An Overview of AMM Mechanisms

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Overview

We will start from the basic principles of market making, and cover major production AMMs including

Basic AMMs

- Constant Product
- Constant Sum

Hybrid AMMs

- StableSwap
- Solidly Stable Pairs
- Dodo PMM
- Clipper
- CryptoSwap

Virtual Reserve AMMs

- Kyber DMM
- Uniswap V3

Finally, we will cover how we can leverage off-chain resources to build on top of AMMs

Section 1

Market Making Primitives

Market Making Objective

A market maker seeks to earn yield on a portfolio of assets by providing trading liquidity

- The market maker earns revenue via a spread, or the difference between the buy and sell price
    - In AMMs, this is often a near-one multiplier the trade amount, such as 0.997 for Uniswap V2 (0.3% fee)

- The market maker can lose money if the portfolio decreases in value
    - This phenomenon can be described with a concise mathematical formula in Uniswap V2 and is often called impermanent loss.

Maximize Δportfolio value + fee revenue maximize

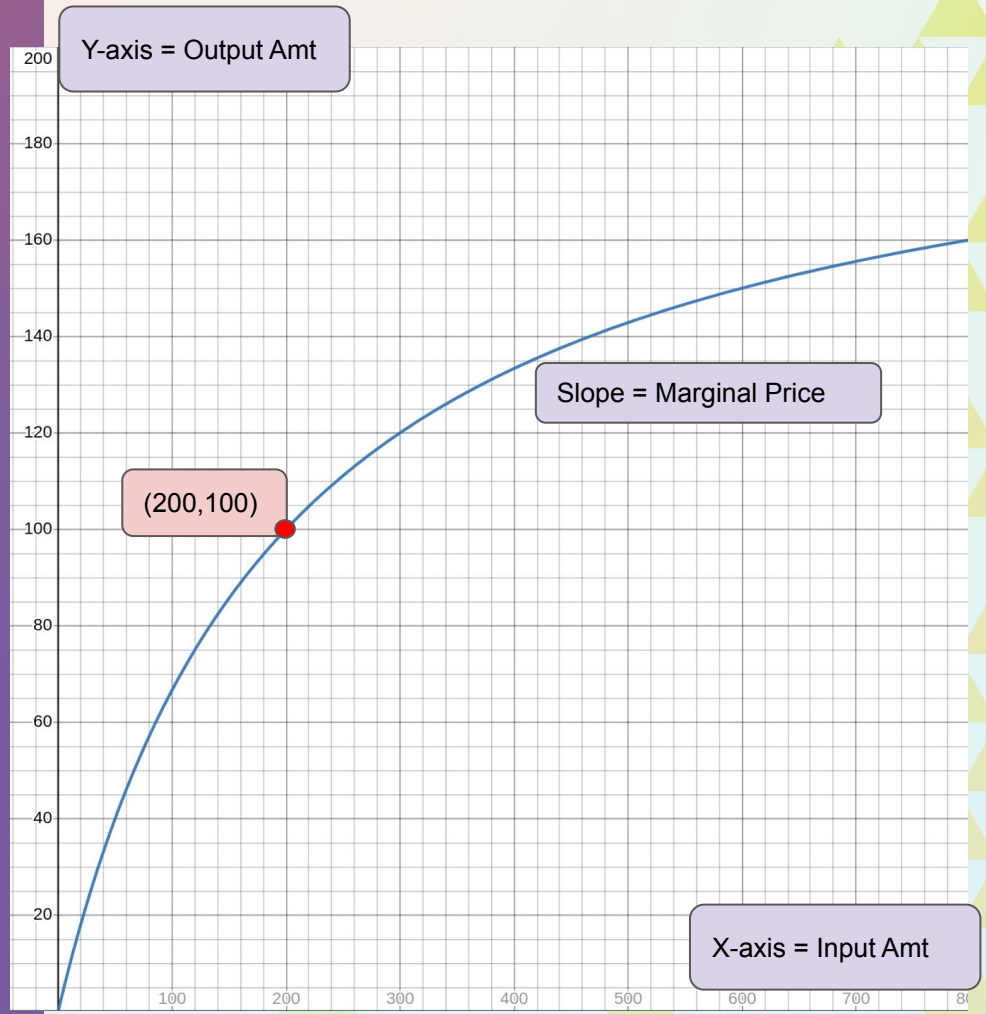
Info for Market Making

1. **Price Discovery** - How much of each asset does the portfolio have?
    - The current portfolio allocations reflect which assets have been more desirable at the prices being offered, “discovering” the current market price
2. **Price Oracles** - What do external prices say these assets are worth?
    - External pricing can be leveraged for more efficient market making, but introduces external dependencies
    - E.g. The underlying peg of an asset, Chainlink Oracles, pricing of other DEXs (Uniswap V3 TWAP), etc.

