Systemic Fragility in Decentralized Markets

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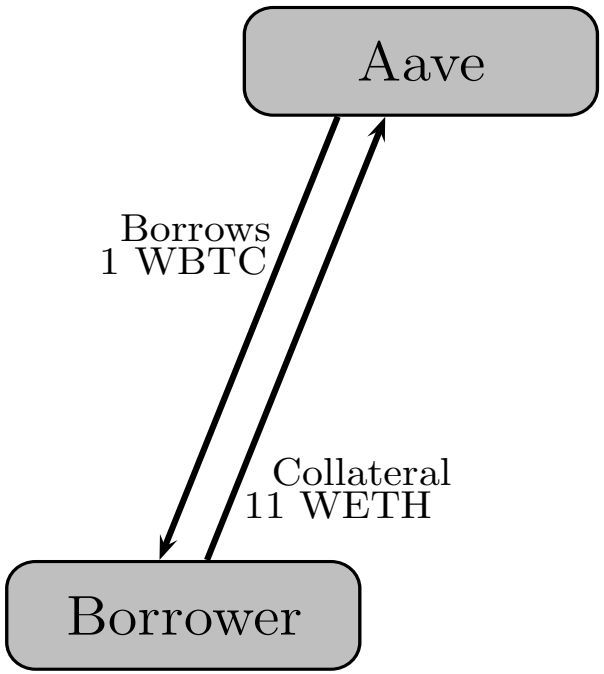
Introduction

- 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

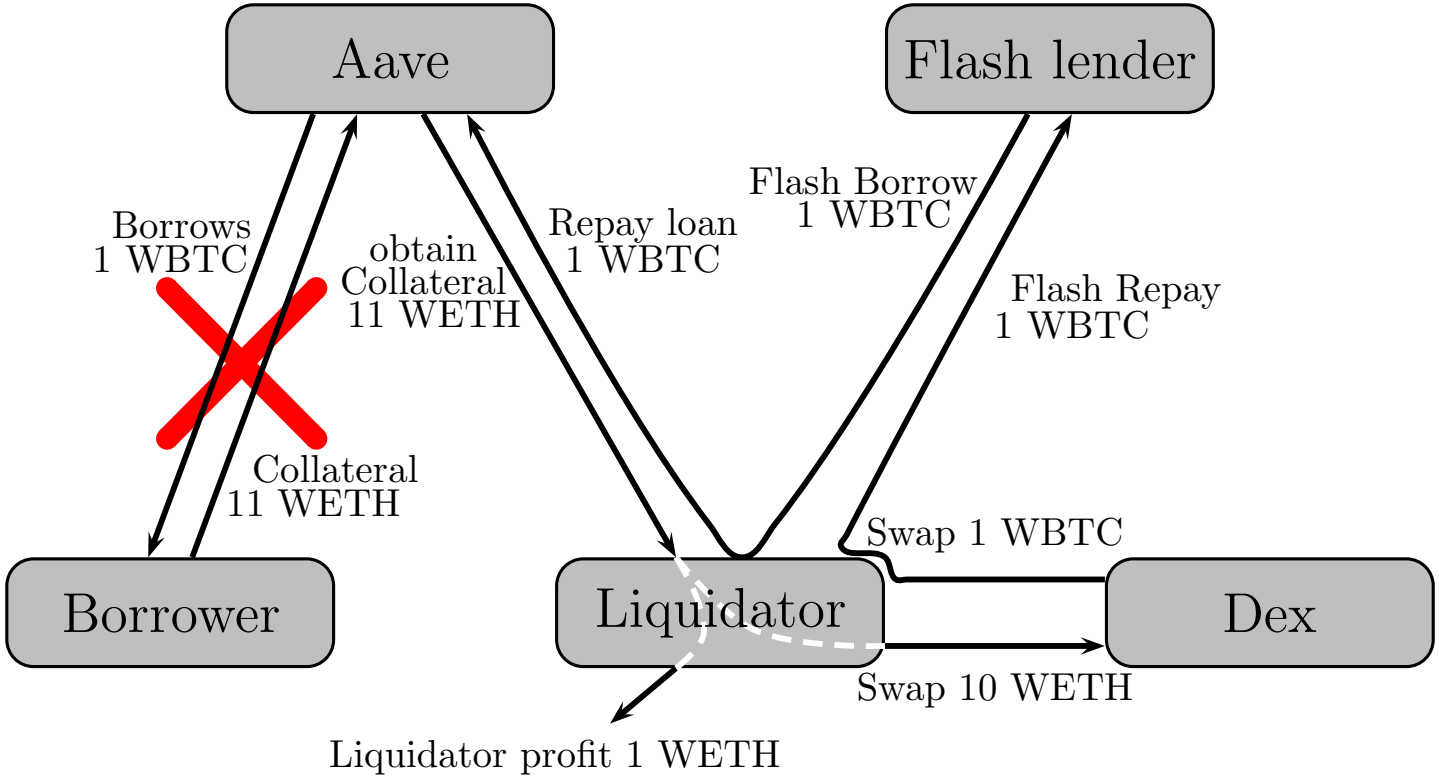
- Collateralized lending is second largest DeFi application
- DeFi Lending: \$16 b (AAVE: \$6.23 b, Compund: \$2.64 b)
- We document systemic fragility of lending platforms
- Negative feedback loops:
  - Undercollateralized loans get liquidated and collateral often gets sold immediately
  - Downward price pressure on collateral
  - More loans get liquidated

