DeFi Lending: Banking Without Banks

Module 3: The Trust Problem

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Digital Finance — BSc Course

Standalone lecture — explores how DeFi lending protocols replace banks with smart contracts.

Why does a bank loan cost 6–8% interest and take two weeks to approve?

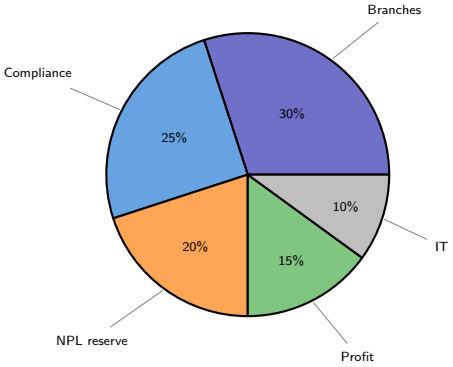
The traditional lending process:

- Application with income proof and credit history
- Credit scoring and manual underwriting (5–15 business days)
- Loan agreement, legal review, disbursement
- Ongoing monitoring and collection

Where your interest payment goes:

- **Branch network:** physical offices, staff, ATMs
- **Compliance:** KYC, AML checks, regulatory reporting
- **Non-performing loan (NPL) provisions:** reserves for defaults
- **Profit margin:** shareholder returns
- **Net interest margin:** difference between deposit and loan rates

Key insight: Most of the cost is operational overhead, not the actual risk of lending.



Typical bank cost breakdown (stylized teaching example). Over half the cost is operations, not credit risk.

Banks are expensive because they bundle lending with branch networks, compliance departments, and loss reserves — DeFi strips these away.

Imagine getting a $10,000 loan in 12 seconds — no paperwork, no credit check

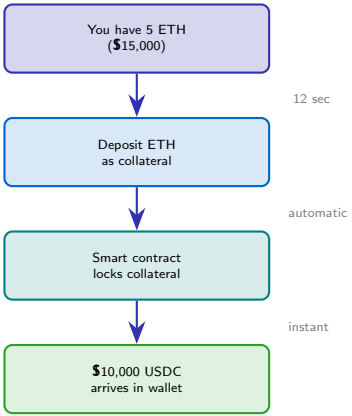
The scenario:
You own $15,000 in ETH (ETH is the native token of the Ethereum blockchain, used as collateral and to pay transaction fees). You need $10,000 cash for an emergency. You do not want to sell your ETH because you believe the price will rise.

At a bank:

- Apply for a secured loan against your crypto (few banks accept this)
- Wait 5–15 business days for approval
- Pay 6–8% annual interest plus origination fees

With DeFi lending:

- Connect your wallet to a lending protocol
- Deposit your ETH as collateral
- Borrow USDC instantly (USDC is a **stablecoin** — a cryptocurrency pegged to the US dollar, issued by Circle) — no identity check, no waiting
- Pay 2–4% annual interest (variable)
- Repay any time to unlock your ETH



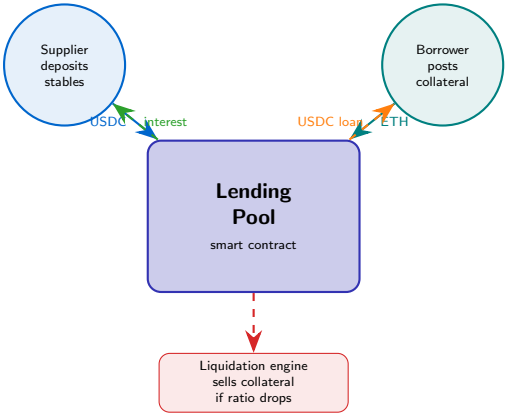
Speed: Transaction confirms in one block (~12 seconds on Ethereum).

DeFi replaces weeks of paperwork with a single blockchain transaction — but you need crypto collateral worth more than your loan.

How does DeFi lending work without credit officers, branches, or identity checks?

Definition: DeFi Lending

A system where smart contracts automatically match suppliers (depositors earning interest) with borrowers (who post crypto collateral), with interest rates set algorithmically based on pool utilisation.



Three core mechanisms:

1. **Overcollateralisation:** Borrow less than you deposit (typically 50–75% of collateral value)
2. **Algorithmic interest rates:** Rates rise as pool utilisation increases, attracting more deposits
3. **Automatic liquidation:** If collateral value drops below threshold, the protocol sells it to repay the loan

Why no credit check?
The collateral *is* the credit. If you default, the protocol keeps your collateral. No trust in the borrower is needed.

Key insight: DeFi replaces trust in people with trust in collateral and code.

Suppliers earn interest, borrowers get liquidity, and the smart contract enforces rules automatically — no bank needed.

How did Aave become a $10B+ lending protocol with 0.1% fees?

Aave at a glance (early 2026; Source: DeFi Llama):

- Founded 2017 by Stani Kulechov (Finland)
- Total Value Locked (TVL): $20B+ (defillama.com/protocol/aave)
- Deployed on Ethereum, Polygon, Arbitrum, Optimism, Avalanche
- Supports 100+ assets as collateral
- Governed by AAVE token holders

Fee comparison:

- **Traditional bank:** 2–5% origination fee + 6–8% APR
- **Aave:** 0.1% flash loan fee, or variable borrow APR (typically 2–5%)
- **Savings:** No origination fee, no branch overhead

Innovation — flash loans:
Borrow any amount, use it, and repay within a single transaction block. If repayment fails, the entire transaction reverts. Fee: 0.09%.

Key insight: Aave processes more lending volume per employee than any bank in history.

Feature	Bank	Aave
Approval time	5–15 days	12 seconds
Credit check	Required	None
Origination fee	2–5%	0–0.1%
Borrow APR	6–8%	2–5%
Collateral type	Property	Crypto
Deposit insurance	Yes	No
24/7 access	No	Yes
Min. loan size	$1,000+	$1
Employees	Thousands	<100

Flash loans — unique to DeFi — allow instant, uncollateralised borrowing for arbitrage and liquidation. No equivalent exists in traditional finance.

Aave demonstrates that smart contracts can replicate core bank lending functions at a fraction of the cost — but without deposit insurance.

Worked example: deposit ETH, borrow USDC, and track your liquidation price

Setup:

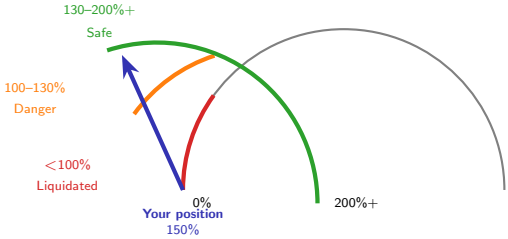
- You deposit **10 ETH** at \$3,000/ETH = **\$30,000 collateral**
- Protocol requires 150% collateralisation ratio
- Maximum borrow = \$30,000 / 1.5 = **\$20,000 USDC**

Your position:

- Collateral: \$30,000 (10 ETH)
- Debt: \$20,000 USDC
- Health factor: 30,000 / 20,000 = **1.50**
- Liquidation threshold: health factor < 1.0

Liquidation price calculation:

- Liquidation when: 10 ETH $\times$ price $\times$ 0.825 = \$20,000
- (0.825 = liquidation threshold for ETH on Aave)
- ETH price at liquidation = \$20,000 / (10 $\times$ 0.825) = **\$2,424**
- If ETH drops from \$3,000 to \$2,424 (a 19% drop), you get liquidated



ETH price	Health factor
\$3,000	1.50 (safe)
\$2,800	1.40
\$2,600	1.30 (caution)
\$2,424	1.00 (liquidation)

Warning: Borrowing the maximum is dangerous. A 20% price drop triggers liquidation plus a penalty (typically 5–10%).

