates on household deposits in less competitive or oligopolistic segments of the bank market adjust incompletely and/or with a significant delay, while interest rates set in a fully competitive environment react faster and usually completely (Laudadio, 1987). Previous studies (Gigineishvili, 2011) have shown positive effects of the following variables on transmission mechanism: GDP, inflation, loan quality and banking competition. On the other hand, excess of liquidity has a negative impact on the transmission mechanism.

A large number of research papers have found strong evidence in favor of nonlinearity and heterogeneity in interest rate pass-through, as financial institutions negotiate imperfections in financial markets. When it comes to the transmission mechanism, it is important to take into account the degree of dollarization of the economy in which the effect of this mechanism is assessed. Namely, in economies with a high degree of dollarization, the central bank has little power to influence interest rates. This is exactly the situation in Bosnia and Herzegovina (B&H).

Mihaylov (2016) uses error correction models to study the effects of money market conditions in the EA on lending interest rates in Bulgaria regarding the sector breakdown, the currency breakdown and the maturity of loans. The analysis shows a complete pass-through from Eurozone interest rates to all domestic lending rates in the long-term. The short-run pass-through is not complete (at 58%) and statistically significant only for corporate lending rates. There is no evidence for asymmetric reaction of domestic interest rates when money market conditions in the Eurozone are expansionary or contractionary.

Cross-country research studies have also analyzed the spill-over effects from the Eurozone to domestic monetary conditions (including the impact of the unconventional monetary policy) on non-euro area countries, including Bulgaria. While Potjagailo (2016) finds a complete and immediate pass-through from EA short-term rates to short-term money market rates in Bulgaria, Moder (2017) does not find statistically significant reactions of domestic interest rates to changes in the foreign monetary conditions.

3.1 Theoretical framework and empirical hypotheses

The Monti-Klein model of imperfect banking competition

To develop our empirical hypotheses we study a model of imperfect competition in the banking sector – the Monti-Klein model. We want to understand how different bank groups with different ownership structures, size or market power influence the transmission mechanism. Our analysis of elasticity of banks' interest rate as the theoretical starting point is based on the influential papers of Monti (1972) and Klein (1971).

In the Monti-Klein model, banks maximize profits in the current period and have the capacity to set the price in both loan and deposit markets. The bank's decision variables are L (the value of loans) and D (the value of deposits), while its level of equity is assumed to be given. The bank takes into account the influence of its deposit (loan) volume on the interest rates it pays (receives) on deposits (loans). The model assumes that the bank takes the money market rate r as given, either because it is fixed by the Central Bank of Bosnia and Herzegovina (CBBH) or because it is determined by the equilibrium rate on international capital markets:

$$\pi(D,L) = r_L L + r\left((1-\alpha)D - L\right) - r_D D - C(D,L)$$

Where:

- Loan and deposit volume: L, D;
- Loan & deposit rates: r_L, r_D
- Banks have perfect access to the interbank market at rate: r
- Required reserves rate: α
- Cost function is separable with constant marginal costs: $C(D,L) \rightarrow \quad C_D' = \gamma_D;\ C_L' = \gamma_L$

The greater the market power of the bank on deposits, the smaller the elasticity of supply and the higher the Lerner index[2]. The competitive model corresponds to the limit case of infinite elasticities. Therefore, the intuitive result is that intermediation margins are higher when banks have a higher market power. The equilibrium intermediation spread on deposits is given by:

[2] price minus cost divided by price

$$\frac{r(1-\alpha)-\gamma_D-r_D^*}{r_D^*}=\frac{1}{\boldsymbol{N}\,\varepsilon_D(r_D^*)}$$

The sensitivity of r_D^* to changes in the money market rate r (Euribor) depends on market power of banks:

$$\frac{1}{\varepsilon_D(r_D^*)}$$

The Monti-Klein model can easily be reinterpreted as a model of imperfect (Cournot) competition between a finite number N of banks. Sensitivity of r_D^* to changes in the money market rate r (Euribor) then also depends on the number of competing banks. As N increases r_D^* becomes more sensitive to change in r (for a given market power of each bank in their "home" market).

Based on this theory framework we derive two empirical hypotheses:

Hypothesis 1 (Bank size): Pass-through of Eurozone policy rates to bank deposit rates in Bosnia & Herzegovina (B&H) will depend on the domestic market power of B&H banks. Small banks with less market power should display stronger pass-through.

Hypothesis 2 (Bank ownership): Pass-through of Eurozone policy rates to bank deposit rates in B&H will depend on access of B&H banks to the Eurozone money market. Foreign banks with better access to the Eurozone market should display stronger pass-through.

