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UNISWAP

V3 Liquidity Provider Simulation Platform: A Case Study

Examining the economic feasibility of liquidity provisioning into Version 3 (V3) pools employing advanced capabilities of the Chaos Labs V3 Simulation platform. We investigate the broad spectrum of profitability, risk, and reward in this data-driven analysis.

July 27, 2023

Uniswap V3 LP Simulation Platform: A Case Study

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July 2023

Abstract

This case study probes the economic feasibility of liquidity provisioning into Version 3 (V3) pools, employing the advanced functionalities of the Chaos Labs V3 Simulation platform. The platform, a joint venture between Chaos Labs and the Uniswap Foundation, offers users the ability to perform comprehensive backtesting of liquidity provider (LP) strategies across V3 pools, thereby offering substantial insights into strategy performance and essential success conditions.

This investigation holds a two-fold objective. Firstly, it seeks to accentuate the sophisticated capabilities of the Chaos Labs V3 Simulation platform. Secondly, it scrutinizes a specific historical timeframe, from August to November 2021, with the intent to discover profitable LP strategies. This dual-purpose approach seeks to address the long-standing question within the Uniswap V3 community: "Is liquidity provisioning on Uniswap V3 a worthwhile endeavor?" By revealing that LP-ing can indeed be lucrative given the right strategies, this study seeks to provide a definitive answer.

By leveraging the platform's simulation capabilities, we are able to conduct robust backtesting, undertake exploratory investigations, and uncover promising opportunities. The platform also guides LPs towards relevant pools and strategies based on their preferences and market sentiment. Our analysis covers a spectrum of profitability, risk, and reward related to these economic activities in decentralized finance, building our case on meticulously gathered data and quantitative analysis.

Contents

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Chapter 1

Overview

1 Value Proposition of the Uniswap V3 LP Simulation Platform

The Chaos Labs Uniswap V3 Liquidity Provider Simulation Platform is a comprehensive tool for backtesting a wide range of LP strategies. It enables users to understand better strategy performance and returns across various market conditions, liquidity environments, and price sentiments. The platform empowers LPs to make data-driven decisions, allowing them to allocate resources to Uniswap pools confidently.

1.1 Existing LP Simulation Applications

Several impressive Liquidity Provider (LP) Backtesting tools already exist, providing substantial inspiration for our research and development efforts. The existing tools, while diverse in their functionality, predominantly concentrate on the following attributes:

1. Existing applications are designed to backtest a specific pool.
2. Existing applications enable users to backtest a single, user-defined scenario.
3. While they facilitate in-depth strategy analysis, they are less suited for the exploration of profitable opportunities.

1.2 What Makes the Chaos Labs LP Simulation Platform Unique?

In contrast, the Chaos Labs platform has positioned itself as an "LP Search Engine". It grants users the flexibility to customize their asset/chain exposure or to target LP opportunities based on asset characteristics. Moreover, when utilizing the *search* function, the application automatically ranks LP pools by their historical profitability, thereby prioritizing and highlighting the most rewarding opportunities at the forefront. Thus, the Chaos Labs platform offers a more dynamic, comprehensive, and user-friendly approach to LP backtesting and strategy development.

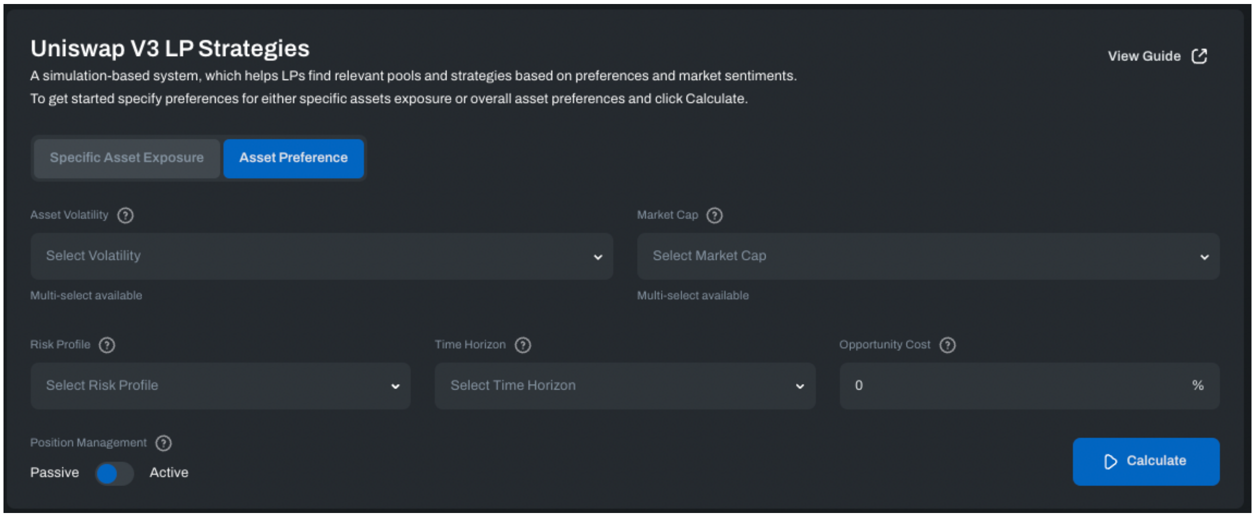


Figure 1.1: The image depicted above displays the outcome of a Liquidity Provider (LP) Search Query, showcasing a pool that aligns with the preferences specified by the user. This illustrates the utility of the search function in sourcing and displaying pools which meet individual user criteria, further demonstrating the practicality of the Chaos Labs platform.

1.3 Case Study Goals

The purpose of this case study is two-fold. Firstly, it aims to illuminate the utility of the Chaos Labs platform through a tangible example, thereby demonstrating its advanced functionalities. Secondly, it endeavors to exhibit that with appropriate strategies, LP-ing can indeed yield profitable outcomes. While, in retrospect, this observation may not seem groundbreaking, the identification of profitable strategies should facilitate readers in comprehending which approaches could have performed optimally across various historical market conditions.

To demonstrate the functionality of the platform, we conduct a case study centered around a Twitter thread that asserts LP-ing on V3 is inherently unprofitable, by examining a specified timeframe. By leveraging the simulation platform, we explore different LP strategies and present evidence that profitable LP-ing was possible during the specified period. It is important to note that the intention of this case study is not to provide a definitive statement on the overall profitability of LP-ing on Uniswap. Readers are encouraged to conduct their own research, as this study does not constitute financial advice. However, the case study aims to introduce a robust tool to assist advanced DeFi users in gaining deeper insights into their deployment strategies. Without further ado, let us delve into the details of the study.

Chapter 2

Exploring the Uniswap V3 LP Simulation Platform

1 LP Simulator Usage

The Chaos Labs Uniswap V3 LP Simulation platform is a publicly accessible tool expressly tailored to facilitate market makers in making astute decisions regarding asset and strategy selection. This is achieved by curating a user-friendly interface that provides optimal matches based on user preferences and a comprehensive analysis of the simulation results.

As we embark upon a comprehensive exploration of the use case, it becomes imperative to first familiarize ourselves with the Simulation platform and its myriad offerings. Our foundational understanding of the platform and its benefits will enable us to probe into different use cases and spotlight intriguing data surrounding LP strategies in the subsequent sections.

The Chaos Labs Uniswap V3 LP Simulation platform, publicly accessible and meticulously designed, serves as a a powerful tool for market makers. Its primary role involves aiding market makers in making astute, data-informed decisions concerning asset selection and strategy adoption. To accomplish this, the platform hosts a user-centric interface that promotes optimal matches drawn from user preferences, supplemented by an in-depth analysis of the simulation outcomes. Let's get acclimated with the protocol user interface. Subsequent to this, we can commence our detailed journey into the case study.

1.1 Specific Asset Exposure Mode vs. Asset Preference Exposure Mode

The Uniswap V3 LP Simulation Platform incorporates the following distinct modes:

1. **Specific Asset Exposure:** The first permits users to precisely designate desired LP assets.

2. **Asset Preference Exposure Mode:** The second mode enables the selection of specific asset characteristics, like market capitalization and volatility. It then initiates a search against pools containing assets that fulfill these criteria, yielding corresponding results.

In the following sections, we will explore the user interface associated with each segment.

1.2 Specific Asset Exposure User Interface

The subsequent illustration presents the 'Specific Asset Exposure' input field. This interface facilitates users in pinpointing pools that host specified assets on designated blockchain networks.

