

# DeFi Deep Dive: Advanced Charts and Mechanisms

## Supplementary Visuals for the DeFi Ecosystem Lecture

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## The main lecture covered:

- What DeFi is and the 4-layer stack
- AMM constant product formula
- Impermanent loss mechanics
- Lending, health factor, liquidation
- Stablecoin trilemma
- Terra/Luna collapse

## This addendum goes deeper:

- Infrastructure: oracles, MEV
- Strategies: yield farming, flash loans
- Governance: token concentration
- Systemic risk: composability graphs

## 10 new charts across 4 themes:

### 1. Infrastructure

Oracle price feeds, MEV extraction

### 2. Mechanisms

Yield farming, flash loan attacks, fee-tier liquidity, protocol revenue

### 3. Governance

Token distribution and whale power

### 4. Systemic Risk

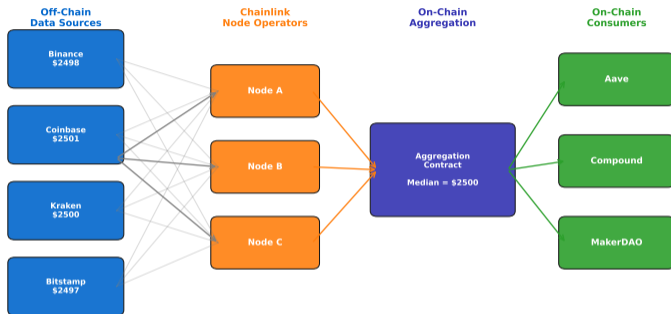
Composability dependencies, liquidation cascades, risk heatmap

*Each chart fills a teaching gap not covered by the main lecture's 12 charts.*

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This addendum uses 6 matplotlib charts and 4 graphviz diagrams — the project's first graphviz-based visualizations.

# Oracle Price Feed Architecture

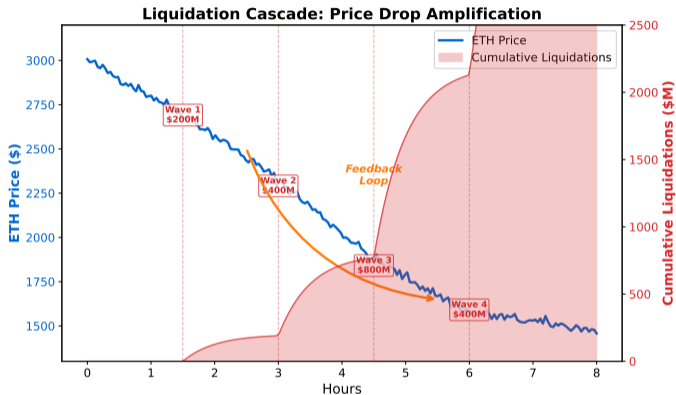


Heartbeat: 1 hour | Deviation threshold: 0.5%

- **What you see:** Four layers of the Chainlink oracle — off-chain data sources report prices, node operators aggregate them, the on-chain contract computes the median, and DeFi protocols consume the result
- **Key pattern:** The oracle is DeFi's single biggest trust assumption — every lending protocol, every liquidation, every stablecoin peg depends on accurate price feeds
- **Takeaway:** If the oracle reports a wrong price, liquidations fire on false data. Mango Markets lost \$114M to oracle manipulation in 2022

Chainlink's decentralized oracle network processes over 1 billion data points per year across 1,000+ price feeds.