4. Data & Methodology

4.1. Data

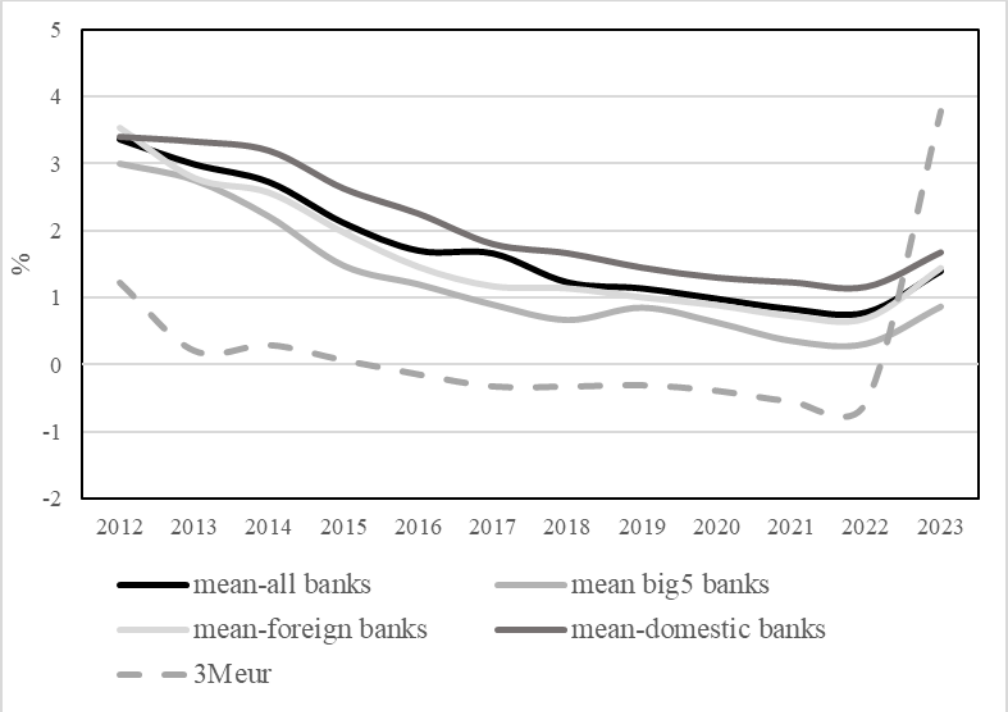
The data used in our empirical analysis comes from CBBH and ECB sources. The first comprises variables at a monthly frequency from January 2012 to December 2023 for Bosnia and Herzegovina from the interest rate (MIR) dataset[3] of CBBH. This is what may be called the aggregate bank dataset. The second dataset consists of interest rates (also at a monthly frequency for the same period taken from a sample of individual B&H banks. The data for individual banks

[3] We make use of monthly data on interest rates from the harmonized monetary and financial institutions' interest rate (MIR) dataset from CBBH

are provided by the CBBH, giving bank-level series for 21 banks over the period January 2012 to December 2023. This disaggregation enables us to have results derived from both an aggregated data set and using individual bank-level data. The disaggregate results confirm those from the main aggregate dataset, but with statistical significance for different breakdowns in the model (maturity, sectoral and bank groups). The market rate used to indicate the changes in monetary policy of ECB is the 3M Euribor and Euro government bond and deposit facility rate for robustness check.

We explore factors that influence the degree of delay in market interest rate response to changes in the policy rate. Based on our hypotheses, the main characteristics we examine are the size of the bank and ownership of the bank (foreign vs. domestic). Graph 3 below displays average interest rates for our observation period by bank size and ownership.

Graph 3: Descriptive statistics (mean) of dependent variables



Source: CBBH

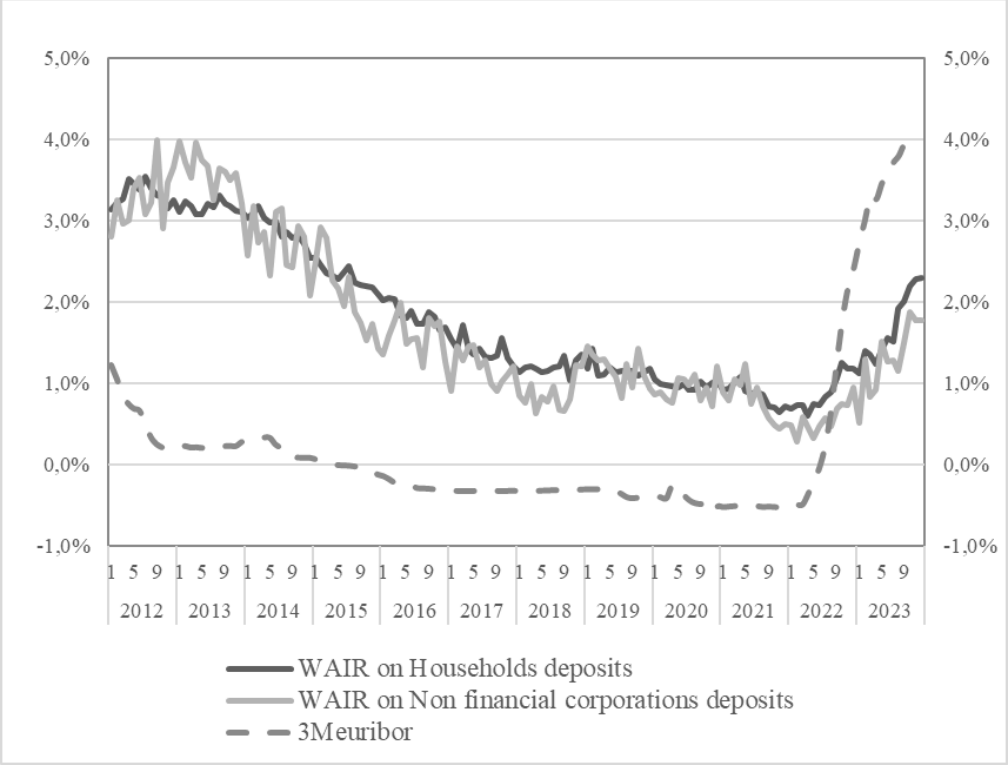
Note: "Big 5" banks – banks with the biggest market share(total 50%) – all foreign owned

