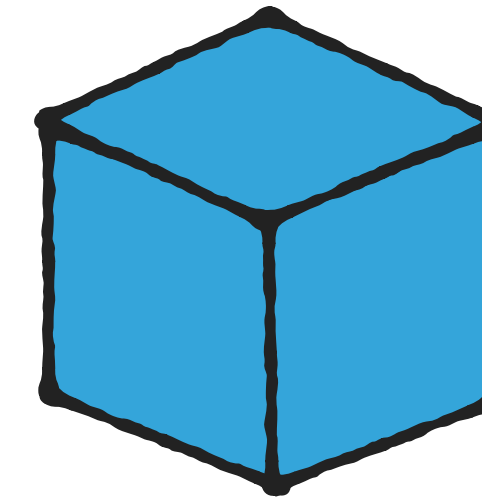
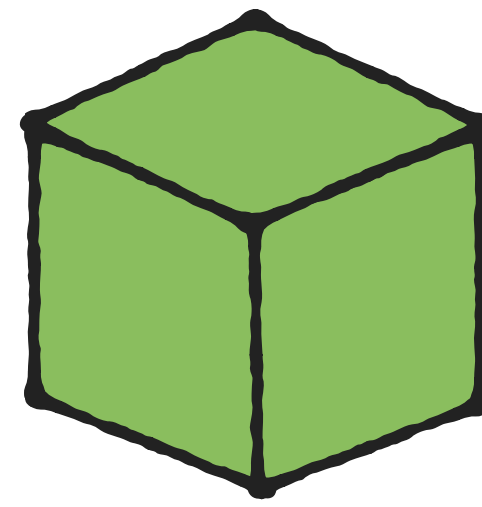
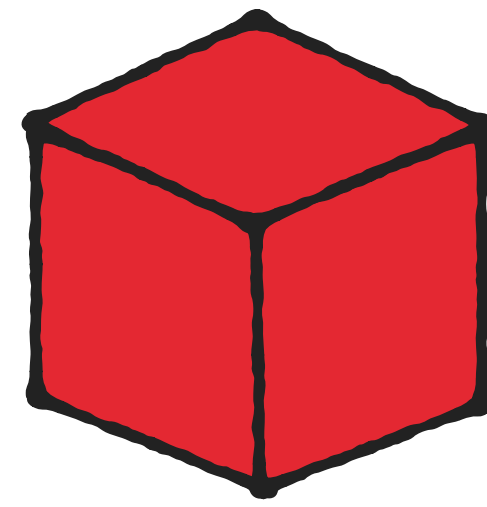




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SDBD'20

Joint w/ Mohamed Alzayat, Balakrishnan Chandrasekaran, and Krishna P. Gummadi



MAX PLANCK INSTITUTE
FOR SOFTWARE SYSTEMS



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UNIVERSITÄT
DES
SAARLANDES

50+ BLOCKCHAIN REAL WORLD USES CASES

GOVERNMENT

Essentia develops world's first blockchain solution to manage international logistics hub together with Traffic Labs and the Finnish Government

 **essentia.one**

IDENTIFICATION

Voter registration is being facilitated via a blockchain project in Switzerland spearheaded by Uport.

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INSURANCE

A smart contract-based blockchain is being used by Insurer American International Group Inc as a means of saving costs and increasing transparency.

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The protection of endangered species is being facilitated via a blockchain project that records the activities of these rare animals.



CARBON OFFSETS

IBM is using the Hyperledger Fabric blockchain in China to monitor carbon offset trading.

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 **HYPERLEDGER**

ENTERPRISE

Ethereum's blockchain can be accessed as a cloud-based service courtesy of Microsoft Azure.

 **Microsoft Azure**

BORDER CONTROL

Essentia has devised a border control system that would use blockchain to store passenger data in the Netherlands.

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SUPPLY CHAINS

IBM and Walmart have partnered in China to create a blockchain project that will monitor food safety.

 **IBM**

 **Walmart**

HEALTHCARE

A number of healthcare systems that store data on the blockchain have been pioneered including MedRec.

 **MEDREC**

SHIPPING

Shipping is a natural fit for blockchain, and Maersk have been trialling a blockchainbased project within the maritime logistics industry.

 **MÆRSK**

REAL ESTATE

Blockchain is now being used to complete real estate deals, the first of which was conducted in Kiev by Propy.

