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Forecasting the Volatility of the Russian Stock Market in the Context of International Economic Sanctions

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ABSTRACT

The article is devoted to the study of trends in the development of the Russian stock market in the context of international economic sanctions. The purpose of the study is to make forecasts of the volatility of the Russian stock market using a scenario approach. Statistical data of the Moscow Stock Exchange were used for calculations. The authors have made a forecast of the volatility of the stock exchange market of the Russian Federation. The basis of the forecast calculations is the dynamics of the Moscow Exchange Index (IMOEX), taken as a key indicator of the Russian organized securities market, for the period from June 2013 to July 2022. Based on the basic historical dynamics of the Moscow Stock Exchange Index, negative (international economic sanctions are being tightened) and positive (implies the easing and/or lifting of some sanctions) scenarios for the development of the stock market of the Russian Federation are compiled. The scientific novelty is the authors' assessment of the convergence of the volatility forecast under negative and positive scenarios to a certain level of volatility in 2023. The results of the calculations showed that under different scenarios of the situation, volatility tends to the same value at different assumed values of the Moscow Exchange Index, which allowed us to draw a new and practically significant conclusion that over time the economy of the Russian Federation stabilizes regardless of the tightening or easing of international economic sanctions — this may be due to the implementation of the country has a policy of import substitution, the formation of national production in most areas of the economy and the development of the domestic market. The work carried out by the authors contributes to the development of theoretical and applied economics in terms of making forecasts for the development of the stock market and using the results of forecasting to make economically sound decisions.

Keywords: global stock market; Russian stock market; stock market volatility; international economic sanctions; GARCH and E-GARCH models; Moscow Exchange Index (IMOEX)

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INTRODUCTION

Forecasting the volatility of the Russian stock market becomes relevant in the unstable economic conditions caused by both the internal crisis and the external economic/political influence on the economy of the country. The current economic situation in the Russian Federation is largely determined by global geopolitical changes and the imposition of international economic sanctions on the Russian economy. Thus, the relevance of the study is seen by the need to develop and implement a scenario approach for forecasting the volatility of the Russian stock exchange market in the context of international economic sanctions. The object of the study is the Russian stock exchange market, the subject — is the forecast of the volatility of Russian stock market. The purpose of the study is to prepare forecasts of the volatility of the Russian stock market, taking into account international economic sanctions based on a scenario approach. The elements of scientific novelty are contained in the forecasts of volatility of the Russian stock exchange market using a scenario approach, taking into account international economic sanctions; in the authors' assessment of the convergence of volatility forecasts with negative and positive scenarios to a certain level of volatility in 2023; and in identifying the causes of convergent forecasts.

The authors examined a large amount of literature on estimating stock market volatility. The absolute majority of researchers indicate that the forecasting and assessment of stock market volatility is relevant in times of crises regardless of their nature and causes [1–5]. Increasing international sanctions pressure on the Russian economy increases the volatility of the Russian stock exchange market, therefore, forecasting and assessing its volatility becomes appropriate and necessary.

Studies such as [6–8] indicate that the main index of the national stock exchange is capable of predicting the volatility of the domestic stock market, which is sufficient to justify the use of the Moscow Exchange Index (further — IMOEX) to forecast the volatility of the Russian stock market.

A large number of papers by Russian and foreign authors is devoted to mathematical modeling of volatility and forecasting of stock markets [9–12]. While many researchers use the models of the GARCH, ARFIMA and HAR groups, more and more studies appear to prove the advantages of hybrid models using neural networks.

Interest in modeling and forecasting stock markets can be explained by the fact that, firstly, in an uncertain and volatile economy, modeling market volatility is a convenient tool for making decisions taking into account possible risks, resources required, external and internal environment factors. Secondly, forecasting using the scenario approach will allow to calculate the maximum possible and/or desirable number of options for developing the situation in order to choose the optimal scenario for the situation and build on it the development strategy.