The Trading Function

Shows Output as a Function of Input

Each point is a possible trade



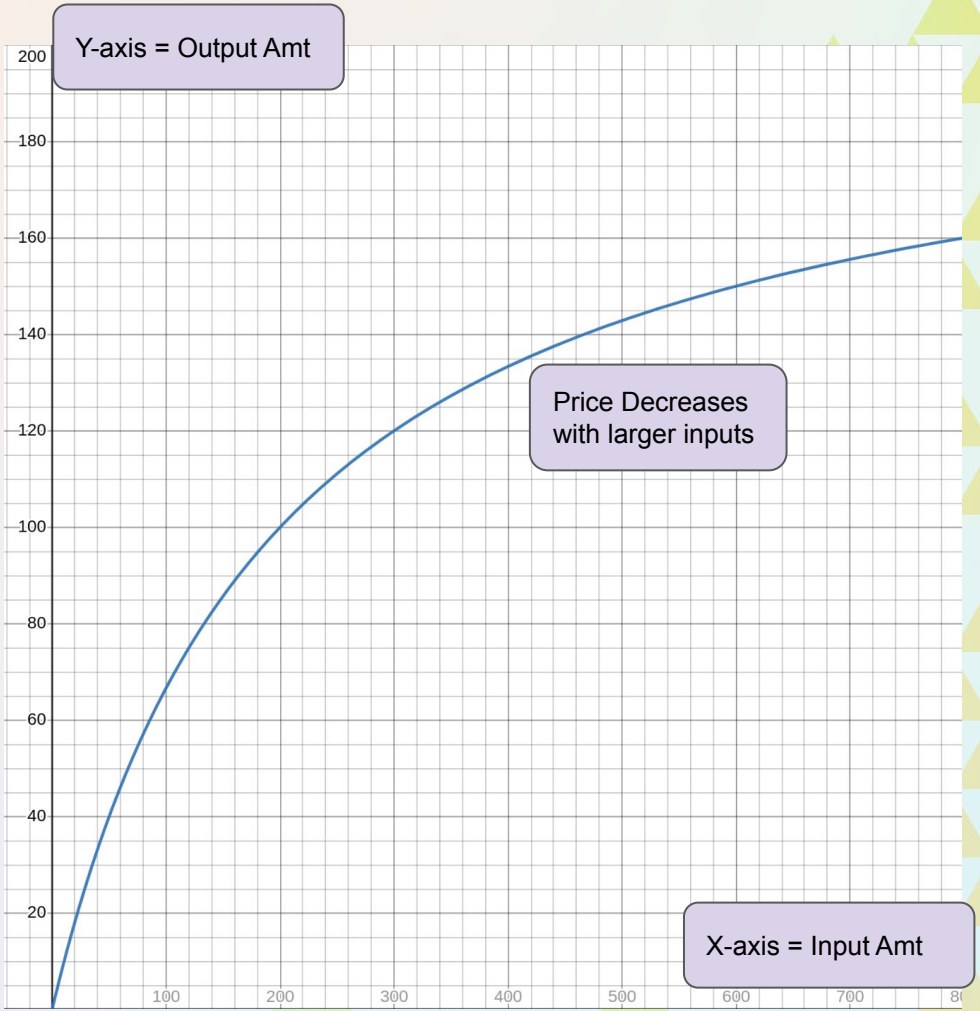
Constant Product Market Makers (CPMMs)

Relying on **only price discovery**, CPMMs set the price as the ratio of the reserves. The price of an asset will naturally increase as it is bought.

Examples include Bancor, Uniswap V1, Uniswap V2, and Balancer (generalization of CPMM that allows for portfolio weights to be set)

Best for long tail assets, when no reliable external price oracles exist

Capital inefficient - less swapping & revenue!



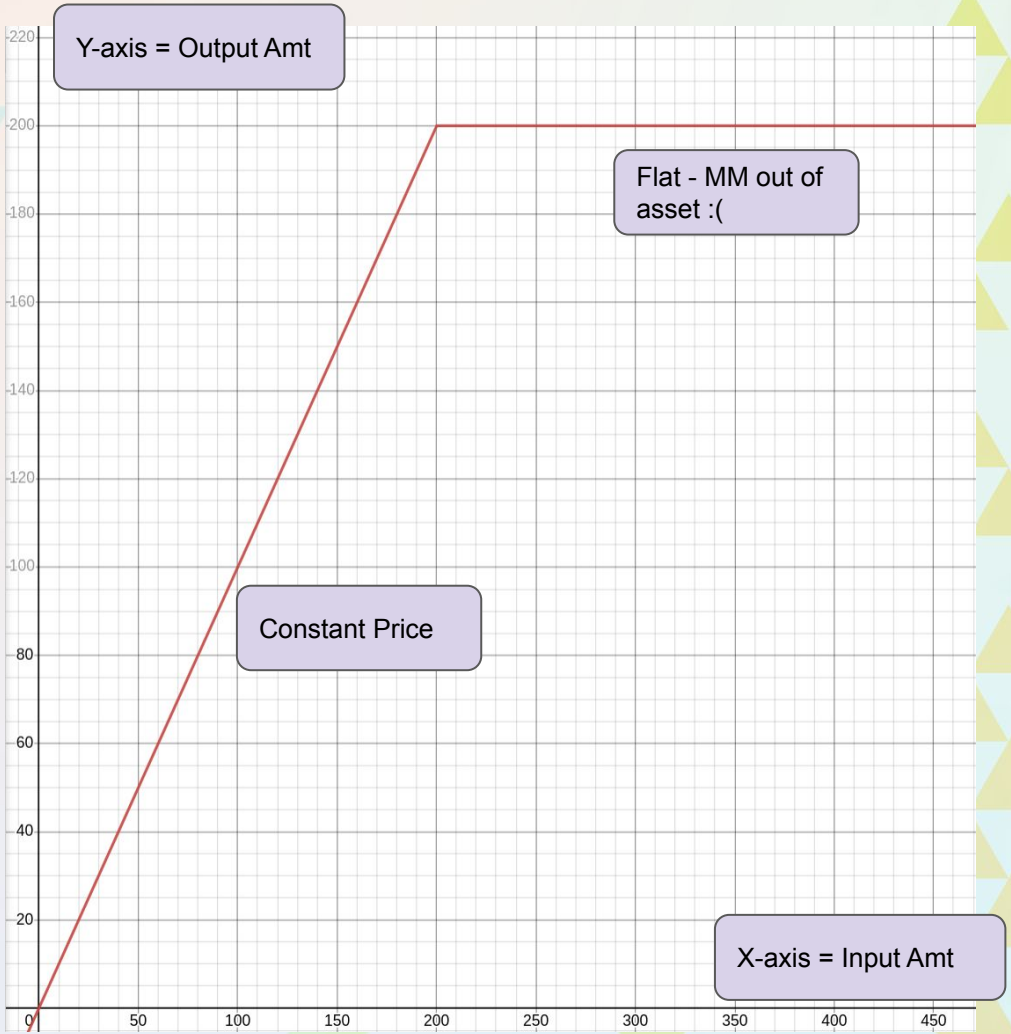
Constant Sum Market Makers (CSMMs)