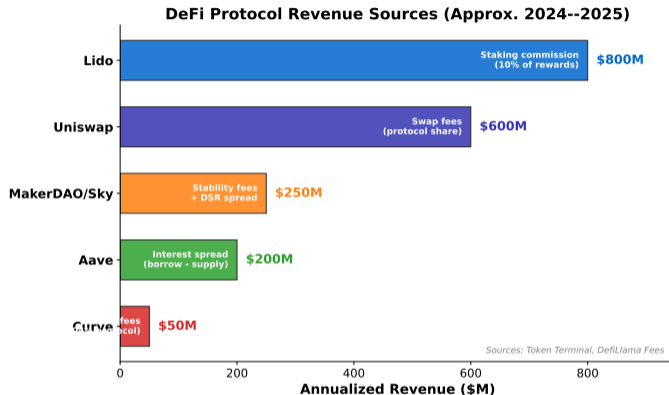
# Liquidation Cascade: Price Drop Amplification



- **What you see:** ETH price drops (blue line) trigger liquidation waves (red shaded area) — each wave of forced selling pushes the price lower, triggering more liquidations
- **Key pattern:** The feedback loop — liquidations create selling pressure that triggers more liquidations. This is the DeFi equivalent of a bank run
- **Takeaway:** \$1.8B in liquidations over 8 hours because each wave amplifies the next. Overcollateralization does not prevent cascades — it delays them

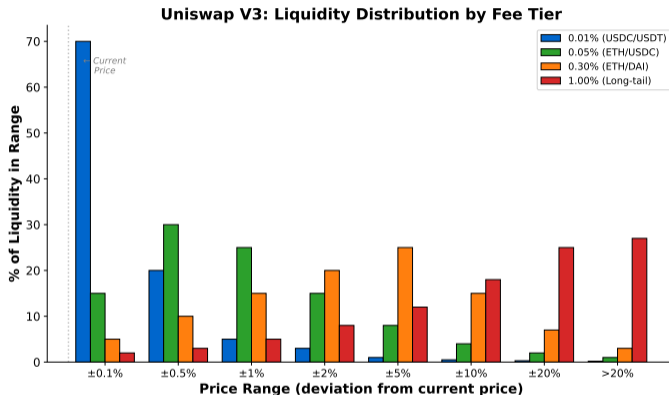
On May 19, 2021, over \$8.6B was liquidated across DeFi in 24 hours — the largest single-day cascade in DeFi history.

# Where Does DeFi Revenue Come From?



- **What you see:** Annualized revenue by protocol — Lido earns \$800M from staking commissions, Uniswap \$600M from swap fees, and lending protocols earn interest spreads
- **Key pattern:** The protocols with the highest revenue have the simplest business models — Lido takes 10% of staking rewards, Uniswap takes a share of trading fees
- **Takeaway:** Sustainable DeFi needs real revenue from economic activity, not token emissions. If the yield disappears when the token price drops, the yield was never real

Sources: Token Terminal, DefiLlama Fees. Figures are approximate annualized 2024–2025 data.



- **What you see:** Liquidity concentration varies dramatically by fee tier — the 0.01% tier (stablecoins) concentrates 70% of liquidity within  $\pm 0.1\%$  of the peg, while the 1% tier (exotic pairs) spreads across  $\pm 20\%$
- **Key pattern:** LPs self-sort by expected volatility — low-fee tiers attract concentrated liquidity for stable pairs; high-fee tiers attract wide-range positions for volatile pairs
- **Takeaway:** Fee tier choice is a risk signal — it reveals how volatile LPs expect the pair to be

Uniswap V3's concentrated liquidity model allows LPs to provide up to 4,000x more capital efficiency than V2's full-range positions.

# Yield Farming: Composability as a Strategy

**What is yield farming?** Chaining protocols to maximize returns. Each "hop" adds yield AND risk.

**A typical 5-hop strategy:**

1. Deposit ETH into Lido → staking yield
2. stETH as collateral in Aave
3. Borrow USDC against stETH
4. LP on Curve → trading fees
5. Stake LP on Convex → boosted CRV + CVX

**The yield stack:**

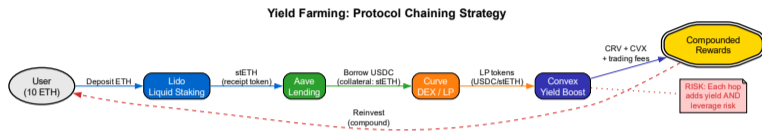
| Source        | APY          |
|---------------|--------------|
| Lido staking  | 3.5%         |
| Aave supply   | 0.5%         |
| Curve fees    | 2.0%         |
| CRV emissions | 5.0%         |
| CVX boost     | 3.0%         |
| <b>Total</b>  | <b>14.0%</b> |

**The catch:** 11% of 14% comes from token emissions, not economic activity. When emissions decrease, strategy collapses.