MATERIALS AND METHODS

There are several models for calculating and forecasting volatility in the market, such as the ARCH model, which can be used to simulate changes in dispersion in a time series, or the p-adic forecast of volatility [13]. Similarly, in the presence of a stable trend or marked seasonality of an unstable time series, along with the parameters of the trend or seasonless, the dispersion itself changes, which leads to the heteroscedasticity of the series. In this case, it makes sense to use ARCH only for series that do not have seasonal or trend effects. For this time series it is necessary to pre "clean" from seasonality/trend with, for example, exogenous regressors, ARIMA and other models — and only then come to evaluation with the help of ARCH. This model responds relatively slowly to shocks of large value and treats the impact on the volatility of positive and negative shocks in the same way, which is a fairly significant disadvantage in assessing the volatility of the stock market.

GARCH (Generalized Autoregressive Conditional Heteroskedasticity) — is a model

that forecasts the change in volatility in financial markets over time. The GARCH-model assumes that the reaction to a shock depends only on its size and does not depend on a sign. GARCH models also take into account market asymmetry and leverage [14]. But when calculating, you can see that in the falling market the primary specification of the GARCH model tends to be higher than on the rising one, which means that with asymmetric exposure this model does not confirm the hypothesis of the existence of leverage effect.

The more adaptive exponential model E-GARCH allows the problem of asymmetric effect in the market to be avoided when calculating volatility. This extension of the GARCH model not only takes into account past values to be analyzed, but also information about events that may affect volatility, which allows for more accurate forecasting of future volatility and reduce investment risk. E-GARCH implies the use of conditional deviations to weaken the positive limits of coefficients. In the time series of stock market volatility there are often asymmetrical reactions to positive and negative shocks [15], so the most convenient and adaptive tool for forecasting will be the exponential E-GARCH model.

For the research period of 2013 to 2022, calculations were performed using the above model. The improved result is compared with the existing stock market situation in order to confirm or disprove the reliability of the forecast obtained using the E-GARCH model.

The basic tool for calculating and forecasting are the NumXL plugin in Microsoft Excel. Suppose there is a certain time moment t, then the risk of an asset at that time will be the uncertainty of its future value at that moment $t + \Delta t$. A measure of the risk of an asset at a given interval t and will represent the volatility characterizing the dispersion of the time series.

If the dispersion of the asset at the moment t be $\left(\sigma_t^2\right)$, and the yield at the same moment be — r_k. then the presentation of the generalized ARCH-model (Generalized ARCH-GARCH) will take the form:

$$\sigma_t^2 = a_0 + \sum_{i=1}^{p} a_i r_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2, \quad (1)$$

where $a_0 > 0$, $a_i \geqslant 0$ and $\beta_i \geqslant 0$.

The exponential model of the E-GARCH depends on both the size and the sign of the lagged shocks. Model represented by formula:

$$\ln \sigma_t^2 = K + \sum_{t=1}^{q} \alpha_t (\varphi z_{t-1} + \psi \left(|z_{t-1}| - E\left[|z_{t-1}| \right] \right)) + \sum_{t=1}^{p} \beta_t \ln\left(\sigma_t^2\right). \quad (2)$$

Further, with the use of this model will be made calculations on possible scenarios of development of the market of the Russian Federation.

RESULTS AND DISCUSSION

Based on the E-GARCH forecasting model, this study prepared a forecast of the volatility of the Russian stock market taking into account international economic sanctions in the current period. The calculations were made using the NumXL plugin in Microsoft Excel based on IMOEX data for the period from June 2013 to July 2022.

Fig. 1 shows a graph of the IMOEX baseline historical dynamics, on the basis of which negative and positive scenarios will be proposed in the future.

Time series IMOEX are not stationary and therefore not suitable for econometric analysis. Therefore, it was first necessary to convert the price indicator into the monthly growth indicator of the index (*Fig. 2*). In addition, the choice fell to logarithmic return instead of simple return to distribute time series values, since simple return by definition cannot be less than –1 (–100%).

