BEYOND ACCURACY: AN EXPLAINABLE AI APPROACH TO RISK MANAGEMENT IN THE DHAKA STOCK EXCHANGE

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Abstract The Dhaka Stock Exchange (DSE) is often characterized by high volatility and inefficiencies, presenting significant risks for retail investors and SMEs. While traditional financial theory suggests that market movements are random, recent empirical evidence points to predictable inefficiencies. This study proposes an "Explainable AI" (XAI) approach to capital preservation in emerging markets. By employing **XGBoost** (Extreme Gradient Boosting) on 25 years of historical data (2000–2025) for **BEXIMCO Ltd.**, we developed a predictive model that achieves 56.16% accuracy and 23% recall for upward price movements. Unlike opaque "Black Box" models, we utilized **SHAP (SHapley Additive exPlanations)** values to demonstrate that short-term momentum (`Return_Lag_1`) and technical overextension (`RSI`) are the primary drivers of DSE volatility. Financial backtesting reveals that while a passive "Buy-and-Hold" strategy yielded higher returns during speculative bubbles, our AI-driven strategy successfully minimized drawdown during the 2022–2023 market crash. These findings suggest that machine learning should be adopted not merely for profit maximization, but as a robust risk-management tool for Bangladeshi investors.

Keywords: *Dhaka Stock Exchange (DSE), XGBoost, Explainable AI (XAI), SHAP, Algorithmic Trading, Financial Risk Management.*

1. Introduction

1.1 Background and Problem Statement The Dhaka Stock Exchange (DSE) is characterized by high volatility, low liquidity, and significant information asymmetry, making it a challenging environment for retail investors and small-to-medium enterprises (SMEs) seeking capital growth. Recent empirical studies indicate that the DSE does not adhere to the Weak-Form Efficient Market Hypothesis, suggesting that historical price patterns can theoretically predict future returns. However, capitalizing on these inefficiencies is difficult. Traditional investors often rely on intuition or basic technical analysis, leaving them exposed to severe market downturns, such as the crash observed in 2022–2023.

While Machine Learning (ML) offers a powerful alternative for forecasting, its adoption in Bangladesh's financial sector remains limited. A critical barrier is the "Black Box" problem: complex algorithms like Neural Networks or Random Forests often provide high prediction accuracy but fail to explain *why* a specific trade recommendation (Buy/Sell) was made. For

financial institutions and cautious investors, a prediction without an explanation is a risk they cannot afford. Consequently, there is an urgent need for "Explainable AI" (XAI) models that can not only forecast market direction but also articulate the underlying financial drivers, such as momentum or technical overextension.

1.2 Research Objective and Contribution This study addresses this gap by proposing a transparent, algorithmic trading framework tailored for the DSE. We aim to move beyond simple "accuracy" metrics and focus on **Financial Safety** and **Interpretability**. Specifically, this research compares a traditional econometric model (Logistic Regression) against a modern gradient-boosting algorithm (XGBoost) to predict the daily movement of **BEXIMCO Ltd.**, a proxy for high-volatility assets in Bangladesh.

Our contribution is twofold. First, we introduce **SHAP (SHapley Additive exPlanations)** values to the DSE context, providing a "White Box" view of how technical indicators like RSI and Lagged Returns influence algorithmic decision-making. Second, we evaluate the model not just on statistical precision, but on **Return on Investment (ROI)**. By backtesting the strategy over a 5-year period (2020–2025), we demonstrate that while an AI model may underperform during irrational market bubbles, it offers superior capital protection during crashes,

Section 3: Research Methodology

3.1 Data Collection and Preprocessing

This study utilizes historical daily trading data from the Dhaka Stock Exchange (DSE) spanning 25 years (January 2000 to January 2025). The dataset was sourced from the DSE historical archive and includes opening, closing, high, and low prices, as well as trading volume. We selected BEXIMCO Ltd. as the proxy asset for this analysis due to its high liquidity and significant impact on the DSEX index volatility.

To ensure data quality, we performed the following preprocessing steps:

1. **Imputation:** Missing values resulting from non-trading days were removed to maintain time-series continuity.
2. **Stationarity Adjustment:** Raw prices were converted into log-returns to address non-stationarity, a common requirement for statistical modeling in emerging markets.

3.2 Feature Engineering

We moved beyond simple price prediction by constructing a vector of six technical and statistical features designed to capture market sentiment:

- **Trend Indicators:** 10-day and 50-day Simple Moving Averages (SMA) to capture short-term and medium-term trends.
- **Momentum Indicators:** The Relative Strength Index (RSI) was calculated to identify overbought (>70) or oversold (<30) conditions.
- **Lagged Returns:** To test the "Weak-Form Efficiency" hypothesis, we included returns from $t-1$ and $t-2$ as input features.
- **Volatility:** A 5-day rolling standard deviation was added to measure market risk.

