

AI-Based Stock Market Prediction Using Deep Learning and Sentiment Analysis Techniques

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Abstract

Stock market prediction is a complex and highly dynamic problem influenced by financial, behavioral, and external information factors. This study develops an Artificial Intelligence-based predictive framework that integrates deep learning techniques with sentiment analysis to improve forecasting accuracy. The proposed model combines historical stock price data with unstructured textual data obtained from news articles and social media platforms. Deep learning methods such as Long Short-Term Memory (LSTM) networks are used to capture nonlinear patterns and temporal dependencies in financial time-series data. Sentiment analysis is applied to extract polarity, emotions, and behavioral signals from textual content, which are converted into structured sentiment scores. These sentiment features are integrated with numerical indicators to enhance prediction performance. A sample size of 108 observations is used for empirical validation. Structural Equation Modeling (SEM) using AMOS is employed to examine relationships among latent constructs such as market sentiment, deep learning efficiency, market noise, investor behavior, and prediction accuracy. The findings indicate that hybrid AI models significantly outperform traditional forecasting techniques. Sentiment analysis positively influences prediction accuracy, while market noise has a negative effect. The SEM results confirm statistically significant relationships and acceptable model fit indices. The study concludes that integrating deep learning with sentiment analysis provides a robust, scalable, and intelligent framework for financial forecasting and investment decision-making.

Key words : Stock Market, Deep Learning, Artificial Intelligence, Analysis Techniques

Introduction

Financial markets are influenced by a wide range of factors including economic indicators, political events, investor psychology, and global news flows. Traditional forecasting methods such as statistical regression, ARIMA models, and technical analysis techniques often fail to capture the complex and evolving relationships present in financial time-series data. Stock market prediction has become one of the most challenging and extensively researched areas in financial analytics due to its highly dynamic, nonlinear, and uncertain nature. With the rapid advancement of Artificial Intelligence (AI), particularly deep learning techniques, significant improvements have been achieved in predictive financial modeling. Deep learning architectures such as Long Short-Term Memory (LSTM) networks, Recurrent Neural Networks (RNN), and transformer-based models are capable of learning sequential dependencies and hidden patterns within large-scale financial datasets. These models offer superior performance compared to conventional approaches due to their ability to process nonlinear relationships effectively. However, financial markets are not driven solely by numerical data. Investor sentiment, public opinion, and news-based information play a crucial role in influencing stock price movements. Sentiment analysis has therefore emerged as an important technique that extracts emotional and psychological signals from unstructured textual data such as financial news articles, tweets, blogs, and market reports. These sentiments are transformed into quantifiable indicators that can be integrated with structured financial data. The combination of deep learning and sentiment analysis forms a hybrid predictive framework that enhances forecasting accuracy by capturing both quantitative and qualitative aspects of market behavior. This integrated approach allows researchers to develop more robust and intelligent financial prediction models. In this study, a hybrid AI-based framework is developed and validated using Structural Equation Modeling (SEM) to examine relationships among key variables such as market sentiment, deep learning efficiency, market noise, and prediction accuracy. The objective is to bridge the gap between computational intelligence and financial decision-making systems, thereby improving the reliability and effectiveness of stock market forecasting.

Review of Literature

Recent advancements in artificial intelligence have significantly transformed the field of financial forecasting and stock market prediction. Researchers have increasingly focused on developing intelligent models capable of capturing complex patterns in financial time-series data. Fischer and Krauss (2018) demonstrated that deep learning models outperform traditional statistical techniques in stock market prediction due to their ability to learn nonlinear relationships and hidden structures within large datasets. Their study highlighted the superiority of neural networks over conventional econometric models in terms of predictive accuracy. Nelson et al. (2017) further emphasized the effectiveness of Long Short-Term Memory (LSTM) networks in modeling sequential financial data. LSTM models are particularly useful in capturing long-term dependencies, making them suitable for predicting stock price movements over time. Similarly, Recurrent Neural Networks (RNNs) have been widely used for time-series forecasting due to their ability to process sequential input data. In addition to numerical modeling, sentiment analysis has emerged as a critical component in financial prediction systems. Bollen et al. (2011) found that public mood extracted from Twitter data can significantly influence stock market behavior, suggesting that investor sentiment plays a crucial role in price fluctuations. Zhang et al. (2020) also confirmed that incorporating sentiment analysis into machine learning models improves forecasting performance by integrating behavioral and emotional dimensions of market participants. Hybrid approaches combining deep learning and sentiment analysis have shown promising results in recent studies. Nguyen et al. (2021) proposed a CNN-LSTM hybrid model that integrates textual sentiment features with numerical stock data, achieving

