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Pricing Analysis of Russian Mortgage-Backed Securities

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ABSTRACT

The rapid growth of the mortgage lending market in recent years has resulted in an increase in the issuance of mortgage bonds, which, on the one hand, represent an object of investment and, on the other hand, a source of funding for the banking sector. In 2023, the total volume of mortgage lending in Russia reached 4 trillion rubles, an increase of 25% compared to the previous year. The experience of financial engineering that led to the mortgage crisis in 2008 in the USA, the high volatility of the Russian stock market and the Bank of Russia rates that reached 21% in 2024 have **actualized** the study of securitization risks. The **purpose** of this study is to identify the key factors affecting the price of Russian mortgage bonds. The least squares **method** was used to create a model based on significant indicators: the ratio of outstanding liabilities to the estimated total liabilities; the proportion of overdue loans, weighted by outstanding debt; the spread between the pooled loan rate, weighted by the volume of outstanding debt, and the weighted average mortgage rate; the spread between the yield on mortgage bonds and the yield on 10-year government bonds. **The results** obtained led to the conclusion that these factors significantly affect the pricing of MBS and can be utilized by investors and the regulators to more accurately forecast prices for mortgage bonds.

Keywords: mortgage-backed securities; mortgage lending; securitization; mortgage; mortgage assets; valuation of securities

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INTRODUCTION

The significant consequences of the 2008 mortgage crisis in the United States for the global economy for many years have set the task of determining the factors influencing the formation of prices and yields of mortgage-backed securities in order to prevent new such shocks. The boom in mortgage lending in Russia over the past decade (the bank's portfolio grew by 30.1% in 2023 and reached 18.0 trillion rubles) has led to the development of securitization, which carries the risks of such a crisis. Determining the factors influencing the price and profitability of Russian mortgage-backed securities is an urgent research topic, but it is still poorly understood. There are especially few empirical studies, which creates the need to continue the discussion on the specifics of mortgage bond pricing and, in particular, to solve the following tasks:

1. To build a pricing model for mortgage bonds;
2. To rank the factors according to the degree of influence on the change in the price of mortgage bonds;
3. To evaluate the possibility of forecasting mortgage bond prices.

The results of the study will help reduce the risks of a potential mortgage crisis, increase the predictability of bond prices and supplement the analytical base for the development of securitization.

ANALYSIS OF CREDIT MARKETS AND MORTGAGE SECURITIZATION

The Russian mortgage lending market grew actively in 2019–2023, which was mainly caused by the implementation of mortgage programs with a government-subsidized rate: family (2018), preferential for new buildings (2020), Far Eastern (2019), mortgage program for IT specialists (2022). The share of these programs in disbursements in 2022 and 2023

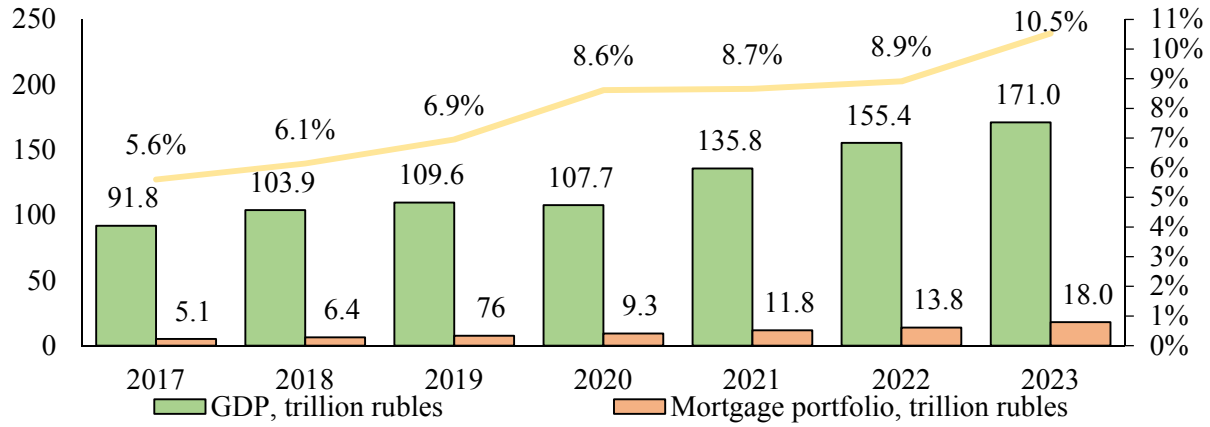

Fig. 1. **Dynamics of Russia's GDP and Mortgage Portfolio for 2017–2023, Trillion Rubles**

Source: Compiled by the authors based on the data of the Bank of Russia and the Federal State Statistics Service. URL: https://rosstat.gov.ru/statistics/accounts (accessed on 18.09.2024).

amounted to 46% and 63%, respectively.[1] There is also an increase in the share of the mortgage portfolio (debt) in GDP, over 5 years the indicator has increased to 8.9% (in 2017–5.6%). The mortgage portfolio grew by an average of 21.4% annually (*Fig. 1*).

As the share of subsidized programs in disbursements has increased, the difference between the weighted average mortgage rate and the central bank's key rate has become negative. This demonstrates the importance of subsidizing rates in the growth of mortgage lending and, most importantly, in lowering the cost of credit for borrowers (*Fig. 2*).

