

# A Hybrid Artificial Intelligence Framework for Stock Market Prediction Using Price, Sentiment and Macro Economic Indicators

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## Abstract

Artificial Intelligence (AI) models are used to predict stock market trends and help investors make better investment decisions. To study this topic, keywords related to AI and stock market prediction were searched in the Scopus and Web of Science databases. A total of 69 research titles were reviewed, and 43 systematic review papers covering more than 379 studies were examined. From these, ten studies were finally selected for detailed analysis. The study found that Support Vector Machines (SVM), Long Short-Term Memory (LSTM), and Artificial Neural Networks (ANN) are the most commonly used AI methods for predicting stock markets. Most prediction models mainly use historical closing stock prices as their data source. Accuracy is the most frequently used measure to evaluate model performance. And the study also identified several research gaps and areas for future work. Future studies should explore additional data sources and their combinations, as well as compare different AI methods and strategies, since each method may perform better under certain conditions. Finally, better evaluation measures and standards are needed to clearly show the real usefulness and impact of stock market prediction models.

## INTRODUCTION

Predicting the stock market is difficult, but it is very important for investors, traders, and researchers. Many methods have been developed to forecast stock prices, including mathematical, statistical, and Artificial Intelligence (AI) techniques. In recent years, AI-based methods especially Machine Learning (ML) and Deep Learning (DL) have gained significant attention because of their strong performance in prediction tasks. Although Different researchers have studied the relationship between AI techniques and stock market prediction from various viewpoints. Several studies show that using hybrid approaches, which combine multiple AI techniques and different types of data, can improve prediction accuracy. However, the performance of AI models depends on many factors such as data quality, feature selection, model structure, parameter tuning, and evaluation methods.

In this study, the definitions of AI, ML, and DL follow the explanation given by Jakhar and Kaur (2020). AI refers to computer systems that show human-like intelligence. ML is a part of AI that allows computers to learn from data without being explicitly programmed. ML systems learn patterns from data and use them to make decisions. Deep Learning is a further subset of ML and is based on artificial neural networks that are inspired by the

human brain. DL models are especially good at handling complex and unstructured data, but they require large amounts of data and high computing resources. Although many review studies have examined AI-based stock market prediction, there is still no agreement on which AI methods work best or are most suitable. Some recent reviews have highlighted gaps in existing research and emphasized the need to rethink current approaches to AI-based stock prediction. The Traditional financial theories such as the Random Walk Model and the Efficient Market Hypothesis suggest that stock prices change based on new information that cannot be predicted in advance. However, research in behavioural finance and socio-economic analysis shows that stock market movements can be predicted to some extent using patterns in data. Recent studies show that stock market prediction methods can be broadly divided into two groups: mathematical methods and AI-based methods. Mathematical methods mainly use statistical techniques, while AI-based methods use machine learning algorithms. Most recent research focuses on ML-based approaches, including deep learning models. From this view, stock prediction techniques can be classified into traditional machine learning methods and deep learning or neural network models. One important research

question is identifying which of these methods are used most often and perform best.

This paper presents a meta-review that analyses recent research on AI-based stock market prediction across fields such as economics, finance, statistics, and computer science. The study systematically examines and compares existing review papers to summarize their findings and assess the strength of the evidence. The goal is to support better research design and decision-making in future studies.

The main objective of this work is to support future stock market investment strategies. It aims to identify the most commonly used AI algorithms, the types of data used for prediction, and the performance metrics applied in existing research.

In addition, this study seeks to identify gaps, limitations, and weaknesses in current review papers and suggest ways to improve the quality and reliability of future reviews. It also highlights areas where researchers agree or disagree and explores possible reasons for conflicting results. Finally, the study identifies new trends, challenges, and opportunities in AI-based stock market prediction and suggests directions for future research.

This meta-review focuses only on studies that use AI techniques such as machine learning, deep learning, neural networks, support vector machines, and sentiment analysis for stock market prediction. Studies related to other topics, such as market risk, volatility, portfolio optimization, or trading strategies, are excluded. Reviews that use only mathematical or statistical methods without AI techniques are also excluded.

## LITERATURE REVIEW

Traditional statistical models are not very effective in predicting stock markets because they cannot handle complex, nonlinear, and changing financial patterns. Due to this limitation, artificial intelligence (AI) has become widely used in stock market prediction. Earlier studies mainly relied on classical econometric time-series models, but recent research shows that machine learning (ML) and deep learning (DL) methods provide better results. This is because AI models can learn complex and nonlinear relationships from financial data.

Among AI techniques, Support Vector Machines (SVM), Long Short-Term Memory (LSTM)

networks, and Artificial Neural Networks (ANN) are the most commonly used methods. LSTM is especially suitable for stock price prediction because it can handle long-term time dependencies and solve the vanishing gradient problem. SVM is mostly used for classification tasks, such as predicting whether stock prices will rise or fall. Studies also report that hybrid and ensemble models, which combine multiple AI techniques, achieve higher prediction accuracy.

