HFT Quant Trading Strategies

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Presentation structure

- Intro
  a. In sample H1 2023
     - S&P 500
     - OBI-VWAP as baseline
     - Narrowed to 46 with positive returns
  b. Out of Sample H2 2023
     - Added Noise filter and down sampled for high frequency data
- Three HFT Strategies
  a. OBI-VWAP baseline
     - What is OBI and VWAP
  b. Mean Reversion
     - Adjusted VWAP and volume, Volatility
  c. Inverted OBI-VWAP
     - Inverted OBI and VWAP (centered around median)
  - Charts for performance
- Performance
  a. Overall H2 2023 average returns
  b. Best strategies in aggregate / Best for reduced drawdown
  c. Correlation of strategies
  d. Key takeaways
- Future work
  a. Combine to improve performance with portfolio of strategies for internal trade crossing, position netting and diversification

We set out to build **HFT strategies** that work in **US Equity Market**.

Our aim was to extract intraday **alpha** from equities using **nanosecond order book dynamics** and **simple price indicators**.

Data Collection and Backtesting Methodology

TAQ Data

H1 2023

✅Gathered and Cleaned noisy TAQ data from WRDS

✅Originally backtested the OBI strat on selected days of H1 2023 to narrow stock universe from 500 to 46 stocks.

Universe

Trade Rules

✅Always crossed the spread (no mid-price fills)

✅Max position size of 10 units per stock.

Added trading cost of .02 dollars per share.

Risk Mgmt

Risk

✅Used 1% stop loss and 1% take profit

✅Measured performance with cash tracking, trade logs, and signal quality.

✅Max hold time of any position is 100 ticks.

Simplifying

✅Pruned very high-frequency stocks (e.g., OXY) to 1/10th number of ticks.

✅Always crossed the spread (no mid-price fills)

Cleaning

H2 2023

✅Out of sample backtested across H2 2023

✅Positions reset daily (intra-day only)

✅Trades executed immediately on signal.

Out Sample

Evaluate Performance

✅Run through all H2 2023

Metrics

Data Collection and Backtesting Methodology

- Gathered and Cleaned **noisy TAQ data from WRDS**
- Originally backtested the OBI strat on selected days of **H1 2023** to narrow stock universe from **500 to 46 stocks**.
- **Pruned very high-frequency stocks** (e.g., OXY) to 1/10th number of ticks.
- **Always crossed the spread** (no mid-price fills)
- Max position size of **10 units** per stock.
- Added **trading cost of .02 dollars** per share.

- **Out of sample** backtested across **H2 2023**
- **Positions reset daily** (intra-day only)
- Trades executed **immediately** on **signal**.
- Used **1% stop loss and 1% take profit**
- Measured performance with cash tracking, trade logs, and signal quality.
- **Max hold time** of any position is **100 ticks**.

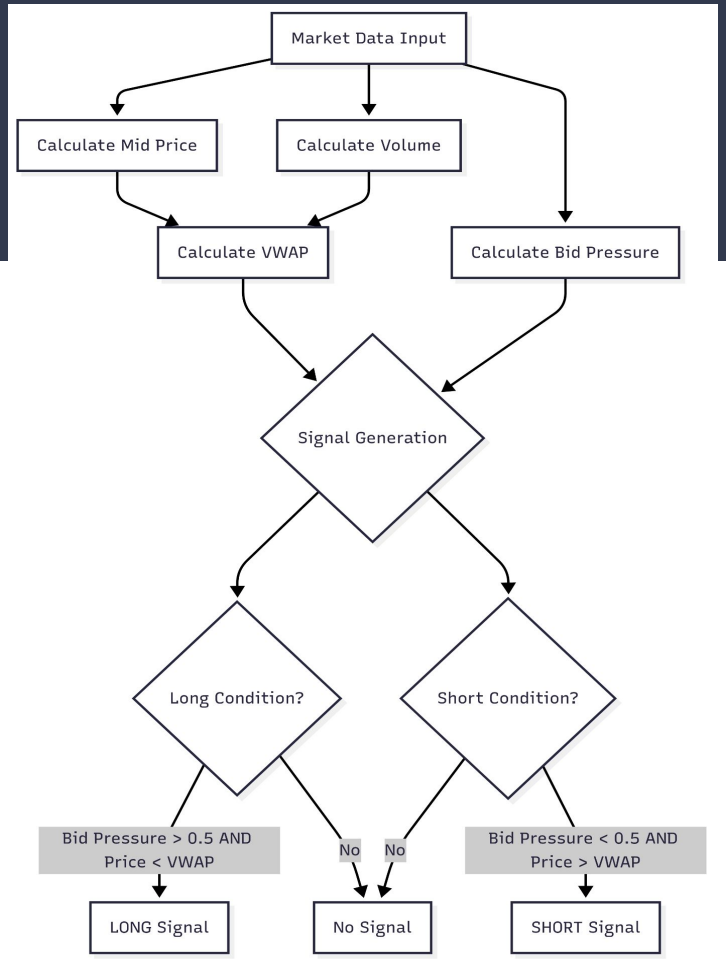
HFT Strategies

3 strategies using nanosecond price data
and simple indicators

OBI VWAP Strategy

Core Logic:

- Combines **Order Book Imbalance (OBI)** and **VWAP** positioning.
- Signal rules:
  - Go **long** when **bid pressure > 50%** and **mid-price < VWAP**.
  - Go **short** when **ask pressure > 50%** and **mid-price > VWAP**.
- Additional filters: price impact, trend, volatility regime, and signal quality.



OBI-VWAP baseline: Economic Reasoning

Order Book Imbalance

- Bid Pressure = Bid Size / (Bid + Ask) Size
- Bid/Ask Depth Ratios = Bid Size / Ask or vice versa
- Intuition being when there are more buyers than sellers **“Buy” and more sellers than buyers “Sell”**

Volume Weighted Avg Price

- Volume adjusted mean price established in each session
- **Data using quoted prices which we use midpoint of bid/ask as mid-price.**
- Get VWAP from summing up all the mid-price * size / total volume
- Rolling mean reversion in this case if below VWAP “Buy” if above “Sell”

OBI-VWAP baseline: Economic Reasoning

Trend/Vol/Regime Filters

- Filters set in place to determine quality of the trend if there is any trend
- Price and volume momentums observed
- Signal quality pre-entering position

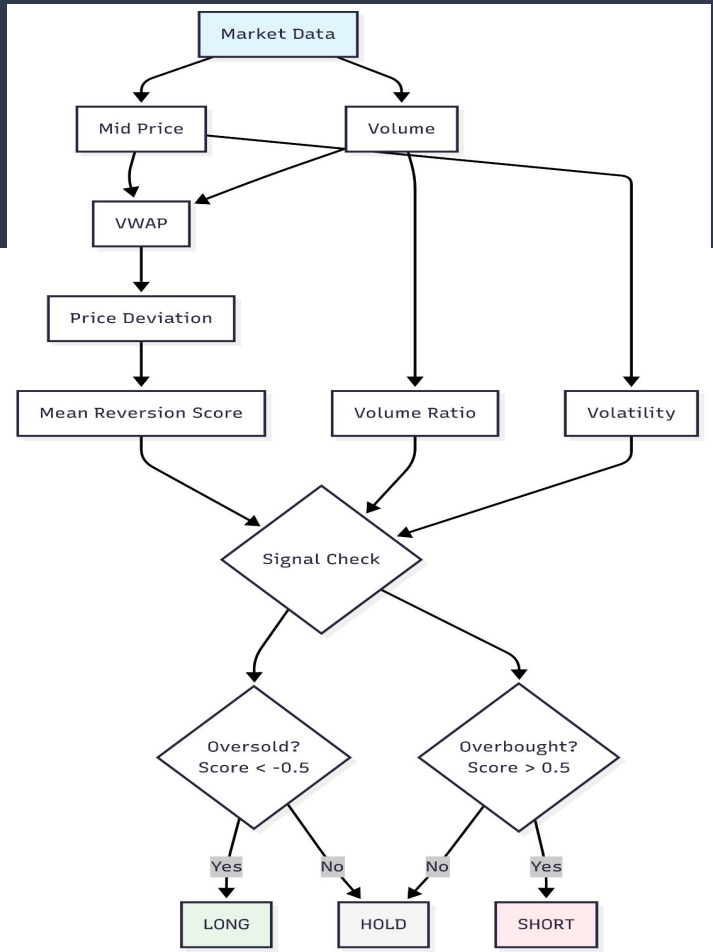
Entry/Exit

- Enter when VWAP deviates enough from the mean
- Enter when there is strong bid/ask imbalance (bid pressure + ratios)
- Enter when trend filter is valid.

