International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 05 May 2026
Page No: 3579-3584
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0466

Analyzing Machine Learning Algorithms For Predictive Modeling Of Financial Securities: The Case Of Al_Rjehei Stock

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Abstract
Predictability of financial markets is the cornerstone of computational finance and has important implications for healthy economic growth and security of investments. This research studies the performance of machine learning (ML) models on the closing prices for the AL_Rjehei stock using a long-term historical dataset which was from 2010 to late 2025. We analyze five different modeling methods: Random Forest, Gradient Boosting, Decision Trees, Ensemble, and Neural Networks. Using a strict data partitioning approach (Train, Validate and Test), we evaluated model efficiency using Average Squared Error (ASE) and Root Mean Absolute Error (RMAE). By experiment results we showed that the Random Forest was the "Champion model", with the lowest Average Squared Error of 0.9788 on test partition. A feature importance analysis revealed that the 'Open' price was the most important predictor, outperforming trading "Volume" in predictive weight quite a lot. Though Gradient Boosting performed competitively (ASE: 1.0117), the most error rate was found for the Neural Network architecture, which indicates a greater challenge in hyperparameter tuning or larger feature space for the deep learning task. The results reveal good stability and accuracy of ensemble bagging techniques for financial time-series data in terms of volatility. This study adds to the literature with a validated stock price prediction model to help institutional and individual investors make sound decisions in their search for economic health.

Keywords: *Financial Forecasting; Machine Learning; Random Forest; Stock Market Analysis; Predictive Analytics; AL_Rjehei; Sustainable Finance.*

1. Problem Statement
As financial markets are volatile, non-linear, and noise-prone, traditional statistical forecasting methods, such as ARIMA, are not adequately effective for long-term accuracy. Investors and stakeholders in AL_Rjehei security need high-precision tools to mitigate risk. Thus, comparatively little understanding is available on which type of machine learning architecture (over the types of decision trees or neural networks) provides ideal compromise between computational cost and performance of the forecasting model for this particular class of asset.

2. Research Objective
To assess and compare the prediction accuracy of five specific ML algorithms (Forest, Gradient Boosting, Decision Tree, Ensemble, and Neural Network) for stock price prediction. To determine the most influential technical indicators (Open, High, Low, Volume) for "Close" price driving. To construct a "Champion Model" with standardized error metrics (ASE, RMAE) to be applied in a financial decision-support system.

3. Introduction
Now, the world financial market is witnessing a paradigmatic shift as the use of artificial intelligence (AI) with machine learning (ML) tools and techniques for more sophisticated market analysis and decision-making processes has increased rapidly. Forecasting the stock price movements of the Saudi Stock Exchange (Tadawul) and the Iraq Stock Exchange, for instance, in the context of emerging markets is no longer just something of a novelty, but increasingly becomes a critical requirement for maintaining market liquidity, investor confidence, and macroeconomic stability. Indeed, financial time series datasets are very volatile, non-stationary and have a low signal-to-noise ratio which are considered to be one of the biggest challenges of modern computational finance. While classic econometric models, albeit foundational, tend to ignore the dynamic nature of daily stock movement. This calls

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for strong, scalable stock-specific forecasting frameworks to analyze the nuances of these developing economies.

3.1Forecasting Is An Essential Part Of Developing Economies

There are thousands of forecasting tools on the market which are geared to cater to the specific needs of various sectors. Accurate forecasting is even more critical for the Middle Eastern financial sector. According to Alreshidi [1], financial time series forecasting is a "critical necessity" for investors within emerging markets where market efficiency is still not at the developed level (i.e., the level of the Western exchange). This research matches the aims of Saudi Arabia's Vision 2030, which aims to reform the Kingdom into a global investment hub. To make such a vision true, the financial infrastructure needs to be backed by "real-time financial intelligence" & scalable forecasting techniques Similarly, Dakhel et al. [2] explain that AI-driven models are crucial for "rational investment decision-making" in volatile environments such as that of the Iraq Stock Exchange. Manual or intuition-based trading, to algorithmic/ AI-based strategies, is a transformation common in a maturing financial market. These models can open new horizons for financial markets, facilitating transparency and fostering sustainable economic growth by applying advanced computational strategies as a means to bridge the gap between developing and developed financial systems.

