

Decentralized Finance

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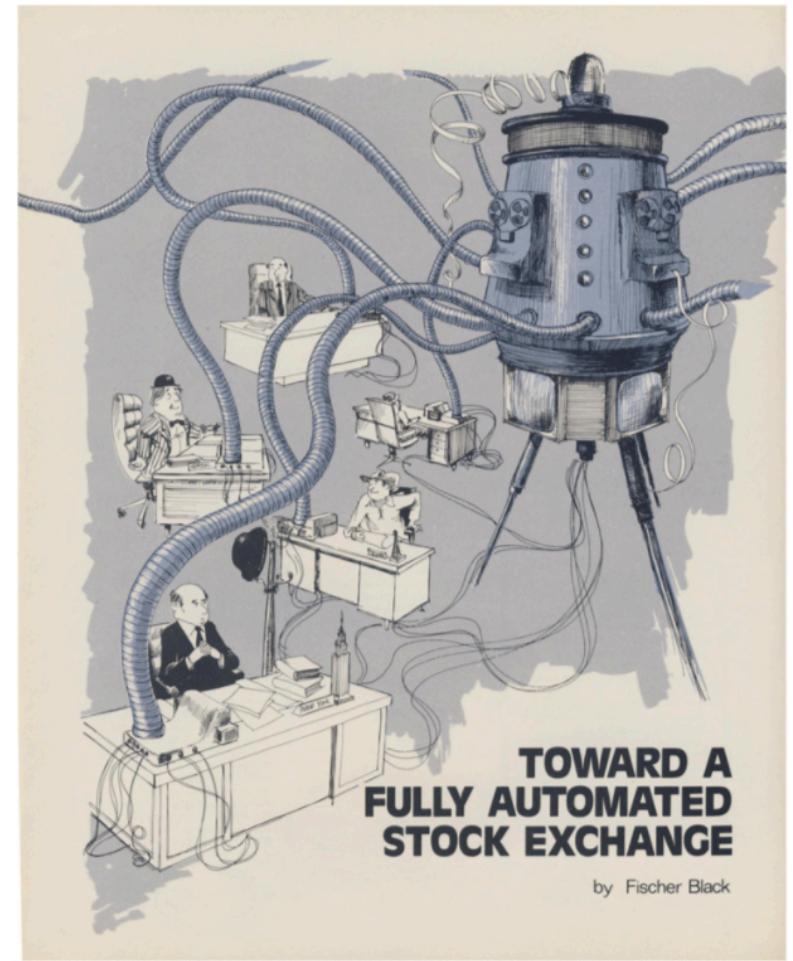
DeFi is fascinating

About me

- Assistant Professor of Finance at KU
- My research: High-frequency trading, Big data, DeFi
- You can find more about my research here: voigtstefan.me

