

# DeFi Trading: How Prices Set Themselves

## Automated Market Makers

Prof. Dr. Jörg Osterrieder

BSc Blockchain, Crypto Economy & NFTs

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**By the end of this lecture, you will be able to:**

1. **Explain** how an AMM sets prices without an order book [Understand]
2. **Describe** slippage and why pool size matters [Understand]
3. **Compare** AMM trading vs order-book trading [Analyze]
4. **Evaluate** whether providing liquidity is profitable [Evaluate]

**No math required.** Main slides use only plain English and pictures.  
Technical formulas are in the Appendix for those who want them.

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**Bloom's levels covered: Understand, Analyze, Evaluate. Formulas in Appendix.**

# What You Need to Know Before This Lecture

## DeFi

Financial services (trading, lending, saving) built on blockchain instead of banks.

## Smart Contract

A program that runs on a blockchain. It enforces rules automatically — no human needed.

## Liquidity

How easily you can buy or sell something without moving the price. More liquidity = smoother trading.

## Token

A digital asset on a blockchain. Can represent currency, ownership, or access rights.

## TVL (Total Value Locked)

The total amount of money deposited in a DeFi protocol. A rough measure of trust and adoption.

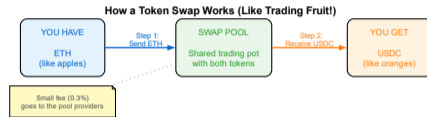
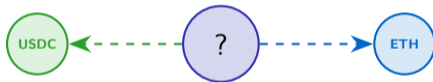
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All terms are from Deck 1: DeFi Intro. You can also look them up as you go.

**You want to trade ETH for USDC.**

No order book. No broker. No matching engine.

**How does the price get set?**



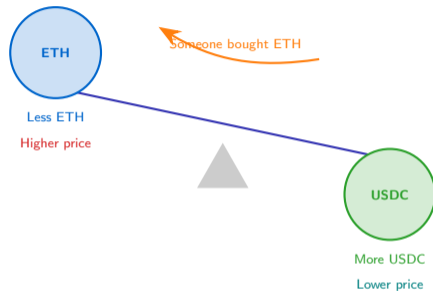
**In traditional finance, a broker matches buyers and sellers. In DeFi, math does it.**

# The Seesaw Analogy

A **liquidity pool** is like a seesaw.

- Two tokens sit on opposite sides
- Buy from one side: that side gets **lighter** and **more expensive**
- Sell to one side: that side gets **heavier** and **cheaper**

The pool **automatically** adjusts prices based on what people buy and sell.



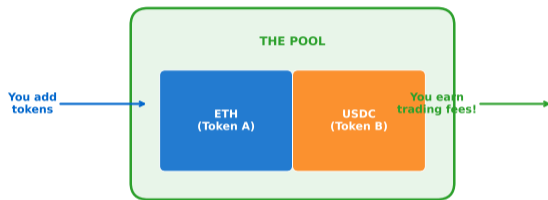
This single idea explains 90% of how DeFi trading works.

# What Is a Liquidity Pool?

A **liquidity pool** is a smart contract holding two tokens.

- Anyone can deposit tokens into it
- Traders swap against the pool, not against another person
- No order book, no market maker
- Just a pool of tokens and a formula

## Liquidity Pool = Shared Trading Pot



*Traders swap tokens from this pool and pay a small fee.*

**You get a share of those fees for providing your tokens.**

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**No order book. No market maker. Just a pool of tokens and a formula.**

### What you see:

- Pick tokens and amount
- Click “Swap”
- Confirm in wallet

### What happens behind the scenes:

- Smart contract receives your tokens
- Formula calculates the output
- Pool rebalances automatically

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The whole process takes about 12 seconds on Ethereum, or 2 seconds on Layer 2.

# The Price Sets Itself

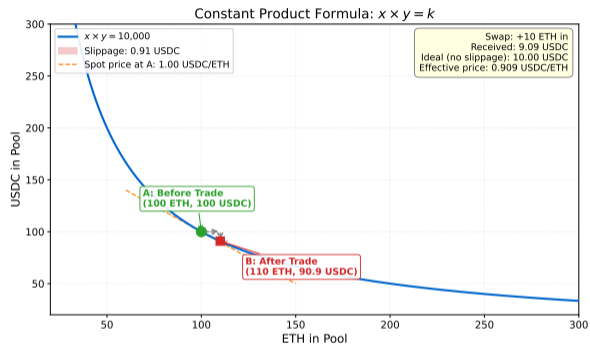
## When people buy ETH from the pool:

- Less ETH in the pool
- Less supply = **higher price**

## When people sell ETH to the pool:

- More ETH in the pool
- More supply = **lower price**

The formula adjusts prices **automatically** after every trade.