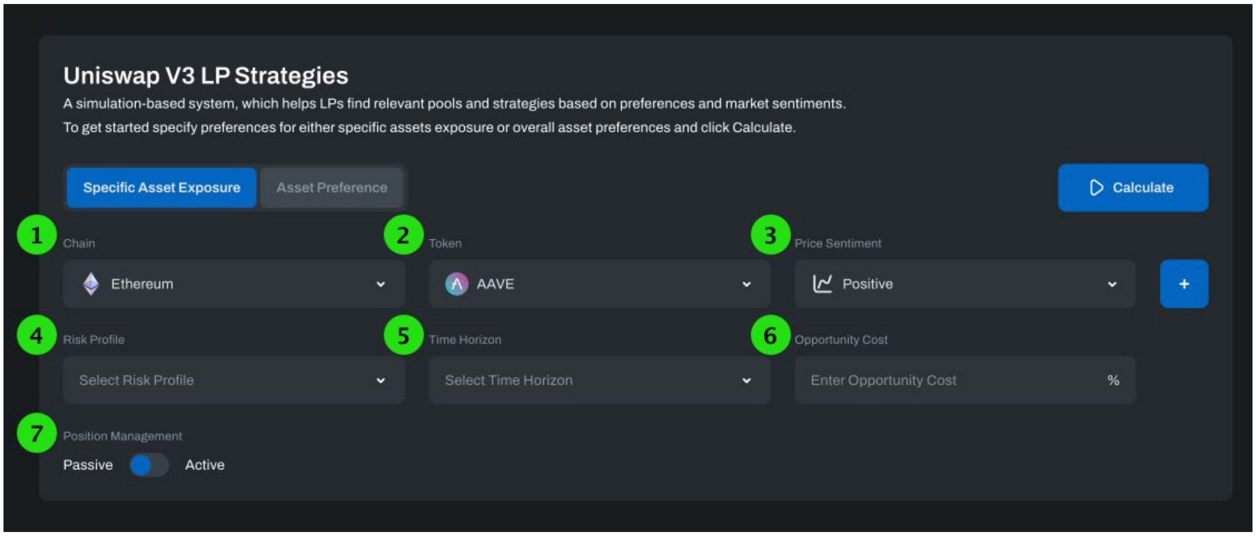


Figure 2.1: Users can customize simulations, specifying assets, price sentiments, time horizons, and more.

(1) Blockchain Network Selector

The Uniswap V3 LP Simulation Platform is compatible with Uniswap V3 deployments on Ethereum and Polygon networks.

(2) Asset Preference Determination

Users are required to designate their preferred token for liquidity provisioning. The Uniswap V3 backtester, unlike other platforms necessitating explicit pool selection, adopts a more user-oriented methodology. This system autonomously peruses high-volume pools encompassing the selected token, committing to only the most pertinent pools.

(3) Price Sentiment Analysis

Users supply their estimate of price sentiment pertaining to the chosen asset. They possess the autonomy to select the type of market they wish to employ for data simulation. The provided options reflect positive, neutral, or negative market sentiments:

1. **Positive** - the market maker envisages an elevation in the asset price.
2. **Neutral** - the market maker predicts the asset price will stabilize approximately at the current levels.
3. **Negative** - the market maker anticipates a decline in the asset price.

(4) Risk Profile

Users are mandated to specify their risk tolerance level. Adhering to traditional financial investment principles, the profit potential intensifies concomitantly with risk. The options extend from conservative through aggressive to very aggressive. Customarily, users selecting a higher-risk profile tend to opt for a narrower liquidity provision range. Moreover, individuals with a higher risk tolerance are typically more inclined to dedicate a greater time allotment to liquidity provisioning compared to their conservative counterparts.

(5) Time Horizon

Users are endowed with the liberty to determine their investment period from a gamut of predefined durations, encapsulating short-term spans such as one week to more extended intervals like one month.

(6) Opportunity Cost

Users are counseled to delineate their opportunity cost of liquidity provisioning. For instance, if the funds employed for providing liquidity are borrowed, the Annual Percentage Rate (APR) of the loan would constitute the alternative cost. This information is instrumental in formulating the user's Profit and Loss (PnL) statement.

$$PnL \ = \ Balance_{End} \ - \ Balance_{Start} \ * \ (1 \ + \ Cost\ of\ Capital)$$

Opportunity Cost Analysis

Users are prompted to denote their opportunity cost of liquidity provisioning. For example, if they have procured borrowed funds for liquidity provisioning, this would equate to the Annual Percentage Rate (APR) of the loan. The provided data is subsequently utilized to compute their Profit and Loss (PnL) statement.

(7) Position Management

The Uniswap V3 Backtester accommodates a broad spectrum of user skill levels by providing passive and active strategy evaluation options. With *passive* strategies, liquidity is provided within a predetermined range for the entire backtesting period. This method suits users who do not rely on automated systems to manage their positions.

In contrast, more proficient users might prefer to employ *active* strategies. In this approach, liquidity is tactically withdrawn and redeployed in alignment with fluctuations in the market price. For an in-depth understanding of these distinct strategies, readers are directed to the aforementioned 'Market Making Strategies' section.

1.3 Asset Preference

User Mode Selection

The Uniswap V3 LP Simulation Platform incorporates two distinct modes—the first permits users to precisely designate desired LP assets. The second mode enables the selection of specific asset characteristics, like market capitalization and volatility. It then initiates a search against pools containing assets that fulfill these criteria, yielding corresponding results.

The 'Asset Preference' mode can be aptly compared to a search engine. This feature enables users to navigate through various pools that conform to their selected criteria, thereby facilitating a targeted exploration of potential investment opportunities.

In the following section, we will explore the user interface associated with each segment.

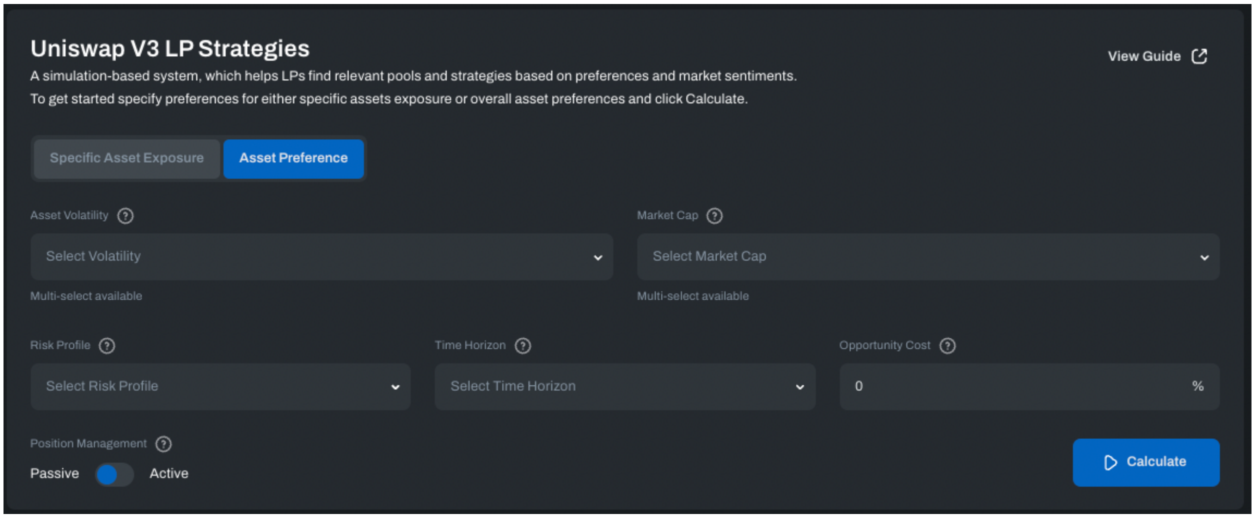


Figure 2.2: Users can execute a "search" against pools that meet the selected criterion.

The Chaos Labs Uniswap V3 Backtester provides a comprehensive perspective of the most profitable pools and strategies that align with users' preferences. Users are empowered to evaluate different options based on factors such as pool composition, Profit and Loss (PnL) outcomes, alternative costs of LvR, and rebalancing frequency.

(9) Asset Volatility

During the backtesting process, assets are segregated into three distinctive categories based on historical volatility. This arrangement enables users to express a preference for the volatility level of the assets for which they desire to provide liquidity.

