# Pressure on interest rates on deposits in Croatia: government bonds or European Central Bank?

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**Abstract**

*The paper analyses the importance of government bonds as the key instrument on the capital market and their effect on interest rates on deposits in Croatia. February 2023 saw the first government bonds issued in Croatia, which provided citizens with safe investment opportunities, especially following low interest rates periods across Europe that continued several months into Croatia's accession to the euro area. The authors define two hypotheses regarding the effect of government bonds and the European Central Bank (ECB) on interest rates, trying to determine whose relative effect was greater of the two. Combining principal component analysis and regression analysis, the authors determine that government bonds have a limited effect on interest rates, whereas ECB's effect is much more significant. The results suggest a complex dynamic between fiscal and monetary policy, highlighting proactive government measures for stimulating investments and development of the Croatian capital market.*

*Keywords: factor analysis, government bonds, interest rates, deposits, regression analysis, Croatia*

## 1 INTRODUCTION

Having an understanding of government bonds, which are a significant determinant of money and capital markets, is extremely important since they provide a deeper insight into a country's fiscal policy as well as reflect general macro-economic conditions and shape the investors' expectations. In February 2023, the Croatian Ministry of Finance issued government bonds, a security aimed at small investors, for the very first time. According to the Ministry, this first edition turned into the largest-ever investment of natural persons in a single security in Croatia's history.

The introduction of government bonds was preceded by a long period of low interest rates in Europe, which did not leave Croatian citizens with much alternative for investing their additional savings. The objective of government bonds is to provide Croatian citizens with access to secure and favourable investments on the capital market, setting the path for them to deposit their savings under more favourable interest rates compared to those provided by commercial banks. In addition, the amount of research done on the topic of government bonds is relatively small if we consider their potential effect on the financial system and the role they currently play in Croatia.

Two assumptions serve as the authors' starting points. The first assumption is that government bonds had a more pronounced effect on changes to interest rates compared to the policies of the European Central Bank (ECB), while the second assumption is that the ECB had a more significant effect on changes to interest rates.

Since citizens still predominantly channel their savings to current account deposits, the Analysis of household sector deposits by counties has shown, as expected, that the deposits of Croatian households increased by 7.3 billion euro in the past

two years (HGK, 2024). Croatian National Bank (CNB, 2024) reports total household deposits reaching 37.6 billion euro, which signifies the importance of investment instruments such as government bonds being available. With the first edition of government bonds collecting 1.85 million euro of citizens' savings, such instruments may attract these funds and provide citizens with safer and more favourable investment opportunities in the context of widespread effects of monetary policies and interest rates dynamics.

Croatian citizens have several other investment alternatives to government bonds at their disposal, such as structured deposits and money market funds. All of these meet the key criteria of availability, low risk and short maturity period with higher potential returns compared to classic saving schemes. In addition to debt instruments, which have lower risk levels than ownership instruments, investors have at their disposal a wide array of instruments through which they can effectively diversify their portfolios. While bond funds offer a more stable return with lower profit potential, equity funds enable diversification and higher returns in the long term but are also more prone to market fluctuations. Investing in real estate, which is a popular instrument among Croatian citizens, provides income from rent and capital growth but requires higher initial investments. Precious metals, such as gold, are also a popular instrument, but they, just like foreign currency savings, are highly volatile and risk-prone.

The paper is structured as follows: the second section provides an overview of empirical and theoretical research on the topic of government bonds and their correlation with trends in interest rates on deposits. Section three describes the methodology used in the research, clarifying the two types of analysis used – principal component analysis and regression analysis, while section four explains data sources and structure. Section five presents the results of the empirical analysis, while the final chapter provides concluding remarks.

## 2 LITERATURE OVERVIEW

Leko and Stojanović (2018) describe government-issued bonds, together with interest rates, yields and trends as one of the indicators of movement and a benchmark of money and capital markets. The stability of the financial and banking system – but of the economy as a whole as well – is indirectly liable to interest rates on government bonds, since benchmark interest rates applied by the state when financing deficits through debt are, as described by ECB (2019) the basis for all kinds of financial contracts. Government bonds, as defined by HANFA (2023), are bonds issued by the Ministry of Finance and intended for direct purchase by small investors, i.e. citizens. Following their initial listing on the Zagreb Stock Exchange, government bonds may be sold and bought at the secondary market.