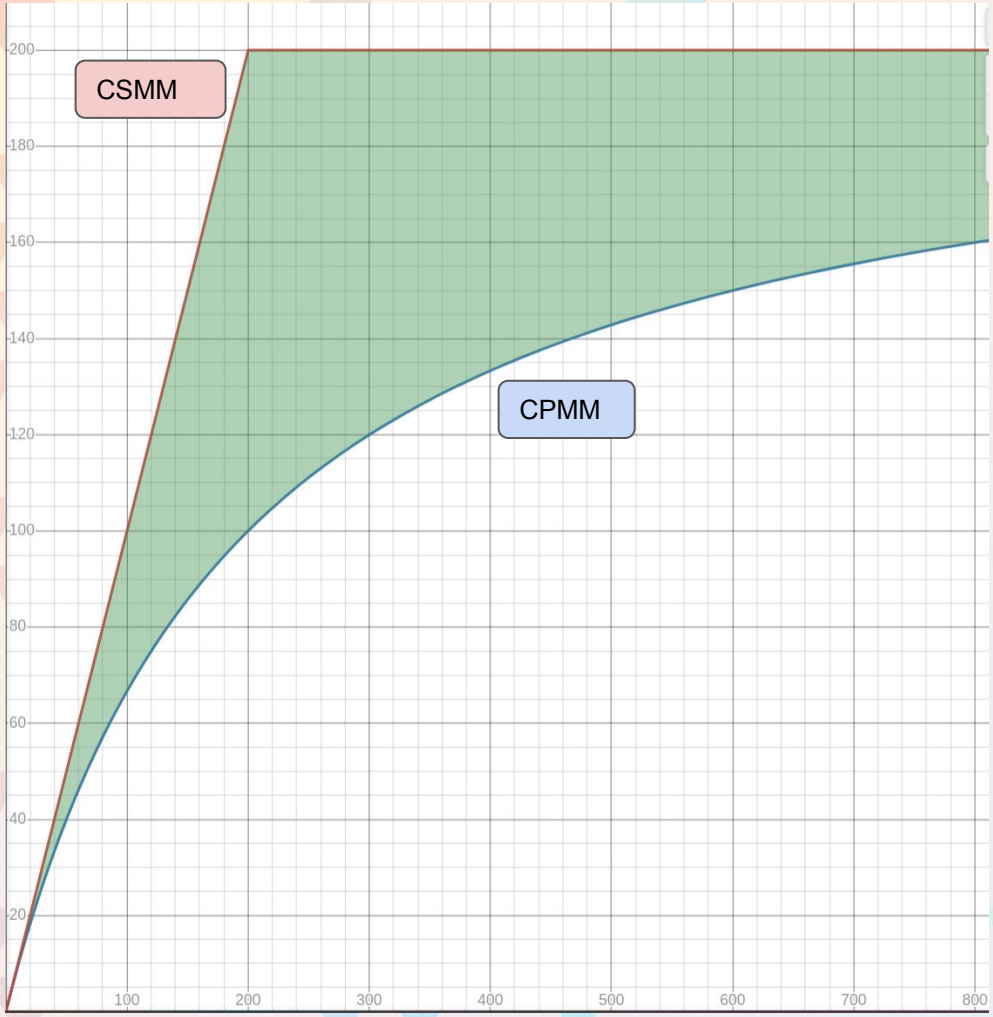
Relying on **only price oracles**, CSMMs ignore the current portfolio and allow exchange at a fixed rate (Until all no more assets are left!)

Examples include Aave, Maker's Peg Stability Module (PSM), Synthetix atomic swap

Best for short tail assets, when robust external price oracles can be leveraged (caution still required!)

High Chance of Illiquidity & Portfolio Risk!





The Middle Ground

External oracles are powerful, but the CSMM is a very high risk option in the case of any small deviations from that oracle.

CPMMs are great as a universally general solution, but are also the most inefficient with capital allocation.

The best solution is usually somewhere in the middle of these two extremes!