 **PROPY**

ENERGY

Essentia is developing a test project that will help energy suppliers track the distribution of their resources in real time, whilst maintaining data confidentiality.

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LAND REGISTRY

Land registry titles are now being stored on the blockchain in Georgia in a project developed by the National Agency of Public Registry.

 **NATIONAL AGENCY of PUBLIC REGISTRY**

COMPUTATION

Digital Currency Group are helping Amazon Web Services examine ways in which the distributed ledger technology can help improve database security.

 **DIGITAL CURRENCY GROUP**

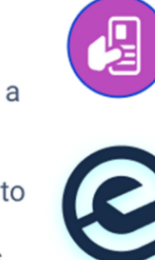
ADVERTISING

New York Interactive Advertising Exchange has been experimenting with blockchain as a means of providing an ads marketplace for publishers.

 **NYIAX**

BORDER CONTROL

Essentia is developing a blockchain project for border control that will allow customs agents to record passenger data from an array of inputs and safely store it.

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JOURNALISM

Decentralized journalism, as enabled by blockchain technology, has the potential to prevent censorship and increase transparency, as Civil has shown.

 **CIVIL**

WASTE MANAGEMENT

Waltonchain is using RFID technology to store waste management data on the blockchain in China.

 **WALTONCHAIN**

ENERGY

Food importation is another industry where blockchain is proving its worth, with Louis Dreyfus Co trialling a soybean importation operation using this technology.

 **LDC**

DIAMONDS

The De Beers Group is using blockchain to track the importation and sale of diamonds.

 **DE BEERS GROUP OF COMPANIES**

FINE ART

By storing certificates of authenticity on the blockchain, it's possible to dramatically reduce art forgeries, as one blockchain project is proving.



NATIONAL SECURITY

For the past two years, the US Department of Homeland Security has been using blockchain to record and safely store data captured from its security cameras.

 **U.S. DEPARTMENT OF HOMELAND SECURITY**

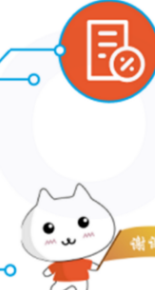
TOURISM

In a bid to boost its tourism economy, Hawaii is examining ways in which blockchain-based cryptocurrencies can be adopted throughout the US state.

 **STATE OF HAWAII**

TAXATION

In China, a tax-based initiative is using blockchain to store tax records and electronic invoices led by Miaocai Network.

 **MIAOCAI NETWORK**

ENERGY

Chile's National Energy Commission has started using blockchain technology as a way of certifying data pertaining to the country's energy usage as it seeks to update its electrical infrastructure.

 **CNE COMISIÓN NACIONAL DE ENERGÍA**

RAILWAYS

Russian rail operator Novotrans is storing inventory data on a blockchain pertaining to repair requests and rolling stock

 **НОВОТРАНС**

ENTERPRISE

Google is building its own blockchain which will be integrated into its cloud-based services, enabling businesses to store data on it, and to request their own white label version developed by Alphabet Inc