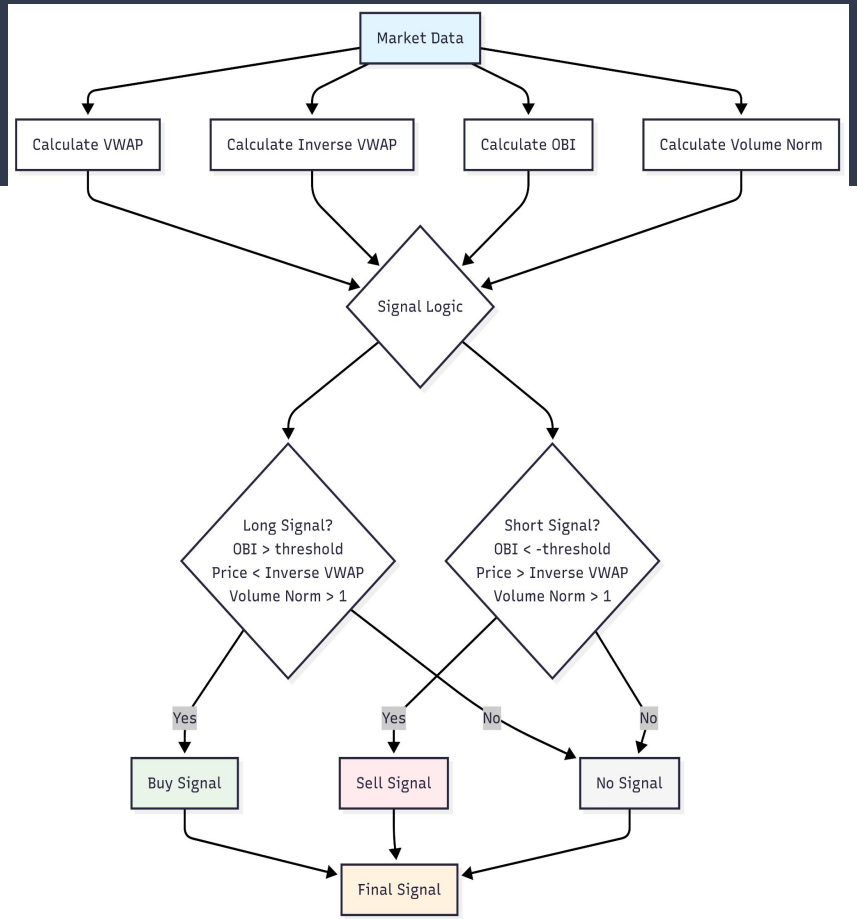
Mean Reversion Strategy

Core Logic:

- Calculate VWAP & Deviation
  - VWAP = Rolling sum of (Mid Price × Volume) ÷ Rolling sum of Volume
  - Price Deviation = (Mid Price − VWAP) ÷ VWAP
- Estimate Volatility
  - Volatility = Rolling mean of |% change in Mid Price|
  - Volume Ratio = Current Volume ÷ Rolling Mean Volume
  - Score = (Price Deviation − Rolling Mean of Deviation) ÷ (Volatility + ε)



Inverse OBI-VWAP Strategy



Core Logic:

- Uses **Inverse VWAP**: median VWAP + (median VWAP – VWAP)
- Uses **Inverted Volume**: median volume + (median – current volume)
- Combines with smoothed **Order Book Imbalance (OBI)**.
- **Signal Triggers:**
    - Go **long** if:
      OBI is positive,
      price < Inverse VWAP,
      inverted volume is high.
    - Go **short** if:
      OBI is negative,
      price > Inverse VWAP,
      inverted volume is high.

Inverse OBI – Order Book Imbalance Traps

Key Ideas

- Book is heavily skewed and you get baited into entry signal
- No strong reaction in desired direction and even resulted in loss

How Can It Be?

- Spoofing large orders (queue in orders at each levels to populate and when bids comes in, cancel the queues.
- Large Iceberg orders e.g. 500 lots at X price clearing at 5 lots at a time (100 times)

Inverse OBI Strategy - Median VWAP

Key Ideas

- We avoid outliers in this case but forgo some explanatory power in trend detection and market sentiment of “fair value”
- Rolling Median VWAP channel with upper and lower with the median at its center

Why?

- Noisy data and in HFT environments, sudden large trades swings the signal and it happens often on large caps
- Slower to reflect real market sentiments but it is more stable and centered and more resilient to sudden swings

Inverse OBI Strategy - Main idea

Key Ideas

- Order Book RSI to sense fade strength
- Price impacts should be low if there are large absorptions
- High bid/ask spreads which vol filters activates to block entry

Its Purpose

- Contrarian to avoid traps
- Do not get baited into false positive signals from OBI
- Avoid fake pressure