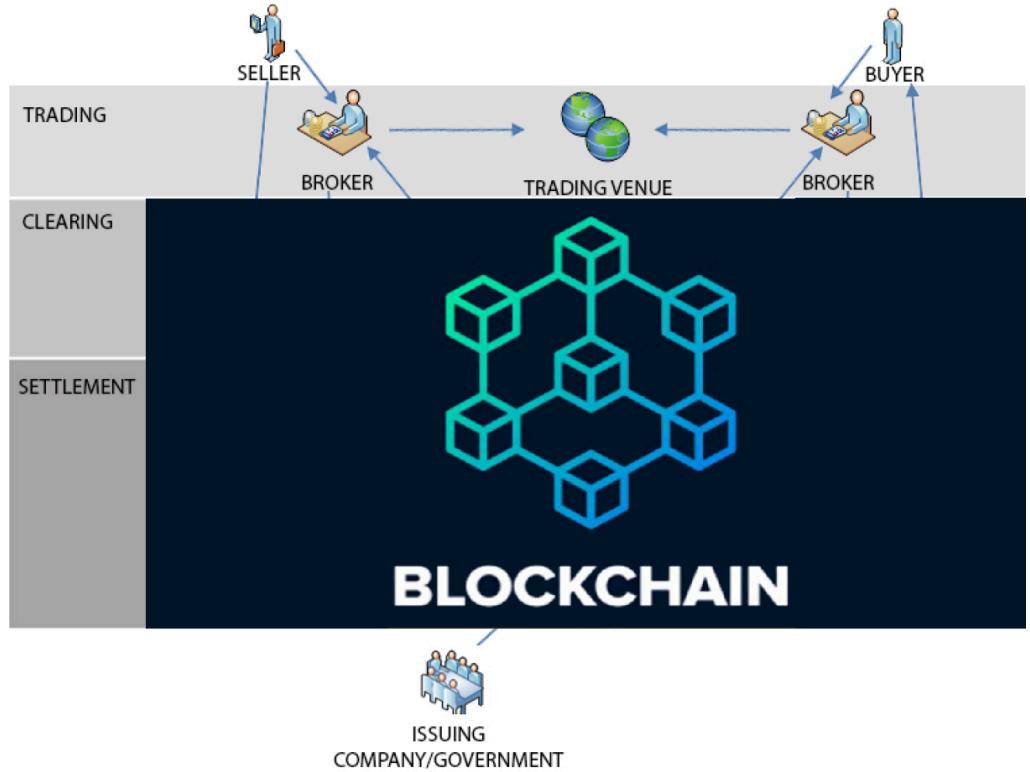
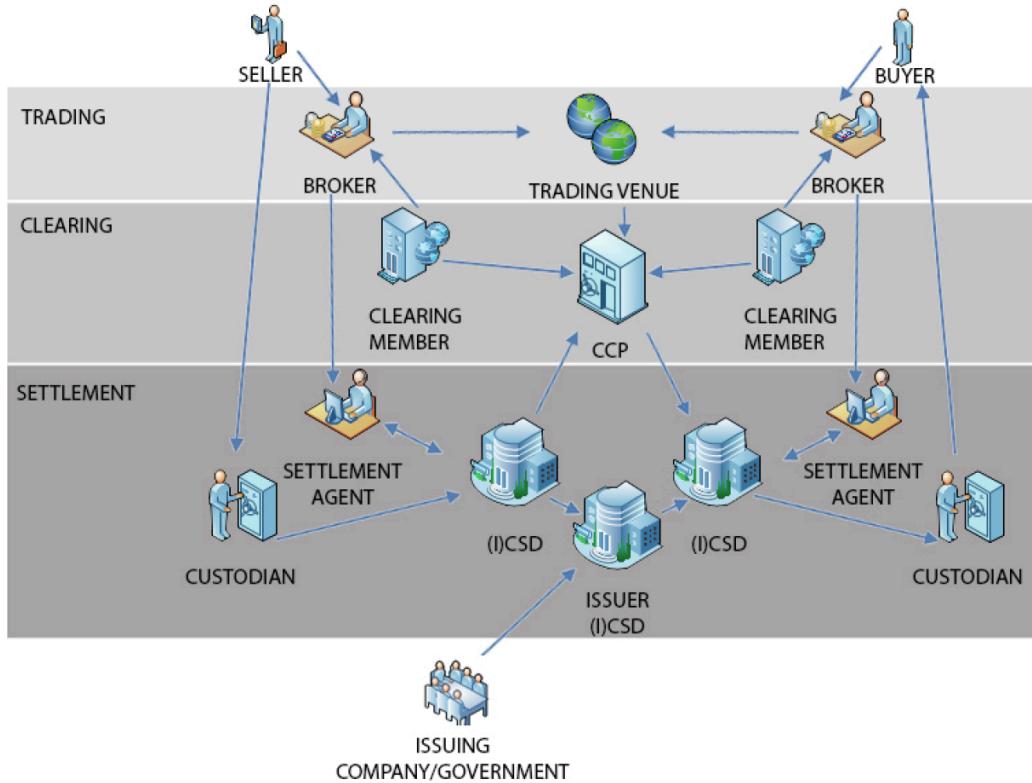
Short outline

- How do we trade?
- Intermediation and blockchain
- Dcentralized Exchanges
- Arbitrage and the DeFi Dilemma



Source: Black (1971)

Blockchain as alternatives to “traditional” markets?