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 **Alphabet**

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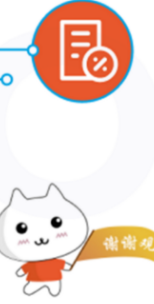
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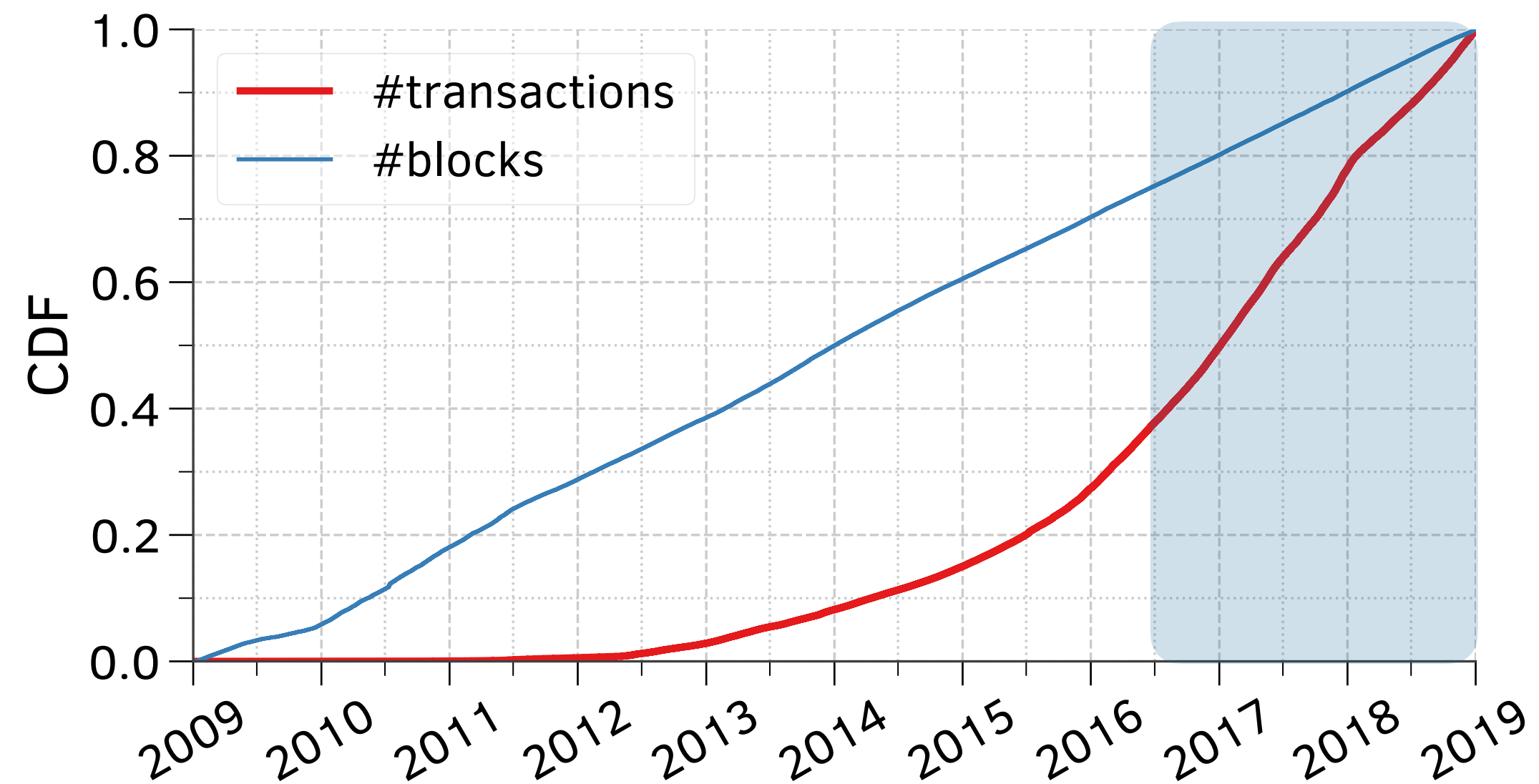
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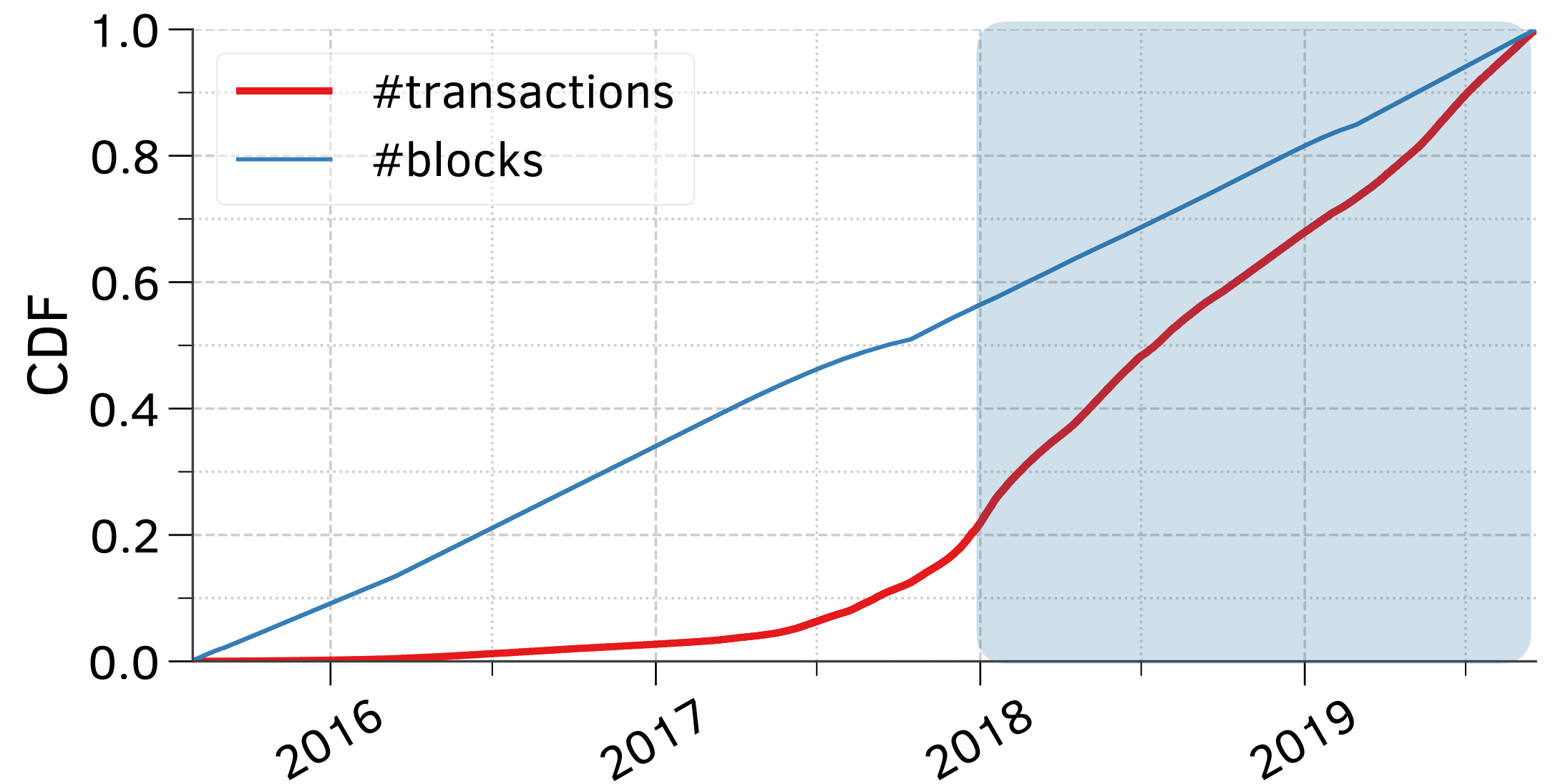
The Current Status of the Top-2 Blockchains

