Liquidity Provider Strategies for Uniswap: Liquidity Rebalancing

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This article describes liquidity rebalancing and it's effects on the principal capital. It's part of a

[series

](/liquidity-provider-strategies-for-uniswap-v3-table-of-contents-64725c6c0b10).

Liquidity rebalancing or relocation refers to moving the liquidity around to a different price boundaries. It's typically used to move out-of-range LP positions back into the range, where the active price is.

A very common error that new Uni LPs commit is "chasing the price" — that is, moving the liquidity too frequently. Getting an amazing fee APR can feel good, but too often the "profit" is an illusion because the value of the principal capital dwindles. The problem is psychological — fee yield and APR are very salient metrics, and it's tempting to maximize them even at the expense of longer-term capital losses, which are less visible to the beginner LP. To the credit of Uniswap, it doesn't show the fee APR on the Uniswap v3 info page; however, many third-party sites and analyses do.

At the same time, when used properly, liquidity relocation is a powerful tool that not only maximizes fees, but also preserves the value of the principal capital better than some purely passive strategies.

Let's start with examples to build intuition on this subject.

Examples

Example #1: unstable coins

Let's consider a hypothetical "Super USD (SUSD)" coin that is a top-quality stablecoin, guaranteed to be always backed 1:1 by fiat. (No, really — suspend your disbelief for the sake of this example!) If you are an LP in the USDC/SUSD pool, you're likely to have 1.0 as the center price and narrow range for you positions, around 0.1% or less.

One morning, you wake up and check the news, discovering that USDC has once again depegged, currently trading at 98 cents. Because of that, your LP portfolio consists of 100% USDC.

You check the Uniswap pool stats and notice a 200% APR in the USDC/SUSD pair. The trading volume is high, and the liquidity at the current price shallow. You want to convert half of your SUSD to USDC and become an LP at the 0.98 center price.

To initiate the new position, you close the existing one, swap 50% of your assets for SUSD, and provide liquidity at the 0.98 center price and 0.1% range. A day later, with a sigh of relief, you find that USDC has returned to its $1.0 valuation. Your new position is now entirely in SUSD. You can repeat this process to redeploy the LP position back at the 1.0 center price.

The sequence of events is:

1. Deploy a USDC/SUSD LP position at price equal to 1.0.
2. USDC depegs, trades at 0.98 with high APR, position fully in USDC.
3. Close the position, collect the assets, put the collected fees aside, swap 50% of USDC for SUSD.
4. Redeploy the USDC/SUSD LP at 0.98.
5. USDC price stabilizes to $1 again, new position is fully in SUSD.
6. Close the position, collect assets, put fees aside, swap 50% SUSD for SUSD.

7. Redeploy the USDC/SUSD LP back at 1.0.

Question:

are you better off?

One way to answer that is to notice that a single relocation reduces the liquidity of the position by approximately 1%, since sqrt(0.98) ~= 0.99

. You better hope that the fee collected during the single day is grater than 2% of the principal. Otherwise it would have been better to keep the initial position unmoved.

Example #2: chasing the ETH

Let's assume ETH/USDC price is $2000. An LP deploys a symmetrical position at the center price P=$2000

and range [P_a = P / r, P_b = P · r]

, where r = 1.1

. When the price goes out of the range, LP redeploys the position at the old boundary price P_a

or P_b

as the new center price, using the same range r

.

The LP is competing with a few other strategies:

1) Static — deploy and forget. It uses the same parameters: center price andr

as the range;

2) Wide range — same strategy, but uses r^2

as the range;

3) HODL — keep the initial assets as they are.

The initial value of assets is $1000.

Scenario #1: upwards momentum

Here, the price increases by a factor of r

once, and then by the same factor again. The active LP rebalances once: when the price reaches/exceeds the initial P_b

the first time.

Final values:

- Active LP: 1049.40
- Static LP: 1024.40 (— 2.44%)
- Wide-range LP: 1050.00 (+0.06%)
- Holder: 1105.00 (+5.03%)

The active LP beats the static narrow-range LP, but loses to other strategies.

Scenario #2: downwards momentum

Same idea, opposite direction.

Final values:

- Active LP: 867.28
- Static LP: 846.62 (— 2.44%)

- Wide-range LP: 867.77 (+0.06%)
- Holder: 913.22 (+5.03%)

The gains in % terms are the same as in the Scenario #1, even though the values obviously are different from #1.

Scenario #3: oscillations

Here, the price increases/decreases by a factor of r

once, and then does the opposite, reverting back to start.