However, the growth of mortgage lending slowed down due to restrictions introduced at the end of 2023: a reduction in the loan principal amount for a preferential mortgage on new buildings from 12 million rubles to 6 million rubles. for Moscow, St. Petersburg and the regions (the share of their disbursements in 2023 was 26%), as well as an increase in the down payment from 20% to 30%).[2] In July 2024, preferential mortgages for new buildings ended and restrictions on family mortgages were introduced, therefore, the majority of borrowers will be able to take out mortgages at market rates. Given the high key interest rate, the issue of reducing market mortgage rates is even more acute [1, 2]. Mortgage-backed securities that bridge the liquidity gap between the loan being issued and its sources of financing can help [3, 4]. Mortgage-backed securities in Russia are represented by bonds, the fulfillment of obligations under which is secured by mortgage collateral, that is, payments on them are secured by repayment of mortgage loans.

Despite the fact that the first issue of mortgage-backed securities was back in 2006 (ISIN: XS0254447872; XS0254451395; XS0254451551), significant volumes of issues occurred in 2013–2014.[3] Starting from 2017–2018, the mortgage securitization market has shown rapid growth, which is primarily caused by an increase in lending volumes and the development of legislation in the field of mortgage securitization (*Fig. 3*) [5].

The issues of mortgage-backed bonds guaranteed by DOM.RF JSC are used as the statistical basis for the study, as they currently account for more than 98% of the total volume of mortgage-backed securities in circulation.

[1] Indicators of the housing (mortgage housing) lending market. URL: https://www.cbr.ru/statistics/bank_sector/mortgage (accessed on 18.09.2024).

[2] In Russia, the conditions of preferential mortgages have been tightened. What does it mean? URL: https://realty.rbc.ru/news/6580675d9a79471247092 (accessed on 18.09. 2024).

[3] Cbonds information portal. URL: https://cbonds.ru (accessed on 18.09.2024).

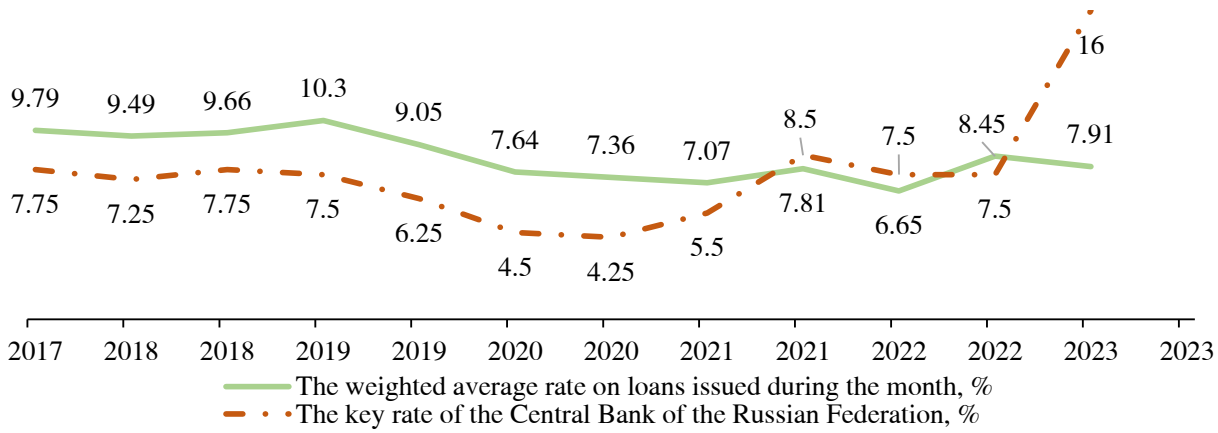

Fig. 2. **Dynamics of Weighted Average Mortgage Rate and Key Rate of the Bank of Russia for 2017–2023, %**

Source: Compiled by the authors based on the data of the Bank of Russia.

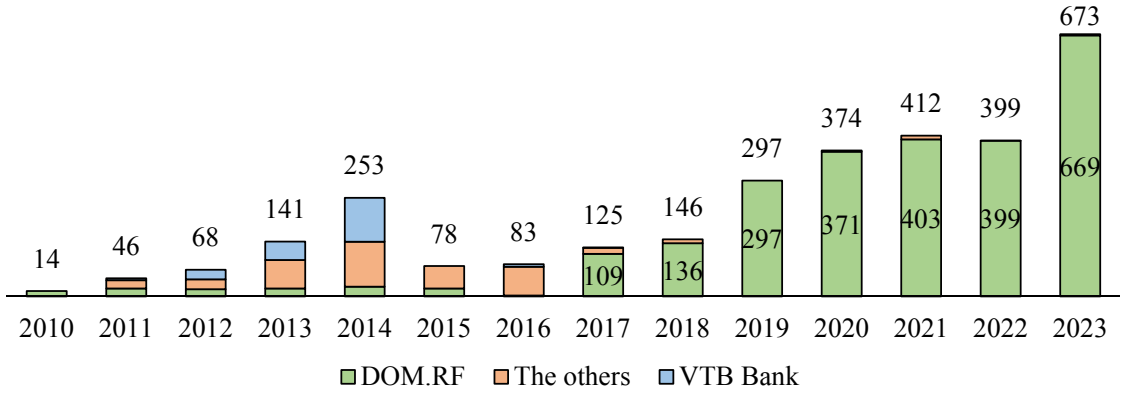

Fig. 3. **The Dynamics of Mortgage-Backed Security Issuance by Major Issuers in Russia from 2010 to 2023, in Billion Rubles**

Source: Compiled by the authors based on the data of Cbonds.