Most prediction models mainly use historical stock price data. However, recent studies emphasize the importance of using sentiment and textual data, such as financial news and social media posts, to capture investor emotions and market psychology. Research shows that combining sentiment analysis with technical indicators improves prediction performance.

Model evaluation is another important aspect discussed in the literature. Commonly used performance measures include accuracy, mean squared error (MSE), mean absolute error (MAE), root mean squared error (RMSE), and mean absolute percentage error (MAPE). Among these, accuracy and MSE are used most frequently. However, researchers suggest that the choice of evaluation metrics should be clearly justified.

Recent studies also point out several limitations in existing research. These include poor analysis of model parameters, difficulty in understanding model behaviour, limited focus on predicting individual stocks rather than market indices, lack of standard datasets, and problems in applying models to different market conditions.

Future research should focus on making prediction models more practical and easier to interpret. It should also use larger and more diverse datasets and compare different AI methods more thoroughly. Overall, current studies show that AI-based methods—especially LSTM, SVM, and ANN—are very promising for stock market prediction. However, better validation methods and improved research techniques are needed to make these models more useful in real-world applications.

## RESEARCH OBJECTIVE

The main goal of this project is to design and test a hybrid Artificial Intelligence (AI) system that uses deep learning, machine learning, and sentiment

analysis together to improve the accuracy of stock market predictions.

The specific objectives of the project are:

- To study and summarize existing research on AI-based stock market prediction, especially methods using machine learning, deep learning, and hybrid approaches.
- To develop a hybrid AI model by combining deep learning models for time-series data (such as LSTM and GRU), machine learning models (such as SVM and XG Boost), and sentiment analysis techniques.
- To integrate different types of data, including past stock prices, technical indicators, and sentiment information from financial news and social media, into one prediction system.
- To evaluate the performance of the proposed model using standard prediction and classification measures such as MSE, RMSE, MAE, MAPE, Accuracy, Precision, Recall, and F1-score.
- To compare the hybrid model with individual AI models to determine how much the hybrid approach improves prediction accuracy and reliability.
- To identify the limitations of AI-based stock market prediction methods and discuss practical challenges, while also suggesting directions for future research.

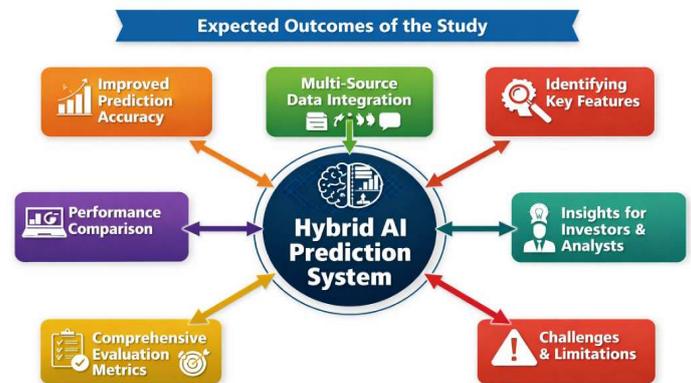
## EXPECTED OUTCOME

This study is expected to produce the following outcomes:

- Development of a hybrid AI system that successfully combines deep learning, machine learning, and sentiment analysis for predicting stock market movements.
- Better prediction results, with higher accuracy and fewer errors compared to using only one model, such as LSTM or SVM alone.
- Proof that using multiple data sources—like past stock prices, technical indicators, and sentiment from news and social media—leads to more reliable predictions than using price data alone.
- Identification of the most important features and types of data that improve prediction accuracy, which can help in building better models in future research.

- A detailed performance comparison using different evaluation measures, including accuracy, RMSE, MAPE, MAE, precision, recall, and F1-score, for both research and real-world use.
- Creation of a general prediction model that can be applied to both individual stocks and stock market indexes.
- Practical insights into how AI-based predictions can support investors, analysts, and financial decision-makers.
- Clear identification of limitations and challenges, such as noisy data, difficulty in understanding model decisions, and market volatility, to guide future research.

Fig 1.1 Outcome of the study



## CONCLUSION & FUTURE WORK

This study reviewed previous research on AI-based stock market prediction and proposed a hybrid AI model that combines deep learning, machine learning, and sentiment analysis. The review showed that models like LSTM, ANN, and SVM are commonly used because they can capture complex market patterns. However, earlier studies had problems such as using different evaluation methods, limited data sources, and poor comparison between models. And to address these issues, this study introduced a hybrid approach that combines historical stock prices, technical indicators, and investor sentiment. This model is expected to predict market trends more accurately and reduce prediction errors compared to single AI models. The results highlight the usefulness of hybrid AI systems for stock market forecasting. For future work, the model can be tested in different markets, sectors, and economic

conditions. More data sources such as economic indicators, global events, and alternative data can be added. Advanced AI methods like transformers and reinforcement learning can also be explored. Future studies should focus on making AI models easier to understand and test them in real trading environments. Finally, real financial outcomes such as profit and risk should be evaluated to connect prediction accuracy with real-world success.

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