High-Frequency Quantitative Trading Strategy Report
— A Bitcoin Trend-Following Strategy Based on Order Book Momentum Factors

1.1 Factor Library

This strategy primarily uses traditional momentum factors such as VWAP momentum, price momentum, order imbalance, and order acceleration. Each factor is calculated over multiple time windows and then validated for effectiveness.

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因子有效性分析报告
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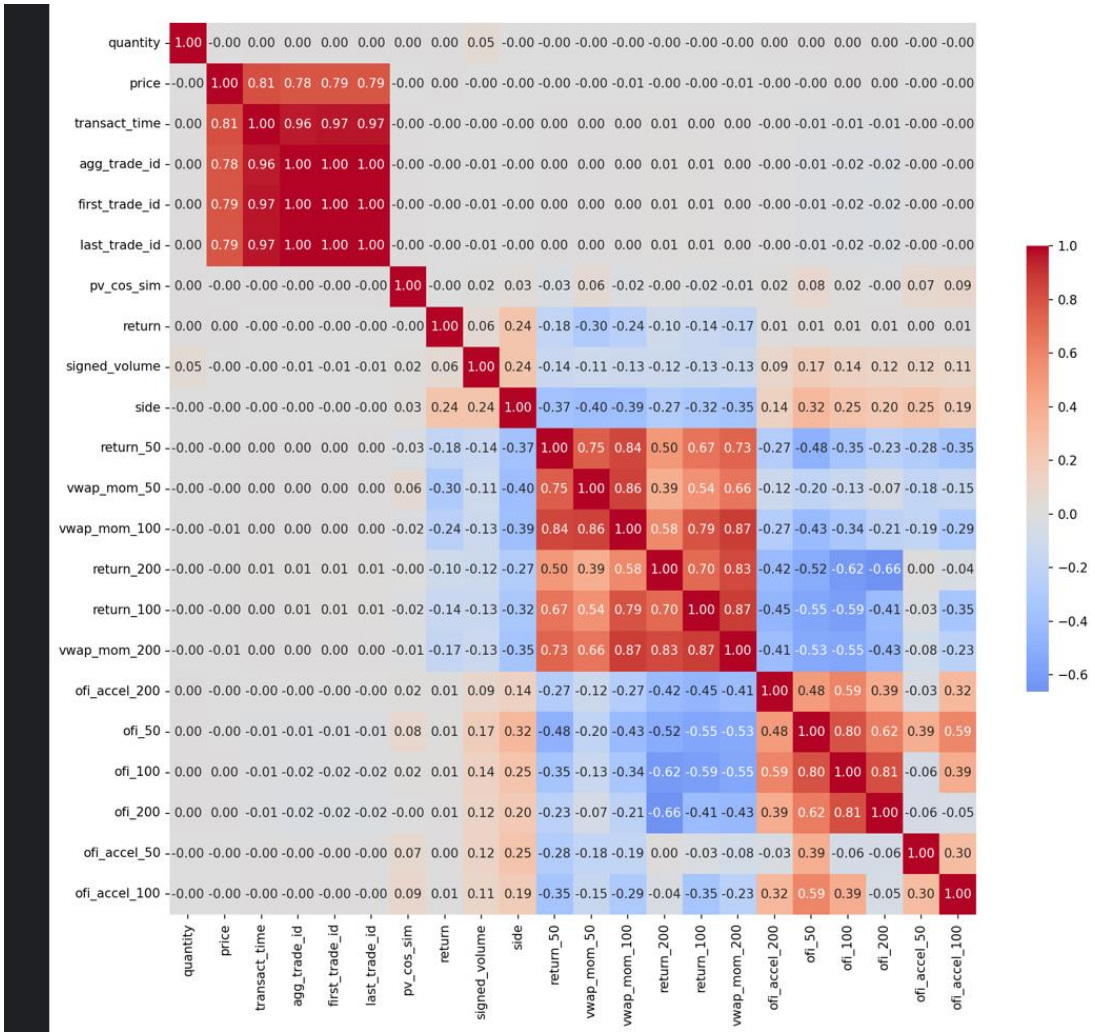
有效因子数量: 12
平均信息系数: 0.0700

Top 10因子:
vwap_mom_50      0.152502
ofi_50           0.098540
vwap_mom_100     0.094031
ofi_accel_50     0.081863
ofi_accel_100    0.072909
ofi_100          0.070648
return_50        0.062313
vwap_mom_200     0.055797
ofi_accel_200    0.054910
ofi_200          0.045790
```

Since there are only four core factors and the others are derived from different time windows, strong multicollinearity exists. Therefore, we perform collinearity tests and select the most informative factors with higher IC values.