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**Yield farming peaked during "DeFi Summer" (2020) with APYs over 1,000%. Most were unsustainable.**

# Yield Farming: Protocol Chaining Flow



- **What you see:** A directed graph showing how a yield farming strategy chains 4 protocols — Lido, Aave, Curve, and Convex — with token flows on each edge
- **Key pattern:** Each hop transforms one token into another (ETH → stETH → collateral → USDC → LP tokens → boosted rewards) and adds both yield and risk
- **Takeaway:** Yield farming is composability weaponized — the reinvestment loop creates leverage without explicit borrowing

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If any protocol in the chain fails (e.g., stETH depegs), the entire strategy unwinds. Composability is contagion.

# Flash Loan Attack: Beanstalk Governance (\$182M)

## Flash Loan Attack: Beanstalk Governance Attack (\$182M)



- **What you see:** Seven steps inside a single atomic transaction — the attacker borrows \$1B, acquires governance power, votes to drain the treasury, and repays the loan
- **Key pattern:** The dashed border is the key — everything happens in one block. If any step fails, the entire transaction reverts and the attacker loses nothing except gas
- **Takeaway:** Flash loans compress time — you can temporarily become the largest token holder, execute governance, and disappear in 12 seconds

The Beanstalk attack (April 2022) was executed in a single Ethereum transaction. The attacker's total cost was approximately \$900K in fees.

# MEV: The Invisible Tax on Every Trade

## What is MEV?

Maximal Extractable Value (MEV) is the profit bots extract by reordering, inserting, or censoring transactions within a block.

## Three forms of MEV:

1. **Arbitrage** — exploit price differences across DEXs (beneficial)
2. **Liquidation** — race to liquidate positions (extractive)
3. **Sandwich attacks** — front-run and back-run a user's trade (purely extractive)

## MEV by the numbers:

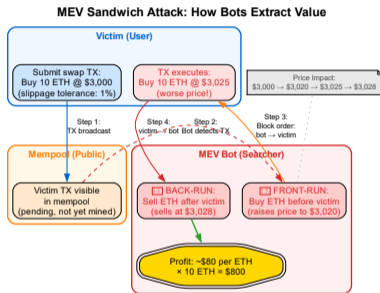
| Metric                   | Value       |
|--------------------------|-------------|
| Cumulative MEV extracted | \$600M+     |
| Daily sandwich attacks   | 2,000–5,000 |
| Avg. cost to victim      | \$5–\$50    |
| MEV as % of gas fees     | 10–15%      |

**Mitigation:** Private mempools (Flashbots Protect), intent-based trading (CoW Protocol), encrypted mempools.

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MEV is “the invisible tax” on DeFi users. Flashbots estimated over \$600M extracted on Ethereum through 2024.

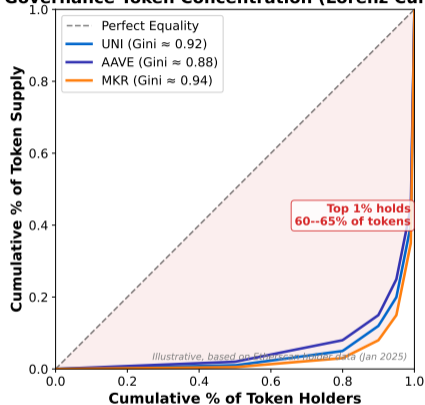
# MEV Sandwich Attack: How Bots Extract Value