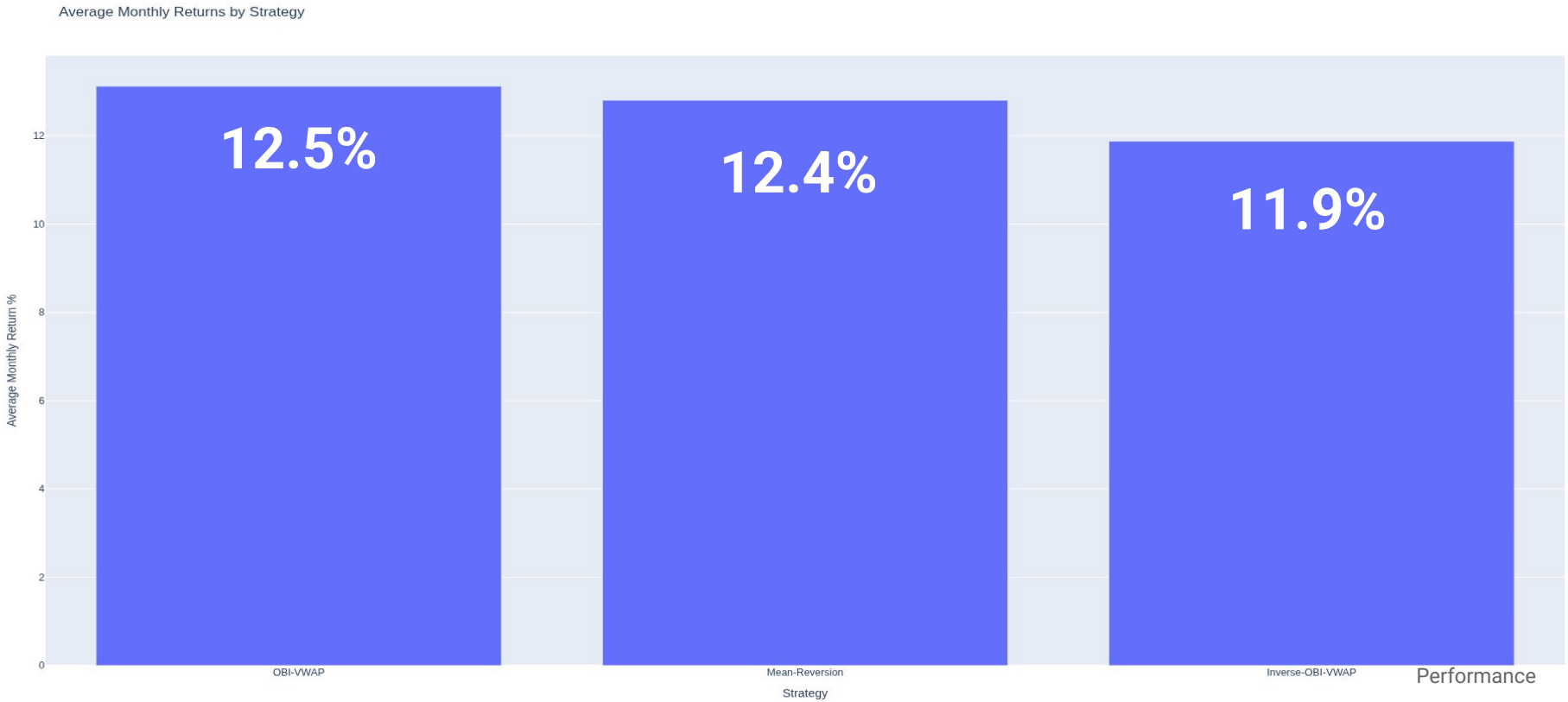

Bid/Ask/VWAP with Signals for ZION on 2023-07-14
Signals
Bid
Ask
VWAP
OBI-VWAP - Buy Signal
OBI-VWAP - Sell Signal
Inverse-OBI-VWAP - Buy Signal
Inverse-OBI-VWAP - Sell Signal
Mean-Reversion - Sell Signal
Price
30.95
30.9
30.85
30.8
30.75
30.7
30.65
30.6
30.55
11:10
Jul 14, 2023
11:15
11:20
11:25
11:30
11:35
11:40
11:45
Timestamp
Median mid price
Strategies are giving unsynchronised buy signals on the same bid ask

