Lending and Borrowing

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Lending and Borrowing in Tradfi

- Some agents have more money than they need to spend, willing to save
  - Firms, households, governments...
- Some agents want to spend now and pay back later
  - Firms, households, governments...
- **Fixed income** contracts – debt – is the simplest way to get funds from borrowers to savers
  - Mortgages, auto loans, bank deposits, margin loans, bonds, treasuries, commercial paper, repo...

The Design Problem: Fixed Income in Decentralized Finance

- Core problem for fixed income in web3 settings: lack of persistent identity
- Any lending system based on reputation won't work!
- Solution: collateralized lending

Collateralized lending

- Lending can either be based on reputation, or collateral
- Collateralized lending IRL:
  - Houses $\Longrightarrow$ mortgages
  - Cars $\Longrightarrow$ auto loans
  - Stocks $\Longrightarrow$ margin loans
  - Firms $\Longrightarrow$ equipment, real estate, etc. collateralized loans
  - Bonds $\Longrightarrow$ repo loans

Defi Collateralized Lending

- Collateralized lending requires:
  1. System for collateral custody
  2. System for evaluating collateral value and "margin calls"
- Defi good at 1., can have a "collateral pot" smart contract
- Defi less good at 2.!

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  - Increase collateral
  - Decrease borrowing (pay back loans)
  - Some collateral gets liquidated

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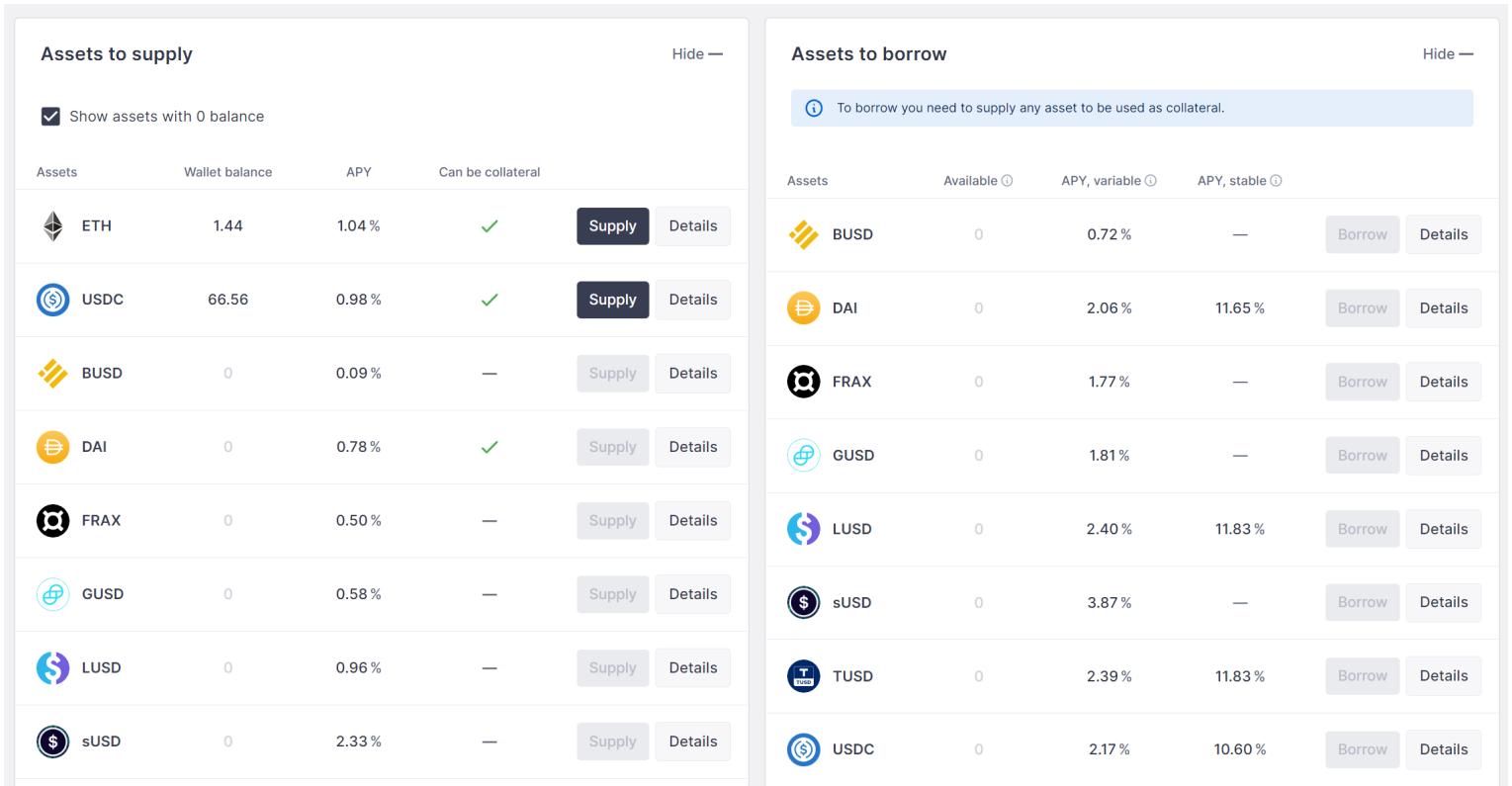
- Thus, system should never lose money