Collateral ratio = collateral value / debt. Below 100% the protocol sells your collateral automatically — you lose your ETH plus a penalty.

What happens when DeFi lending goes wrong — and it has, spectacularly

March 2020 — Black Thursday:

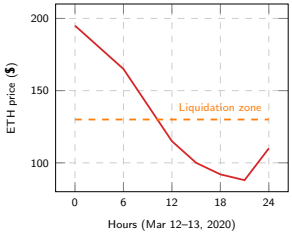
- ETH crashed 43% in 24 hours
- MakerDAO liquidation auctions failed due to network congestion
- Some vaults liquidated at $0 bids — borrowers lost everything
- $8.3 million in undercollateralised debt created

March 2023 — Euler Finance hack:

- $197 million stolen via flash loan exploit
- Attacker manipulated donation function in smart contract
- Funds later returned after on-chain negotiation

Systemic risks:

- **Oracle manipulation:** price feeds can be exploited
- **Smart contract bugs:** code is law, but code has bugs
- **Liquidation cascades:** mass selling drives prices lower
- **No deposit insurance:** if the protocol fails, you lose everything
- **Regulatory uncertainty:** no legal recourse in most jurisdictions



Failure	Root cause
Black Thursday	Network congestion broke auctions
Euler hack	Flash loan + code bug
Oracle attack	Manipulated price feed

DeFi removes human intermediaries but introduces smart contract risk, oracle risk, and liquidation cascades — failure modes that do not exist in traditional banking.

Where is DeFi lending today — $30B+ in deposits across multiple chains?

Market size (early 2026; Source: DeFi Llama):

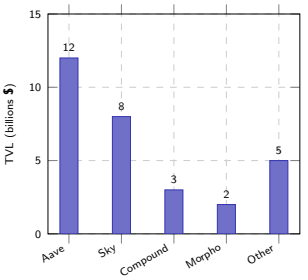
- Total DeFi lending TVL: $40B+ (defillama.com/lending)
- Aave: ∼$20B TVL, deployed on 7+ chains
- Compound: ∼$2–3B TVL, Ethereum-focused
- Sky (formerly MakerDAO): ∼$5–7B TVL, DAI stablecoin issuer
- Morpho, Spark, Venus: growing alternatives

Institutional DeFi:

- **Aave Arc:** permissioned pool with KYC for institutions
- **Compound Treasury:** fixed 4% yield for corporates
- **Centrifuge:** real-world asset lending on-chain

Multi-chain expansion:

- Layer 2 rollups (Arbitrum, Optimism) reduce gas costs 10–50x
- Cross-chain lending emerging but risky (bridge exploits)



Trend: Aave dominates, but new protocols compete on specialisation (fixed rates, real-world assets, undercollateralised lending).

TVL fluctuates with crypto prices; source: DeFi Llama (defillama.com/lending).

Key insight: DeFi lending is moving from crypto-native speculation toward real-world assets and institutional capital.

DeFi lending has grown from zero to $30B+ in five years — faster adoption than online banking, but still 0.02% of global bank lending.

Who wins and who loses when lending moves from banks to smart contracts?

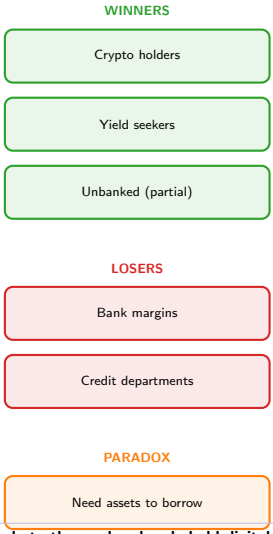
Winners:

- **Crypto holders:** borrow against assets without selling (tax event avoidance)
- **Yield seekers:** earn 2–8% on stablecoins vs 0–1% in bank savings
- **Unbanked populations:** access lending with no identity requirements
- **Developers:** build financial products without banking licences

Losers:

- **Bank lending margins:** DeFi compresses net interest margins
- **Credit departments:** overcollateralisation makes credit analysis irrelevant
- **Compliance industry:** permissionless protocols bypass KYC/AML

The nuance:
DeFi lending *only works for those who already have crypto assets.* You cannot get a DeFi mortgage to buy a house. Overcollateralisation means DeFi serves the already-wealthy, not the credit-constrained.



DeFi lending is cheaper and faster than banks — but it requires crypto collateral, making it accessible only to those who already hold digital assets.

So what? One sentence to remember about DeFi lending

DeFi lending replaces credit officers with collateral ratios — cheaper and faster, but only for those who already have crypto assets.

What it solves	What it does not solve	What comes next
Speed (seconds vs weeks)	Credit for the asset-poor	Undercollateralised DeFi
Cost (0.1% vs 2–5%)	Deposit insurance	Real-world asset lending
Access (24/7, global)	Legal recourse	Institutional adoption
Transparency (on-chain)	Regulatory clarity	Regulatory frameworks

DeFi lending is a genuine innovation in financial plumbing — but it complements rather than replaces traditional banking for most use cases.

Your turn: Is DeFi lending more or less inclusive than traditional banking?

Discussion Question

DeFi lending requires no credit check, no identity, no bank account. Anyone with a wallet and crypto collateral can borrow.

But: You need to already own crypto worth more than your loan.

Debate: *If DeFi does not require a credit check, is it more or less inclusive than traditional banking? Who benefits and who is excluded?*

Further Reading

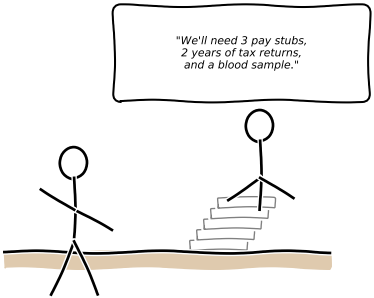
- Aave Documentation: `docs.aave.com`
- Gudgeon et al. (2020), "DeFi Protocols for Loanable Funds"
- Schär (2021), "Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets," *Federal Reserve Bank of St. Louis Review*

Reflection

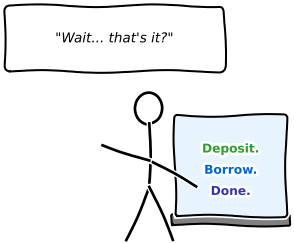
DeFi lending eliminates gatekeepers but creates new barriers. True financial inclusion requires more than removing the credit check.

