Curve

UZH Summer School, 17. July 2024

uzhss24.cryptonative.ch



About me



@martinkrung



Narrative

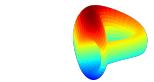
Pooled finance (DeFi) vs Termed finance (TradFi)



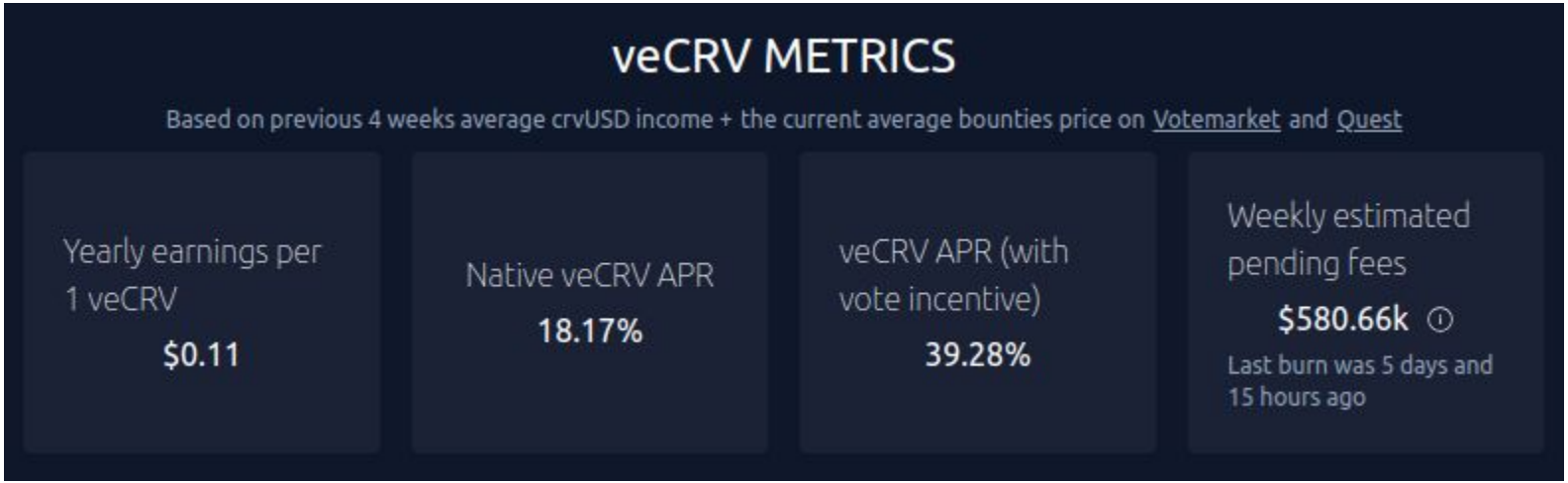
Curve Today



Curve is a DAO
Curve is an AMM
Curve is crvUSD
Curve is lending market

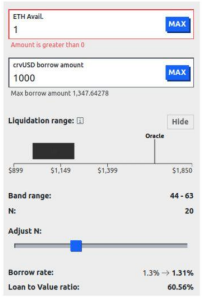


Curve DAO


veCRV METRICS
Based on previous 4 weeks average crvUSD income + the current average bounties price on Votemarket and Quest
Yearly earnings per 1 veCRV
$0.11
Native veCRV APR
18.17%
veCRV APR (with vote incentive)
39.28%
Weekly estimated pending fees
$580.66k
Last burn was 5 days and 15 hours ago

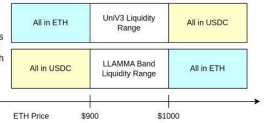
Loans

- To create a loan you have control over three variables:
  - collateral - The amount of ETH/wBTC/etc to deposit and borrow against
  - debt - The amount of crvUSD you want to borrow
  - N - The number of bands to split the collateral into
- Increasing amount collateral lets you borrow more crvUSD (increase debt)
- Increasing N either decreases the amount you can borrow (if the midpoint for the liquidation range needs to move lower as it widens to stay under current price band) or puts you into soft liquidation earlier (if midpoint can stay the same as range widens). See liquidation ranges and band sections for more details
- To max borrow set N=4.
- The max loan to value (LTV) = 88.88% which is the highest of any platform in DeFi
- Collateral is deposited in LLAMMA where bands are defined



LLAMMA

- Inverse AMM where in a ETH/USDC pair you can be all in ETH when price is high and all in USDC when price is low
- There is one LLAMMA contract for each collateral type, eg. ETH/crvUSD
- Each loan has it's collateral set to be sold in many small price ranges (like UniV3 positions) called bands
- MEV searchers are incentivised to trade through LLAMMA to rebalance it to the oracle price



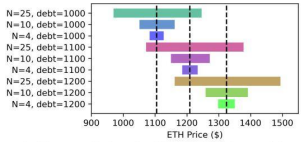
Difference between a UniV3 Liq range and a LLAMMA band's liq range

Liquidation Ranges

- Liquidation Ranges are defined by 4 variables:
  - N - number of bands, controlled by the user
  - debt - crvUSD you borrow, controlled by the user
  - oraclePrice - current market price of collateral, eg. ETH/crvUSD, controlled by market forces
  - A - amplification factor of collateral in LLAMMA, controlled by the CurveDAO
- Your Liquidation Range is spread evenly around a midpoint as shown by the vertical black dashed lines in the below chart. The midpoint can be estimated to be:

$$\text{midpoint} = \text{debt} \times 1.1$$

- The midpoint does not rely on N, only the amount of debt you borrow
- Increasing N increases the amount of higher and lower bands from the midpoint
- *Note the chart below looks like it spreads through more higher priced bands than lower priced bands. This is because bands increase in size at higher prices as well as the midpoint only being an estimation*



Liquidity ranges after borrowing different amounts of crvUSD debt and changing N

Loan Health / Hard Liquidation

- Loan health is a measure of how much your collateral is worth and how much debt you have. It is calculated based on the following formula:

$$\text{health} = \text{collatVal}\left[\frac{1 - \text{liqDiscount}}{\text{debt}}\right] - 1$$

where:
- collatVal - the collateral valuation based on current LLAMMA prices not current Oracle prices (see soft liquidation section for explanation)
- liqDiscount - the liquidation discount which is 6% for all markets currently
- debt - the amount of crvUSD borrowed

- When your health is 0% your collateral will be worth 106% of your debt
- Hard liquidations only occur when your health is under 0%
- It is possible to be below the liquidity range and have all your collateral converted to crvUSD while still having positive health. At this point you are unable to get hard liquidated by any further downwards price movements. You will lose health from interest accuring to your debt and for trading fees occured moving back up through the bands if price increases

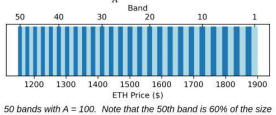
Bands

- Collateral is allocated to and split evenly between the number of bands (N) chosen by the user
- The minimum number of bands is N=4, the max is N=50
- Bands are defined for all loans based on two variables:
  - A - the amplification coefficient (can be defined for each LLAMMA collateral type but currently all are set to 100)
  - basePrice - the oracle price at contract deployment increased over time by the flucuating interest rate of each LLAMMA collateral type
- Each band can have many loans. So bands are not defined specifically for each loan, each loan will go into a range of the current LLAMMA bands
- The price range of any band n is exactly defined by:

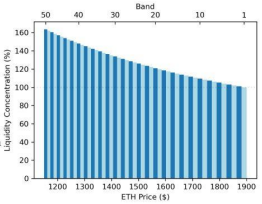
$$\text{bandUpperLimit} = \text{basePrice}\left[\frac{A-1}{A}\right]^{n} \qquad \text{bandLowerLimit} = \text{basePrice}\left[\frac{A-1}{A}\right]^{n+1}$$

- The width of the any band at any oracle price can be estimated to be:

$$\text{bandWidth} \approx \frac{\text{oraclePrice}}{A}$$



50 bands with A = 100. Note that the 50th band is 60% of the size of the 1st band



50 bands each with the same area showing the increased concentration of liquidity at the higher bands

- All current LLAMMA markets on Curve all have A=100. This means the 50th band is 40% smaller than the 1st band and liquidity is concentrated 60% more at the 50th band compared to the first band. You can see these relationships in the images to the left and above
- Bands drift higher over time as the base_price increases in proportion to the current interest rate

Soft Liquidations

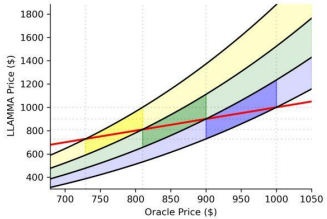
How they work:
When LLAMMA price enters a band you have collateral in, you enter soft liquidation.

