Liquidity Depth and Slippage Analysis in the OLAS-ETH Uniswap-v2 pool

15th September 2023
Author: Mariapia Moscatiello

TL;DR

This analysis of the OLAS-ETH Uniswap-v2 pool suggests that the current liquidity depth is sufficient to sustain current trading activity, with most (specifically 94.7% of 10k simulated) trades experiencing less than 1% slippage.

Introduction

In decentralized finance liquidity pools, the depth of liquidity plays a crucial role in determining the efficiency and effectiveness of trading activities. A deeper pool can lead to lower slippage and increased trading volume, resulting in higher protocol fees. This analysis aims to assess the health of liquidity depth within the OLAS-ETH Uniswap-v2 pool by examining whether the current liquidity is sufficient to sustain the current market activity.

Specifically, this document provides the following insights for the liquidity depth and slippage behavior within the pool.

1. **Distribution of Swaps:** The distribution of historical swaps indicates the range of ETH and OLAS amounts swapped in the pool. This provides a comprehensive overview of the trading activity within the pool.
2. **Slippage Analysis - Single Trade:** For single trades involving either ETH or OLAS, analysis shows that a significant portion of trades can be executed with minimal slippage. Specifically, a swap of ETH for OLAS with a value at the 96.5% of the cumulative distribution and a swap of OLAS for ETH with a value at 89.7% of the cumulative distribution experienced less than 1% slippage. Even trades at the median value of the distributions exhibit minimal slippage.
3. **Slippage Analysis - Multiple Trades in the same Direction**: The analysis of multiple consecutive trades shows that slippage, in terms of the numeraire asset, tends to decrease when several swaps occur in the same direction and with the same input amount.
4. **Slippage Analysis - Trades in Multiple Directions:** Simulated trades, involving 10’000 consecutive swaps between OLAS and ETH assets and using amounts generated from the cumulative distributions of trades, show that the majority

(94.7%) of these experience slippage lower than 1%. This suggests that trades in different directions within the pool can still be executed with relatively low slippage.

This analysis only takes into account current trading activity. A comprehensive analysis demonstrating the maximum trading activity the pool can sustain can provide additional clues, but is beyond the scope of this document.

Distribution of the swaps

To begin our analysis, we first study the distribution of swaps within the aforementioned pool. Specifically, to obtain the distributions of trades in both directions, we can focus on: the distribution of swaps of ETH for OLAS into the pool (i.e. OLAS are bought from the pool) and the distribution of swaps of OLAS for ETH into the pool (i.e. ETH are bought from the pool).
Data for the simulations assessing swaps and the pool's status were collected from July 12, 2023, at 18:23, to September 13, 2023, at 07:15, using the following queries https://dune.com/queries/3016473 and https://dune.com/queries/3021602).

Distribution of ETH swapped for OLAS and added to the pool

In Fig. 1, we present the distribution of historical ETH amounts swapped for OLAS into the pool.

The following values are obtained from the distribution.

- The maximum value of distribution is 178.56 ETH
- The median value of the distribution is 0.5 ETH
- The mean value of the distribution is 1.67 ETH