The active LP rebalances once: when the price reaches the initial P_a

or P_b

.

- Active LP: 954.00
- Static LP: 1000.00 (+4.6%)
- Wide-range LP: 1000.00 (+4.6%)
- Holder: 1000.00 (+4.6%)

Here, active LP is clearly the worst strategy. It turns

the impermanent loss into permanent loss

.

Technical explanation of how "chasing the price" reduces liquidity

Why does the value of position go down due to price reversions after rebalancing?

With the $xy=k$

bonding curve, the same amount of assets deployed at different prices creates different liquidity depths.

For instance, let's look at a single-sided narrow range 1 ETH position in USDC/ETH pool. It can be interpreted as a limit order: "when price reaches X, sell ETH for USDC".

- If the position is deployed 2000 USDC/ETH as the center price, a sum of 2000 USDC is required to fully buy out the ETH in the position.
- If deployed at 4000 USDC/ETH, 2x more $ is required.
- If deployed at 8000 USDC/ETH, 4x more $.

Also consider that swapping 4x more tokens at a fixed price P

leads tosqrt(4)

= 2x higher price impact. (Proof follows from the relation $\sqrt{P} = L \cdot$

$y = L/x$, and the fact that L remains constant after a swap.)

- From one side, the trader is swapping 4x more USDC tokens so that should lead tosqrt(4)

= 2x higher price impact;

- From the other side, the trader is swapping 1 ETH, so the price impact should stay the same.

The way to reconcile these two requirements is make the liquidity 2x as deep if the single ETH is deployed at $8000.

Not only is the ETH priced more, it actually creates a deeper liquidity!

More formally, the [v3 liquidity math] defines the liquidity L

of single-sided positions (only X or only Y assets) as:

It follows that:

- a position of x

tokens relocated at α

times higher

price has sqrt(α)

times higher

liquidity, assuming that the range r=sqrt(P_b/P_a)

of the position remains the same — see proof below:

- a position ofy

tokens relocated α

times lower

price has sqrt(α)

times higher

liquidity. (Proof follows from the above, as x

and y

are symmetrical in the xy=k

equation.)

Moving assets away from the current price always increases the liquidity.

If a position with liquidity L

is relocated as soon as it goes out of the range (p < P_a

or p > P_b

) and re-centered around the previous P_a

orP_

b, then on each relocation:

- half of the position stays the same distance from the new center price;
- half of the position moves r

times closer.

The new liquidity L_new

is given by:

We know that the range r

is always larger than 1.0

, because all valid positions have non-zero width. Therefore L_new

is strictly less than L_old

.

Now it's possible to answer the question from above:

Why does the value of position go down due to rebalancing?

What happens is:

- the liquidity of the position decreases on every rebalance;
- if the price reverts

, the value of the position goes down relative to the initial value, due to the lower liquidity.

An aside: academic papers and prestigious universities

As a side note: in my opinion, no research paper has been more harmful to the understanding of concentrated liquidity in the DeFi community than the preprint "Strategic Liquidity Provision in Uniswap v3" from Harvard. For one, it used to advertise[1] the extremely misleading "230x times more utility" in Uniswap v3 compared with Uniswap v2. While I haven't seen the code behind their results, I strongly suspect they did not correctly model the liquidity evolution over time.

If you're interested in academic approaches on Uniswap v3, start by looking at "Concentrated Liquidity in Automated Market Makers" instead. It's short, easy to understand, and does

take into account the liquidity evolution along with the accrued fees.

[1] — It seems that since 2021 the paper has had a major rewrite; in 2023 a

[new version was published

](https://arxiv.org/abs/2106.12033v3), and the 230x figure is now gone.

Simulations

The simulations show the expected final value a year after the position was first created, for different levels of yearly volatility σ.

Caveat: in this article, I keep focusing only on the evolution of the principal capital over time, ignoring fees. As the different strategies are going to have different fee yields, a lower "expected final value" does not always mean the strategy is worse. Especially for higher σ, fee yields are expected to be large! However, fee yields depend mostly on external factors, and are difficult to predict & analyze mathematically. (For a deep dive: this research paper from 2023 does give it a shot, but they are focusing on just arb fees, ignoring "normal" market trades, for the unpredictability reasons.)

A technical note:

the simulations use GBM price evolution and show the average

results for N=10,000

simulated trajectories. The median

results would be worse. Costs for rebalancing swap fees, transaction fees & other operating expenses are ignored, for simplicity.