LITERATURE REVIEW

Our scientific contribution to the existing work of economists is related to the study of mortgage-backed securities pricing in Russia. Quite a lot of research has been devoted to the study of models for determining the profitability of mortgage-backed securities abroad, and models for determining the value of mortgage-backed securities that rely on the embedded options method are also widely considered. This method determines the risk of early repayment and the risk of a loan going into arrears (mortgage default) as the main risk factors for mortgage-backed securities. The main works on this topic are the scientific works of the authors K.B. Dunn and J.J. McConnell [6], G. Marcato and G.A. Tira [7]. It can be noted that the embedded options method used in the K.B. Dunn and J.J. McConnell model contains fewer factors that can affect the coupon yield of mortgage-backed securities and, as a result, their price. The article by G. Marcato and G.A. Tira, devoted to determining the factors influencing the spread of commercial mortgage bonds (CMBS) during initial placement, provides the following model:

$$Spread = Interc + \sum_{j=1}^{n} Bond_j + \sum_{i=1}^{m} Mortgage_i + \sum_{k=1}^{p} Real\ Estate_k + \sum_{l=1}^{r} Multinational_l. \quad (1)$$

The spread is represented as a logarithmic function, so the authors of the model transform the value using an exponential function. Each regressor of the model consists of several more variables, and the structure of each regressor is described below:

1) *Bond* (bond parameters): coupon variable (floating/constant), bond tranche rating, type of issuer (bank/non-bank), total market value of mortgage coverage, difference between long-term and short-term rates, weighted average maturity of the bond;

2) *Mortgage* (mortgage factors): the yield on mortgage loans, expressed as the spread of the loan rate over the yield curve; the size of the mortgage market, which is measured as the total amount of mortgage loans issued in the market;

3) *Real Estate* (factors affecting real estate): The percentage change in market rents with different time lags is considered; market liquidity indicators such as turnover and net investment are also used;

4) *Multinational* (parameters of issuers and markets): comparison of the liquidity of the markets of the studied countries through dummy variables (Great Britain, Ireland, Germany, etc.), country concentration of asset portfolios, listing of companies in the UK (as the most liquid market in Europe, according to G. Marcato and G.A. Tira).

The article by N. Wallace examines the effectiveness of using the credit default swaps index for a basket of mortgage bonds as a benchmark for the issuance of the MBS portfolio [8]. The author includes the following indicators in the regression model:

1) Changes in delay rates (30, 60 and 90 days);

2) Changing the default rate;

3) S&P returns;

4) Profitability of investments in real estate;

5) Price changes for 10-year Treasury bonds.

A study prepared by M. Goswami, A. Jobst and X. Long analyzes some macro-financial links of securitization [9]. In particular, they consider the impact of securitization on the effectiveness of monetary policy and the transfer of interest rates to the real economy. The authors found that securitization weakened the elasticity of the interest rate of real output through the balance sheet channel (while reducing the transfer of the interest rate from policy rates to market rates).

In their model, the authors used the average effective Federal Reserve rate over the past four quarters, the average inflation rate, and the share of securitized mortgage loans in total mortgage volume. They also used the financing ratio, which reflects the change in direct financing compared to indirect financing (through bank loans to the non-financial sector). The authors used the credit growth indicator, which is the natural logarithm of the ratio of private sector loans to GDP, to measure the growth of aggregate demand. The paper "The Macroeconomic Risk of Prepayment and the Valuation of Mortgage-Backed Bonds" examines factors that influence the early repayment of mortgage-backed securities [10]. The authors conclude that the implied prepayment rates significantly exceed the actual prepayment rates, which results in a significant premium for the risk of early repayment in the price of MBS. To analyze the CPR (credit protection risk), the authors use data on mortgage-backed securities with different coupon rates on the TBA (to-be-announced) market.

When modeling the MBS price, the potential difference between the Treasury bond rate and the discount rate for the estimated cash flows is considered. The researchers found that cash flows from MBS are discounted at an average rate of 72 basis points higher than cash flows from Treasury bonds. This spread varies over time and is closely linked to the credit spread between Fannie Mae mortgage agency bonds and Treasury bonds. In addition to the monthly change in the credit spread, the researchers include in the model: a change in the amount of mortgage-backed securities held by dealers, a change in the REPO rate for collateral, net issuance of foreign currency, and

the proportion of foreign currency purchases by the Federal Reserve to total net issuance.

As another factor influencing the price of mortgage bonds, the authors consider the "turnover rate". This rate contains indicators that reflect the degree of financial difficulties in the mortgage markets and the state of the macroeconomy. The authors use changes in the levels of mortgage delinquency and foreclosure as indicators of financial difficulties. They also use macroeconomic indicators such as the growth rate of consumer spending and changes in the unemployment rate to assess the overall economic health. Additionally, they include variables that may reflect the welfare and consumption incentives of mortgage borrowers, such as profitability indicators for the Barclays aggregate bond index and the CRSP index.

The "response rate" (reaction rate) is also used as the main factor, reflecting the difficulties faced by the borrower when refinancing the loan. Among the variables of this factor, the change in the average loan-to-value ratio of the mortgage loan facility (LTV) is used, the decrease of which implies a tightening of mortgage lending by lenders. Along with this, a change in the total amount of outstanding non-mortgage consumer loans is included, which may reflect a change in fundamental factors of credit availability for borrowers. In his work, O.A. Obrimah explores the impact of providing liquidity on the prices of securities [11]. The author examines the price effects of the provision of liquidity by the mortgage agency Fannie Mae in the secondary market of mortgage securities. The author cites as elements of the theoretical profitability of MBS: prepayment, reinvestment, liquidity, financing, and repayment risk spreads relative to a certain benchmark. O.A. Obrimah explores the risk measure specific to MBS in order to obtain so-called option-adjusted spreads. The author examines the influence of dealers in the secondary market of MBS, as the main factors he identifies the volume of mortgage bonds on the balance sheet, the ratio of portfolio size to the volume of securities in circulation and the volume of trade turnover. O.A. Obrimah concludes that the presence of dealers in the secondary market of securities reduces prices, reduces transaction costs and risk premiums ITB. Several key works have been devoted to the securitization of mortgage-backed securities in Russia, some of them describe the problems of the development of this market, and others represent empirical research.