Signals in Charts

Signals in Charts

Performance

Performance: H2 2023 out of sample



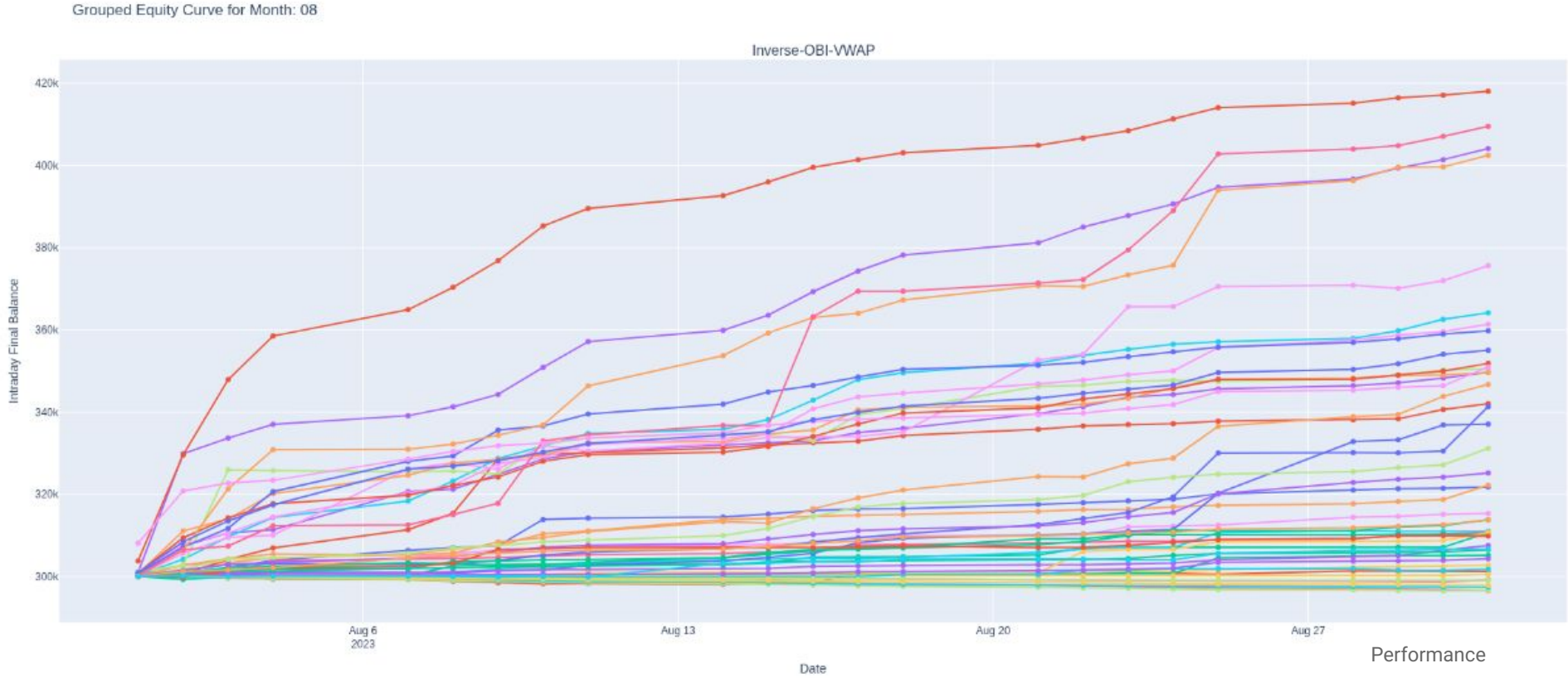
Performance: Monthly performers by Strategy

Month	Best Sharpe Stock - Strategy	Ave. Annualised Return of Best Strat	Ave Max Drawdown (Best Strat)	Best Sharpe Stock - Strategy	Sharpe Ratio
Jun 2023	OBI-VWAP	10.3%	-1.46%	COF - OBI-VWAP	2.97
Jul 2023	Mean-Reversion	8.5%	-0.11%	PSA - Mean-Reversion	3.08
Aug 2023	Mean-Reversion	11.6%	-0.29%	PSA - Mean-Reversion	3.00
Sep 2023	Inverse-OBI-VWAP	13.0%	-31.5%	OXY - Inverse-OBI-VWAP	3.88
Oct 2023	Mean-Reversion	14.1%	-0.25%	HBAN - Mean-Reversion	6.44
Nov 2023	Mean-Reversion	17.6%	-0.95%	JPM - Mean-Reversion	3.88
Dec 2023	Inverse-OBI-VWAP	19.9%	´-0.19%	KEY - Inverse-OBI-VWAP	12.84