Consider: who actually uses DeFi lending today — the unbanked, or crypto-wealthy traders seeking leverage and tax efficiency?

The Loan Officer



At the bank



On DeFi: 12 seconds

The future of borrowing: no paperwork, no humans, no waiting.

Getting a bank loan in 2024 still requires paperwork that would impress a medieval scribe.

Learning Objectives

After completing this lecture, you will be able to:

1. **Define** overcollateralisation and explain why DeFi lending requires it [Understand]
2. **Calculate** liquidation thresholds given collateral ratios and price movements [Apply]
3. **Trace** a DeFi lending transaction from deposit to repayment through a smart contract [Apply]
4. **Compare** DeFi and traditional lending on cost, speed, access, and risk [Analyze]
5. **Evaluate** whether DeFi lending truly delivers on its financial inclusion promise [Evaluate]

Bloom's levels covered: Understand, Apply, Analyze, Evaluate

Objectives follow Bloom's taxonomy — each maps to a specific skill you will practise in this lecture.

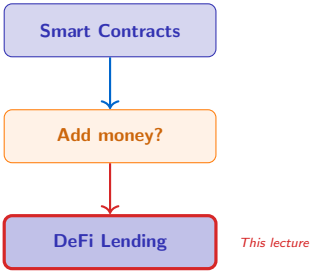
Bridge: From Smart Contracts to DeFi Lending

In Lesson 3.3 (Smart Contracts) you learned:

- Code can execute agreements automatically
- No human intermediary is needed once deployed
- Ethereum made programmable money possible

This lecture asks:

What happens when we use that code to build an entire lending system?



Smart contracts gave us programmable rules; DeFi lending is their most impactful financial application.

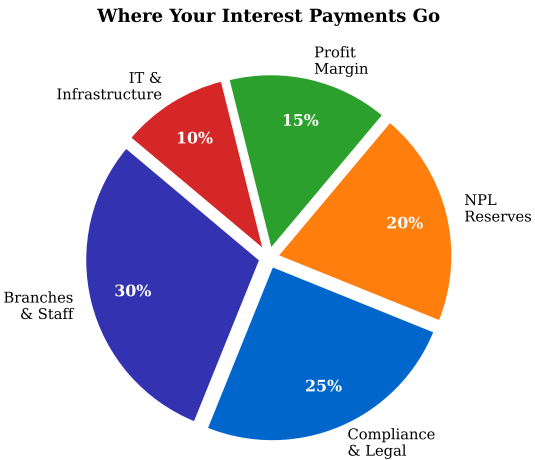
The Central Question

"What if you could borrow $10,000 in 12 seconds without a bank, a credit check, or a human being?"

That is not a thought experiment. It is happening right now, 24/7, on Ethereum.

Over $30 billion sits in DeFi lending protocols today — managed entirely by code (source: DeFiLlama, illustrative).

Why Banks Charge 6–8%



Source: McKinsey Global Banking Report (illustrative breakdown)

- **What you see:** A pie chart breaking down where your interest payments go when you borrow from a bank
- **Key pattern:** Only 15% of what you pay is the bank's profit — the rest covers physical branches, lawyers, and reserves for bad loans
- **Takeaway:** Banks are not greedy — they are expensive to run. That is the opportunity DeFi exploits

Source: McKinsey Global Banking Report (illustrative breakdown). Physical branches alone cost banks $50–80 billion per year globally.

The Interest Rate You Actually Pay

Key insight: The advertised rate is never the full cost.

Hidden Costs in a Typical Bank Loan

Fee Type	Typical Amount	DeFi Equivalent
Headline interest rate	6–8% APR	2–4% APR
Origination fee	1–2% of loan	0%
Processing fee	$200–500 flat	0%
Late payment penalty	$25–50 per event	Automatic
Insurance (PMI)	0.5–1% annually	None required
Effective cost	**8–12% first year**	**2–4%**

DeFi eliminates most of these because a smart contract has no office, no staff, and no paperwork.

DeFi's cost advantage comes from automation, not from taking more risk. The risk is managed differently — through overcollateralisation.

Three People Who Pay Too Much for Banking

Maria (São Paulo)

Freelance designer. No pay stubs. Bank rejected her loan application three times. She needs $5,000 to buy equipment.

Problem: No proof of steady income

James (London)

Saves £20,000 in a high-street bank. Earns 0.5% interest — below inflation. His purchasing power shrinks every year.

Problem: Savings lose value

Priya (Mumbai)

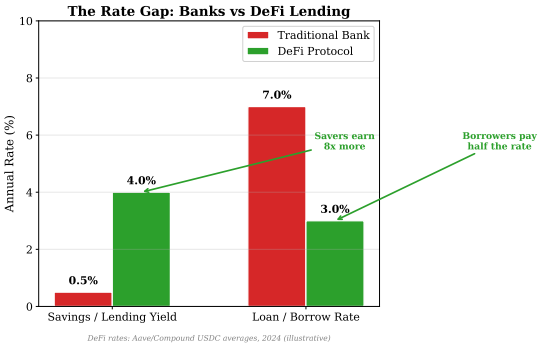
Crypto trader with 10 ETH. Needs cash for rent but does not want to sell her ETH (expects price to rise).

Problem: Liquidity without selling

Key insight: DeFi lending can help James and Priya today. Maria's case is harder — and that reveals DeFi's biggest limitation.

These three personas illustrate DeFi's real-world use cases and limitations. We will revisit them throughout this lecture.

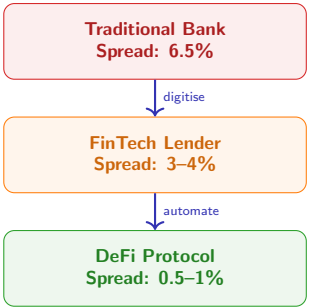
The Rate Paradox: Savers Get Pennies, Borrowers Pay Dollars



- **What you see:** Side-by-side comparison of bank and DeFi rates for both savers and borrowers
- **Key pattern:** Banks keep a 6.5 percentage point "spread" between what they pay savers (0.5%) and charge borrowers (7%). DeFi compresses this to roughly 1 percentage point
- **Takeaway:** DeFi lending pools connect savers and borrowers more directly — cutting out the bank's overhead

The bank "spread" (difference between deposit and loan rates) covers all the costs shown in the previous pie chart. DeFi eliminates most of them.

What If Code Could Do It for 0.1%?



Branches, staff, compliance

App, fewer staff, some compliance

Smart contract, no staff, no branches

Key insight: Each layer of automation removes a layer of cost. DeFi takes this to its logical conclusion: *what if the entire bank is just code?*

FinTech companies (Revolut, N26) started this trend. DeFi protocols (Aave, Compound) take it to the extreme.

How many of you have a savings account earning less than inflation?

If your bank pays 0.5% and inflation is 2–3%, your savings lose purchasing power every single day.

James's problem is your problem.

Raise your hand or type "yes" in the chat.

This is not a hypothetical — negative real interest rates have been the norm in Europe and the US since 2020.

What Is DeFi Lending?