The formula is in the **Appendix (A1)**. Main idea: the pool automatically adjusts prices based on supply.

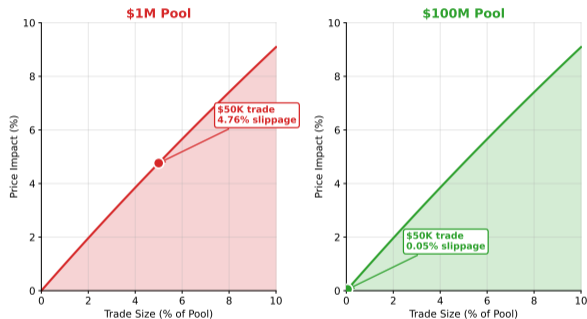
# Slippage: Why Big Trades Cost More

**Slippage** = the difference between the price you expected and the price you actually paid.

- Buying 1 ETH from a big pool barely moves the price
- Buying 100 ETH from a small pool moves it **a lot**

**Rule of thumb:**  
Bigger trade = more slippage  
Bigger pool = less slippage

## Slippage: Why Pool Size Matters



*Larger pools absorb trades with minimal price impact -- deep liquidity protects traders*

**Slippage = the difference between expected price and actual price. Bigger trade = more slippage. Formula in Appendix (A2).**

Pool Size	Trade Size	Approx. Slippage	Verdict
mired!10 \$100K	\$1,000	~1%	Expensive
morange!10 \$1M	\$1,000	~0.1%	Decent
mlgreen!10 \$10M	\$1,000	~0.01%	Smooth
mlgreen!10 \$100M	\$1,000	~0.001%	Near zero

### Small Pool

Your trade moves the price significantly. You pay a "tax" for being a big fish in a small pond.

### Large Pool

Your trade barely moves the price. Like exchanging currency at a major airport.

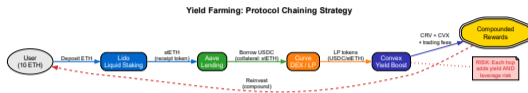
This is why Uniswap ETH/USDC pool (\$200M+) gives you almost zero slippage on normal trades.

# Who Fills the Pool? Liquidity Providers

**Liquidity Providers (LPs)** deposit equal value of both tokens into a pool.

In return, they earn a share of every trade's fee.

- Deposit 50% ETH + 50% USDC
- Every swap pays a small fee
- Fees are split among all LPs
- You can withdraw any time



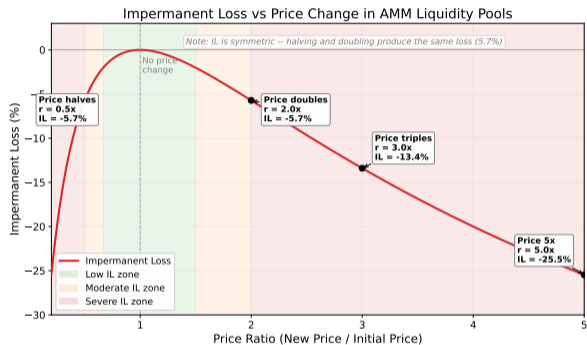
Providing liquidity = putting your tokens to work. But there is a catch (next slide).

# The Catch: Impermanent Loss

If the price of one token changes a lot, LPs end up with **less value** than if they had just held.

This is called **impermanent loss (IL)**.

Price Change	IL
1.25x	0.6%
1.50x	2.0%
2x	5.7%
3x	13.4%
5x	25.5%



Only 37.2% of non-stablecoin V3 LP positions were profitable in 2025. Formula in Appendix (A3).

# Fees vs Impermanent Loss

LPs earn fees on every trade. The question is whether fees outweigh IL.



