UDK 336.76:004

DEVELOPMENT OF A METHOD AND SOFTWARE FOR FORECASTING AND RISK MANAGEMENT IN THE FINANCIAL MARKETS OF SECURITIES

VADYM VOLKOV, OLEKSANDR KHOSHABA, VNTU, (pzmag2022@gmail.com)

Abstract: This research focuses on developing a novel method and software tool to improve forecasting accuracy and manage risk in securities financial markets. The primary goal is to design a solution integrating advanced statistical models with machine learning algorithms to predict market trends and minimize financial risks. We also want to improve prediction accuracy and enhance risk mitigation strategies by integrating machine learning techniques and stochastic modeling. The methodology involves collecting data from historical market trends, analyzing them through advanced algorithms, and implementing predictive models to manage financial risks effectively. Initial results demonstrate significant improvements in prediction accuracy and risk mitigation, contributing to better decision-making processes in volatile financial environments. The results indicate a significant improvement in prediction accuracy and the optimization of risk management strategies, demonstrating the practical applicability of the developed method and software. The proposed system has been validated through backtesting and stress-testing scenarios using real-world market data.

In today's fast-paced financial environment, accurately forecasting market trends and managing risks are critical to ensuring success in the securities market. Financial markets' volatility and complexity make them unpredictable, leaving financial institutions vulnerable to significant losses. This challenge is further compounded by the growing reliance on automated trading systems, which require real-time data processing and advanced prediction capabilities. So, financial markets, characterized by their volatility and complex dynamics, present significant challenges in forecasting and risk management. Securities, including stocks, bonds, and derivatives, are particularly susceptible to market fluctuations, making effective risk management essential for investors and institutions.

Recent advances in computational tools and machine learning (ML) techniques have shown promise in improving forecasting accuracy and mitigating risks. However, integrating these technologies in the practical domain of financial securities remains an active research area. The increasing complexity of financial markets and the rapid growth of available market data demand innovative approaches beyond traditional statistical methods. Conventional forecasting models, while helpful, often fall short in highly volatile environments where rapid and unexpected market movements can lead to substantial financial losses. The unpredictability of external factors such as political events, economic shifts, and natural disasters further exacerbates the challenge. This research addresses these limitations by developing a method and software that leverage modern ML algorithms and stochastic models to enhance forecasting accuracy and improve risk management practices.

Also, the problem of forecasting and risk management in the securities markets has long been a subject of interest for researchers and practitioners alike. However, many traditional models, such as linear regressions and moving averages, often need to capture the complexities of financial data. These models struggle with dynamic market behaviors, including sudden volatility spikes, geopolitical impacts, and other external factors.

The primary objective of this study is to create a robust forecasting tool capable of analyzing vast amounts of market data in real-time, predicting potential risks, and assisting in dynamic portfolio management. By offering more accurate forecasts and improved risk assessments, this tool will enable financial institutions to make more informed decisions, minimize losses, and optimize returns.

Therefore, there is a pressing need for more sophisticated approaches to improve market predictions' accuracy and enhance risk management mechanisms. In light of this, this research aims to develop an advanced method and software tool that integrates cutting-edge techniques in machine learning and statistical analysis to address these challenges effectively. The main objectives of this study are to (1) improve the accuracy of forecasting models using time-series analysis and machine learning algorithms, (2) optimize risk management strategies through Monte Carlo simulations, and (3) develop a user-friendly software solution that traders and analysts can employ in the financial sector.

The methodology employed in this research combines machine learning algorithms, stochastic modeling, and financial data analytics. The core focus is predicting future trends in the securities market, emphasizing risk assessment and mitigation. The following methods are central to the research:

- data collection and preprocessing, where historical market data, including stock prices, trading volumes, and macroeconomic indicators, were collected from public financial databases. Data preprocessing involved filtering noise, handling missing values, and normalizing data for input into the model;

- machine learning algorithms, where various ML algorithms, including decision trees, support vector machines, and neural networks, were trained on the historical data to forecast future trends. These models were optimized using grid search and cross-validation to improve prediction accuracy;

- stochastic modeling, where stochastic differential equations (SDEs) were integrated into the forecasting model to account for market volatility and uncertainty. The SDEs allow the model to simulate multiple market scenarios and assess risks associated with each scenario;

- backtesting and stress testing, where the models were tested using historical data through backtesting to evaluate their performance in predicting past market trends. Additionally, stress testing was conducted to simulate extreme market conditions and assess the robustness of the risk management framework.

