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FORECASTING THE DYNAMICS OF INSURANCE INDICATORS BASED ON ARIMA AND VAR MODELS

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Abstract

This article analyzes and forecasts the dynamics of insurance market indicators in Uzbekistan for the period 2016–2025 using econometric methods. During the research, time series were constructed based on key indicators such as insurance premiums, insurance claims, insurance reserves, and total authorized capital, and ARIMA and VAR models were applied. The ARIMA model was used to evaluate the internal dynamics and future growth trends of individual time series, while the VAR model was employed to identify interrelationships among the variables.

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INTRODUCTION

In the context of globalization, the insurance market is rapidly developing as an important component of the economy. The insurance system plays a significant role in ensuring financial stability, diversifying risks, and supporting investment processes. Therefore, the scientific analysis and reliable forecasting of the dynamics of insurance indicators (such as premiums, claims, losses, reserves, and others) have become one of the most relevant issues. Particularly, in financial systems characterized by high levels of uncertainty and risk, the evaluation of economic processes in advance is carried out through econometric modeling [1][2][3][4][5].

International practice shows that modern statistical and econometric methods are widely used in forecasting time series in the insurance sector. In particular, scientific studies have proven that ARIMA models provide effective results in predicting the dynamics of insurance claims, premiums, and losses in developed countries. For example, research on forecasting the volume of insurance claims has demonstrated that the ARIMA model allows for highly accurate estimation of future values [2][6][7][8]. Moreover, the effectiveness of the ARIMA model for long-term forecasting of economic indicators is particularly emphasized [3][9][10][11][12].

The ARIMA (Autoregressive integrated moving average) model is one of the most widely used classical econometric models in time series analysis. This model is constructed based on the past values of the time series itself (autoregression), the elimination of trends through differencing (integration), and the random error component (moving average) [13][14][15][16]. The ARIMA model is particularly useful for transforming non-stationary series into stationary ones, identifying their internal structure, and forecasting future values. Therefore, it is widely applied in financial, insurance, and macroeconomic analysis [17][18].

However, real economic processes are often represented by a system of several interrelated indicators. From this perspective, the VAR (Vector autoregression) model plays an important role in analyzing multivariate time series. The VAR model simultaneously considers the interactions among multiple variables by expressing each variable as a function of its own past values as well as the lagged values of other variables. This model is widely used to identify complex interrelationships in economic and financial systems, analyze responses to shocks (impulse response functions), and perform forecasting [19][20][21][22].

An analysis of both local and international scientific literature indicates that the combined use of ARIMA and VAR models enhances the accuracy of forecasting insurance indicators. While the ARIMA model allows for an in-depth analysis of the internal dynamics of individual time series, the VAR model ensures a more comprehensive forecasting approach by accounting for the interrelationships among variables. Therefore, the integrated application of these models has significant scientific and practical importance in identifying the development trends of the insurance market [23].

LITERATURE REVIEW

According to researchers A.V.Tregub and I.V.Tregub, if a time series becomes stationary after taking *d* successive differences, then a combined model consisting of autoregressive and moving average components – ARIMA(p,d,q) – can be applied to forecast its levels. In this abbreviation, the letter "I" stands for "integrated," indicating the use of differencing to achieve stationarity [4][24][25][26].

Scientists such as I.Hossack, J.Pollard, B.Zehnwirth, P.England, and R.Verrall have extensively studied the actuarial and mathematical foundations of insurance processes. Their scientific works emphasize the use of statistical regularities in assessing insurance risks, forecasting losses based on probability theory, and scientifically determining insurance tariffs. These approaches play a crucial role in ensuring the financial stability of insurance companies [5][27][28][29].

According to researcher O.D. Brykin, who conducted dissertation research in mathematical modeling, the main idea of the ARIMA model is that an observed time series can be represented as a combination of its past values (autoregression, AR), random fluctuations (moving average, MA), and, when necessary, differencing (integration, I) applied to achieve stationarity. The model is usually denoted as ARIMA(p,d,q),

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where p represents the order of autoregression, d is the degree of differencing (the number of applied differences), and q denotes the order of the moving average [6][30].

Researchers M. Faiziyeva and J.Saukhanov have paid particular attention to the application of econometric tools in assessing the stability of the national economy [7][31]. In their scientific works, it is substantiated that the use of regression, time series, and panel data models allows for a comprehensive and in-depth analysis of economic development processes [8][32].

RESEARCH METHODOLOGY

In this study, econometric methods were used to analyze and forecast insurance market indicators. Empirical data consisted of insurance premiums, insurance claims, insurance reserves, and authorized capital formed during the period 2016–2025. Initially, time series were constructed, their stationarity was tested, and differencing was applied where necessary. For forecasting purposes, the ARIMA model was used to evaluate the dynamics of individual indicators, while the VAR model was applied to analyze the interrelationships among variables. Based on the obtained results, trends and forecasts for the development of the insurance market were formulated.

RESULTS AND DISCUSSION

Significant reforms are being implemented in the insurance market of our country. In particular, starting from August 1, 2025, it is предусмотрено the centralized registration, storage, transmission, and accounting of each insurance policy within the Unified automated information system. Furthermore, beginning from April 1, 2026, payments for insurance premiums under policies issued in the Unified automated information system will be processed centrally through the Unified Insurance Billing System [9][33][34][35].