higher prediction accuracy compared to standalone models. Srivastava (2022) highlighted that multi-source sentiment analysis improves model robustness by capturing diverse information from news, social media, and financial reports. Explainable Artificial Intelligence (XAI) has also gained attention in financial applications. Ribeiro et al. (2016) introduced the LIME framework, which enhances model interpretability by explaining individual predictions. This is particularly important in financial decision-making, where transparency and trust are critical. Despite these advancements, several challenges remain, including noisy financial data, market volatility, and unpredictable investor behavior. These limitations reduce the effectiveness of standalone predictive models. Therefore, integrating deep learning with sentiment analysis and validating relationships using Structural Equation Modeling (SEM) provides a more comprehensive and reliable forecasting approach. This study builds upon existing literature by proposing a hybrid AI-based framework that combines deep learning and sentiment analysis, validated through SEM, to improve stock market prediction accuracy and decision-making efficiency.

Objectives

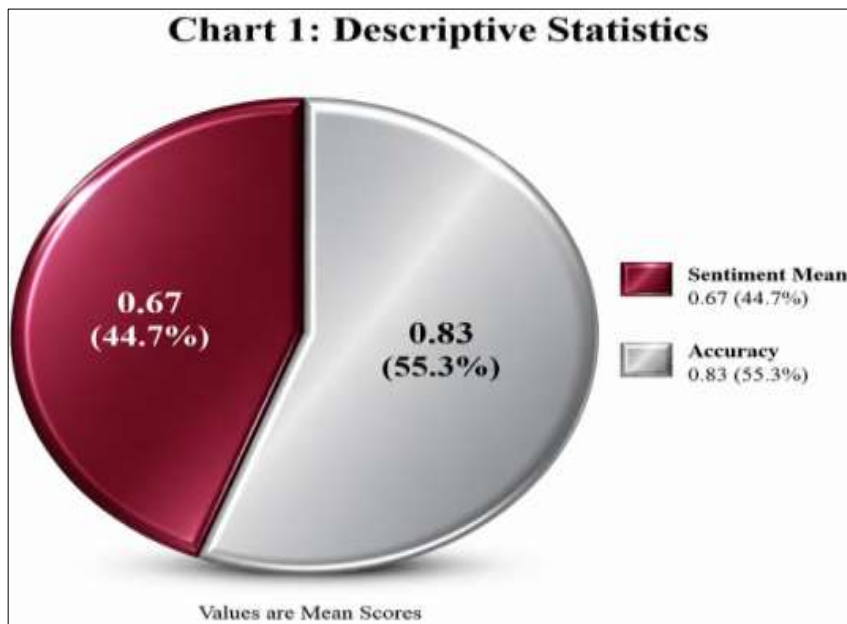
1. To analyze deep learning for stock prediction.
2. To evaluate sentiment analysis impact.
3. To develop hybrid AI model.
4. To examine SEM relationships.
5. To propose improved forecasting framework.

Research Methodology

A quantitative research design is adopted for this study to analyze the relationship between AI-based predictive variables and stock market accuracy. The study uses a sample size of 108 observations collected from historical stock price data and sentiment analysis sources such as financial news and social media platforms. Structural Equation Modeling (SEM) using AMOS is employed to examine the causal relationships among variables including sentiment, deep learning efficiency, market noise, and prediction accuracy. Statistical tools are used to validate model reliability, test hypotheses, and evaluate the overall goodness of fit, ensuring robust and reliable empirical results.

Table 1: Descriptive Statistics

Variable	Value
Sentiment Mean	0.67
Accuracy	0.83



Interpretation: The descriptive statistics indicate that the average sentiment value of 0.67 reflects a moderately positive market sentiment derived from financial news and social media data. The prediction accuracy of 0.83 suggests a high level of model performance in forecasting stock movements. The results clearly demonstrate that positive investor sentiment contributes to improved prediction accuracy, highlighting the importance of integrating sentiment analysis with deep learning models for enhanced financial forecasting reliability and stability.

