



## BOND MARKET EFFICIENCY AND VOLATILITY: EVIDENCE FROM RUSSIA

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### Abstract

**Purpose of the study:** In this paper, we use daily return for the Moscow Exchange Government Bond index (RGBITR) and Moscow Exchange Corporate Bond index (MICEXCBITR) over the period 2013 to 2018.

**Methodology:** Normality test, unit root test (ADF) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model will be used in this paper.

**Results:** The empirical results reveal that both government and corporate bond markets in Russia are not weak-form efficient. Furthermore, the volatility is persistent in both bond indices and resembles the same movement in returns. We find also that the GARCH (1,1) model is a good representation of the behavior of daily bond index returns in corporate and government bond markets in Russia.

**Applications of this study:** This research can be used for the universities, teachers, and students.

**Novelty/Originality of this study:** In this paper, for the first-time model of bond market efficiency and volatility has been studied.

**Keywords:** bond market, GARCH model, market efficiency, volatility.

### INTRODUCTION

The Efficient Market Hypothesis (EMH), confirm that the financial markets are informationally efficient. There are three forms of market efficiency, i.e. weak-form efficient market, semi-strong form efficient market and strong form efficient market. These three forms of efficient market imply that the price of securities cannot be predicted. Bond market efficiency is a much less studied subject than stock market efficiency, and for that reason it is important to pay more attention to the bond market and fill the research gap in this field of study. The same methods used to analyze stock market efficiency can be used in bond market analysis. [Treepongkaruna, S., & Wu, E. \(2012\)](#).

The Russian bond market continues to grow at a high rate and has an increased development potential compared to Western markets. Global investors have invested heavily in Russian treasury bonds, known as federal loan bonds (OFZ), since mid-2015 because of their attractive returns. [Treepongkaruna, S., & Wu, E. \(2012\)](#).

In the context of Western sanctions, Russian investors have limited access to Western debt markets. But the vulnerability of Russian government bonds in these sanctions has not decreased compared to a few years ago, due to the fact that Russia no longer needs external financing, so any new sanctions can stimulate some volatility only in the short term.

Although the bond market in emerging markets including Russia continues to show impressive growth, there are many issues to consider; for example, many corporate bond markets are still underdeveloped, their secondary markets are illiquid offering relatively poor-quality bonds, and the size of the bond issue is also small.

The study of the Russian bond market is relevant because the Russian government is currently providing an active fiscal and monetary policy, with the aim to develop this market and improve its liquidity and efficiency.

The development of the domestic bond market in Russia can contribute to the effective pricing of credit risks and risk management by introducing various risk management tools that will limit the impact of investor risks. Furthermore, a reliable domestic bond market is an alternative source of debt financing and can also help reduce dependence on bank financing, thereby providing greater diversification of funding sources across several asset classes, so the bond market can be considered as a source of stability, especially during periods of financial crisis ([Barjasteh et al. 2016](#); [Metsämuuronen, 2018](#)).

The empirical test in our study uses statistical and econometrical techniques, to compare the results and increases the reliability of this research. the study includes both Nonparametric and Parametric tests for testing market efficiency in a weak form in Russia. [Treepongkaruna, S., & Wu, E. \(2012\)](#).

In this paper, two historic time series data sets (government bond index RGBITR, corporate bond index MICEXCBITR) were analyzed to test the weak form of bond market efficiency, investigate the existence of volatility clustering and Bera, stationarity tested using the Augmented Dickey-Fuller (ADF) test and GARCH (1,1) were used to study the behavior of bond returns and estimate volatility.

## LITERATURE REVIEW

### The Efficient Market Hypothesis (EMH)

Jie Grace Liu tested the efficiency of the bond market in South Africa using test of evolving efficiency (TEE) method and GARCH model, he found that the South African bond market is weak-form efficiency and investors cannot use technical analysis to beat the market.

[Sarath Babu \(2017\)](#) examined the random walk behavior of the Indian bond market from 3rd Jan. 2011 to 30th Dec. 2016 daily and weekly data. Variance tests applied to test the RWH are robust to heteroscedasticity and non-normality. The results showed that Indian bond market is not efficient in weak-form and does not follow random walk behavior.