On *Fig. 3* shows the time series of exponentially weighted moving average (EWMA). Comparing IMOEX average annual growth values and built time series exponential weighted moving graphs, we can see the change

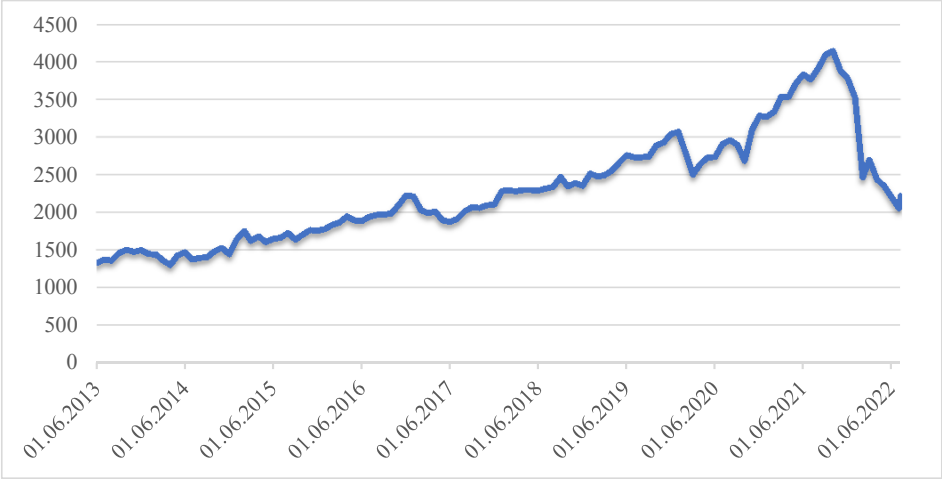

Fig. 1. **IMOEX in the Period from June 2013 to June 2022**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 15.02.2023).

in volatility in the period under analysis from 1 June 2013 to 1 June 2022.

The graph show that exponential weighted volatility is changing smoothly — as opposed to the index's monthly growth rate — until the index price drops sharply at the end of December 2021. But keep in mind that the indicator is more sensitive to negative than positive market returns.

Furthermore, within the framework of this study, the forecast of the weighted volatility of the Russian stock market until the autumn of 2023, for which the indicators of statistical data (monitoring of monthly returns) were used: average values and their standard deviation, etc. (*Fig. 4*).

Using actual and forecast IMOEX values from January to October 2023, graphs were generated, from which it was possible to conclude that the Russian stock market might stabilize in the Q3 of 2023 (*Fig. 5*).

However, the calculation of only one option of developments does not allow to consider possible changes and fluctuations in the index of market volatility due to the uncertainty of the current geopolitical situation in the world. For a more detailed analysis, we will calculate the volatility of the index in the implementation of positive and negative scenarios of the development of the stock market of the Russian Federation.

POSITIVE FORECAST (GROWTH OF THE IMOEX)

A more positive forecast could also be assumed in the event of a political/economic/social event that could have a positive impact on the current state of the country's economy and on IMOEX, respectively, which would be reflected in a significant increase in its indicators. An example of such an event against the background of the existing sanctions pressure on the Russian economy may be the easing / lifting of part of sanctions on Russian energy exports in the cold season. Under these circumstances, the value of the index in the autumn and winter period will rise (*Fig. 6*); taking into account the expected positive changes IMOEX has made further calculations.

The IMOEX volatility forecast with the E-GARCH model (*Fig. 7*), shows that with the lifting of some of the sanctions on Russian energy exports, the country is expected to increase the overall volatility in the market. It may be assumed that this will be due to increased uncertainty among major market players.

NEGATIVE FORECAST (DECLINE IN THE IMOEX)

In the case of increasing international economic sanctions, such as the enactment of a global minimum price for Russian energy sources, a