Bitcoin



60% of all transactions were added in the last **2.5** years

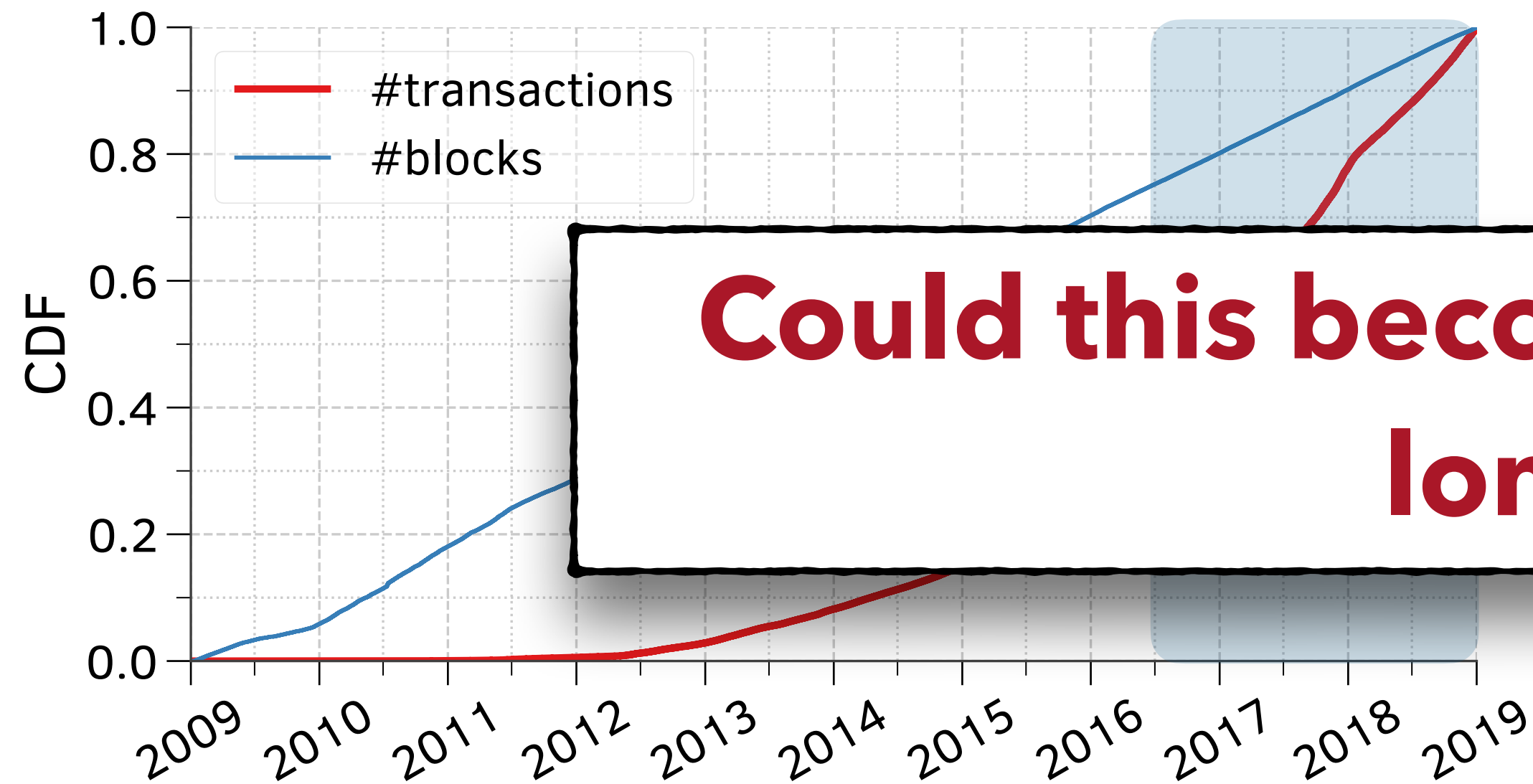
Ethereum



80% of all transactions