[Fatma Siala Guermezi and Amani Boussaada \(2016\)](#) investigated the EMH in the Tunisian Stock Exchange during the period July 2012 to June 2013. GARCH (1, 1) and its extension EGARCH (1,1) is developed to estimate volatility. The results indicated that the Tunisian stock market, in particular the banking sector would not show characteristics of market efficiency and it is not efficient under the weak form of the hypothesis.

Daniel Stefan Armeanu and Sorin-Iulian Cioacă tested the efficient market hypothesis on the Romanian capital market form January. 2002 to May. 2014 using unit root test, Jarque-Bera test, multiple variance ratio tests, and GARCH model. The results obtained show that the Romanian capital market is not weak-form efficient.

### The volatility estimation

Hansen and Lunde argued that GARCH (1, 1) works quite well in estimating the volatility of financial returns as compared to more complicated models. In modeling volatility of Chinese stock market, Hung-Chung et al showed that GARCH model with an underlying leptokurtic asymmetric distribution has better forecasting ability as compared to an underlying normal distribution. Wilhemsson using GARCH (1, 1) model with a fat tail error distribution leads to an improvement in a Volatility forecast. [Lucey, B. M., & Voronkova, S. \(2005\)](#).

## MATERIALS AND METHODS

### Sampling and Data Collection

All data were collected from the DataStream database of Moscow Exchange. The Moscow Exchange database contains information about trading in stocks and bonds listed on the Russian Financial market. For our analysis, Moscow Exchange Government Bond index (RGBITR) provides daily closing prices and turnover in government bonds, as well as Moscow Exchange Corporate Bond Index (MICEXCBITR) provides daily closing prices and trading volume in corporate bonds. In order to calculate daily returns in bonds, the closing prices obtained from indices are adjusted for non-trade days and bond splits. [Treepongkaruna, S., & Wu, E. \(2012\)](#).

Moscow exchange corporate Bond index is the benchmark that measures the performance of the Russian corporate debt market. It consists of most liquid Russian corporate bonds with duration more than 1 year.

Moscow exchange government Bond index provides a wide range of indicators that measures the performance of different segments of the Russian sovereign debt market, segmented by duration. It consists of most liquid Russian government bonds, calculated by Clean Price and Total return methods on an end-of-day basis.

The selection of these indices is based on their general characteristics that guarantee a sufficiently long-time series. In this article we analyze the daily return of tow bond indices, from 04.06.2013 until 30.11.2018, giving a total of N = 1385 data points for government bond index and from 03.04.2013 until 30.11.2018, giving a total of N = 1427 data points for corporate bond index daily record. [Lucey, B. M., & Voronkova, S. \(2005\)](#).

### Econometric Model

The ARCH and GARCH models are the most popular instruments for measuring volatility dynamics in financial time series. The GARCH model makes a current conditional variance dependent on lags of its previous variance. [Duffie, D., Pedersen, L. H., & Singleton, K. J. \(2003\)](#).

#### GARCH 1: model

$\gamma_t = \mu + \sigma_t \varepsilon_t$	(1)
$\sigma_t^2 = \alpha_0 + \alpha \gamma_{t-1}^2 + \beta \sigma_{t-1}^2$	(2)

Where: Returns are represented by  $\gamma_t$  and their mean value  $\mu$ .

$\sigma_t^2$	Conditional variance (Volatility).
$\varepsilon_t$	Is the error term.
$\alpha_0, \alpha, \beta$	The model parameters.

$\gamma_t$  is a function of variables with an error term.  $\sigma_t^2$  (Conditional variance) is one period ahead of forecast variance based on past information.

$\alpha_0$  is a constant term;  $\gamma_{t-1}^2$  (ARCH term) is news about volatility from the previous period measured as a

Lag of squared residual from the mean equation.  $\sigma_{t-1}^2$  (GARCH term) is the last period forecast variance.

The (1,1) in the GARCH refers to the presence of first-order autoregressive GARCH term and the first-order moving average ARCH term. An ARCH model is a special case of GARCH specification in form of GARCH (0,1).

In this article, two historic time series data sets (government bond index (RGBITR), corporate bond index (MICEXCBITR)) were analyzed to test the bond market efficiency in Russia and investigate the existence of volatility clustering in the Russian bond market. Normality in the data was evaluated by the Jaque Bera, and stationarity with the Augmented Dickey-Fuller (ADF) test, the ARCH, and GARCH (1,1) models was used to study the behavior of bond returns and estimate volatility model.

