Creative Economy
2025, VOL. 9, NO. 2, 130-132
DOI: 10.47297/wspceWSP2516-251922.20250902

A review of hybrid models in stock price forecasting models

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ABSTRACT
With the increasing complexity and uncertainty of financial markets, traditional single forecasting models can no longer meet the needs of accurate forecasting. Hybrid models show significant advantages in stock price forecasting by integrating the advantages of multiple algorithms. This paper elaborates on the development process of traditional forecasting models and hybrid models, reviews the research progress of hybrid models in the field of stock price forecasting, and focuses on the application of hybrid models in stock price forecasting and their advantages and disadvantages. It is found that it can improve the accuracy of prediction, improve the applicability and reliability of the model in different scenarios, and improve the robustness and stability of the model, but it also faces challenges such as complex construction and optimization process. The purpose of this study is to provide a scientific basis for investors to make decisions, to provide a basis for policymakers to improve relevant laws and regulations, and to point out the future direction of academic research.

KEYWORDS
Stock price forecasting; Hybrid model; Prediction accuracy

1 Introduction

Stock price prediction has always been an important research topic in the financial field, which is of great significance to investor decision-making and risk management. With the rapid development of the financial market, the influencing factors of stock price fluctuations are becoming increasingly complex, and traditional forecasting methods have been difficult to deal with. In recent years, the application of hybrid models in stock price forecasting has attracted a lot of attention. By combining the advantages of multiple algorithms, the hybrid model can better capture the nonlinear characteristics and complex patterns of stock price changes and improve the prediction accuracy.

The purpose of this paper is to systematically review the research progress of hybrid models in stock price prediction models. Firstly, the background and traditional methods of stock price forecasting are introduced, and then the development process, application effect, advantages and disadvantages of the hybrid model are emphatically explained. Finally, the challenges and future development directions of hybrid models are discussed, so as to provide reference and enlightenment for related research.

2 Research status at home and abroad

In the field of traditional stock forecasting, a variety of classical methods are still widely used. Early stock price forecasting models were mainly based on traditional statistical methods, such as time series analysis (ARMA, ARIMA, etc.) and statistical machine learning (SVM, decision trees, etc.). These methods predict future stock price movements through the analysis and modeling of historical data. The GARCH model and its extended forms (such as EGARCH, TGARCH, etc.) are also important tools for stock price volatility prediction. However, due to the nonlinearity, non-stationarity, and complexity of the stock market, these traditional models have limited predictive accuracy. Yuehao Pan used a statistical method with uncertainty characteristics to establish a stock price prediction model for an uncertain time series, which expanded the applicability of uncertain statistics in financial modeling and effectively fitted Tencent's stock price. Guoshun Zhao and Rui Wan (2022) both studied stock price trends based on the GARCH model. Yuxia Wu (2016), Jianqiang Wan (2001) and Xiaoling Chen (2018) et al. used the ARIMA model for stock price research.

With the rapid development of machine learning technology, its application in stock forecasting is becoming more and more extensive. Machine learning models are able to process complex data relationships and discover market patterns that are difficult to capture with traditional methods. Deep learning models such as recurrent neural networks (RNNs), long short-term memory networks (LSTMs), and gated recursive units (GRUs) have demonstrated strong performance in stock forecasting. These models are able to capture long-term dependencies in stock price time series, improving the accuracy of forecasting. Zhongyuan Chen (2024), Tingyi Zhang (2024), J. Aswini (2024), and Zhenwen Li (2024) have all studied LSTM models. Dongyang Chen (2024) [1] proposed an online stock price prediction model (Increformer) based on incremental learning and sustained attention mechanism. Tong Wang (2022) conducts stock price forecasting research based on CNN model.

In addition, convolutional neural networks have become a research hotspot in the fields of speech recognition, image

recognition and classification, and natural language processing, and have been widely and successfully applied in these fields. A convolutional neural network prediction model suitable for financial time series data was established, and the model was applied to stock index forecasting. Combining the advantages of convolutional neural network to extract effective features and the good classification prediction ability of support vector machine, a hybrid model of convolutional neural network and support vector machine is proposed to predict stock index and improve the prediction accuracy. Fujia Gao (2019) [2] conducted an in-depth study of the BP model.

A single forecasting model is often difficult to cope with the complex and volatile financial markets. Therefore, the composite forecasting framework has become a hot topic of current research and the focus of this paper.