The NCB Pricing Center of NSD JSC has developed a methodology for determining the value of mortgage-backed securities (mortgage bonds) [12]. According to this methodology, the fair value of mortgage bonds can be calculated based on three approaches (depending on the initial data):

1) Market price method (using transaction information);

2) Index extrapolation method (using calculation of future payment flows);

3) The method of factor decomposition of the price (using factors characterizing the general bond market conditions).

Let's take a closer look at the calculation of future payment flows. To do this, the annuity income stream is first determined, and the interest rate for all mortgages, weighted by the amount of the principal debt, is used on an annual basis.

The share of early repayment of mortgages is also calculated using the formula:

$$SMMj = \frac{U_j}{B_j - F_j}, \quad (2)$$

where j — number of published mortgage coverage registers, month before the estimation date; U_j — is the difference between the actual and planned repayment of the principal amount (early repayment); B_j — outstanding amount of the principal debt; F_j — scheduled repayment of the principal debt.

Based on this, the annual early repayment rate (CPR) is calculated:

$$CPR_j = 1 - \left(1 - SMM_j\right)^{12}. \quad (3)$$

The mortgage default rate (*CDR j*) is calculated as follows:

$$CDR_j = 1 - (1 - \frac{D_j}{B_j - F_j})^{12}, \quad (4)$$

where D_j —is the amount of the principal debt on the mortgage that has defaulted.

The article by T.V. Teplova, T.V. Sokolova and K.V. Galenskaya examines the drivers and brakes of the development of corporate bond markets, especially bonds issued in national currencies (CBNC) [13]. The authors constructed a model of the dependence of the share of CBNC in the total volume of new placements and the logarithm [1 + CBNC volume (% of GDP)]. It depends on two groups of factors: macroeconomic and institutional. The following macroeconomic factors were used:

1) The logarithm of market capitalization;

2) The change in the exchange rate of the national currency for the current quarter,%;

3) The volume of mutual fund assets to GDP,%;

4) The volume of pension fund assets as a percentage of GDP,%;

5) Real GDP growth rate in the current quarter (YoY,%);

6) The rate of inflation growth (monthly average in the current quarter);

7) Inflation stability (the difference between the values for the current and the previous quarter).

As a result, the authors conclude that the depreciation of the national currency and the acceleration of inflation have a positive impact on the market. At the same time, the sign for variable capitalization of stocks is negative, which can be explained by the substitution effect in emerging markets.

N.V. Popova's articles consider the parameters of bonds and their relationship to the main risks associated with this type of security: credit risk and interest rate risk. The author uses the coupon yield rate, the frequency of coupon payment, the level of market rates, the maturity, as well as changes in the bond price as factors that determine the interest rate risk, as well as the degree of its change depending on the selected bond parameters. The research results have shown that bonds with shorter maturity dates and more frequent coupon payment periods have lower interest rate risk. Reducing interest rate risk due to these parameters of bond loans can attract investors even in times of instability and crisis [14–16].

The article by N.E. Annenskaya and P.K. Dymochkin explores the issue of forecasting early repayment (CPR) on mortgage bonds [17]. The authors use the data clustering method to eliminate the problem of heterogeneity of pools and improve estimates of CPR model parameters. They chose the logistic regression model as their model and used the maximum likelihood method. The regressors in the model were:

1) The ratio of loan size to property value (LTV);

2) The spread between the loan rate (the contract rate) and the market mortgage rates;

3) The "age" of the loan;

4) The ratio of the monthly payment to the total amount owed;

5) The ratio of interest paid to accrued;

6) The ratio of the paid part of the debt to its initial amount.

The results of the study showed that the ROC-AUC method is effectively used to assess the quality of clustering pools of mortgage loans securing mortgage bonds. This, in turn, helps to increase the accuracy of forecasting the dynamics of early repayment of mortgage loans.

The article by D.A. Aksakov "Modeling long-term repayment of the principal debt on mortgage-backed securities" provides the main reasons for early repayment of debt [18]:

1) Change of residence;

2) Default;

3) Refinancing.

The author highlights refinancing as the main element in early returns, although he notes the most variable nature of this element.

The paper highlights several key factors influencing early returns:

1) Interest rate levels;

2) Age of the loan;

3) Depletion effect (the level of early repayments decreases with gradual decreases and increases in interest rates);

4) Seasonality;

5) The unemployment rate;

6) Price dynamics in the housing market.

The author uses these factors to analyze early repayment of principal on mortgage-backed securities issued by U.S. government mortgage agencies. The article by S.V. Shautin presents an empirical study, the purpose of which is to build a risk factor model of the spread of mortgage-backed securities during placement [19].

$$TRP = \alpha \cdot MRP + \beta \cdot CRP + \gamma \cdot CCY + \delta \cdot Pool\ Excess + \\ + \zeta \cdot ExcessiveSpread + \eta \cdot LTV + \theta \cdot NPL30 + \iota \cdot CPR + \\ + \kappa \cdot MAX\ 20 + \lambda \cdot REGION + \mu \cdot AHML + \nu \cdot VTB + \\ + \xi \cdot Delta + o \cdot Zhilfinance + \pi \cdot SPV + \rho \cdot Foreign + \\ + \tau \cdot Overcollateralization + \upsilon \cdot Structure + \varepsilon. \quad (5)$$

The factors in the model are: the total spread of MBS, premiums for systematic risk of MBS, country risk, currency risk, excess pool risk, the amount of debt/collateral value, the share of overdue payments, the rate of early repayment, the share of the 20 largest borrowers, the number of regions of residence of borrowers, originators, balance sheet/ off-balance sheet transaction, the share of the tranche in the issue.

