Volatility Voyage: Forecasting-Based Portfolio Construction and Backtesting using NIFTY 50 Stocks

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Abstract

This report presents a volatility-based portfolio construction and backtesting framework using NIFTY 50 stocks. We forecast volatility using Rolling Mean (20-day), EWMA, and AR(1) methods. Stocks are allocated into portfolios based on their forecasted volatilities and mapped to investor risk preferences. The constructed portfolios are then tested using Buy and Hold, MACD, and ATR-based strategies to assess performance.

1 Introduction

Volatility is a key measure of financial risk. Forecasting volatility and aligning investments to risk profiles is a useful strategy in portfolio construction. This project uses historical daily closing prices of NIFTY 50 stocks to forecast volatility and create diversified portfolios that match investor risk tolerance.

2 Data Description

The dataset includes daily adjusted closing prices for NIFTY 50 constituent stocks from January 2020 to May 2023. Missing values are handled using forward fill.

3 Volatility Forecasting Methods

3.1 20-Day Rolling Volatility

Rolling volatility is calculated using a 20-day rolling window over daily log returns:

$$\sigma_{\text{rolling}} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(r_i - \bar{r})^2}$$

3.2 Exponentially Weighted Moving Average (EWMA)

EWMA gives more weight to recent returns. The formula is:

$$\sigma^2_{\text{EWMA},t} = \lambda \sigma^2_{\text{EWMA},t-1} + (1-\lambda) r_t^2$$

We use $\lambda = 0.94$, consistent with RiskMetrics.

3.3 Auto-Regressive Model: AR(1)

We fit an AR(1) model to the squared returns:

$$r_t^2 = \alpha + \beta r_{t-1}^2 + \epsilon_t$$

Forecasted volatility is obtained from predicted r_t^2 values.

4 Volatility-Based Portfolio Construction

For each method (Rolling, EWMA, AR(1)), the average forecasted volatility across time is computed for each stock. Based on the resulting distribution, stocks are classified into three buckets:

- **Low Risk**: Bottom 33% of volatility values
- **Medium Risk**: Middle 33%
- **High Risk**: Top 33%

Each portfolio consists of an equal-weight combination of stocks in that risk category.

5 Strategy 1: Buy and Hold

Each risk portfolio is simulated using a Buy and Hold strategy. The portfolio value is tracked over time from the start date.

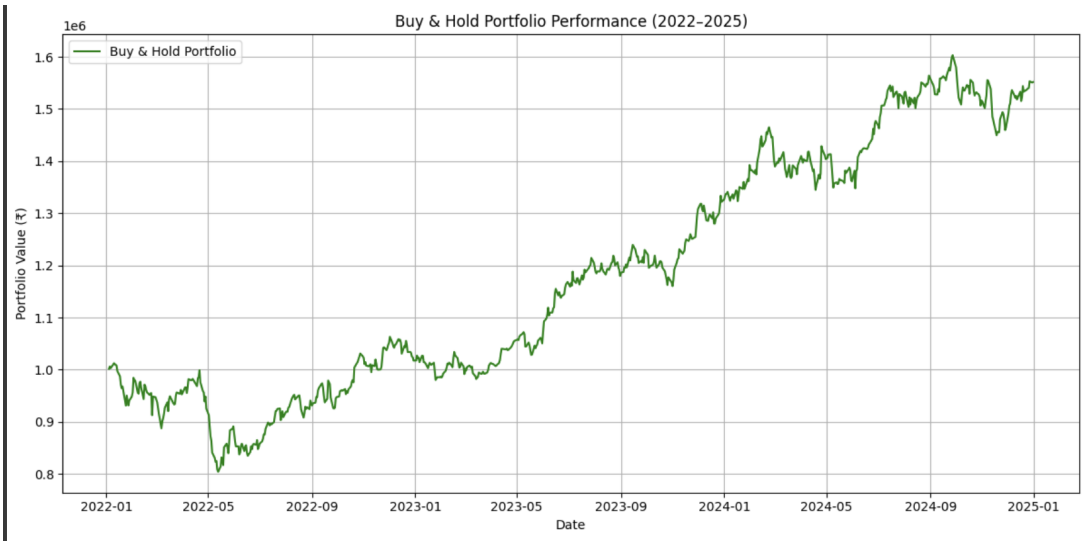

Figure 1: Buy and Hold Strategy: Normalized Portfolio Value

6 Strategy 2: MACD and ATR-based Trading

This strategy applies a dynamic trading rule using the MACD indicator and ATR filter:

- **Buy Signal**: MACD line crosses above signal line
- **Sell Signal**: MACD line crosses below signal line or ATR rises sharply

Each stock in the portfolio is traded using this rule and the aggregated portfolio performance is plotted.

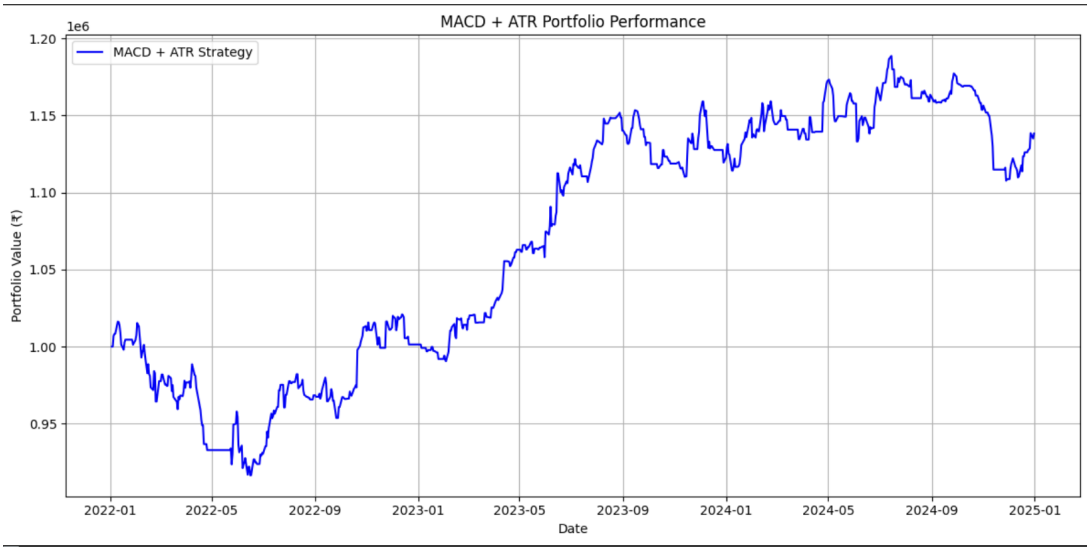

Figure 2: MACD + ATR Strategy: Normalized Portfolio Value

7 Results and Analysis

Buy and Hold Strategy

- Medium Risk portfolio showed the highest cumulative return.
- Low Risk portfolio showed the most stable trajectory.
- High Risk portfolio exhibited higher volatility with occasional sharp gains.

MACD + ATR Strategy

- All portfolios showed improved downside protection.
- Returns were slightly lower compared to Buy and Hold, but risk-adjusted performance improved.
- ATR provided useful stop-loss signals during high volatility.

8 Conclusion

This project illustrates how volatility forecasting can inform portfolio construction suited to different investor risk preferences. While Buy and Hold yielded higher absolute returns, MACD + ATR reduced drawdowns effectively. Among the forecasting methods, EWMA and AR(1) provided smoother volatility rankings, aiding better risk categorization.