A Guide for Choosing Optimal Uniswap V3 LP Positions, Part 2

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This is the second article in a series of medium posts about choosing and managing Uniswap v3 LP positions. Read

[part 1

](/a-guide-for-choosing-optimal-uniswap-v3-lp-positions-part-1-842b470d2261?sk=0837ea1f98657dfae15c386802a76396)here.

TL;DR: Uni v3 liquidity positions have to balance capital efficiency and the time spent in-the-money. The product of these two effects results in a simple √T dependence for narrow liquidity ranges. Holding a position for a long time and/or deploying to wider ranges reduce LP returns, a cost we call

radical liquidity drag

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In our previous post, we derived an expression describing the probability of a Uniswap v3 position will end up within the upper/lower tick after a time T. Since fees are continuously accrued when a position is within range of the LP position, perhaps a more sensible question to ask is:what fraction of time is spent within a specific range between times 0 and T

?

In this article, we will derive an expression for the expected amount of fees to be accrued by a LP position. We will find that the amount of fee is a combination of the effective liquidity

, which depends on the upper/lower ticks of the LP position, and the time spent in-the-money,

which depends on the volatility of the underlying asset.

An overview of Uniswap Fees

Liquidity providers collect fees based on trading volume. The total amount of collected fees during a given time window should depend on

1. The fee tier: 0.05%, 0.3% or 1%
2. The trading volume.
3. The total liquidity at the traded tick.
4. The LP position's liquidity.
5. Fraction of time spent inside the upper/lower ticks.
6. The total amount of time the LP position is deployed

We can separate the expression for the amount of fees collected into three components, which can be written as:

- Fee accrual rate:

the fee tier, trading volume, and total liquidity are dictated by the AMMs smart contract and the market. Thus, when deploying liquidity, users should target Uniswap pools that optimize this quantity (ie. consider the volume, TVL and fee tier).

- Effective liquidity:

The effective size of a position is the product of the amount of assets locked in each tick of the position and the total time spent inside the range of the liquidity position. This is controlled by the liquidity provider when the LP position is deployed.

- Duration

: this is simply the amount of time a position is held before it is removed or rebalanced.

Since the fee accrual rate is not under the control of the user, the only way to optimize a LP position is to optimize the effective liquidity and remain in the position for a duration that maximizes returns.

Capital Efficiency and Position Liquidity

In Uniswap v2, liquidity is spread across all possible prices, from 0 to ∞, meaning that a large fraction of the liquidity provided may never be "used" because price may not be traded at that specific price. Uniswap v3 set out to fix these capital inefficiency issues by allowing LP to deploy concentrated liquidity between any two "price ticks".

In Uniswap v3, each tick i

defines a specific price P = 1.0001^i. The index i

can be any integer number between (-887272, 887272). When deploying a position, a liquidity provider defines a lower tick i_L and an upper tick i_U so that liquidity is deployed between a lower and upper price (t_L, t_H) equal to 1.0001^{i_L} and 1.0001^{i_U}.

Deploying liquidity to a specific range is much more capital efficient than in Uniswap v2, here's Hayden's tweet about this and [this analysis by Tienshaoku]:

Hence, the effective liquidity of the position will be much larger for narrow ranges

. Since the total liquidity L is "split" equally into small δL = L/N chunks between all ticks between the upper and lower limits, we can compare the relative capital efficiency of a ranged Uniswap v3 position and a corresponding Uniswap v2 position (the "Full Range" option on the Uniswap v3 interface deploys liquidity between the (-887,272, +887,272) ticks. For a ranged position, the number of liquidity ticks N in a position is given by:

To compare the capital efficiency of Uniswap v3 compared to a "Full Range" position, we plot the number of liquidity ticks as a function of the range factor r for each of the 0.05%, 0.3% and 1% fee tiers to get:

A couple of takeaways here. First, liquidity deployed to a single-tick in Uniswap v3 is 1,774,544 more capital efficient

than the corresponding Uniswap v2 (ie. Full Range) position. Even a more modest range factor r=1.2 for a 0.3% pool leads to a staggering 29,200-fold improvement in liquidity over the "Full range" option.

Second, extending the range splits the liquidy

equally among all ticks between the lower and upper ticks. Specifically, the amount δL of liquidity inside each chunk scales as δL~1/ln(r). This means that liquidity deployed using r = 1.2 is effectively 2.5x larger than liquidity deployed using r=1.6.

Finally, liquidity fragmentation

can be significant when liquidity is deployed to a smaller fee tier. In other words, deploying liquidity at a range factor r=1.6 results in a splitting of the liquidity into 47 ticks for the 1% pool, 156 ticks for the 0.3% pool, and 940 ticks for the 0.05% pool.