- **What you see:** Three actors — victim submits swap, bot detects it in mempool, front-runs (buys, raises price), victim executes at worse price, bot back-runs (sells higher)
- **Key pattern:** The mempool is a public waiting room — bots read your transactions before they execute
- **Takeaway:** \$800 per attack × thousands daily = significant hidden cost for DeFi users

**Protection:** Flashbots Protect (private mempool), tight slippage limits, or intent-based DEXs like CoW Protocol.

## Governance Token Concentration (Lorenz Curves)



- **What you see:** Lorenz curves for UNI, AAVE, and MKR governance tokens — all far below the equality line, with Gini coefficients of 0.88–0.94
- **Key pattern:** The top 1% of token holders control 55–65% of voting power. “Decentralized governance” in practice means governance by a small number of whales, VCs, and the founding team
- **Takeaway:** Token-weighted voting concentrates power. Alternatives: quadratic voting, delegation, conviction voting, or time-weighted governance

Illustrative distribution based on Etherscan holder data (Jan 2025). Gini coefficients are approximate.

## The composability paradox:

Composability is DeFi's greatest strength (anyone can build on anyone else's protocol) and its greatest vulnerability (failure propagates through every connection).

## Hub protocols create systemic risk:

- **Chainlink** feeds prices to 90%+ of lending protocols. If Chainlink fails, mass liquidations fire on bad data.
- **USDC** is collateral in Aave, Compound, Maker, and liquidity in Uniswap, Curve. Circle's banking crisis (March 2023) briefly depegged USDC and cascaded across DeFi.
- **Lido's stETH** is used as collateral across the ecosystem. A stETH depeg would trigger cascading liquidations.

## Contagion channels:

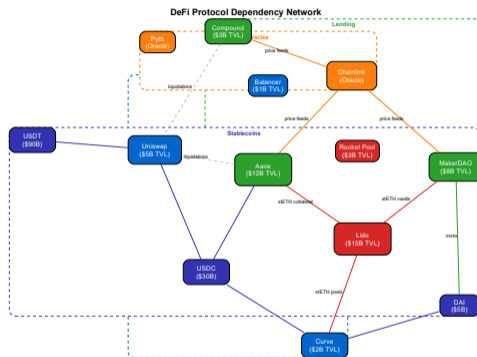
1. **Price contagion** — oracle failure or asset depeg cascades through all protocols using that asset
2. **Liquidity contagion** — LPs withdraw from one protocol, reducing depth for all connected protocols
3. **Governance contagion** — a governance attack on one protocol can drain assets deposited from others

**Key insight:** DeFi has recreated the "too interconnected to fail" problem from traditional finance — but without a central bank as lender of last resort.

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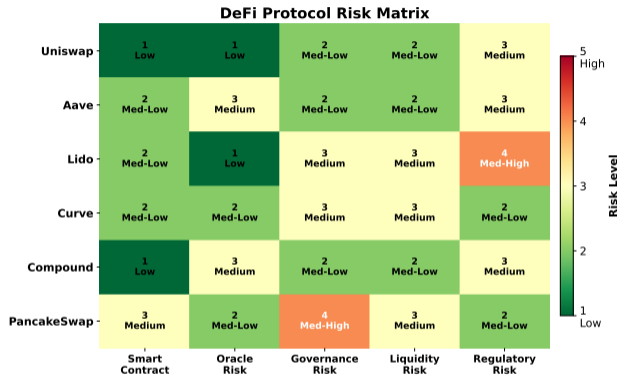
The Silicon Valley Bank crisis (March 2023) caused USDC to depeg to \$0.87, triggering \$2B in DeFi liquidations in 48 hours.