(10) Market Cap

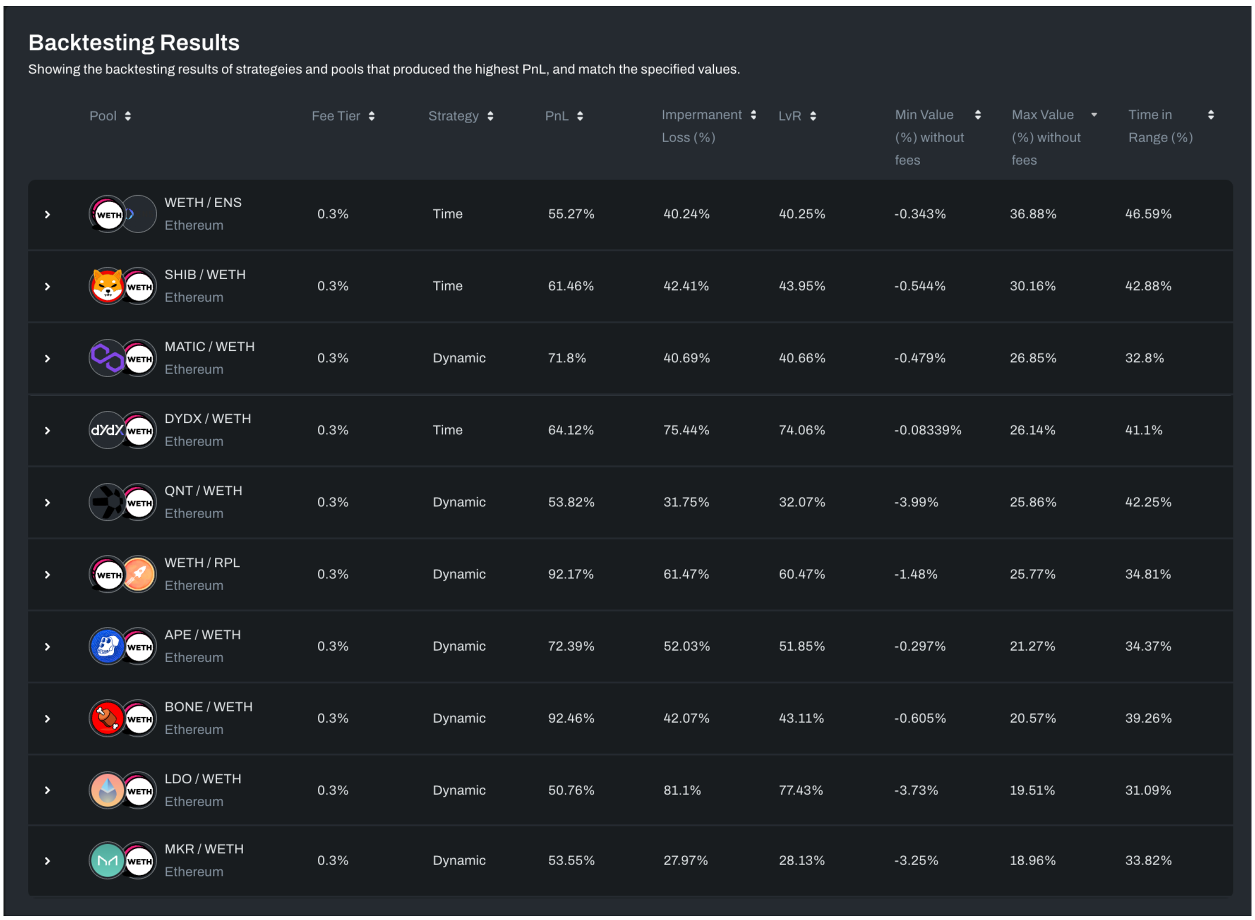
Market capitalization is a significant parameter that market makers often contemplate when distinguishing between different assets. Therefore, users are provided the flexibility to select either higher or lower market cap tokens for liquidity provisioning. This feature amplifies the customization potential of the Chaos Labs Uni V3 Backtester, empowering users to modify their investment strategy to reflect their unique objectives and risk tolerance.

Despite stablecoins potentially exhibiting varying market cap levels, the dynamics of market-making in pools where both assets are stablecoins are markedly different due to their inherent low price volatility and high concentration of liquidity. As a result, the platform affords users the explicit choice to engage in market-making in such pools. We note the following distinct pool categories within the simulator.

Pool Type	Assets
Blue Chip	BTC, ETH
High Marketcap	Market Cap >$1B
Medium Marketcap	$250M ¡ Market Cap ¡ $1B
Stables Pool	Pools where both assets are stablecoins
Low Marketcap	Marketcap < $250m

1.4 LP Simulation Results

The Chaos Labs Uni V3 Backtester furnishes a panoramic view of the most advantageous pools and strategies, customized according to user preferences. Users can appraise various options predicated on specific pool compositions, profit and loss (PnL) records, as well as alternative costs of LvR and rebalancing frequency.



Backtesting Results

Showing the backtesting results of strategeies and pools that produced the highest PnL, and match the specified values.

Pool	Fee Tier	Strategy	PnL	Impermanent Loss (%)	LvR	Min Value (%) without fees	Max Value (%) without fees	Time in Range (%)
WETH / ENS Ethereum	0.3%	Time	55.27%	40.24%	40.25%	-0.343%	36.88%	46.59%
SHIB / WETH Ethereum	0.3%	Time	61.46%	42.41%	43.95%	-0.544%	30.16%	42.88%
MATIC / WETH Ethereum	0.3%	Dynamic	71.8%	40.69%	40.66%	-0.479%	26.85%	32.8%
DYDX / WETH Ethereum	0.3%	Time	64.12%	75.44%	74.06%	-0.08339%	26.14%	41.1%
QNT / WETH Ethereum	0.3%	Dynamic	53.82%	31.75%	32.07%	-3.99%	25.86%	42.25%
WETH / RPL Ethereum	0.3%	Dynamic	92.17%	61.47%	60.47%	-1.48%	25.77%	34.81%
APE / WETH Ethereum	0.3%	Dynamic	72.39%	52.03%	51.85%	-0.297%	21.27%	34.37%
BONE / WETH Ethereum	0.3%	Dynamic	92.46%	42.07%	43.11%	-0.605%	20.57%	39.26%
LDO / WETH Ethereum	0.3%	Dynamic	50.76%	81.1%	77.43%	-3.73%	19.51%	31.09%
MKR / WETH Ethereum	0.3%	Dynamic	53.55%	27.97%	28.13%	-3.25%	18.96%	33.82%

Figure 2.3: Users can execute a "search" against pools that meet the selected criterion.

In-Depth Examination of Liquidity Provision Strategy Backtests

The efficacy of the Chaos Labs Uni V3 Backtester becomes apparent upon closely examining the outcomes of specific strategy iterations. The results page offers a thorough and intuitive visualization of the simulation, enabling market makers to discern the primary profit constituents. This includes the assessment of impermanent loss, LvR, and the corresponding risks, thereby fostering an all-encompassing understanding of the strategic terrain.

Figure 2.4: Users can execute a "search" against pools that meet the selected criterion.

(1) Profit and Loss (PnL)

The overall profit derives from the accrued fees and the changes in asset valuations.

(2) Impermanent Loss

Impermanent loss refers to the opportunity cost of buying and holding assets. It occurs when the value of tokens in a liquidity pool changes compared to when they were initially deposited. Liquidity providers (LPs) may incur losses if the price of one token in the pool diverges significantly from the other token. This risk is inherent in providing liquidity for volatile or asymmetrically valued token pairs.

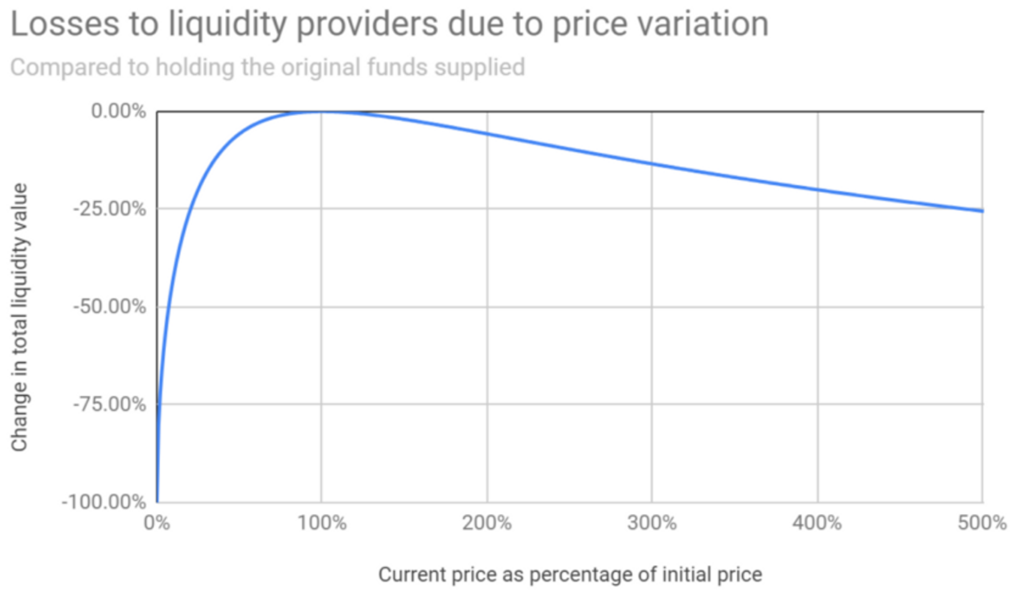


Figure 2.5: Users can execute a "search" against pools that meet the selected criterion.

(3) Loss versus Rebalancing (LvR)

While Impermanent Loss is a renowned benchmark metric for Liquidity Provisioning, it has inherent limitations. In response, we propose the Loss versus Rebalancing (LVR) metric, which juxtaposes the value of assets in an LP with the value of holding and periodically rebalancing the same assets outside the LP in response to changes in the price ratio. The calculation of LvR (Leverage Ratio) occurs only once per period for a position that is evenly balanced. It remains consistent across different price sentiments and is not altered based on varying sentiments. Consequently, when considering the same pool and period, the LvR value will be identical for simulations involving Positive, Neutral, and Negative price sentiments.