Foreign banks other – foreign-owned banks excluding the "Big 5" (total market share 28%)

Domestic banks – all domestic owned banks in the system (total market share 22%) and smallest banks on the market at the same time

In extensions we also study the pass-through of ECB policy rates to deposit rates by counterparty (households and nonfinancial companies) and maturity (short-term deposits and long-term deposits) of the deposit contract. Graph 4 below displays banks deposit rates by counterparty.

Graph 4: Deposit rate development by sectors



Source: CBBH, ECB.

Note: Share of Household deposits 50%, share of non-financial corporate deposits 29%

For the overall sample period weighted deposit rates for all banks[4] vary between 0,037% and 4,95% (see Table 2 below). The variation of deposit rate for all observed models varies from 0,789% to 1,282%.

[4] Transferable deposits are not included in the weighted average

Table 2: Descriptive statistics

Panel	Mean	Min	Max	Sd	Obs
Weighted Deposit rate:					
All banks	1.713	0.037	4.95	1.127	3024
Big 5(foreign owned)	1.275	0.003	4.696	1.027	720
Foreign banks other	1.607	0.105	4.75	1.051	1152
Domestic banks	2.092	0.209	4.95	1.140	1152
Restrictive MP	1.086	0.003	3.800	0.789	504
Expansive MP	2.409	0.182	4.763	0.983	1008
HH deposits	1.891	0.002	5.00	1.096	3022
NFC deposits	1.414	0.00	5.156	1.282	2880
Short term deposits	1.828	0.002	4.989	1.053	3021
Long term deposits	2.037	0.001	5.00	1.173	3.021
3 month EURIBOR	0.237	-0.59	3.975	1.117	3024

Note: All interest rates are in percentages, the sample period is from January 2012 to December 2023

4.2. Methodology

Interest rate pass-through is usually investigated using either a model of immediate pass-through (first-difference model) or a model of sluggish adjustment (error correction model). For our analyses we consider both types of models as listed below:

Table 3. Empirical models

Model 1a: First difference regression (aggregated bank rates)	[1a] $\Delta DepositRate_t = \beta \Delta MarketRate_t + year_t + \varepsilon_t$
Model 1b: First difference regression (individual bank rates)	[1b] $\Delta DepositRate_{b,t} = \beta \Delta MarketRate_t + bank_b + year_t + \varepsilon_t$
Model 2a: Error correction Model (aggregated bank rates)	[2a] $\Delta DepositRate_t = -\alpha(DepositRate_{t-1} - MarketRate_{t-1}) + \beta \Delta MarketRate_t + \varepsilon_t$
Model 2b: Error correction Model (individual bank rates)	[2b] $\Delta DepositRate_{b,t} = -\alpha\big(DepositRate_{b,t-1} - MarketRate_{t-1}\big) + \beta \Delta MarketRate_t + bank_b + \varepsilon_t$

The immediate pass-through parameter β should be equal to 1 under perfect competition in all models. However, full (or perfect or complete) pass-through may not prevail if markets are imperfect. In Bosnia and Herzegovina (B&H) this is likely to be the case with the dominant presence of large foreign-owned "Big 5" banks with 50% of market share.

In addition, the pass-through from the policy rate to retail rates may not only be incomplete in the long-run, but could be sluggish in the short-run due to an array of other factors (such as characteristics of banks and the market). First, some banks in the market could respond more slowly to changes in the market rates than others because of control power and they may decide to

adjust rates less frequently because of high liquidity also. In other words, it matters how responsive their liability side to market rates is. We therefore also study a cointegration and error correction mechanism model, to overcome the potential problem of spurious regression associated with non-stationary series. For the cointegration process we provided a two-step procedure:

- Integration of the variables with Augmented Dickey–Fuller (ADF) test (unit root test), and
- We checked for existence of a long-run relationship between endogenous and exogenous variables in the model.

After testing for unit root and establishing the long-run relationship via the Engle and Granger test, the next step is to declare error correction term and provide error correction model to check short-run relationship[5].

According to Granger, instead of stationary in the series a priori in order to avoid the fallacious regression situation, the best approach would be to test whether the regression residuals are stationary, so the error-correction model can be estimated with non-stationary series and give better results in the dynamics of the short and long-term relationship.

From the tests provided in Table 4 below, all variables used for the study (3M Euribor and weighted average deposit interest rates) have strong evidence in favor of the null hypothesis of the stationarity in their (0) levels. This justifies the need to difference the variables to obtain stationarity. The p value of first differences on the variables were at critical value at the 1% level so we can reject the H0.