下图是因子共线性矩阵：



The following four factors were ultimately selected:

The following is a data sample:

vwap_mom_50	vwap_mom_200	ofi_50	ofi_accel_100	transact_tim
-5.86E-05	-0.000200824	0.576929	-0.209609929	1.61E+12
-8.59E-05	-0.000228625	0.57598	-0.206528464	1.61E+12
-5.62E-05	-0.000198966	0.574484	-0.205499678	1.61E+12
-2.55E-06	-0.000145033	0.572785	-0.201933065	1.61E+12
-5.67E-05	-0.000191016	0.575249	-0.215454298	1.61E+12
1.44E-05	-0.000119892	0.576297	-0.197283325	1.61E+12
4.84E-05	-8.56E-05	0.562128	-0.207164923	1.61E+12
-5.23E-05	-0.000189181	0.561959	-0.216251308	1.61E+12

1.2 Signal Generation

All four factors are standardized using Z-score and equally weighted. Their sum forms the trading signal.

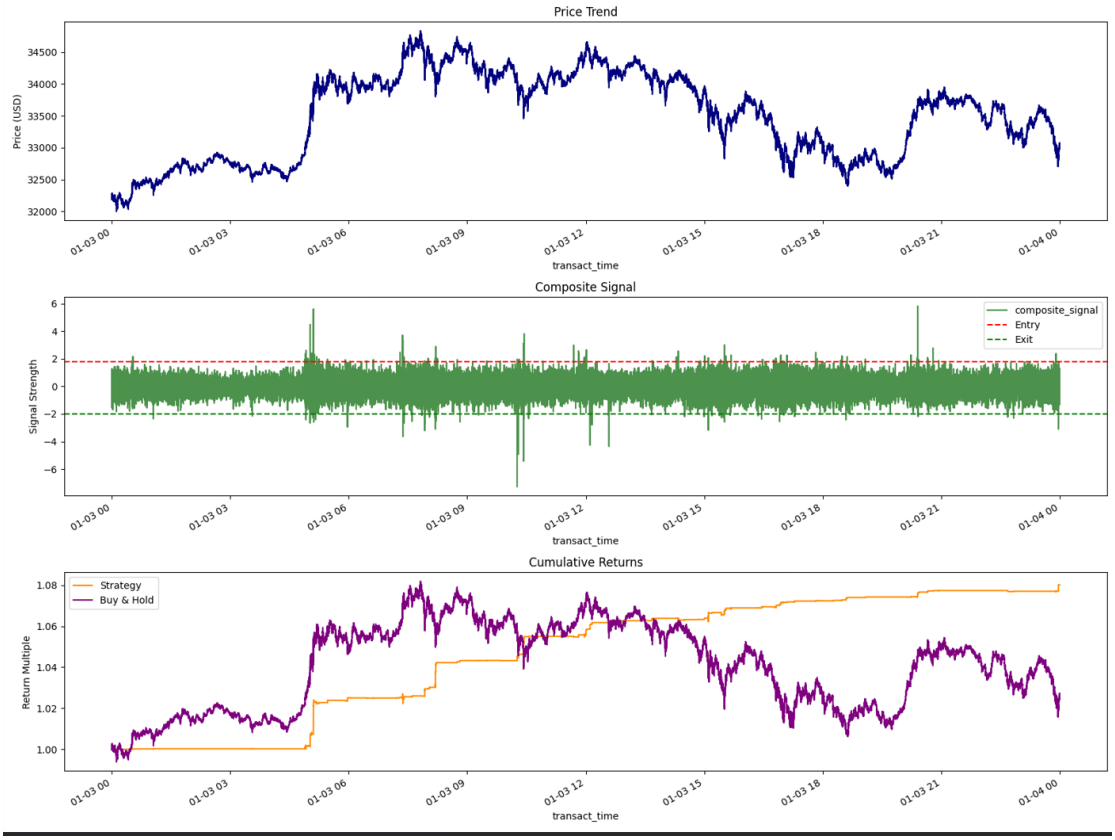
A buy or sell position is triggered when the signal crosses a predefined threshold.

2 Threshold Design

2.1 Fixed Threshold

Backtesting shows that using a fixed threshold leads to very few trades on low-volatility days. If the threshold is set too low, it results in overtrading on high-volatility days and can cause performance to fall below transaction costs, leading to losses.