### EMPIRICAL RESULTS

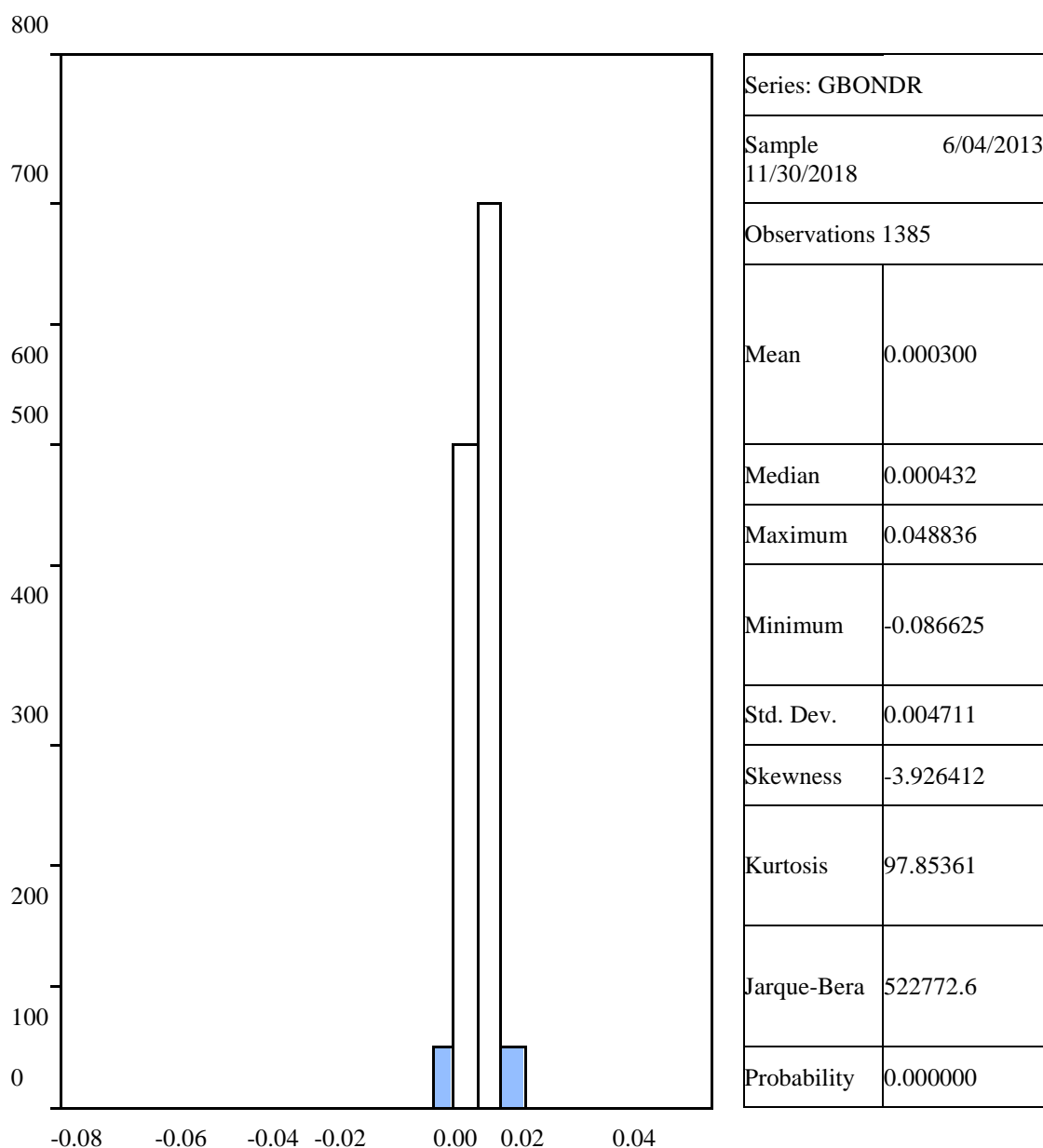