Definition: DeFi Lending

Decentralised Finance (DeFi) lending is the use of smart contracts on a blockchain to create lending pools where anyone can deposit assets to earn interest, or borrow assets by posting collateral — without a bank, credit check, or human approval.

Three key differences from traditional lending:

1. **No credit check** — the smart contract does not care who you are; it cares what collateral you have
2. **Instant settlement** — borrow and receive funds in the same blockchain transaction (seconds, not days)
3. **Permissionless access** — anyone with a crypto wallet can participate, anywhere in the world, 24/7

Key insight: DeFi lending replaces the credit officer's judgment with a mathematical rule: "if collateral is worth more than the loan, approve it."

DeFi = Decentralised Finance. The term was coined around 2018 and refers to financial services built on public blockchains.

The Key Innovation: Overcollateralisation

Key insight: No credit check is needed because the borrower puts up *more* than they borrow.

Traditional Bank Mortgage:

- You want a $300,000 house
- Bank lends $240,000 (80%)
- You put down $60,000 (20%)
- Collateral ratio: 125%

DeFi Lending (e.g., Aave):

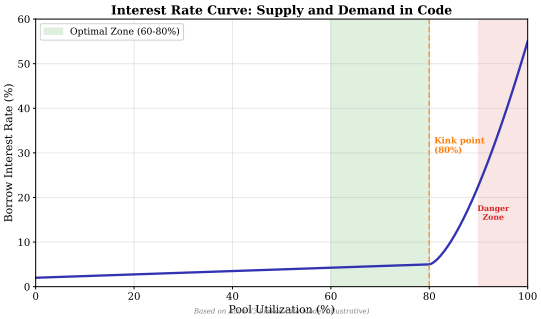
- You want to borrow $20,000
- You deposit $30,000 in ETH (150%)
- No income check, no documents
- Collateral ratio: 150%

Definition: Overcollateralisation

Posting collateral worth **more** than the amount borrowed. In DeFi, typical ratios range from 120% to 200%. This protects the lender even if the collateral's price drops.

Overcollateralisation is the single most important concept in DeFi lending — it replaces trust in the borrower with trust in mathematics.

How Interest Rates Are Set: Supply and Demand in Code

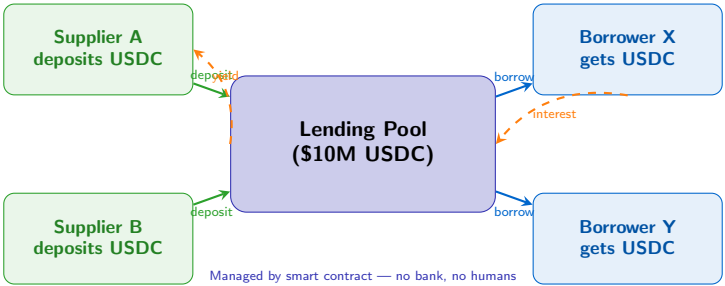


- **What you see:** A "kinked" curve showing how borrow rates change as the lending pool fills up
- **Key pattern:** Below 80% utilisation, rates stay low (2–5%) to encourage borrowing. Above 80%, rates spike sharply to attract new deposits
- **Takeaway:** No committee sets these rates — they emerge automatically from a formula written into the smart contract

Key insight: The "kink" at 80% acts like a thermostat — it keeps the pool in a healthy range automatically.

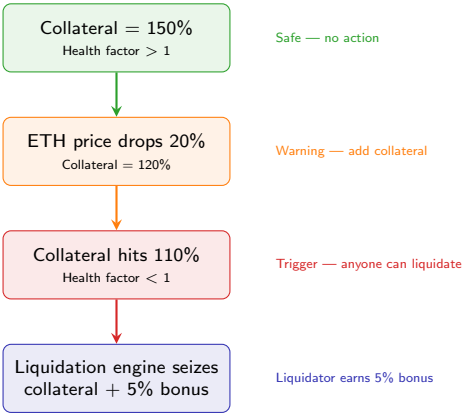
Aave V3 uses a "kinked" interest rate model. The kink point (optimal utilisation) varies by asset — typically 70–90%.

The Lending Pool: How Money Flows



Suppliers earn interest from borrowers. The smart contract sets rates automatically based on how much of the pool is being used (utilisation).

The Liquidation Mechanism: What Happens When Prices Drop



Definition: Liquidation

The automatic seizure and sale of a borrower's collateral when its value drops below the required threshold. In DeFi, third-party "liquidators" (bots) compete to perform this task and earn a bonus.

Liquidation protects suppliers from losses. The 5% bonus incentivises liquidator bots to act quickly, keeping the protocol solvent.

Case Study: Aave — $12B in Deposits, Minimal Operational Staff

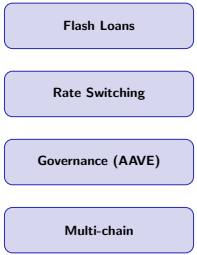
What is Aave?

- Founded 2017 by Stani Kulechov (Finland)
- Originally called "ETHLend" — peer-to-peer lending
- Pivoted to lending *pools* in 2020 (Aave V1)
- Now the largest DeFi lending protocol

By the numbers (early 2026):

- Total deposits: $20B+ (*DeFi Llama*, 2026)
- 7 blockchain networks supported
- 150+ assets available to borrow
- Protocol fee: 0.09% (vs bank's 2–5%)

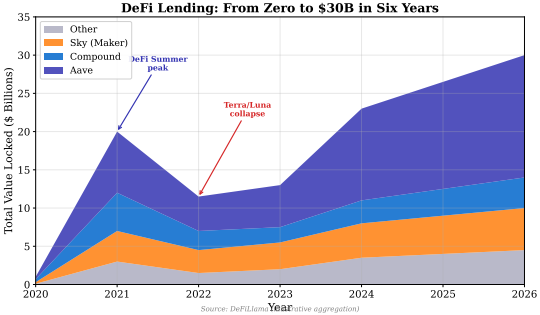
Aave V3 Features



"Aave" means "ghost" in Finnish — fitting for a bank with no physical presence.

Aave the protocol runs on-chain without a CEO or board. Aave Companies (the issuer/dev house) employs roughly 80 people for R&D, governance support, and compliance (LinkedIn, 2025). "Minimal staff," not "zero".

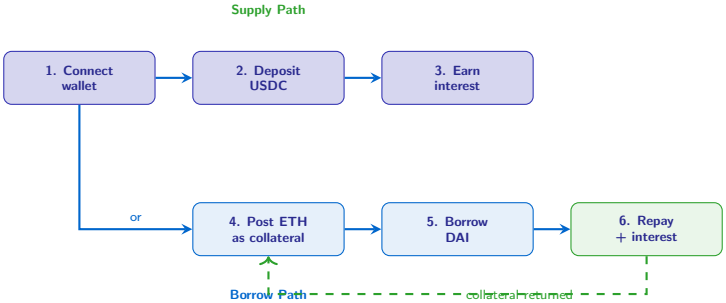
DeFi Lending Growth: From Zero to $30 Billion



- **What you see:** Stacked area chart showing Total Value Locked (TVL) in the four largest DeFi lending protocols from 2020 to 2026
- **Key pattern:** Explosive growth in "DeFi Summer" 2021, followed by a crash after Terra/Luna. Recovery began in 2023 and continues
- **Takeaway:** Despite a 50%+ crash, DeFi lending survived and grew back — suggesting real demand, not just speculation

TVL = Total Value Locked, the total amount of crypto deposited in a protocol. It is the closest equivalent to "assets under management" in traditional finance.