were added in the last **1.5** years

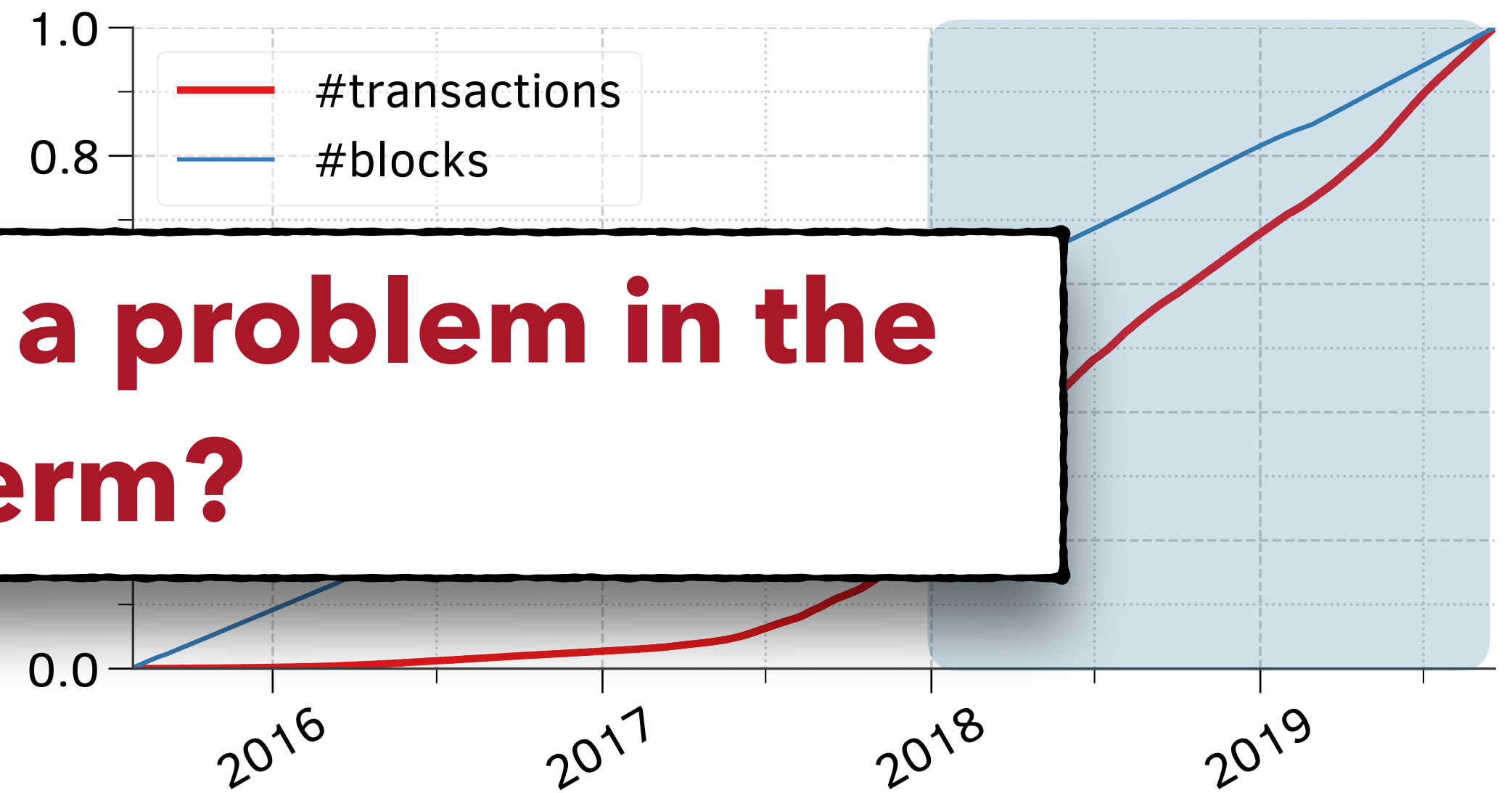
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