Even though investors usually rely on generating a desired level of return at an adequate level of risk, Dragić and Lamza (2004) highlight that, in the case of investing in government bonds, investors primarily rely on acquired trust since

government bonds are not secured by collateral. Bond purchaser is motivated by making profit through capital gain and current return, while the total return on government bond is expressed as the return until maturity. The longer the period for which bonds are issued, the higher the risk of change in market value for potential investors, which Orsag (2011) relates to the risk of interest rate changes. During the period of economic uncertainty, investors often prefer the security of government bonds over deposits, which may lead to a rise in interest rates on deposits as means of adapting to changes in demand.

In February 2023, the Republic of Croatia, represented by the Ministry of Finance, published a Public Offer expressing its intention to issue government bonds at a nominal value of 1 billion euro with a fixed annual interest rate of 3.25% minimum, with annual interest payment and one-off repayment of principal amount and 2025 as the maturity period. According to Croatian Government data (2023), by issuing government bonds for the purpose of bond refinancing and paying off due debts, a total of 1.850 billion euro was collected, which is the largest-ever investment of natural persons in a single piece of security. Whereas the first round of government bonds was primarily aimed at citizens, who registered 1.335 billion euro in bonds (Croatian Government, 2023), the second round also provided institutional investors with an opportunity to register bonds, resulting in 515 million euro of bonds registered by legal entities. Research conducted by CNB and HANFA (2023) shows that citizens' affinity toward saving, which is the part of finance with highest public awareness levels, is extremely low and only 51% of citizens (out of 1,000 respondents), are users of at least one form of active saving. The results of this research show that one-third of citizens keep their savings at home or in their wallet while one-sixth deposits them at a savings account; only 1% of citizens decided to invest their money in bonds or fixed-term deposits.

Empirical literature on the effect of government bonds on interest rates on deposits indicates a correlation between the financial instruments above. Various research has studied the way governments act when issuing bonds, which has an effect on bank deposits and, in turn, on many other macro-economic indicators.

Mourão and Stawska (2020) discovered a substantial substitution effect between government bonds and bank deposits in European countries. The authors conclude that, if the volume of bank deposits was to increase by 1%, the significance of bonds in the GDP of the analysed countries would become greater. More specifically, it increases by 0.52%, which is an especially high rate in times of expansion policies. In addition, negative interest rates may endanger depositary preferences of capital and regular investors, which further increases the appeal of government bonds and treasury bills as an alternative instrument (Mourão and Stawska, 2020). The authors also highlight that the zero interest rate (circumstances in which Croatia has found itself for the past couple of years) supports fiscal stimulation as it creates conditions for increasing budgetary deficits with lower borrowing costs. Furthermore, in the course of their research, Mourão and Stawska (2020)

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demonstrated a significant effect of the government's fiscal policies on bank deposits. The results of their analysis suggest that governments that are more dependent on issuing government bonds are able to reduce the appeal of bank deposits as a form of saving.

Grigorian and Manole (2016) also researched the return on government bonds and deposits in Europe, arriving to the conclusion that low interest rates may lead to deposit withdrawals from banks and a surge in demand for more secure government bonds, which can, in turn, further reduce interest rates on deposits. Gennaioli, Martin and Rossi (2018) conducted a similar analysis, in which they explored the relation between banks, government bonds and risks of outstanding commitments, concluding that banks often hold substantial amounts of government bonds, which can act as a stabiliser during economic crises but can also increase the banking sector's exposure to the country's credit risk. This exposure may have an effect on interest rates on deposits offered by banks, especially in situations of higher uncertainty and risk of a country going bankrupt. In addition, Grigorian and Manole (2016) highlight that changes to global economic conditions, such as recessions or financial crises, may affect the dynamics between government bonds and bank deposits.

Banks play a crucial role in transmitting monetary policies, especially in Europe as a bank-centred system. In transition economies, which need to integrate their systems with the European, the primary challenge is understanding the transmission mechanism, including its implementation and application in the financial system at hand (Žigman and Lovrinčević, 2005). Problems in transmitting monetary policies are the result of non-conventional measures prioritising economic growth and causing negative interest rates. These measures were implemented by the European Central Bank, which strives to solve the challenges which complicate the attainment of the defined inflation goals (Fernandez, 2004). Objective limitation to the transmission mechanism of monetary policies in Croatia is derived from reduced monetary sovereignty, followed by an absence of classic transmission mechanisms such as interest rates and credit channels (Žigman and Lovrinčević, 2005).