DeFi Lending



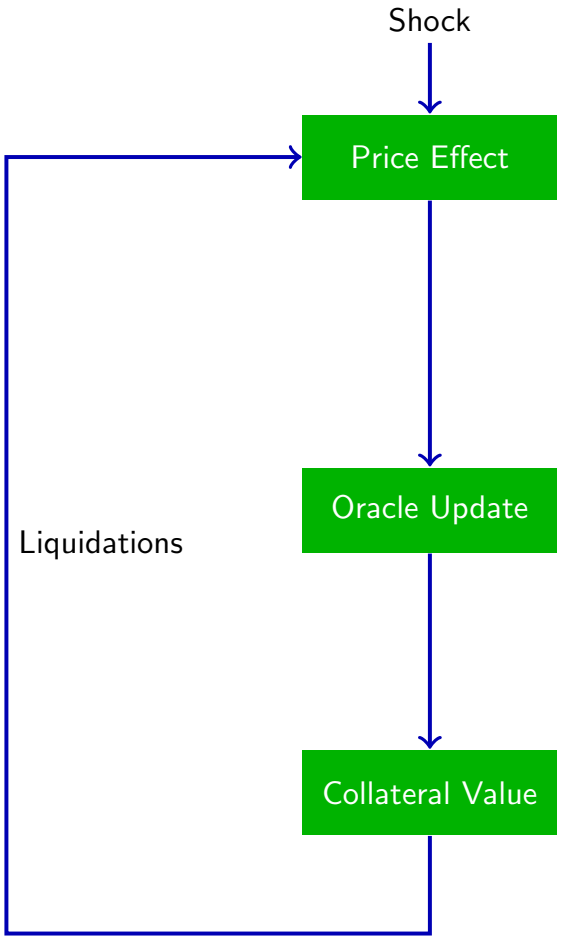
- Give collateral to lending platform (e.g. AAVE)
- Borrow another cryptocurrency
- Value of collateral has to be κ times the value of debt
- $\kappa > 1$, depends on collateral,debt, and platform, often 1.2
- Similar to
  - Repo market
  - Margin account

DeFi Lending - Liquidations



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

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

Data

- Liquidations: AAVE and Compound
  - September 25, 2018 to May 16, 2022
  - 42,324 liquidations
  - 37 distinct collateral tokens
  - 41 debt tokens
  - total liquidations of $2,487,543,624
  - average liquidation $64,756 and median $3,586
  - 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

Most popular token pairs

Collateral		Debt Token		Num. Liq.	Amount USD	Amount ETH
WETH	Wrapped Ether	USDC	USD Coin	6,287	518,773,703	267,019
WETH	Wrapped Ether	USDT	Tether USD	3,952	398,853,641	180,786
WETH	Wrapped Ether	DAI	Dai Stablecoin	5,078	333,387,258	306,990
WBTC	Wrapped BTC	USDC	USD Coin	1,211	162,090,711	69,783
WBTC	Wrapped BTC	USDT	Tether USD	697	124,277,693	51,375
LINK	ChainLink Token	USDC	USD Coin	2,351	85,400,856	49,354
WBTC	Wrapped BTC	DAI	Dai Stablecoin	797	58,693,780	33,513
LINK	ChainLink Token	USDT	Tether USD	1,283	52,097,818	28,281
WETH	Wrapped Ether	WBTC	Wrapped BTC	129	49,183,070	30,326
USDC	USD Coin	USDT	Tether USD	120	39,887,094	18,931