The top right image shows how LLAMMA should rebalance its collateral through its bands in an ideal world:

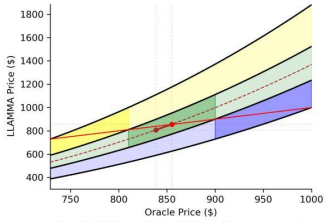
- There is an Oracle price (external price) and a LLAMMA price (internal price in LLAMMA). The red line illustrates the scenario where the oracle price equals the LLAMMA price, typically occurring during smooth price fluctuations.
- The different colours are different bands:
  - Blue is a band with a range of $900-$1000
  - Green is a band with a range of $810-$900
  - Yellow is a band with a range of ~$730-$810
- Bands are defined by Oracle price. Darker shading means you are in the normal price range, lighter shading means you are outside the normal range of the band
- If the oracle price is higher than the band range, the band should be all in the collateral, eg. ETH. If the oracle price is lower than band range the band should be all in crvUSD
- eg. if oracle price is at $855 we are in the middle of the green band, so the blue band should be 100% in crvUSD, the green band should have 50% ETH, 50% crvUSD, while the yellow band should be 100% in ETH
- Collateral is evenly sold through the band. The blue band range is from $900 to $1000. If the price is $980 we have decended $20 through the band and have $80 left to go. We have decended 20% through the band and so 20% of the collateral should be converted to crvUSD at this point

LLAMMA uses price differences between oracle price and it's own price to incentivise anyone to route trades through LLAMMA and rebalance the bands. It can set the LLAMMA price at a discount if it needs a rebalance quickly. An example of this is the image on the bottom right. It works in the following way:

- Let's start at the red dot half way through the green band where oracle price = LLAMMA price = $855.
- If suddenly we get a drop and oracle price updates to $840 and no one rebalances in the same block we move along the dashed brown line and end up at the brown dot.
- LLAMMA knows it has to rebalance here so it tries to sell collateral off cheap. The band range is $810 to $900, the price decreases from $855 to $840, it needs to sell:
  ($855 - $840) / ($900 - $810) = ~17%
  So LLAMMA sells 17% of the collateral in the green band at $800 to rebalance quickly and then sets LLAMMA price back to equal oracle price (on the red line). Anyone with collateral in the band loses the following amount to rebalancing fees:
  17% x ($840-800) / $840 = ~0.8% of their collateral in the band
- If big price moves occur bands can move out of their normal range and sell collateral off at very low prices, eg. If price went from $855 (red dot) to $750 LLAMMA would sell collateral at $575
- Big price swings have been used to illustrate how this works, but because price oracles update frequently and arbitrage is so competitive, large price swings without instant rebalances are very rare and LLAMMA and oracle prices roughly do follow the red line.



The oracle price (real price of ETH) vs. the current LLAMMA price of ETH. Red line is when oracle_price = LLAMMA_price. LLAMMA price should follow the red line if no big sudden price movements occur. Note in this example A=10 so we had nice numbers for bands, but A=100 in all crvUSD markets today.



A example of how LLAMMA incentivises rebalances when oracle price changes occur. Note in this example A=10 so we had nice numbers for bands, but A=100 in all crvUSD markets today.

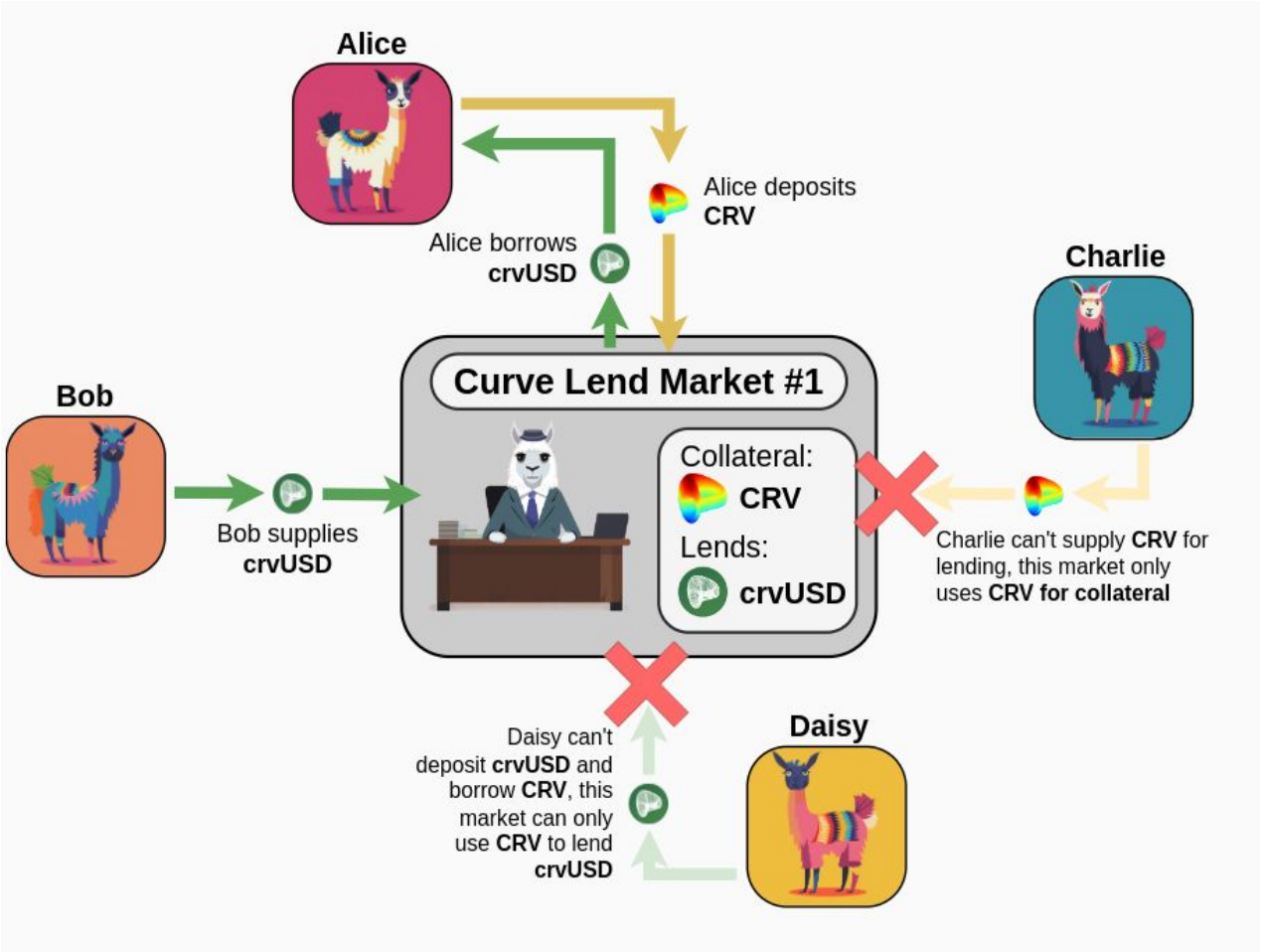
What it all means:

- Higher amplication factor (A) means higher impermanent loss if price moves against you but it is also erased quickly if price moves back up
- Having a low number of bands (low N) is seen as less risky which is why it allows a higher LTV ratio. Because there are less bands there should be less rebalancing losses if price action is smoothly up or down. Use low N if you predict crab markets/low volatility.
- High number of band loans (high N) protect better against external liquidation with sharp price drops, as there is more time to react and a wider spread of collateral. Use high N if you predict high volatility.



crvUSD minting

Markets	Borrow rate	↓ Total debt	Cap	Available to borrow	Total collateral value
ETH	25.15% → 25.19%	42.78M	200M	157.22M	$64.89M
WBTC	27.37% → 25.02%	35.65M	200M	164.35M	$68.39M
wstETH	36.03% → 35.66%	28.29M	150M	121.71M	$44.24M
sfrxETH v2	38.84% → 35.83%	10.83M	50M	39.17M	$16.33M
tBTC	27.20% → 24.64%	3.61M	50M	46.39M	$5.65M
sfrxETH	23.86% → 34.76%	276,621	0	0	$807,654