Table 4: Test for main variables

	p-value			
	Augmented-Dickey Fuller	Phillips-Perron	KPSS	
3M euribor(0)	0,23	0,84	0,34	H0:Has a unit root
wair (0)	0,11	0,19	0,13	
3M euribor(1)	0.00	0.00	0.00	H0:Has a unit root
wair (1)	0.00	0.00	0.00	
etc(0)	0.00	0.00	0.00	H0:Has a unit root

[5] Kremers and al. (1992) analyzed the power of cointegration by showing that the error-correction model gives more efficient results. They found that when there is a cointegration relationship, the error-correction model is usually more powerful. Several empirical studies of money demand demonstrate this power of the error-correction model and its strategic implications for monetary policy making (Hendry and Ericsson 1991, Mehra 1991).

To examine the variables for a long-run cointegration relationship we also provide a test for residuals. In this way we confirm a long-run relationship between variables and we can proceed to estimating the short-run and long-run cointegration model by using first difference regression (Models 1a and 1b) and the error correction approach (Models 2a and 2b).

5. Results

5.1. First difference regressions

We first report results for a first-difference regression based on aggregate-level data. Table 5 below displays the results for the following regression:

$$\Delta DepositRate_t = \beta \Delta MarketRate_t + year_t + \varepsilon_t \qquad (1a)^6$$

Table 5: First difference model, aggregate data (Model 1a results)

Weighted Deposit rate H0	**Immediate pass-through** ß = 0	**Number observation**	**R-squared**
All banks	0,175 (0,086)	143	0,0208
Big 5(foreign owned)	0,143 (0,324)	143	0,0069
Foreign banks other	0,244 (0,138)	143	0,0156
Domestic banks	0,148 (0,360)	143	0,0059
Restrictive MP	0,047 (0,846)	23	0,0018
Expansive MP	-0,554 (0,141)	47	0,0475

Note: p-value denotes in brackets

To investigate further evidence of different transmission mechanisms for different group of banks we run first difference regression but on bank level data:

[6] Dependent variable is weighted average bank deposit rate (by different bank groups and sample periods)
Independent variable is Eurozone market rate – 3Meuribor

$$\Delta DepositRate_{b,t} = \beta \Delta MarketRate_t + bank_b + year_t + \varepsilon_t \quad (1b)^7$$

Table 6: First difference model, bank-level data (Model 1b results)

Weighted Deposit rate H0	**Immediate pass-through** ß = 0	**Number observation**	**R-squared**
All banks	0,184 (0,0310)	3003	0,0016
Big 5(foreign owned)	0,141 (0,3310)	715	0,0013
Foreign banks other	0,246 (0,0840)	1144	0,0026
Domestic banks	0,150 (0,308)	1144	0,0009
Restrictive MP	0,053 (0,629)	483	0,0005
Expansive MP	-0,118 (0,790)	987	0,0001

Note: p-value denotes in brackets

We obtain similar findings for models 1a and models 2b. First, it appears that there is an incomplete pass-through from the key monetary policy rate to average deposit market rates (18%). The pass-through from money market rates towards deposit banks rates is strongest for other foreign banks (25%). By comparison both the "Big 5" banks and small domestic banks display a weaker and statistically insignificant pass-through (14%-15%). This finding is in line with our hypotheses: Banks have stronger pass-through when they have little market power (small size), but good access to foreign money markets (foreign ownership).

5.2.Error correction approaches

Given the above theoretical and empirical reasons for expecting sluggish price adjustment in the deposit rates, the next step is to use an error correction model to examine short- and long-run

[7] Dependent variable is weighted average bank deposit rate (by different bank groups and sample periods)
Independent variable is eurozone market rate – 3Meuribor

behavior. We first study an error correction framework for aggregate data as in the following equation:

$$\Delta DepositRate_t = \alpha(DepositRate_{t-1} - MarketRate_{t-1}) + \beta\Delta MarketRate_t + \varepsilon_t \quad (2a)$$

Table 7: ECM estimations , aggregate bank level. (Model 2a results)

Weighted Deposit rate H0	**Immediate pass-through** ß = 0	**ECT** α = 1	**Adjustment speed in months** (ß-1)/ α	**Cointegration relation** α = 0	**Number observation**	**R-squared**
All banks	0,244	-0,3242	2,332	Yes*	142	0,1318
	(0,013)	(0,000)				
Big 5(foreign owned)	0,133	-0,2705	3,207	Yes*	142	0,079
	(0,346)	(0,001)				
Foreign banks other	0,281	-0,4965	1,449	Yes*	142	0,2657
	(0,051)	(0,000)				
Domestic banks	0,127	-0,4227	2,066	Yes*	142	0,1865
	(0,390)	(0,000)				
Restrictive MP	0,115	-0,5044	1,755	Yes*	22	0,2535
	(0,610)	(0,020)				
Expansive MP	-0,264	-0,3417	3,700	Yes*	46	0,1295
	(0,493)	(0,023)				

Note: p-value denotes in brackets
For adjustment speed in months we used Hendrys (1995) approach
* Denote significance of the F-statistic at the 1%

Table 7 displays our ECM estimates for aggregate bank data. As in our first difference models, the immediate response of the bank (coefficient beta) is strongest for small banks with foreign ownership. The error correction loading α captures the speed at which banks adjust their rates to deviations from the long-run relation. The speed of adjustment is also highest for small, foreign-owned banks. Deviations from the long-run equilibrium are more quickly corrected in the case of this bank group and small domestic banks where the relative speed of adjustment ranges between -0.423 and -0.497, compared to a coefficient for the "Big 5" banks at -0.271.