How Aave Works: Step by Step



Supply path: Deposit tokens, earn interest automatically.
Borrow path: Post collateral, borrow tokens, repay later to get collateral back.
Both paths: Managed entirely by a smart contract — no approval needed, no waiting.

Users can supply and borrow simultaneously. Supplied assets earn interest that offsets borrow costs — a strategy called "leverage looping."

Worked Example (1/3): The Setup

Priya wants to borrow $20,000 without selling her ETH.

Step-by-step

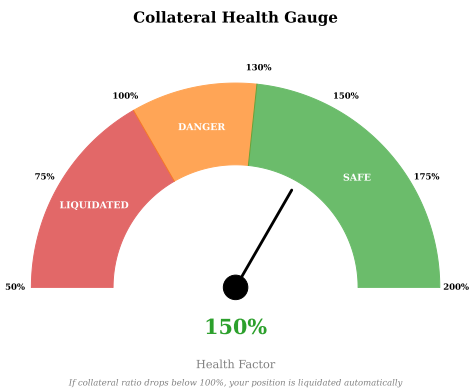
1. Priya owns **10 ETH** at the current price of **$3,000 per ETH**
2. Total collateral value: $10 \times \$3{,}000 = \$30{,}000$
3. She deposits all 10 ETH into Aave as collateral
4. Aave allows her to borrow up to 82.5% of collateral value (for ETH)
5. Maximum borrow: $\$30{,}000 \times 0.825 = \$24{,}750$
6. Priya borrows **$20,000 in USDC** (leaving a safety margin)

Collateral Ratio Calculation

$$\text{Collateral Ratio} = \frac{\text{Collateral Value}}{\text{Borrowed Amount}} = \frac{\$30{,}000}{\$20{,}000} = 150\%$$

The 82.5% loan-to-value ratio is specific to ETH on Aave V3. Stablecoins allow up to 93%; riskier tokens may allow only 65%.

Worked Example (2/3): Reading the Health Gauge



- **What you see:** A semicircular gauge showing Priya's collateral health at 150% — safely in the green zone
- **Key pattern:** Three zones — Green (safe), Orange (danger, add collateral), Red (liquidated, your collateral is seized)
- **Takeaway:** Priya has a 50 percentage point cushion. But if ETH drops 33%, she enters the danger zone

Health Factor

$$\text{Health Factor} = \frac{\text{Collateral} \times \text{Liq. Threshold}}{\text{Debt}}$$

If health factor < 1, liquidation begins.

Priya must monitor this gauge 24/7. If she is asleep when ETH crashes, her collateral can be liquidated before she wakes up.

Worked Example (3/3): When It Goes Wrong

What ETH price triggers Priya's liquidation?

Liquidation Price Calculation

1. Priya borrowed \$20,000 against 10 ETH
2. Aave's liquidation threshold for ETH: 82.5%
3. Liquidation happens when: ETH price $\times$ 10 $\times$ 0.825 = \$20,000
4. Solving: ETH price = $\frac{\$20{,}000}{10 \times 0.825}$ = \$2,424

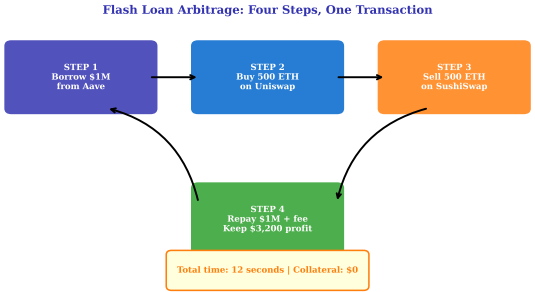
If ETH drops from \$3,000 to \$2,424 (a 19.2% drop), Priya's position gets liquidated.

What happens then:

- A liquidator bot repays part of Priya's debt
- The bot receives Priya's ETH at a 5% discount as reward
- Priya loses a portion of her collateral permanently
- This all happens automatically in seconds — no phone call, no warning

On Black Thursday (March 2020), ETH dropped 55% in 24 hours. Thousands of positions like Priya's were liquidated simultaneously.

What Are Flash Loans? Borrowing Millions for 12 Seconds



- **What you see:** A four-step flow where someone borrows $1 million, executes an arbitrage trade, and repays — all in one transaction
- **Key pattern:** Zero collateral required because the loan *must* be repaid within the same transaction. If repayment fails, the entire transaction reverts as if it never happened
- **Takeaway:** Flash loans are only possible on a blockchain — they exploit the "atomic" nature of transactions

Definition: Flash Loan

An uncollateralised loan that must be borrowed and repaid within a single blockchain transaction. If not repaid, the transaction automatically reverts.

Flash loans were invented by Aave in 2020. They have legitimate uses (arbitrage, collateral swaps) but have also been used in attacks.

Flash Loans in Numbers

Feature	Detail
Collateral required	$0 (zero)
Loan fee (Aave)	0.09% of amount borrowed
Maximum amount	Limited only by pool liquidity
Time to repay	Within the same transaction
Largest single flash loan	$200M+ (various protocols)
Daily volume	Multiple billions USD; varies daily (Source: DeFi Llama)

Key insight: Flash loans democratise access to large capital. Previously, only hedge funds with $100M+ could execute arbitrage. Now anyone who can write a smart contract can do it.

The dark side: Flash loans have been used to manipulate prices and exploit vulnerable protocols. We will cover this in Act 3.

Flash loans are unique to DeFi — they have no equivalent in traditional finance because banks cannot reverse a completed transfer.

Beyond Aave: Compound and Sky (formerly MakerDAO)

Compound

- Founded 2017, Robert Leshner (San Francisco)
- Pioneered the "cToken" model — you get receipt tokens when you deposit
- Simpler interest rate model than Aave
- Governed by COMP token holders
- TVL: $2–3B (*DeFi Llama*, 2026)

Sky (formerly MakerDAO)

- Founded 2015, Rune Christensen (Denmark)
- Creates DAI stablecoin through lending
- Borrowers mint DAI by locking collateral
- Rebranded to "Sky" in 2024
- TVL: $5–7B (*DeFi Llama*, 2026)

Key insight: All three protocols do fundamentally the same thing — pool-based, overcollateralised lending via smart contracts. They compete on rates, supported assets, and risk management.

Compound pioneered "yield farming" when it distributed COMP tokens to users in 2020 — sparking "DeFi Summer." Sky is unique because it creates its own stablecoin (DAI).