Section 2

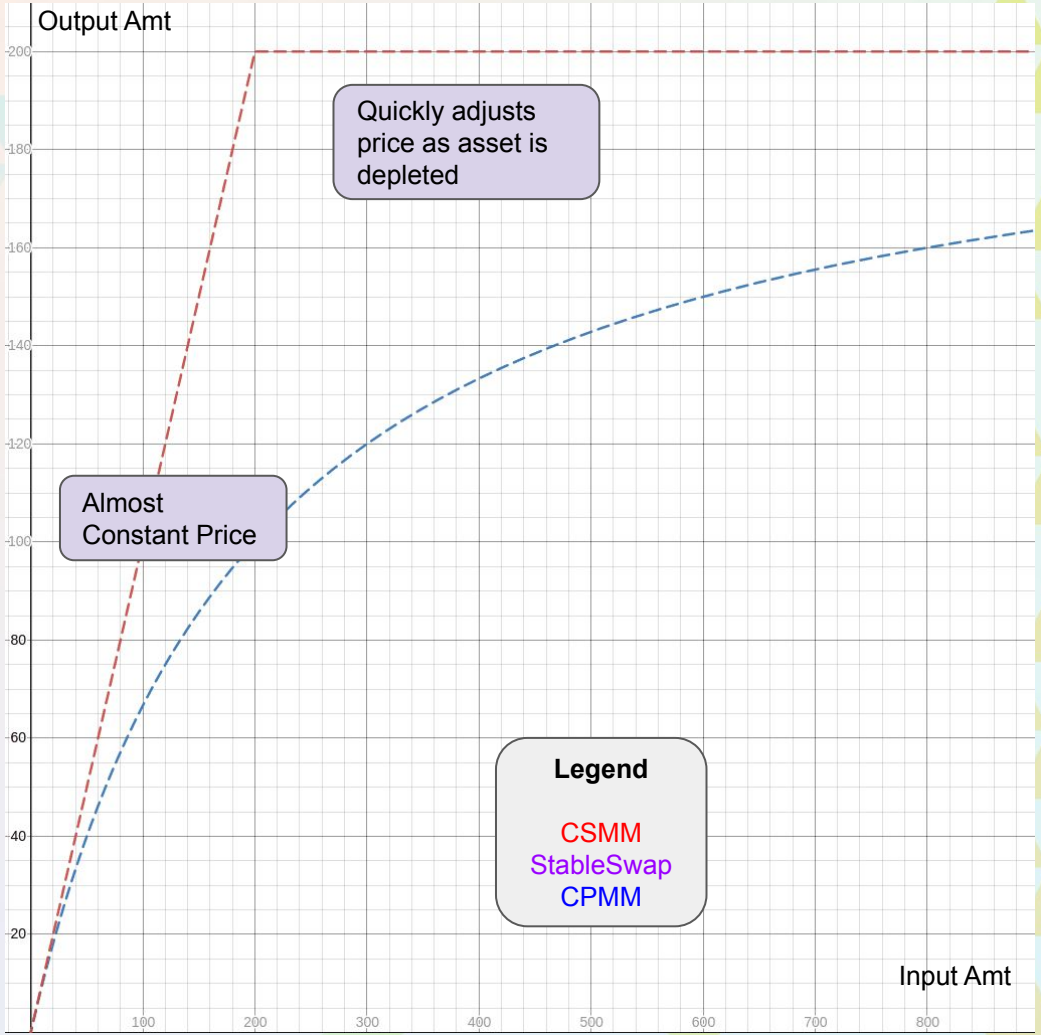
Hybrid AMMs

StableSwap

Dynamically switches from CSMM to CPMM as the reserves get further and further out of balance. Switch rate is dynamically adjustable via Amplification parameter

Examples include Curve, Saddle Finance, Synapse, Balancer Stable Pools

Best for wide range of pegged assets (e.g. stablecoins)



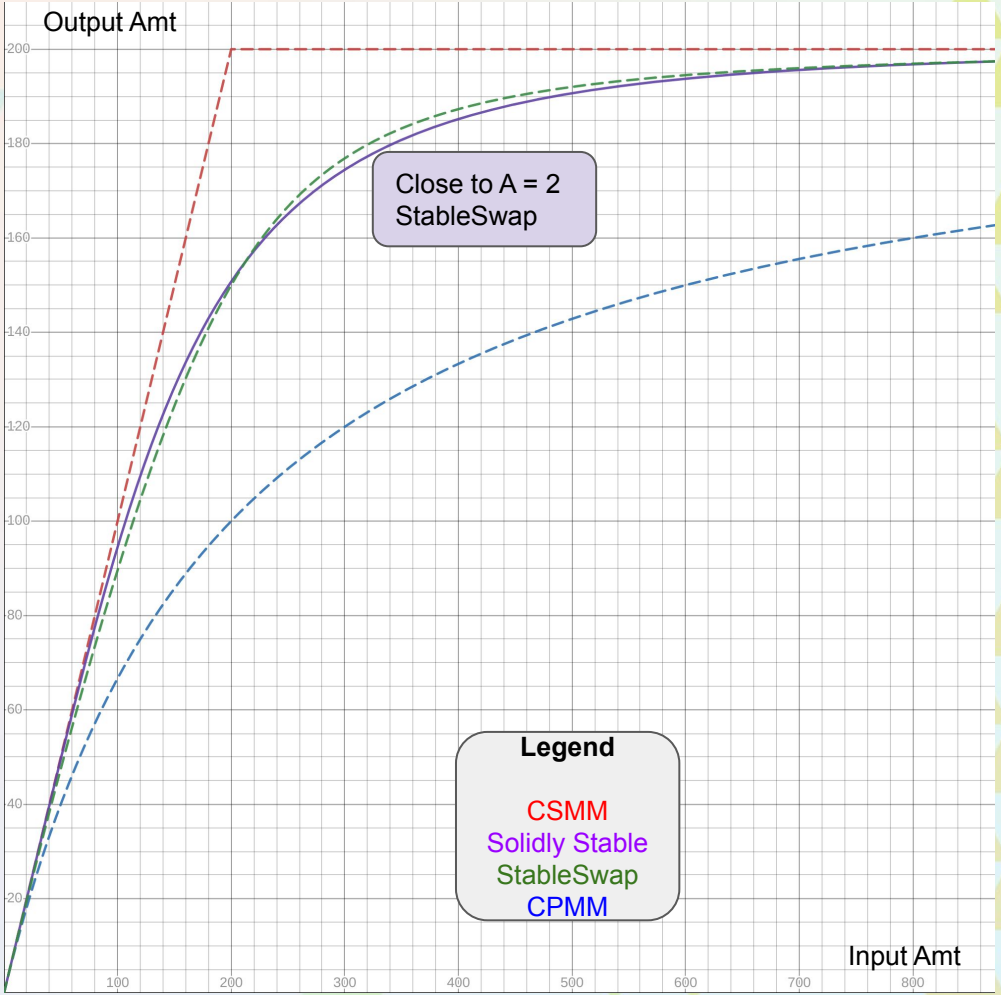
https://curve.fi/files/stableswap-paper.pdf

Solidly Stable Pairs

Adds higher order terms to the CPMM invariant to flatten the curve around a 1:1 exchange rate, producing a simpler (and unadjustable) but similar result to StableSwap (A = 2)

Examples include Solidly (Fantom), Dystopia (Polygon), Velodrome (Optimism)

Simpler solution for pegged assets (e.g. stablecoins), acceptable for less stable pegs.