- Consistent with levered positions in ETH

Dex-Price Impact

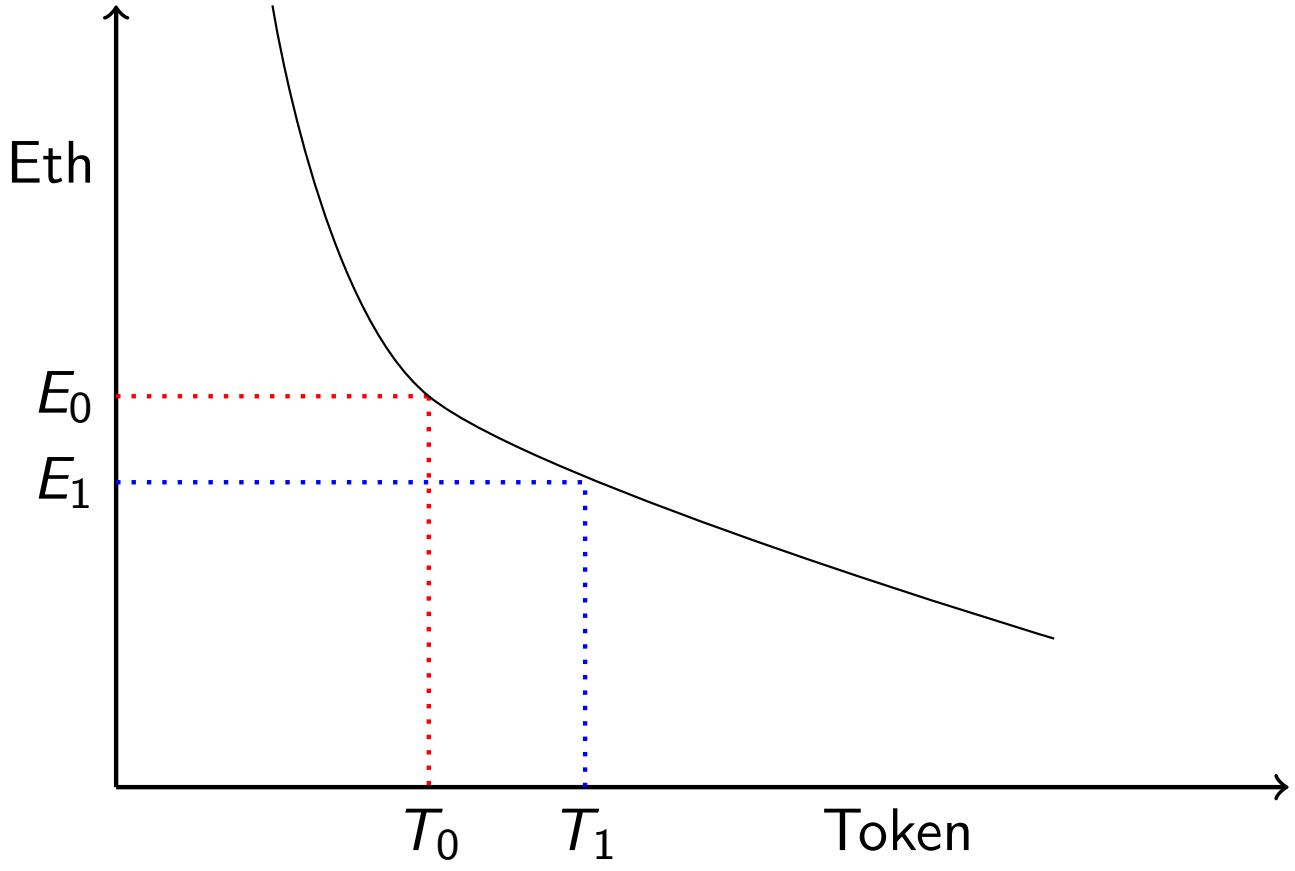
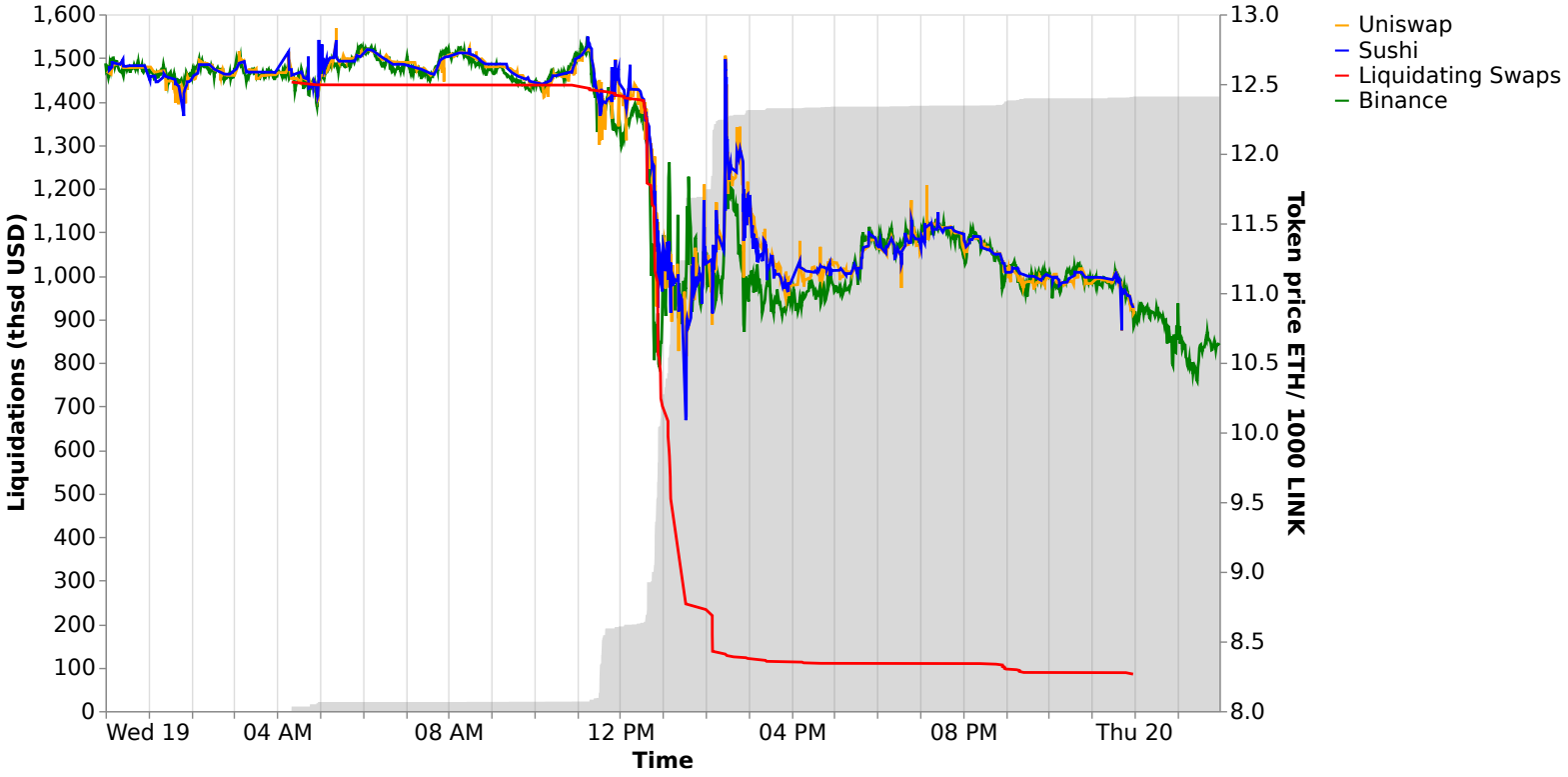