Analyzing the above studies, the authors have identified the main factors (in addition to the loan going into arrears and early repayment) that may affect the price of MBS:

1) The ratio of the amount owed to the value of the collateral;

2) The proportion of loans with overdue payments of 30 days or more;

3) The rate of early repayment of the pool;

4) The number of regions where borrowers live;

5) The level of real incomes of the population in the borrower's region of residence;

6) The unemployment rate in the borrower's region of residence;

7) Housing market price index.

According to the authors, the spread between the yield on mortgage bonds and the yield on ten-year government bonds during the observation period for each month, as well as the yield on the most liquid corporate bonds, can be considered as one of the additional factors.

In general, the development of the mortgage securities market in Russia and the identification of factors affecting their price and profitability are still poorly understood today. There is especially little empirical research on this topic, which makes it possible to continue the discussion on the specifics of mortgage bond pricing in Russia.

The authors also adhere to the position that the level of development of the stock market has a positive effect on economic growth. The position of the authors corresponds to the research results obtained in the article by E.A. Fedorova, S.O. Musienko, D.O. Afanasyev [20]. The current level of the key interest rate and the development of the bond market set the task of improving valuations of mortgage-backed securities and increasing the liquidity of this market, including for effective pricing of these securities.

ECONOMETRIC PRICING MODEL FOR MORTGAGE BONDS

The authors propose a model of the factors of the price of securities, based on the previously mentioned works describing the issue of bonds, the risks of issuing mortgage bonds, and the modeling of the CPR indicator. The following mortgage bonds were selected as analyzed.[4, 5]

1) "Mortgage Agent DOM 1P16" (IADOM 1P16, RU 000A104B 79), issued at the end of

[4] Mortgage bonds guaranteed by DOM.RF. URL: https://ицб.дом.рф/bonds/mbs/domrf / (accessed on 18.09.2024).

[5] Trading results on the Moscow Stock Exchange. URL: https://www.moex.com/ru/marketdata (accessed on 18.09.2024).

2021 for 10 years, secured by 101.6 thousand loans, coupon rate — 7.65%;

2) "Mortgage Agent DOM 1P4" (IADOM B 1P4, RU 000A102K13), issued at the end of 2020 for 30.5 years, secured by 123.0 thousand loans, coupon rate — 7.90%.

According to the initial logical assumption, the ratio of the amount of outstanding obligations to the total amount of obligations has the main effect on the price of MBS, since this is the basis for payments on mortgage bonds. It is assumed that the spread between the loan origination rate and the current market rate is a significant amount, since borrowers can refinance the loan, thereby their loans will leave the pool, and the price of MBS will decrease. The authors also hypothesize that the spread between the yield of the MBS and deposit rates will not be a significant factor affecting the price of the MBS. This is due to the fact that mortgage bondholders are focused on long-term investments, and in recent years, Russia has seen significant fluctuations in the Bank of Russia's deposit rate due to the COVID-19 pandemic and Western sanctions, which has led to a predominance of short-term bank deposits of the population. Based on the above information, the following parameters were selected as factors influencing the price of mortgage bonds:

1) The ratio of the amount of outstanding obligations to the estimated total amount of obligations;

2) The spread between the loan rate included in the pool and weighted by the amount of outstanding debt, and the weighted average mortgage rate issued for the current month (a condition was introduced under which a negative spread was not taken into account);

3) The share of loans with overdue debts, weighted by the volume of outstanding debt;

4) The share of mortgage payments from the average per capita income in the region where the loan was issued (it can be replaced with an indicator that contains the average income minus the cost of living);

5) The spread between the yield on mortgage bonds and the yield on ten-year government bonds;[6]

6) The spread between the yield of mortgage bonds and the maximum deposit rate of ten credit institutions that attract the largest volume of deposits from individuals.[7]

For the analysis, monthly figures were taken from March 2022 to December 2023, the size of the initial sample was $n_{и} = 33$ (some of the data in the sample was missing, as there might not have been transactions in the reporting periods, so they were excluded from the sample). *Table 1* shows the variables and their designations, as well as statistical characteristics.

During the construction of the econometric model of multiple regression (least squares method), the following parameters turned out to be significant factors (*Table 2*):

1) The ratio of the amount of outstanding obligations to the estimated total amount of obligations;

2) The share of loans with overdue debts, weighted by the volume of outstanding debt;

3) The spread between the loan rate included in the pool and weighted by the amount of outstanding debt, and the weighted average mortgage rate issued for the current month;

4) The spread between the yield on mortgage bonds and the yield on 10-year government bonds (based on the yield on the DOMMBSCP and RUGBITR 10Y indices).[8]

$$t_{crit.} = \text{T.INV.2T}(0.05; 27) = 2.05. \qquad (6)$$

All regressors with $t_{obs.}$ greater than $t_{crit.}$ are 95% likely to be significant. Based on the above conditions, a model specification was obtained, which is a linear multiple regression equation:

[6] DOM RF Mortgage Bond Index. URL: https://www.moex.com/ru/index/DOMMBSCP (accessed on 18.09.2024).

[7] Dynamics of the maximum interest rate (on deposits in Russian rubles) of ten credit institutions attracting the largest volume of deposits from individuals. URL: https://cbr.ru/statistics/avgprocstav (accessed on 18.09.2024).

[8] RUGBITR 10Y Government bond index. URL: https://www.moex.com/ru/index/RUGBITR 10Y (accessed on 18.09.2024).