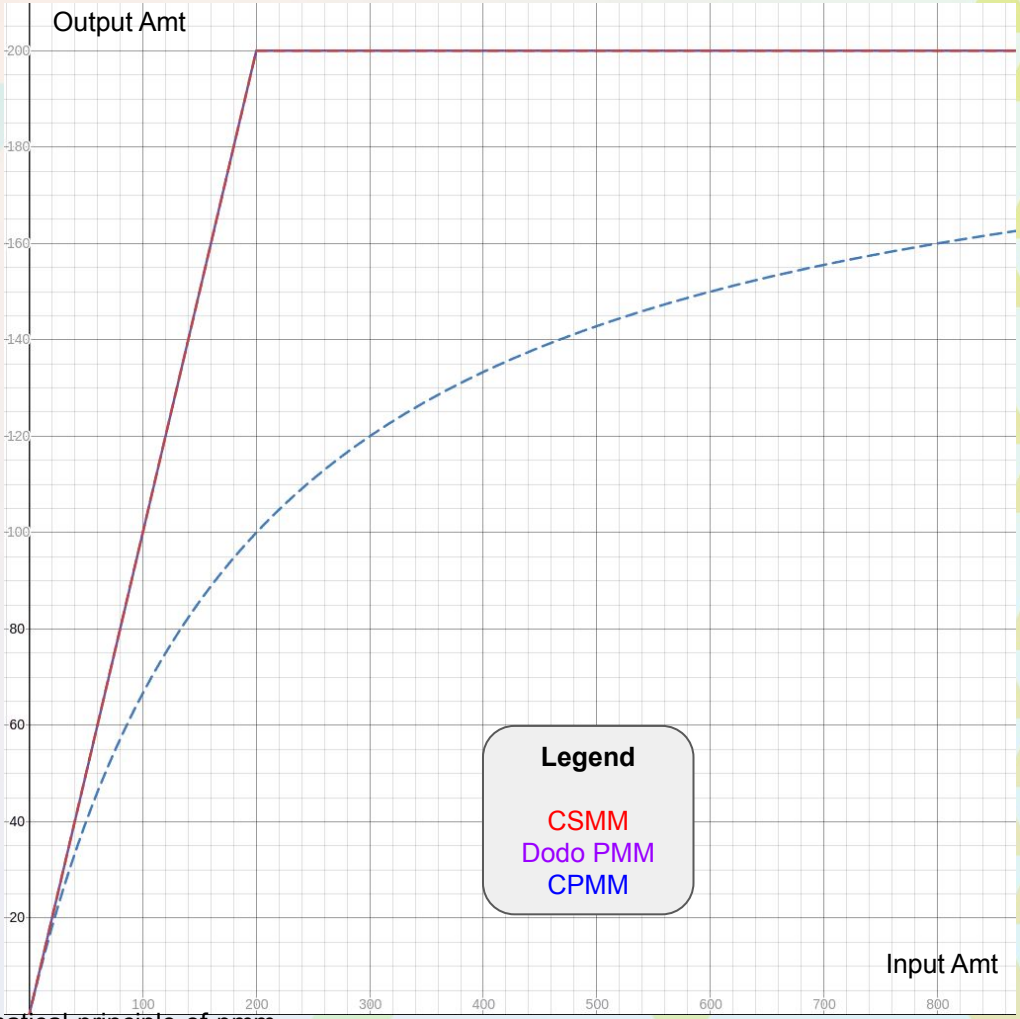
https://docs.velodrome.finance/liquidity

Dodo Proactive Market Maker

Uses an external oracle to flatten the CPMM curve around that oracle price according to a parameter k, allowing it to effectively move between the CSMM (k = 0) and CPMM (k = 1).

Examples include Dodo V1 & V2

Can be applied to many different type of assets depending on k, with k effectively representing the confidence in the oracle.(k = 0 needs no oracle)