Figure: A bonding curve

Liquidations have lasting price impact

Wave of 180 liquidations of LINK on May 19^{th} 2021

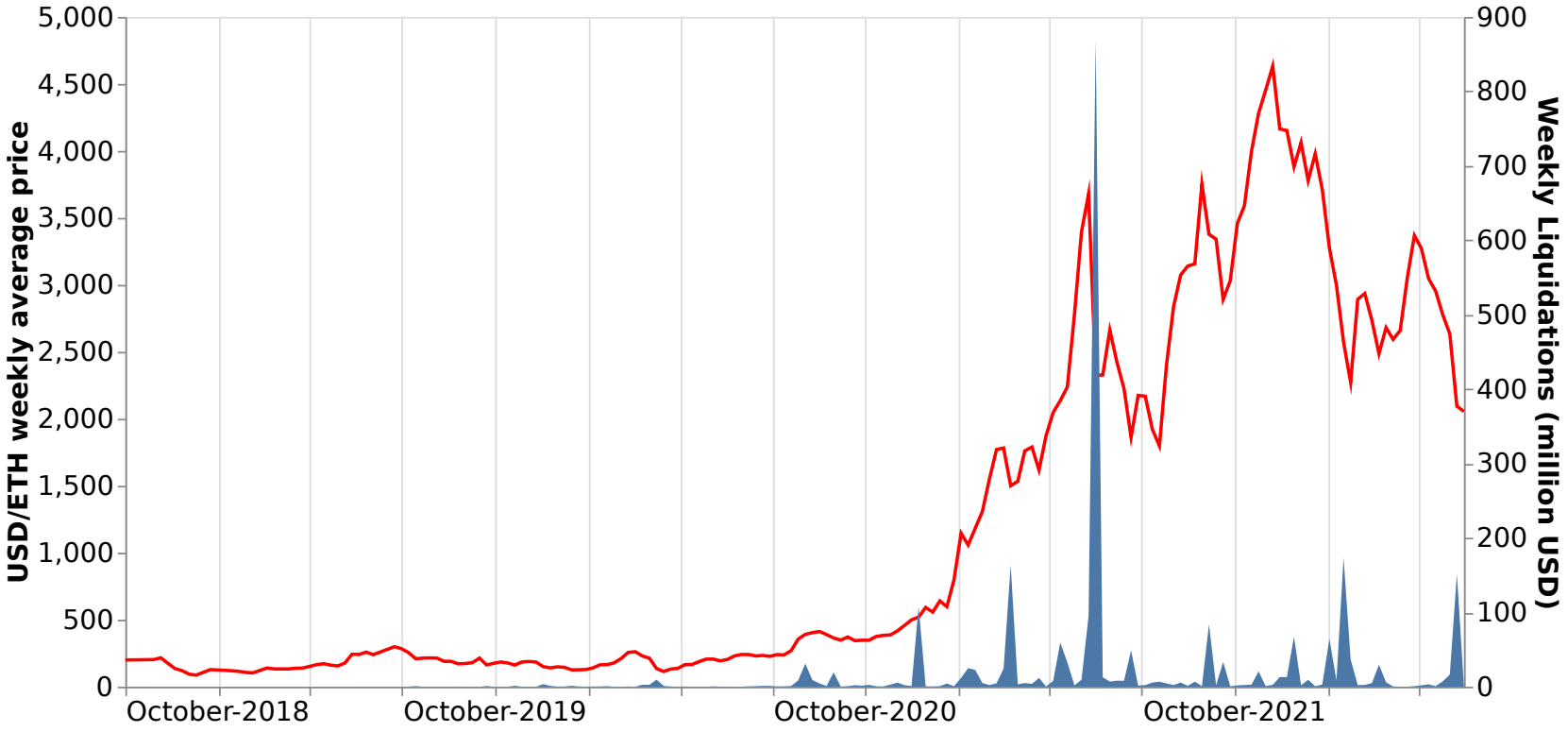


- Aggregate loan liquidations (grey)
- Cumulative price impact of liquidators' swaps (red)