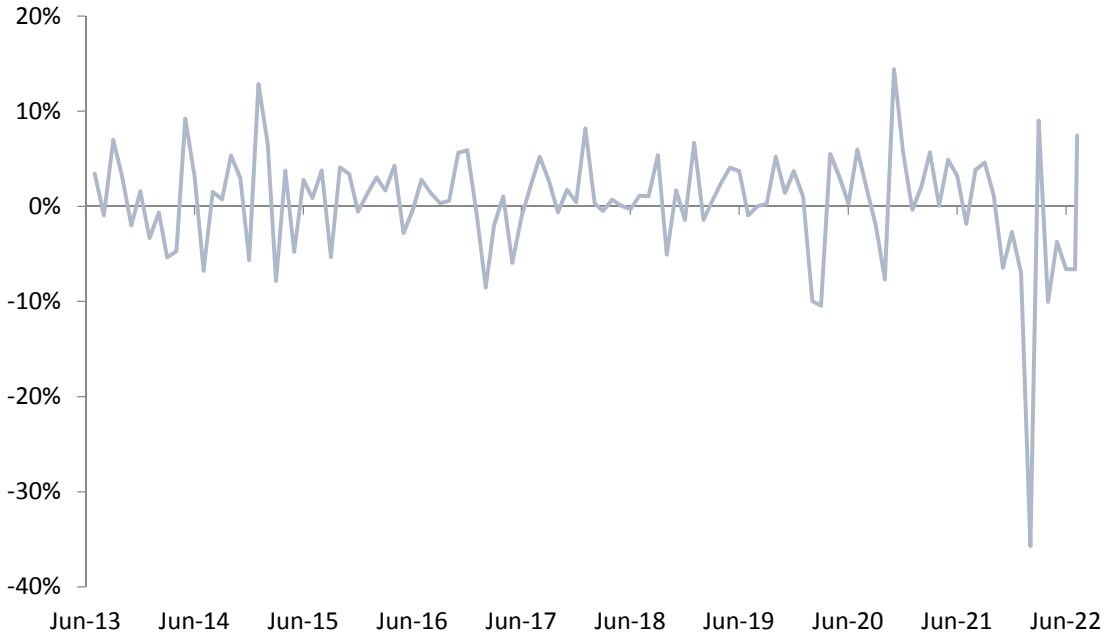

Fig. 2. **The Indicator of the Monthly Increment of the IMOEX**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 15.02.2023).