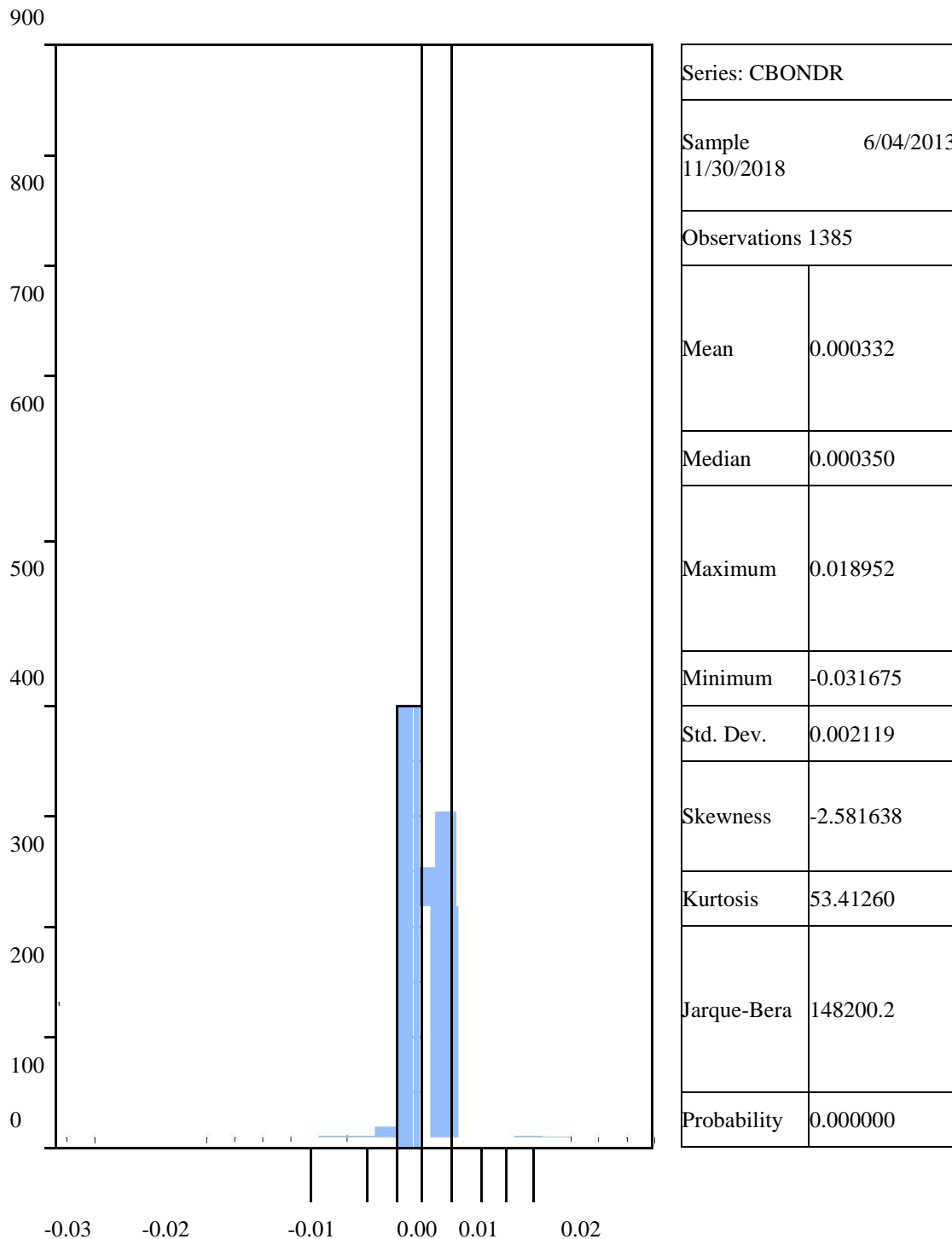