Curve Lending is a single side market

Curve core innovations

Stableswap

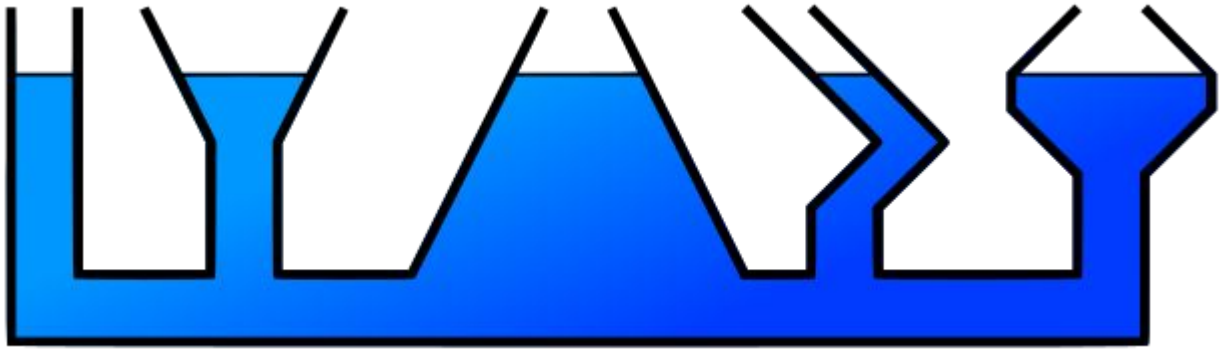
ve-Tokenomics (veCRV)

Soft-liquidation (crvUSD/curve lending)

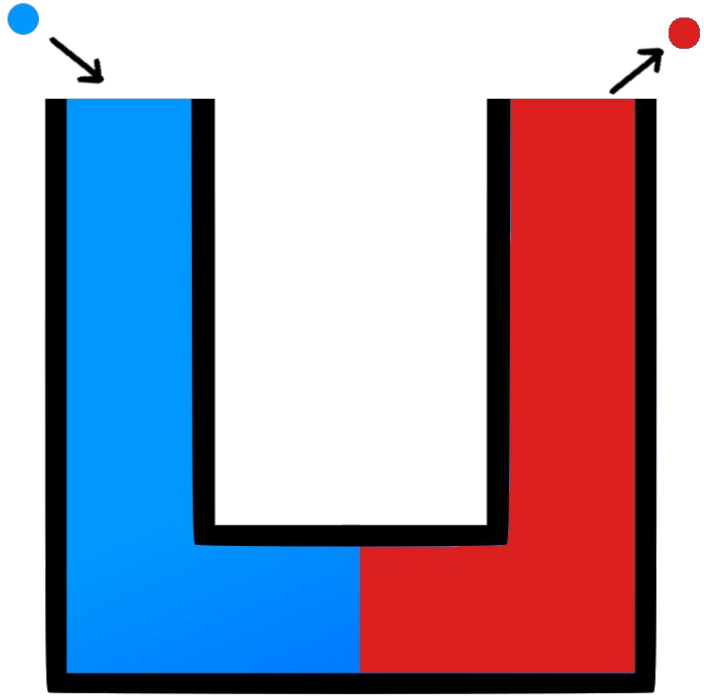


AMM

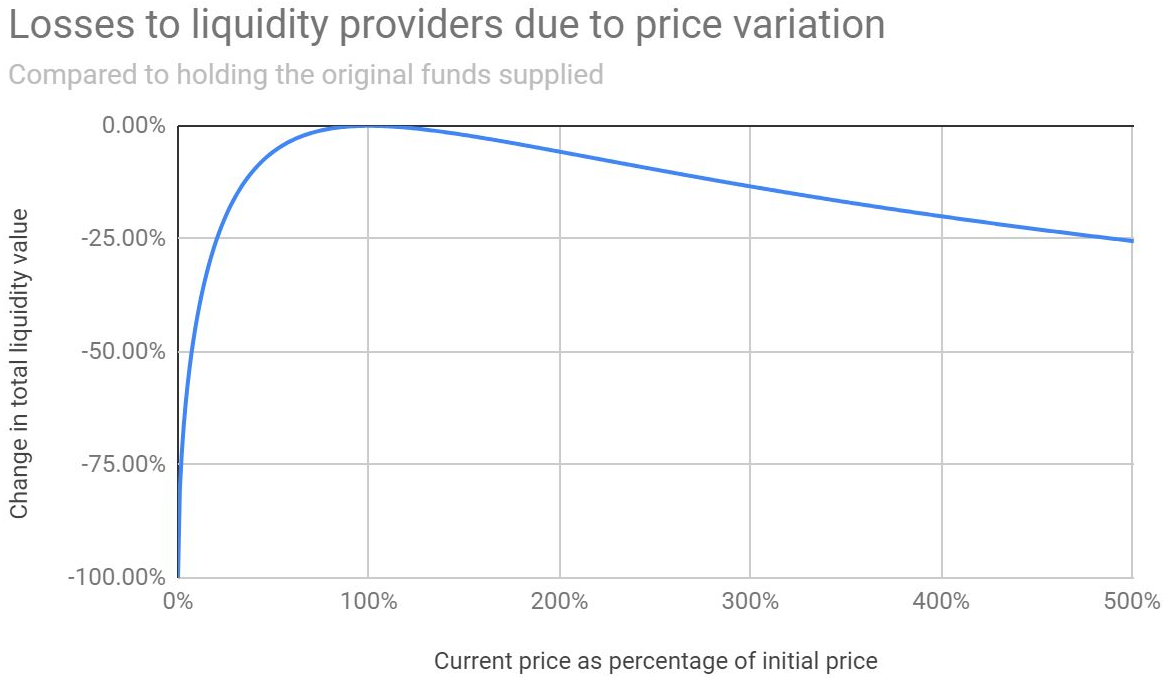
x*y=k



AMM



Divergence loss



ETH/BTC Pool
1y
-0.47%

Impermanent Loss Calculator

This calculator uses Uniswap's constant product formula to determine impermanent loss.

Fees are not included within results.

Initial Prices

Token A (ETH) - $ 1900

Token B (BTC) - $ 29000

Future Prices

Token A - $ 3400

Token B - $ 63000

Results

Impermanent loss: 0.47%

If $500 of Token A and $500 of Token B were held

- Have 0.26 Token A and 0.02 Token B
- Value if held: $1,980.94

If $500 of Token A and $500 of Token B were provided as liquidity

- Have 0.29 Token A and 0.02 Token B (in liquidity pool)
- Value if providing liquidity: $1,971.67



ETH/USD Pool
1y
-4.09%

Impermanent Loss Calculator

This calculator uses Uniswap's constant product formula to determine impermanent loss.

Fees are not included within results.

Initial Prices

Token A (ETH) - $ 1900

Token B (USD) - $ 1

Future Prices

Token A - $ 3400

Token B - $ 1

Results

Impermanent loss: 4.09%

If $500 of Token A and $500 of Token B were held

- Have 0.26 Token A and 500.00 Token B
- Value if held: $1,394.74

If $500 of Token A and $500 of Token B were provided as liquidity

- Have 0.20 Token A and 668.86 Token B (in liquidity pool)
- Value if providing liquidity: $1,337.71



ETH/USD Pool
ETH $100
-66.6%

Impermanent Loss Calculator

This calculator uses Uniswap's constant product formula to determine impermanent loss.

Fees are not included within results.

Initial Prices

Token A (ETH) - $ 100

Token B (USD) - $ 1

Future Prices

Token A - $ 3400

Token B - $ 1

Results

Impermanent loss: 66.68%

If $500 of Token A and $500 of Token B were held

- Have 5.00 Token A and 500.00 Token B
- Value if held: $17,500.00

If $500 of Token A and $500 of Token B were provided as liquidity

- Have 0.86 Token A and 2,915.48 Token B (in liquidity pool)
- Value if providing liquidity: $5,830.95