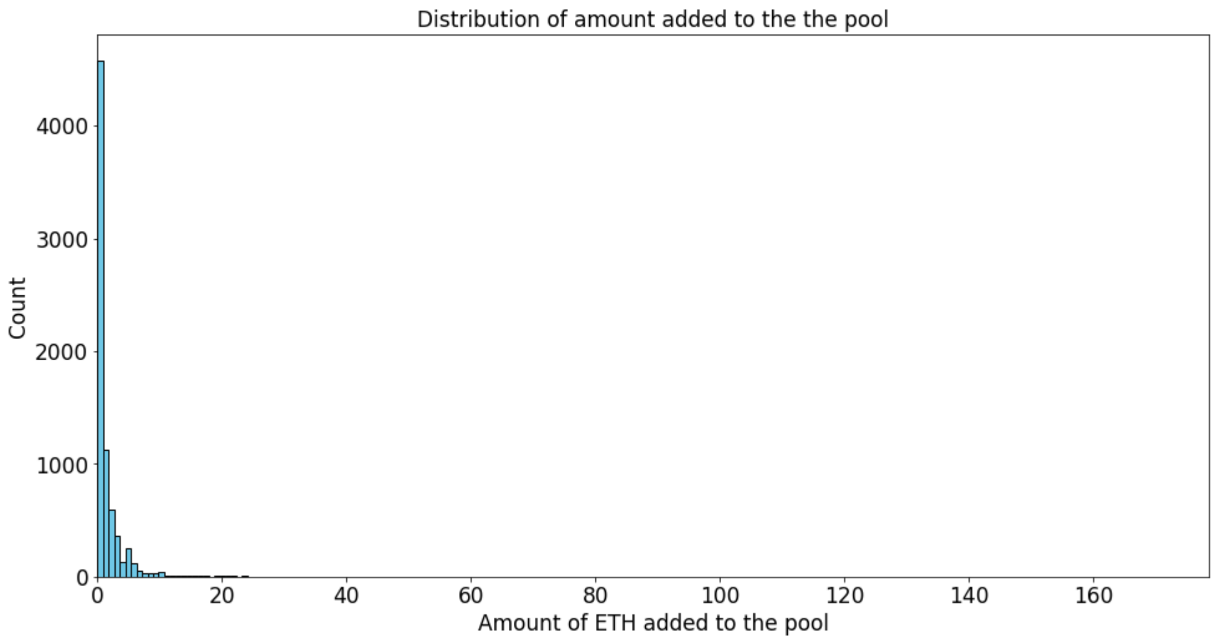

Fig. 1 Distribution of the amounts of ETH added to the pool during a swap.

Fig. 2. displays the cumulative distribution of ETH added to the pool during a swap, revealing that 99.7% of the ETH added to the pool is smaller than 35 ETH.