The main metric that is comparable across pools is the strategy PnL. LVR and IL are not good comparisons between pools, as they don't consider fees. A pool that has a higher LVR than another might have significantly larger fees, thus making it seem better, although it has more LVR

(4) Strategy Volatility

This section offers insights into the fluctuations in the value of the portfolio throughout the simulation, thereby enabling users to ascertain whether it aligns with their risk profile.

(5) Number of Position Rebalancing Events

The number of rebalancing events provides a brief overview of the anticipated transaction fees, serving as a valuable measure for users to assess transaction costs.

(6) Time in Market

A standard metric in Market Making is the percentage of time liquidity is provided.

(7) Strategy Returns

An interactive graph illustrates the evolution of PnL throughout the simulation.

(8) Position Bounds

An interactive graph displays the base asset price over the simulation and the position bounds at each point in time. This offers a comprehensive view of the asset price along with the market-making activity and reactions to changes in volatility.

Chapter 3

Strategies and Heuristics for Managing LP Positions

1 Analytical Framework: Strategies and User Preferences

The distinct backtesting scenarios, encapsulated by our study, can be distinguished into two central constituents - user preferences and LP strategy selection:

User Preferences

User Preferences are driven by the following three primary factors:

1. **Price Sentiment:** The user's price sentiment with regards to the asset. Price sentiment enables users to express a broad perspective on an asset's price movement rather than indicating a precise rate of price alteration.

   When opting for a positive price sentiment, the historical testing interval will correspond to the week or month exhibiting the most substantial price increase within the preceding 180 days.

   Conversely, when selecting positive price sentiment, the backtesting timeframe will align with the week or month featuring the most significant price decline over the preceding 180 days.

   In the event of a positive price sentiment selection, the backtested period will align with the week or month, displaying the slightest price variation throughout the last 180 days.

2. **Risk Profile:** User's individual risk profile.

3. **LP Time Horizon:** User's chosen Liquidity Provisioning (LP) duration.

LP Strategies

Four distinct liquidity provisioning strategies have been outlined in this analysis, which includes one passive strategy and three active strategies.

1. **Passive Strategy:** In the passive strategy, liquidity is allocated to a pre-determined range for the entirety of the LPing period.

2. **Active Strategies:** In contrast, active strategies entail position rebalancing influenced by price volatility or market duration. This refers to the percentage of time during which liquidity remains deployed throughout the LPing interval.

1.1 User Preferences

The influence of user preferences on the liquidity provisioning position and the subsequent backtesting scenario are delineated as follows:

Time Horizon

This preference specifies whether the backtesting period will encompass a week or a month.

Price Sentiment

The user's belief about future price direction influences both the selection of the backtesting period and the orientation of the liquidity provisioning position.

Backtesting Period Selection

The selection of the backtesting period is determined by the following algorithm:

Algorithm 1 Select Backtesting Period

```
timeHorizon ← userInput.TimeHorizon
priceSentiment ← userInput.PriceSentiment
if priceSentiment == positive then
    backTestingPeriod ← $timeHorizon over 12 months with greatest asset appreciation
else if priceSentiment == negative then
    backTestingPeriod ← $timeHorizon over 12 months with greatest asset depreciation
else priceSentment == neutral
    backTestingPeriod ← $timeHorizon over 12 months with minimal asset fluctuation
end if
```

Risk Profile

Risk preferences influence the concentration of liquidity. Analogous to any investment, higher rewards correspond to elevated risk. As a result, strategies that cater to a high-risk profile will focus liquidity within a narrow position to optimize their share of the trading fees, but are more vulnerable to the risk of the price escaping the position boundaries. Let us delineate the following scenarios:

- **Conservative Risk Profile:** For users with a conservative risk profile, the range of the position bounds is set to two standard deviations of the asset price during the hour preceding the opening of the position for both positive and negative price sentiments, and four standard deviations for neutral price sentiment.
- **Aggressive Risk Profile:** For users with an aggressive risk profile, the range of the position bounds is set to one standard deviation of the asset price during the hour preceding the opening of the position for both positive and negative price sentiments, and two standard deviations for neutral price sentiment.

- **Highly Aggressive Risk Profile:** For users with a highly aggressive risk profile, the range of the position bounds is set to 0.5 of the standard deviation of the asset price during the hour preceding the opening of the position for both positive and negative price sentiments, and one standard deviation for neutral price sentiment.

Position Range

Orientation is also tailored to the user's price sentiment. The platform utilizes the following logic.

- In the scenario where the user anticipates a positive price trajectory, the lower limit of the position is set at the current price. This strategy capitalizes on an anticipated price increase by concentrating liquidity above the current price.
- If the user anticipates a negative price trajectory, the upper limit of the position is set at the current price, thereby aligning with the sentiment that optimal liquidity provision occurs below the current price when a price decrease is expected.
- If the user anticipates a neutral price trajectory, the upper and lower limits of the position are symmetrically positioned around the current price. This strategy accommodates regular price volatility under the expectation that the price will fluctuate around its current level.

In pseudocode, we observe the following:

Algorithm 2 Set Position Range

```
priceTrajectory ← userInput.priceTrajectory
positionLowerBound ← null
positionUpperBound ← null
if priceTrajectory == positive then
    positionLowerBound ← $assetCurrentPrice
    positionUpperBound ← positionLowerBound + $positionRisk(userInput.riskProfile)
else if priceTrajectory == negative then
    positionUpperBound ← $assetCurrentPrice
    positionLowerBound ← $assetCurrentPrice − $positionRisk(userInput.riskProfile)
else priceTrajectory == neutral
    positionUpperBound ← $assetCurrentPrice + positionRisk(userInput.riskProfile)
    positionLowerBound ← $assetCurrentPrice − positionRisk(userInput.riskProfile)
end if
```

Visualizing Position Bounds Algorithm

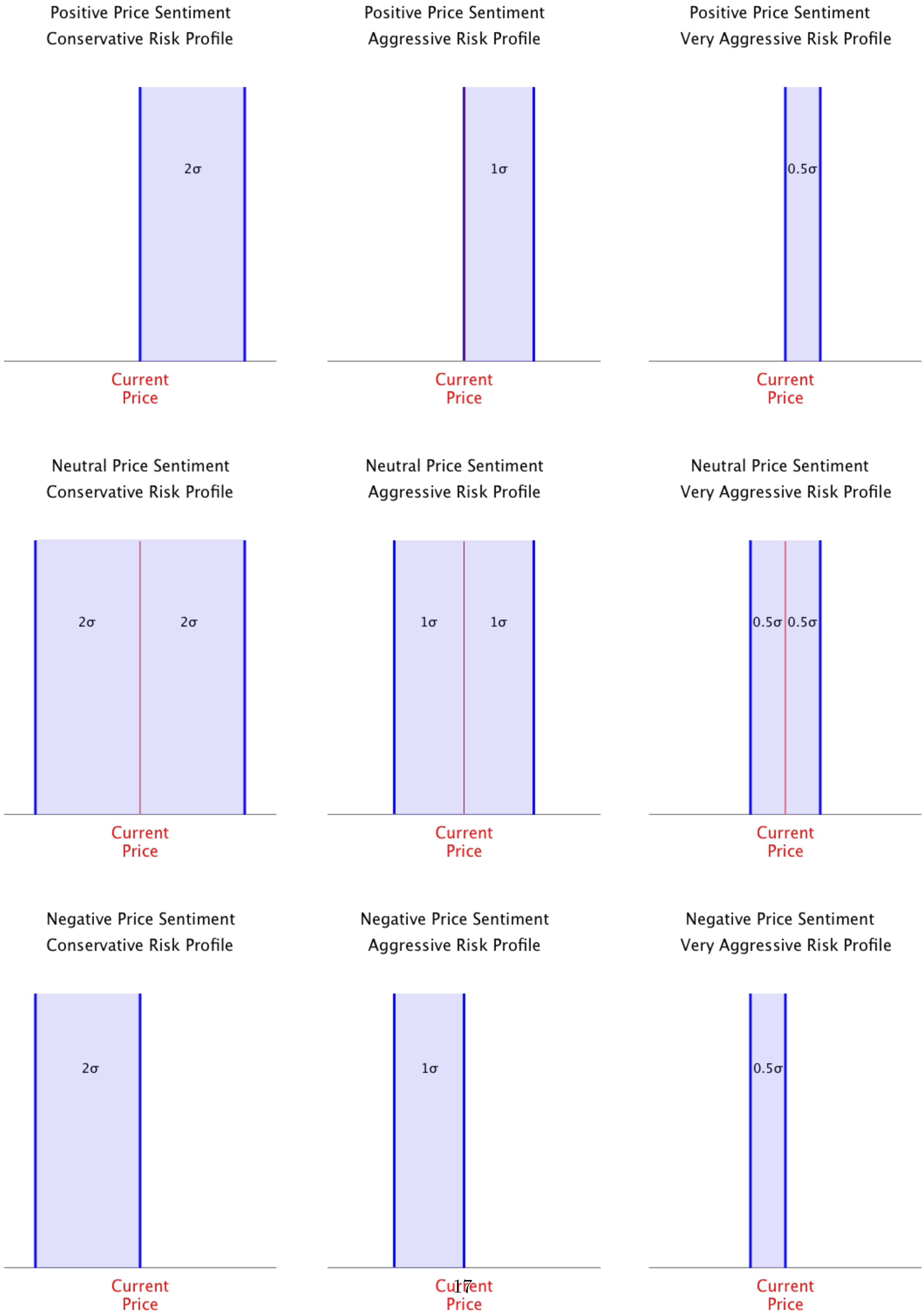


Figure 3.1

1.2 LP Strategies

The four distinct liquidity provision strategies under our backtesting framework are as follows:

Passive Strategy

This is the only strategy that lets users deploy liquidity without necessitating rebalancing. Under this strategy, liquidity is deployed within a position, the bounds of which are dictated by the user's selected Risk Profile and Price Sentiment. The liquidity remains undisturbed for the entire duration of the backtesting period.