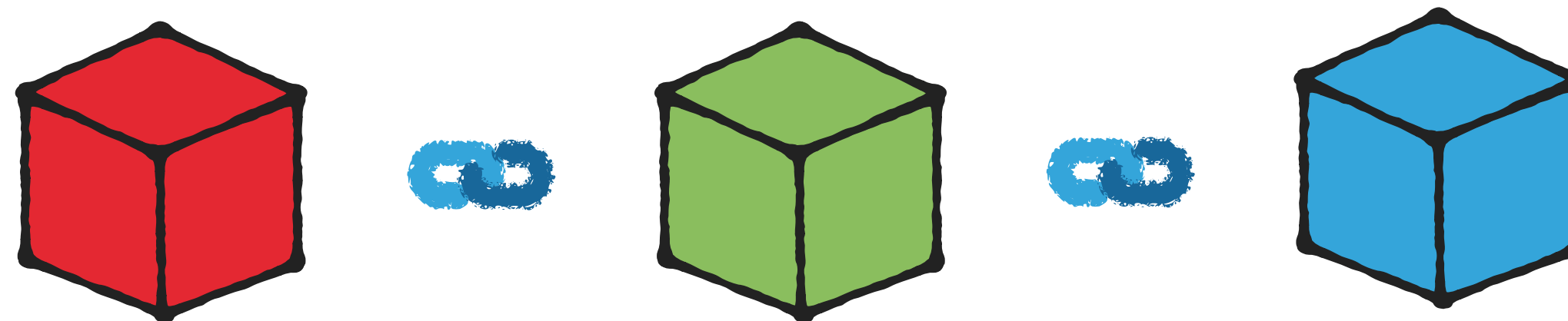
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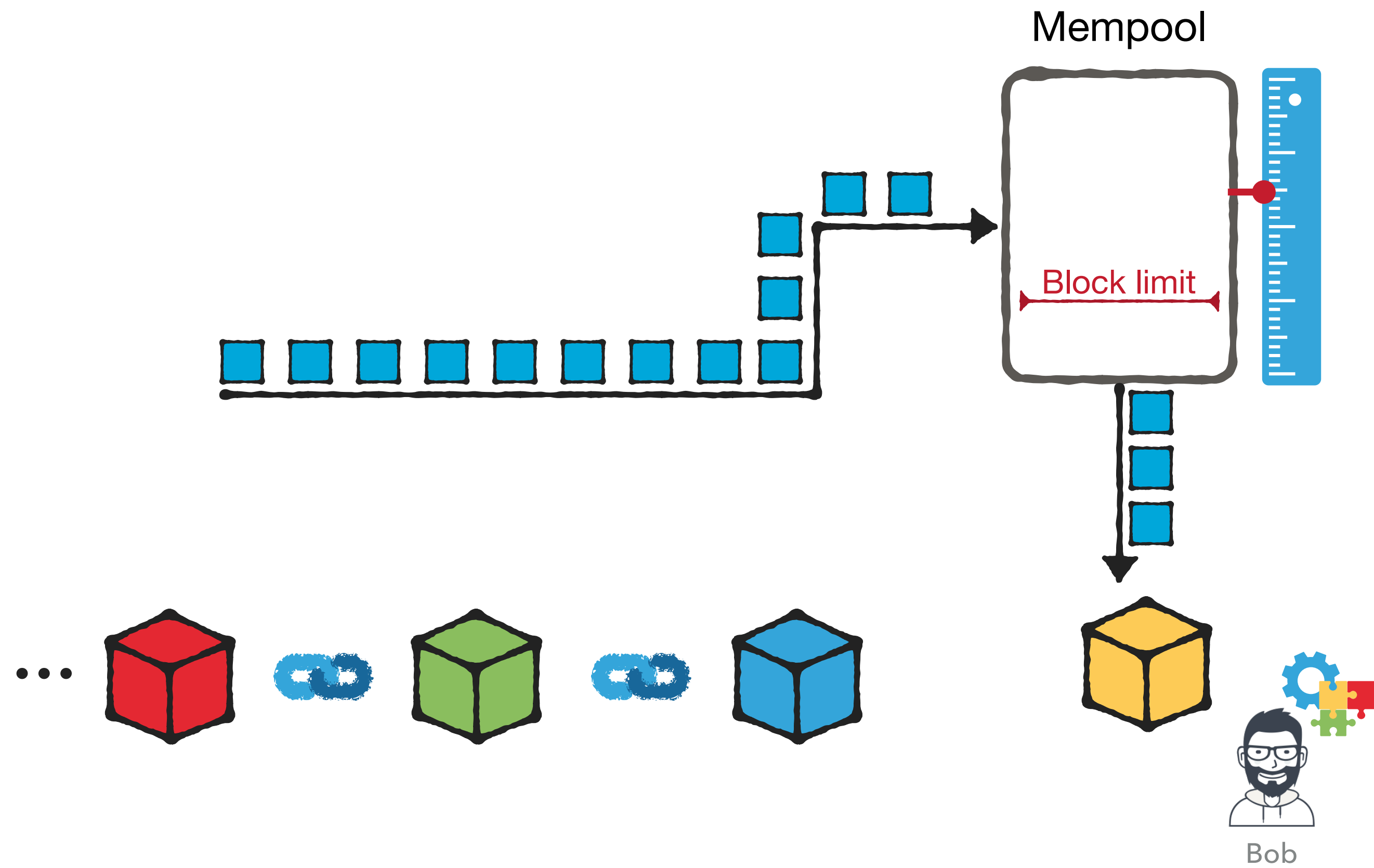
Could This Become a Problem?

