Feature Importance & SHAP Analysis

Random Forest model relies **most heavily on recent trend-direction features**, especially the *1-period lag trend indicator*. Momentum, volume, and simple moving averages (SMAs) matter, but much less.

- **trend_lag1_Uptrend — 0.3289**

  - This single feature accounts for **~33%** of the model's predictive power. The model strongly depends on whether the **previous period** was classified as an *uptrend*. This suggests strong short-term trend persistence in your target variable (e.g., returns or trend prediction).

- **trend_lag1_Sideways — 0.1137**

- **trend_lag2_Uptrend — 0.0796**

- **trend_lag3_Uptrend — 0.0484**

The model uses a **lagged trend structure**, with **lag 1 > lag 2 > lag 3**. The influence decays over time, which is typical in price-action models where recent movement matters more. Combined, lagged trend variables contribute **~57%** of importance which mean model is **trend-regime-driven**.

Momentum indicators

- **momentum_10 — 0.0411**

- **momentum_20 — 0.0367**

Moderate importance. Reinforces that *short-term price acceleration* helps predict target.

Volume features

- **volume_ratio — 0.0364**

- **volume_sma_20 — 0.0342**

Volume conditions add meaningful context. Volume relative to average seems slightly more predictive.

Moving averages

- **sma_200 — 0.0356**

- **sma_20 — 0.0350**

Both long-term (200) and short-term (20) SMAs matter roughly equally. Suggests model uses SMA levels as contextual signals rather than dominant drivers. Overall model likely performs best in **trending markets**, possibly worse in choppy sideways markets.

SHAP Analysis

sma_20: Strongest interaction driver, indicating the model relies heavily on medium-term moving averages to detect trend direction.

momentum_10: Provides short-term directional information but with smaller interaction strength.

momentum_20: Offers medium-term momentum signals with moderate influence.

A high **sma_20** value generally pushes the model toward **Uptrend** predictions.

Low or declining **sma_20** supports **Downtrend** predictions.

Momentum indicators act as confirmation signals, helping the model refine trend classification when used with moving averages.

Limitations - Interaction values are relatively small, meaning the model is mostly additive rather than highly nonlinear. Momentum indicators can be noisy, especially in sideways markets. Random

Forest does not capture long-range temporal dependencies.