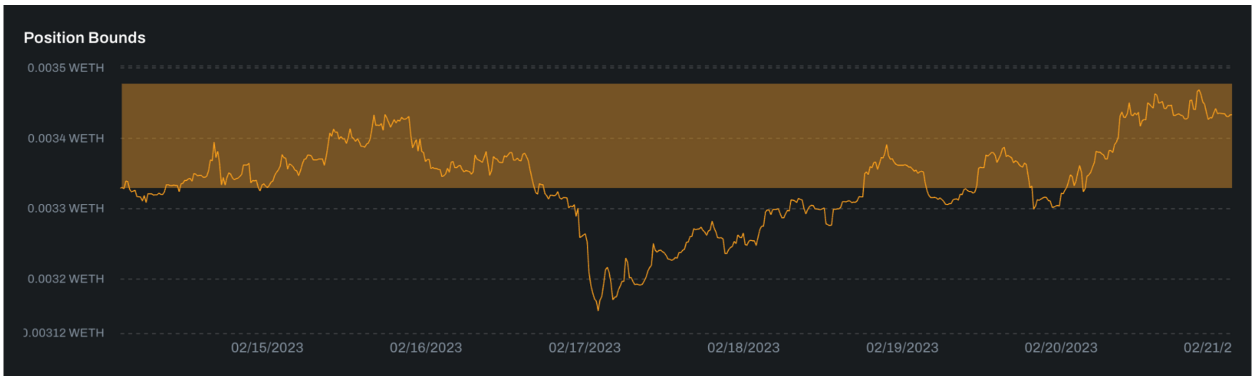


Figure 3.2: Pool: APE/WETH 0.3%, Strategy: Passive, Risk Profile: Conservative, Price Sentiment: Positive, Time Horizon: 1 Week, Dates: 14.2.23-21.2.23

Dynamic Ranges

This strategy begins with a position range set around the current price, following user preferences, similar to the passive strategy. However, in response to significant price fluctuations based on asset volatility, the position range is recalibrated around the new price. We define a significant price movement as a scenario where the standard deviation of the price over the last hour surpasses thrice the standard deviation of the price over the previous 24 hours. Following such a recalibration, the standard deviation that determines the concentration of liquidity is recalculated.

Risk Profile	Time in Market
Conservative	70%
Aggressive	80%
Very Aggressive	90%

Figure 3.3: Pool: APE/WETH 0.3%, Strategy: Dynamic Ranges, Risk Profile: Conservative, Price Sentiment: Positive, Time Horizon: 1 Month, Dates: 12.3.23-11.4.23

Time in Market

This strategy mirrors the Dynamic Ranges strategy, with the key distinction being the closure of the position when the 'time in market' meets a predefined threshold, as determined by the user's risk profile. Once a position is closed, it is reopened under the same volatility constraint as the Dynamic Ranges strategy - that is, when the standard deviation of the price over the last hour exceeds three times the standard deviation of the price over the past 24 hours.

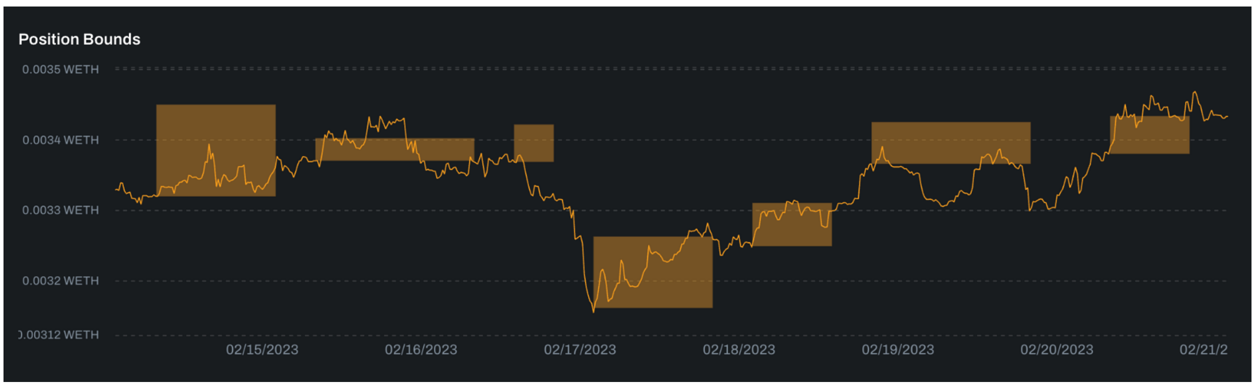


Figure 3.4: Pool: APE/WETH 0.3%, Strategy: Time in Market, Risk Profile: Conservative, Price Sentiment: Positive, Time Horizon: 1 Week, Dates: 14.2.23-21.2.23

Hybrid

This strategy melds the decision rules from both Dynamic Ranges and Time in the Market to govern position closure. Consequently, a position is closed either when the 'time in market' threshold (as defined by the risk profile) is reached or when the price volatility becomes excessively high.

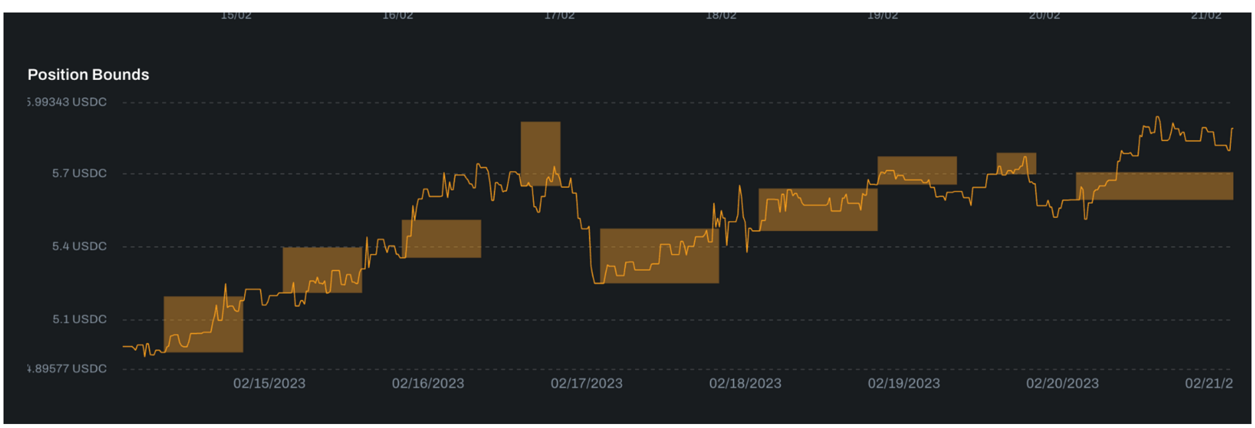


Figure 3.5: Pool: APE/USDC 0.3%, Strategy: Hybrid, Risk Profile: Conservative, Price Sentiment: Positive, Time Horizon: 1 Week, Dates: 14.2.23-21.2.23

1.3 Gas Cost Consideration and Potential Calculations

In the process of our simulations, we did not account for the gas costs allied with rebalancing of positions. This oversight is justified as the influence of gas costs varies markedly based on the size of the position. For instance, a $100 gas cost would inflict a 1% impact on a $10,000 position, whereas it would only levy a 1 basis point (bp) impact on a $1 million position.

In order to enable users to accurately incorporate gas costs into their profit and loss (PnL) calculations, we now share two crucial pieces of information. Firstly, we disclose the number of rebalances that transpired over the course of the simulation. Secondly, we offer distinct indicators of the specific opening and closings of positions.

With this data, we empower users to make more informed decisions about their trading strategies, comprehending how gas costs impinge on their overall profitability. They can scrutinize the frequency of rebalances and evaluate their implications on varying position sizes during distinct timeframes. This information facilitates users to better optimize their strategies, modulate position sizes, and select more advantageous trading periods, all whilst taking into account the ramifications of gas costs.