Aave Rates



Assets to supply — Hide

Show assets with 0 balance

Assets	Wallet balance	APY	Can be collateral	
ETH	1.44	1.04 %	✓	Supply Details
USDC	66.56	0.98 %	✓	Supply Details
BUSD	0	0.09 %	—	Supply Details
DAI	0	0.78 %	✓	Supply Details
FRAX	0	0.50 %	—	Supply Details
GUSD	0	0.58 %	—	Supply Details
LUSD	0	0.96 %	—	Supply Details
sUSD	0	2.33 %	—	Supply Details

Assets to borrow — Hide

To borrow you need to supply any asset to be used as collateral.

Assets	Available	APY, variable	APY, stable	
BUSD	0	0.72 %	—	Borrow Details
DAI	0	2.06 %	11.65 %	Borrow Details
FRAX	0	1.77 %	—	Borrow Details
GUSD	0	1.81 %	—	Borrow Details
LUSD	0	2.40 %	11.83 %	Borrow Details
sUSD	0	3.87 %	—	Borrow Details
TUSD	0	2.39 %	11.83 %	Borrow Details
USDC	0	2.17 %	10.60 %	Borrow Details

Who uses Aave?

Why would you lend to Aave?

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  - Leverage: hold $100 of assets with only $50 of cash
  - Mortgages, margin buying...
  - Borrow stablecoins against ETH

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  - Mortgages, margin buying...
  - Borrow stablecoins against ETH
- Need tokens for some utility function
  - Borrow tokens to vote on governance proposals?

Why Aave?

Why use Aave, instead of tradfi?

- Tradfi institutions won't lend against crypto easily
- Capital market completeness: can borrow/lend across jurisdictions

Rate Setting on Aave

- Aave interest rates based on utilization:

$$U = \frac{Total\ Borrowed}{Total\ Lent}$$

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- When few people want to borrow, what happens?
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  - Pool equilibrates at a smaller size
- When some lenders need to withdraw, what happens?
  - U increases, so remaining lenders have incentive to stay in pool
  - New lenders higher incentive to join pool
  - Borrowers have incentives to scale down

See Aave website

What is defi?

All of defi is a big securitization machine, which turns a moderately risky asset (crypto) into a very risky asset (levered crypto) and a less risky asset (crypto-backed loans)

The Defi Fixed Income Ecosystem

Borrowing/lending protocols imply there is now an ecosystem of fixed income strategies available in defi:

- Pure borrow/lend (Aave, Compound)
- Stablecoin market making (Curve, Convex)
- Clones/variants on other chains besides ETH
- Frontiers (later): uncollateralized lending, fixed rates...

Aave vs Maker

- Suppose you have ETH and WBTC. Two choices:
  - Make 2 MakerDAO vaults, print DAI
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- Main difference: collateral values are pooled in Aave, vs. separate in Maker
- If rates are the same, which do you prefer?

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- Subtle differences!

Ideal Liquidation

- Suppose you borrow $100 USD against $150 of ETH
- ETH price drops to be worth $149, so your position must be liquidated
- "Ideal" procedure:
  - Protocol detects that ETH price dropped, your position is insolvent
  - Protocol sells ETH to pay down your debt
- Is this possible?

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Liquidation in Practice: Trigger

- Human initiates a "liquidation"
- Smart contract checks oracle price: if sufficiently low, liquidation begins
- Question: how to sell collateral?

Liquidation in Practice: Sale Mechanism

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- Sell to humans? How?
- **Aave/Compound:** fixed price, below current oracle price, see risk parameters
  - Fast!
  - Pays liquidators a lot...
- **Maker**: collateral sold in descending auction
  - Slower, but may get better deal

Fire Sale Loops

- Suppose price of ETH drops
- People borrowing against ETH get liquidated, so ETH gets sold
- Selling pressure pushes down ETH prices...
- Leading to more liquidations...

Systemic Fragility

Systemic Fragility in Decentralized Markets

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Preliminary
Comments Welcome

Abstract

We analyze a unique data set of collateral liquidations on two Decentralized Finance lending platforms – Compound and Aave. Such liquidations require arbitrageurs to repay the loan in return for the discounted collateral. Using Blockchain transaction data, we observe if arbitrageurs liquidate positions out of their own inventory or obtain "flash loans." To repay flash loans, arbitrageurs immediately sell the collateral asset. We document the high frequency price impact of such liquidity trades on nine different decentralized exchanges. Consistent with large block trades in equity markets there is a temporary and permanent price impact of collateral asset sales in DeFi. We document the effect of these trades on return distributions. Our work highlights the systemic fragility of decentralized markets.