Curve Stableswap

Uniswap V1 2018, curve stableswap in January 2020, Uniswap V2 2020, V3 2021

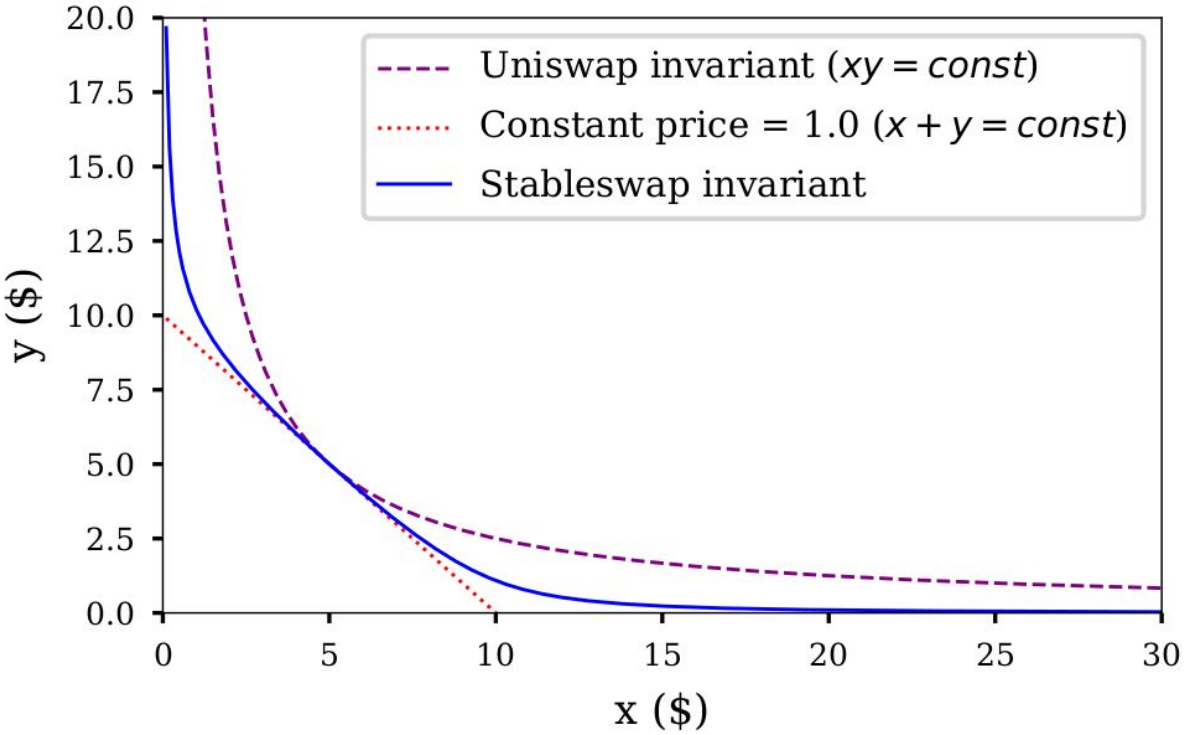
Permissionless: everyone can deploy a pool and be liquidity provider

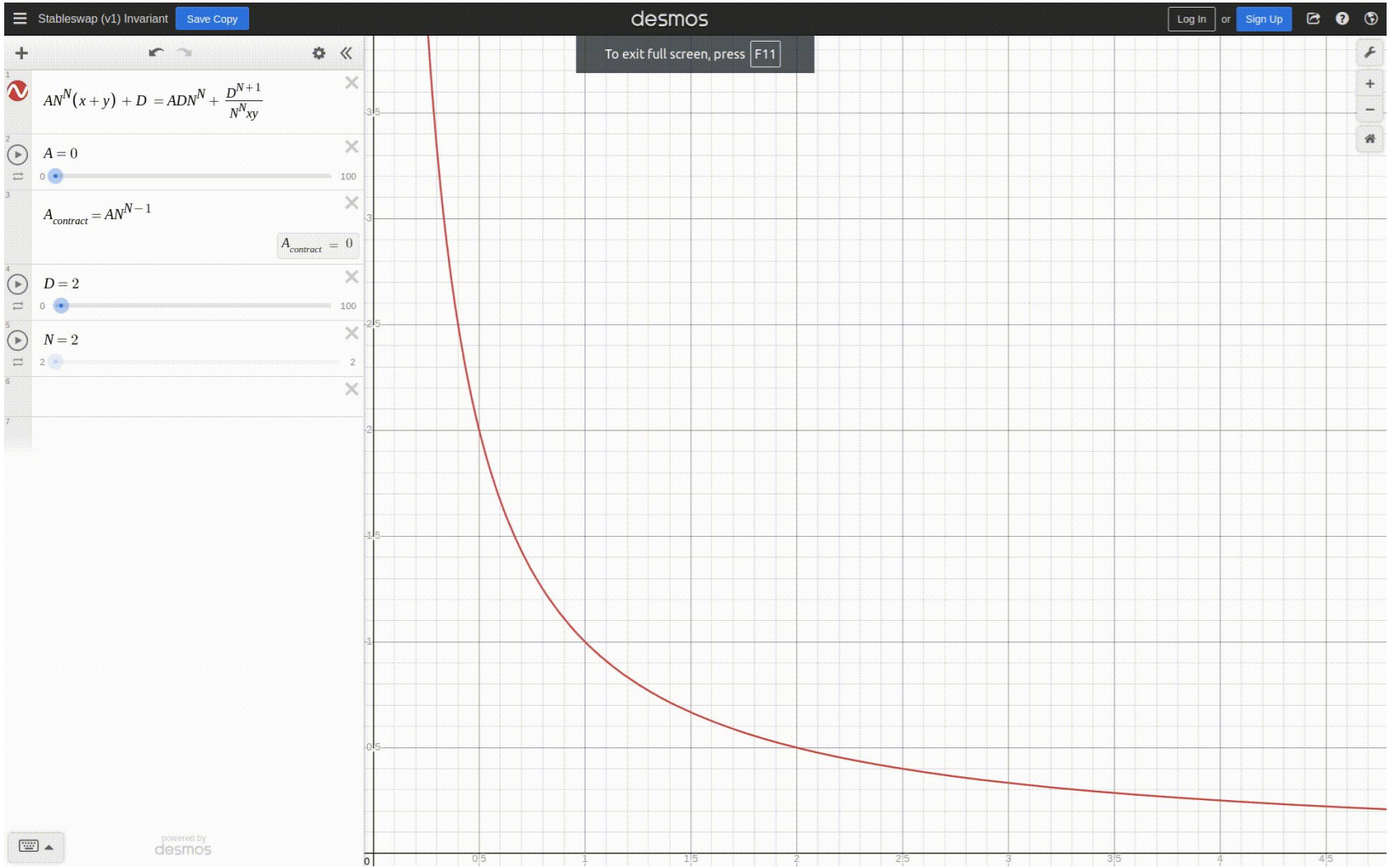
Liquidity Pool Token is composable and fungible

Less slippage, less liquidity needed, because concentrated liquidity

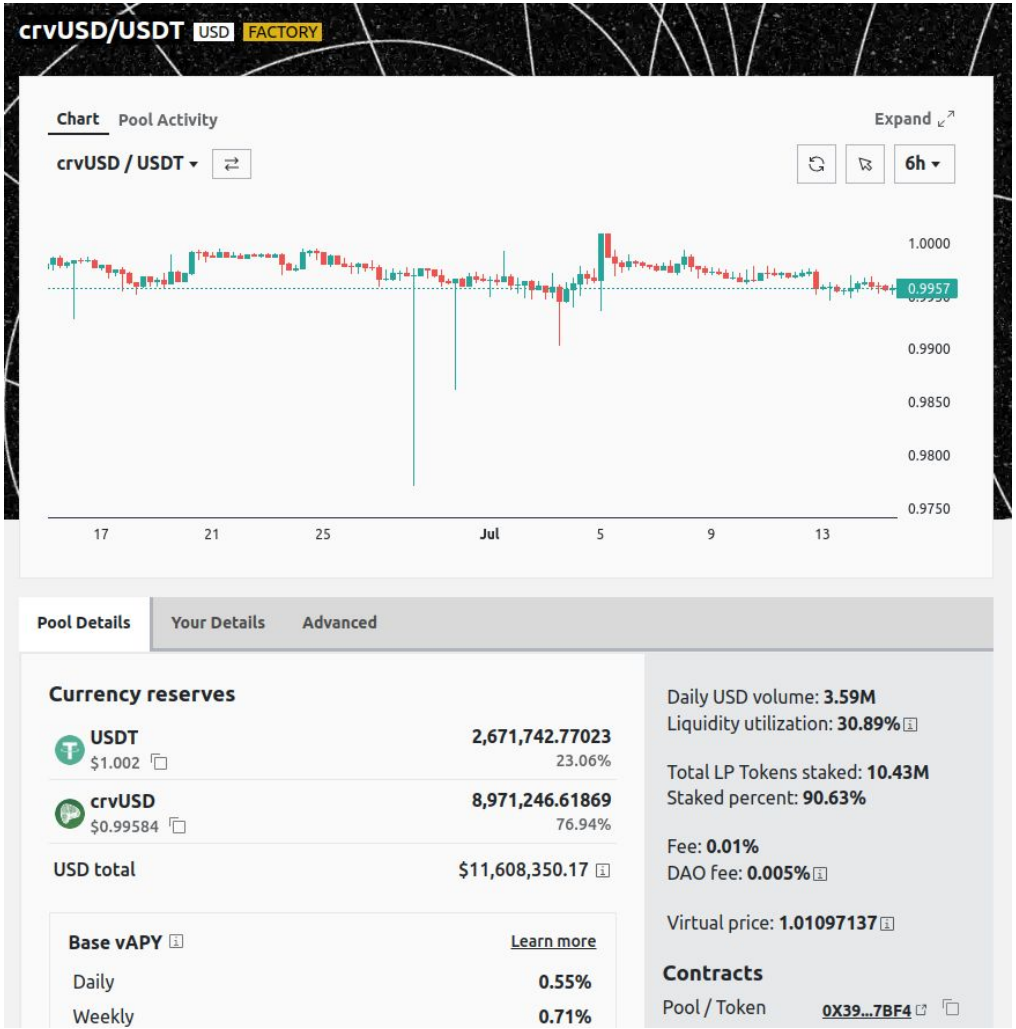


Curve Stableswap




Stableswap (v1) Invariant
Save Copy
desmos
Log In
or
Sign Up
To exit full screen, press F11
$AN^N(x+y)+D=ADN^N+\frac{D^{N+1}}{N^N xy}$
$A=0$
0
100
$A_{contract}=AN^N-1$
$A_{contract}=0$
$D=2$
0
100
$N=2$
2
2
powered by
desmos