For deposit rates at different sample periods regarding the restrictive and expansive monetary policy the speed of adjustment coefficients are higher for the restrictive period for B&H economy. In other words, for our sample size, we can say that the deposit rate reacts faster in general for the period of high market rates. This is different from most research for asymmetric results regarding different monetary policy directions. Hannan and Berger (1991) found that banks adjust deposit

rates in an asymmetric fashion, as rates tend to be more rigid in the case of market rate increases than in periods of decreasing market rates. In our sample we captured the period with historically highest market rates for the period between 2021-2023 (restrictive monetary policy). But at the same time, for our second sample period (expansive monetary policy) B&H banks have already been in a period of extremely low deposit rates. This is why it is logical to have a stronger reaction in a period of very restrictive monetary policy in the last 2,5 years, after a long period of very low deposit interest rates (see Graph A2 in Appendix on page 35).

Table 8 below reports the results of our error correction estimates based on individual banks data as in the following equation:

$$\Delta DepositRate_{b,t} = \alpha\left(DepositRate_{b,t-1} - MarketRate_{t-1}\right) + \beta\Delta MarketRate_t + bank_b + \varepsilon_t \qquad (2b)$$

Table 8: ECM estimations, bank-level data (Model 2b results)

Weighted Deposit rate H0	**Immediate pass-through** ß = 0	**ECT** α = 1	**Adjustment speed in months** (1-ß)/ α	**Cointegration relation** α = 0	**Number observation**	**R-squared**
All banks	0,186 (0,017)	-0,430 (0,000)	1,894	Yes*	2982	0,446
Big 5(foreign owned)	0,127 (0,353)	-0,384 (0,000)	2,275	Yes*	710	0,988
Foreign banks other	0,281 (0,026)	-0,476 (0,000)	1,512	Yes*	1136	0,9287
Domestic banks	0,127 (0,348)	-0,406 (0,000)	2,151	Yes*	1136	0,1606
Restrictive MP	0,019 (0,855)	-0,389 (0,000)	2,518	Yes*	462	0,8179
Expansive MP	-0,236 (0,572)	-0,415 (0,000)	2,978	Yes*	966	0,3710

Note: p-value denotes in brackets
For adjustment speed in months we used Hendrys (1995) approach
* Denote significance of the F-statistic at the 1%

The results for bank-level data are mostly in line with our results for the aggregate data. First, the highest immediate pass-through is found to be 28% in the case of the (small) foreign banks group. Second, the pass-through of market interest rates to deposit bank interest rates is clearly slow with the average speed of adjustment for all banks at 43% per month. The fastest pass-through is found

to be 47,6%, again in the case of the foreign banks group, and the lowest one at 38,4% in the "Big 5" group. The average speed for deposit bank interest rates to fully adjust to market interest rate changes is typically between 1 and 3 months.

5.3. Extension: Subsample Interest Rates

Below, we take into account both short-run and long-run relations between the different interest rates by maturity and counterparty using an error correction framework for individual banks rate as in the following equation:

$$\Delta DepositRate_{b,t} = -\alpha\left(\Delta DepositRate_{b,t-1} - \Delta MarketRate_{t-1}\right) + \beta\Delta MarketRate_t + bank_b + \varepsilon_t \qquad (2c)$$

Table 9. Pass-through by counterparty and maturity

Weighted Deposit rate	**Immediate pass-through**	**ECT**	**Adjustment speed in months**	**Cointegration relation**	**Number observation**	**R-squared**
H0	ß = 0	α = 1	(1-ß)/ α	α = 0		
All banks	0,186 (0,017)	-0,43 (0,000)	1,894	Yes*	2982	0,446
Interest rates on HH deposits	0,169 (0,001)	-0,325 (0,000)	2,555	Yes*	2973	0,0789
Interest rates on NFC deposits	0,181 (0,228)	-0,461 (0,000)	1,776	Yes*	2967	0,4936
Interest rates on short term deposits	0,027 (0,000)	-0,314 (0,000)	3,099	Yes*	2973	0,1101
Interest rates on long term deposits	0,202 (0,000)	-0,409 (0,000)	1,949	Yes*	2973	0,1733

Note: p-value denotes in brackets
For adjustment speed in months we used Hendrys (1995) approach
* Denote significance of the F-statistic at the 1%

Table 9 above shows a regression of pass-through in the sample period for different maturity and sector deposit rates. Non-financial counterparties (NFCs), do not have statistically significant pass-through. However, for household deposits, the regression coefficient is lower but statistically significant.

The empirical literature by Egert and MacDonald (2009) has found, that for deposits, the pass-through seems to be less complete, but increases for products with higher maturities. Regarding

results in Table 9, the speed of adjustment seems to be much faster for long-term deposits compared to the short-term deposits for the B&H economy. Like the results in the table, the long-run pass-through is higher again for long-term rates compared to short-term rates, but still implying an incomplete and very sluggish pass-through.

6. Robustness check

This section presents two robustness checks: i) applying as alternative explanatory variables Euro government bond and Deposit facility rate (ECB) and, ii) employing an alternative empirical framework, namely the auto-regressive distributed lag (ARDL) model.