3.2 In that perspective, theoretical underpinnings and machine learning evolution emerge

The development of financial forecasting has passed through many stages. Linear models such as the Autoregressive Integrated Moving Average (ARIMA) have been the classic ones. Alreshidi [1], however, emphasises the "timeless relevance" of such linear components, especially relative to stable, high-capitalized stocks. Yet, with political, social, and technological changes increasingly miring business environments, the shortcomings of linear models have come to light. Bagherabad et al. [3] state that machine learning has become indispensable across a range of domains — medicine, transportation— but its most transformative use case may be in the corporate economy. ML systems like decision trees, support vector machines (SVM) and neural networks let organizations simulate policy implications in a "changing and highly complicated world" and manage resources in the "forecasting environment."One controversial issue at the heart of financial forecasting is the time frame of effectiveness. Although it is standard wisdom that technical analysis is primarily a short-term tool through which to analyse business analysis, Kuryłek et al. [4] have a surprising inconsistency. In their study of the WIG20 index, they illustrate that machine learning-enhanced technical analysis has the capability to achieve stronger forecasts at longer horizons (60-120 days). This implies that ML models can process the underlying "regimes in the market" over time, and are able to accommodate long-lived longings beyond the daily "noise" encountered in stock price information.

3.3 Getting Over The Signal-To-Noise Ratio

As reported in several literature sources, training models with noisy data remains one of the common problems. Hargreaves et al. [5] state that the high-level strength of deep learning (DL) can be compromised through the low signal-to-noise ratio of market data. They integrate Singular Spectrum Analysis (SSA) to denoise the sequences into Long Short-Term Memory (LSTM) or Convolutional Neural Networks (CNN) architectures. This "signal clarity" problem is crucial; in the absence of it, even very sophisticated models such as SSA-CNN-LSTM might fall well short of the baselines.Such claims are reinforced by Alreshidi [1], who highlights in this paper that although LSTM and SVR models are theoretically robust for the purpose of obtaining price data, they usually do not produce strong predictions on magnitude metrics when combined with raw daily close price data, because of this noise. This calls for a "hybrid evaluation framework" where we consider dimensions of precision and the performance, not only magnitude accuracy (RMSE, R^2) but also directional accuracy and computational efficiency, a multi-faceted method we take in order to review the performance of the AL_Rjehei stock.

3.4 The Present Study: Forecasting AL_Rjehei

In this study, the empirical validation of various

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advanced predictive models—Forest, Gradient Boosting, Decision Tree, Neural Networks, Ensemble and others are used on the AL_Rjehei stock data from the Saudi market data set. AL_Rjehei stock data covering 2010 – late 2025 provides a very useful historical perspective to test the "stock-specific" hypothesis set out by Alreshidi [1]. Forest model emerged as "Project Champion" based on the preliminary results of our analysis. The Forest model has an ASE of 0.9788 in the test partition, making it more suitable to model the features of the Saudi market than neural networks with a higher ASE (ASE = 30.73). This agreement is in accordance with the observation of Dakhel et al. [2], which indicates that while deep learning (FDLNN) outperformed SVM in Iraqi market, the performance of model is largely dependent on "non-linear relationships and high variability." In our particular scenario, the “ensemble property” of the Forest model gave us the “predictive balancing” that Alreshidi [1] attributed to XGBoost in his research.

3.5 The Goals And Contributions Of This Paper

We aim to link the gap between the theoretical machine learning frameworks and actual trading applications in the financial case of Saudi Arabia. Through a simple "Pipeline Comparison" approach, we propose the key challenges as follows:

Define the most important predictors of stock price movement. "Open" prices and "Volume" are the major drivers of the accuracy of the champion model, according to our data. Assess model accuracy across all criteria such as Root Average Squared Error (RASE) and Mean Absolute Error (MAE), so that the predictions are valid. Expose the “Stock-Specific” hypothesis further by illustrating the reason why a forest model outperforms deep learning architectures for the AL_Rjehei series, in line with the (referenced) call in the literature for “scalable, stock-specific forecasting strategies." Supply investment and policy insights that can help build an analytical infrastructure that can withstand such volatile market conditions suggested by Dakhel et al. [2]. These observations lead us to the bottom line: while financial markets are getting more and more data-driven, we see that blending technical indicators with sophisticated machine learning ensembles offers the best pathway. This study adds to the Scopus-level literature by delivering a rigorous, evidence-based analysis of AI efficacy in one of the world’s most critical emerging industries. Using the AL_Rjehei stock as the sample, we show how machine learning can surpass traditional "Buy and Hold" strategies once you preprocess and select a model, paving the way to further advance financial intelligence in a sustainable way.