## 3 METHODOLOGY

Introduced back in 1901 in a paper by Pearson and developed as an independent method by Hotelling in 1933, Principal Components Analysis (PCA) is the oldest and most well-known technique for multivariate data analysis. In the words of Johnson and Wichern (2013), PCA relies on explaining the structure of variances and covariances of a set of variables through several linear combinations of these variables. They also add that PCA serves as an intermediary step in more complex research, which is also the present authors' objective – the result of PCA, i.e. several PC variables will be used in the multivariate linear regression model, in which the number of independent variables depends on the number of components which will be selected for the model, depending on the results.

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Considering the complexity of the financial system and heterogeneity of the analysed countries, the authors have chosen this method in order to simplify the model which would include at least 20 independent variables in the opposite case, i.e. one variable for each euro area member state and one which signifies changes in demand for credits. Furthermore, by reducing the number of independent variables in the regression model through a factorial analysis, we prevent the loss of degrees of freedom and avoid the problem of multicollinearity.

Even though $p$ components are required to reproduce the overall variability of the system, the majority of this variability can often be explained through a smaller number $k$ of principal components. If this is the case, $k$ components contain almost the same amount of information as the original $p$ variables. Therefore, $k$ of principal components can replace the initial $p$ variables, while the original dataset, comprising of $n$ measurements of $p$ variables, is reduced to a dataset comprising of $n$ measurements of $k$ principal components (Johnson and Wichern, 2013).

According to Johnson and Wichern (2013), principal components (PC) are dependent on the correlation matrix $R$, or the co-variation matrix of $\sum$ variables $X_1$, $X_2$,..., $X_p$ Random vector $X' = [X_1, X_2,..., X_p]$ shall contain the covariation matrix $\sum$ with specific values $\lambda_1 \geq \lambda_2 \geq ... \lambda_p \geq 0$. In such a scenario, linear combinations are the following:

$$\begin{aligned} Y_1 &= a'_1 X = a_{11}X_1 + a_{12}X_2 + ... + a_{1p}X_p \\ Y_2 &= a'_2 X = a_{21}X_1 + a_{22}X_2 + ... + a_{2p}X_p \\ &\vdots \\ Y_p &= a'_p X = a_{p1}X_1 + a_{p2}X_2 + ... + a_{pp}X_p \end{aligned} \tag{1}$$

Equation (1) is then transformed into:

$$\begin{aligned} Var(Y_i) &= a'_i \Sigma a_i \qquad i = 1, 2, ..., p \\ Cov(Y_i, Y_k) &= a'_i \Sigma a_k \qquad i, k = 1, 2, ..., p \end{aligned} \tag{2}$$

PCs therefore represent uncorrelated linear combinations $Y_1$, $Y_2$, ... , $Y_p$ whose variances from (2) are maximally possible. The first PC is a linear combination with the highest dispersion (data variance), while the share of explained data variability progressively decreases in PCs that follow it. More precisely, the first PC maximises the expression $Var(Y_i) = a'_i \Sigma a_i$ which can be increased by multiplying $a_1$ with any constant. Furthermore, to eliminate this lack of definitiveness, the authors consider it reliable enough to limit the coefficients to a single-unit length to ensure lack of correlation between principal components and that each component includes the maximum possible variation of original data. From this the following is derived:

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$$\textit{First principal component } (PC_1) = \textit{linear combination of } a'_1 X \textit{ maximising } Var\,(a'_1 X) \textit{ provided that } a'_1 a_1 = 1 \quad (3a)$$

$$\textit{Second principal component } (PC_2) = \textit{linear combination of } a'_2 X \textit{ maximising } Var\,(a'_2 X) \textit{ provided that } a'_2 a_2 = 1 \textit{ and } Cov\,(a'_1 X, a'_2 X) = 0 \quad (3b)$$

and on the $i^{th}$ iteration

$$i^{th} \textit{ principal component } (PC_i) = \textit{linear combination of } a'_i X \textit{ maximising } Var\,(a'_i X) \textit{ provided that } a'_i a_i = 1 \textit{ and } Cov\,(a'_i X, a'_k X) = 0 \textit{ for } k < i \quad (3c)$$