Liquidation Waves

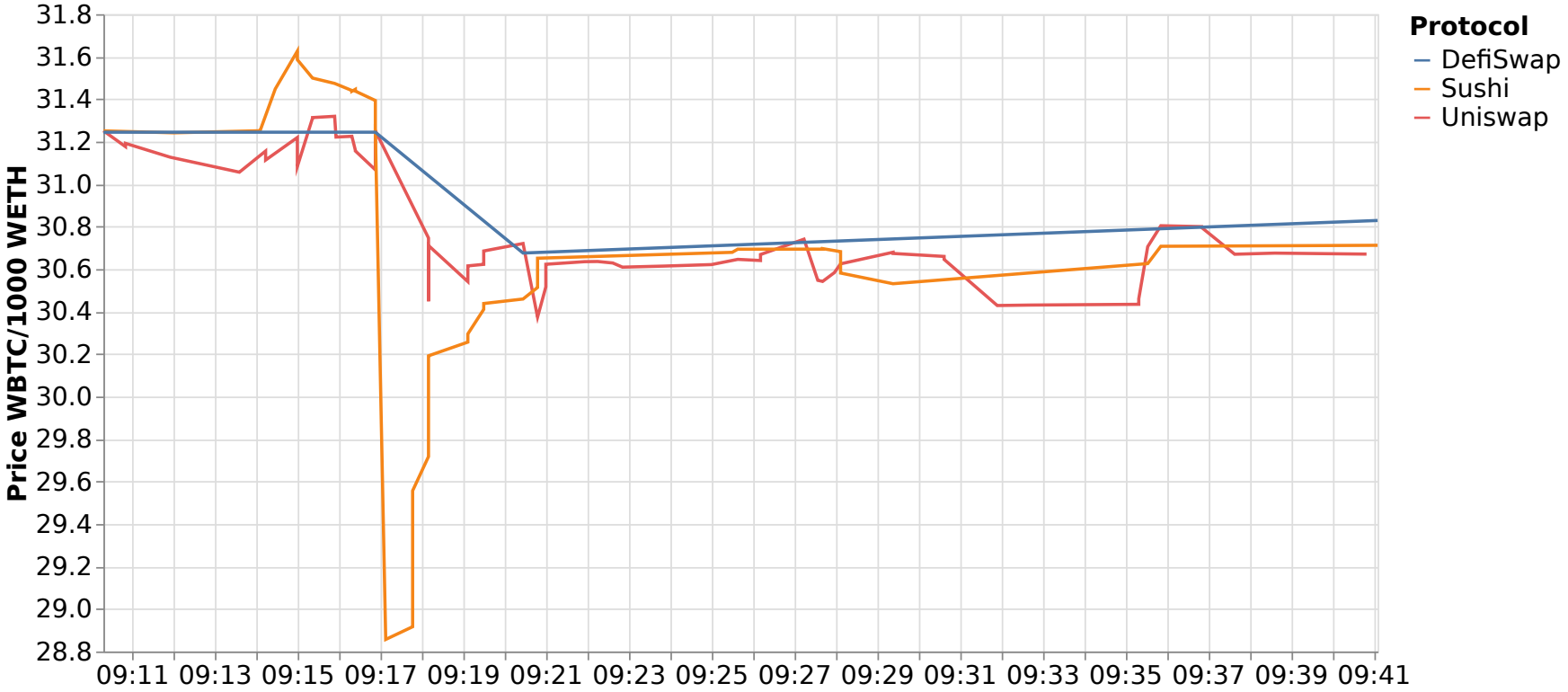
- A Liquidation is part of a wave if it occurs less one hour after a previous liquidation of the same collateral token.
- We find 1,028 waves that involve at least 5 liquidations each.
  - In these waves at total of 27,239 loans are liquidated.
- A total of 19,710 liquidations occur within waves of at least 20 liquidations.
- In the biggest wave 1,056 loans were liquidated.
- The average wave with at least 5 liquidations lasts approx 2 hours.
- Liquidation waves could reflect a prior increase in the relative value of the collateral asset that led to a cluster of vaults with similar liquidation thresholds.