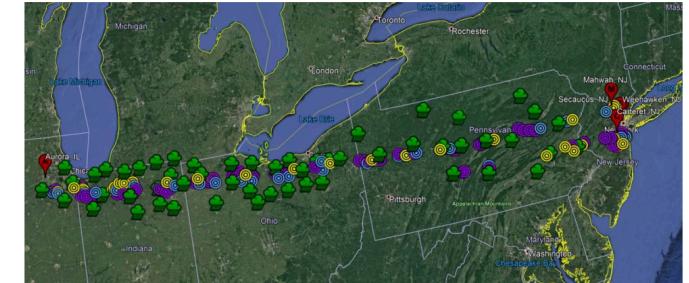
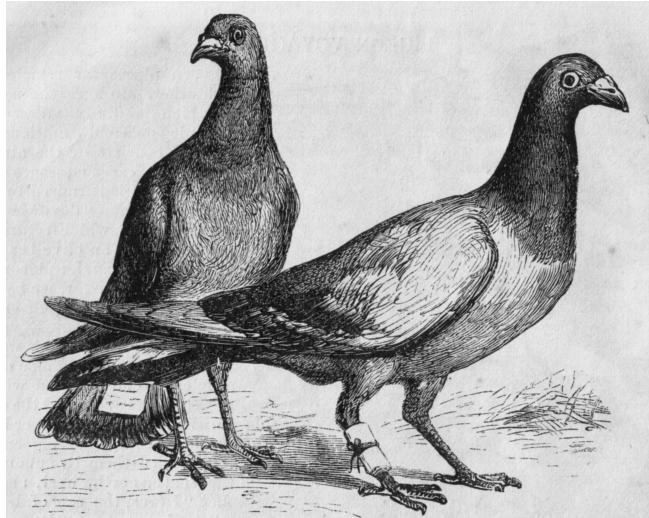


Source: Pinna (2016)

- The way we structure the exchange of goods affects transaction costs, price informativeness, volatility

How do we trade?

- Financial transactions are typically centered around specialized exchanges
- Exchanges serve as matchmakers to connect willing buyers and sellers
- Classical financial markets: dominated by high-frequency trading



Source: Shkilko and Sokolov (2020)

- HFT is not necessarily a bad thing ([Menkveld and Zoican 2017](#))
- HFTs provide liquidity and serve to increase price informativeness
- At the same time: HFTs may affect market fragility
- In this talk we look at similar trade-offs for blockchain-based assets

Counterparty risks render trading costly

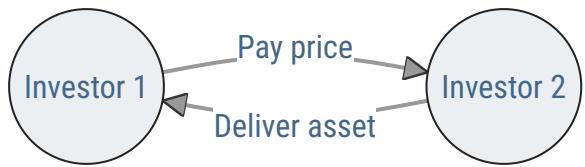


Figure 1: Exchanging goods

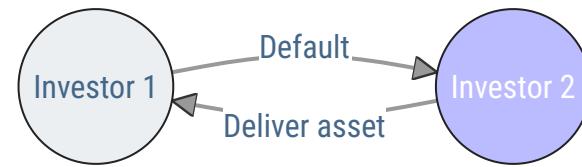


Figure 2: Default on delivery

- Counterparty risk hampers trading
- Traditional solution: Central clearing counterparties (CCCPs)

How can a central intermediary or a blockchain address counterparty risk?

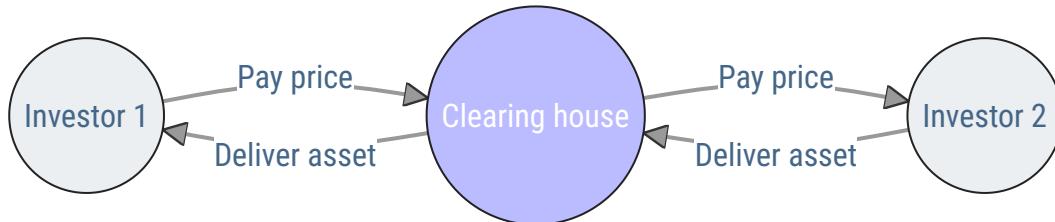


Figure 3: Trading with a central clearing counterparty

- What if CCCPs fail? (Happens, but very rarely ...)
- Blockchain promises to render trusted intermediation obsolete