- software development, where a user-friendly software tool was developed to implement the forecasting and risk management methods. The software offers real-time analysis and visualization, enabling portfolio managers to dynamically monitor market trends and adjust investment strategies.

This methodological approach ensures a comprehensive and adaptable solution for forecasting and managing risks in securities' financial markets.

The study employs time-series analysis, Monte Carlo simulations, and machine learning techniques to forecast securities market trends and manage financial risks. Time-series analysis is used to understand historical market data and identify patterns that may influence future movements. Techniques such as autoregressive integrated moving average (ARIMA) models and exponential smoothing are applied to capture seasonality and trends. Monte Carlo simulations are integrated to generate probabilistic forecasts based on various possible market scenarios. This method helps assess potential risks by running thousands of simulations considering various market conditions, from stable environments to high volatility. By evaluating the distribution of possible outcomes, this approach enables the optimization of risk management strategies.

In addition, machine learning algorithms, particularly neural networks and decision trees, are employed to analyze large datasets and refine predictions. Neural networks, specifically Long-Short-Term Memory (LSTM) models, are designed to handle the non-linear nature of financial data and predict market fluctuations with greater accuracy. Combining these techniques forms the backbone of the software developed in this research, allowing users to run complex analyses and make informed decisions in real-time.

The scientific novelty of this research lies in integrating machine learning techniques with stochastic modeling to enhance the accuracy of market forecasting and the robustness of risk management strategies. While previous studies have explored the use of ML algorithms in financial forecasting, few have effectively incorporated stochastic elements to account for market volatility and uncertainty. This research addresses this gap by developing a hybrid model that combines the strengths of both approaches. Developing a software tool specifically designed for real-time forecasting and risk management also represents a significant advancement in the field. The tool's ability to dynamically adjust portfolio strategies based on real-time data sets it apart from existing solutions, which often rely on static models. By incorporating real-time market data and continuously updating forecasts, the software enables financial institutions to respond more effectively to market changes, reducing the likelihood of significant financial losses. Backtesting and stress testing to validate the models further enhance this work's scientific contribution. These testing methods ensure that the models perform well in stable market conditions and periods of extreme volatility, making the system highly reliable for real-world applications.

This research introduces several innovative elements to financial forecasting and risk management. First, integrating machine learning algorithms, particularly LSTM models, with traditional time-series analysis methods provides a more accurate approach to predicting market trends. Previous studies have often relied on either one or the other. Still, the combination presented here allows for more robust predictions that account for linear and non-linear financial data patterns. Second, using Monte Carlo simulations to enhance risk management strategies is a novel approach in the securities market. While Monte Carlo methods have been applied in other fields, their integration into financial forecasting tools is limited. This study demonstrates how these simulations can anticipate various market scenarios, enabling traders and analysts to adopt more flexible and proactive risk management strategies. Third, developing a user-friendly software tool that integrates these advanced forecasting and risk management methods is a unique contribution. Unlike many existing tools that are either too complex or not sufficiently sophisticated, this software is designed to be accessible to expert financial analysts and those with limited technical knowledge. Its intuitive interface allows for real-time analysis, making it a practical solution for day-to-day trading operations.

The research presented in this study highlights the effectiveness of combining time-series analysis, Monte Carlo simulations, and machine learning algorithms to improve forecasting accuracy and risk management in securities financial markets. The developed method and software tool provide a novel approach to handling the complexities of financial data, offering significant improvements over traditional forecasting models. The development of a real-time software tool offers practical benefits for financial institutions, enabling dynamic portfolio management and enhanced risk mitigation.

The results of this study indicate that the proposed system significantly outperforms traditional forecasting methods, particularly in volatile market environments. By providing more accurate forecasts and real-time risk assessments, the software contributes to more informed decision-making processes in the financial sector.