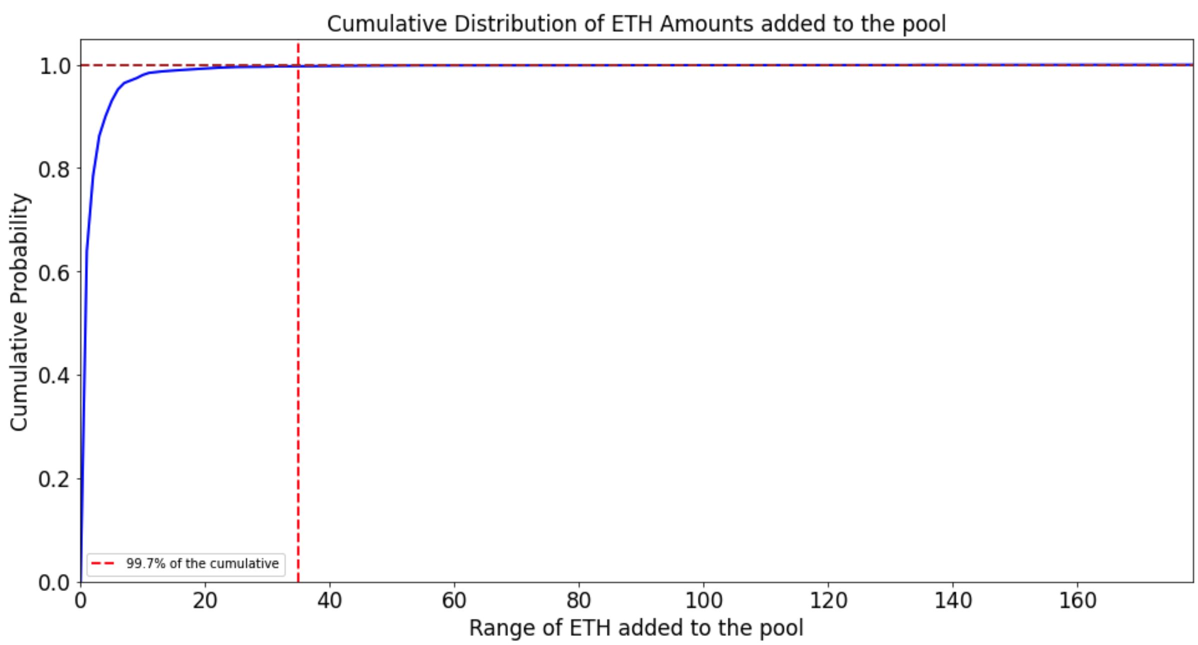

Fig. 2 Cumulative distribution of the amounts of ETH added to the pool during a swap. The vertical red line, representing the 99.7% of the cumulative distribution.

Distribution of OLAS swapped for ETH and added to the pool

In Fig. 2, we present the distribution of historical OLAS amounts swapped for ETH into the pool.

The following values are obtained from the distribution.

- The maximum value of distribution is 292’926.49 OLAS
- The median value of the distribution is 2’521.14 OLAS
- The mean value of the distribution is 6’783.85 OLAS

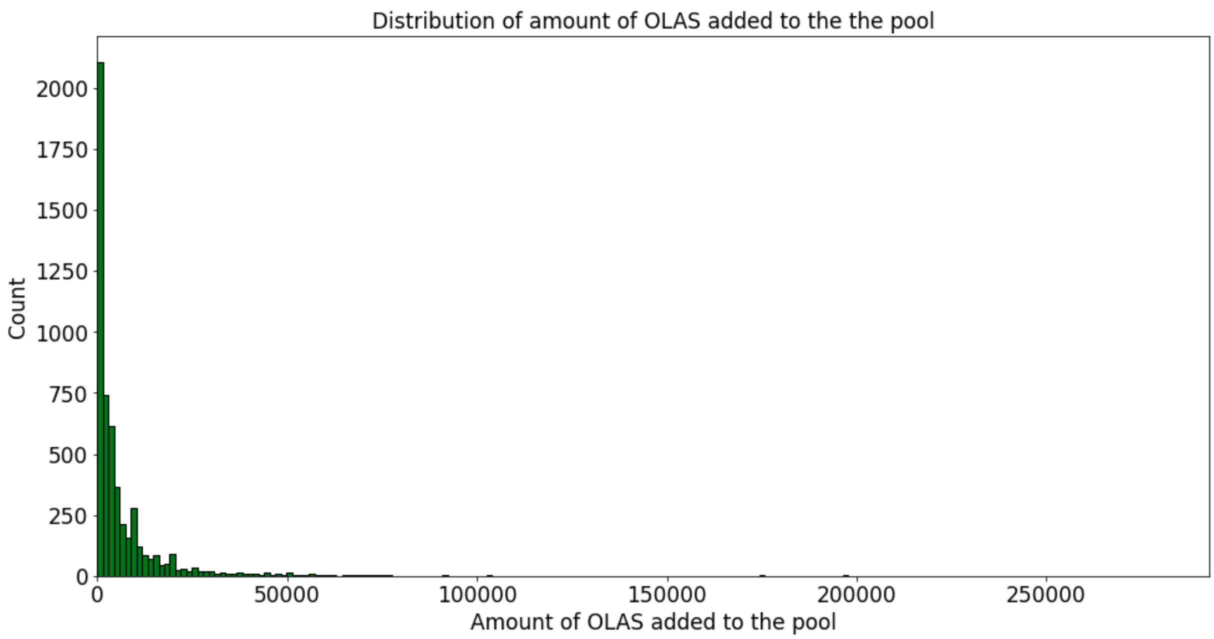

Fig. 3 Distribution of the amounts of ETH added to the pool during a swap.