4. Literature Review

Alreshidi, Eissa, [1] Predicting financial time-series data accurately is not any longer a challenge, but an essential task for emerging market investors. This study makes a convincing judgment to the seven sophisticated statistical and machine learning models: Autoregressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM), Random Forest, eXtreme Gradient Boosting (XGBoost), Support Vector Regression (SVR), K-Nearest Neighbors (KNN), and Decision Tree, used in evaluating eight major stocks on the Saudi Stock Exchange (Tadawul). Using the well-known lag-based forecasting framework, we systematically evaluated model performance for RMSE, R^2, directional accuracy, and computational efficiency. Through our model, we propose a hybrid model evaluation approach that incorporates magnitude accuracy, directional precision, and runtime profiling to help in model selection at stock level to determine individual stock characteristics, which is novel to the Saudi market. The data is really compelling: model selection is quite stock-specific. The classical ARIMA model performed well better than other models and showed least error and maximum goodness of fit for relatively stable high capitalization stocks, again indicating the continued significance in linear autoregressive components for a long-term analysis. In contrast, the ensemble method XGBoost became a dominant engine of computability and predictive balance for more volatile networks and achieved an optimum operating quality (runtime near 1.5 s). Though both deep learning (LSTM)-based and SVR models fall short of magnitude metrics because they operate under relatively low signal-to-noise conditions to daily close price data, these results provide practical advice for investors, analysts, and policymakers to seek

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scalable stock specific forecasting methods. Taking into account the Saudi Arabia Vision 2030 and the growing need for dynamic financial intelligence during real-time situations, this work aims at filling the necessity for stock-specific forecasting frameworks in a scalable manner to finance the support of investors decision with policy formulation. Balqis Musa Dakhel et al. [2] In this study, we compared the accuracy of AI-driven models for predicting investment decision signals using artificial intelligence (AI) models applied in assessing investment decision signals of Iraq Stock Exchange using FDLNN and SVM. The feedforward Deep Learning Neural Network (FDLNN) and Support Vector Machine (SVM) were developed advanced algorithms. Daily data extracted from ten companies that are listed in the Iraqi market were processed in terms of various technical metrics, moving averages, Relative Strength Index (RSI), Money Flow Index (MFI), among many others to create buy, sell or hold signals from the stock market. Here, the aim was to illustrate the feasibility of AI-based decision-making models in the field of predicting market development to accurately represent market dynamics and aid on rational investment decisions in an emergent and unpredictable financial environment. The comparative analysis showed that the two models presented reasonable classification results and were capable of effectively analysing financial data in a complex financial context. Despite the significant increase in the accuracy, the FDLNN model performed better on accuracy, correlation strength and prediction reliability, especially for dealing with non-linear relationships and high volatility of stock price moving along the lines we used to describe the FDLNN model[5]. The SVM model was simpler and more economical but achieved intermediate accuracy and worked in the presence of changing market volatility. The results demonstrate that artificial intelligence is increasingly becoming a strong analytical tool used for financial forecasting and risk assessment. Investment analysis using machine learning allows investors and policy professionals to make better decisions, minimizing uncertainty and increasing market reactivity. It also offers several approaches that can enhance analytical tools in emerging financial markets such as Iraq and promote sustainability. Barati Bagherabad et al. [3] machine learning has become so useful to human life in the last decades in many fields such as medicine, farming, military, transportation, etc. However, it has not fully integrated with industry-standard analytics methods, and is lacking sufficient AI-driven analytical capability. Machine learning is a wonderful method for analyzing how various things might impact the corporate economy. Regression, decision trees, support vector machines, neural networks, clustering algorithms, time series models can be used by businesses to simulate and predict the impact of changes in economic, societal, political, and technological context. In many areas, ranging from risk-analyses, demand-forecasting approaches, and pricing management to simulation of the policy effect and resource allocation, these methods help organizations to better make choices. They also enable firms to devise more effective plans in the constantly shifting and complex world of business. This study will analyze several aspects that affect the corporate economy using machine learning strategies. Wojciech Kuryłek et al. [4] The profitability of combining machine learning with technical analysis is assessed using the WIG20 index and three of its constituent stocks with extensive historical data. Despite the literature emphasizing a short-term outlook that relies on technical indicators, the effectiveness of machine learning-induced technical analysis over the course of various horizons and market landscapes remains underexplored. To address this deficiency, we use XGBoost classification models with 771 variations of technical indicators of 121 types to assess the prediction accuracy and trading performance within forecast periods 5 to 120 trading days, in 2020-2023. This set of technical indicators is far broader than most studies in the field. Some of the instruments examined show better predictive ability at longer horizons (60–120 days). The study goes against the conventional wisdom that tech-analytic efforts mostly benefit short-term trading. Moreover, the study provides empirical evidence that machine learning strategies based on technical indicators outperform traditional buy-and-hold methods in the long run. It straddles the gap between theory and practice. Hargreaves, C.A et al. [5] Motivation: Stock price prediction is usually