Desirable properties of blockchain-based settlement

1. Security

- We should be able to rely on the information stored on a blockchain
- Tampering with transactions ex-post should be prohibitively costly

2. Speed

- Transactions should be processed by the validators at high speed to ensure fast information throughput

3. Scalability

- Financial markets process billions of transactions. Blockchain-based trading should be scalable and guarantee a functioning network at reasonable costs even for many transactions
- The blockchain **dilemma**: Compromises are necessary along at least one dimension ([Abadi and Brunnermeier 2022](#))

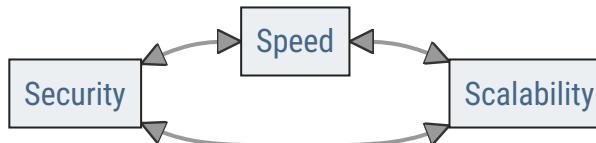


Figure 4: The blockchain dilemma

- Different consensus protocols coexist: PoW, PoS, ... ([Saleh 2020](#); [Biais et al. 2021](#))

Building blocks for Decentralized Finance (DeFi) applications



- (*Pre-Trade Transparency*) Dispersion of validators requires information distribution about pending transactions ([Cong and He 2019](#))
- Trading on a public ledger reveals transactions ex-ante
- More information can be good *and* bad ([Glosten and Milgrom 1985](#))
- (*Transaction fees*) Blocks possess capacity constraints so that validators optimally supply the service of validating transactions in exchange for transaction fees ([Chiu and Koepll 2019](#); [D. Easley, O'Hara, and Basu 2019](#); [Hinzen, John, and Saleh 2022](#))

Blockchain-based asset trading

- Trading venues are the core pillar of any decentralized finance application



CEX (Centralized Exchange)

CEXes keep their order matching systems off-chain, meaning they operate as escrows for their clients without recording transactions on the blockchain. Infamous examples: Mt. Gox, FTX



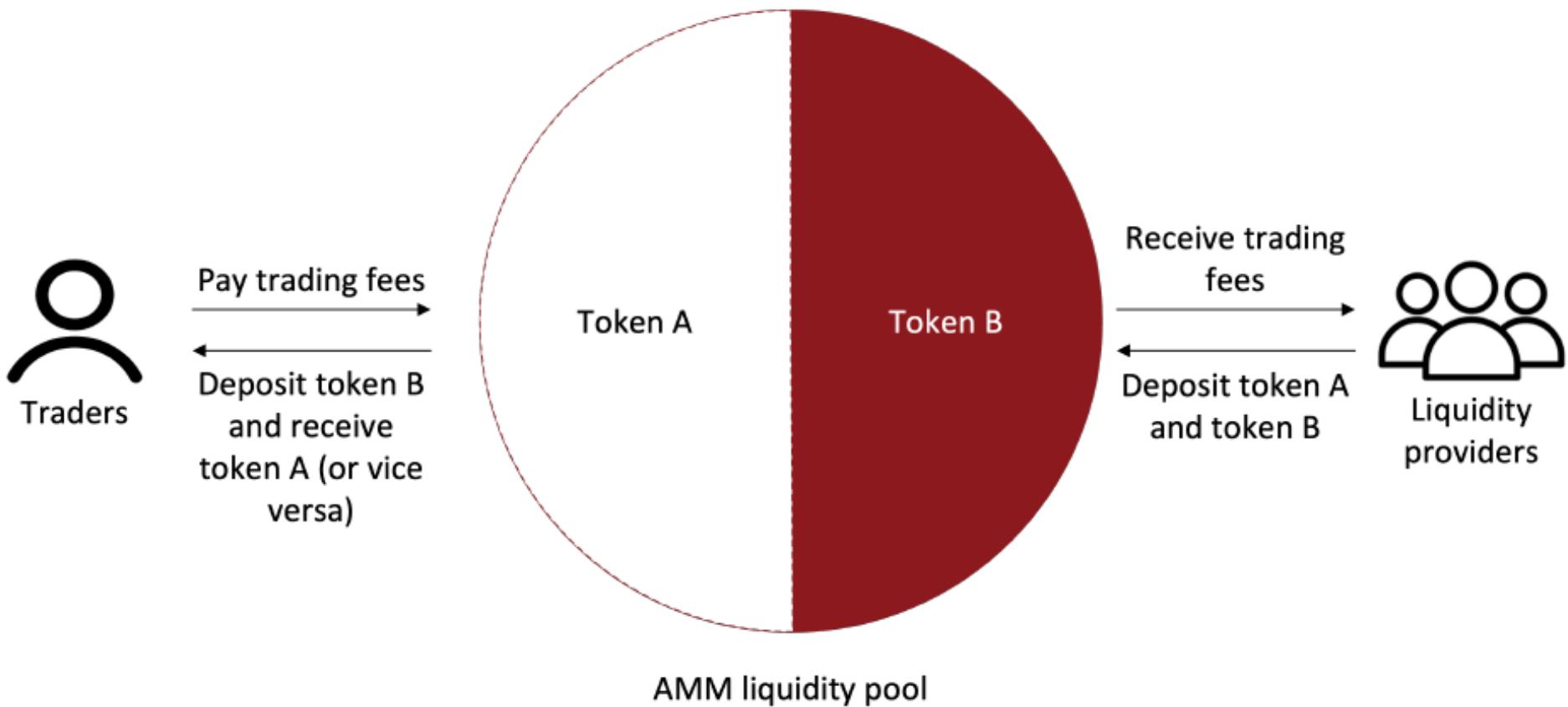
DEX (Decentralized Exchange)