Figure 4 displays the cumulative distribution of OLAS added to the pool during a sawp, showing that 99.7% of the OLAS added to the pool is smaller than 95’832 OLAS.

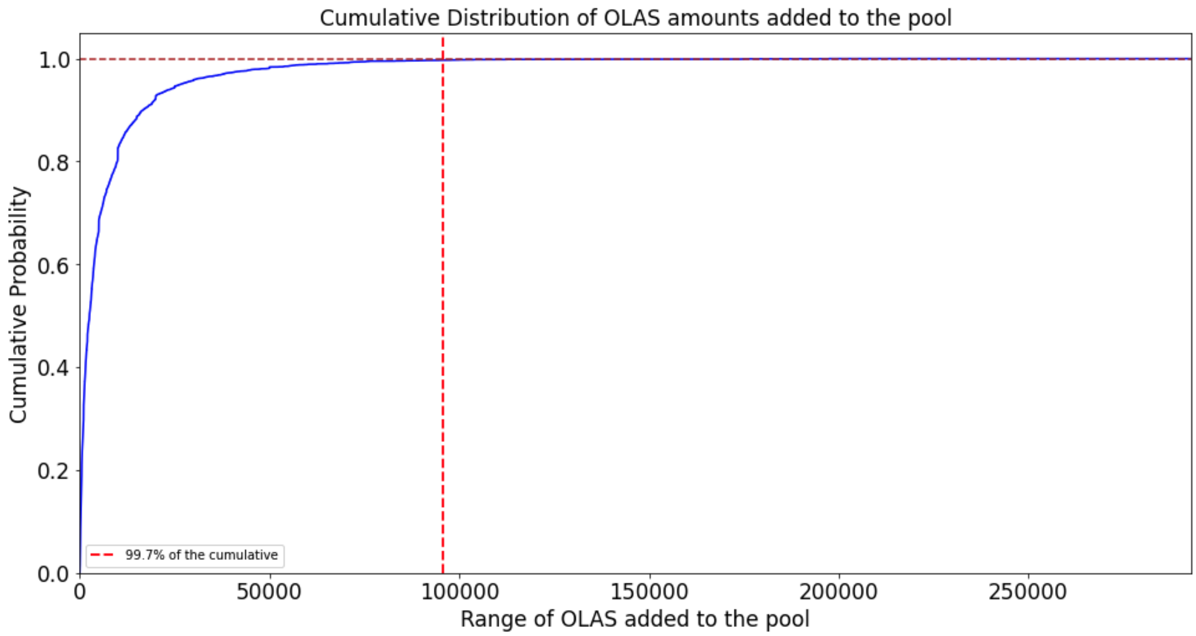

Fig. 4 Cumulative distribution of the amounts of OLAS added to the pool. The vertical red line, representing the 99.7% of the cumulative distribution.

Slippage

Slippage is a critical factor in assessing the efficiency of a pool. We define slippage as the difference between the expected trade price and the actual price received after a swap (cf. references 1, 2). The following mathematical formulas describe slippage.

Mathematical formulation

Trigger warning: math formulation.

We recall that for constant-product-market makers such us Uniswap-v2, OLAS *spot price, OLAS_spot_price,* and, ETH *spot price, ETH_spot_price,* is determined by the reserve of the assets in follows[1]:

$$OLAS\_spot\_price = \frac{ETH\_Reserve}{OLAS\_Reserve} \quad and \quad ETH\_spot\_price = \frac{OLAS\_Reserve}{ETH\_Reserve} \quad (1)$$

For more details see reference 3. However, the *spot price* is not not the price at which your trade is executed. Specifically, the amount of OLAS (resp. ETH), *OLAS_out* (resp.

[1] We are focusing the analysis on the OLAS-ETH Uniswap v2 pool, but it's important to note that the principles discussed apply broadly to any pair of assets within Uniswap v2 pools.