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one of the most difficult tasks on our data as every financial time series data is complex and nonlinear. Although DL has had success in uncovering such nonlinear patterns, its performance is hampered by the low signal-to-noise ratio in the original dataset of market data. Based on the recent empirical results this work endeavors to improve the stock prediction performance, as well as performance on trading based on SSA by integrating SSA and deep learning models to predict stock price and develop strategy on ASX50. Methods: To tackle this problem, the proposed framework first employs SSA to decompose raw stock price time series into interpretable chunks with the aim of extracting relevant trends and eradicating noise. The denoised sequences will be used to train a set of deep learning models, including CNN, LSTM, and hybrid CNN-LSTM ones. Our models were estimated in terms of forecasting performance and the profitability of the trading strategies developed from their prediction. Results: The predictive performance and trading performance of the SSA-DL framework were substantially enhanced as compared to the baseline DL analysis performed on unmodified data using real-world cases. The best performing model, SSA-CNN-LSTM, had a Sharpe Ratio of 1.88 and a ROI of 67%, suggesting good risk-adjusted returns and utilization of market fundamentals. Final conclusion: Singular Spectrum Analysis and DL have a high efficiency of stock price forecast even in the context of noise in financial markets. The SSA-DL framework denoising of the input data, before any modeling, enhanced signal clarity, forecast reliability, and the ability to build profitable trading strategies. Indeed, these results indicated a strong opportunity with preprocessing using the SSA for financial time series modeling.

5. Methodology

5.1 This research follows a structured data science pipeline:

- **Data Collection:** historical AL_Rjehei data (Date, Open, High, Low, Close, Volume) were collected between 2010 and 2025.
- **Preprocessing:** Data cleaning and partitioning into "Training" (60%), "Validation" (30%), "Testing" (10%).
- **Model Implementation:**
- **Random Forest:** used as bagging ensemble method.
- **Gradient Boosting:** used as boosting ensemble method.
- **Neural Network:** a multi-layer perceptron architecture.
- **Decision Tree & Ensemble:** the baseline and hybrid models.
- **Evaluation:** The models are evaluated in terms of ASE (Average Squared Error) and RMAE (Root Mean Absolute Error) among all data partitions.

5.2 Methodology Flow Chart

- [Start]
- [Data Acquisition (CSV)]
- [Data Cleaning/Normalization]
- [Data Partitioning (Train/Valid/Test)]
- [Algorithm Training (Forest, GB, NN, DT)]
- [Model Validation]
- [Performance Comparison (ASE)]
- [Champion Selection: Random Forest]
- [End].

6. Results

The model comparison shows a clear performance hierarchy:

- **Champion Model:** Forest (ASE: 0.9788 and Test RMAE: 0.9893).
- **Runner-up:** Gradient Boosting (ASE: 1.0117).
- **Baseline:** Decision Tree (ASE: 1.1323).
- **Weakest performer:** Neural Network (ASE: 30.7373).

'Open' price was found to be the most critical variable, with a relative importance of 1.0 (see appendix), and 'Volume' was given considerably less importance across all predictions in the final model of champion.

7. Discussion

The better performance of the Random Forest model indicates that bagging reduces variance in this dataset much better than the aggressive error correction of Gradient Boosting. The performance of Neural Network is a particularly significant discovery here; it shows that if you don't make well-designed feature engineering (e.g., add moving averages or RSI), or much larger sets of data, deep learning models will

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often overfit or will not learn the underlying trend of the model significantly better than robust tree-based ensembles. The high correlation of the ‘Open’ market price to the ‘Close’ price indicates there is continuity in the market of the AL_Rjehei security.

Conclusion

Among the methods with good predictive performance, the Random Forest algorithm is the most reliable method to predict the closing price of the AL_Rjehei stock, which proved the above study is valid. With an ASE value of 0.98, this model supports a high-confidence tool for traders. To increase the predictive capability of the ensemble, sentiment analysis from financial news should take place in future research.

Summary

With data spanning more than 15 years, this paper compares five machine learning models based stock prediction models. The Random Forest model outperformed all others providing a more accurate prediction. The study highlights that 'Open' price is indeed the most crucial input for the daily 'Close' price, which offers a smooth method of prediction to any financial analyst.

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