The ideal scenario:



On days with weaker signal averages, a fixed threshold causes trading frequency and returns to decline:

2.2 Dynamic Threshold

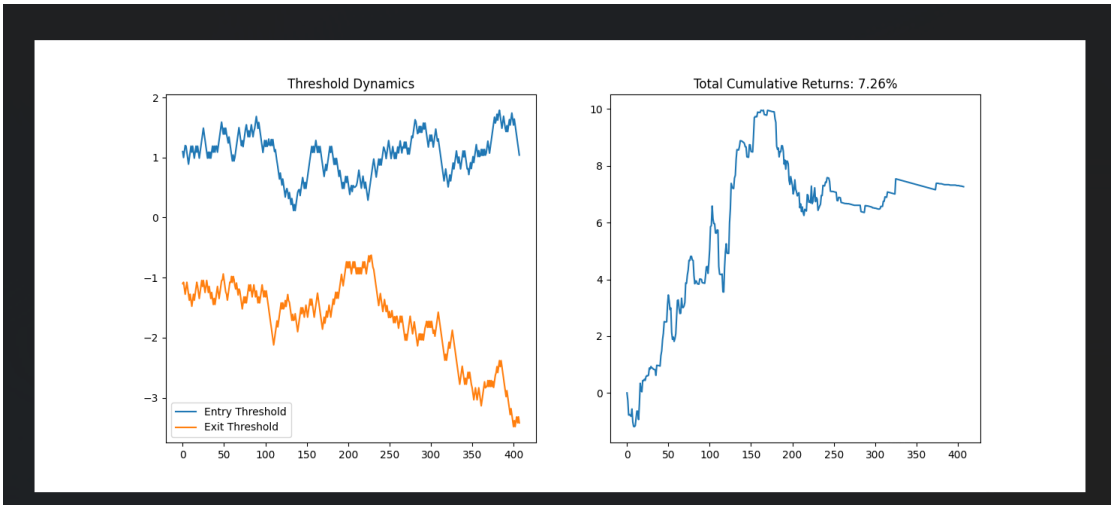
Since market activity may be influenced by news events or economic data, signal strength tends to persist over time. The preliminary idea is to use a reinforcement learning model that takes the momentum factors and volume-price features from a given window as input, with cumulative return as the target. The model dynamically adjusts thresholds to maximize profit.

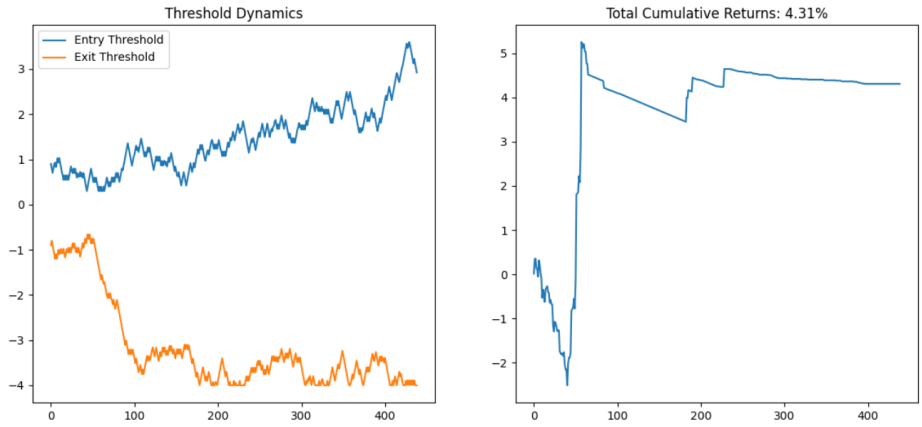
Based on literature and similar projects, we chose the PPO reinforcement learning model, which is well-suited for continuous action spaces.

Training a model with per-step input/output causes threshold changes at every step, preventing signal trend capture and model evaluation. We thus define a chunk of 5000 data points (~4-5 minutes) as the training unit. Instead of raw factors, statistical summaries of signal intensity (max, min, mean, variance) are used as features, with the chunk's return as the target.

Due to computational constraints, only 3 days of data were used for training and 2 days for testing.

After applying the dynamic threshold:





3 Future Considerations

Hyperparameters:

More hyperparameters can be optimized, such as training window size, initial thresholds, model parameters, and factor window lengths.

Backtesting Framework:

The current backtesting framework is relatively simple and may not reflect real market conditions. Enhancements such as slippage modeling and execution speed simulation are necessary.

Factors:

The momentum and OFI factors are basic and limited in number. More sophisticated and diverse

factors should be explored to improve signal quality.

Model Training:

Training and testing should be conducted on longer time spans with more epochs to enable the model to better capture signal dynamics.