Liquidity-provision plus delta-neutral hedge strategy

Abstract

Strategy pairs concentrated ETH/USDT liquidity on Uniswap V3 with a hedge on Hyperliquid perps, neutralizing ETH exposure.

Introduction

Automated market-maker platforms give opportunities for earning yield by acting as a liquidity provider. Uniswap V3 allows LPs to earn transaction fees more efficiently by specifying custom price ranges. However, providing liquidity on a volatile asset pair like ETH/USDT exposes LPs to impermanent loss — unrealized losses when the price diverges from the initial deposit ratio.

This report presents a delta-neutral liquidity-provision strategy that combines Uniswap V3 LP positions with a hedge on Hyperliquid. By dynamically rebalancing a short ETH-perp position against the LP's ETH exposure, the strategy isolates profit and loss to collected AMM fees (minus gas and trading costs, funding rate spreads).

Strategy design

Strategy key steps.

- Initial deposit: if LP and hedge positions not exist, allocate capital and open both sides.
- LP rebalance: when the on-chain ETH/USDT price exits the current Uniswap V3 range $[p_l, p_u]$, withdraw liquidity and re-deploy it.
- Hedge rebalance: compute the LP's ETH exposure (Δ_P) and only adjust ETH-perp position if the relative deviation $\frac{\text{current\_hedge } + \Delta_P}{\Delta_P}$ exceeds threshold.

Delta calculation.

Function which calculates LP's ETH exposure:

```
function compute_lp_delta(p, pl, pu):
    // p: current ETH/USDC price
    // pl: position lower price
    // ph: position upper price

    if p < pl:
        // price below lower bound → LP fully in ETH
        return L * (1 / sqrt(pl) - 1 / sqrt(ph))

    else if p > ph:
        // price above upper bound → LP fully in
USDC
        // No ETH remains → zero exposure
        return 0.0

    else:
        // price within [pl,ph] → mixed ETH/USDC
        return L * (1 / sqrt(p) - 1 / sqrt(ph))
```

Hedge rebalancing rule.

The hedge is only re-allocated when its size drifts beyond a fraction of the target (e.g. 5 %). This avoids excessive funding and gas costs.

```
delta_lp = compute_lp_delta(p)

desired_hedge_size = − delta_lp
current_hedge_size = hedge.size

if |desired_hedge_size| < ε:
    hedge_deviation = |current_hedge_size|
else:
    hedge_deviation = |current_hedge_size −
desired_hedge_size|  / |desired_hedge_size|

if hedge_deviation > HEDGE_REBALANCE_THRESHOLD:
    adjustment_amount = desired_hedge_size −
current_hedge_size
    rebalance_hedge(adjustment_amount)
```

Initial allocation.

Measure how far price p can diviate in Uniswap price range $[p_l, p_u]$:

- $\delta_u = \frac{p_u - p}{p}$
- $\delta_l = \frac{p_l - p}{p}$
- $\delta_{\max} = \max(\delta_u, \delta_l)$

Algorithm is measuring max leverage:

$$L_{\max} = \frac{1}{\delta_{\max}}$$

Then apply a safety factor:

$$L_{\text{target}} = s * L_{\max}$$

So the initial allocation will be:

$$\text{hedge} = \frac{\text{initial\_balance}}{1+L_{\text{target}}}$$

LP = initial_balance - hedge

Data and Backtesting Framework

Strategy was backtested with fractal-defi framework on hour timeframe data of three time-series for the period 22.08.2022 - 01.01.2025.

Time series:

- Uniswap V3 pool state
- ETH Spot price
- Perpetual funding rates

These three series joined on their timestamps, missing funding rates forward-filled and all remaining NaNs are dropped.

Funding rate analyze.

Positive perp funding rate on Hyperliquid means that longs is paying shorts.

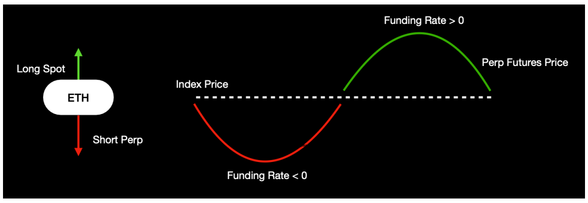

Figure 1: Who is paying?

An analysis of historical funding-rate data over our backtest period confirms that the average perp funding rate on ETH/USD is statistically positive, meaning that shorts earn from the funding payment more often than they pay. By maintaining a net short perp position to hedge our LP exposure, the **strategy not only captures Uniswap V3 trading fees but also systematically gains funding-rate income**.

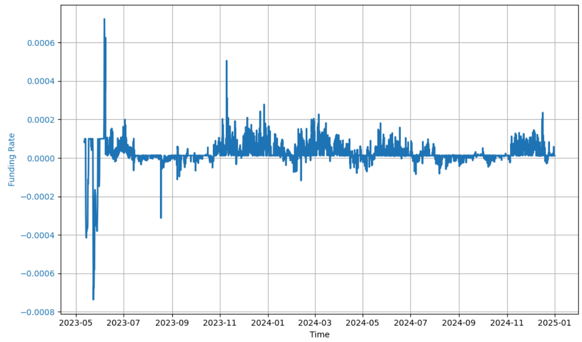

Figure 2: Funding rate ETH/USDT.