Keywords: Decentralized Lending, Blockchain, Decentralized Finance, Systemic Risk

Source

Risks: Oracle Risk

- Unlike AMMs, collateralized lending systems require oracle inputs for prices
- Risk factor: if oracle gets manipulated, lending system is at risk!
- How would you attack Aave through oracle manipulation?

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- Unlike AMMs, collateralized lending systems require oracle inputs for prices
- Risk factor: if oracle gets manipulated, lending system is at risk!
- How would you attack Aave through oracle manipulation?
  1. Deposit $100 Xtoken as collateral
  2. Manipulate oracle, make Aave think $100 Xtoken is worth $100,000
  3. Borrow $50,000 USDC against your Xtoken
  4. Default: you've just traded $100 Xtoken for $50,000 USDC!
- See here for other examples of oracle attacks
- Chainlink is the main oracle provider
  - Uses off-chain data! Ironic, as it's more "principled" to use on-chain data

Risks: Operational Risk

- Lending code particularly tricky to get right, because your funds are locked in contract, and can be lent out
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- Lending code particularly tricky to get right, because your funds are locked in contract, and can be lent out
- How does this differ from AMM trading?
- Many examples, such as CREAM finance, Compound

Flash Loans

- Unlike traditional finance, transactions in defi are atomic: either the whole tx finishes, or none of it does
- Enables a cool trick called flash loans
- You can borrow a very large amount of money, unsecured...
- ...as long as you pay it back in the same transaction!
- If you can't pay back the money, tx fails, so you never borrowed it in the first place!
- Flash loans available from Aave, Compound...

Flash Loans: Consequences

- In tradfi, arbitrage requires capital and infrastructure
  - Hedge funds can do trades you can't, because they have money and trading infra
- In defi, infra is democratized by default; flash loans democratize capital
- If there are arbitrage opportunities, anyone can extract them!
- A number of interesting consequences...

Case Study: The Cream Finance Hack

- See my blog post on the CREAM finance attack
- Attacker submitted a bundle of 20 transactions, borrowed a billion dollars, made $130mil, paid $6,500 in gas fees!
- Details complicated, but essentially:
  - CREAM finance allows you to borrow collateralized, borrowing amount determined by price oracle
  - Attacker builds a large collateral + debt position through "rehypothecation"
  - Flash borrow $1.5bil, deposit in CREAM
  - Manipulate price, to make CREAM think $1.5bil of collateral is worth $3bil
  - Borrow $2bil of ETH against collateral, worth only $1.5bil
  - Default on collateral, keep $2bil in ETH, pay back $1.5bil flash loan, keep $500mil ish in profit (actually only $130mil)

Case Study: The Beanstalk Farms Attack

- See my tweet thread on the Beanstalk attack (cited by Matt Levine!)
- Beanstalk is an algo-stable, holds a bunch of collateral
- Governance done through equity tokens: majority token vote approves any change
- Attacker proposed: "send entire treasury to my address"
- Flash borrowed a bunch of equity tokens, passed the proposal, took all the money!

Flash Loans: Consequences

Consequences of flash loans:

- "On-chain" price oracles (for collateral valuation, derivatives settlement, etc.) very rarely used: often attackable
- Hacky solution: just use Binance prices, imported through Chainlink, instead
- Governance attacks rarer: beanstalk a unique case
  - However, Curve/Convex demonstrates that the "market for votes" – flash loans aside – still very important

Frontiers of Fixed Income

Where might fixed income go next?

- Fixed rates
- Credit derivatives
- Other forms of lending

Fixed Rates

- Defi rates mostly floating
- Many tradfi institutions prefer long-term fixed rates (why?)
  - **Lenders:** asset-liability matching, pensions have fixed long-term liabilities, want predictable-return assets
  - **Borrowers:** predictable interest payments (most mortgages, auto loans are fixed-rate)

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- Financial engineering: fixed rates can be synthesized out of floating rates, through interest rate swaps
  - Pay me all your Aave interest on $1,000 for 1 year, and,
  - I'll pay you fixed 5%
- Aave now allows stable-rate borrowing
- Some groups working on this: ElementFi, Yield protocol, Notional, and more

Credit Derivatives

- You can think of:

$$r_{risky} = r_{safe} + \Delta_{credit}$$

- Sometimes, different people want to hold Δ_{credit} versus r_{safe}
  - Mortgages: tranched MBS
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- Credit derivatives protocols: marketplace for insurance against protocol risk
- One player in this space is Risk Harbor

Other Kinds of Lending

- Lending/borrowing in defi is essentially only "margin loans" collateralized by liquid assets – very restrictive! What about:
  - Illiquid asset-backed borrowing? (Mortgages, secured corporate debt)
  - Undercollateralized, reputation-based borrowing? (Credit cards)
  - Cash flow/equity-backed borrowing? (Corporate bonds)
- What are barriers to each of these?

See here on undercollateralized lending, also my blog post

Other Kinds of Lending: Readings

- Undercollateralized lending: Maple finance major player. See Delphi Digital report
- Illiquid assets: see RWA
- "Equity upon default" design: doesn't appear to exist yet!
- All potentially good ideas for class projects!