ETH_out), you would receive when adding *ETH_in* (resp. *OLAS_in*) amount of ETH (resp. OLAS) can be computed as follows:

$$OLAS\_out = \frac{f\cdot\ ETH\_in\cdot\ OLAS\_Reserve}{ETH\_Reserve + f\cdot\ ETH\_in}\ \left(resp.,\ ETH\_out = \frac{f\cdot\ OLAS\_in\cdot\ ETH\_Reserve}{OLAS\_Reserve + f\cdot\ OLAS\_in}\right), \quad (2)$$

where $f = 1 - fee$ and the Uniswap-v2 fee is 0.3%.

It should be clear now where the slippage comes from. Using equation (1) and (2) we get that the percentage of slippage experienced by a trader adding *ETH_in* or *OLAS_in* can be computed as follows:

$$SlippagePercentage(OLAS\_in) = 100 \cdot \frac{f\cdot OLAS\_in\cdot OLAS\_spot\_price - ETH\_out}{f\cdot OLAS\_in\cdot OLAS\_spot\_price} \quad (3)$$

$$SlippagePercentage(ETH\_in) = 100 \cdot \frac{f\cdot ETH\_in\cdot ETH\_spot\_price - OLAS\_out}{f\cdot ETH\_in\cdot ETH\_spot\_price} \quad (4)$$

Results of the analysis

We conducted a comprehensive analysis of slippage percentages using the distributions of swaps (ETH for OLAS and OLAS for ETH) discussed earlier.

Part 1. Single trade

Our analysis reveals that for a significant portion of the cumulative distribution, single trades involving the addition of either ETH or OLAS can be executed with slippage below 1%. Specifically:

- When swapping ETH for OLAS, a trade within the 96.5% of cumulative distribution (as described in Fig. 3) experiences less than 1% slippage (see Fig. 5)
- When swapping OLAS for ETH, a trade within the 89.7% of the cumulative distribution (as described in Fig. 4) also incurs less than 1% slippage (see Fig. 6).

Furthermore, it's noteworthy that:

- Swapping ETH for OLAS at the median value of the swaps distribution (as shown in Fig. 1) results in a minimal slippage of only 0.06%.
- Swapping OLAS for ETH at the median value of the swaps distribution (as depicted in Fig. 2) yields a similarly low slippage of just 0.16%.