Performance: Ave. Drawdown champion

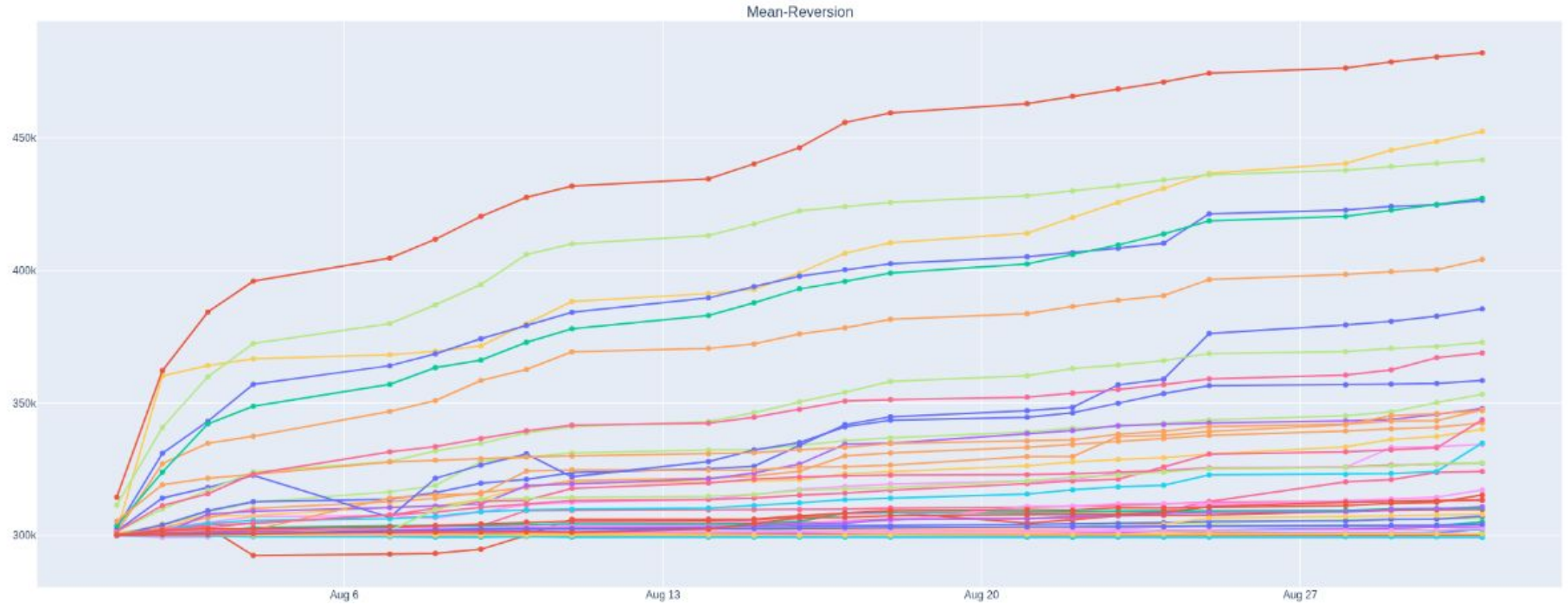
Month	OBI-VWAP Ave. Max Drawdown (%)	Mean-Reversion Ave. Max Drawdown (%)	Inverse-OBI-VWAP Ave. Max Drawdown (%)
Jun 2023	-0.2	-7026.20 🛑	-1.5
Jul 2023	-0.1	-0.10	-8.0
Aug 2023	-0.3	-0.3	-0.5
Sep 2023	-4.3	-0.2	-31.5 🛑
Oct 2023	-3.2	-0.3	-3.8
Nov 2023	-0.0	-1.0	-0.0
Dec 2023	-0.9	-0.2	-0.1