The Competitive Landscape: Traditional vs DeFi

Traditional Banking vs DeFi Lending

Dimension	Traditional Bank	DeFi Protocol
Cost	2-5% fees	0.1-0.5%
Speed	1-5 days	12 seconds
Access	Credit check required	Wallet only (permissionless)
Risk	FDIC insured	No deposit insurance

Green = advantage in that dimension | Red = disadvantage (illustrative comparison)

- **What you see:** A side-by-side comparison of traditional banking and DeFi lending across four dimensions
- **Key pattern:** DeFi wins on cost, speed, and access — but traditional banking wins on risk (deposit insurance, consumer protection)
- **Takeaway:** Neither system dominates across all dimensions. The "right" choice depends on what the user values most

This is the fundamental trade-off in DeFi: lower costs and broader access come at the price of less protection. There is no free lunch.

How DeFi Connects to Traditional Finance

Key insight: The boundary between DeFi and traditional finance is blurring.

- **Aave Arc** (2021): Permissioned version of Aave for institutions. Users must pass KYC (Know Your Customer) checks before accessing the protocol
- **MakerDAO / Sky**: Began investing its reserves in US Treasury bills in 2023 — a DeFi protocol buying traditional government debt
- **BlackRock (BUIDL)**: The world's largest asset manager launched a tokenised money market fund on Ethereum in 2024
- **JPMorgan (Onyx)**: Built a private blockchain for institutional lending — using the same pool-based mechanics as Aave

The trend: Institutions are not replacing DeFi — they are building bridges to it. The future likely combines the efficiency of DeFi with the consumer protection of traditional regulation.

"Institutional DeFi" adds identity verification (KYC/AML) to DeFi protocols. Critics argue this defeats the "permissionless" purpose.

Think-Pair-Share: Design a DeFi Product for Student Loans

Your Challenge (5 minutes)

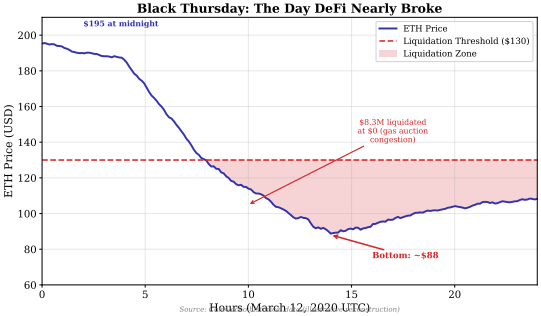
Design a DeFi lending product for **student loans**. Discuss with a partner:

1. **What collateral would you accept?** (Students typically have no crypto assets)
2. **What interest rate would you charge?** (And how would you set it?)
3. **Who bears the risk if the student drops out?**
4. **Is overcollateralisation feasible for students?** If not, what alternatives exist?

Hint: This exercise is intentionally hard. If you find yourself saying "this cannot work with DeFi's current design," you may be right — and that is an important insight about DeFi's limitations.

The inability to serve uncollateralised borrowers (like students) is DeFi lending's most fundamental limitation. Some protocols are experimenting with reputation-based lending.

Black Thursday: March 12, 2020



- **What you see:** ETH price crashing from $195 to $88 in 24 hours, with a red liquidation zone below $130
- **Key pattern:** The crash was so fast that Ethereum's network became congested — liquidation bots could not execute, and MakerDAO auctions cleared at $0
- **Takeaway:** DeFi's liquidation system works in normal markets but can fail catastrophically in extreme crashes

Black Thursday was DeFi's first major stress test. COVID-19 panic caused ETH to lose 55% in one day, exposing critical infrastructure weaknesses.

The $0 Liquidation: $8.3M Stolen by a Bug

What happened on Black Thursday (continued):

1. ETH price crashed so fast that thousands of positions needed liquidation simultaneously
2. Ethereum's network became congested — gas fees spiked 10x
3. MakerDAO's auction system required competitive bidding. But only one bidder showed up — because others' transactions failed due to high gas
4. That single bidder won $8.3 million in ETH collateral for a bid of **$0 DAI**
5. The system worked *exactly as coded* — but the outcome was catastrophic

Lesson: "Code Is Law" Has Consequences

The smart contract did not have a minimum bid requirement. Nobody had anticipated that network congestion would reduce the auction to a single bidder. The protocol paid $8.3M for this oversight.

MakerDAO later added minimum bid requirements and a circuit breaker. But the incident showed that "code is law" can mean "bugs are law" too.

Euler Finance: $197M Stolen in 2023

The attack (March 13, 2023):

1. Attacker used a flash loan to borrow $30M from Aave
2. Deposited into Euler and borrowed against it — creating artificial leverage
3. Exploited a vulnerability in Euler's "donate" function that allowed inflating collateral value
4. Drained $197 million from the protocol in a single transaction
5. Total time: approximately 30 seconds

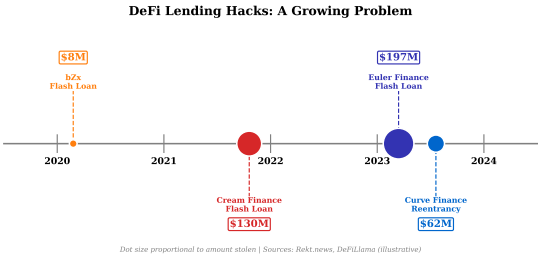
The aftermath:

- Euler negotiated with the attacker (who was later identified)
- $177M was returned over the following weeks
- The protocol relaunched with redesigned security in 2024

Key insight: The attack combined a flash loan (legitimate tool) with a code vulnerability (bug). Flash loans amplified the damage by giving the attacker capital they never had.

The Euler hack was the largest DeFi lending exploit in history. The attacker initially seemed anonymous but was later traced through on-chain analysis.

DeFi Lending Hack History

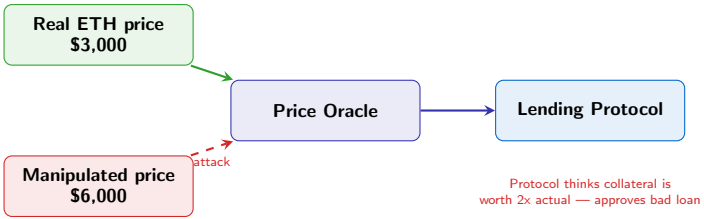


- **What you see:** Timeline of major DeFi lending hacks from 2020 to 2023, with dot sizes showing the amount stolen
- **Key pattern:** Attacks are getting larger — from $8M (bZx, 2020) to $197M (Euler, 2023). Flash loans are the common enabler
- **Takeaway:** DeFi protocols are getting more complex, and complexity creates more attack surface. Security audits help but cannot prevent all exploits

Total DeFi losses across all protocols exceeded $3 billion from 2020 to 2024 (source: Rekt.news, illustrative). Lending protocols account for roughly one-third.

Oracle Manipulation: Corrupting the Price Feed

Key insight: DeFi protocols need external price data ("oracles") to calculate collateral values. If the oracle lies, everything breaks.



Definition: Oracle

A service that feeds real-world data (e.g., asset prices) to blockchain smart contracts. The most widely used oracle network is Chainlink.