Mishra et al. (2017) argue that having obtained co-variation or correlation matrix, one should calculate eigenvalues and eigenvectors of the matrix concerned, which would be used to analyse the variance PCs. Eigenvalues and eigenvectors provide eigen-decomposition of the matrix, which analyses the matrix structure and is used for discovering the maximum of functions that are present in the matrix, i.e. the maximum variability of original data. This decomposition, or the selection of PCs from equation 3, will be simplified in the form of a Scree plot, which is presented in section 5.

In order to adequately analyse the correlation between interest rates on deposits and the issuance of government bonds, the authors include in the regression model dummy variables which, according to Venkataramana et al. (2016), are used as the classification component that splits the analysed sample into different groups and enables regression analysis to be run for each group separately. Taking into account that the authors' objective is to analyse the effect of government bonds and ECB on the levels of interest rates on deposits in Croatia, the model includes two dummy variables, the definitions of which are explained in the next section.

## 4 DATA

Key data sources include various variables selected for the purpose of PCA, and their outcome will be implemented in the regression model. The earliest data for Croatian interest rates on deposits is available from January 2012, so all data used in the analysis have been collected on a monthly basis and cover the period between January 2012 to July 2024, which is the last month for which data was accessible. In addition, interest rate data is secondary, expressed in relative terms (interest rate amount) and has been taken over from several sources.

Data for Croatia consists of weighted averages of interest rates on fixed-term deposits of households from the consolidated balance sheet of monetary institutions, downloaded from the Croatian National Bank's website. In addition, EURIBOR historical values, which is the benchmark interest rate of the money market, administered by the European Money Markets Institute (EMMI) and which is calculated for several maturities, have been downloaded from the ECB website as the average of

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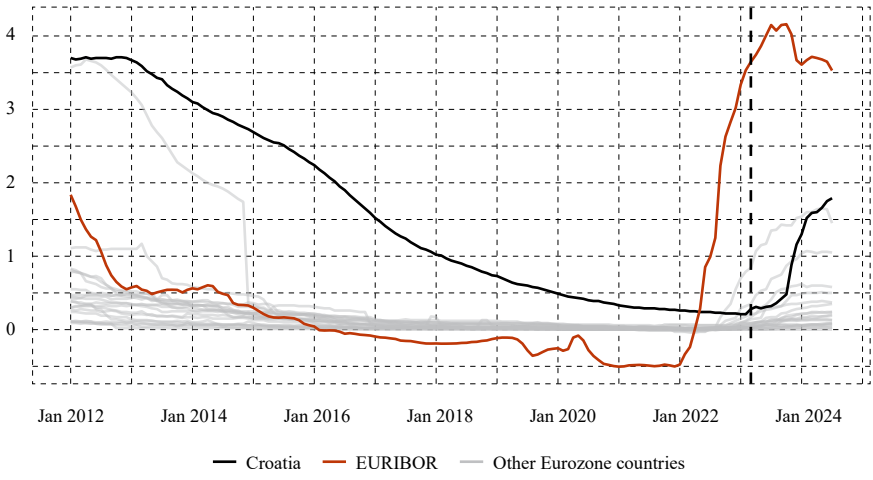
month-long observations for the euro area with variable composition (ECB, 2019). Data for other euro area countries are at the same time variables which will be used in the PCA (Austria, Belgium, Cyprus, Estonia, Finland, France, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Germany, Netherlands, Portugal, Slovenia, Slovakia and Spain). This data was also downloaded from ECB's database and represents interest rates on overnight household deposits on newly contracted deals. Considering that banks had no urge for increasing interest rates for several reasons, such as the high liquidity surpluses as mentioned above and high demand for consumer credits, the authors introduced an additional variable into their model – credit demand. The data for this variable, seasonally adjusted, was also downloaded from the ECB website and represents an annual growth rate of credits issued to households in the euro area compared to the same period in the previous year.