Figure 1: NORMALITY TEST (RGBITR) INDEX.

Source: EViews 10



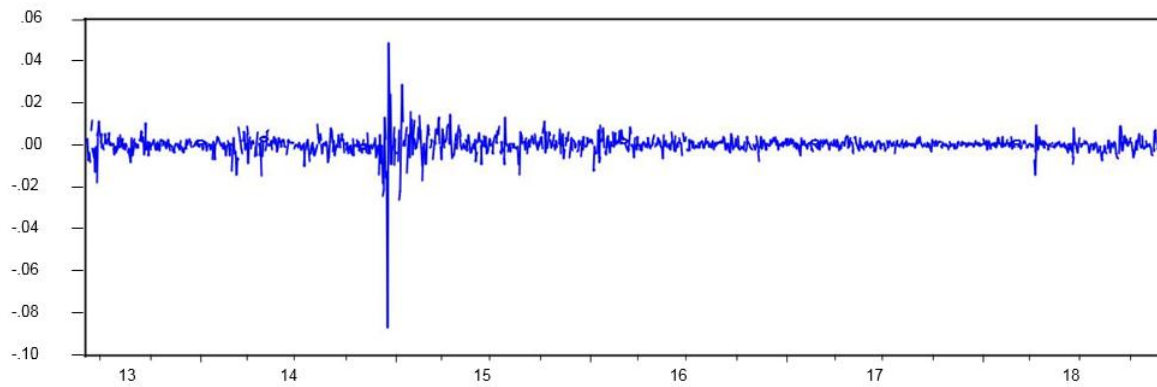
**Figure 2:** Normality Test (Micexcbitr) Index.

Source: EViews 10

It can be reasoned from the histogram in Figure 3 that the distribution of returns for both indices is not normal, especially in the case of higher kurtosis ( $97.85 > 3$  for government bond index) ( $53.41260$  for corporate bond index) and negative skewness for both, which is typical of much financial time series. We reject the normality distribution of returns also in terms of high value of Jarque–Bera statistic. We conclude that the Russian Bond market is not weak-form efficient because the daily returns for government and corporate bond markets do not follow a normal distribution.

We will examine whether the return of each index is stationary. Based on Augmented Dickey–Fuller’s test The following are graphs plotted against logarithm form of return for the whole investigation period for tow bond indices.

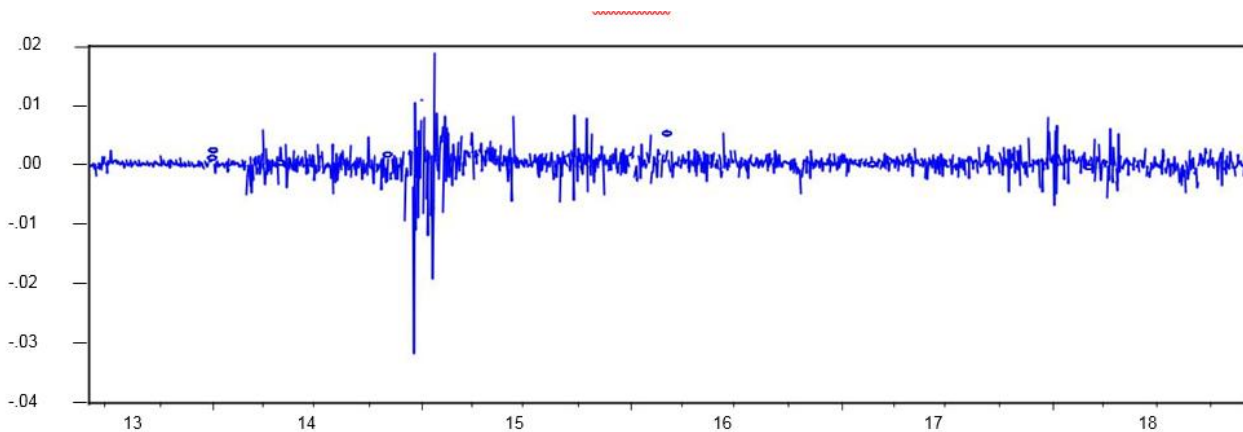
BondR



**Figure 3:** Unit Root Test For Government Bond Index (Rgbitr).

Source: EViews 10

CBondR



**Figure 4:** Unit Root Test For Corporate Bond Index (Micexcbitr).

Source: EViews 10

The y-axis represents returns, the x-axis represents days. From the graph the return seems to be stationary for the given period for both indices. However, we will still use Unit Root test to confirm whether the underlying series is indeed a stationary process which is a precondition for being a random walk process.

**Table 1:** Adf Results for Government Bond Index (Rgbitr)

Null Hypothesis: GBONDR has a unit root		
Exogenous: Constant		
Lag Length: 4 (Automatic - based on SIC, maxlag=23)		
		t-Statistic
Augmented Dickey-Fuller test statistic		-15.66773
Test critical values:	1% level	-3.434879
	5% level	-2.863427
	10% level	-2.567824
*MacKinnon (1996) one-sided p-values.		