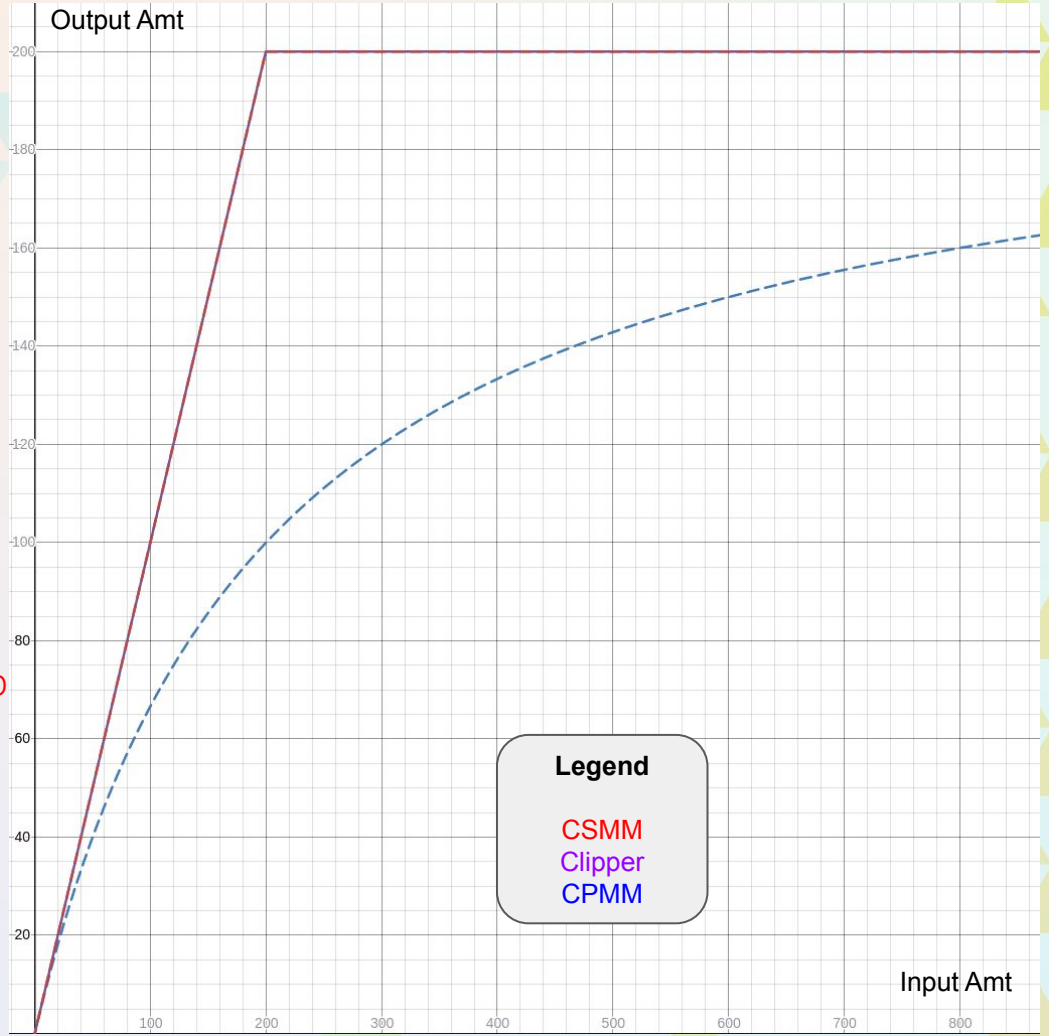
https://docs.dodoex.io/english/dodo-academy/pmm-overview/the-mathematical-principle-of-pmm

Clipper

Uses a parameter k to more directly adjust between a CSMM and CPMM

Examples include Clipper AMM (deprecated) and Clipper RFQ

Is typically used in a multi-token pool of large cap assets, with k effectively representing the confidence in the oracle



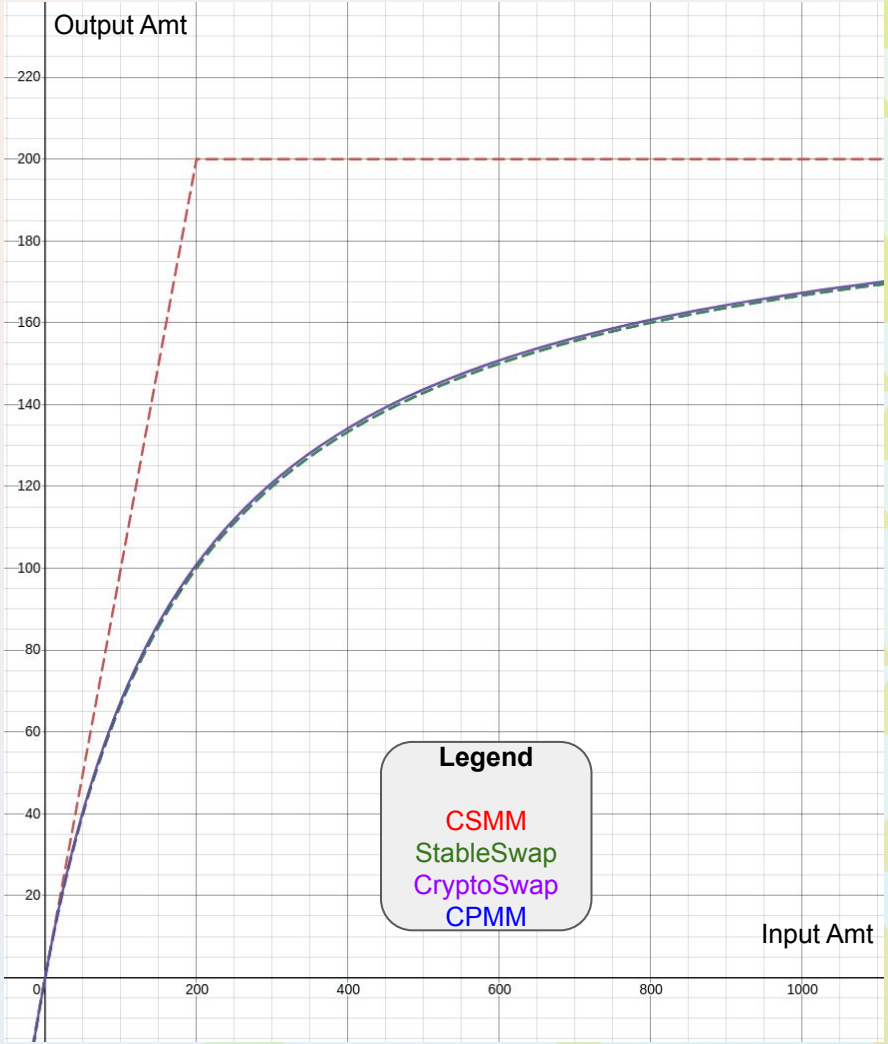
https://github.com/shipyard-software/market-making-whitepaper

CryptoSwap

Adds another degree of freedom to StableSwap via a “gamma” parameter. This allows the curve to more quickly adapt from CSMM to CPMM as reserves deviate from the oracle price, making it more suited for more volatile oracles.

