Introduction
ooooo

Data and Stylized Facts
oooooo

Analysis
oooooo

Conclusion
o

Systemic Fragility in Decentralized Markets

Alfred Lehar   Christine A. Parlour
Calgary   Berkeley

2022 RiskLab/BoF/ESRB Conference on Systemic Risk
Analytics

Introduction

- Contagion and systemic risk have been explored in banking and mainstream financial markets
- Little to no work in DeFi markets
- Unique characteristics
  - Capital can move freely
  - Innovations to overcome capital constraints
  - Closed Information system: all information on chain
 - No regulators: circuit breakers, LOLR

Introduction

- Collateralized lending is largest DeFi application
- DeFi Lending: $53 b (AAVE: $13.72 b, Compund: $6.69 b)
- We document systemic fragility of lending platforms
- Negative feedback loops:
  - Undercollateralized loans get liquidated and collateral often gets sold immediately
  - Downward price pressure on collateral
 - More loans get liquidated

DeFi Lending
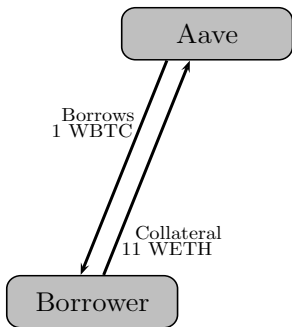
- Give collateral to lending platform (e.g. AAVE)
- Borrow another cryptocurrency
- Value of collateral has to be κ times the value of debt
- $\kappa > 1$, depends on collateral,debt, and platform, often 1.2
- Similar to
  - Repo market
  - Margin account

DeFi Lending - Liquidations
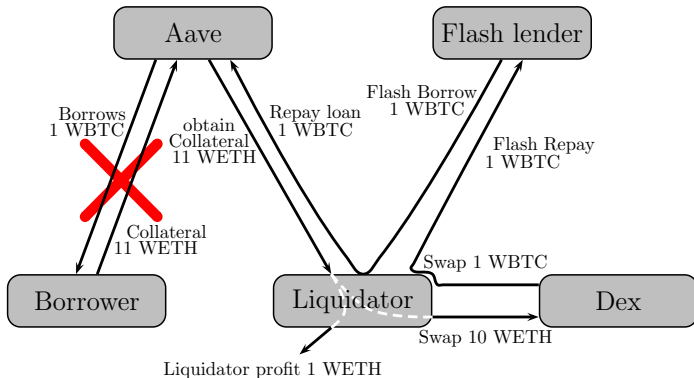
- Under-collateralized loans can be liquidated by anyone
- Assume price 1 WBTC = 10 WETH
- Liquidators obtain collateral at a discount

Introduction
○○○○●

Data and Stylized Facts
○○○○○○

Analysis
○○○○○○

Conclusion
○

Systemic Fragility
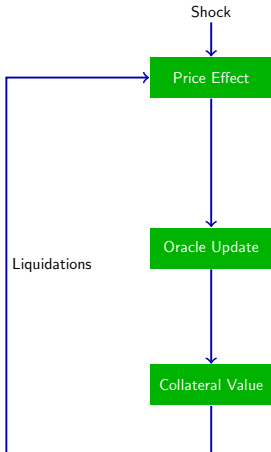
We show:

- Liquidators often sell collateral immediately on a Dex
- Liquidations have a lasting price impact on
    - Exchanges where liquidations happen
    - Contagion to other exchanges

    causing oracles to update
- Liquidation waves occur
- Collateral sales explain a big part of collateral token returns in a wave

Introduction
00000

Data and Stylized Facts
●00000

Analysis
000000

Conclusion
0

Data

- Liquidations: AAVE and Compound
  - September 25, 2018 to November 8, 2021
  - 24,212 liquidations
  - 38 distinct collateral tokens
  - 40 debt tokens
  - total liquidations of $1,349,890,516
  - average liquidation $66,517 and median $2,534
  - largest single loan liquidation: $50,508,256 worth of DAI collateral on Compound on Nov 26, 2020
- Token trades: Uniswap, SushiSwap and 6 other clones