Inverse OBI VWAP returns for August

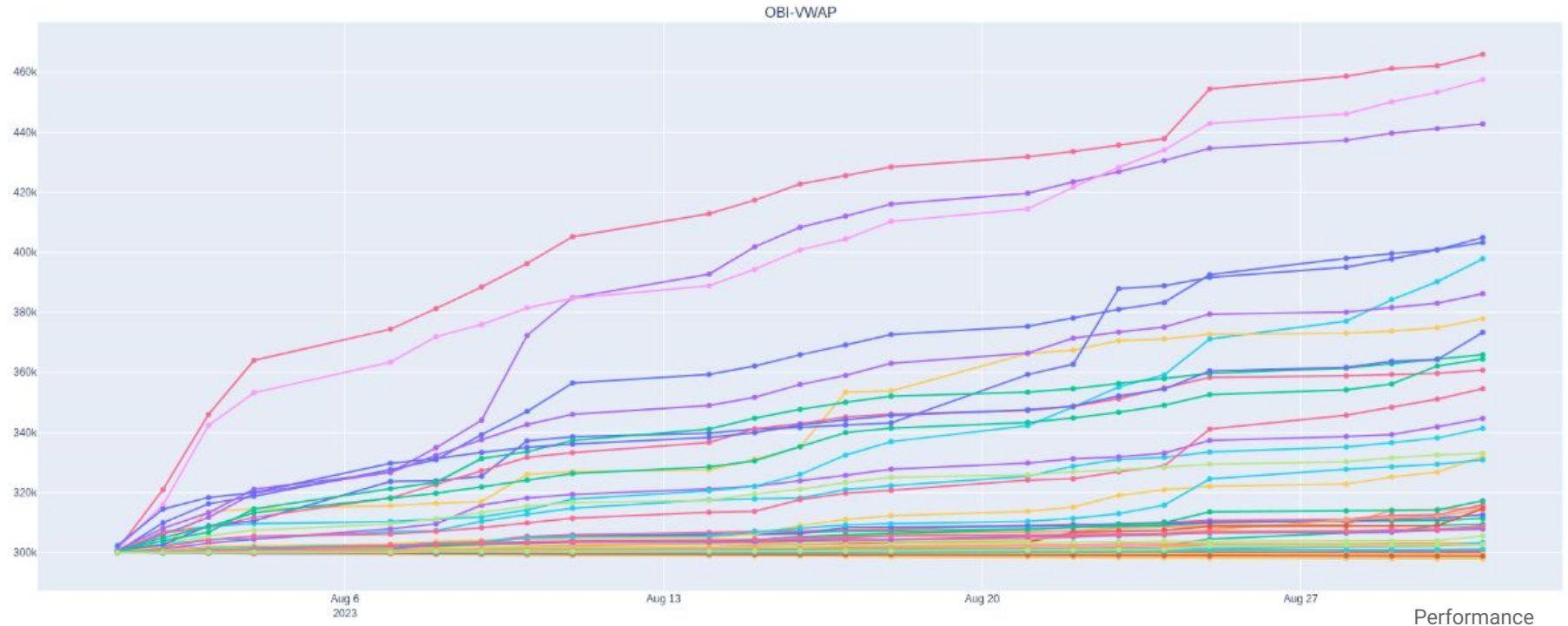


Performance

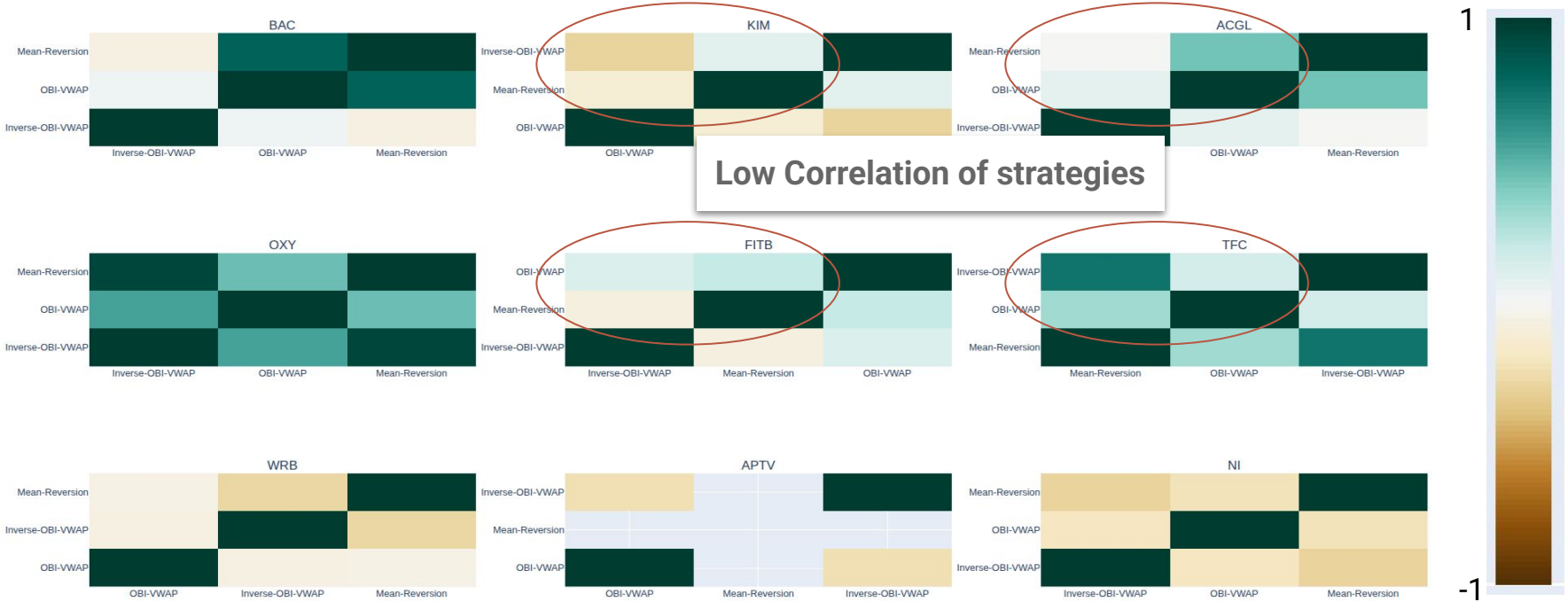
Mean Reversion returns for August



OBI - VWAP returns for August



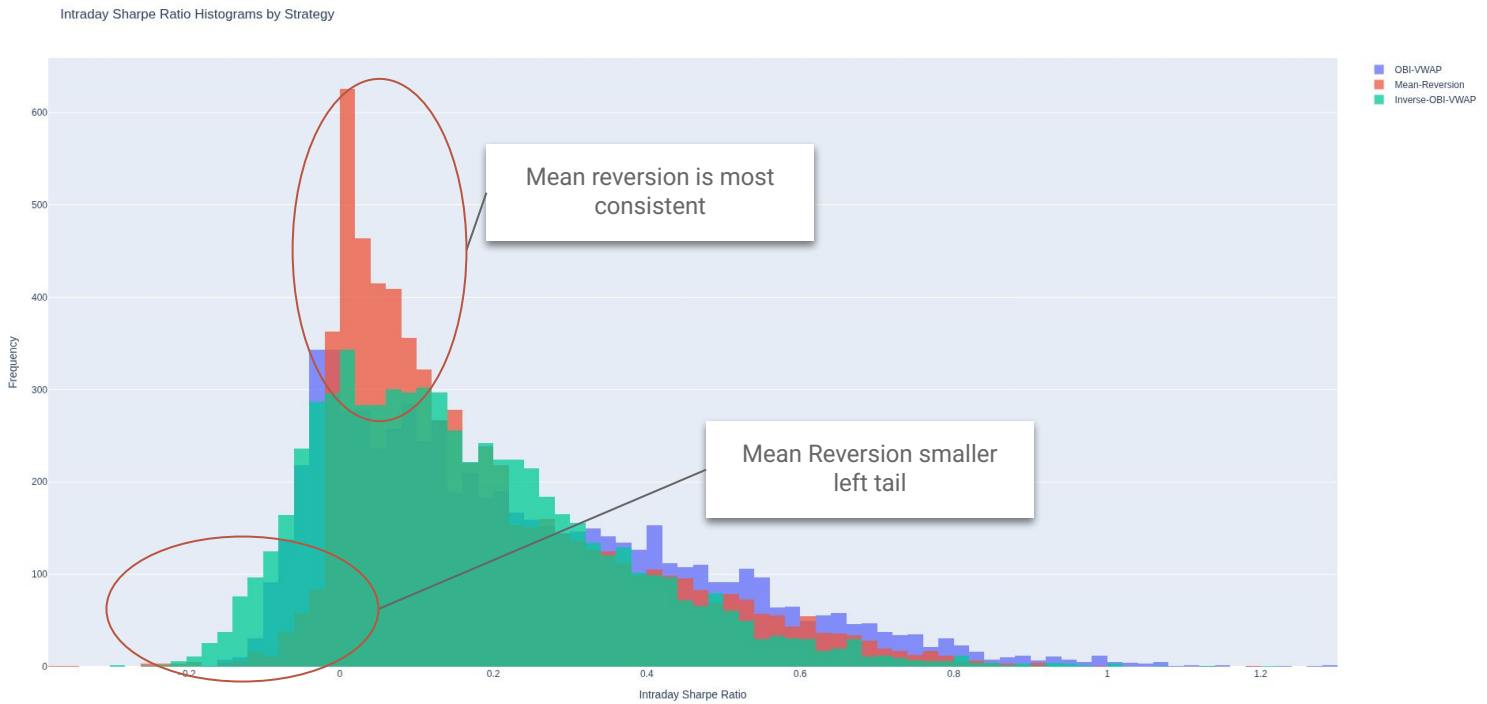
Performance: Strategy Correlations over Stocks



Performance: Strategy Correlations over Stocks

Performance: Strategy Signals

Performance: robustness of strategies



Performance

1. Mean-Reversion: Consistent & Stable Performer

- Outperformed in **5 out of 7 months** (June, July, Aug, Sept, Dec).
- Delivered **Sharpe ratios above 3.0** in Jul (3.08), Aug (3.00), Nov (3.88), Oct (6.44), showing consistent risk-adjusted returns.
- Maintained **minimal drawdowns**, e.g. **-0.11% in Jul**, **-0.18% in Dec**, confirming strategy stability.

Performance: Compare H2 2023 across stocks

Mean Reversion Strategy has most tickers with positive returns across stocks

Performance

2. OBI-VWAP: High Return During Trendy Regimes

- Best performing strategy in **Oct (14.11% return)** and **Nov (17.63%)**, both periods with higher volatility.
- Strategy had **top Sharpe of 6.44 in Oct (HBAN)** and strong momentum alignment.
- Handles breakout behavior well when **OBI and price trend align**, capturing trend-following opportunities.

Performance

3. Performance Evolved Over Time

- Total returns **improved month-over-month**, from 10.27% (Jun) to 19.86% (Dec) for Mean-Reversion.
- Sharpe ratios peaked in later months (e.g. **Dec: 12.84 on KEY - Inverse-OBI-VWAP**), showing strategy refinement.
- Highlights need for **adaptive signal tuning** and **regime awareness** in HFT.

Conclusion & Extensions

Questioning assumptions	• Do research on market impact analysis
Portfolio of Strategies	• Improve performance with internal crossing, net positioning and diversification of strats

References

https://github.com/changjulian17/qf621_hft/tree/first_commit