Estimation of potential earnings from exclusive access arbitrage in DEX pools

Konrad Wierzbik
konrad.wierzbik@gmail.com

Igor Cieślar
igor.cieslar@gmail.com

Abstract

In this study, we analyze the potential profits from arbitrage between decentralized exchanges (DEXs) and centralized exchanges (CEXs), specifically examining scenarios where an arbitrager possesses exclusive swap access to Uniswap V3 like pools ETH-USD and BTC-USD. We employ a straightforward strategy wherein the arbitrager conducts swaps at intervals of 1, 2, 15, and 60 seconds to align DEX prices with current Binance CEX prices. Our findings reveal that arbitragers can generate significant profits comparable to those generated from fee collection.

1 Introduction

Arbitrage opportunities are a fundamental and inextricable feature of decentralized exchanges (DEXs) such as Uniswap V3, due to the inherent design of these platforms. The asynchronous price updates between decentralized and centralized exchanges (CEXs) create discrepancies that can be exploited for profit. According to recent data from Glassnode, the trading volume attributed to arbitrageurs has reached levels comparable to that of human traders, underscoring the prominence and potential of arbitrage within the DEX landscape.

In this context, our research aims to quantify the potential earnings from arbitrage by assuming exclusive access to DEX pools, such as ETH-USDC and BTC-USDC on Uniswap V3. We simulate a scenario in which an arbitrager aligns DEX prices with those of a major centralized exchange, Binance, at frequent intervals (1, 2, 15, and 60 seconds), to gauge the profitability of such operations.

This investigation serves as a fundamental analysis to measure the potential profits that can be consistently generated from structured arbitrage opportunities within DEX environments. By quantifying these earnings under a scenario of exclusive market access, we lay the groundwork for evaluating various models, including the Contract Special Access Leasing (CSAL) mechanism. This study provides essential data that could help determine whether implementing CSAL might truly enhance liquidity provider yields, thereby supporting more sustainable economic dynamics in decentralized finance.

2 Calculation Methods

The calculations were performed by simulating the Uniswap v2 liquidity pool model, using historical data from the Binance exchange. The methodology was structured around several key assumptions:

Input Data: Initial liquidity in the pool was assumed to be $1,000,000 USD. The proportions of tokens in the pool were aligned to match the price from beginning of historical data.

Fee Parameter: The model incorporates the swap fee charged by the pool.

2.1 Strategy

The strategy for analyzing historical data and executing profitable trades involved a process outlined in the following steps:

Selection of Historical Data: A specific subset of historical data from the Binance exchange was selected, corresponding to various time intervals such as every second, every other second, every fifteenth second, and so forth.

Analysis of Data Points: At each data point, an analysis is conducted to determine whether there is an opportunity to execute arbitrage operations between DEX and CEX. This is achieved by comparing the token valuation at the given moment on Binance to the price determined by the token proportions in the pool, taking into account the fees charged by the pool.

Decision on Operations: Decisions to execute swaps were based on the profitability determined at each data point. Transactions were initiated only when a profitable opportunity was identified.

3 Uniswap V3 Pools

Uniswap V3 introduced the concept of concentrated liquidity, enabling Liquidity Providers (LPs) to allocate their capital within specific price ranges, thereby optimizing capital efficiency. To accurately estimate potential arbitrage profits from actual Uniswap V3 pools, it is essential to compare the virtual liquidity in real pools with that of a simulated pool initialized with $1 million. This comparison utilizes formulas (1) and (2) from the [Unic].

The current largest V3 pool for ETH paired with a stablecoin is the USDC/ETH pool [Unia], boasting a Total Value Locked (TVL) of approximately $200 million. About $300,000 of this is concentrated in each price range near the current market price. Price ranges in this pool are defined by the powers of 1.001.

In a similar vein, the most substantial pool for BTC and a stablecoin is the WBTC/USDT pool [Unib], with a TVL of around $40 million. Approximately $60,000 is locked in each price range near the current price, with price ranges set by the powers of 1.005.

Given the nature of concentrated liquidity in these pools, the potential arbitrage profits for pools like ETH could be up to 1,000 times, and for BTC up to 50 times greater than those calculated using the methods outlined above.

4 Results

The following results were obtained using historical data from January 1, 2024, to March 31, 2024, for the ETH/USDT and BTC/USDT pairs. Calculations were performed considering different fee scenarios: {0%, 0.01%, 0.05%, 0.3%} and data selection intervals of {1s, 2s, 15s, 60s}.

	0%	**0.01%**	**0.05%**	**0.3%**
1s	$10313	$5689	$2302	$650
2s	$11474	$6754	$2779	$804
15s	$14247	$10821	$5402	$1779
60s	$15344	$13296	$8428	$3191

Table 1: DEX-CEX ETH/USDT arbitrage profits of different strategies generated on simulation pools with different fees.

	0%	**0.01%**	**0.05%**	**0.3%**
1s	$9006	$5022	$2069	$618
2s	$10028	$6009	$2556	$714
15s	$12215	$9300	$4789	$1507
60s	$12709	$10918	$6775	$2440

Table 2: DEX-CEX BTC/USDT arbitrage profits of different strategies generated on simulation pools with different fees.