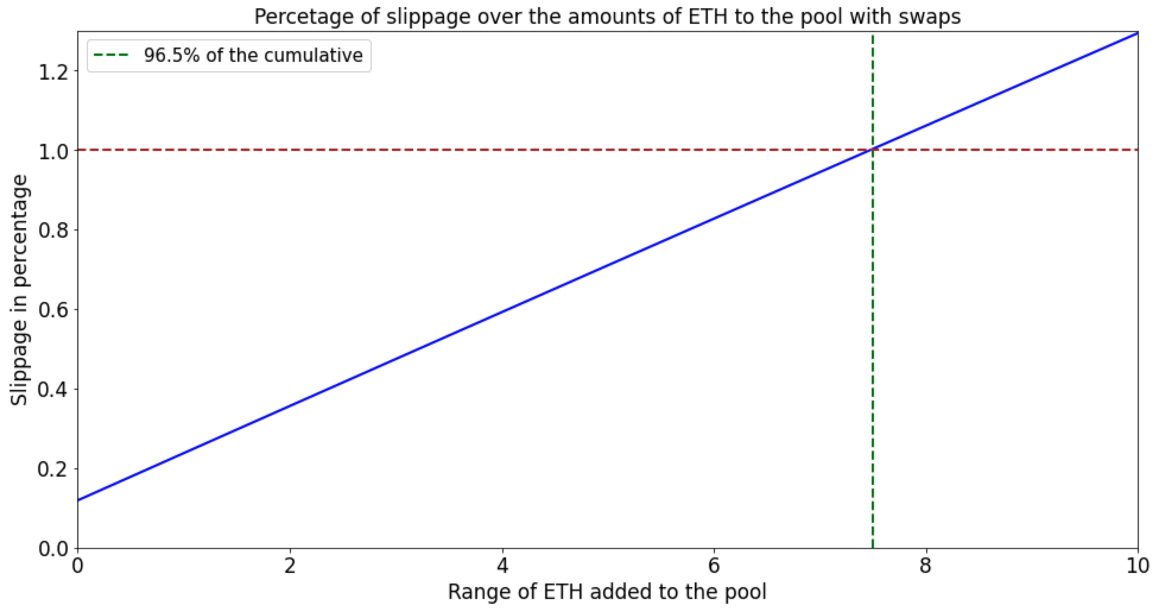

Fig. 5 Percentage slippage swapping ETH for OLAS into the pool. The green line represents the 96.5% of the cumulative.

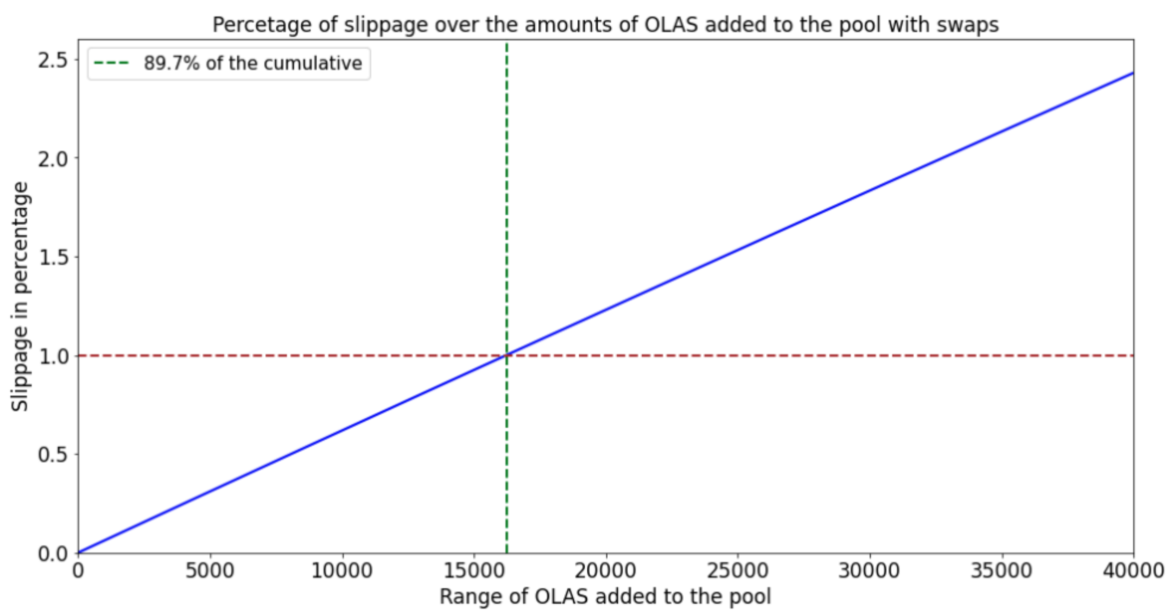

Fig. 6 Percentage slippage swapping OLAS for ETH into the pool. The green line represents the 89.7% of the cumulative.

Part 2. Multiple trades

Trades in the same direction

Multiple swaps in the same direction, such as OLAS for ETH or ETH for OLAS, with the same input amount, result in reduced slippage. This phenomenon can be intuitively understood by considering that multiple same-direction swaps increase the reserve of the added asset. As a result, the added amount becomes relatively smaller compared to the reserves, causing the trade's execution price to approach the spot price.

