L37: Lending Protocols

Module E: DeFi Ecosystem

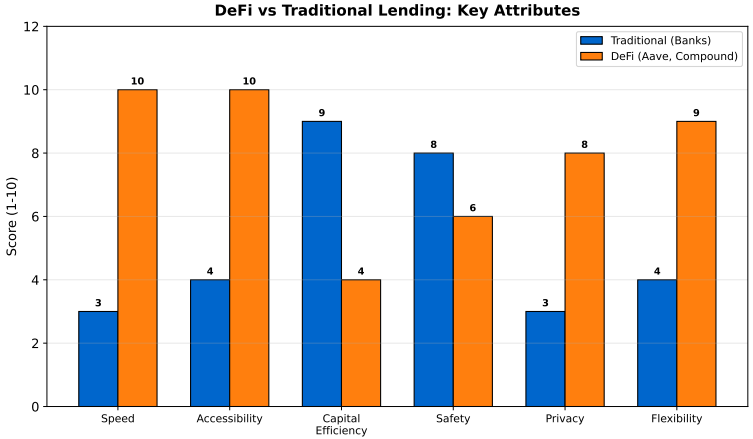
Blockchain & Cryptocurrency

December 2025

Learning Objectives

- Understand how DeFi lending protocols work (Aave, Compound)
- Analyze overcollateralization and its necessity
- Calculate health factors and liquidation thresholds
- Explore interest rate models (utilization-based)
- Compare DeFi lending to traditional finance

DeFi vs Traditional Lending



DeFi trades capital efficiency for accessibility and speed

Traditional vs DeFi Lending

Traditional Lending

- Credit checks, KYC required
- Undercollateralized possible
- Long approval process
- Geographic restrictions

DeFi Lending

- No credit checks
- Overcollateralized only
- Instant approval
- Global access, 24/7

Key Trade-off: DeFi accessibility vs. capital efficiency (must lock more than you borrow).

How DeFi Lending Works

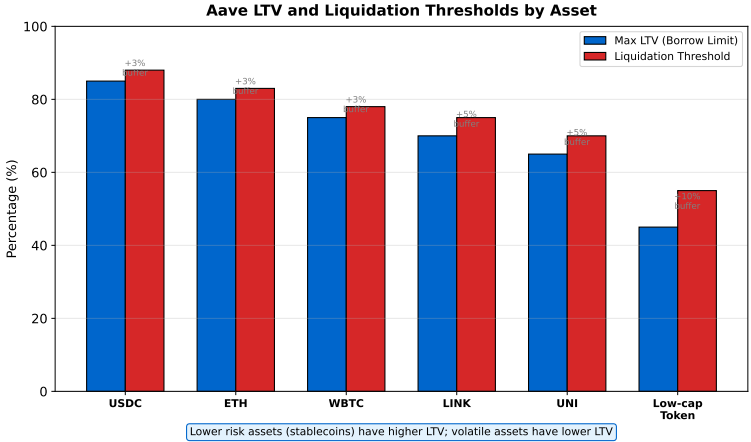
Core Mechanism:

1. **Lenders (Suppliers):** Deposit assets, earn interest (APY varies)
2. **Borrowers:** Deposit collateral, borrow up to LTV%, pay interest
3. **Protocol:** Matches via smart contracts, manages liquidations

Example: Borrowing on Aave

- Deposit 10 ETH ($20,000), receive aETH tokens
- ETH has 80% LTV: max borrow = $16,000
- Borrow $10,000 USDC (safe margin)
- Pay 5% APY on debt, earn 2% on collateral

LTV and Liquidation Thresholds



Buffer between LTV and liquidation threshold protects against immediate liquidation

Loan-to-Value (LTV) Explained

Definition:

$$\text{LTV} = \frac{\text{Borrowed Value}}{\text{Collateral Value}} \times 100\%$$