The highest profits in both pools can be observed for fee equal to 0% and intervals of 60s. If the profits are rescaled to match the real Uniswap V3 pools one could generate much higher profits witch are presented in table below:

pool	**rescaled profit**	**real collected fee**
V3 ETH/USDC	$15.3 million	$12,45 million
V3 BTC/USDT	$630,450	$564,481

Table 3: Potential arbitrager profits on Uniswap V3 ETH/USDC and BTC/USDT pools assuming exclusive access and no fee and the real pools' collected fee from 01.01.2024 to 31.03.2024.

4.1 Swap analysis

Swap analysis was also conducted based on calculations for the ETH/USDT and BTC/USDT with fee equal to 0% and a data selection interval of 60 seconds.

4.1.1 Generated Gain

The charts below illustrate the distribution of generated profit based on the size of swaps (grouped into baskets).

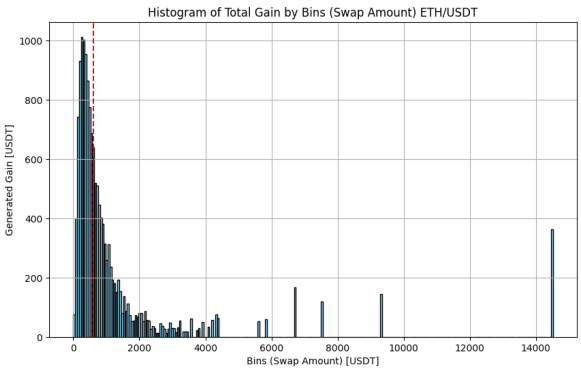

Figure 1: Histogram of Total Gain within Bins (Swap Amount) ETH/USDT. The red line indicates a median of distribution.

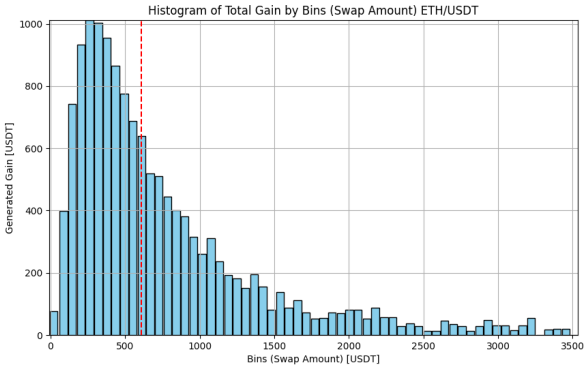

Figure 2: Histogram of Total Gain within Bins (Swap Amount) ETH/USDT. The red line indicates a median of distribution.

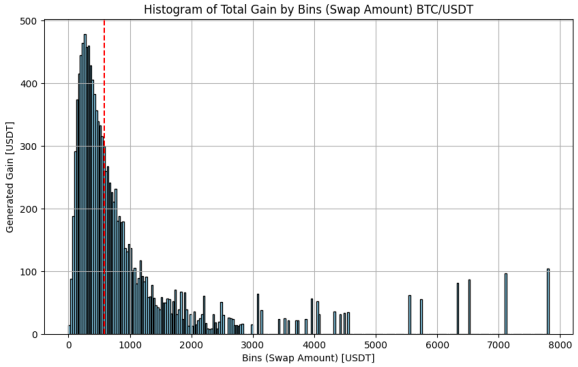

Figure 3: Histogram of Total Gain within Bins (Swap Amount) BTC/USDT. The red line indicates a median of distribution.

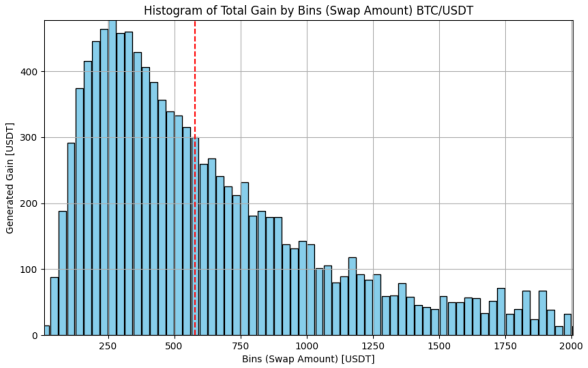

Figure 4: Histogram of Total Gain within Bins (Swap Amount) BTC/USDT. The red line indicates a median of distribution.

4.1.2 Swap Sizes

The charts below illustrate the distribution of swaped amounts based on their size.