- ▶ The common wisdom: transactions are prioritized based on fee-per-byte
 - ▶ There is no guarantee that it has been followed!
- ▶ Are miners "fair" on the transaction order?
- ▶ We want to investigate how miners order transactions!



How Transactions Are Selected?

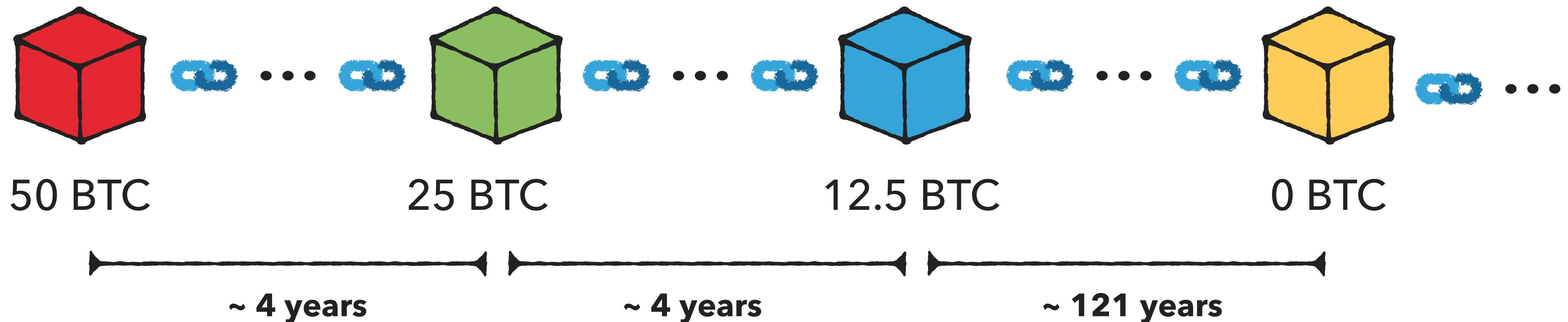
How Transactions Are Selected?