Introduction
○○○○○

Data and Stylized Facts
○●○○○○

Analysis
○○○○○○

Conclusion
○

Largest collateral tokens

|	Collateral Token	Number Liqidations	Amount USD	Amount ETH
WETH	Wrapped Ether	10400	742,332,338	611,161
WBTC	Wrapped BTC	1482	196,443,206	102,833
USDC	USD Coin	1209	101,196,401	159,740
DAI	Dai Stablecoin	1120	96,884,794	165,650
LINK	ChainLink Token	2468	94,308,050	69,184
AAVE	Aave Token	424	24,380,537	12,646
UNI	Uniswap	709	22,113,655	14,012
YFI	yearn.finance	339	21,178,595	23,002
COMP	Compound	271	12,213,477	5,089
ZRX	0x Protocol Token	290	8,542,142	6,393

Introduction
00000

Data and Stylized Facts
000●000

Analysis
000000

Conclusion
0

Most popular token pairs

Collateral		Debt Token		Num. Liq.	Amount USD	Amount ETH
WETH	Wrapped Ether	USDC	USD Coin	2811	229,016,007	151,627
WETH	Wrapped Ether	DAI	Dai Stablecoin	2981	222,535,759	263,761
WETH	Wrapped Ether	USDT	Tether USD	1635	205,507,710	103,844
WBTC	Wrapped BTC	USDC	USD Coin	484	73,633,874	33,591
WBTC	Wrapped BTC	USDT	Tether USD	275	51,324,156	22,054
WETH	Wrapped Ether	WBTC	Wrapped BTC	86	42,943,870	27,486
USDC	USD Coin	LINK	ChainLink Token	307	39,262,350	96,858
LINK	ChainLink Token	USDC	USD Coin	972	38,958,821	28,828
WBTC	Wrapped BTC	DAI	Dai Stablecoin	380	28,463,916	20,959
LINK	ChainLink Token	USDT	Tether USD	537	25,546,332	17,099

- Consistent with levered positions in ETH

Introduction
○○○○○

Data and Stylized Facts
○○○●○○
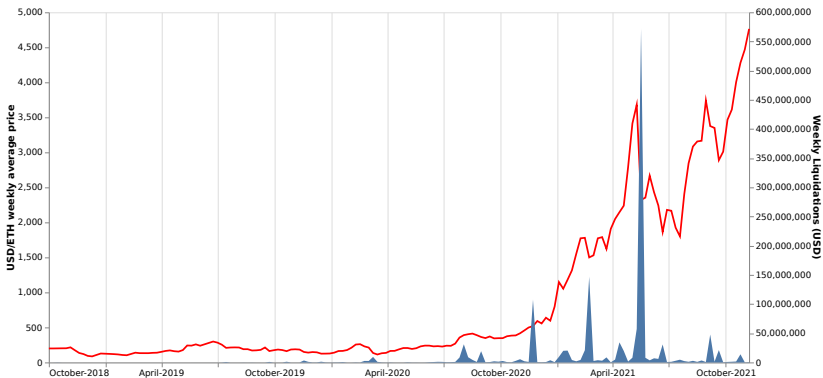
Analysis
○○○○○○

Conclusion
○

Liquidations have lasting price impact

Wave of 180 liquidations of LINK on May 19th 2021
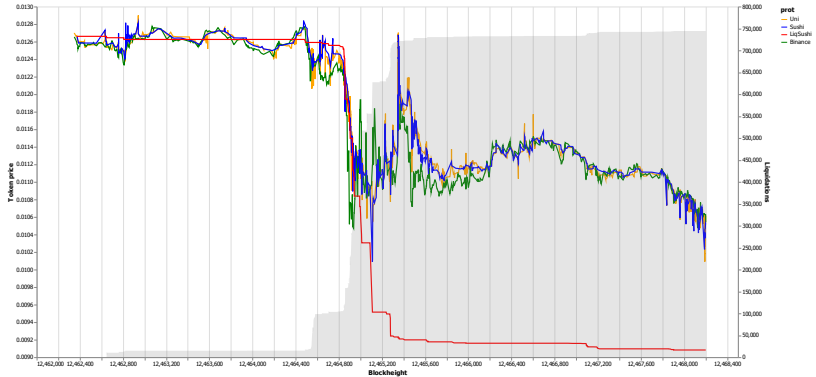
- Aggregate loan liquidations (grey)
- Cumulative price impact of liquidators' swaps (red)