crvUSD/USDT pool



WETH/pxETH



Pool Details | Advanced

Currency reserves

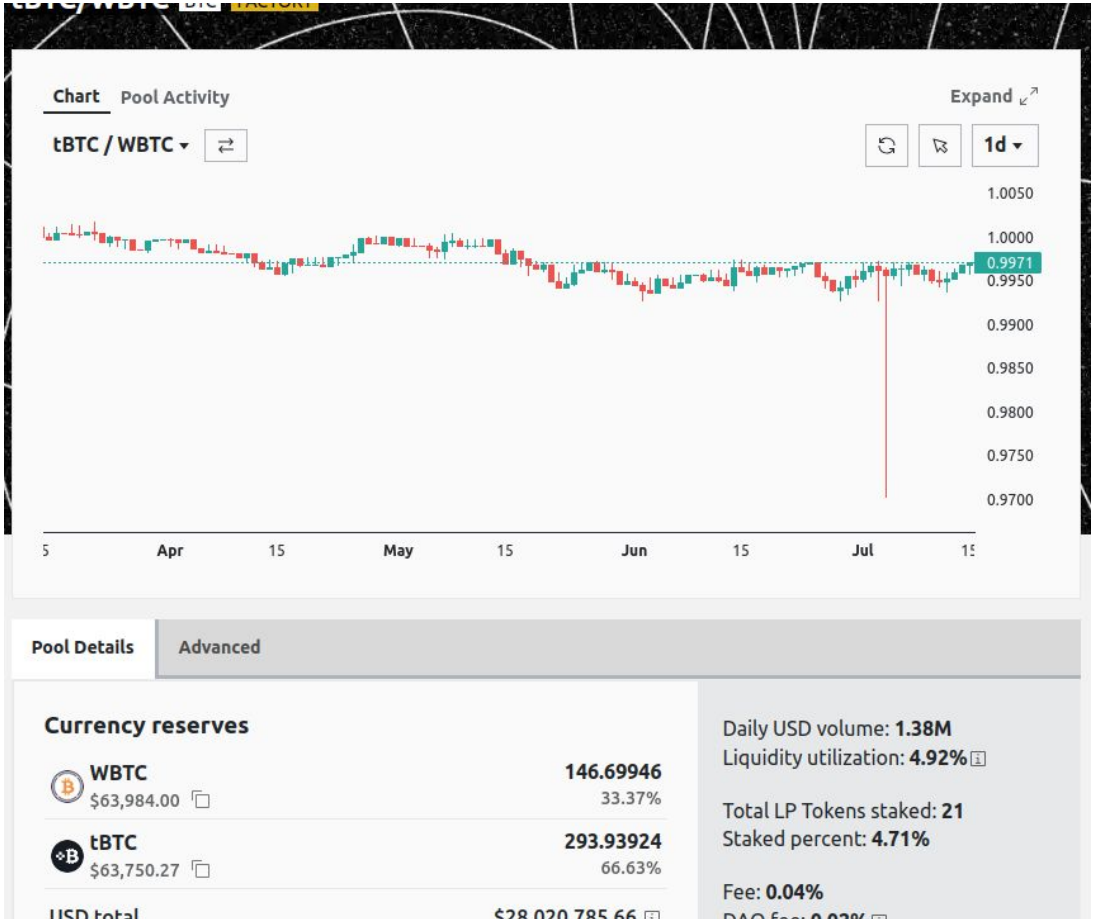
WETH $3,412.96	400.93679 27.38%
pxETH $3,393.01	1,069.79542 72.62%
USD total	$4,997,286.12

Daily USD volume: **213,531**
Liquidity utilization: **4.27%**

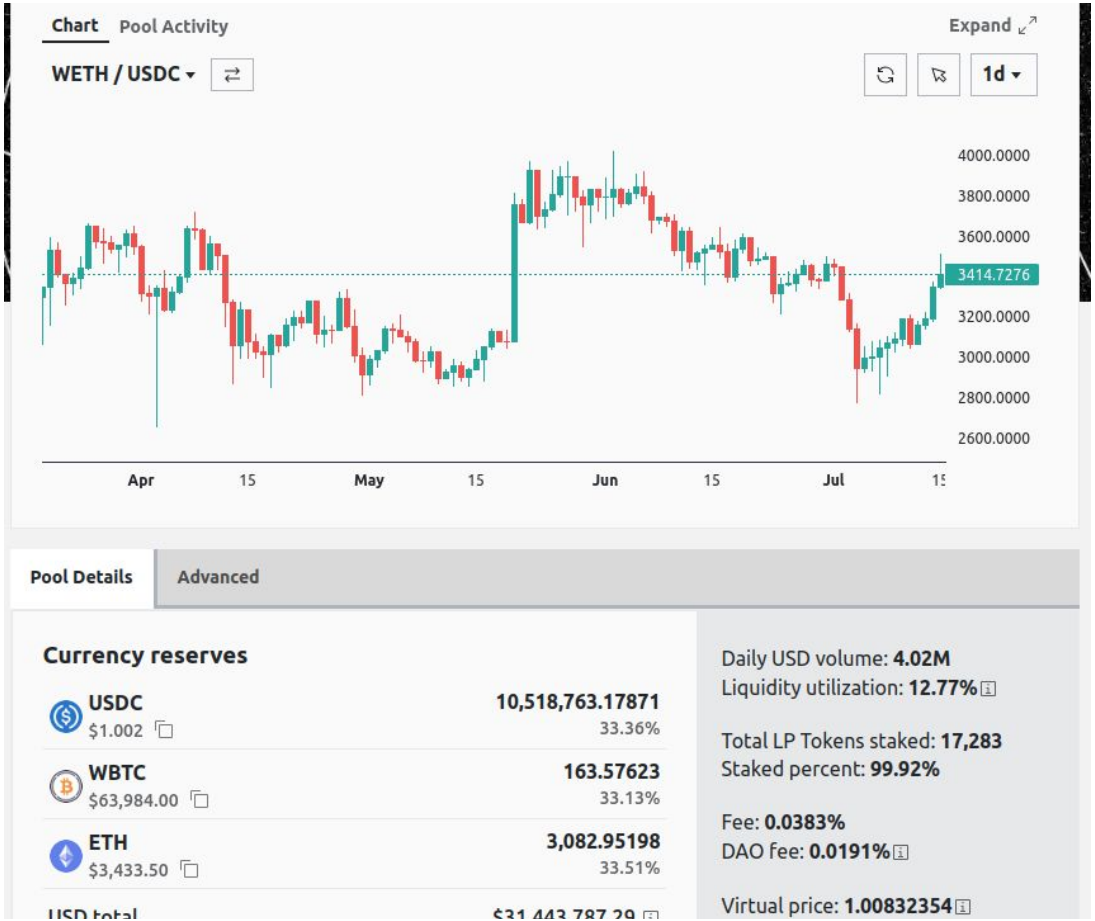
Total LP Tokens staked: **1,435**
Staked percent: **97.62%**