SOURCE: EViews 10

The ADF statistic value of the government bond index is -15.66773 and p-value (for a test with 1385 observations) is less than 0.0001. In addition, EViews reports critical values at 1%, 5%, and 10% levels. Notice here that the absolute value of t-statistic is significant so that we reject the null at conventional test sizes and conclude that there is no unit root and return data series is stationary, in other words, the investigated underlying data do not follow a random walk process and RGBITR is not a weak form of efficient markets. [Singh, S. P. \(2014\).](#)

**Table 2:** Adf Results For Corporate Bond Index (Micexcbitr)

Null Hypothesis: CBONDR has a unit root		
Exogenous: Constant		
Lag Length: 2 (Automatic - based on SIC, maxlag=23)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-19.62164	0.0000
Test critical values:	1% level	-3.434872
	5% level	-2.863424
	10% level	-2.567822
*MacKinnon (1996) one-sided p-values.		

SOURCE: EViews 10

The ADF test statistics reject the null hypothesis that there is an existence of a unit root in the return data series of the corporate bond index.

Before estimating a GARCH model for a financial time series, it is necessary to check for the presence of ARCH effects in the residuals. If there are no ARCH effects in the residuals, then the GARCH model is unnecessary and misspecified.

To test the ARCH-effects, the ARCH-LM test of Engle (1982) was used. Under ARCH-LM test the null and alternative hypothesis for both bond indices are as follows [Singh, S. P. \(2014\)](#):

H0: there is no ARCH effect present

H1: there is ARCH effect present

**Table 3:** Arch Test Results For Government Bond Index

Heteroskedasticity Test:			Prob.
ARCH			
F-statistic	4.254706	Prob. F(1,1382)	0.0393
Obs*R-squared	4.24778	Prob. Chi-Square(1)	0.0393
	6		

SOURCE: EViews 10

TABLE 4. ARCH TEST RESULTS FOR CORPORATE BOND INDE

Heteroskedasticity Test:			Prob.
ARCH			
F-statistic	26.40624	Prob. F(1,1424)	0.0000
Obs*R-squared	25.96190	Prob. Chi-Square(1)	0.0000

Similar results; from the test results, we conclude that both the F version and LM-Statistic are statistically significant, suggesting the presence of ARCH in the financial data series of bond returns. The results confirmed the presence of ARCH effects in the series for both indices. [Kovačić, Z. \(2007\)](#).

We continue testing the weak-form efficiency of the Russian bond market using a GARCH (1,1) model, to test the null hypothesis, the ARCH model of Engle and GARCH model of Bollerslev were used, the results being:

**Table 5:** Garch Model for Government Bond Index (Rgbitr)

Dependent Variable: GBONDR				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date: 12/31/18 Time: 02:03				
Sample: 6/04/2013 11/30/2018				
Included observations: 1385				
Convergence achieved after 24 iterations				
Coefficient covariance computed using the outer product of gradients				
Presample variance: backcast (parameter = 0.7)				
GARCH = C (2) + C (3) *RESID (-1) ^2 + C(4)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000412	4.99E-05	8.246356	0.0000
Variance Equation				
C	3.44E-07	3.89E-08	8.826247	0.0000

RESID (-1) <sup>2</sup> $\alpha$	0.249140	0.018347	14.12403	0.0000
GARCH (-1) $\beta$	0.741401	0.014066	53.42143	0.0000
R-squared	-0.000566	Mean dependent var		0.000300
Adjusted R-squared	-0.000566	S.D. dependent var		0.004711
S.E. of regression	0.004712	Akaike info criterion		-8.820581
Sum squared resid	0.030735	Schwarz criterion		-8.805466
Log-likelihood	6112.252	Hannan-Quinn criter.		-8.814928
Durbin-Watson stat	1.823566			
SOURCE: EViews 10				

Parameters  $\alpha$  and  $\beta$  of the GARCH model are all positive and statistically significant for the government bond index. This means that the GARCH (1,1) model is a good representation of the behavior of daily government bond index returns because it managed to successfully capture the time dependence of the volatility of the index returns.