Chapter 4

Learning Through Examples

1 LP-ing WETH

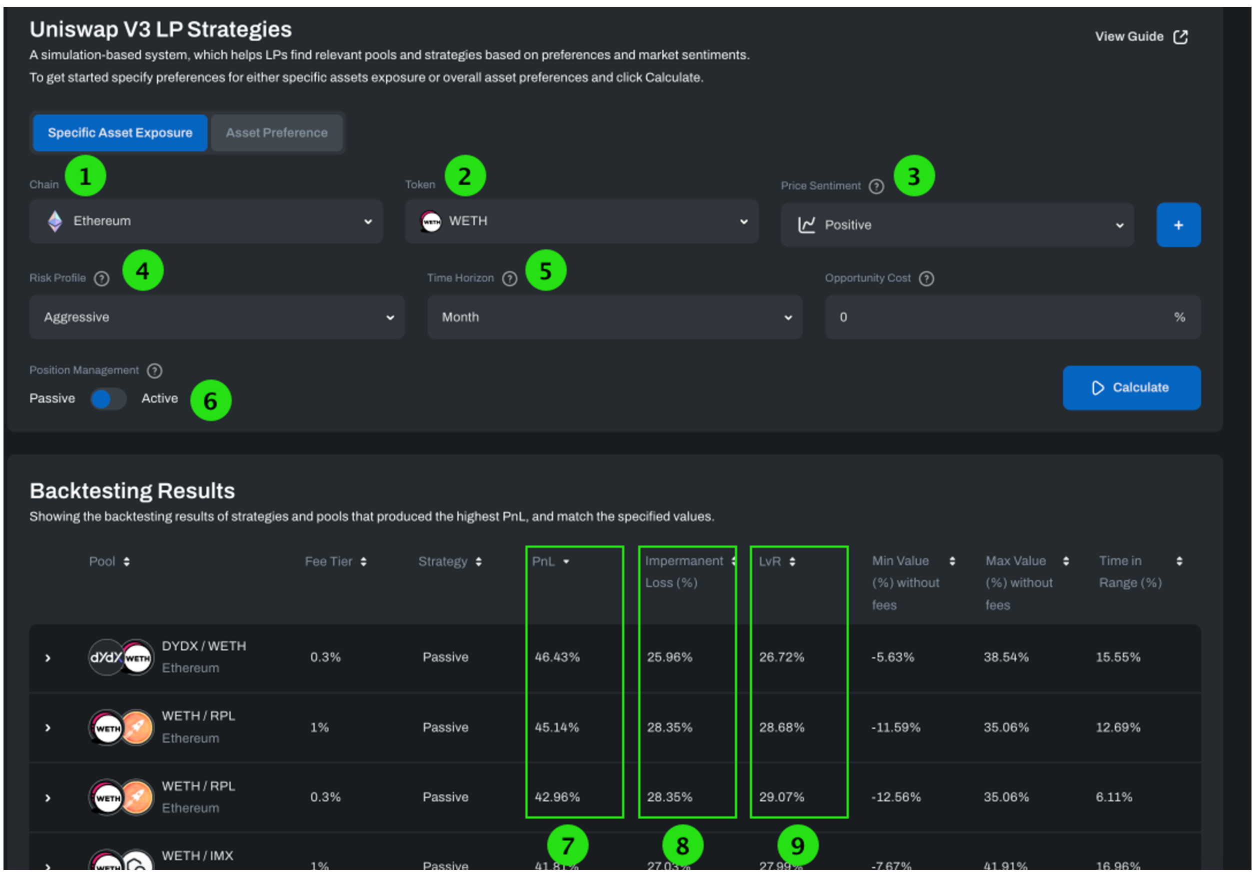


Figure 4.1

1.1 User Preferences

In this instance, we consider a Liquidity Provider (LP) intending to provide liquidity for a one-month period (5) to pools featuring WETH (2) on the Ethereum network (1), predicated on the assumption of an upward trajectory for WETH price (3). The LP adopts an Aggressive risk profile (4) and initially does not engage in active fund management (6).

1.2 Top Performing Pools

We can see that with a passive LP strategy, the best-performing pools yield over 40% APR (7), significantly higher than impermanent loss (8) and LvR (9), which are below 30%.

Figure 4.2

1.3 Analysis of DYDX/WETH Pool

The provision of liquidity to the DYDX/WETH pool proved most lucrative (10) during the selected backtesting period. An examination of the strategy backtest details reveals that despite the relatively narrow position bounds (11), the price remained within these bounds over 15% of the time (12), leading to the accrual of substantial fees (13).

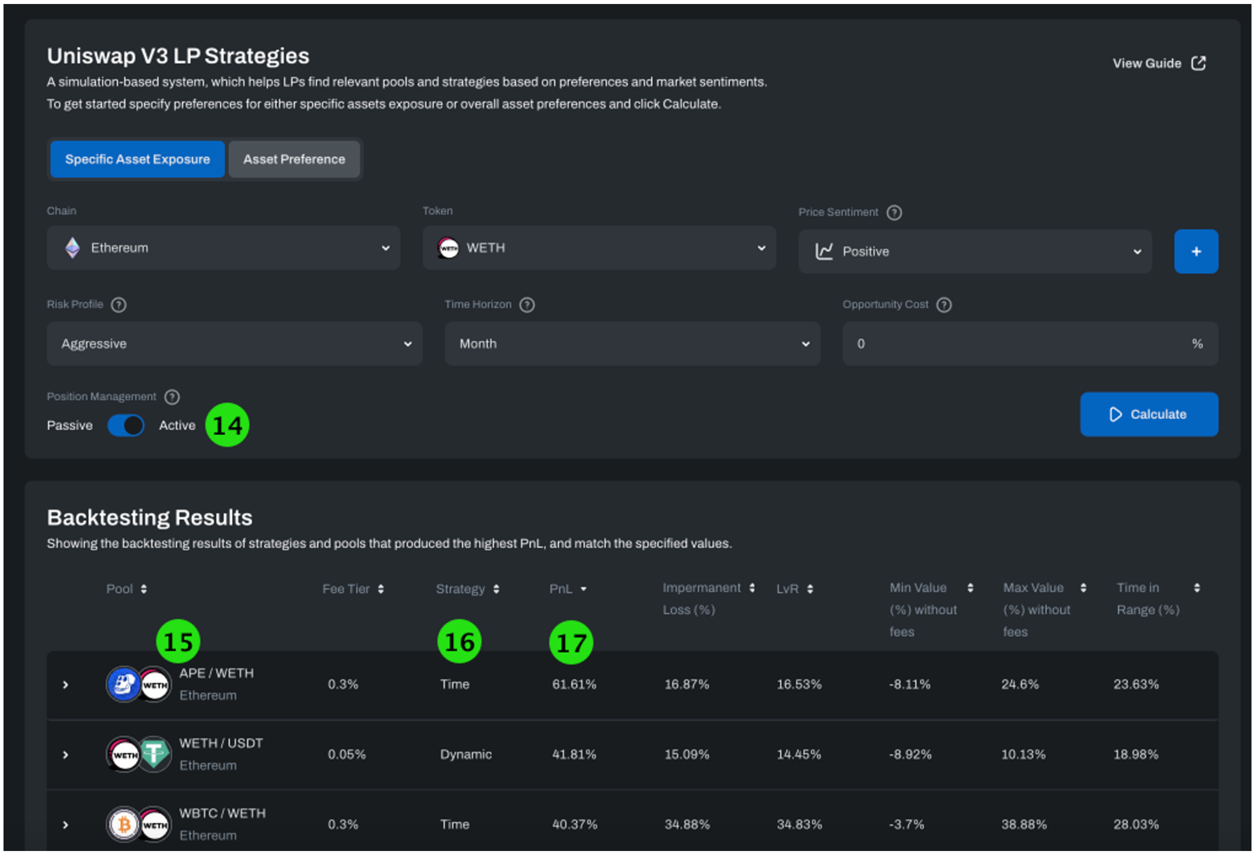


Figure 4.3

As we observe the position bounds throughout the simulation, we can see the varying position width due to the changing price volatility.

Figure 4.4

1.4 Analysis of APE/WETH Pool

Upon examining the Time in Market strategy, we observe that due to position rebalancing 23 times (20), the price remained within position bounds 23.63% of the time during the backtested period. This facilitated a more consistent fee accrual throughout the simulation (19) as compared to the results derived from the passive strategy.

As we inspect the position bounds throughout the simulation, we can discern the fluctuating position width, reflective of the changing price volatility throughout the duration of the simulation.