Liquidation Waves and price of ETH



Liquidations have lasting price impact

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

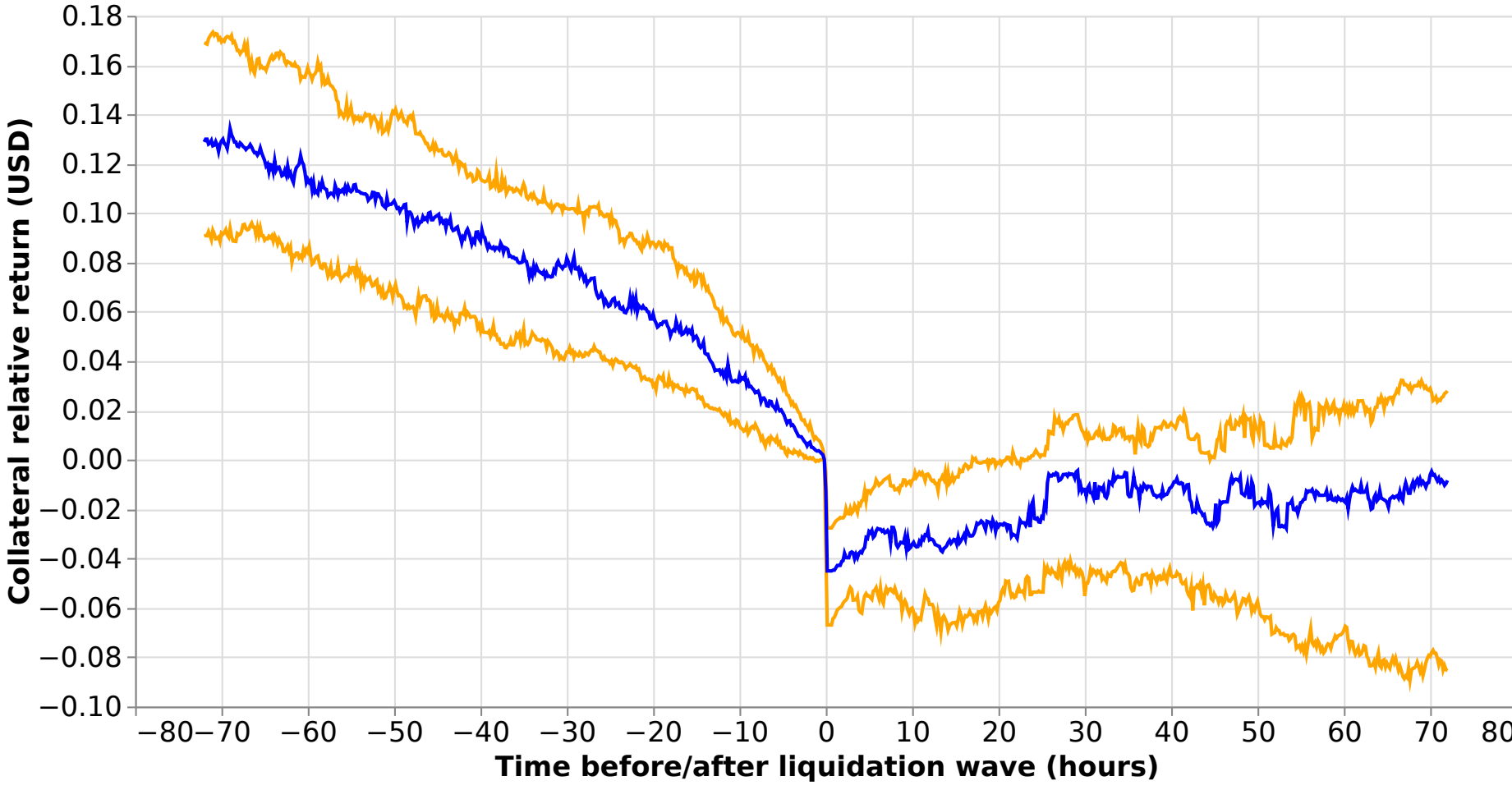


Liquidations have lasting price impact

	Other exchanges		Dex where liquidated	
Return of liquidating Swap	1.302***	1.081***	0.389***	0.387***
	(0.273)	(0.236)	(0.0718)	(0.0717)
Gas Price	-1.87e-16*	3.93e-17	1.73e-16***	1.62e-16***
	(1.00e-16)	(7.88e-17)	(3.73e-17)	(3.84e-17)
Wave Length		-0.00714***		-0.000118***
		(0.00196)		(0.0000232)
Position in Wave		0.00760		0.00395***
		(0.00955)		(0.000222)
R^2	0.000362	0.00246	0.0916	0.0972
Observations	38,812	38,812	7,786	7,786