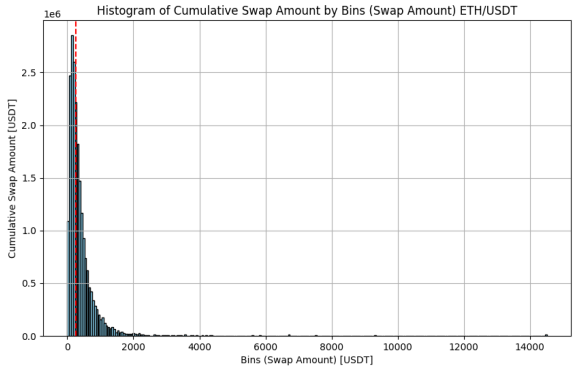

Figure 5: Histogram of Number of swaps within Bins (Swap Amount) ETH/USDT. The red line indicates a median of distribution.

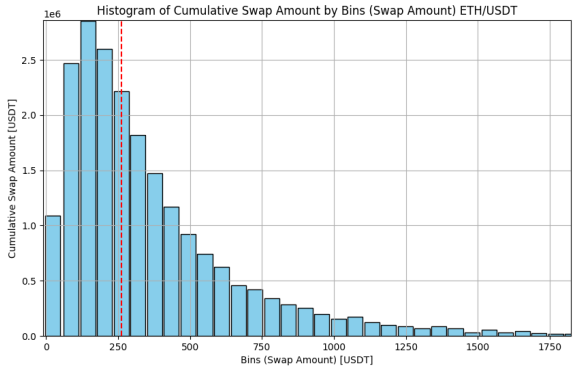

Figure 6: Histogram of Number of swaps within Bins (Swap Amount) ETH/USDT. The red line indicates a median of distribution.

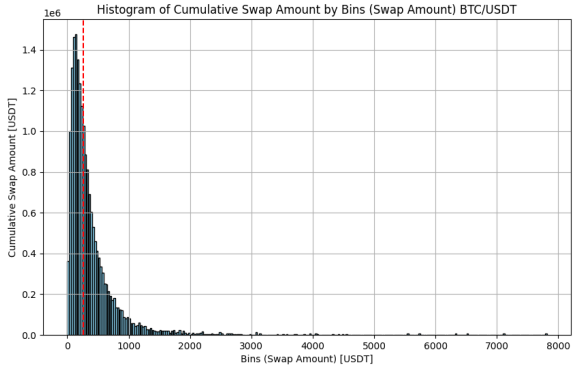

Figure 7: Histogram of Number of swaps within Bins (Swap Amount) BTC/USDT. The red line indicates a median of distribution.

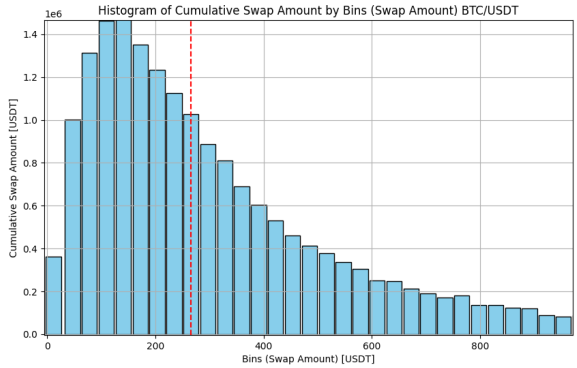

Figure 8: Histogram of Number of swaps within Bins (Swap Amount) BTC/USDT. The red line indicates a median of distribution.

5 Discussion

Based on Table 3, it is evident that an arbitrager performing fee-free swaps with exclusive access to pools can generate higher profits than the fees collected by Liquidity Providers, using a straightforward strategy. However, a critical question remains before concluding that these profits are attainable in reality: the potential impact of arbitrager transactions on CEX order books. Observing Figures 2 and 4, it becomes apparent that most profits in the simulation pool were generated by swaps valued under $600. Given the scale of V3 pools and their concentrated liquidity, these figures correspond to $6 million and $30,000 for ETH/USDC and BTC/USDT pools, respectively. While a $30,000 trade is unlikely to affect the CEX BTC market significantly, a $6 million ETH trade might impact it to a small extent, potentially reducing profits slightly.

Based on that from the last month [Def], UniswapV3 collects $1 041 millions fees yearly. Assuming that all pools behave similarly to the studied pools (in terms of rescaled profits and collected fee) the potential profit from exclusive arbitrage could amount to $1 000 - $1200 millions annually.

6 Conclusion

Our findings indicate that arbitragers with exclusive access to Uniswap V3 pools, if allowed to perform fee-free swaps, could realize profits exceeding the fees collected by Liquidity Providers. This observation suggests that the

current profit distribution model in Uniswap V3-like pools might not be optimally efficient for Liquidity Providers. Implementing a system to capture arbitrage profits could substantially enhance liquidity providers' yields. It is also important to note that the arbitrage strategies employed in this study were relatively basic; more sophisticated and potentially more profitable strategies could be developed to further enhance the profitability for arbitragers with exclusive pool access.

References

[Def] DefiLlama. Accessed: 2024-04-30.

[Unia] Uniswap V3 ETH/USDC 0.05% pool. Accessed: 2024-04-30.

[Unib] Uniswap V3 BTC/USDT 0.3% pool. Accessed: 2024-04-30.

[Unic] Uniswap V3 Whitepaper. Accessed: 2024-04-30.