As seen in Table 10, by using different independent (explanatory) variables through ECM we obtained the best results (measured with R-square and p- value) with 3M Euribor as the independent variable. Since we are aware that banks operating in Bosnia and Herzegovina (B&H) are mainly doing money market operations on the Eurozone market, it was expected to get this result for 3M Euribor. Even though the Euro Government Bond is also a measure of reaction to ECB monetary policy, it has a postponed effect that is obviously not desirable in terms of pass-through. Overall, all these results are in line with our baseline results.

As an alternative empirical model we employ the ARDL model, because of its advantage in ability to handle cointegration with inherent robustness to misspecification of integration orders of relevant variables. Robustness results have shown that by applying the ARDL model we get similar results as with ECM (estimated α is almost the same).

Table 10: Robustness checks

	Error Correction Model			ARDL
	3M euribor	Euro Government Bond	Deposit Facility Rate (ECB)	3M euribor
Estimate for α	-0,430	-0,429	-0,430	-0,446
(p-value)	0,000	0,000	0,000	0,000
Estimate for ß	0,186	0,165	0,181	0,201
(p-value)	0,017	0,016	0,004	0.000
Number observation	2982	2982	2982	3003
R-squared	0.446	0,1879	0,1885	

By applying a robustness test for different explanatory variables on the model and model extensions, we have obtained similar results to our main analysis. A more detailed robustness check specification can be found in Appendix Table A5 (page 34).

7. Conclusion

This paper is the first study that analyses the interest rate pass-through process at the Bosnian and Herzegovinian (B&H) level using error correction and ARDL empirical method. Furthermore, the paper explicitly focuses on how changes in market interest rates (3M Euribor), are passed through to bank deposit rates.

At the very beginning of this paper we have addressed three research questions: (i) How do Eurozone policy rates (anchor currency) pass-through to bank deposit rates in B&H in general? (ii) Does interest rate pass-through depend on foreign ownership and market power of banks? (iii) Does interest rate pass-through depend on the counterparty (households, non-financial corporations) and contract type (maturity)?

In line with the questions defined above, we can derive several conclusions. Regarding the pass-through of ECB policy rates to bank deposit rates in general, the evidence seems to be fairly weak

in general regarding the bank interest rate channel. Use of bank level data suggests that bank deposit activity is definitely affected by monetary policy changes but on a very slow and low path.

Regarding the differences in pass-through depending on ownership and market power, it has been found that the most notable sluggish deposit bank rates are the interest rates for group "Big 5". However, deposit rates for the "Big 5" bank group may be less responsive to monetary policy changes than deposit rates for foreign-owned banks. In that regard , foreign ownership seems to matter and the reaction of foreign-owned banks is more pronounced to a change in foreign monetary conditions than other specified groups. In addition, it seems that the size of banks is not important for strength and speed of the transmission mechanism, having in mind that the domestic banks in our analysis are simultaneously the smallest banks on the B&H market. Thus, we can confirm the findings of Kishan & Opiela (2000) that small banks are not more sensitive to monetary policy shocks than large banks.

In line with the last research question, we have found that there isn't a significant difference in interest rate pass-through depending on the counterparty. Both of the observed categories (households and non-financial corporations) have imperfect and very sluggish pass-through. On the other hand, when we are looking at different maturities, we have found that the speed of adjustment seems to be much faster for long-term deposits compared to the short-term deposits for the B&H economy. However, still implying an incomplete and very sluggish pass-through.

From a policy perspective, measures to reduce bank concentration and boost competition in the financial system could be instrumental in enhancing the effectiveness of monetary policy transmission mechanism by reducing asymmetries in the adjustment of deposit rates. Regarding the fact that this analysis focuses mostly on the post-crisis period with very low interest rates and a number of non-standard monetary policy measures, we cannot confirm that findings of this paper apply to 'normal' times as well, so that can remain for future research.