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

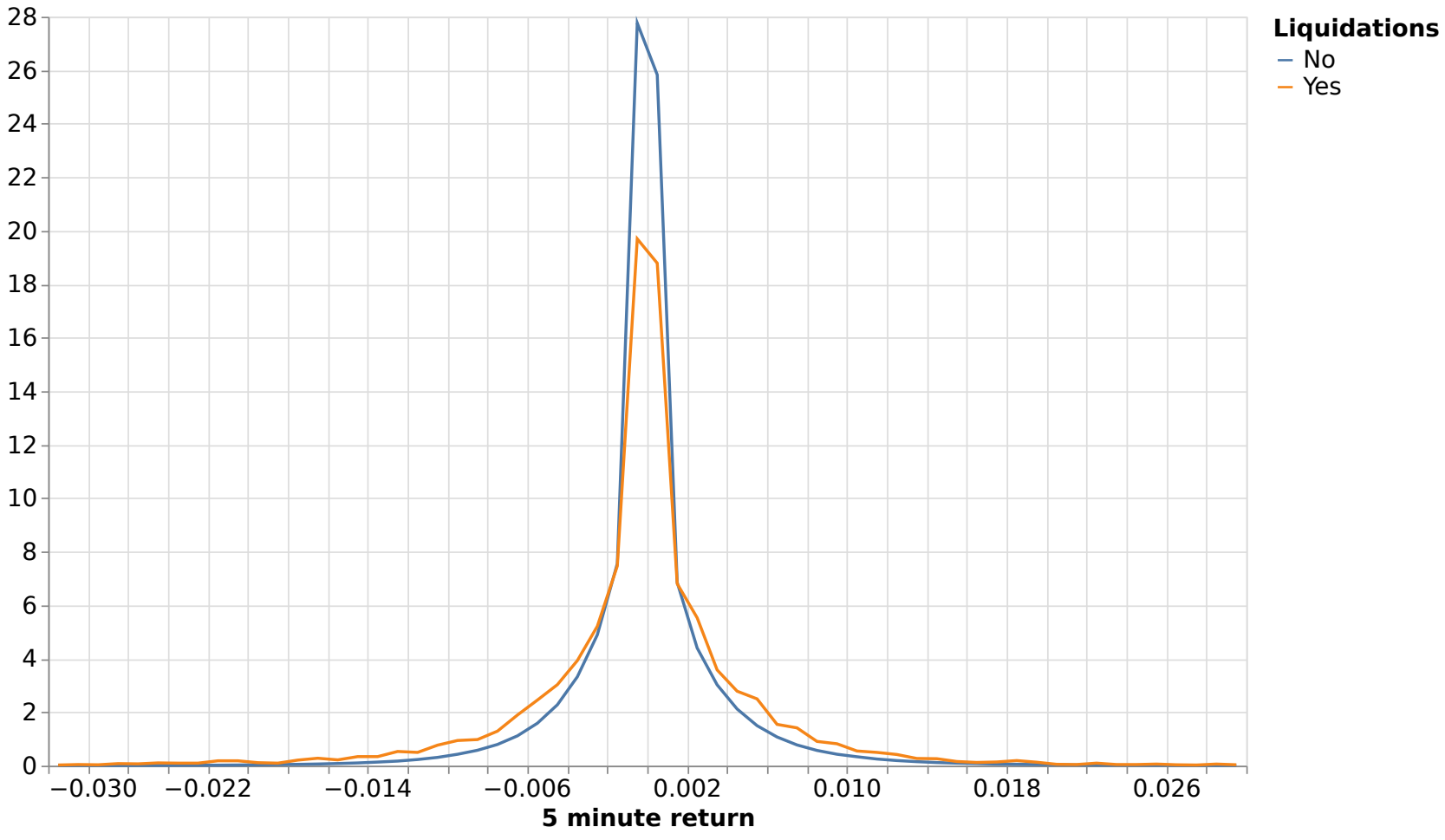
Price impact around liquidation waves



Liquidation Returns throughout wave

	Multiple liquidations		Single liquidations	
	(1)	(2)	(3)	(4)
Return of liquidating Swaps	0.0306***	0.0306***	0.00137	0.00108
	(0.00261)	(0.00271)	(0.00313)	(0.00313)
Wave Size		0.0000671		-0.00200***
		(0.0000686)		(0.000611)
Wave Length		-0.000169		
		(0.000425)		
Gas Price		0.000129		0.0000362
		(0.000473)		(0.0000823)
R^2	0.106	0.107	0.000126	0.00713
Observations	1,154	1,154	1,516	1,516

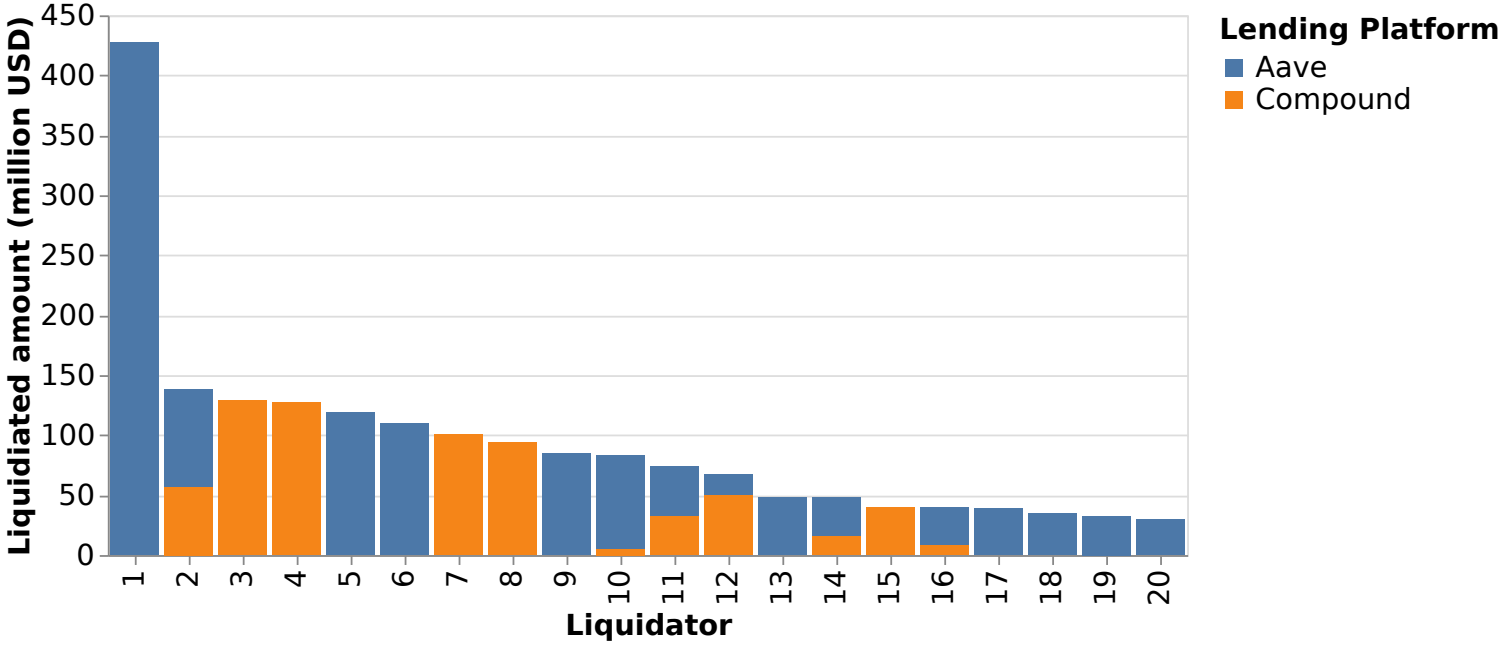
Liquidations impact token returns



Liquidators

- We observe 1,007 distinct liquidators (liquidator address).
- Any liquidator may control multiple addresses, so the distinct number of addresses corresponds to an upper bound on the number of liquidators.
- Liquidation activity is very concentrated with the top 20 liquidators performing 48.50% of the liquidations and liquidating 75.01% of the collateral.
- The top liquidator in our sample liquidated 2,732 loans with a total collateral value of USD 427,381,388.