Table 1

The Set of Variables of the Initial Sample and Their Statistical Indicators

Variable	Name	Dimension	mean*	s.d.**	min	max
Bond price (dependent variable)	P	ratio	92.25	6.76	87.70	96.80
The ratio of the amount of outstanding obligations to the estimated total amount of obligations	OD	ratio	0.65	0.00	0.57	0.73
The share of loans with overdue debts, weighted by the volume of outstanding debt	NPL	ratio	0.01	0.00	0.01	0.02
The spread between the loan rate included in the pool and weighted by the amount of outstanding debt, and the weighted average mortgage rate issued for the current month	CrS	p.p.***	1.74	0.80	0.36	3.12
The share of mortgage payments from the average per capita income	Ex	ratio	0.44	0.00	0.35	0.53
The spread between the yield on mortgage bonds and the yield on ten-year government bonds	GY	p.p.***	–2.25	5.45	–8.59	4.09
The spread between the yield of mortgage bonds and the maximum deposit rate of ten credit institutions that attract the largest volume of deposits from individuals	DY	p.p.***	–3.69	27.39	–14.43	7.05

Source: Authors' calculations.

Note: * — mean-average value; **s.d. — standard deviation; *** — percentage points.

Table 2

Coefficient Indices for Regressors, Their Standard Errors and *t*-observed

Indicator	Od_t	NPL_t	CrS_t	Ex_t	GY_t	DY_t
Coefficient for regressor (ā)	126.45	1573.26	–2.09	–18.48	0.60	–0.09
The standard error (Sā)	12.43	181.58	0.89	18.03	0.23	0.10
Tobs	10.17	8.66	2.34	1.03	2.64	0.92

Source: Authors' calculations.

$$\begin{cases} P_t = a_1 * OD_t + a_2 * NPL_t + a_3 * CrS_t + a_4 * GY_t + u_t \\ a_1 > 0,\ a_2 < 0,\ a_3 > 0 \\ E(u) = 0; E(u^2) = \sigma^2. \end{cases} \quad (7)$$

This specification was checked for three types of errors, the fulfillment of the prerequisites of the Gauss-Markov theorem was carried out, as well as checking the quality of the model and the adequacy of the model. To do this, the sample under study was first ranked modulo the sum of the regressors and divided into three parts, where $n_1 = n_3 = 13$. Next, we performed the LSM procedure in Excel using the "LINEST" function and checked that the estimated model parameters for the two samples were within the range of values of each other (*Table 3*).

Table 3

Areas of Estimated Regression Values

Subsamples	First subsample				Second subsample			
Indicator	$\tilde{a}_4$	$\tilde{a}_3$	$\tilde{a}_2$	$\tilde{a}_1$	$\tilde{a}_4$	$\tilde{a}_3$	$\tilde{a}_2$	$\tilde{a}_1$
Parameter value	–0.26	–6.09	2194.3	108.21	0.84	–1.94	1679.2	109.63
Lower limit	–1.15	–9.90	1662.6	102.52	0.58	–3.36	1384.1	103.97
Upper limit	0.63	–2.27	2725.9	113.89	1.10	–0.53	1974.3	115.30

Source: Authors' calculations.

Table 4

Coefficient Indices for Regressors, Their Standard Errors and *t*-observed

Indicator	$\tilde{a}_4$	$\tilde{a}_3$	$\tilde{a}_2$	$\tilde{a}_1$
Coefficient for regressor (ã)	0.60	–2.07	1603.87	113.75
The standard error (Sã)	0.21	0.85	175.95	2.67
Tobs.	2.88	2.44	9.12	42.54

Source: Authors' calculations.

From *Table 3* it can be seen that the data areas of the estimated parameter values for both subsamples have common sets, therefore, an error of type 1 is not observed and the regression equation is chosen correctly. Let's check the model for the second type of error, namely, the inclusion of unnecessary regressors in the model using the "Student's test" at a significance level of 0.05. The following results were obtained (*Table 4*).

$$t_{crit.} = \text{T.INV.2T}(0.05; 29) = 2.05. \quad (8)$$

Since all t-values are greater than t-criteria, the hypothesis of the significance of regressors is accepted with a 95% probability. Checking the model using the series method for the third type of error, namely, whether the necessary regressors were missed in the model, showed that the number of rows — k (13) falls within the interval between the lower and upper bounds — k_1 and k_2 (11; 24). Therefore, the null hypothesis H0 is accepted: that there is no autocorrelation of random residuals. The model was checked for the fourth type of error — whether variable parameter estimates are used in the model. For this purpose, the maximum value of the price of MBS was found, after which the quotes decreased, the value in May 2023 (*Fig. 4*). In order to understand whether the values of the parameter estimates have changed, the Chow test was performed.

The z value was calculated using the following formula:

$$z = \frac{\left(ESS - \left(ESS' + ESS''\right)\right)/k}{\left(ESS' + ESS''\right)/\left(n_1 + n_2 - 2*k\right)} = 1{,}56. \quad (9)$$

The F value of the statistic was 2.76. The z value is less than Fcr, therefore no error is observed. With a 95% probability, we can say that the hypothesis of the constant use of the estimated model parameters is applied. The condition of the Gauss-Markov theorem on the zero mathematical expectation of random residuals was also checked, and a value of 0.0595 was obtained, which indicates that this