Fee: **0.02%**
DAO fee: **0.01%**

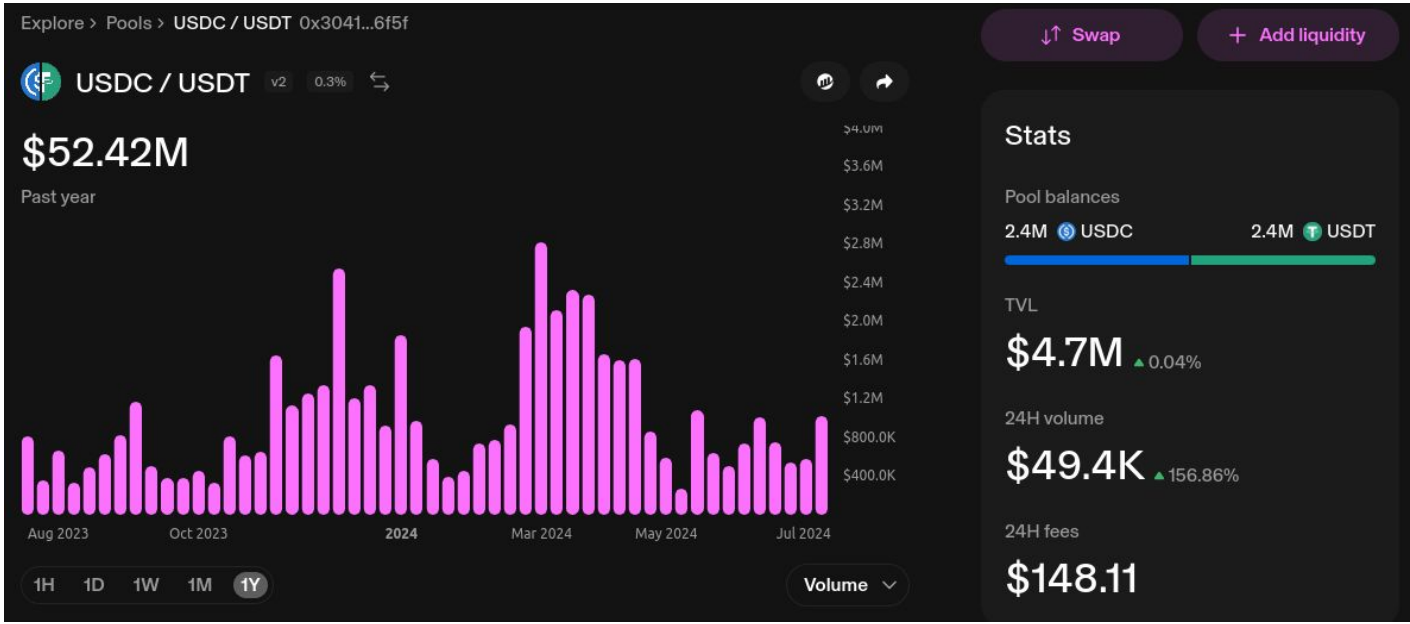
tBTC/WBTC


Chart
Pool Activity
Expand
tBTC / WBTC
1d
1.0050
1.0000
0.9971
0.9950
0.9900
0.9850
0.9800
0.9750
0.9700
Apr
15
May
15
Jun
15
Jul
Pool Details
Advanced
Currency reserves
WBTC
$63,984.00
146.69946
33.37%
tBTC
$63,750.27
293.93924
66.63%
Daily USD volume: 1.38M
Liquidity utilization: 4.92%
Total LP Tokens staked: 21
Staked percent: 4.71%
Fee: 0.04%