## When it works:

- Stablecoin pairs (USDC/USDT)
- High-volume pools
- Prices stay in a narrow range

## When it does not:

- Volatile token pairs
- Low-volume pools
- Large price swings

**Stablecoin pairs (USDC/USDT) have near-zero IL. That is why they are popular LP positions.**

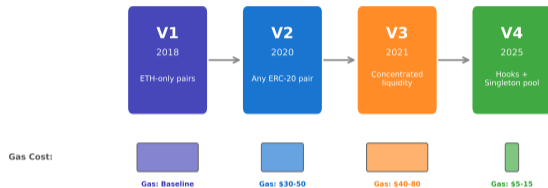
# Uniswap: The DeFi Exchange

**Uniswap** is the largest decentralized exchange. Launched in 2018 by Hayden Adams.

- Annual volume exceeded **\$1 trillion**
- Peak month: **\$116.6B** (Oct 2025)
- Deployed on 20+ chains
- Completely open-source

**V1** (2018): ETH-only pairs  
**V2** (2020): Any token pair  
**V3** (2021): Concentrated liquidity  
**V4** (Jan 30, 2025): Hooks + custom logic

## Uniswap Evolution: V1 to V4



V4 hooks enable custom logic per pool -- gas reduced by 99% via singleton architecture

**V1: ETH-only pairs. V2: Any token pair. V3: Concentrated liquidity. V4: Hooks and custom logic.**

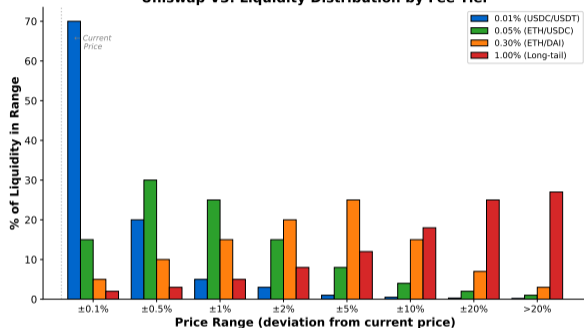
# Uniswap Fee Tiers

You choose your fee tier when providing liquidity:

Fee	Best For
mblue!10 0.01%	Stablecoins
mgreen!10 0.05%	Correlated pairs
mlorange!10 0.30%	Standard pairs
mlred!10 1.00%	Exotic tokens

Lower fee tiers attract more volume but earn less per trade. It is a trade-off.

Uniswap V3: Liquidity Distribution by Fee Tier



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	<b>AMM (Uniswap)</b>	<b>Order Book (Binance)</b>
<b>Price discovery</b>	Formula sets price	Bids and asks match
<b>Liquidity from</b>	Anyone can deposit	Professional market makers
<b>Speed</b>	Block time (12 sec)	Milliseconds
<b>Capital efficiency</b>	V3 concentrated ranges	Full range of prices
<b>Transparency</b>	Fully on-chain	Dark pools possible

### AMM Advantage

Permissionless. Anyone can list a token or provide liquidity. No gatekeepers.

### Order Book Advantage

Faster, more capital-efficient for high-volume pairs. Better for professional traders.

**Most crypto volume still goes through order books (CEXs). DEXs handle 12–21% of spot volume in 2026.**

# Other AMMs: Not Just Uniswap

Different AMM formulas work better for different token types.

## Curve (StableSwap)

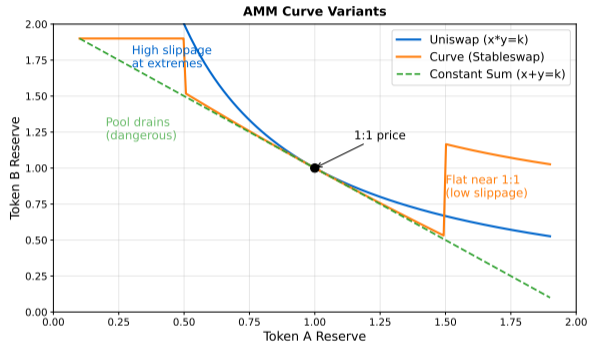
Optimized for similar-price tokens. \$2.2B TVL. Dominates stablecoin swaps.

## Balancer (Weighted Pools)

Pools with custom token weights (e.g., 80/20 instead of 50/50). Multi-token pools.

## PancakeSwap (BNB Chain)

Largest DEX on BNB Chain. Lower fees. Popular in Asia.



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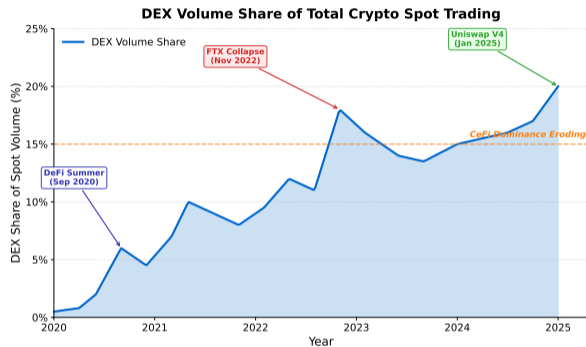
# DEX Volume Is Growing

## DEX-to-CEX spot volume ratio:

- 2020: DEXs handled under 1%
- 2023: DEXs crossed 15%
- 2026: DEX share at 12–21%

The shift is driven by:

- Self-custody after FTX collapse
- Better UX on Layer 2s
- Lower fees and faster confirmation



Uniswap alone: \$1T+ annual volume. Curve: specialized in stablecoin swaps.