**FIGURE 1**

*Trends in interest rates on deposits (in %)*




*Source: Authors' based on EMMI data.*

EURIBOR and interest rates trends in euro area countries in the period between January 2012 and July 2024 are presented in figure 1. Black line represents Croatia, while red line represents EURIBOR. Lighter shade of grey signifies all other countries. In the period 2012-2016, interest rates on deposits demonstrate a decline for all observed countries, including Croatia and EURIBOR. After 2016, interest rates remain low all the way up to late 2022. In June 2022, ECB announced higher interest rates. This increase spilled over to interest rates in other euro area countries in the following months.

Considering the fact that Croatia became a full member of the euro area on 1 January 2023, interest rates were not expected to rise immediately, while interest rate transfer was delayed by higher liquidity arising from a sudden reduction in minimum reserve. The dotted vertical line represents March 2023, the month

when government bonds were first issued in Croatia. We can see that interest rates in Croatia remained low until this period and cannot disregard the slight increase in interest rates in Croatia in the period following the issuance of government bonds, which became even more substantial a few months later.

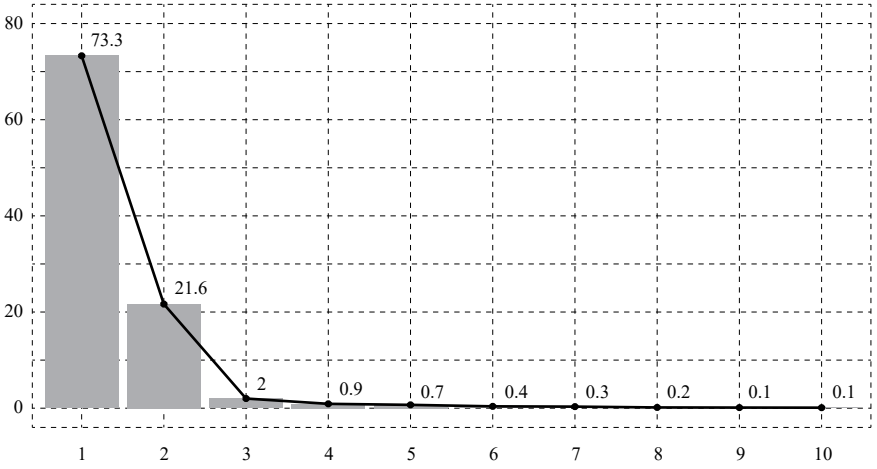
As per Hair et al. (2019), the sample fed into the factor analysis, more specifically principal components analysis, should include at least 100 observations of each variable, with a 5:1 ratio of sample size and number of variables. Since the data covers a period of 151 months and the model defines 22 variables, this condition is considered met. By using the method described above, principal components are selected to represent a linear combination of all original variables derived as orthogonal projections of data to a smaller area. The quantitative analysis of the variables has been run in the RStudio software.

## 5 RESULTS OF EMPIRICAL RESEARCH

The analysis starts out by creating PC variables that include interest rates for individual euro area countries, excluding Croatia. This reduction in data dimensionality has been visualised in the form of a Scree diagram, shown in figure 2, which visualises eigenvalues and enables us to select the number of principal components to be included in further analysis.

**Figure 2**

*Share of explained variance (eigenvalues) of each PC (in %)*




*Source: Authors' based on Eurostat data.*

According to Johnson and Wichern (2013), a Scree plot combines the ordered eigenvalues on the y axis and the number of relevant components on the x axis, sorting them from highest to lowest. The point in which the line bends, the so-called "elbow", represents the final number of components that should be taken into account. It is clear that the first two principal components ($PC_1$ and $PC_2$) explain the largest amount of variability in the data – 94.9% in total – and will

therefore be included in the analysis. Since the remaining components explain for relatively small amounts of variance in the original data on interest rates on deposits in the remaining euro area countries, they are all of similar effect sizes and will not be considered in further analysis.

**Table 1**

*Elements of selected principal components (in %)*

| Country | Share in $PC_1$ | Country | Share in $PC_2$ |
|---|---|---|---|
| Spain | 6.10 | Estonia | 11.55 |
| Italy | 5.99 | Luxembourg | 9.58 |
| France | 5.97 | Lithuania | 7.99 |
| Germany | 5.97 | Austria | 7.37 |
| Slovenia | 5.91 | Greece | 7.00 |

*Source: Authors' calculations.*

Table 1 presents five countries with the highest share selected to represent the principal components. $PC_1$ is more-or-less equally described by countries in the first column, while $PC_2$ is dominated by Estonia, explaining for 11.55% of the share among the countries making up this component. The overall contribution of Luxembourg in $PC_2$ is slightly below 10%, while individual shares of remaining countries are below 8%. Countries such as Spain, Italy, France, Germany and Slovenia have the largest share in $PC_1$, which explains for 73.3% of data variance.