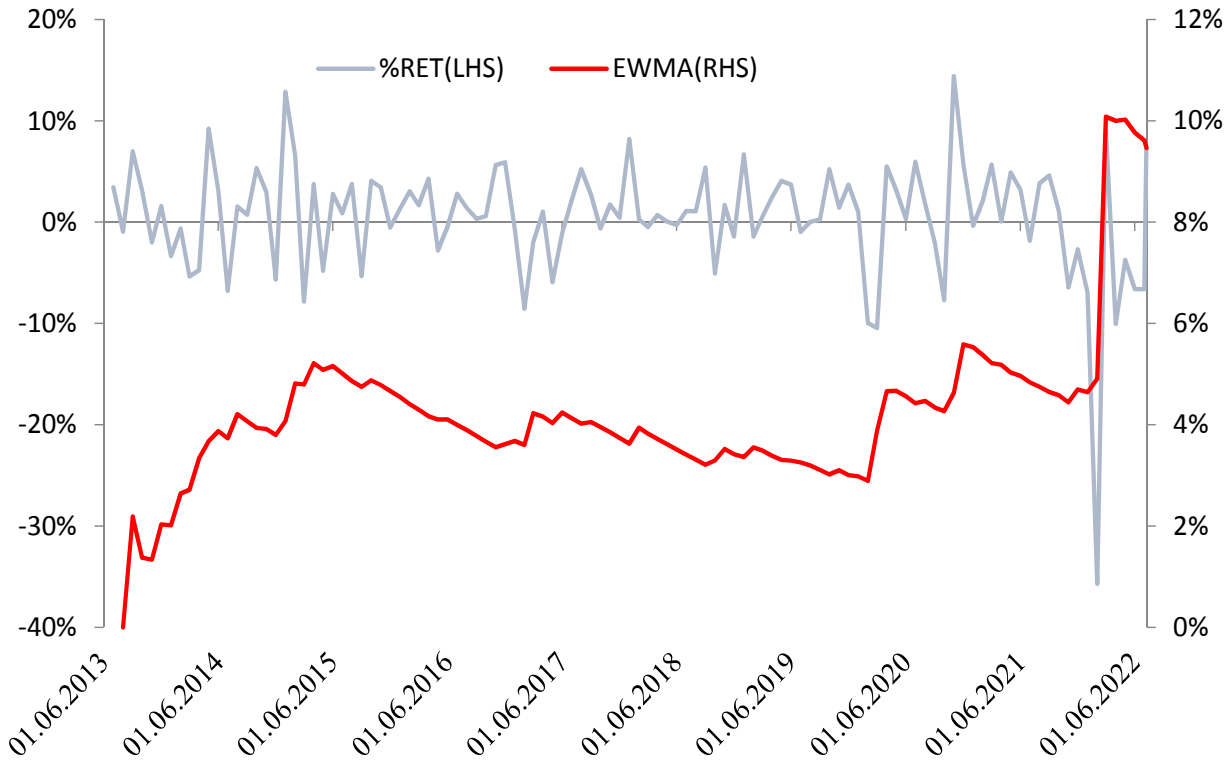

Fig. 3. **Graphs of Annual Increments of the IMOEX and Exponential Weighted Volatility of the Index**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 15.02.2023).

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	B	C	D	E	F	G	H	I	J
16									
17									
18		Summary Statistics				Significance Test			0.05
19						Target	P-Value	SIG?	
20			Average:	0.00465933		0.00	0.200474983	FALSEHOOD	
21			Standard Deviatior	0.057953151					
22			Skew:	-2.244434026		0.00	4.39952E-21	TRUTH	
23			Excess Kurtosis:	13.06128409		0.00	2.87E-149	TRUTH	
24									
25			MEDIAN:	0.010487342					
26			MIN:	-0.35699305					
27			MAX:	0.144083788					
28			Q1:	-0.014313762					
29			Q3:	0.03700336					

Fig. 4. **The Result of a Statistical Evaluation of a Sample of Monthly Returns**

Source: Screenshot of the working program.

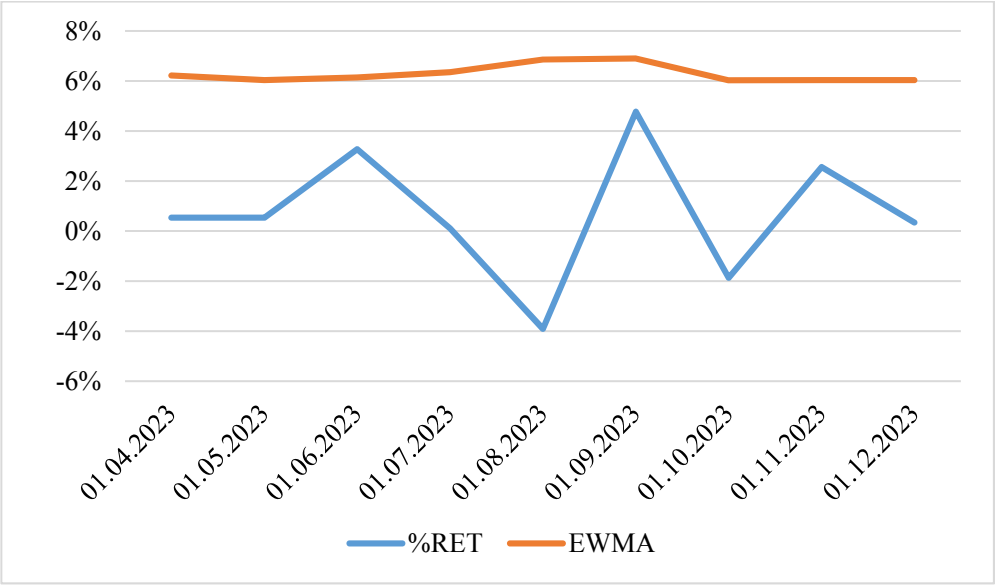

Fig. 5. **Graphs of the Exponential Weighted Volatility and the Effect of the Economic Increment of the IMOEX**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 24.04.2023).

negative forecast was provided. Such a turn of events will affect the state of the entire financial market of the Russian Federation and will cause a fall in the value of the IMOEX price (*Fig. 8*).