# MEV: The Hidden Cost

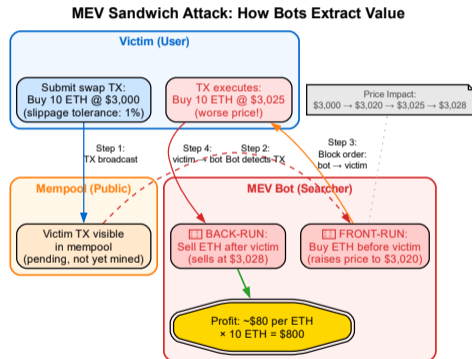
**MEV** = Maximal Extractable Value.

Invisible middlemen who reorder your transactions to profit.

## Sandwich attack:

1. Bot sees your pending trade
2. Bot buys before you (front-run)
3. Your trade executes at worse price
4. Bot sells after you (back-run)

\$3B+ extracted annually in 2026.



MEV is like someone seeing your restaurant order, buying the last ingredient, and selling it to you at markup.

# Your First Swap (Try It)

You can explore Uniswap without spending money.

**Step 1:** Visit [app.uniswap.org](https://app.uniswap.org)

**Step 2:** Connect wallet (read-only is fine)

**Step 3:** Select ETH → USDC

**Step 4:** Enter an amount and read the details



**What to look for:**

- Price impact (slippage)
- Fee tier being used
- Estimated gas cost

You can explore Uniswap without spending money. Just connect and browse.

# Key Takeaways

## Pools, Not Order Books

AMMs use liquidity pools instead of order books. A formula sets prices automatically after every trade.

## Fees vs IL

LPs earn fees on every trade but face impermanent loss. Only 37.2% of V3 positions were profitable.

## Pool Size = Slippage

Bigger pools mean less slippage. A \$200M pool barely moves on a \$1K trade. A \$100K pool moves a lot.

## Uniswap Leads

Uniswap is the largest DEX with \$1T+ annual volume. V4 launched January 30, 2025 with hooks.

Next: DeFi Lending — the automated pawn shop.

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## Quick Quiz (1–5)

**Q1. What is a liquidity pool?**

- A) A savings account at a bank mechanism    B) A smart contract holding two tokens for traders to swap against    C) An order book on Binance    D) A token airdrop mechanism

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**Answer: B** – Traders swap against the pool, not against another person.

### Q2. What happens to ETH price in a pool when someone buys ETH?

- A) It increases (less ETH in pool = higher price)   B) It decreases   C) It stays the same   D) It resets

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**Answer: A** – Less ETH in the pool means each remaining ETH is more expensive.

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**Answer: C** – Bigger trades cause more slippage because they move the pool ratio further.

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**Answer: B** – IL grows as the price ratio between the two tokens changes.

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**Answer: A** – V3 lets LPs concentrate their capital in specific price ranges for better efficiency.

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**Answer: A** – Stablecoin pairs have near-zero IL and high-volume pools generate more fees.

# Appendix

## Technical Deep Dives

The math behind the intuition

Click [blue links](#) in appendix slides to jump back to the main deck.

# A1: The Constant Product Rule

The AMM uses one elegant equation to set prices automatically:

$$x \cdot y = k$$

- $x$  = quantity of Token A in the pool (e.g., ETH)
- $y$  = quantity of Token B in the pool (e.g., USDC)
- $k$  = a constant that never changes during a trade

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**Spot price:** Price of ETH =  $\frac{y}{x} = \frac{\text{USDC in pool}}{\text{ETH in pool}}$

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**Spot price:** Price of ETH =  $\frac{y}{x} = \frac{\text{USDC in pool}}{\text{ETH in pool}}$

**Worked example:** Pool has 100 ETH + 200,000 USDC.  $k = 100 \times 200,000 = 20,000,000$

Spot price:  $\frac{200,000}{100} = 2,000$  USDC per ETH.

**Buy 10 ETH:** Pool now has 90 ETH. New USDC:  $\frac{20,000,000}{90} = 222,222$ . You pay:  $222,222 - 200,000 = 22,222$  USDC.