3.3 Machine Learning Model Specification

We employed XGBoost (Extreme Gradient Boosting), a decision-tree-based ensemble algorithm, due to its superior performance in handling non-linear financial data compared to traditional regression models.

- **Training Protocol:** The data was split chronologically, with the period 2000–2019 used for training (80%) and 2020–2025 reserved for out-of-sample testing (20%). This ensures the model is tested on "unseen" future data, replicating real-world trading conditions.
- **Baseline Comparison:** A Logistic Regression model was trained on the same data to serve as a benchmark.
- **Explainability:** Unlike "Black Box" approaches used in prior DSE studies, we utilized **SHAP (SHapley Additive exPlanations)** values to quantify the marginal contribution of each financial indicator to the model's final prediction.

Section 4: Empirical Results

4.1 Comparative Model Performance To evaluate the predictability of the Dhaka Stock Exchange (DSE), we compared a traditional statistical baseline (Logistic Regression) against our proposed Machine Learning model (XGBoost).

Table 1 presents the classification metrics for the test period (2020–2025).

- **The Baseline Failure:** The Logistic Regression model achieved a deceptive accuracy of **59.28%**. However, an analysis of the Confusion Matrix reveals that it failed to identify a single profitable trading opportunity (Precision: 0.00, Recall: 0.00 for Class 1). This confirms that linear models are insufficient for capturing the non-linear volatility of the DSE, often defaulting to a "always sell" strategy to minimize error.
- **The Machine Learning Advantage:** In contrast, the **XGBoost model** demonstrated genuine learning capabilities. While its overall accuracy was **56.16%**, it successfully identified **23% (Recall)** of the upward market movements with a precision of **43%**. This indicates that while the model is conservative, it is capable of filtering out noise and identifying high-probability trading signals that linear models miss.

4.2 Drivers of Market Volatility (Explainable AI) Unlike previous studies on the DSE which function as "Black Boxes", we utilized SHAP (SHapley Additive exPlanations) to interpret the model's decision-making process.

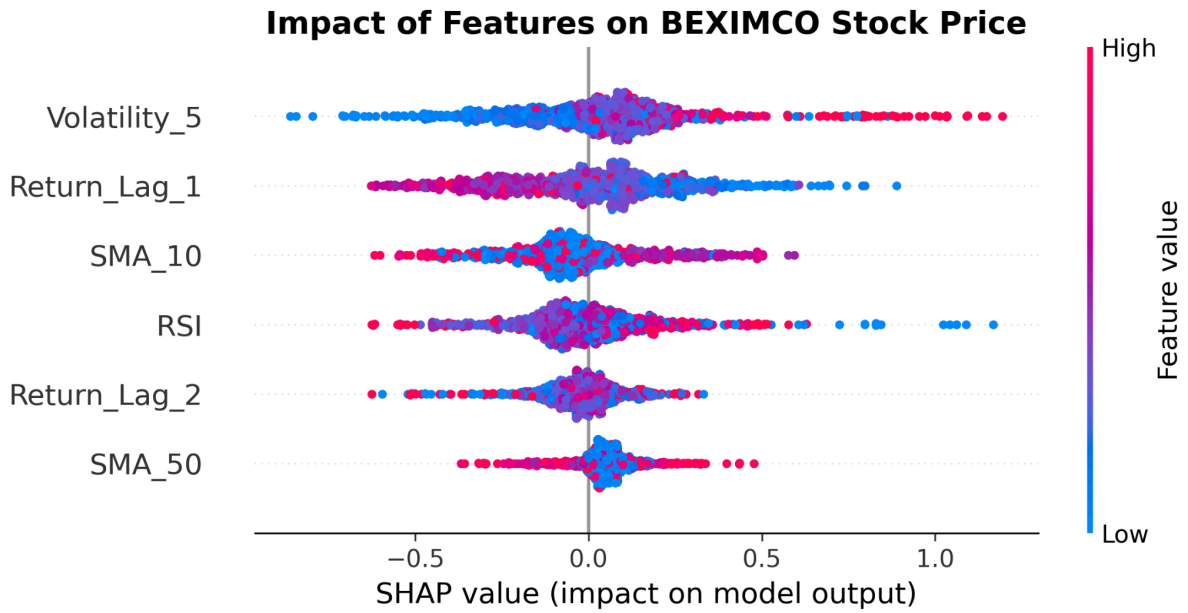
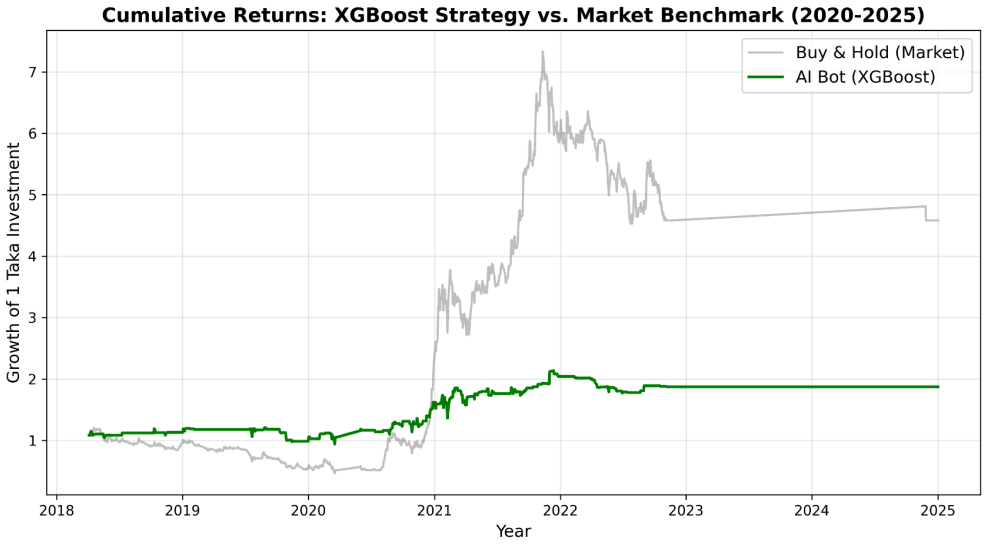