8. Reference list

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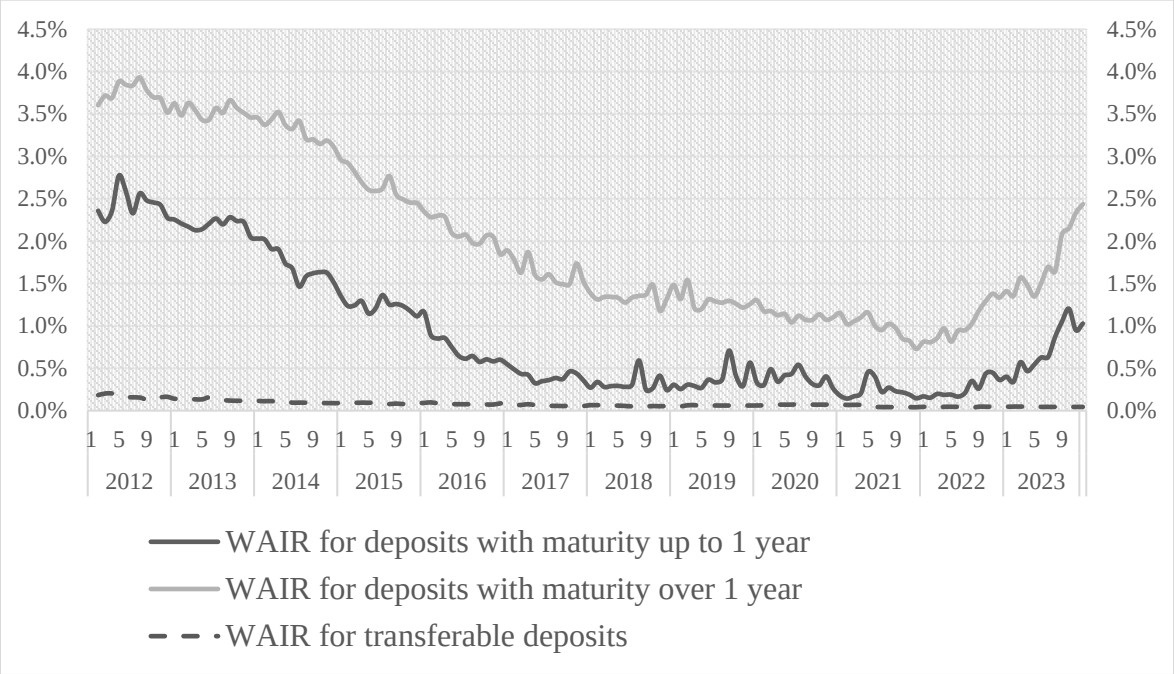
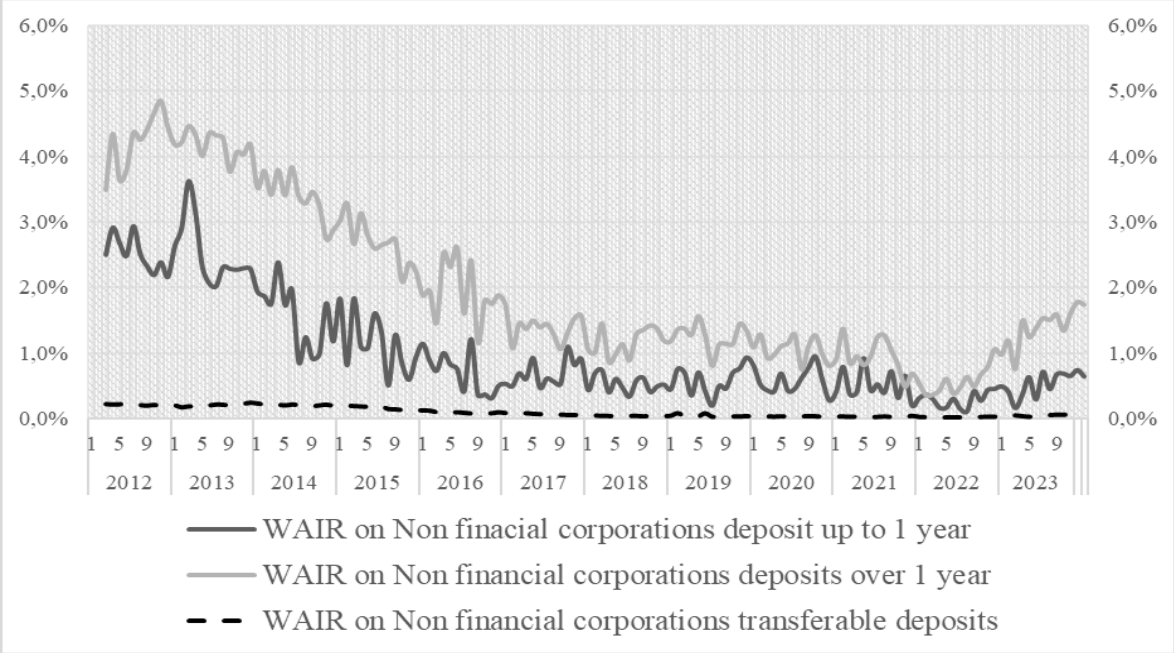
9. Appendix

Graph A1: Deposit rates to Households and non-financial corporations by maturity





Source: CBBH

Table A1: Consolidate balance sheet of commercial banks (in million KM)

ASSETS		LIABILITIES	
Reserves	7.827	Central Government Deposits	2.052
Foreign Assets	6.081	**Transf. Dep. Other Resident Sectors in Dom. Curr.**	**14.844**
Claims on Central Government	3.421	**Transf. Dep. Other Resident Sectors in For. Curr.**	**4.051**
Claims on Public Non-financial enterprises	626	Other Dep. Other Resident Sectors in Dom. Curr.	2.946
Claims on Private Non-financial enterprises	9.680	Other Dep. Other Resident Sectors in For. Curr.	7.075
Claims on Other Financial Corporations	212	Securities other than shares	4
Claims on Other Resident Sector	11.820	Loans	648
Total Assets	39.667	Foreign Liabilities	1.455
		Government Lending Funds	0
		Counterpart Funds	0
		Shares and Other Equity	5.162
		Other items (net)	1.431
		Total Liabilities	39.667