3 Application of hybrid model in stock price forecasting

A hybrid model is a statistical model that combines the advantages of many different models or algorithms. The core idea is to make up for the shortcomings of a single model by integrating the characteristics of multiple models, so as to achieve more comprehensive, flexible and effective functions. This model is widely used in a variety of fields, including machine learning, data science, and business and finance. Especially in financial markets, hybrid models play an important role in tasks such as market trend forecasting, risk assessment, and credit scoring. In the field of stock price forecasting, the application of hybrid models is also of great significance. The complexity of the stock market makes it difficult for a single model to accurately capture market dynamics, and hybrid models can process stock price time series data more efficiently and improve the accuracy of forecasts by combining the advantages of multiple models.

The development of hybrid models has gone through a process from simple combination to deep integration. In the early days, hybrid models mainly used simple series or parallel connections, Shikuo Fu [3] combined the Transformer model with Fourier frequency attention, etc., and Shaocong Wu (2017)[4] fused the time series dataset with the DB-ARIMA model and the deep learning model. Jiahui Li [5] combined the knowledge of support vector machine and Markov theory to establish the least squares support vector regression machine (LS-SVR) and Markov mixture model to improve the prediction accuracy of a single model.

Zhouyang Xin (2023) [6] aims to improve the Transformer model, establish a TST (Time-Series Transformer) model for time series forecasting, add LSTM to the Transformer structure, propose the LSTM-TST model, and then combine EMD and other signal decomposition methods with the above neural network model. A series of hybrid models were established. Yuankai Guo (2020) [7] proposed a stock price prediction model (DWT-GS-XGBoost) combining discrete wavelet transform and optimized XGBoost algorithm. Considering the advantages of DWT and XGBoost models, the discrete wavelet transform is used for data noise reduction and decomposition. Wenjiao Wang [8] proposed a hybrid model for stock prediction (RF_RFE-LSTM-TCNA) that combines recursive feature elimination (RF_RFE) based on random forest, long short-term memory network (LSTM), temporal convolutional neural network (TCN) and attention mechanism.

4 Advantages and disadvantages of hybrid forecasting models

4.1 Advantages

By combining the characteristics of different models, the hybrid model can make full use of their respective advantages, improve the overall performance, make up for the shortcomings of their respective models, more comprehensively capture the dynamic characteristics of stock prices, and improve the accuracy of forecasting. Through diversified design, the hybrid model can improve the applicability and reliability of the model in different scenarios. Traditional statistical models may struggle to capture nonlinear relationships in data, while machine learning models may be at risk of overfitting. By using a mixture, you can balance these shortcomings and improve the robustness and stability of the model. The hybrid model can be adjusted and optimized according to different scenarios and data characteristics, and is suitable for different types of stock price forecasting tasks. Yuankai Guo (2020) showed that the DWT-ARIMA-GSXGB stock price prediction model has better fitting ability and generalization ability through comparison with a single model, which greatly improves the prediction performance of a single ARIMA model or a single XGBoost model in predicting stock prices. The CNN-GRU-Attention model and the TCN-CBAM-Bi GRU model designed by Jinchao Qi [9] give full play to their respective advantages in feature extraction, time series analysis and key information capture, effectively improve the accuracy and performance of forecasting, and prove that the combination of multiple advanced technologies can effectively improve the performance of the stock price prediction model.

4.2 Challenges

First, the increased complexity of the model can lead to the risk of overfitting, especially if the amount of data is

limited. Second, the process of building and optimizing hybrid models is complex and requires a lot of computing resources and expertise. Furthermore, there is still a lack of unified theoretical guidance on how to choose the appropriate base model and combination strategy. In addition, hybrid models are often less interpretable, which can be a limiting factor in the financial sector where risk control is important.

5 Summary and outlook

Hybrid models have shown strong advantages in stock price forecasting, improving the accuracy, robustness, and adaptability of forecasts by combining the advantages of multiple models. However, there are still problems such as high complexity and high consumption of computing resources in stock price forecasting of hybrid models. In the future, the direction of hybrid models in stock price forecasting may include:

5.1 Optimizing the model architecture

Further simplify the model architecture, reduce the computational complexity, and improve the operation efficiency of the model.

5.2 Introducing new algorithms

Continuously explore and introduce new machine learning algorithms and deep learning techniques to improve the prediction performance of models.

5.3 Integrating multi-source information

In addition to stock price data, other relevant information, such as social media data, news reports, etc., can be introduced to reflect market dynamics more comprehensively.

5.4 Strengthening the explanatory nature of the model

While improving the forecast performance, we should pay attention to the explanatory nature of the model to provide investors with more intuitive and easy-to-understand forecast results.

All in all, the hybrid model has a broad application prospect and far-reaching research significance in stock price forecasting. In the context of today's era, more effective model combinations are still worthy of continuous exploration by researchers.

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