Predictive Modeling of Nifty 50 Volatility Using India VIX and Machine Learning Techniques

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Abstract: Financial markets are shaped not only by macroeconomic fundamentals but by fluctuations in collective uncertainty, often materialized through volatility indices. In the Indian equity landscape, India VIX, published by the National Stock Exchange, serves as a forward-looking indicator of expected market turbulence derived from Nifty 50 option prices. This study investigates whether implied volatility, as represented by India VIX, can effectively forecast short-term realized volatility in Nifty 50 returns through a hybrid econometric and machine learning framework. A comprehensive dataset of daily India VIX values and Nifty 50 closing prices spanning multiple market cycles is compiled and processed using Python-based analytical techniques. Data preprocessing includes logarithmic return transformation, rolling-window volatility estimation, lag feature generation, normalization procedures, and time-series structuring to capture both nonlinear dependencies and volatility clustering effects. Feature engineering further incorporates moving averages and volatility ratios to enhance predictive sensitivity. The modeling architecture evaluates both traditional linear regression and supervised machine learning algorithms, including Random Forest Regression, Support Vector Regression, and Gradient Boosting models. Performance robustness is assessed using time-series-aware train/test segmentation and cross-validation techniques. Predictive accuracy is evaluated through Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and R^2 metrics to ensure statistical reliability. Empirical findings indicate that ensemble-based learning models demonstrate superior capability in capturing nonlinear volatility dynamics compared to classical regression frameworks. Elevated India VIX levels are found to significantly precede intensified realized volatility, confirming its informational efficiency as a risk proxy rather than a directional indicator. The proposed computational framework offers a scalable and data-driven approach for traders, portfolio managers, and risk management professionals seeking enhanced volatility forecasting precision. Future extensions may incorporate deep learning architectures such as Long Short-Term Memory networks to further model temporal dependencies in financial time series.

KEYWORDS : : India VIX, Nifty 50 Returns, Volatility Forecasting, Machine Learning: Random Forest, Python Analytics, Risk Modeling.