Examples include Curve V2 Crypto Pools

Is typically used in a multi-token pool of large cap assets, with k effectively representing the confidence in the oracle



https://curve.fi/files/crypto-pools-paper.pdf

Section 3

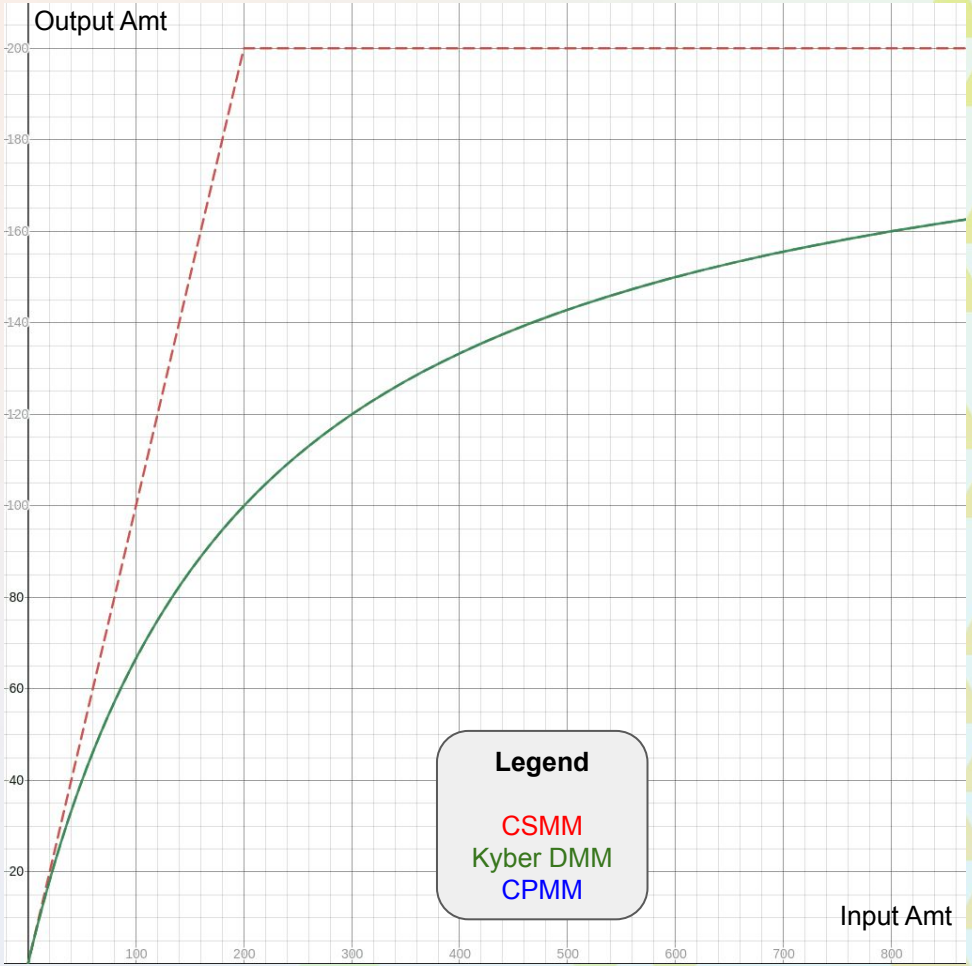
Virtual Reserves

Kyber DMM

Uses a parameter A to multiply reserves in CPMM equation, moving from a CPMM to a CSMM as A approaches infinity

Examples include Kyber DMM (also has dynamic fee), Stable Plaza

Best use case is for stable coins, but can also be used with caution for other correlated assets



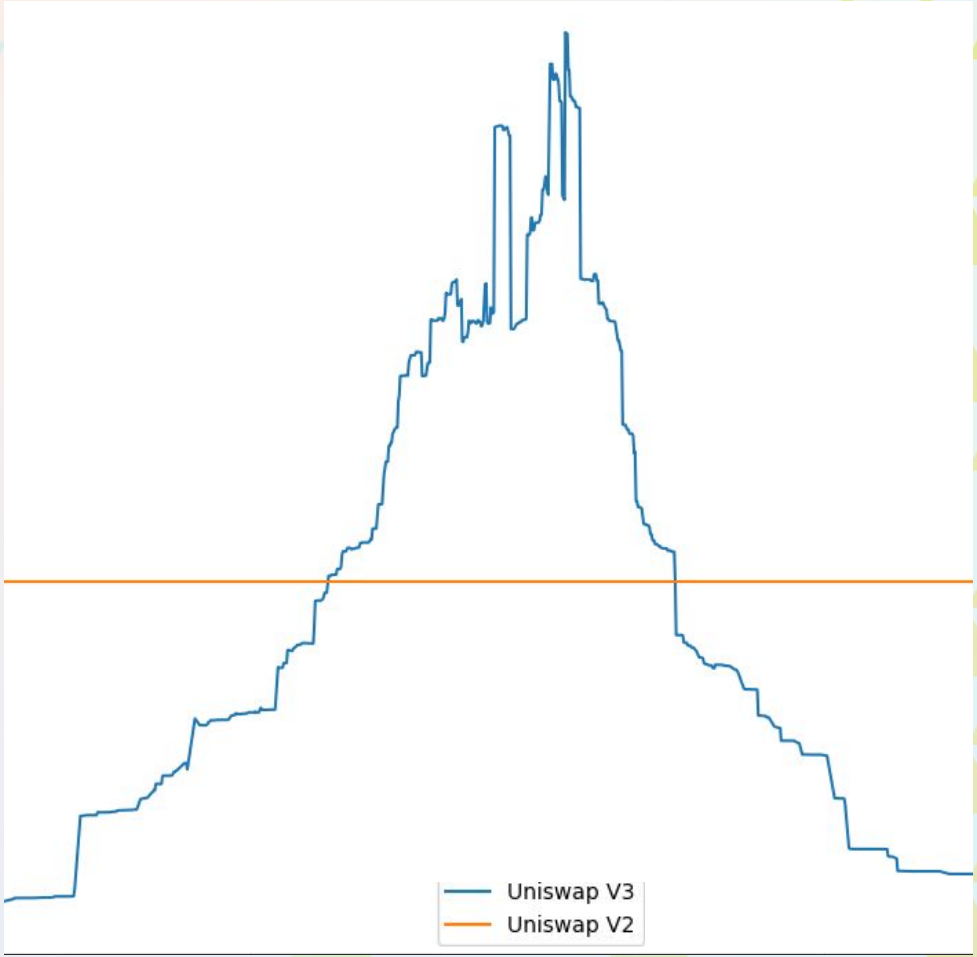
https://files.kyber.network/DMM-Feb21.pdf