As described above, apart from the principal components $PC_1$ and $PC_2$ as independent variables, the model also includes dummy variables representing specific time periods. The multivariate linear regression model has been set up to analyse the effect of these variables on changes to interest rate levels in Croatia, as represented in the following equation:

$$Croatia_t = \beta_0 + \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 PC_{1t} + \beta_4 PC_{2t} + \beta_5 credits_t + \varepsilon_t \qquad (4a)$$

in which $Croatia_t$ represents the dependent variable – the level of interest rates on deposits in Croatia in the period $t$, $D_{1t}$ and $D_{2t}$ are qualitative (dummy) variables that would be tested through several definitions, $\beta_0$ is the constant, $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$ and $\beta_5$ are regression coefficients assigned to independent variables and $\varepsilon_t$ represents random error. In order to remove the trends and ensure data stationarity, variables $Croatia_t$, $PC_{1t}$ and $PC_{2t}$ were transformed into their first differences, variable $credits_t$ was squared, leading to the final regression equation (4a) expressed in the following form:

$$dCroatia_{i,t} = \beta_0 + \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 dPC_{1t} + \beta_4 dPC_{2t} + \beta_5 credits_t^2 + \varepsilon_{i,t} \qquad (4b)$$

The model has been trained with several different definitions of dummy variables in order to arrive at a more thorough analysis of the issuance of government bonds. These definitions are provided in table 2. For each of the three definitions, $D_2$ acquires the value 1 in the period in which Croatia was a euro area member,

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with $D_1$ defined differently in order to analyse the effect of government bonds: (1) throughout the period following their issuance – long-term effect, (2) at the time of issuance – immediate effect, and (3) with a delayed effect following Hrvatska poštanska banka (HPB) announcement regarding higher interest rates – additional state intervention.

**Table 2**
*Definitions of dummy variables*

| | $D_1$ (government bonds) | $D_2$ (ECB) |
|---|---|---|
| Model 1 | 3/2023-7/2024 | 1/2023-7/2024 |
| Model 2 | 3/2023 | 1/2023-7/2024 |
| Model 3 | 10/2023 | 1/2023-7/2024 |

*Note: Table columns represent periods (month/year) in which each dummy variable in the model assumes the value 1 (implying the value 0 in all other columns).*

*Source: Authors' own specification.*

Table 3 shows the results of the regression models for the definitions of dummy variables presented above. We can see that the first dummy variable ($D_1$) is statistically significant only in Model 1, which indicates a potential long-term effect of government bonds on interest rates in Croatia. Furthermore, beta coefficient in this model is higher for $D_1$ than it is for $D_2$, which implies a relatively stronger effect in comparison to ECB, a variable that is not statistically significant at standard significance levels. On the other hand, in the remaining two models $D_2$ reaches statistical significance only at 1% significance level. The variable "credits" has a statistically significant positive effect on interest rates trends in Croatia in all three models, which was the assumption since a rise in demand for loans leads to a rise in the price of money, i.e. interest rates. In addition, $PC_1$ is not significant in either of the models, which means that changes in interest rates in countries such as Spain, Italy, France, Germany and Slovenia do not affect interest rate trends in Croatia. On the other hand, $PC_2$ is statistically significant (but with a negative effect) in the analysed models at 5% significance level. This can be attributed to the fact that the economies of countries making up $PC_2$ (Luxembourg, Austria, Estonia, Lithuania and Greece) are more similar to Croatia's economy than are the economies of $PC_1$ countries.