2 Asset Preference-Based Pool Selection

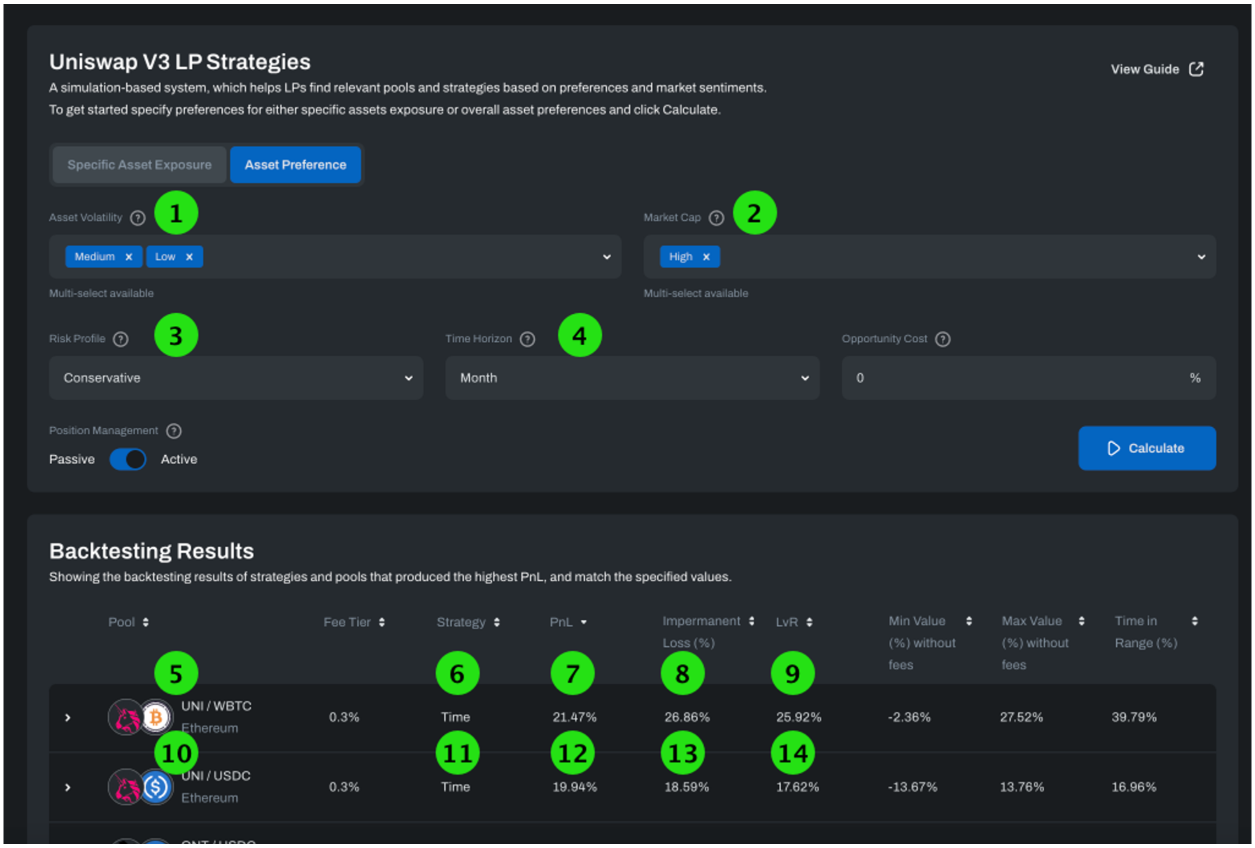


Figure 4.5

In this example, we utilize the asset preferences feature of the Uniswap V3 LP Simulation Platform to seek out optimal opportunities for conservative liquidity providers (LPs). We evaluate the best avenues to actively manage liquidity provision for a duration of one month (4) for high market cap tokens (2) with low to medium price volatility (1), under a conservative risk profile (3).

As seen from the backtesting results, the most lucrative option emerges as the UNI/WBTC pool (5) when employing a Time in Market strategy (6). However, it's worth noting that the Profit and Loss (PnL) from LPing (7) falls below the levels of impermanent loss (8) and leverage (LvR) (9).

The second most profitable option appears to be LPing to the UNI/USDC pool (10) using the Time in Market strategy (11). In this case, the strategy yields a PnL of 19.94% APR (12), outperforming both Impermanent Loss (13) and LvR (14).

3 1INCH with Negative Price Sentiment; Not All Strategies Succeed

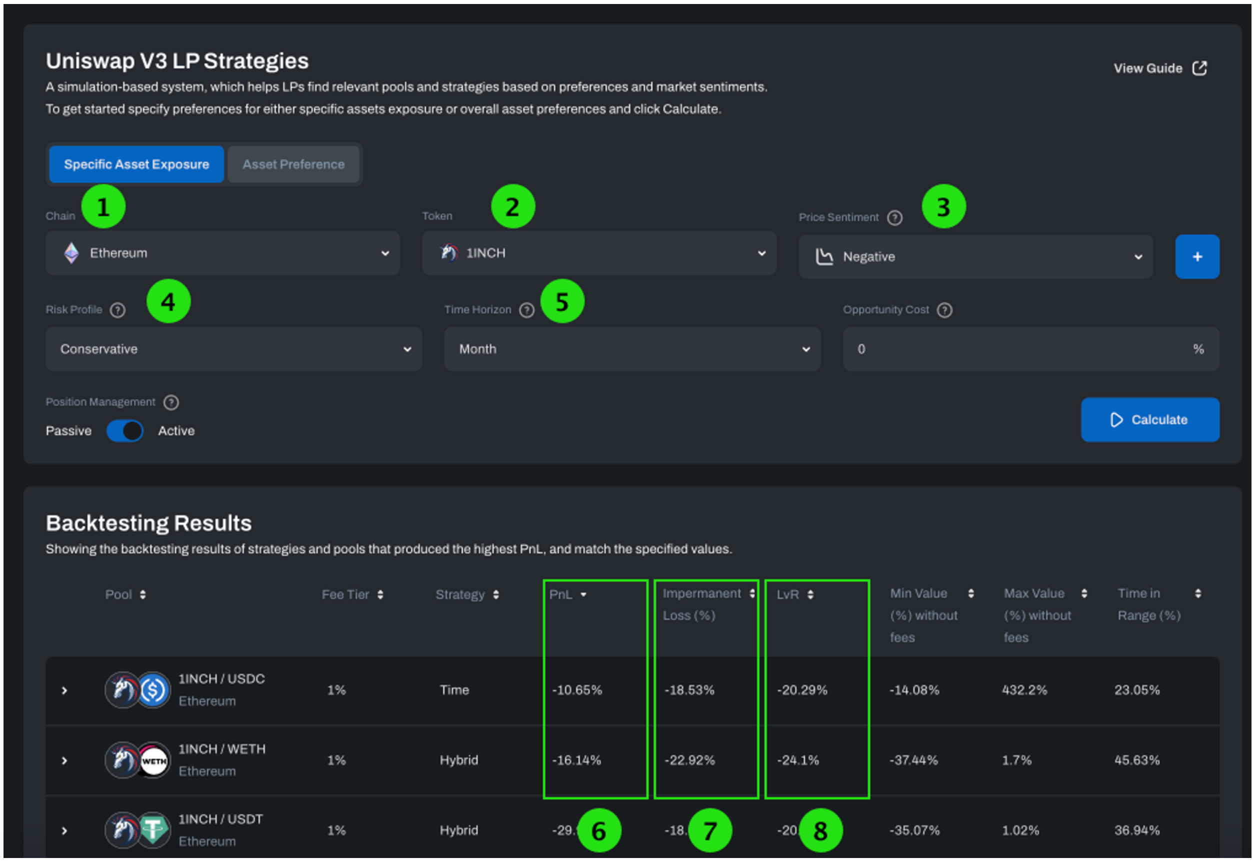


Figure 4.6

Let's explore the optimal strategies to provide liquidity to a 1INCH pool (2) on Ethereum (1) for one month (5), under the assumption that the token price is expected to drop (3) and with a conservative risk profile (4).

As seen from the results, the PnL of the best-performing strategies is negative (6). However, on examining the top 2 strategies, we note that they still manage to outperform both Impermanent Loss (7) and LvR (8), despite the unfavorable conditions.