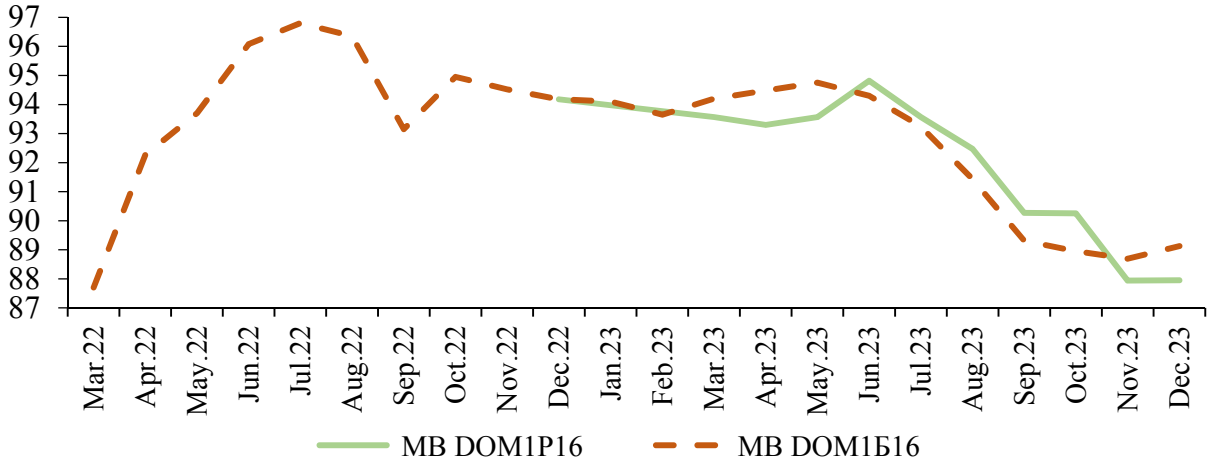

Fig. 4. **The Dynamics of Mortgage Bond Prices from April 2022 to December 2023**

Source: Compiled by the authors based on the data of Moscow Exchange. URL: https://www.moex.com/ru/marketdata (accessed on 18.09. 2024).

condition is fulfilled. The second condition of the Gauss-Markov theorem on the homoscedasticity of random residuals is verified. The Goldfeld-Quandt (*GQ*) test was performed. The calculated *GQ* and GQ^{-1} values are 0.95 and 1.06, respectively.

Since the condition is met that both indicators are simultaneously less than *Fcr* =3.18, we can say that with a 95% probability the second condition of the Gauss-Markov theorem on the homoscedasticity of random residuals is fulfilled. The quality control of the model was carried out using the *F*-test procedure. *F*obs = 9,374.66; *F*cr = 2.93. It can be seen that *F*obs is many times higher than *F*cr, therefore, with a 95% probability, we can say that the model is of high quality. In addition, the coefficient of determination is *R* ^2 = 99.92%, which indicates a very high (maximum) degree of explanatory ability of regressors. With a high degree of probability, it is the ratio of the amount of outstanding obligations to the estimated total amount of obligations that gives such a high value, which, of course, is explained by the specifics of these bonds. When checking the adequacy of the model, bond prices were calculated for the past studied periods based on the model obtained, in 70% of cases random balances do not exceed the standard deviation of the model, which indicates its adequacy. As a result of the work carried out, an estimated model of the dependence of the mortgage bond price on (the standard errors of the coefficient estimates are shown in parentheses) was obtained:

1) The ratio of the amount of outstanding obligations to the estimated total amount of obligations;

2) The share of loans with overdue debts, weighted by the volume of outstanding debt;

3) The spread between the loan rate included in the pool and weighted by the amount of outstanding debt, and the weighted average mortgage rate issued for the current month;

4) The spread between the yield on mortgage bonds and the yield on ten-year government bonds.

$$\begin{cases} P_t = 113{,}75 * OD_t + 1603{,}87 * NPL_t - 2{,}07 * CrS_t + 0{,}60 * GY_t + u_t \\ \quad (2{,}67) \qquad (175{,}95) \qquad (0{,}85) \qquad (0{,}21) \quad (2{,}75) \end{cases} \tag{10}$$

Based on the checks conducted, it can be concluded that the model is of good quality and accuracy, and can be used to make further predictions about the value under study.

INTERPRETATION OF THE MODEL

Based on the model obtained, several conclusions can be drawn:

1. If the ratio of the amount of outstanding obligations to the estimated total amount of obligations decreases by 0.01 (1 percentage point), the price of MBS decreases by 1.1375 percentage points (11.37 rubles). When the share of outstanding loans decreases, the price of the bond also decreases, as the nominal value of the bond reduces.

2. With an increase in the share of loans with overdue debts, weighted by the volume of outstanding debt by 0.01 (1 percentage point), the price of MBS increases by 16.0387 percentage points (160.39 rubles).

3. With an increase in the spread between the loan rate included in the pool and the volume-weighted outstanding debt and the weighted average mortgage rate issued for the current month by 1 percentage point, the price of MBS decreases by 2.0716 percentage points (20.72 rubles).

4. With an increase in the spread between the yield of the mortgage bond index and the yield for ten-year government bonds, the price of MBS increases by 0.6025 percentage points (6.03 rubles).

CONCLUSIONS

The study analyzed the factors influencing the price and profitability of mortgage-backed securities (MBS) in Russia. The constructed econometric model showed that the main factors influencing the price of MBS are the ratio of the amount of outstanding obligations to the total amount of obligations, the share of loans with overdue debts, the spread between the loan rate in the pool and the weighted average mortgage rate, as well as the spread between the yield of MBS and the yield on ten-year government bonds. An increase in the share of outstanding loans leads to a decrease in the price of bonds, which indicates the importance of the quality of the mortgage portfolio. On the contrary, an increase in the share of overdue loans has a positive effect on MBS prices, which may be related to investors' perception of risk. In the model proposed by the authors, the rate of delinquency and early repayment was not calculated due to technical limitations, which sets them the task of optimizing calculations and applying them to other mortgage bond issues. It should be noted that the securities were issued 2–3 years ago and, possibly, the indicator "share of overdue loans" was quite low due to the high quality of borrowers or the short life of loans. The analysis of trade turnover on the studied securities revealed their very low dynamics, which may not reflect reliable price dynamics based on transactions. In the following papers on this topic, the authors will additionally pay attention to the liquidity of the paper. In general, the model has demonstrated a high degree of explanatory ability, which allows it to be used to predict MBS prices in the future.