**Table 3**
*Results of the regression analysis*

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **p-value** | **Coefficient** | **p-value** | **Coefficient** | **p-value** |
| constant | -0.039 | 0.000*** | -0.037 | 0.000*** | -0.037 | 0.000*** |
| $D_1$ | 0.106 | 0.001*** | -0.020 | 0.646 | 0.002 | 0.962 |
| $D_2$ | 0.044 | 0.166 | 0.140 | 0.000*** | 0.139 | 0.000*** |
| $PC_1$ | -0.007 | 0.756 | -0.008 | 0.746 | -0.007 | 0.769 |
| $PC_2$ | -0.057 | 0.017** | -0.062 | 0.012** | -0.062 | 0.013** |
| credits | 0.002 | 0.010** | 0.001 | 0.038** | 0.001 | 0.042** |

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

*Source: Authors' calculations.*

When we consider the results above, we can conclude that government bonds have a statistically significant effect on the increase in interest rates on deposits in Croatia if observed in the long term ($D_1$ assumes the value 1 throughout the period following the issuance). However, in this very same model ECB has no statistically significant effect on interest rates. If the effect of bonds is observed as an immediate effect (Model 2), then the bonds will have no statistically significant effect, while the effect of ECB is positive and statistically significant. In addition, if we take into consideration the initial response of HPB (bank whose majority shareholder is the state) to the Government's appeal to increase interest rates in October 2023, followed by increases in other banks, in this case the issuance of bonds has no statistically significant effect on interest rate trends.

**Table 4**

*Verification of model robustness – model without PCs*

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **p-value** | **Coefficient** | **p-value** | **Coefficient** | **p-value** |
| constant | -0.077 | 0.000*** | -0.078 | 0.000*** | -0.078 | 0.000*** |
| $D_1$ | 0.100 | 0.001*** | -0.009 | 0.820 | -0.025 | 0.539 |
| $D_2$ | 0.012 | 0.664 | 0.100 | 0.000*** | 0.100 | 0.000*** |
| euro area | 0.167 | 0.000*** | 0.178 | 0.000*** | 0.180 | 0.000*** |
| credits | 0.004 | 0.000*** | 0.004 | 0.000*** | 0.004 | 0.000*** |

*Note: *** p<0.01, **p<0.05, *p<0.1.*

*Source: Authors' calculations.*

In order to test the model robustness, the model replaced PCA with euro area as the independent variable coding for EURIBOR rates downloaded from ECB website. The results provided in table 4 are similar to data in table 3, where $D_1$ is significant only in Model 1, $D_2$ is significant in Models 2 and 3, while the variables "credit" and "euro area" are significant in all three models.

## 6 CONCLUSION

Even though government securities are primarily intended for meeting fiscal policy objectives, the issuance of government bonds to the Croatian capital market has shown that their use is much wider than just collecting funds for financing budget deficits with relatively low interest rates. Specifically channelling government bonds toward small and conservative investors enables citizens to invest securely with favourable interest rates, which stimulates financial involvement and expands the pool of investors.

With Croatia joining the euro area, the previously limited transmission mechanism of interest rates should now have a more substantial effect on bank behaviour. However, since Croatia joined the euro zone fairly recently, delays and obstacles in its functioning are possible.

The combination of PCA and regression analysis was done in order to test the correlation of the issuance of government bonds on interest rates on deposits. As shown in the Scree diagram, the first two principal components were selected because they explain almost 95% of overall variation in data, which suggests that these two components are significant for describing changes to interest rates on deposits in Croatia. Regression models were tested by means of several definitions of dummy variables: $D_2$ takes the value of 1 during Croatia's euro zone membership, while $D_1$ analyses the effect of bonds through three definitions: long-term effect since issuance, immediate effect upon issuance, and delayed effect after seven months, when HPB announced higher interest rates. Regression analysis results indicate statistical significance of the issuance of government bonds only in Model 1, in which ECB's effect is non-significant. Furthermore, the remaining two models indicate a statistically significant effect of ECB on interest rate trends in Croatia but also a non-significant effect of government bonds.

Considering that the government is the majority shareholder in HPB, we can assume that this intervention was aimed at enhancing the effect of government bonds, which further explains their correlation with the increase of interest rates. All the results above indicate how complex the financial system is, in which phenomena such as government bonds have mixed results, depending on which of the tested models is being considered. Model 1 confirms the authors' hypothesis that government bonds have a relatively larger effect on interest rates in relation to ECB, whereas in Models 2 and 3 the opposite is the case – by increasing its interest rates, ECB had a greater effect on interest rates in Croatia than government bonds.