Oracle manipulation was the attack vector behind the Cream Finance ($130M) and bZx ($8M) exploits. Chainlink TWAP (time-weighted average price) oracles reduce but do not eliminate this risk.

No Deposit Insurance: "If Aave Gets Hacked, Your Money Is Gone"

Traditional banking safety net:

- FDIC (USA): Insures up to $250,000 per depositor
- FSCS (UK): Insures up to £85,000
- DGS (EU): Insures up to €100,000
- Central bank as lender of last resort
- Government bailouts (2008)

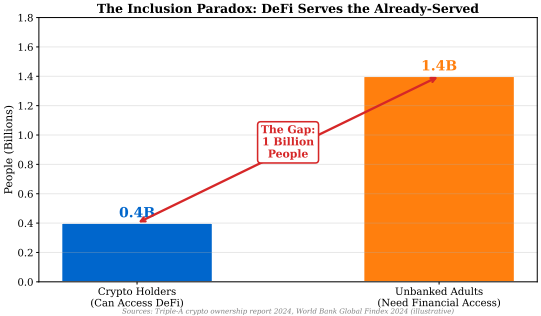
DeFi safety net:

- No government guarantee
- No deposit insurance
- No lender of last resort
- Protocol may have a "safety module" (Aave stakes AAVE tokens as a backstop) — but it covers only a fraction of total deposits
- Third-party insurance (Nexus Mutual) exists but is limited and expensive

The hard truth: Higher returns in DeFi exist *because* there is more risk. The extra yield is compensation for the possibility of total loss.

"Risk-free rate" in DeFi is a misnomer. Every DeFi yield carries smart contract risk, oracle risk, governance risk, and regulatory risk.

The Inclusion Paradox: DeFi Serves the Already-Served



- **What you see:** Bar chart comparing 400 million crypto holders who can access DeFi versus 1.4 billion unbanked adults who need financial services
- **Key pattern:** There is a 1 billion person gap. The people who *need* DeFi most cannot access it because they do not have crypto to use as collateral
- **Takeaway:** DeFi lending helps crypto-rich users get cheaper loans — it does not solve financial exclusion for the world's poorest

Remember Maria? She needs $5,000 for equipment but has no crypto. DeFi cannot help her today. This is DeFi's most uncomfortable truth.

Some projects (Goldfinch, Centrifuge) are building "undercollateralised" DeFi lending for emerging markets — but they add trusted intermediaries, partially defeating the "decentralised" purpose.

Regulatory Landscape: Who Controls What No One Controls?

Regulator	Position on DeFi Lending	Key Action
SEC (USA)	DeFi tokens may be securities	Sued several DeFi projects; BlockFi settled for $100M (2022)
MiCA (EU)	Comprehensive crypto regulation	Requires licensing for "crypto-asset service providers" from 2025
FINMA (Switzerland)	Pragmatic, case-by-case	Published DeFi guidance; allows regulated tokenisation
MAS (Singapore)	Innovation-friendly with guardrails	Project Guardian: institutional DeFi pilot with JPMorgan

Key insight: The fundamental regulatory question is: *who is responsible when a decentralised protocol fails?* If there is no company, no CEO, and no board — who do regulators hold accountable?

Emerging answer: Regulators are focusing on "front-end" operators (the websites) and "governance token holders" (who vote on protocol changes).

MiCA = Markets in Crypto-Assets Regulation (EU, 2025). It is the world's first comprehensive crypto regulatory framework.

DeFi Lending: Pros and Cons

Advantages	Disadvantages
Lower fees (0.1% vs 2–5%)	No deposit insurance
24/7 access, instant settlement	Smart contract bugs / hacks
Permissionless — wallet only	Overcollateralisation required
Transparent — all code is open	Oracle manipulation risk
Composable with other protocols	Regulatory uncertainty
Algorithmic, unbiased rates	Excludes the unbanked

A balanced assessment. DeFi lending is not "better" or "worse" than traditional banking — it is a different set of trade-offs suited to different users.

What DeFi Lending Does NOT Solve

1. **Unsecured lending** — You cannot borrow without collateral (except flash loans). Students, entrepreneurs, and the working poor are excluded
2. **Consumer protection** — No ombudsman, no complaints process, no chargebacks. If you send to the wrong address, your money is gone
3. **Financial literacy** — Using DeFi requires understanding wallets, gas fees, collateral ratios, and liquidation risk. Most people cannot do this yet
4. **Fiat on/off ramps** — You need crypto to use DeFi. Converting dollars to crypto still requires a centralised exchange (Coinbase, Binance) with KYC
5. **Systemic risk** — DeFi protocols are deeply interconnected. A failure in one (e.g., a stablecoin depeg) can cascade through the entire ecosystem

Key insight: DeFi optimises for *efficiency* and *access for crypto holders*. It does not optimise for *safety*, *simplicity*, or *inclusion of non-crypto users*.

These five limitations explain why DeFi has not (yet) replaced traditional banking — and may never fully do so. The future is likely hybrid.

Discussion: Is DeFi Lending Inclusive or Exclusive?

Debate Prompt (5 minutes)

"Is DeFi lending more inclusive or less inclusive than traditional banking? For whom?" Arguments for "more inclusive":

- No credit check, no discrimination, no geographic limits
- Anyone with a wallet can participate — no bank account needed

Arguments for "less inclusive":

- Requires crypto assets worth more than what you borrow
- Requires technical knowledge most people lack
- No consumer protection for mistakes

There is no "right" answer — the point is to understand that inclusion is not binary. DeFi shifts *who* is included and *who* is excluded.

This is an open-ended discussion. Listen to your classmates — the best insights come from disagreement.

Key Takeaways

1. **DeFi lending replaces banks with smart contracts** — depositors supply liquidity, borrowers post overcollateralised loans, and algorithms set interest rates
2. **Overcollateralisation is the key trade-off** — it eliminates credit checks but means you must already own more than you borrow
3. **Flash loans are a new primitive** — uncollateralised, atomic, and powerful for both legitimate arbitrage and malicious attacks
4. **DeFi is cheaper and faster, but riskier** — no deposit insurance, smart contract bugs, oracle manipulation, and regulatory uncertainty
5. **The inclusion promise is incomplete** — DeFi serves crypto holders well but cannot yet reach the 1.4 billion unbanked people who need it most

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These five points capture the essence of DeFi lending. If you remember nothing else, remember the trade-off: efficiency and access vs safety and inclusion.

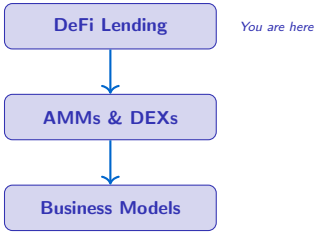
What Comes Next

In this lecture you learned:

- How DeFi lending pools work
- Overcollateralisation and liquidation
- Flash loans and their dual nature
- The inclusion paradox

Coming up in Module 3:

- **Lesson 3.4 (DeFi & Stablecoins):** Automated Market Makers (AMMs), impermanent loss, and tokenomics
- **Trustless Business Models lecture:** Six business models enabled by removing trust



DeFi lending is one piece of a larger DeFi ecosystem. Lesson 3.4 covers the "other half" — decentralised exchanges and automated market makers.