REFERENCES

1. Guseva M. Estimating the equilibrium loan structure for Russia. *Russian Journal of Money and Finance*. 2022;81(4):34–51. (In Russ.: *Den'gi i kredit*. 2022;81(4):34–51.).
2. Perekhod S.A., Mkhitaryan A.V., Selifonkina D.C. International sanctions against Russia (2014–2024): Assessment and implications for the financial market. *Vestnik Instituta ekonomiki Rossiiskoi akademii nauk = Bulletin of the Institute of Economics of the Russian Academy of Sciences*. 2024;(4):116–138. (In Russ.). DOI: 10.52180/2073–6487_2024_4_116_138
3. Khasyanova S. Yu., Samsonov M.E. The estimation model of the mortgage securitization effect on banking business. *Problemy upravleniya = Control Sciences*. 2020;(3):40–48. (In Russ.). DOI: 10.25728/pu.2020.3.5
4. Khutorova N.A. ESG approaches in securitization transactions. *Finansovyi zhurnal = Financial Journal*. 2024;16(2):72–87. (In Russ.). DOI: 10.31107/2075–1990–2024–2–72–87

5. Niyazbekova Sh.U., Mottaeva A.B., Eroshkin S. Yu., Krishtal M.G. Trends in the development of mortgage-backed securities in modern conditions. *MIR (Modernizatsiya. Innovatsii. Razvitie) = MIR (Modernization. Innovation. Research)*. 2022;13(2):322–341. (In Russ.). DOI: 10.18184/2079–4665.2022.13.2.322–341
6. Dunn K.B., McConnell J.J. Valuation of GNMA mortgage-backed securities. *The Journal of Finance*. 1981;36(3):599–616. DOI: 10.1111/j.1540–6261.1981.tb00647.x
7. Tira G., Marcato G. Driving factors in pricing European CMBS: Bond, mortgage and real estate characteristics. *SSRN Electronic Journal*. 2009. DOI: 10.2139/ssrn.1455159
8. Wallace N. The bear's lair: Index credit default swaps and the subprime mortgage crisis. *SSRN Electronic Journal*. 2009. DOI: 10.2139/ssrn.1787848
9. Goswami M., Jobst A., Long X. An investigation of some macro-financial linkages of securitization. IMF Working Paper. 2009;(26). URL: https://www.imf.org/external/pubs/ft/wp/2009/wp0926.pdf (accessed on 18.09.2024).
10. Chernov M., Dunn B., Longstaff F. Macroeconomic-driven prepayment risk and the valuation of mortgage-backed securities. NBER Working Paper. 2016;(22096). URL: https://www.nber.org/system/files/working_papers/w22096/w22096.pdf
11. Obrimah O. The price effects of Fannie Mae's liquidity provision activities within the secondary market for mortgage-backed securities. *SSRN Electronic Journal*. 2013. DOI: 10.2139/ssrn.2005274
12. Methodology for determining the value of mortgage-backed securities. Moscow: National Settlement Depository; 2021. 12 p. URL: https://www.nsd.ru/upload/docs/info/cc/met_icb_2021.pdf?ysclid=m1wqh6unfe593435913 (accessed on 18.09.2024). (In Russ.).
13. Teplova T.V., Sokolova T.V., Galenskaya K.V. Drivers and brakes on the development of corporate bond markets of developed and developing countries. *Voprosy ekonomiki*. 2019;(3):77–100. (In Russ.). DOI: 10.32609/0042–8736–2019–3–77–100
14. Popova N.V. On the yield to maturity of a coupon bond. *Finance: Theory and Practice*. 2023;27(3):126–138. DOI: 10.26794/2587–5671–2023–27–3–126–138
15. Popova N.V. Bond parameters and economic instability. *Finance: Theory and Practice*. 2024;28(6):175–185. DOI: 10.26794/2587–5671–2024–28–6–175–185
16. Popova N.V. Interest rate risk of bonds in the condition of a changing key rate. *Finance: Theory and Practice*. 2022;26(3):186–195. DOI: 10.26794/2587–5671–2022–26–3–186–195
17. Annenskaya N.E., Dymochkin P.K. Improvement of methods for valuating mortgage bonds. *Bankovskie uslugi = Banking Services*. 2020;(7–8):30–38. (In Russ.). DOI: 10.36992/2075–1915_2020_7–8_30
18. Aksakov D.A. Modeling early prepayment of principal on mortgage-backed securities. In: Collection of the International Institute of Economics and Finance of NRU HSE; Moscow: NRU HSE; 2011:85–104. URL: https://icef.hse.ru/data/2011/03/31/1211867135/4Sbornik_05_Aksakov-1_rus.pdf (In Russ.).
19. Shautin S.V. Risk factors of Russian mortgage-backed securities. *Finansy i kredit = Finance and Credit*. 2017;23(26):1533–1544. (In Russ.). DOI: 10.24891/fc.23.26.1533
20. Fedorova E.A., Musienko S.O., Afanas'ev D.O. Impact of the Russian stock market on economic growth. *Finance: Theory and Practice*. 2020;24(3):161–173. DOI: 10.26794/2587–5671–2020–24–3–161–173

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S.A. Perekhod — reviewing and editing, verifying the validity of research findings, selecting sources, analyzing theoretical aspects of the topic.

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