Top Liquidators



Probit – use of swaps in loan liquidations

	(1)	(2)	(3)	(4)
Liq.Collateral	0.350***			0.289***
	(0.122)			(0.110)
Wave Size		0.00657**		0.00582**
		(0.00262)		(0.00252)
Wave Length		-0.0488***		-0.0514***
		(0.0152)		(0.0148)
Liquidator Size			0.0376	0.0357
			(0.0474)	(0.0469)
Gas Price			-0.00392	-0.0157
			(0.0161)	(0.0161)
R^2				
Observations	38,409	38,409	38,403	38,403

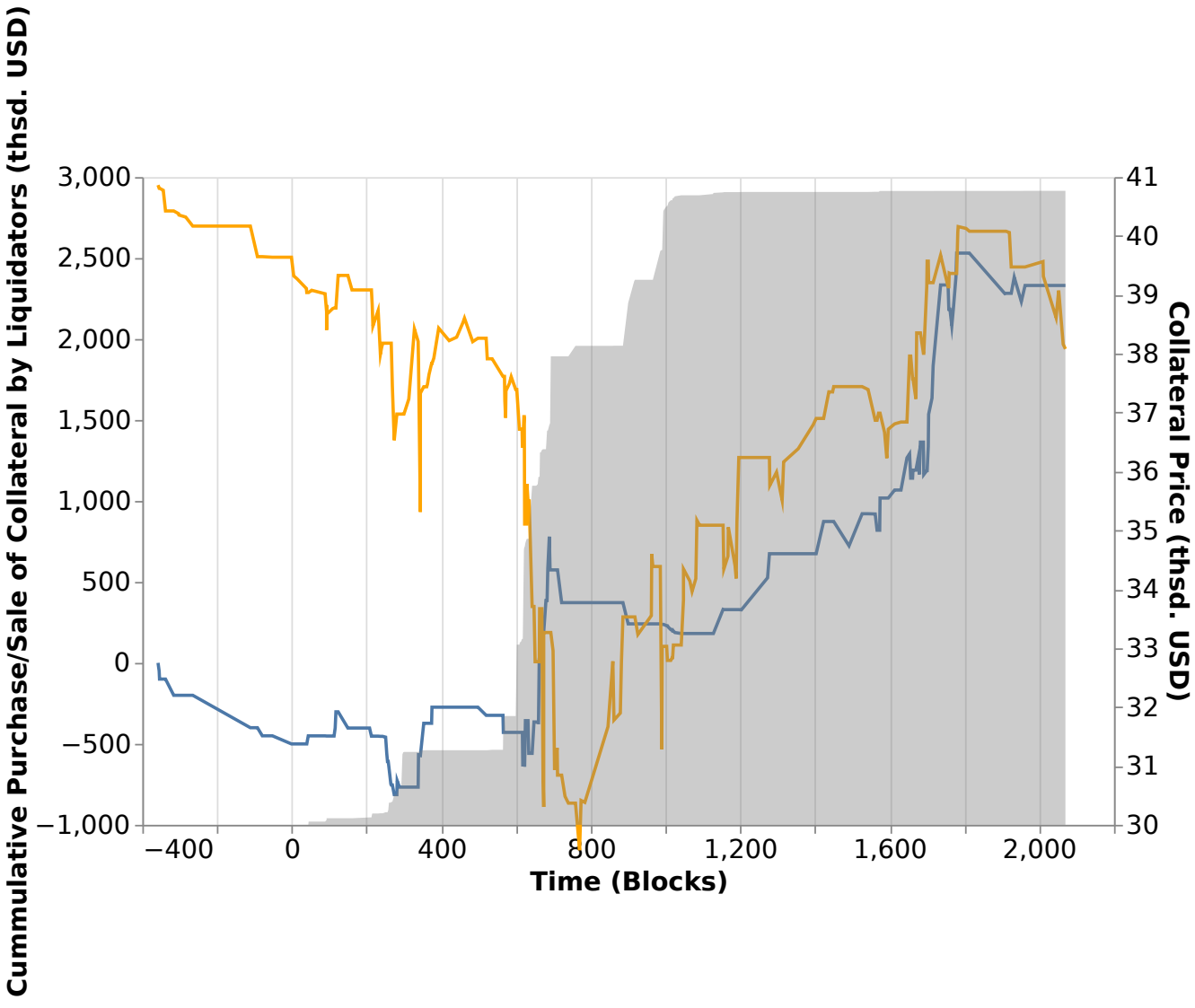
- Can fund liquidation with capital or flash loan (requires swap)
- Larger liquidations get swapped
- swaps occur in big and short waves – causality?

Predatory liquidations - targeted selling

- When a loan at close to the liquidation boundary a liquidator has a lot to gain from pushing the loan over the edge
- Resulting liquidation causes price drop and further liquidations

- Case study: May 19, 2021. 147 loans with WBTC as collateral were liquidated
- About USD 64 million liquidated
- Trace Trades of liquidators 420 blocks before start of liquidation wave

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