This concept can be mathematically proven as follows.
Substituting (1) and (2) in formula (4), we obtain the following:

$$SlippagePercentage(ETH\_Reserve) = 100 \cdot \left(1 - \frac{ETH\_Reserve}{ETH\_Reserve + f \cdot ETH\_in}\right) \qquad (5)$$

Per fixed value of ETH_in, the first derivative of this function is

$$SlippagePercentage'(ETH\_Reserve) = - 100 \cdot \frac{2ETH\_Reserve + f \cdot ETH\_in}{(ETH\_Reserve + f \cdot ETH\_in)^2} \qquad (6)$$

In the function's domain, the derivative is always negative, making $SlippagePercentage(ETH\_in)$ a monotone decreasing function.
Therefore, when using the same amount as input, an increase of the reserve (specifically, ETH reserve), leads to reduced slippage. A similar proof can be applied to equation (3) for OLAS trades.

Trades into multiple directions

To obtain the distribution of the slippages with trades in different directions, such as swapping ETH for OLAS and then swapping OLAS for ETH, or vice versa, we simulated consecutive swaps between OLAS and ETH assets. Each iteration of the simulation represents a single swap, and this process was repeated 10’000 times.

The simulation procedure was as follows:

1. We selected a random value p
2. If p was smaller than the ratio of OLAS trades per ETH to the total number of swaps (i.e., the probability of an OLAS trade relative to all trades), a swap of OLAS for ETH was performed

3. If p was greater than or equal to the probability of an OLAS trade for ETH, a swap of ETH for OLAS was performed.

The traded amounts in steps 2 and 3 were randomly selected from the cumulative distributions of swaps of ETH and of OLAS (shown in Fig. 2 and Fig. 4).

In Figure 7, we present the resulting distributions of slippage obtained from these simulations. The key statistics from the distribution are as follows:

- Maximum slippage: 17.18 %
- Median slippage: 0.1%
- Mean slippage: 0.29%

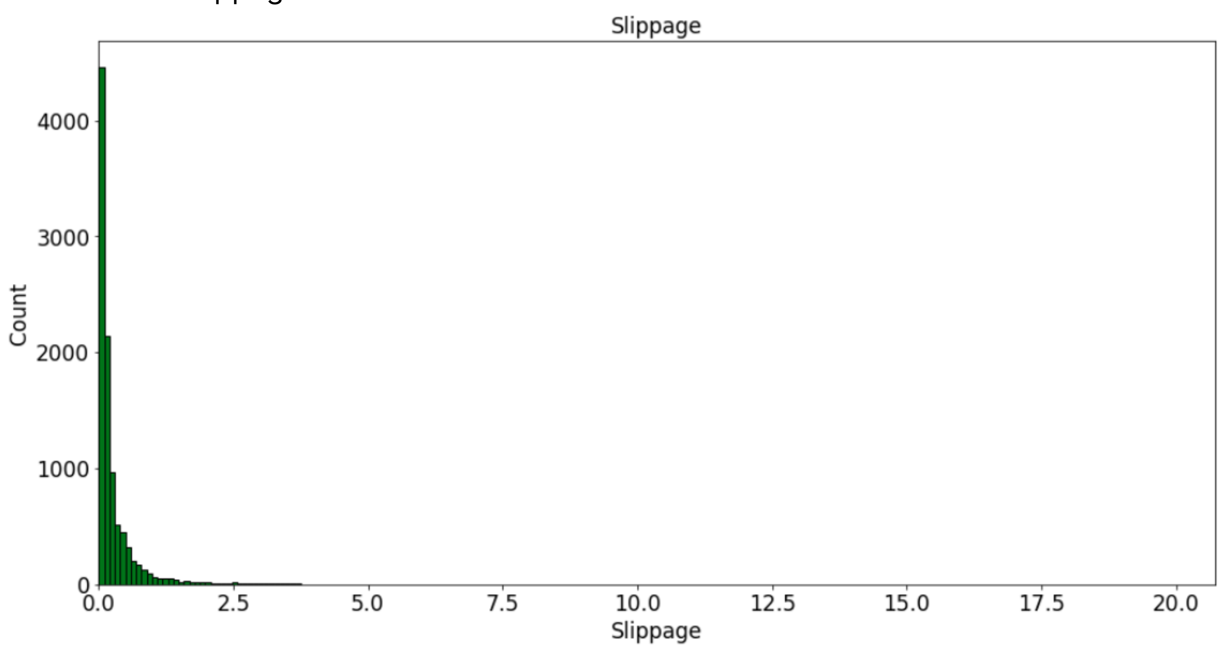

Fig. 7 Distribution of the slippage in simulated trades.