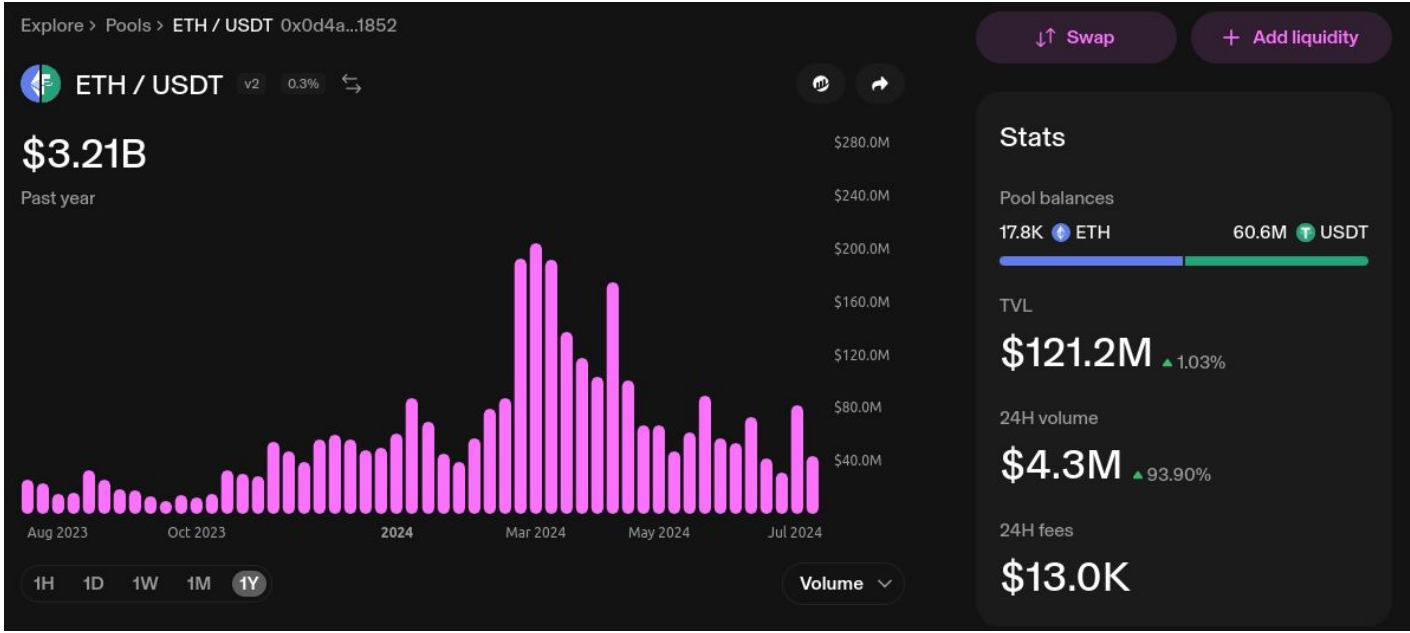
cryptoswap
USDC/WBTC/ETH



Uni V2 USDC/USDT



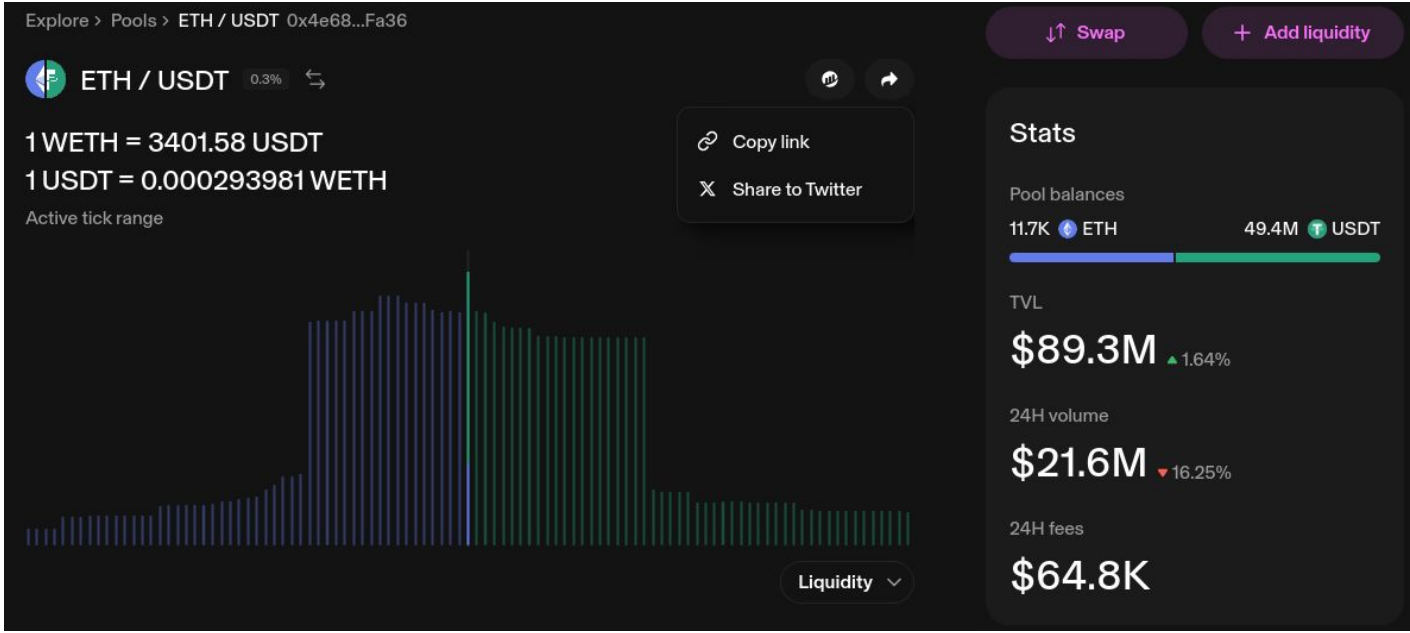
Uni V2 ETH/USDT



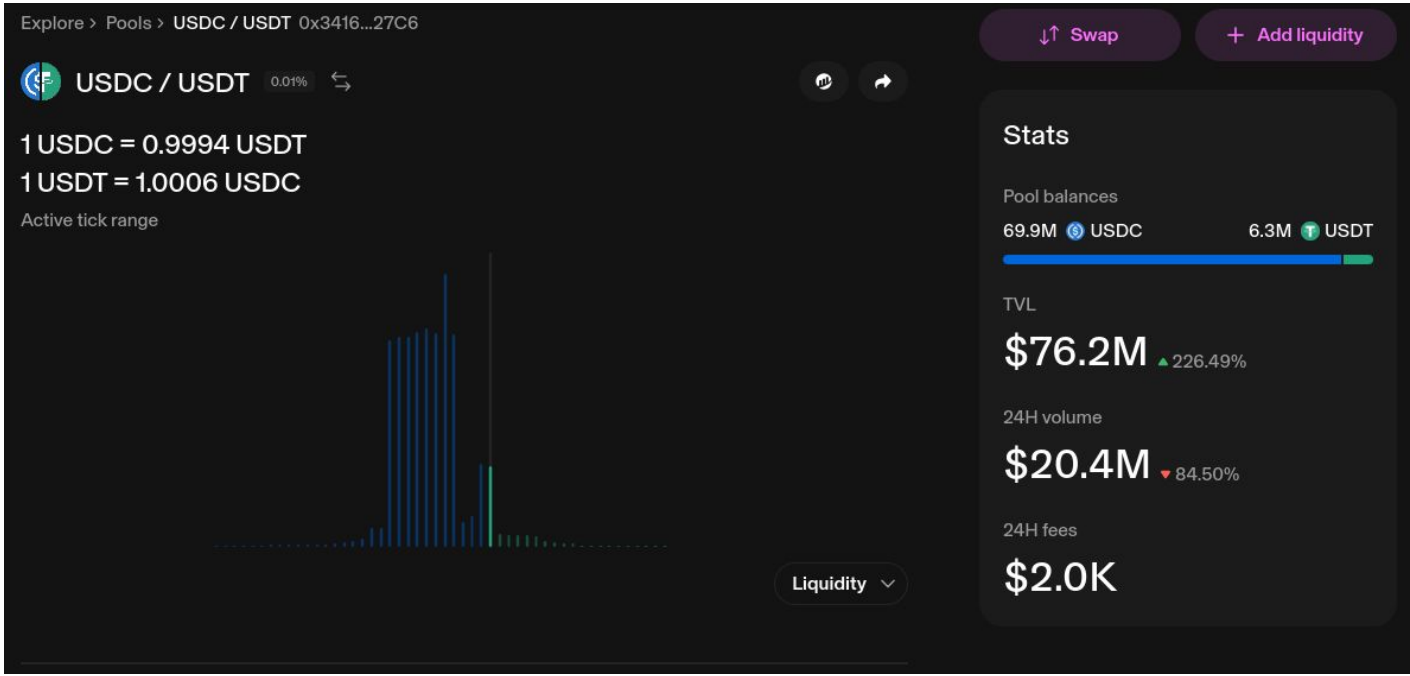
Uni V3 ETH/USDT



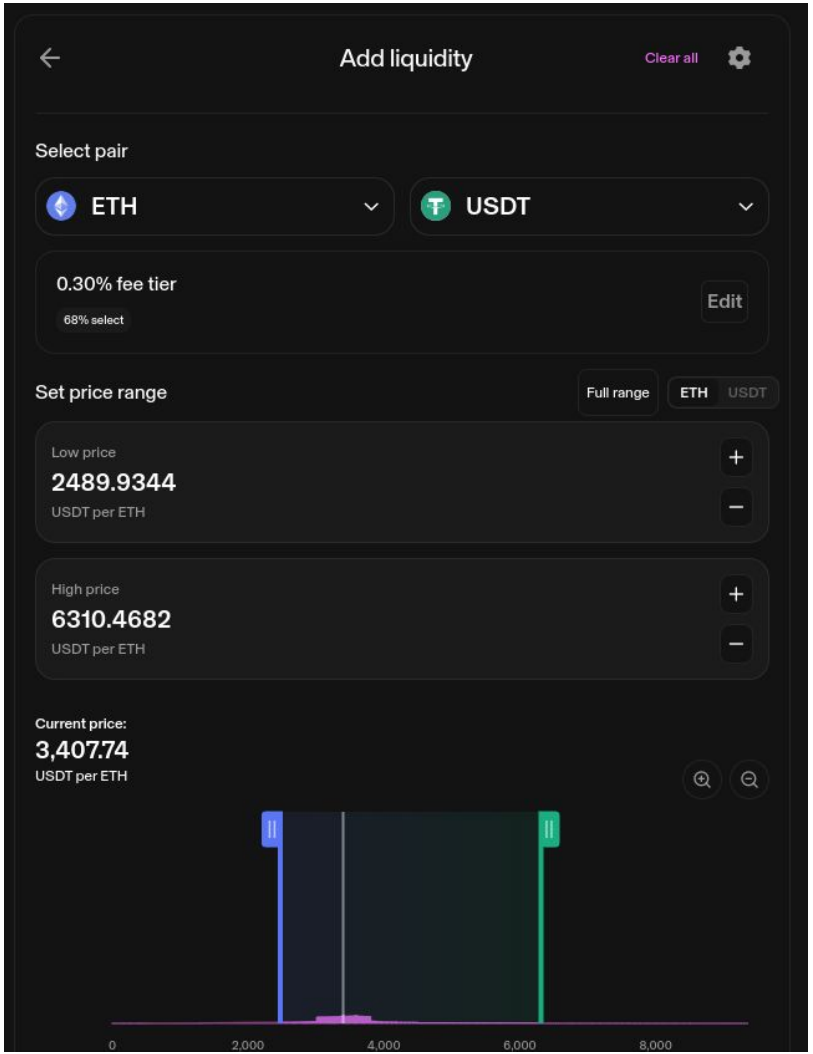
Uni V3 Ticks!


Explore > Pools > ETH / USDT 0x4e68...Fa36
Swap
Add liquidity
ETH / USDT
0.3%
1 WETH = 3401.58 USDT
1 USDT = 0.000293981 WETH
Active tick range
Copy link
Share to Twitter
Liquidity
Stats
Pool balances
11.7K ETH
49.4M USDT
TVL
$89.3M
1.64%
24H volume
$21.6M
16.25%
24H fees
$64.8K

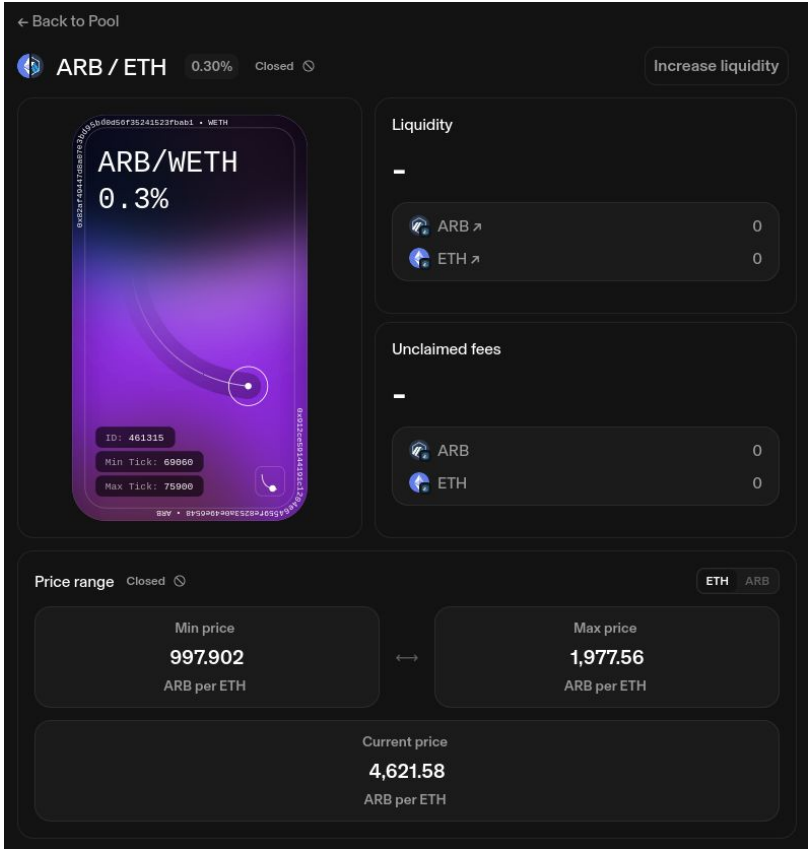
Uni V3 Ticks!