A decentralized exchange (DEX) is a set of smart contracts that interact with each other to facilitate trading of tokens created on the same blockchain ([Harvey, Ramachandran, and Santoro 2021](#); [Lehar and Parlour 2024](#))



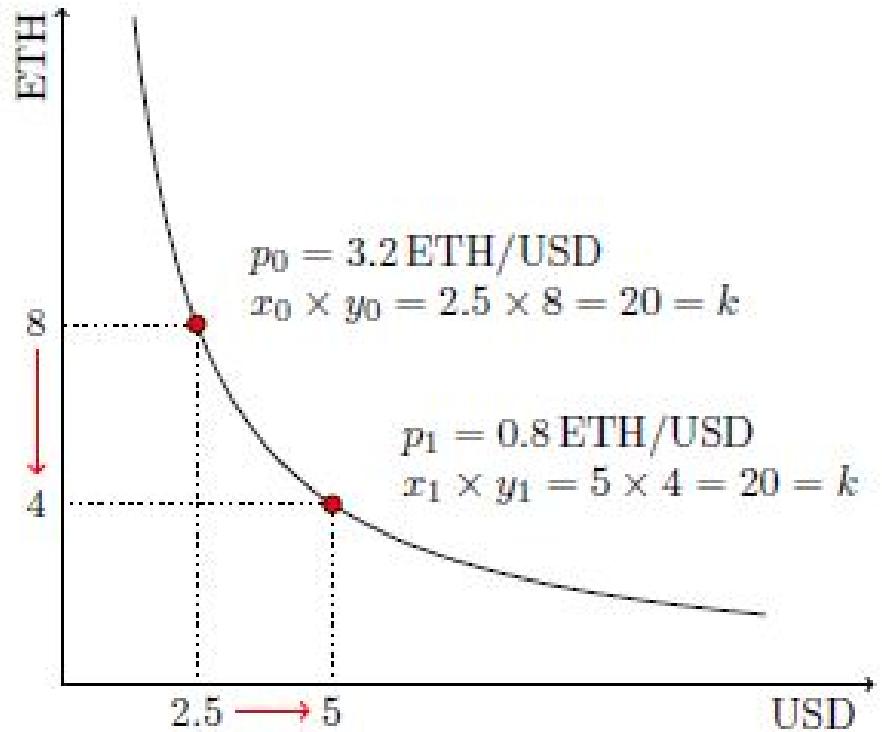
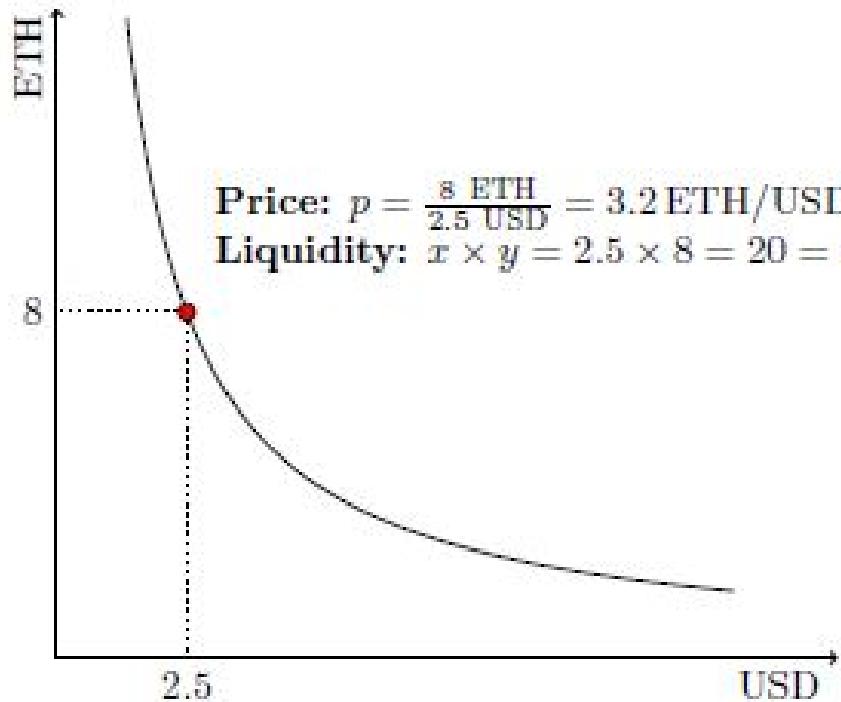
Decentralized Exchanges