Fig. 8 shows the cumulative distribution, indicating that 94.7% of the simulated trades have a slippage lower than 1%.

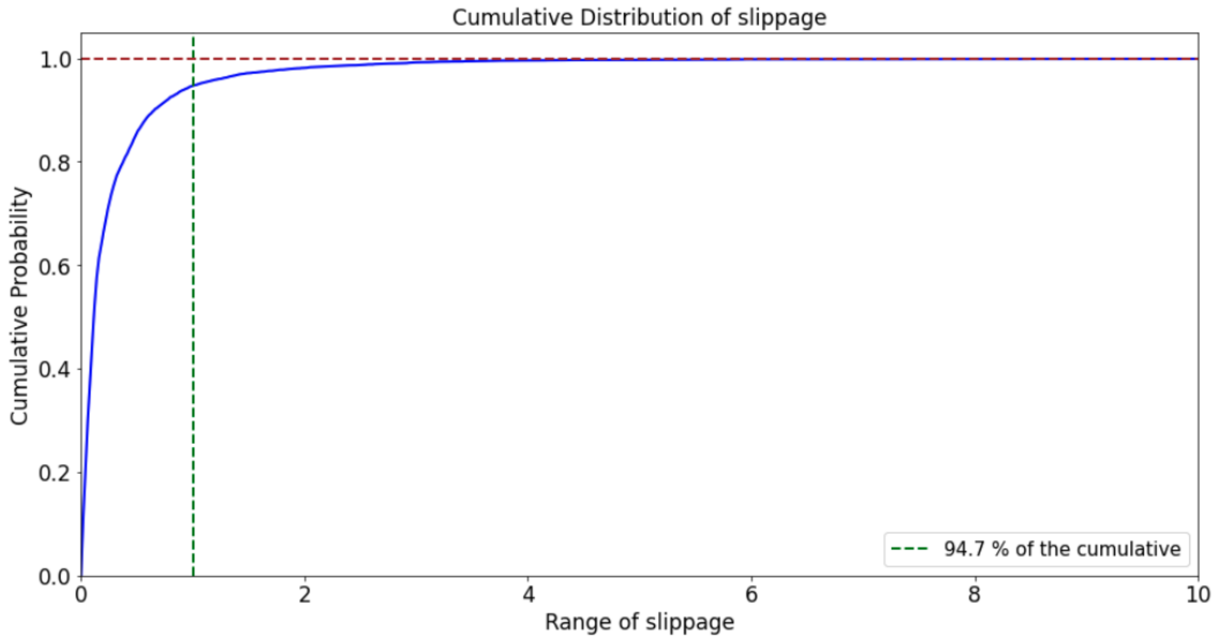

Fig. 2 Cumulative distribution of the slippage from simulated trades. The vertical green line, representing the 94.7% of the cumulative

Conclusion

This analysis provides insights into the liquidity depth and slippage behavior within the studied OLAS-ETH Uniswap V2 pool. It highlights the significance of understanding the distribution of swaps, assessing slippage, and exploring the impact of multiple trades. These insights are crucial for evaluating the health of liquidity depth within the pool in terms of its efficiency and effectiveness in facilitating trading activities.

References

1. https://devweb3.net/how-slippage-works-in-uniswap-v2/
2. https://support.uniswap.org/hc/en-us/articles/8643879653261-What-is-Price-Slippage-
3. https://uniswapv3book.com/docs/introduction/constant-function-market-maker/