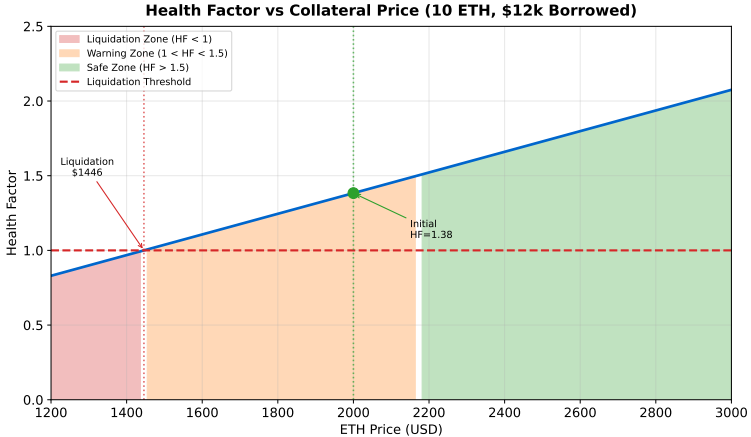
Why Different LTVs?

- Volatile assets = lower LTV (more buffer for price swings)
- Stable assets = higher LTV (minimal price risk)

Example Calculation:

- Collateral: 10 ETH at \$2,000 = \$20,000
- Borrowed: \$12,000 USDC
- LTV: $\frac{12,000}{20,000} = 60\%$ (safe, under 80% max)

Health Factor Dynamics



Health factor must stay above 1; monitor closely during volatility

Health Factor Calculation

Formula (Aave):

$$\text{Health Factor} = \frac{\text{Collateral Value} \times \text{Liquidation Threshold}}{\text{Borrowed Value}}$$

Interpretation:

- HF ¿ 1.5: Safe (comfortable buffer)
- HF 1.0-1.5: Warning zone
- HF ¡ 1: Liquidation occurs

Example:

- Collateral: $20,000 (ETH), Borrowed: $12,000
- Liquidation threshold: 83%
- HF $= \frac{20{,}000 \times 0.83}{12{,}000} = 1.38$ (safe)

Liquidation Process

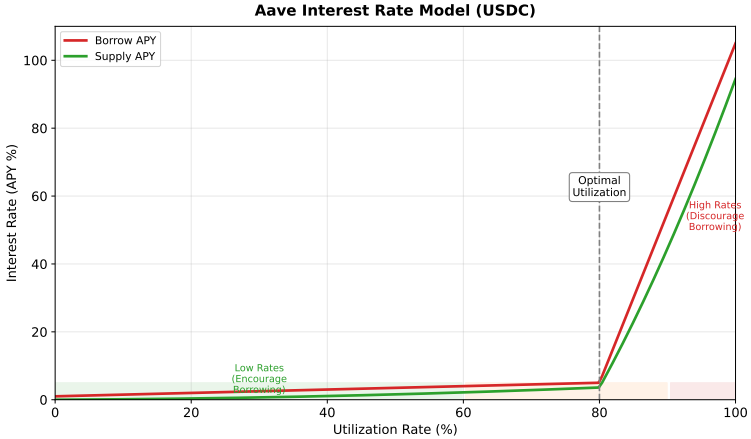
When Health Factor ¡ 1:

1. **Liquidator Bot Detects** unhealthy position
2. **Liquidator Repays** portion of debt (up to 50%)
3. **Liquidator Receives** equivalent collateral + 5-10% bonus
4. **Borrower Loses** liquidation penalty

Example:

- Debt: $12,000, Collateral: $14,460
- Liquidator repays 50% ($6,000), receives $6,300 in ETH
- Borrower loses $300 penalty (5%)

Interest Rate Model



High utilization triggers steep rate increase to prevent liquidity crises

Utilization-Based Interest Rates

Utilization Rate:

$$U = \frac{\text{Total Borrowed}}{\text{Total Supplied}}$$

Rate Behavior:

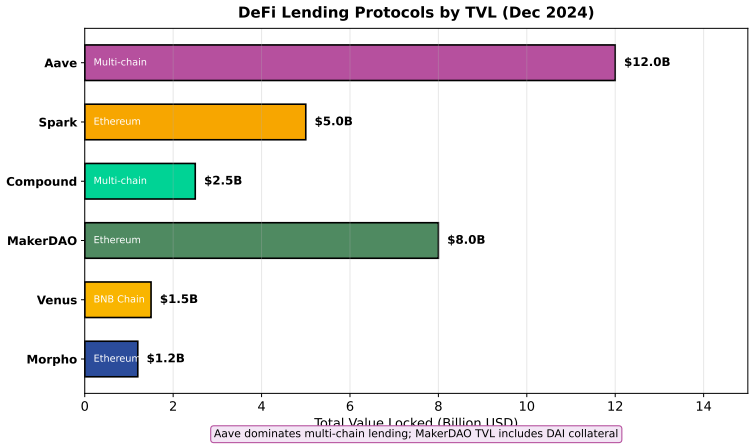
- Low utilization (0-60%): Low rates (encourage borrowing)
- Optimal (80%): Moderate rates (balanced)
- High (¿90%): Very high rates (discourage borrowing)

Supply APY Formula:

$$\text{Supply APY} = \text{Borrow APY} \times U \times (1 - \text{Reserve Factor})$$

Key Insight: Supply APY always lower than borrow APY.

Lending Protocol Market Share



Aave leads through multi-chain expansion; Compound pioneered the model

Aave vs Compound

Aave

- Flash loans (no collateral)
- Stable/variable rate choice
- Credit delegation
- E-Mode for correlated assets
- $12B TVL

Compound

- cTokens (interest-bearing)
- Simpler, fewer features
- Pioneered DeFi lending
- COMP governance token
- $2.5B TVL

Historical Note: Compound launched 2018, Aave 2020. Compound's COMP mining sparked "DeFi Summer" 2020.

Flash Loans

Definition: Borrow any amount without collateral, repay in same transaction.

How It Works:

1. Borrow $1M USDC from Aave
2. Use for arbitrage, collateral swap, or liquidation
3. Repay $1M + 0.09% fee
4. All atomic (succeeds or reverts entirely)

Use Cases:

- Arbitrage across DEXs
- Collateral swaps without closing position
- Self-liquidation to avoid penalty

Risk: Used in many DeFi exploits (oracle manipulation attacks).

Risks in DeFi Lending

1. **Smart Contract Risk**
   - Bugs or exploits (Rari Capital, Cream Finance hacks)
2. **Liquidation Risk**
   - Volatile markets, network congestion prevents adding collateral
3. **Oracle Risk**
   - Price feed manipulation, stale prices
4. **Liquidity Risk**
   - High utilization prevents withdrawals

2022 Lesson: CeFi lenders (Celsius, BlockFi) collapsed; DeFi protocols survived.

Future: Undercollateralized Lending

Current Limitation: Overcollateralization is capital inefficient.

Emerging Solutions:

1. **On-Chain Credit Scores:** Track repayment history (Credora, ARCx)
2. **Real-World Identity:** KYC-linked, legal recourse (Goldfinch, TrueFi)
3. **Social Collateral:** Community vouching (Teller Protocol)

Trade-off: Undercollateralization requires identity or trust, reducing permissionlessness.

Summary

Key Takeaways:

- DeFi lending: permissionless but requires overcollateralization
- LTV ratios vary by asset risk (ETH 80%, low-cap 45%)
- Health factor must stay above 1 to avoid liquidation
- Interest rates adjust algorithmically based on utilization
- Flash loans enable zero-collateral borrowing within one tx
- Aave dominates ($12B TVL); Compound pioneered the model
- Future: undercollateralized lending via credit scoring

Next Lecture: Stablecoin Mechanisms.

Questions for Reflection

1. Calculate health factor: $30k collateral, $20k borrowed, 85% liq threshold.
2. Why is overcollateralization necessary in DeFi lending?
3. How do interest rates adjust to prevent bank runs?
4. What risks do flash loans pose to DeFi protocols?
5. Variable or stable rates for 1-year borrow?