Average price:  $\frac{22,222}{10} = 2,222$  USDC/ETH. Slippage:  $\frac{2,222 - 2,000}{2,000} = 11.1\%$

← [Back to main slide: The Price Sets Itself](#)

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**Buying 10% of the pool's ETH costs you 11.1% above spot. This is why pool size matters.**

## A2: Slippage Formula

For a trade of size  $\Delta x$  in a pool of size  $x$ :

$$\text{Slippage} = \frac{\Delta x}{x - \Delta x}$$

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Examples with a 100 ETH pool:

Trade Size	$\Delta x$	Pool After	Slippage
Buy 1 ETH	1	99 ETH	$\frac{1}{99} = 1.01\%$
Buy 5 ETH	5	95 ETH	$\frac{5}{95} = 5.26\%$
Buy 10 ETH	10	90 ETH	$\frac{10}{90} = 11.11\%$
Buy 50 ETH	50	50 ETH	$\frac{50}{50} = 100\%$

Never buy more than 1–2% of a pool in a single trade.

[← Back to main slide: Why Big Trades Cost More](#)

**Slippage grows non-linearly with trade size. Splitting large trades across pools reduces total slippage.**

## A3: Impermanent Loss — The Formula

If the price ratio between two tokens changes by a factor  $r$ :

$$IL = \frac{2\sqrt{r}}{1+r} - 1$$

Where  $r = \frac{\text{new price}}{\text{original price}}$ .

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Where  $r = \frac{\text{new price}}{\text{original price}}$ .

**Worked example — ETH doubles ( $r = 2$ ):**

- Deposit: 1 ETH + 2,000 USDC (total: **\$4,000**)
- If held: 1 ETH at **\$4,000** + 2,000 USDC = **\$6,000**
- In pool: rebalances to 0.707 ETH + 2,828 USDC = **\$5,656**
- IL:  $\frac{2\sqrt{2}}{1+2} - 1 = \frac{2.828}{3} - 1 = -5.72\%$

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Price Change	$r$	$\sqrt{r}$	IL Formula	IL
1.25x	1.25	1.118	$\frac{2(1.118)}{2.25} - 1$	-0.6%
2x	2.0	1.414	$\frac{2(1.414)}{3.0} - 1$	-5.7%
5x	5.0	2.236	$\frac{2(2.236)}{6.0} - 1$	-25.5%

[← Back to main slide: The Catch: Impermanent Loss](#)

**IL depends only on the magnitude of price change, not the direction. A 2x increase and a 2x decrease produce the same IL.**

## A4: Concentrated Liquidity — How V3 Improves Capital Efficiency

In Uniswap V2, your liquidity is spread across **all prices from 0 to infinity**. Most of it is never used.

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**V3 idea:** LPs choose a **price range** (e.g., ETH between \$1,800 and \$2,200). All liquidity is concentrated in that range.

### V2: Full Range

- Liquidity spread 0 to  $\infty$
- Capital efficiency: low
- Simple to manage

**Effective liquidity for a trade:**

$$L = \sqrt{k} = \sqrt{x \cdot y}$$

### V3: Concentrated Range

- Liquidity in  $[p_a, p_b]$  only
- Capital efficiency: up to 4,000x
- Requires active management

**Virtual liquidity:**

$$L_{\text{virtual}} = L \cdot \frac{\sqrt{p_b}}{\sqrt{p_b} - \sqrt{p_a}}$$

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**Example:** Concentrating in a  $\pm 10\%$  range around current price gives **21x** more capital efficiency. Same fees earned with 21x less capital.

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**The trade-off:** concentrated positions earn more fees but suffer more IL if price moves outside the range.

## A5: The Cryptoeconomics Lens Applied to AMMs

Question	Applied to Automated Market Makers
1. Problem	How do we discover fair prices and enable trading without a centralized exchange or professional market makers?
2. Incentives	LPs earn fees for providing liquidity. Arbitrageurs keep AMM prices aligned with global markets. V4 hooks enable custom incentive logic.
3. Benefits/Costs	Benefits: permissionless token listing, 24/7 trading, transparent pricing. Costs: impermanent loss, MEV extraction, gas fees.
4. Failure Mode	Low liquidity enables manipulation. MEV extracts \$3B+ annually. Flash loan attacks can drain pools. Rug pulls on new tokens.
5. Design	CPMM ( $x \cdot y = k$ ) vs StableSwap (Curve) vs concentrated liquidity (V3) vs weighted pools (Balancer). Each optimizes for different use cases.
6. Alternatives	Central limit order books (CEXs), request-for-quote systems (CoW Protocol), intent-based trading (UniswapX), hybrid on/off-chain matching.

These six questions are the “Cryptoeconomics Lens” — apply them to every blockchain topic you study.