Introduction
○○○○○

Data and Stylized Facts
○○○○●○

Analysis
○○○○○○

Conclusion
○

Liquidation Waves and price of ETH

Introduction
ooooo

Data and Stylized Facts
oooooo●

Analysis
oooooo

Conclusion
o
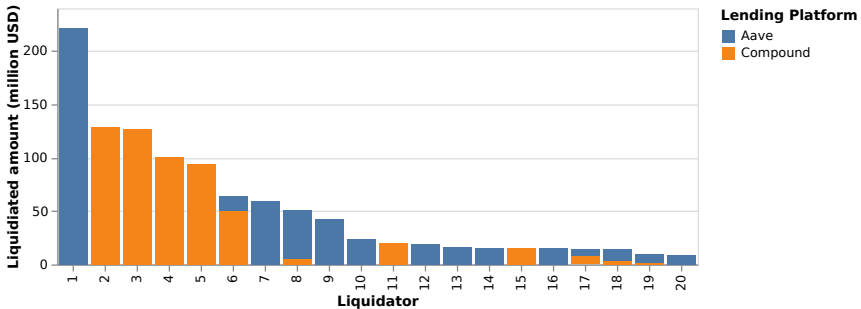
Top Liquidators

Probit – use of swaps in loan liquidations

	(1)	(2)	(3)	(4)
Liq.Collateral	0.441**			0.368***
	(0.174)			(0.142)
Wave Size		0.00721**		0.00477**
		(0.00338)		(0.00225)
Wave Length		-0.0389***		-0.0438***
		(0.0132)		(0.0143)
Liquidator Size			0.0846*	0.0830*
			(0.0490)	(0.0490)
Gas Price			-0.0126	-0.0246*
			(0.0109)	(0.0131)
Observations	20,294	20,294	20,288	20,288

- Can fund liquidation with capital or flash loan (requires swap)
- Larger liquidations get swapped
- swaps occur in big and short waves – causality?
- Higher gas fee - less swapping

Introduction
○○○○○

Data and Stylized Facts
○○○○○○

Analysis
○●○○○○○

Conclusion
○

Liquidations have lasting price impact

liquidation of $20 million of WBTC collateral on February 23rd 2021

Introduction
○○○○○
Data and Stylized Facts
○○○○○○
Analysis
○○●○○○
Conclusion
○
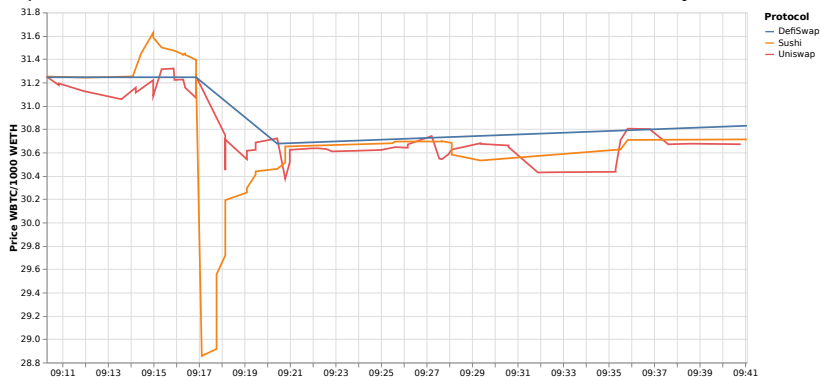
Liquidations have lasting price impact