The weakening of Russia's leading position in the European energy market and the closure of access to the Western financial-credit system will cause a significant decline among the energy and financial market indicators of the Russian Federation. Against this background, it is worth assuming a decrease in the price of IMOEX. Volatility forecast graph (*Fig. 9*) shows possible fall in Russian stock market volatility.

In this IMOEX volatility forecast using the E-GARCH model (*Fig. 9*), it is assumed that with the tightening of sanctions due to the establishment of the global minimum price for Russian energy sources, the Russian stock market is expected to decline the overall volatility to the level of 2.43% per month.

As a result, the E-GARCH model considers the possibility of asymmetry in volatility

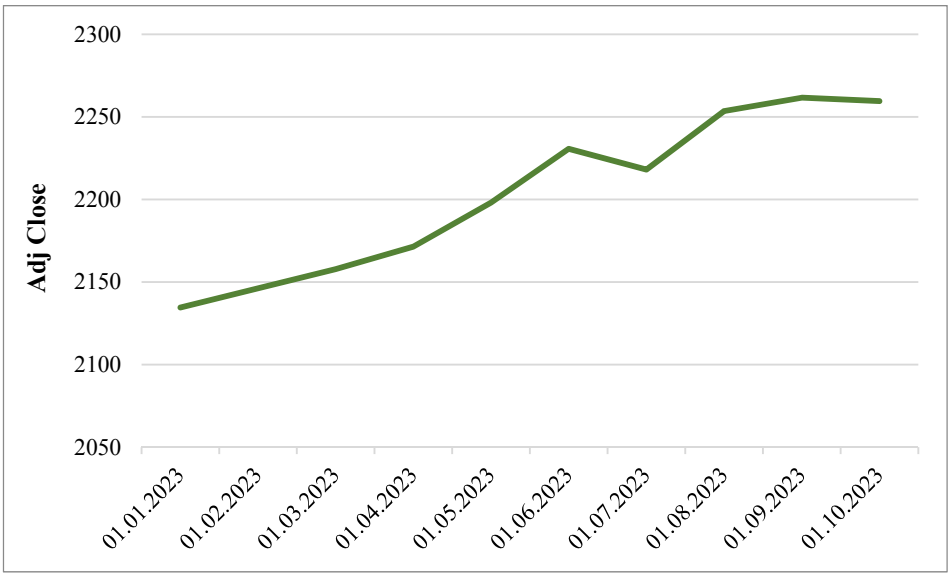

Fig. 6. **The Expected Growth of the IMOEX in the Period from January 2023 to October 2023**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 24.04.2023).