The results of the empirical research indicate a complex dynamics between fiscal policy (issuing government bonds) and monetary policy (interest rate trends) as well as the role of government institutions in regulating the financial market. All of the above, together with the results of the analysis, leave room for future research. Recommendations for future research pertain primarily to the need to study in more detail the causal effect of the issuance of government bonds on trends in interest rates, primarily by expanding the timeframe of the analysis, in order to estimate the long-term effect of government bonds but also the potential delayed effects that have not been recorded in the observed period.

**Disclosure statement**

Authors have no conflict of interest to declare.

## REFERENCES

1. CNB and HANFA, 2023. *Mjerenje financijske pismenosti i financijske uključenosti u Hrvatskoj.* Zagreb: Croatian Financial Services Supervisory Agency; Croatian National Bank.
2. CNB, 2024. *Objava statističkih podataka o depozitima i kreditima kreditnih institucija za lipanj 2024. godine*. Zagreb: Croatian National Bank.
3. Croatian Government, 2023. *Državne obveznice uvrštene na burzu. Velik odaziv poruka je povjerenja građana.* Zagreb.
4. Dragić, K. and Lamza, D., 2004. Determinante dizajniranja domaćeg tržišta državnih vrijednosnica. *Ekonomski pregled*, 55(11-12), pp. 967-1001.
5. ECB, 2019. *What are benchmark rates?* Frankfurt am Main: European Central Bank.
6. ECB, 2022. *Statement by Philip R. Lane, Member of the Executive Board of the ECB, at the G7 Finance Ministers and Central Bank Governors Meeting.* Frankfurt am Main: European Central Bank.
7. Fernández, J. A., 2024. Banking systems in the euro zone and transmission of monetary policy. *Central Bank Review*, 24(1), 100148. https://doi.org/10.1016/j.cbrev.2024.100148
8. Gennaioli, N., Martin, A and Rossi, S., 2018. Banks, Government Bonds and Default: What do the data Say? *Journal of Monetary Economics*, 98, pp. 98-113. https://doi.org/10.1016/j.jmoneco.2018.04.011
9. Grigorian, D. and Manole, V., 2016. Sovereign risk and deposit dynamics: evidence from Europe. *Applied Economics,* 49(29), pp. 2851-2860. https://doi.org/10.1080/00036846.2016.1248358
10. Hair, J. F. [et al.], 2019. *Multivariate Data Analysis*. London: Pearson Prentice.
11. HANFA, 2023. *Edukacija: Što je obveznica?* Zagreb: Croatian Financial Services Supervisory Agency.
12. HGK, 2024. *Depoziti hrvatskih kućanstava u dvije godine porasli za 7,3 milijarde eura*. Zagreb: Croatian Chamber of Commerce.
13. Hotelling, H., 1933. Analysis of a complex of statistical variables into principal components. *Journal of Educational Psychology,* 24(6), pp. 417-441. https://doi.org/10.1037/h0071325
14. Johnson, R. A. and Wichern, D. W., 2013. *Applied Multivariate Statistical Analysis: Pearson New International Edition.* London: Pearson Education.
15. Leko, V. and Stojanović, A., 2018. *Financijske institucije i tržišta.* Zagreb: Faculty of Economics and Business.
16. Mishra, S. [et al.], 2017. Multivariate Statistical Data Analysis – Principal Component Analysis. *International Journal of Livestock Research*, 7(5), pp. 60-78.
17. Mourao, P. R. and Stawska, J. M., 2020. Governments as bankers – how European bonds have substituted bank deposits. *Applied Economics,* 52(42), pp. 4605-4620. https://doi.org/10.1080/00036846.2020.1738328
18. Orsag, S., 2011. *Vrijednosni papiri: Investicije i instrumenti financiranja*. Sarajevo: Revicon.

19. Pearson, K., 1901. LIII. On lines and planes of closest fit to systems of points in space. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 2(11), 559-572. https://doi.org/10.1080/14786440109462720
20. Venkataramana, M. [et al.], 2016. Regression Analysis with Categorical Variables. *International Journal of Statistics and Systems*, 11(2), pp. 135-143.
21. Žigman, A. and Lovrinčević, Ž., 2005. Monetarna politika ciljane inflacije i transmisijski mehanizam. *Ekonomski pregled*, 56 (7-8), pp. 433-457.