Uniswap V3

Uniswap V3 allows each individual liquidity provider to choose their own price range, combining these heterogeneous positions into one liquidity source.

Examples include Uniswap V3, Kyberswap Elastic, Algebra Finance

Great for any pair, if you can find some dedicated liquidity providers



https://files.kyber.network/DMM-Feb21.pdf

Section 4

Leveraging Off-chain Resources

Request For Quote (RFQ)

RFQs bridge the gap between capital-efficient off-chain centralized pricing (e.g. CLOB) and on-chain settlement and composability.

Hashflow - Aggregates PMM order books and combines with on-chain settlement

Clipper RFQ - Uses the Clipper AMM formula with an off-chain rapidly updating oracle price, allowing the k parameter to be set much lower (pushed closer to a CSMM)

Allows for much more hands-on pricing, resulting in better use of capital and more efficient markets, but also adds an off-chain dependency

How do traders navigate this complex landscape?

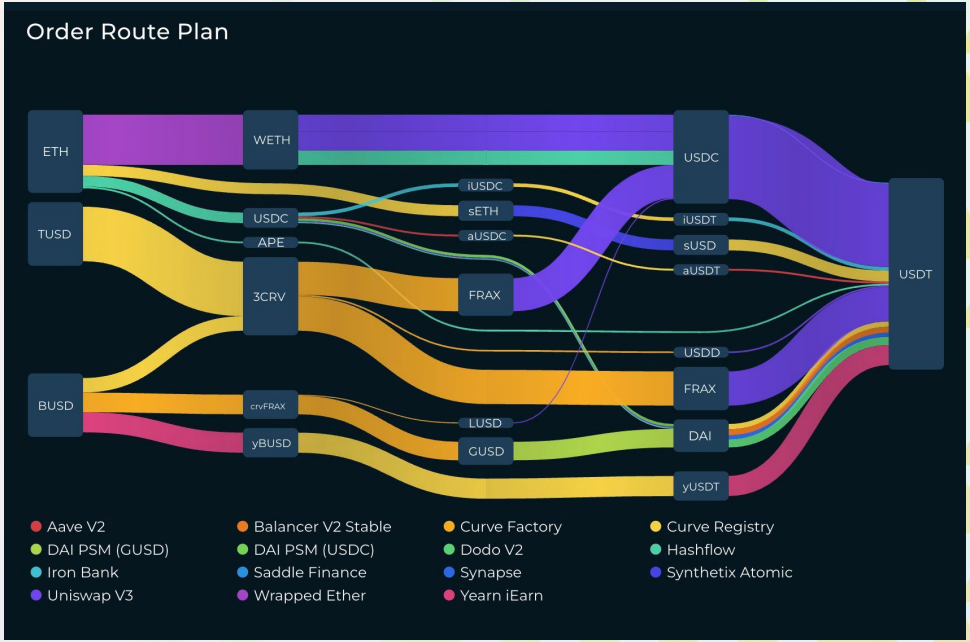
- Many types of AMMs
- 100s of liquidity pools utilizing each AMM
- The best pool for a each pair is often actually a combination of pools
- The best route between tokens often goes through many other pairs

Dex Aggregators!

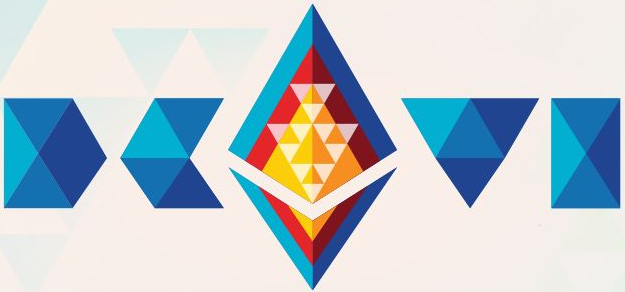
Dex Aggregators

Dex Aggregators leverage off-chain optimization to provide the best pricing while maintaining atomic execution, slippage protection, on-chain settlement, and self-custody.

Odos builds on this concept by considering even more complex paths and operations, like trading multiple assets at once.



https://odos.xyz/



Thank you!

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We are hiring!

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SEMIOTIC LABS

Our other Devcon Talks:

Oct 12th, 10 am
"Reinforcement Learning for Query Pricing in The Graph"

Oct 12th, 11:30 am
"A SNARK's Tale: A Story of Building SNARK Solutions on Mainnet"