The One Sentence

"DeFi lending replaces credit officers with collateral ratios —

cheaper and faster, but only for those

who already have crypto assets."

If you remember only one sentence from this lecture, make it this one.

This sentence captures both the promise (efficiency) and the limitation (exclusion) of DeFi lending.

Further Reading

Primary Sources:

- **Aave Documentation:** `https://docs.aave.com` — Official protocol docs with technical details on interest rate models and governance
- **DeFiLlama:** `https://defillama.com` — Real-time TVL tracking for all DeFi protocols

Academic Papers:

- Gudgeon, L., Perez, D., Harz, D., Livshits, B., & Gervais, A. (2020). "DeFi Protocols for Loanable Funds." *The Decentralized Financial Crisis*. arXiv:2002.08099
- Schär, F. (2021). "Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets." *Federal Reserve Bank of St. Louis Review*, 103(2), 153–174

Further Exploration:

- **Rekt.news:** Post-mortem analyses of DeFi hacks
- **Compound Docs:** `https://docs.compound.finance` — Alternative interest rate model comparison

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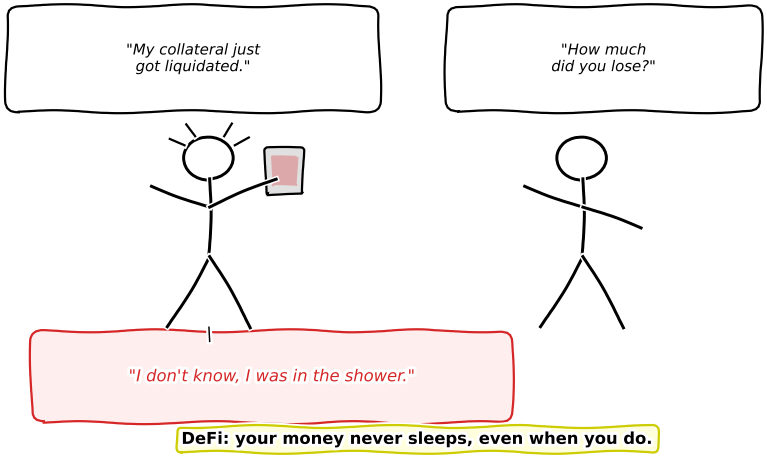
Start with the Schär (2021) paper — it provides the clearest academic overview of DeFi lending and is published by the Federal Reserve.

Collateral Issues



In DeFi, your money never sleeps — even when you do. Always set alerts and never overcollateralise more than you can afford to lose.

Appendix A: The 2022 CeFi Contagion — Why DeFi Lending Cannot Be Studied Alone

Most users experienced crypto-lending through Centralised Finance (CeFi) firms that looked like DeFi. Their simultaneous collapse in 2022 is the missing context for every over-collateralised DeFi pitch.

The domino chain (2022–23)

- **May 2022 — Terra / UST collapse:** $40B+ of token value destroyed (*Chainalysis, Elliptic post-mortems May 2022*, 2022) in ∼5 days (see M3L4 Appendix B)
- **Jun–Jul 2022 — Three Arrows Capital (3AC):** Luna-exposed fund defaulted on $3.5B of counterparty loans (*3AC liquidators' report 2022*, 2022) to crypto lenders
- **Jul 2022 — Celsius bankruptcy:** froze ∼$4.7B of customer deposits (*Celsius Chapter 11 filing SDNY Jul 13, 2022*, 2022); customers were creditors, not depositors; Alex Mashinsky arrested (Jul 2023), convicted (2024)
- **Jul 2022 — Voyager Digital bankruptcy:** ∼$1.3B assets frozen; acquired and wound down
- **Nov 2022 — FTX / Alameda collapse:** customer deposits commingled with hedge-fund trading; S. Bankman-Fried convicted on 7 fraud counts (Nov 2023)
- **Nov 2022 — BlockFi bankruptcy:** ∼$10B AUM at peak; depositors became creditors
- **Jan 2023 — Genesis Trading bankruptcy:** key counterparty to Gemini Earn users
- **Feb 2023 — Gemini Earn customers:** ∼$900M frozen (*SEC/NYAG complaints vs. Gemini + Genesis 2023*, 2023) through the Genesis counterparty exposure

The uncomfortable pattern: CeFi lenders branded as "crypto banks" with DeFi aesthetics; in reality they were *unregulated fractional-reserve intermediaries* with no deposit insurance, no prudential capital, no stress testing. When the collateral (LUNA, GBTC premium, altcoin loans) impaired, the classic **bank-run mechanics** played out at internet speed: withdrawal freezes within hours, equitable-subordination disputes for years.

Source: bankruptcy filings, SDNY dockets for Celsius/FTX/BlockFi; SEC complaints vs. Gemini/Genesis. See also "Crypto and the Blockchain Economy," FSB report 2023. DeFi lending should be taught alongside this story, not instead of it.

Appendix B: DeFi vs CeFi — When the Distinction Collapsed

The "pure protocol" narrative does not survive counterparty reality. The 2022 contagion flowed through the DeFi/CeFi boundary, not around it.

How the boundary broke

- **Celsius held large DeFi positions:** Aave, Compound, MakerDAO vault positions — its failure forced on-chain unwinds
- **FTX ran a DEX (Serum):** Serum's governance and liquidity provisioning depended on Alameda; when Alameda collapsed, the "pure DEX" became non-functional
- **GBTC arbitrage trade:** Genesis, 3AC, BlockFi all borrowed against Grayscale Bitcoin Trust shares; when the GBTC premium inverted, the trade blew up through CeFi *and* wound up at DeFi venues
- **stETH / Lido depeg (May–Jun 2022):** 3AC + Celsius were large stETH holders; forced selling into thin Curve liquidity triggered further de-peg

Concentration and governance risk in DeFi itself

- **Aave/Compound governance tokens** are held heavily by early VCs and the founding teams; vote turnout is low (see DAOs lecture Appendix B)
- **Oracle concentration:** most Aave/Compound markets use Chainlink as the sole price feed; a Chainlink incident propagates through the entire lending stack
- **Liquidity concentration:** a handful of stablecoin pools on Curve / Uniswap v3 absorb most stressed flow; when they de-peg, cascade
- **Admin keys** on most DeFi lending protocols can pause, upgrade, or blacklist

The honest teaching frame: DeFi *structurally* survived 2022–23 better than CeFi — Aave, Compound, and MakerDAO continued to function through the contagion, with liquidations clearing on-chain as designed. That is a real engineering achievement. But the contagion *reached* DeFi through counterparty exposures, oracle stress, and concentrated-liquidity break-points — not around it. "DeFi is immune to bank runs" is not what the 2022 data shows.

Read Gensler's Sep 2021 speech on CeFi-vs-DeFi + Aave / Compound on-chain records for the Q2–Q3 2022 window — you can watch the 3AC / Celsius unwind in real time in block-explorer data. That is unique to DeFi and genuinely valuable for research.