Explore › Pools › USDC / USDT 0x3416...27C6
USDC / USDT
0.01%
1 USDC = 0.9994 USDT
1 USDT = 1.0006 USDC
Active tick range
Liquidity
Swap
Add liquidity
Stats
Pool balances
69.9M USDC
6.3M USDT
TVL
$76.2M
226.49%
24H volume
$20.4M
84.50%
24H fees
$2.0K

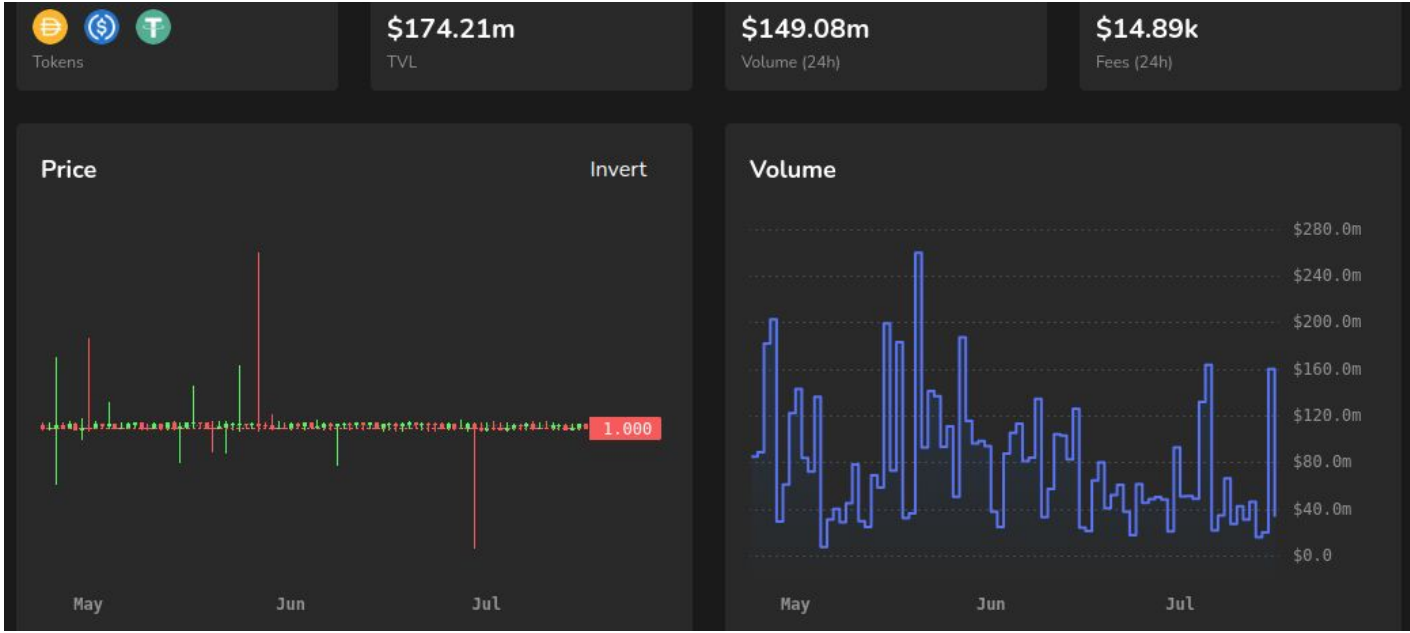
Uni V3 Liquidity



Uni V3 NFT


← Back to Pool
ARB / ETH
0.30%
Closed
Increase liquidity
ARB/WETH
0.3%
ID: 461315
Min Tick: 69060
Max Tick: 75900
Liquidity
-
ARB
0
ETH
0
Unclaimed fees
-
ARB
0
ETH
0
Price range
Closed
ETH
ARB
Min price
997.902
ARB per ETH
Max price
1,977.56
ARB per ETH
Current price
4,621.58
ARB per ETH

curve
DAI/USDC/U
SDT



Pooled finance vs termed finance

Pooled finance (DeFi)

- continuous, composable, fungible, simple, endless

Termed finance (TradFi)

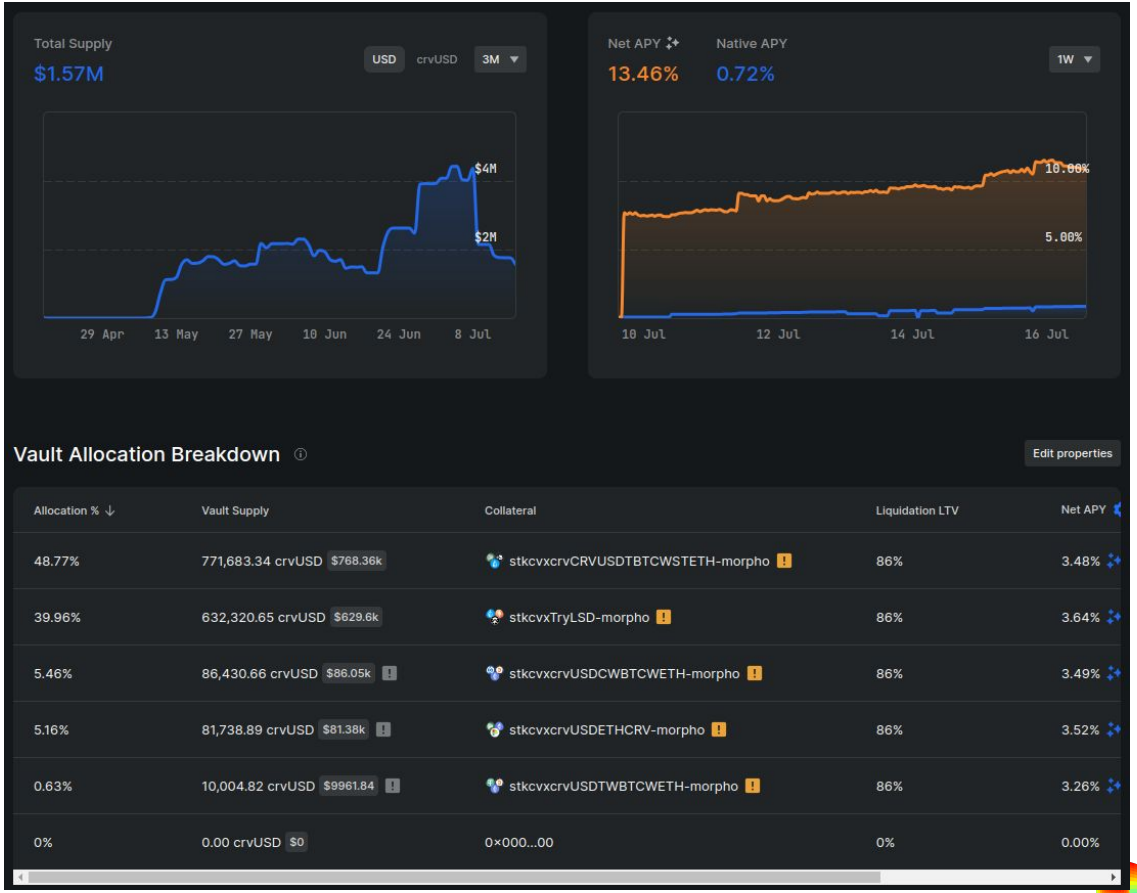
- none continuous, non fungible, has an end, expiry date, otc, clob, price



Sell LP token on cowswap



Use LP token as collateral on lending markets



Complexity and Design Space

Uni V3 and frictions

NFT positions -> liquidity position management tools -> value extraction



Outlook for curve

- Make swaps better!
- We work on a ETH market, currently one of the token the market has to be crvUSD
- More integration and tools build on curve lending
- More chains
- Curve light, AMM side



More info

curve.fi
tg bot @curve_monitor_backup
curvemonitor.com
crvhub.com
resources.curve.fi
docs.curve.fi
tg or Discord



Thanks

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Curve

UZH Summer School, 17. July 2024

uzhss24.cryptonative.ch



Questions?