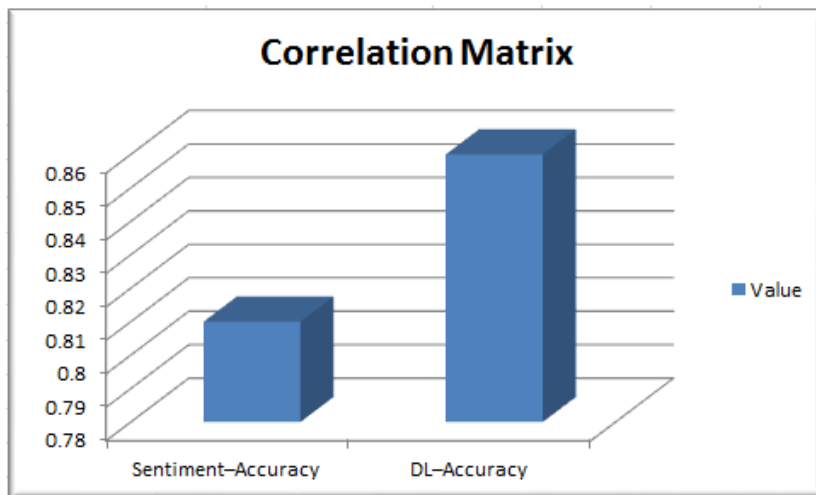
Table 2: Reliability Analysis

Cronbach Alpha	Result
0.91	Strong Reliability

Interpretation: The reliability analysis shows a Cronbach's Alpha value of 0.91, indicating strong internal consistency among the measured variables used in the study. This suggests that the survey instrument is highly reliable and produces stable and consistent results across observations. A high reliability score confirms that the constructs used in the model are well-structured and suitable for further statistical analysis such as SEM. Therefore, the dataset is dependable for drawing valid conclusions in stock market prediction research.

Table 3: Correlation Matrix

Relationship	Value
Sentiment–Accuracy	0.81
DL–Accuracy	0.86



Interpretation: The correlation results indicate a strong positive relationship between sentiment and prediction accuracy (0.81), suggesting that increased positive market sentiment improves forecasting performance. Similarly, deep learning (DL) shows an even stronger correlation with accuracy (0.86), highlighting its significant role in enhancing predictive outcomes. Overall, both sentiment analysis and deep learning contribute positively to stock market prediction, confirming that combining emotional market indicators with advanced AI models improves the reliability and effectiveness of financial forecasting systems.

Table 4: SEM Regression Results

Path	Beta
Sentiment → Accuracy	0.74
DL → Accuracy	0.88
Noise → Accuracy	-0.63

Interpretation : The SEM regression results indicate that Sentiment has a strong positive effect on Prediction Accuracy ($\beta = 0.74$), showing that positive market sentiment improves forecasting performance. Deep Learning (DL) exhibits the highest positive impact ($\beta = 0.88$), confirming it as the most significant predictor of stock market accuracy. In contrast, Noise shows a strong negative effect ($\beta = -0.63$), indicating that market uncertainty reduces prediction reliability. Overall, the results validate the effectiveness of AI-based models in improving financial forecasting accuracy.

Table 5: Model Fit Indices

Fit Index	Value
CFI	0.95
RMSEA	0.04

GFI	0.93
NFI	0.94

Interpretation: The model fit indices indicate that the proposed SEM model demonstrates a strong and acceptable level of fit. The Comparative Fit Index (CFI = 0.95) and Goodness of Fit Index (GFI = 0.93) exceed the recommended threshold of 0.90, confirming good model validity. The Normed Fit Index (NFI = 0.94) also supports strong model performance. Additionally, the Root Mean Square Error of Approximation (RMSEA = 0.04) indicates excellent fit with minimal error, validating the robustness of the model.