Source: CBBiH data; Data at 30.11.2023

Table A2: Banking sector key performance indicators

	Capital adequacy	Asset quality	Profitability		Liquidity	
	Tier 1 capital ratio	NPLs to total loans	Return on average assets	Return on average equity	Liquid assets to total assets	Liquidity coverage ratio (LCR)
2012	14,1	13,5	0,7	4,2	25,3	
2013	15,2	15,1	-0,1	-1,2	26,2	
2014	14,3	14,2	0,8	4,5	26,6	
2015	13,8	13,7	0,3	0,9	26,2	
2016	15,0	11,8	1,1	6,2	26,9	
2017	14,8	10,0	1,4	9,0	28,1	
2018	16,5	8,8	1,3	8,5	29,3	
2019	17,5	7,4	1,4	9,1	29,2	
2020	18,1	6,1	0,7	5,6	28,6	
2021	18,7	5,8	1,3	9,6	30,7	216,9
2022	18,7	4,5	1,6	12,0	30,5	213,8
2023	18,6	4,1	2,0	15,9	28,8	227,9

Source: CBBiH data

Pass-through for panel analysis: Before estimating panel ECM/ARDL existence of cointegration between observed variables was checked.

Table A3: Padroni test

Pedroni test for cointegration

H0: No cointegration		Number of panels	= 20
Ha: All panels are cointegrated		Number of periods	= 143
Cointegrating vector: Panel specific			
Panel means:	Included	Kernel:	Bartlett
Time trend:	Not included	Lags:	2.00 (Newey-West)
AR parameter:	Panel specific	Augmented lags:	1

	Statistic	p-value
Modified Phillips-Perron t	-5.3402	0.0000
Phillips-Perron t	-5.1929	0.0000
Augmented Dickey-Fuller t	-9.0433	0.0000

We also provide robustness test for other different explanatory variables on deposit rates by different maturities and sectors. The corresponding results using different explanatory variables provided in Table A4 are for the extended model. Overall, these results are in line with our findings in Model 2b.

Table A4: Robustness test - Different explanatory variables

	All banks	Interest rates on HH deposits	Interest rates on NFC deposits	Interest rates on short term deposits	Interest rates on long term deposits
Estimate for α	-0,430	-0,325	-0,461	-0,314	-0,409
(p-value)	0,000	0,000	0,000	0,000	0,000
Estimate for ß(meur)	0,186	0,170	0,181	0,027	0,202
(p-value)	0,017	0,001	0,228	0,000	0,000
Number observation	2982	2973	2967	2973	2973
R-squared	0.446	0,0789	0,4936	0,1101	0,1733
Estimate for α	-0,429	-0,325	-0,456	-0,307	-0,408
(p-value)	0,000	0,000	0,000	0,000	0,000
Estimate for ß(bond)	0,165	0,156	0,186	0,043	0,182
(p-value)	0,016	0,000	0,162	0,429	0,001
Number observation	2982	2976	2982	2973	2973
R-squared	0,1879	0,1138	0,2117	0,099	0,1721
Estimate for α	-0,430	-0,325	-0,456	-0,305	-0,410
(p-value)	0,000	0,000	0,000	0,000	0,000
Estimate for ß(dfr)	0,181	0,103	0,254	-0,037	0,174
(p-value)	0,004	0,017	0,037	0,462	0,000
Number observation	2982	2976	2982	2973	2973
R-squared	0,1885	0,1115	0,2125	0,0987	0,1731

Table A5: Robustness test-different specification (ARDL)

(all outcome variables)

	All banks	Big 5(foreign owned)	Foreign banks other	Domestic banks	Restrictive MP	Expansive MP	Interest rates on HH deposits	Interest rates on NFC deposits	Interest rates on short term deposits	Interest rates on long term deposits
				Long-run dynamics						
Estimate for ϒ	0.3185	0,337	0,384	0,275	0,160	0,020	0,355	0,326	0,341	0,466
p-value	0.000	0,000	0,000	0,000	0,032	0,914	0,000	0,000	0,000	0,000
				Short-run dynamics						
Estimate for ß	-0,201	-0,298	-0,160	-0,119	0,808	-0,057	-0,0123	-0,342	-0,0179	0,0236
(p-value)	0,057	0,029	0,343	0,629	0,493	0,673	0,8296	0,042	0,7846	0,6682
Estimate for α	-0,446	-0,365	-0,378	-0,495	-0,366	-0,615	-0,290	-0,665	-0,295	-0,247
(p-value)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
trend	-0,009	-0,007	-0,007	-0,009	0,068	-0,020	-0,006	-0,013	-0,006	-0,006
(p-value)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Number observation	3003	715	1136	1144	483	987	2999	2860	2997	2973
ARDL spec	(1,0)	(1,0)	(2,1)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,1)	(2,1)

The coefficient between the variables was determined by using the PMG estimator, chosen by Hausman test results:

```
. hausman pmg DFE, sigmamore

                 ---- Coefficients ----
                 (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
                 pmg          DFE         Difference       Std. err.
------------------------------------------------------------------------------
        meur     .2682612     .3406092       -.0723481        .0784767
------------------------------------------------------------------------------
                           b = Consistent under H0 and Ha; obtained from xtpmg.
            B = Inconsistent under Ha, efficient under H0; obtained from xtpmg.

Test of H0: Difference in coefficients not systematic

    chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   0.85
Prob > chi2 = 0.3566
```

lag order (ARDL spec) is determined based on the Schwarz criterion

Graph A2: Weighted average deposit rates, deposit facility rate and total deposit of banks in B&H