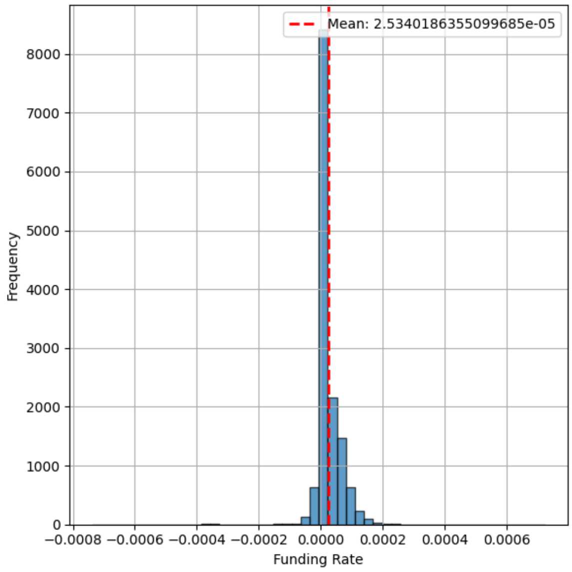

Figure 3: Distribution of funding rates.

Strategy Perfomance

Backtest parameters:

- TAU: from 3 to 30 (step ≈ 2)
- INITIAL_BALANCE: 1 000 000 (fixed)
- HEDGE_REBALANCE_THRESHOLD: from 0.02 to 0.50 (step 0.06)

Tau is parameter that affect price range.

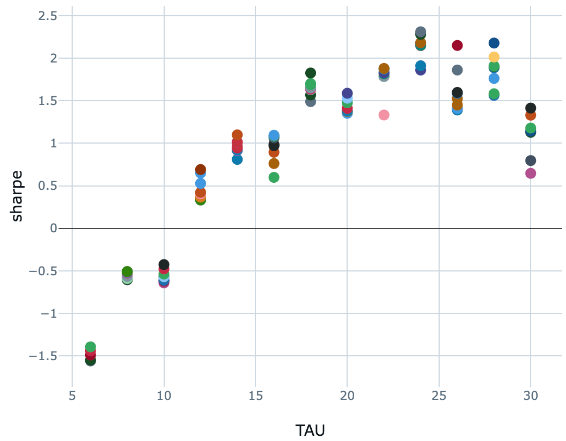

Figure 4: Tau/Sharpe scatter plot.

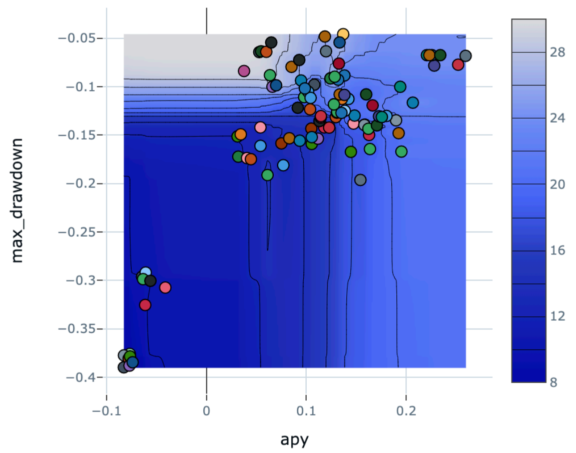

Figure 5: Contour chart (Z axis is TAU).

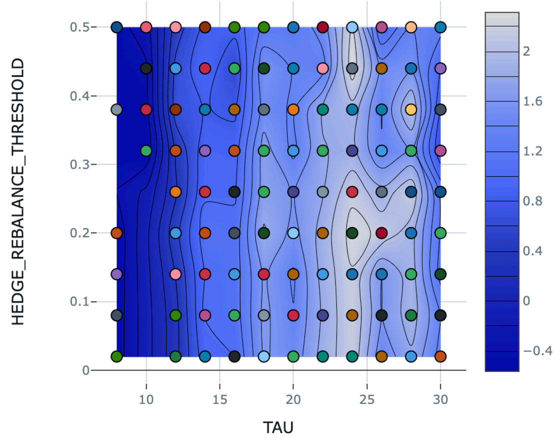

Figure 6: Contour chart (Z axis is Sharpe).

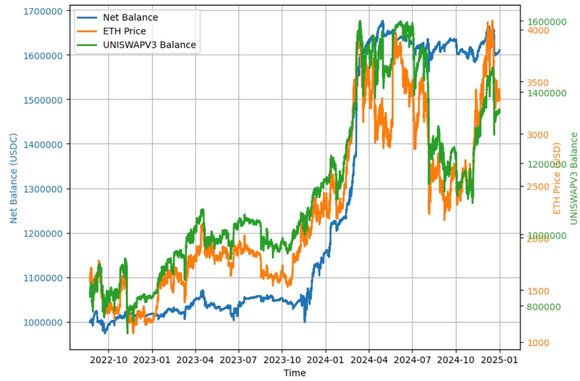

Figure 7: Best param set PnL (blue) with ETH Price (yellow).

Conclusion. The backtest shows that the strategy delivers attractive returns over the 2022-08-22 ⟶ 2025-01-01 sample. Two independent profit income:

- Uniswap V3 fees – earned for supplying tight, concentrated liquidity around the spot price.
- Perp funding income – because ETH-perp funding was structurally positive during the period, shorts were paid by longs. By remaining net-short perps to hedge the LP's long delta, the strategy captured this cash-flow on top of swap fees.

The contour charts and scatter plots highlight that the highest Sharpe and APY cluster at Tau ≈ 24–30, i.e. the widest bands tested. So "big" TAUs are great and they make the strategy more cost-effective and resilient, as the wider bands drastically cut rebalancing costs and maximize net returns.

Draw-downs remained shallow (< 7 %) even during 2023's fast ETH rallies, confirming that the hedge logic capped directional risk.

TAU	THRESHOLD	Acc. PnL	APY	Max DD	Sharpe
24	0.44	61%	25%	-6.8%	2.31
24	0.44	61%	25%	-6.8%	2.31
24	0.2	55%	23%	-6.7%	2.28

Table 1: Top 3 Parameter Sets By Sharpe