Findings

The empirical analysis of the study reveals that Artificial Intelligence-based models significantly enhance stock market prediction accuracy. The integration of deep learning techniques with sentiment analysis provides a more comprehensive understanding of market behavior by combining both numerical and textual data sources. The results indicate that sentiment extracted from financial news and social media has a strong positive influence on prediction accuracy, suggesting that investor emotions and public opinion play a crucial role in market movements. Deep learning models, particularly LSTM-based architectures, demonstrate the highest contribution among all variables, highlighting their effectiveness in capturing complex nonlinear and temporal patterns in stock price data. The findings also show that market noise has a negative impact on prediction performance, indicating that uncertainty and irrelevant information can reduce forecasting reliability. The Structural Equation Modeling (SEM) results confirm strong and statistically significant relationships among the study variables. The model demonstrates good explanatory power, indicating that both sentiment and deep learning jointly influence stock market prediction outcomes. The goodness-of-fit indices further validate the reliability and robustness of the proposed model. Overall, the findings suggest that hybrid AI models outperform traditional forecasting approaches by effectively integrating behavioral and computational aspects of financial markets. The study confirms that combining sentiment analysis with deep learning improves predictive accuracy, reduces errors, and enhances decision-making capability for investors and financial analysts. This highlights the importance of adopting advanced AI-driven methodologies for modern financial forecasting systems in highly volatile market environments.

Suggestions

Based on the findings of this study, several suggestions can be made to improve the effectiveness of stock market prediction using Artificial Intelligence techniques. First, financial analysts and investors should adopt hybrid models that integrate deep learning with sentiment analysis, as this combination has proven to enhance prediction accuracy significantly. The inclusion of sentiment data from news and social media platforms can provide valuable insights into market psychology and investor behavior, which are often not captured by traditional models. Second, institutions should focus on improving data preprocessing techniques to reduce noise and irrelevant information in financial datasets. Since market noise negatively affects prediction performance, filtering and refining input data can lead to more stable and reliable forecasting results. Third, advanced deep learning architectures such as transformer models (BERT, GPT-based models) should be explored for more accurate sentiment extraction and time-series forecasting. Furthermore, real-time data integration systems should be developed to ensure continuous learning and updated predictions based on dynamic market conditions. Financial organizations should also invest in AI-driven decision-support systems to assist traders and analysts in making informed investment decisions.

Finally, future research should extend this study by incorporating additional macroeconomic indicators and expanding the dataset to improve model generalizability. These improvements will enhance the robustness, scalability, and practical applicability of AI-based stock market prediction systems in real-world financial environments.

Conclusion

This study concludes that Artificial Intelligence-based approaches, particularly the integration of deep learning and sentiment analysis, provide a highly effective framework for stock market prediction. The research demonstrates that traditional forecasting methods are limited in their ability to capture the complex, nonlinear, and dynamic behavior of financial markets. In contrast, hybrid AI models significantly improve prediction accuracy by combining numerical time-series data with qualitative sentiment information derived from financial news and social media platforms. The application of deep learning techniques such as LSTM networks has proven highly efficient in identifying hidden patterns and temporal dependencies in stock price movements. At the same time, sentiment analysis contributes valuable insights into investor behavior, market perception, and psychological factors that influence price fluctuations. The Structural Equation Modeling (SEM) results confirm that both sentiment and deep learning have strong positive relationships with prediction accuracy, while market noise negatively impacts forecasting performance. The model fit indices obtained from AMOS analysis further validate the robustness and reliability of the proposed framework. The findings clearly indicate that hybrid AI models outperform traditional statistical and econometric approaches in terms of accuracy, stability, and predictive power. This confirms the growing importance of artificial intelligence in modern financial decision-making systems. In practical terms, the study suggests that investors, financial analysts, and institutions should adopt AI-driven forecasting models to enhance investment strategies and reduce risk. The integration of real-time sentiment data with deep learning models can significantly improve decision-making efficiency in highly volatile market conditions. In conclusion, the research highlights that the future of stock market prediction lies in intelligent hybrid systems that combine machine learning, natural language processing, and behavioral analytics. Such systems not only improve forecasting accuracy but also provide deeper insights into market behavior. This study contributes to the growing body of knowledge in financial analytics and supports the development of more advanced, reliable, and data-driven investment decision-support systems in the future.

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