These developments indicate a high level of digitalization in the sector and enable the formation of a reliable and comprehensive database on the volume of insurance services, financial flows, and operational indicators through systematic record-keeping. In turn, this creates an important methodological foundation for conducting in-depth econometric analysis of insurance service volumes, identifying development trends, and developing scientifically grounded forecasts.

In this study, the main financial indicators of the insurance market of Uzbekistan – total authorized capital, insurance reserves, insurance claims, and insurance premiums – were analyzed for the period 2016-2025. Based on these indicators, time series were constructed, and econometric analysis was carried out using ARIMA and VAR models (Table 1).

Table 1 Analysis of the financial condition of insurance organizations in the Republic of Uzbekistan

Years	Indicators			
	Total authorized capital (billion UZS)	**Insurance reserves (billion UZS)**	**Insurance claims (billion UZS)**	**Insurance premiums (billion UZS)**
2016	443,1	428,4	131,2	692,6
2017	321	566,7	269,9	927,4
2018	543	766	450,8	1635,2
2019	755,2	1112,2	813,5	2313,9
2020	1439,1	1560,4	737,5	2213,7
2021	1512,8	1899,6	802,4	2632,5
2022	1685,2	755,1	845,9	2712,1
2023	2299	1522,5	1568,5	7737,2
2024	2963,7	2382,6	2204,5	9770,1
2025	4005,5	3922,1	2985,5	13463,5

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According to the analysis results, insurance premiums increased more than 19 times during the period 2016-2025, indicating high growth rates in the market. Insurance claims have also shown steady growth, reflecting the expansion of risks. The sharp decline in insurance reserves in 2022 suggests the presence of certain structural changes in the system. The total authorized capital demonstrates a stable upward trend, indicating the strengthening financial position of insurance companies.

In the time series analysis, stationarity was initially tested. Since most of the indicators exhibited a trend component, they were transformed into stationary series using first-order differencing (d=1).

The ARIMA model is generally expressed as follows:

ARIMA (p,d,q)

As a result of the analysis:

– ARIMA (1,1,1) was found to be the most appropriate model for insurance premiums;

– ARIMA (1,1,0) for insurance claims;

– ARIMA (0,1,1) for authorized capital.

In this study, the dynamics of the main financial indicators of the insurance market of Uzbekistan – total authorized capital, insurance reserves, insurance claims, and insurance premiums – were analyzed for the period 2016-2025 using econometric methods. Initial statistical observations showed that all indicators generally exhibit an upward trend, with particularly rapid and significant growth observed in insurance premiums. Specifically, during the analyzed period, the volume of insurance premiums increased several times, reflecting the expansion of the insurance market. At the same time, the growth in insurance claims indicates an increase in risks and obligations, which can be explained by the intensification of insurance activities. In certain years, particularly in 2022, a sharp decline in insurance reserves was observed, suggesting the presence of structural changes in the market or the influence of external economic factors.

The time series analysis revealed a clear trend component in all indicators, and since they were non-stationary, they were transformed into stationary series through first-order differencing. Based on ARIMA model estimations, optimal parameters were selected for insurance premiums, insurance claims, and authorized capital, and the randomness of residuals confirmed the adequacy of the models. The obtained results demonstrate that the ARIMA model provides high accuracy in forecasting future values of insurance indicators. In particular, insurance premiums are expected to maintain a stable growth trend in the future, indicating an increasing demand for insurance services and further expansion of the market.

To conduct multivariate econometric analysis, the VAR model was applied. The VAR model is expressed in the following form:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \varepsilon_t$$

Through this model, interrelationships among the variables were identified, revealing a strong positive relationship between insurance premiums and insurance claims. It was also determined that an increase in authorized capital has a stimulating effect on all other indicators. Furthermore, changes in insurance reserves were observed to have a significant impact on system stability and solvency.

However, an important methodological limitation emerged in the application of the VAR model, namely the insufficient length of the time series, which reduces the accuracy of parameter estimation. From a theoretical perspective, it is recommended that VAR models be applied with at least 20-30 observations, as the number of estimated parameters increases rapidly depending on the square of the number of variables. In this study, only 10 observations were available, which may lead to issues such as overparameterization, multicollinearity, and increased forecasting errors. Therefore, although the results of the VAR model are useful for identifying general trends among variables, their statistical reliability should be interpreted with caution.

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CONCLUSIONS

Based on the results of this study, it can be concluded that the insurance market indicators of Uzbekistan have demonstrated a stable and rapid growth trend in recent years. In particular, the analysis of the dynamics of insurance premiums, claims, authorized capital, and insurance reserves indicates that the role of this sector in the economic system is steadily increasing. This can be explained by the growing demand for insurance services, the development of financial institutions, and the improvement of risk management systems.

In general, the results of the conducted scientific research confirm the high effectiveness of the ARIMA model in forecasting insurance indicators, as well as the importance of the VAR model in identifying systemic interrelationships among variables. At the same time, for achieving more reliable results in future research, it is advisable to use longer time series, apply additional econometric models, and conduct a deeper analysis of external factors affecting the insurance market. These approaches are essential for ensuring the sustainable development of the insurance system and for providing a scientific basis for strategic decision-making processes.

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