- Smart contracts render DEXs pure matchmakers and - in principle - allow for the exchange of assets without any exposure to counterparty risk, execution risk, and limitations to arbitrage capital ([Gromb and Vayanos 2010](#))
- classical HFT seems unfeasible (because of transaction fees)
- instead: price-quantity schedules which liquidity providers populate (e.g. constant product market maker)



Source: Munster (2021)

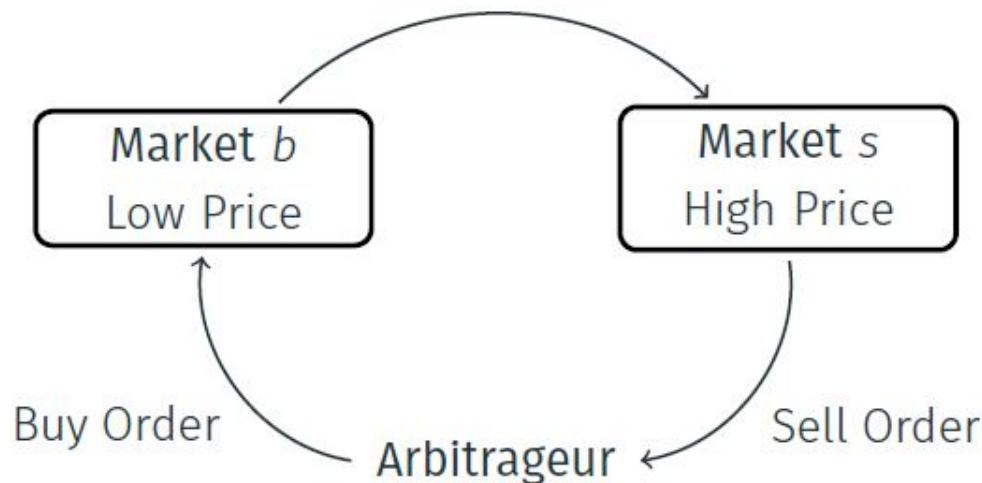
Decentralized Exchanges



- constant product automated market makers are widely adopted across DEXs
- alternatives exist (Sushiswap V3, dYdX)

Do DEXes solve all problems?