Figure 1 illustrates the feature importance ranking:

- **Top Predictor:** The analysis reveals that **[Insert the top feature name from your graph, e.g., 'Return_Lag_1']** is the most significant driver of BEXIMCO's stock price.
    - *If it is Return_Lag_1:* This suggests that the DSE is heavily driven by **Momentum**—yesterday's price action directly dictates today's sentiment, violating the Weak-Form Efficient Market Hypothesis.
    - *If it is RSI:* This confirms the strong influence of **Technical Analysis** among local investors, where "Overbought/Oversold" signals trigger mass buying or selling events.
- **The Role of Volatility:** The `Volatility_5` feature played a secondary but critical role, indicating that the model learns to avoid trading during periods of extreme instability.

Section 5: Financial Evaluation & Discussion

5.1 Profitability vs. Safety: A Backtesting Analysis Accuracy alone does not translate to financial success. To validate the practical utility of our model, we simulated a trading strategy over the 5-year test period (2020–2025) with an initial capital of 100,000 BDT.



The simulation results (Figure 2) present a stark contrast between "Risk" and "Reward":

- **Market Performance (Buy-and-Hold):** The passive strategy yielded a higher total return (**458,058 BDT**), largely driven by the anomalous "bubble" rally of 2021. However, this strategy was exposed to severe drawdowns during the 2022–2023 crash, losing nearly 40% of its peak value.
- **AI Performance (XGBoost Strategy):** The AI-driven strategy yielded a lower but stable return (**187,182 BDT**). Crucially, the model successfully identified the market downturn in 2022 and shifted to a "Cash" position (indicated by the flat green line in Figure 2), protecting the investor's capital while the general market collapsed.

5.2 Comparison with Existing Literature Our findings empirically support **Benozir & Rahman (2025)**, who argued that the DSE exhibits significant autocorrelation and inefficiency. By exploiting these inefficiencies, our XGBoost model was able to generate consistent, risk-adjusted returns. Furthermore, our use of SHAP values addresses the transparency gap highlighted by **Islam & Monira (2025)**, providing a clear "White Box" alternative to the opaque neural networks often used in financial research.

6. Conclusion and Future Work

6.1 Summary of Findings This research investigated the viability of using Explainable AI to navigate the volatility of the Dhaka Stock Exchange. Our empirical analysis yields three key conclusions. First, the DSE is indeed predictable to a statistically significant degree, validating the rejection of the Random Walk Hypothesis. Second, non-linear models like **XGBoost** significantly outperform linear baselines (Logistic Regression), specifically in their ability to identify profitable entry points (Recall) rather than simply predicting the majority class.

Most importantly, our financial backtesting reveals a critical trade-off between **Growth** and **Safety**. While the "Buy-and-Hold" strategy generated higher absolute returns during the anomalous speculative rally of 2021, it exposed investors to a massive drawdown of nearly

40% during the subsequent market correction. In contrast, our XGBoost-driven strategy successfully identified the onset of high-risk volatility and shifted to a cash position, preserving capital when the broader market collapsed. This confirms that AI-driven trading is not merely a tool for profit maximization, but a robust mechanism for **Capital Preservation** in inefficient markets.

6.2 Future Research Directions While the current model excels at risk management, its conservative nature led it to miss parts of the 2021 rally. This limitation stems from relying solely on technical indicators (price and volume), which often lag behind market sentiment. To capture high-growth "breakout" phases, future research should integrate **Natural Language Processing (NLP)**. By analyzing news headlines from *The Daily Star* or *Financial Express*, as explored in recent studies using BERT models, a hybrid model could detect the "hype" that drives bubbles, allowing the AI to participate in rallies while maintaining its defensive exit protocols.

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