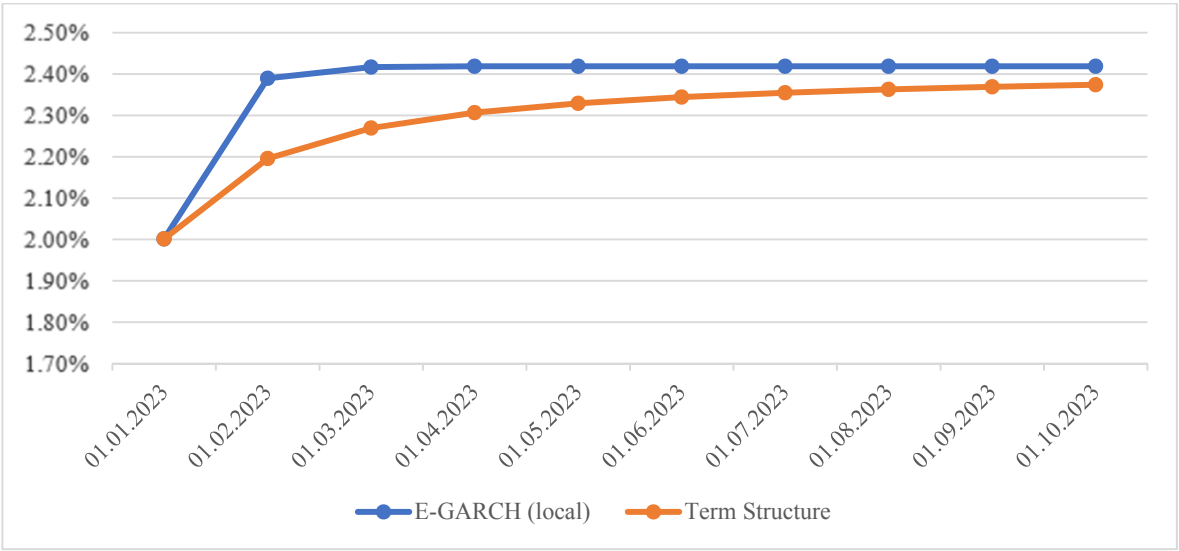

Fig. 7. **The Volatility Forecast of the Moscow Stock Exchange Index, Subject to Positive Events in the Period from January 2023 to October 2023**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 24.04.2023).

change, i.e. the possibility that volatility changes differently as asset prices rise and fall. This increases the flexibility and accuracy of the E-GARCH model in forecasting stock market volatility.

Because of these facts, the E-GARCH model can forecast financial data more accurately in the short-term.

CONCLUSION

Volatility forecasting is an integral part of financial analysis and market modeling. An aggregate analysis of different points of view allows to define volatility as the volatility of market conditions and range of price fluctuations. Furthermore, research into financial data, including volatility, is important both in the long-

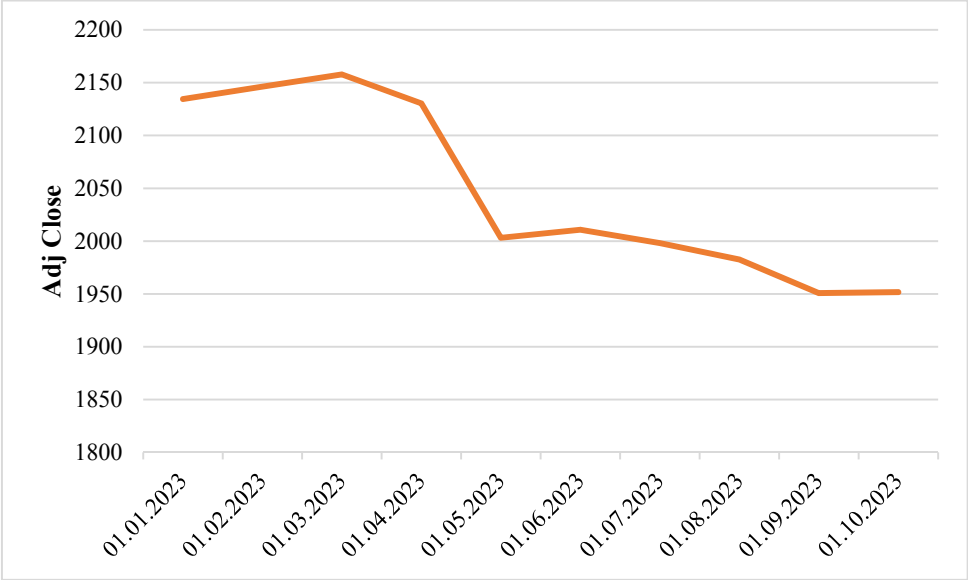

Fig. 8. **The Expected Decline in the IMOEX in the Period from January 2023 to October 2022**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 15.02.2023).