- No! On-chain is a blessing but also the central friction
- What matters for the execution priority is the gas fee
- “Like high-frequency traders on Wall Street, bots exploit inefficiencies in DEXes, paying high transaction fees” (Daian et al. 2019)



💡 Transaction Action:

- Swap 16.290806524344807055 Ether For 19,106.558477 USDC On Balancer
- Swap 19,106.558477 USDC For 6,178.07283593 sil On Sushiswap
- Swap 6,165.71669026 sil For 32.98093614065103254 Ether On Sushiswap

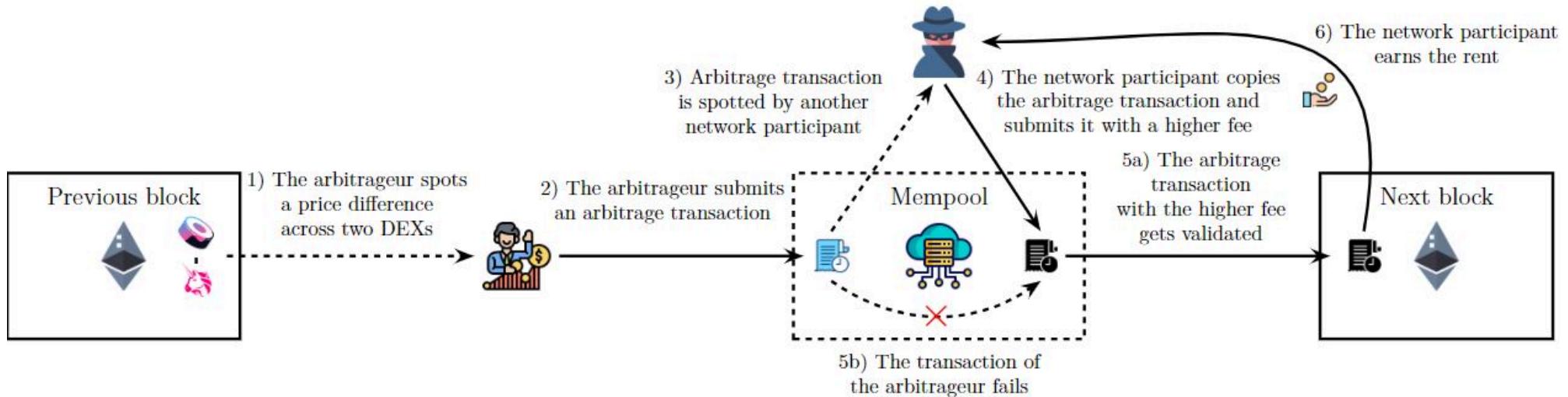
ⓘ Value:

0 Ether (\$0.00)

ⓘ Transaction Fee:

12.006066915817169675 Ether (\$38,161.04)

Arbitrage on DEXes for blockchain-based assets

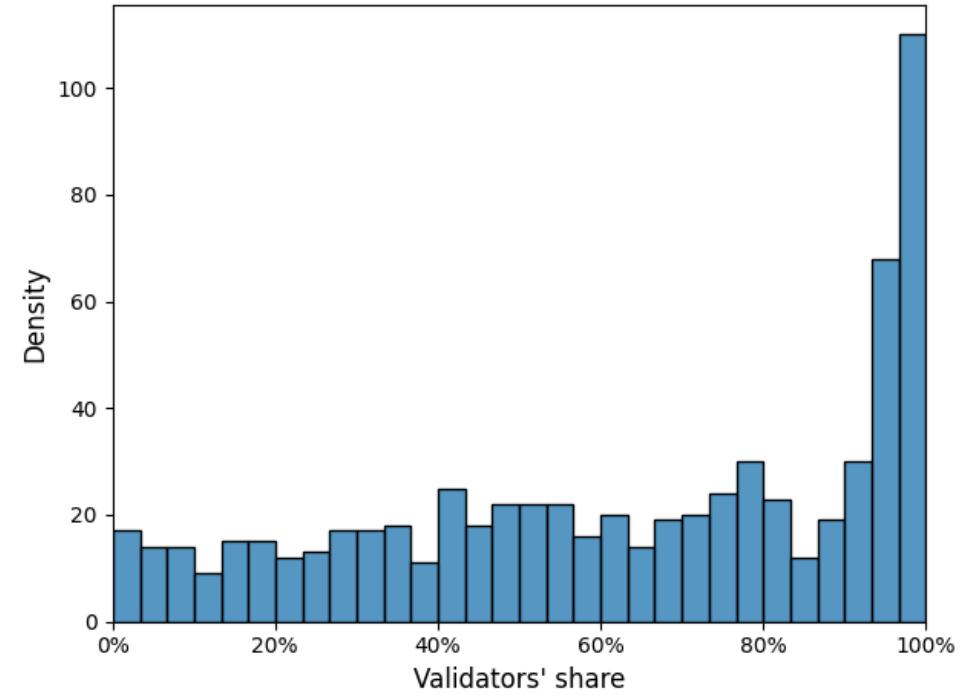


- After an arbitrage transaction is submitted to the network, its value (profit/rent) becomes public information
- Consider the two cases:
 - bid the value of the arbitrage profit (scaring off front-runners) and earn 0 net profit (optimal strategy ([R. F. Easley and Tenorio 2004](#); [Daniel and Hirshleifer 2018](#))
 - deviate and bid a lower transaction fee in hopes of a positive profit. If front-run she earns a 0 gross profit and pays a reversion fee $r > 0$, yielding a loss

With front-running risk, cross-DEX arbitrageurs earns non-positive expected profit

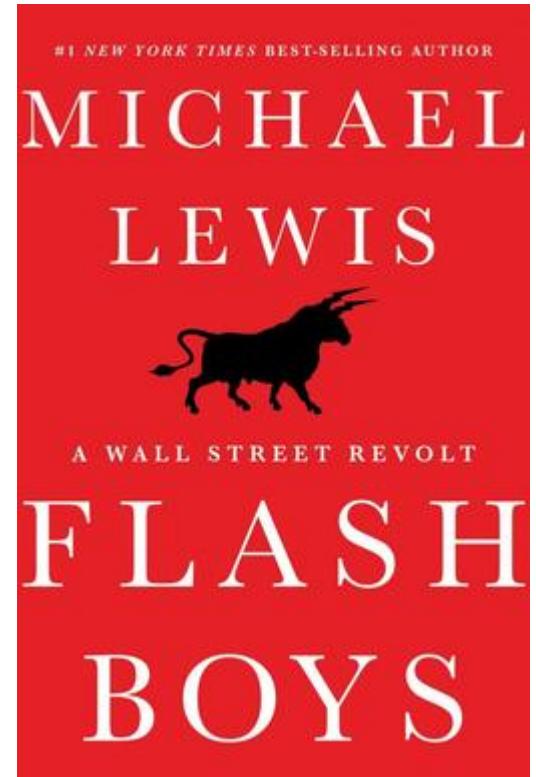
Validators claim on average 64% of the arbitrage profit (Bodisz, Hautsch, Voigt (2024))

- We use granular Flashbots' arbitrage data (December 2020 until August 2022) to identify executed cross-DEX arbitrage transactions
- We document substantial price differences across DEXs. Transaction fees, trading costs, and liquidity cannot explain these violations from the law of one price
- We compute the gross profits from arbitrages, transaction fees/and direct payments to the validators
- Effective median transaction fees are 81% higher than the median transaction settled on the ETH blockchain
- We estimate that 90.8% of the documented price differences could have been eliminated if front-running risk would not prevail



What can be done?

- Good news is: has seen a lot of these issues in the past
- Parts of the DeFi world restore “traditional intermediation” (CEXs, private side-chains, regulation)
- Search for the equilibrium: Nobody should be worse off
- The challenge is: keep everybody on board
- E.g., liquidity providers on DEXes may benefit from frontrunning (HF-trader equivalent)
- Open question: Whom to regulate in DeFi?
 - Relatively easy for CEXes
 - What about DeFi and DEXes?
 - Potential ideas: Random execution order (IEX), Batch Auctions (Budish, Cramton, and Shim (2015)), Price feed from Oracles



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