4 LP-ing during the Most Unfavorable Week

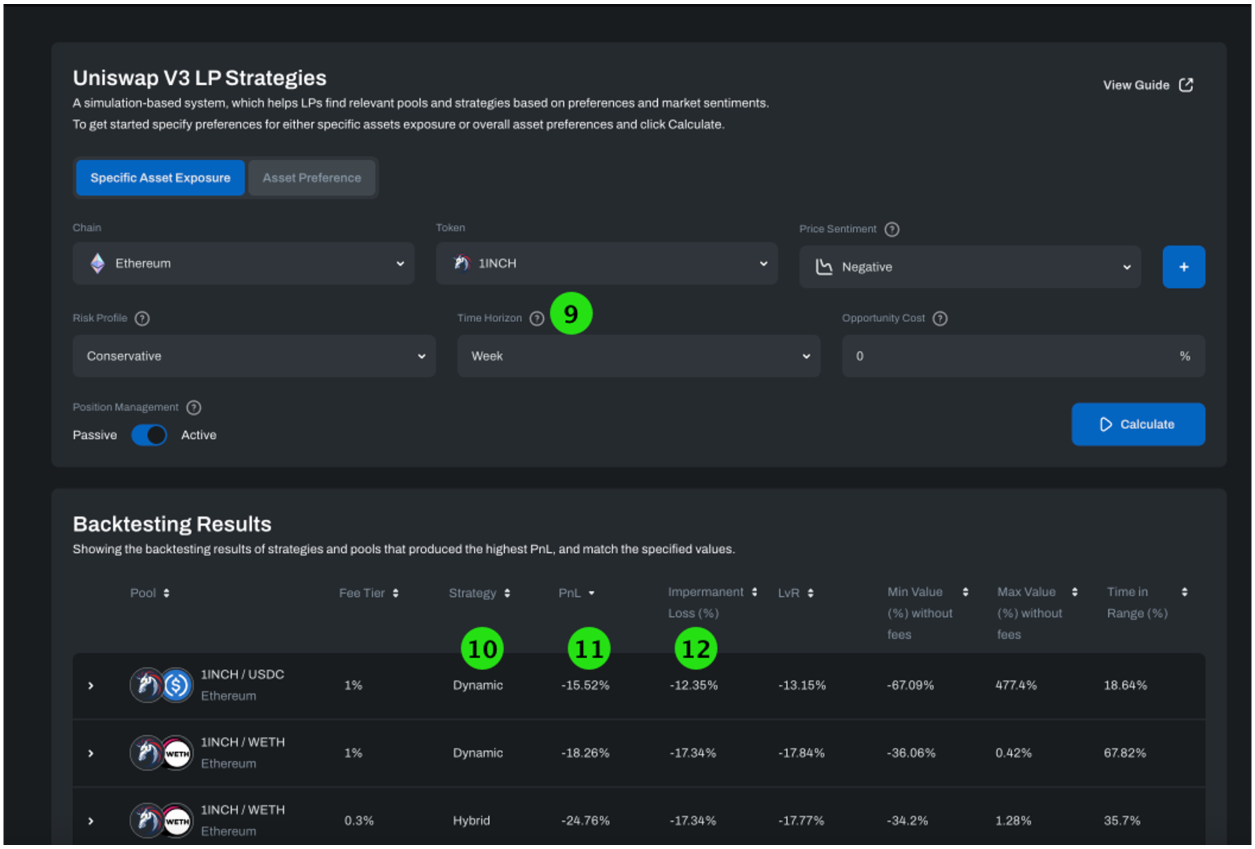


Figure 4.7

If we alter our scenario to provide liquidity with the same preferences, but narrow our time horizon to just one week (9), the backtest will focus on the week with the most significant price drop over the past 180 days. In such a case, we observe that even the top-performing strategy yields a loss (10), which surpasses even the Impermanent Loss (11) and the Leverage (LvR) (12). This serves as a crucial reminder that while the Uniswap V3 LP Simulation Platform can aid in identifying strategies that would have potentially outperformed a majority of alternatives, it's restricted to a set of strategies that may not consistently outperform the market in all scenarios.

Chapter 5

Simulation Architecture and Environment

1 System Overview

The Chaos Labs Uniswap V3 Liquidity Provider (LP) Simulation Platform represents a cutting-edge, cloud-based toolset that empowers users to pinpoint potentially profitable LP opportunities by revealing historically lucrative strategies. The subsequent section elaborates on the platform's runtime environment, the frameworks employed, the freshness of the data, its architecture, among other aspects. This exploration provides readers with an understanding of the overarching mechanics, data flow, and processing mechanisms utilized to ultimately showcase results to the users.

Architecture

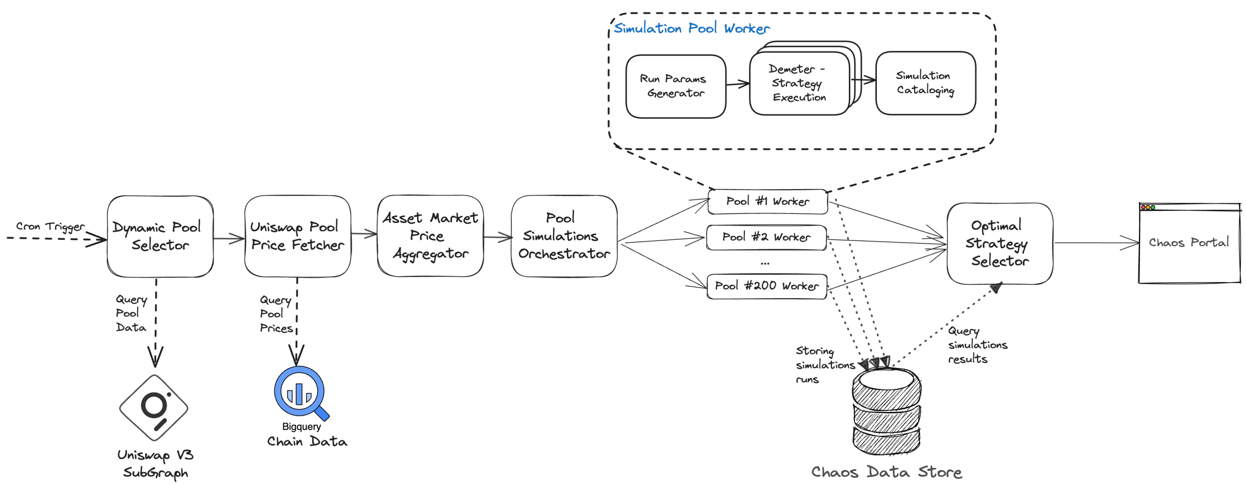


Figure 5.1: System Architecture depicting the end-to-end data flow.

The platform utilizes several core services that power the application end-to-end.

1. **Pool Selection:** Procure top 200 pools characterized by median daily trading volume over the preceding 180 days.
2. **Historical Data Acquisition:** For each pool, obtain a comprehensive history of all swaps executed over the last 180 days.

3. **Demeter Simulation:** Employ Demeter, a well-regarded library for simulating interactions with Uniswap V3 pools.
4. **Offline Simulation Executions:** Upon fetching pool history, simulations are conducted offline, culminating in approximately 40,000 executed simulations across the top 200 pools, as defined by volume, spanning Uniswap V3 deployments on Ethereum and Polygon networks.
5. **Data Storage:** Store the acquired data in a NoSQL Database to expedite the fetching of user-generated queries.

1.1 Historical Data Acquisition

At this juncture, we retrieve all on-chain swaps for the selected pool over a span of 180 days, enabling us to replay them during the backtesting phase. This data retrieval is facilitated via Google BigQuery, which is employed by Demeter intrinsically.

1.2 Demeter Simulation

In receipt of the grant from Uniswap Foundation, it was deemed crucial for Chaos Labs to conduct simulations using open-source libraries, fostering reproducibility and interpretability of the results. In alignment with this goal, we leveraged the Demeter V3 Python package, capable of simulating actions on liquidity pools such as add/remove liquidity, swap, and compute earnings or losses. Throughout the development process, several challenges were encountered with the package, resulting in contributions that have since been incorporated. We extend our gratitude to the Demeter team for the creation and open-sourcing of this valuable library to the wider Uniswap community.

1.3 Time-Based Offline Simulation Executions

Users engaging with the application will experience near-instantaneous resolution of search queries, a benefit derived from our offline simulation execution and data storage approach. Every four weeks, the top 200 pools across Ethereum and Polygon networks are selected, filtered by volume over a 180-day timeframe. For each pool, we backtest all swap history while injecting our positions, as detailed in the Position Management section. This process results in approximately 40,000 simulations being executed and archived. The outcomes of these simulations form the "search space" for the engine, enabling the discovery of historically lucrative LP positions.

1.4 Data Storage and Querying

The results from our simulations are stored in a database and indexed appropriately, thus allowing for swift and efficient data retrieval.

Appendix A

About Chaos Labs

Chaos Labs is a cloud-based platform that develops risk management and economic security tools for decentralized finance (DeFi) protocols. The platform leverages sophisticated and scalable simulations to stress test protocols in adverse and turbulent market conditions. By partnering with DeFi protocols, Chaos Labs aims to create innovative solutions that enhance the efficiency of DeFi marketplaces.

The Chaos Labs team exhibits exceptional talent and represents diverse expertise, encompassing esteemed researchers, engineers, and security professionals. Chaos Labs has garnered its experience and skills from renowned organizations, including Google, Meta, Goldman Sachs, Instagram, Apple, Amazon, and Microsoft. Additionally, the team boasts members who have served in esteemed cyber-intelligence and security military units, further contributing to their unparalleled capabilities.

You can explore our past and ongoing projects for customers like Aave, GMX, Benqi, dYdX, Uniswap, Maker, and more in the Research and Blog sections of our website.

Appendix B

Existing V3 LP Simulation Applications

0.1 Helpful Simulation Applications Resources

As stated at the outset of this report, numerous LP simulation tools are already available. Below, we enumerate several tools that have served as an inspiration in the course of our work.

- DeFi Lab - For each pool, fetch a complete history of all executed swaps, over the last 180 days.
- Revert.finance Fetch 200 pools, Top 200 pools by average daily trading volume over the last 180 days
- Ranges.fi
- Uniswap.fish

Should additional tools have been released since the compilation of this list, we welcome your feedback and suggestions for possible inclusions.

Appendix C

Acknowledgements

We wish to extend our profound appreciation to the Uniswap Foundation, whose constructive critiques have been instrumental in shaping this research. Our heartfelt thanks also go to Fede, whose profound analysis and invaluable experience in the creation of Uniswap LP Backtesting tools significantly influenced our design decisions. Additionally, we are grateful to Jason Milionis for his thorough review of our work and the invaluable insights he provided.