	Other exchanges		Dex where liquidated	
Return of liquidating Swap	0.891**	0.912***	0.417***	0.416***
	(0.334)	(0.236)	(0.0764)	(0.0766)
Gas Price	-0.000369**	-0.000417***	0.000179***	0.000158***
	(0.000165)	(0.0000479)	(0.0000371)	(0.0000389)
Wave Length		-0.00146		-0.000112***
		(0.00309)		(0.0000323)
Position in Wave		0.0199**		0.00488***
		(0.00706)		(0.000343)
R^2	0.00163	0.00334	0.106	0.115
Observations	16,000	16,000	4,080	4,080

- Dex has deterministic price impact
- Sale of collateral explains significant part of 5 block return
- Contagion effects on other exchanges

Introduction
○○○○○

Data and Stylized Facts
○○○○○○

Analysis
○○○●○○

Conclusion
○

Liquidations impact token returns

Introduction
00000

Data and Stylized Facts
000000

Analysis
000●0

Conclusion
0
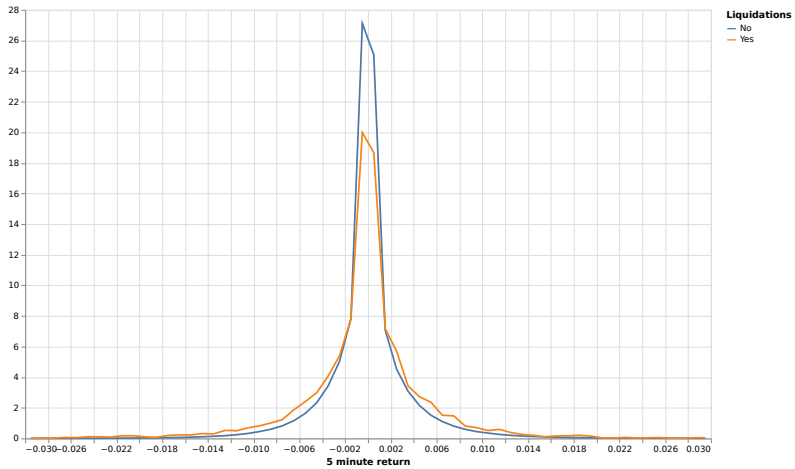
Liquidations have lasting price impact

	Multiple liquidations		Single Liquidations	
Return of liquidating Swaps	0.0656***	0.0643***	0.00566	0.00593
	(0.00456)	(0.00475)	(0.00656)	(0.00655)
Wave Size		0.000110		-0.00259**
		(0.0000769)		(0.00130)
Wave Length		-0.000609		
		(0.000441)		
Gas Price		0.0000619		0.0000454
		(0.000334)		(0.0000873)
R^2	0.189	0.192	0.000557	0.00353
Observations	887	887	1,336	1,336

- Dex has deterministic price impact
- Sale of collateral explains significant part of 5 block return
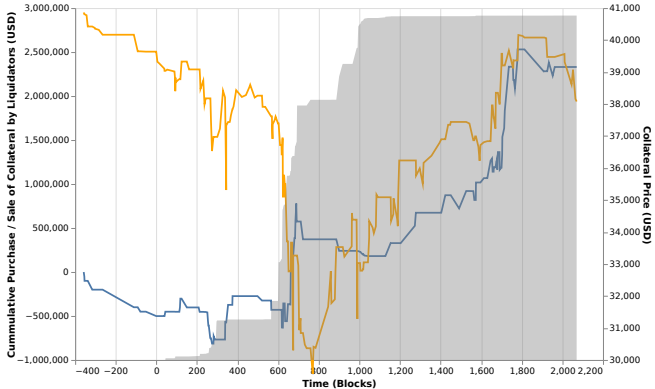- Contagion effects on other exchanges

Introduction
○○○○○

Data and Stylized Facts
○○○○○○

Analysis
○○○○○●

Conclusion
○

Predatory Liquidations – May 19, 2021

Conclusion

- Document systemic fragility in decentralized markets
- Robust evidence of feedback loops
- Market organization affects return distribution of assets
- Transmission of risk from lenders to traders of assets
- Useful to understand fragility and risk of feedback loops in traditional financial markets, e.g., repo market
- With CBDCs smart contract based systems will become more prominent
- Systemic risk in decentralized systems