The results show that the value of  $(\alpha + \beta)$  is very close to 1 for the government bond index, suggesting thereby a high persistence of volatility clusters over the sample period in the market. We can estimate the (RGBITR) daily return volatility, as a result we can find a strategy to beat the market with no risks associated and this is an indication of weak-form market inefficiency. [Singh, S. P. \(2014\).](#)

From Table 5, the Conditional Mean And The Conditional Variance (Volatility) Model For Government Bond Index (RGBITR) That Best Fits The Observed Data is

$$\gamma_t = 0.000411866665355 + \varepsilon_t$$

(3)

$$\sigma_t^2 = 3.43592067998e-07 + 0.249139593061 * \gamma_t^2 + 0.741400927891 * \sigma_{t-1}^2$$

(4)

**Table 6:** Garch Model For Corporate Bond Index (Micexcbitr)

Dependent Variable: CBONDR				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date: 12/31/18 Time: 06:03				
Sample: 4/03/2013 11/30/2018				
Included observations: 1427				
Convergence achieved after 26 iterations				
Coefficient covariance computed using the outer product of gradients				
Presample variance: backcast (parameter = 0.7)				
GARCH = C (2) + C (3) *RESID (-1) <sup>2</sup> + C (4) *GARCH (-1)				
Variable Coefficient Std. Error z-Statistic Prob.				
C	0.000360	2.46E-05	14.61092	0.0000
Variance Equation				
C	1.15E-08	1.84E-09	6.227283	0.0000
RESID (-1) <sup>2</sup> $\alpha$	0.166737	0.011031	16.02189	0.0000
GARCH (-1) $\beta$	0.823196	0.007898	109.2870	0.0000
R-squared	-0.000168	Mean dependent var		0.000333
Adjusted R-squared	-0.000168	S.D. dependent var		0.002089
S.E. of regression	0.002089	Akaike info criterion		-10.30338
Sum squared resid	0.006222	Schwarz criterion		-10.28862
Log-likelihood	7355.460	Hannan-Quinn criter.		-10.29787
Durbin-Watson stat	2.237385			
SOURCE: EViews 10				

The coefficients on both the lagged squared residual ( $\alpha$ ) and lagged conditional variance ( $\beta$ ) in the Variance Equation are statistically significant. Furthermore, the sum of the ARCH and GARCH ( $\alpha + \beta$ ) coefficients of the corporate Bond index (MICEXCBITR) is very close to one. This shows that volatility shocks are quite relentless in the corporate bond market.

Large sums of coefficients imply that large positive and negative returns will lead to future forecast of the variance to be high for a prolonged period.

We can estimate the (MICEXCBITR) daily return volatility from historical data, and we can say that the Russian corporate bond market is not efficient in weak form.

From Table 6, the conditional mean and the conditional variance (Volatility) model for corporate bond index (MICEXCBITR) that best fits the observed data is

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$$\gamma_t = 0.000365976071 + \varepsilon_t$$

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(5)

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$$\sigma_t^2 = 1.14553446033e-08 + 0.166737219034 * \gamma_t^2 + 0.823195700173 * \sigma_{t-1}^2$$

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(6)

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It can be noticed from (table 5, table 6) that most of the information is from the previous days forecast amounting to about 82% for corporate bond index and 74% for government bond index (a fact that contradicts the hypothesis of the efficiency of financial markets) and there is a minimal change on the arrival of new information and there is a very small effect on the long-run average variance.

It should also be noted that for RGBITR and MICEXCBITR, the sum of the parameters of the GARCH model is substantially close to the unit. In such cases, the GARCH process is said to be integrated, which implies that volatility shocks are explosive and persist in future horizons.

## CONCLUSION

In conclusion, the Russian bond market is not weak-form efficient suggesting that there is a systematic way to exploit trading opportunities and acquire excess profits and using the past information from previous days we can predict the return of corporate and government bond indices.

The paper utilized the GARCH (1, 1) model since the objective was to estimate the volatility of financial time series and to test the existence of dependence in bond returns. We found that the model is suitable and sufficient to capture the volatility of bond returns; also the results showed that large positive and negative return will lead to a future forecast of the variance to be high for a prolonged period.

The empirical results obtained in our study would be useful to Russian and foreign investors for two reasons. First, they provide deep analysis and estimation of the nature and volatility of bond returns in the Russian bond market using econometric skills. Second, the implication of rejecting the weak form efficiency for investors is that they can predict bond price movements, by holding a well-diversified portfolio while investing in the Russian financial market.

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