# DeFi Protocol Dependency Network



- **What you see:** A network graph of major DeFi protocols grouped by category (DEXs, Lending, Oracles, Stablecoins) with edges showing dependencies — price feeds, collateral flows, and liquidation paths
- **Key pattern:** Chainlink, USDC, and Lido are hub nodes — they connect to nearly everything. A failure at any hub cascades across the entire network
- **Takeaway:** DeFi is not a collection of independent protocols — it is a tightly coupled system where composability creates hidden systemic risk

This graph is simplified — the real DeFi dependency network has thousands of edges across hundreds of protocols.



- **What you see:** A risk heatmap scoring 6 protocols across 5 dimensions — smart contract, oracle, governance, liquidity, and regulatory risk (1=low, 5=high)
- **Key pattern:** No protocol is uniformly safe — Uniswap has low smart contract risk but medium regulatory risk; Aave has low code risk but high oracle dependency; Lido has significant governance concentration
- **Takeaway:** Risk is multidimensional. A protocol can be secure in its code but vulnerable in its governance, oracle dependency, or regulatory exposure

Risk scores are illustrative assessments based on audit history, oracle dependency, governance structure, TVL concentration, and regulatory scrutiny.

# Connecting the Dots: From Infrastructure to Systemic Risk

## The chain of dependencies:

1. **Oracles** provide prices for health factors
2. **Health factors** trigger liquidations
3. **Liquidations** create selling pressure
4. **Price drops** affect all connected protocols
5. **Composability** = contagion

This is a feedback loop. Each step amplifies the next.

## Defense mechanisms:

- **Circuit breakers** — pause during volatility
- **Isolated markets** — contain contagion per pool
- **Multi-oracle** — 3+ sources, median filtering
- **Gradual liquidation** — Dutch auctions
- **Insurance** — Nexus Mutual, InsurAce

*Goal: contain cascades before they become systemic.*

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After the 2022 cascade (Terra → 3AC → Celsius → FTX), most major protocols added circuit breakers and isolated markets.

## Five ideas from this addendum:

1. **Oracles are DeFi's single point of trust.** Every lending protocol, every liquidation, every stablecoin peg depends on accurate price feeds. If the oracle is wrong, DeFi breaks.
2. **Yield farming is composability weaponized.** Chaining protocols multiplies yield AND risk. Most “high APY” strategies depend on unsustainable token emissions.
3. **Flash loans compress time.** You can temporarily command \$1B in capital, execute governance, and disappear — all in one block. This is a financial instrument impossible in TradFi.
4. **Governance is concentrated, not decentralized.** The top 1% of token holders control 55–65% of voting power. “Decentralized governance” is aspirational, not actual.
5. **Composability creates systemic risk.** DeFi has recreated the “too interconnected to fail” problem — hub protocols (Chainlink, USDC, Lido) are single points of failure for the entire ecosystem.

*Review question: Which hub protocol's failure would cause the most widespread DeFi cascade, and why?*

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These five insights complement the main lecture's 7 takeaways. Together they form a complete DeFi risk framework.

## What we covered:

This addendum explored 10 aspects of DeFi not visualized in the main lecture:

1. Oracle architecture
2. Liquidation cascades
3. Protocol revenue models
4. Fee-tier liquidity distribution
5. Yield farming strategies
6. Flash loan attack anatomy
7. MEV sandwich attacks
8. Governance concentration
9. Protocol dependencies
10. Multi-dimensional risk

## Connection to main lecture:

The main lecture taught you *how DeFi works*. This addendum showed you *what can go wrong* and *how the pieces connect*.

## The meta-lesson:

DeFi is not 200 independent protocols. It is a single interconnected system where oracles feed prices to lending protocols, lending protocols generate liquidations, liquidations move markets, and market moves cascade through every protocol.

## Next: Module F — Advanced Topics

Layer 2 scaling, cross-chain bridges, smart contract security, and formal verification — the tools being built to make DeFi safer and faster.

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Use the 6-Question Framework from the main lecture to evaluate any DeFi protocol. These 10 charts give you the visual vocabulary to understand the answers.