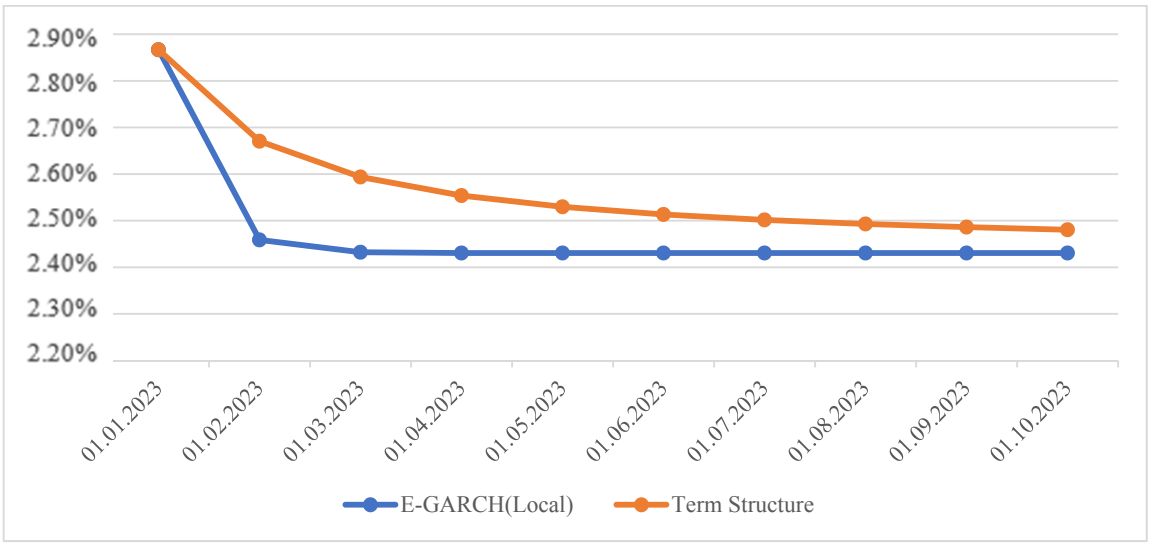

Fig. 9. **The Volatility Forecast of the Moscow Stock Exchange Index, Subject to Negative Events in the Period from January 2023 to October 2023**

Source: Results of author's visualization of data calculations IMOEX for the relevant years. URL: https://www.moex.com/ (accessed on 24.04.2023).

and short-term. Long-term analysis provides an in-depth analysis of market reactions to various events, fluctuations in stock indices and their causes, and short-term analytics allows for an in-depth study of the components of financial indicators and forecasting the future behavior of stock exchange instruments.

The analysis of the dynamics of the Russian stock exchange market in a sufficiently long period of time allowed not only to draw conclusions about the changing place and role of Russian stock market in the world community, but also to prove the approximation of calculations based on the E-GARCH model to the real situation.

Positive and negative volatility forecasts for the Russian market over the medium term (less than a year) based on the E-GARCH model

confirm the model's applicability in practice. It can be noted the convergence of the volatility forecast with negative and positive scenarios to a certain level of volatility in 2023: despite the diversification of the movement of volatility in the negative and the positive forecasts, there is an asymptote to which the curves aspire, equal to approximately 2.43%.

Such results may indicate that the economy of the Russian Federation is stabilizing over time, regardless of the tightening or weakening of international economic sanctions. This could be due to the implementation of import substitution policies in the country, the formation of national production in most areas of the economy and the development of the internal market, which will be reflected in the dynamics of IMOEX. To confirm this assumption, it is advisable to repeat this study in new economic contexts created by international sanctions pressure on the Russian economy.

Currently, with unprecedented sanctions and high market uncertainty, periodic forecasting of such financial indicators is needed. The creation of different scenarios for the development of the country's stock market based on the suggested model would allow for a more complete and clear definition of the situation's possibilities in the presence of both positive and negative impacts.

The results and methodology of the study improved by the authors have theoretical significance in the preparation of stock market forecasts and practical significance, as they can be used for the development and making investment decisions in the stock market.

In conclusion, a few areas of future research can be identified. We consider that improving forecasting methods is relevant and promising. One of the main directions of this development is the creation of hybrid predictive models of stock market volatility based on artificial neural networks. As demonstrated in [16], the results of comparison of the forecasts obtained show that the hybrid models with GDT clearly outperform the projected results with the models of the GARCH. Similar conclusions are presented in the papers [17–20]. We consider it a promising direction to develop models for forecasting the volatility of the Russian stock market using artificial neural networks created by Russian developers.

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