Mining and Rewards

- ▶ Miners get block reward + transaction fees
- ▶ Block reward halves every 4 years
- ▶ In the future, it will become 0!
 - ▶ Fees will be the main mining incentive

Block Reward



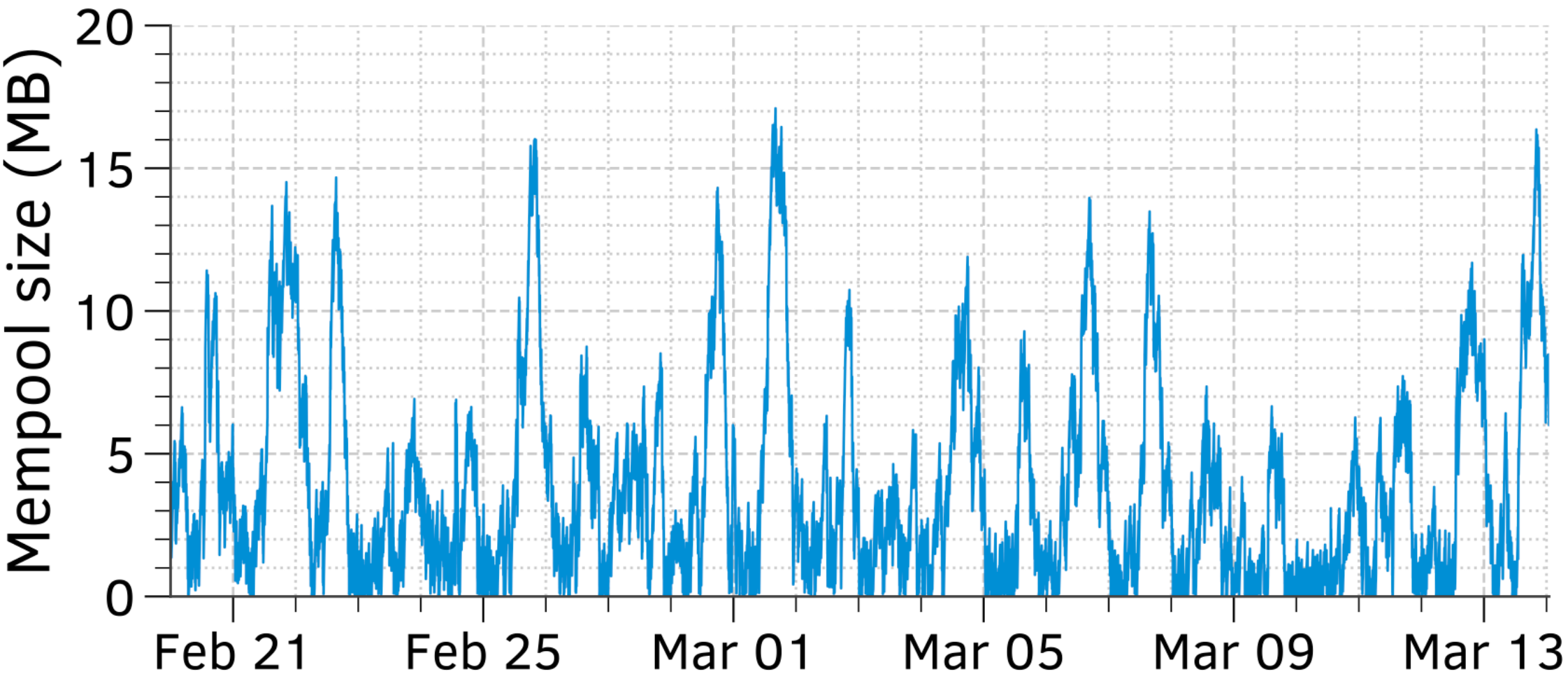
**What Do Transactions Look
Like?**

Blockchain Data Set

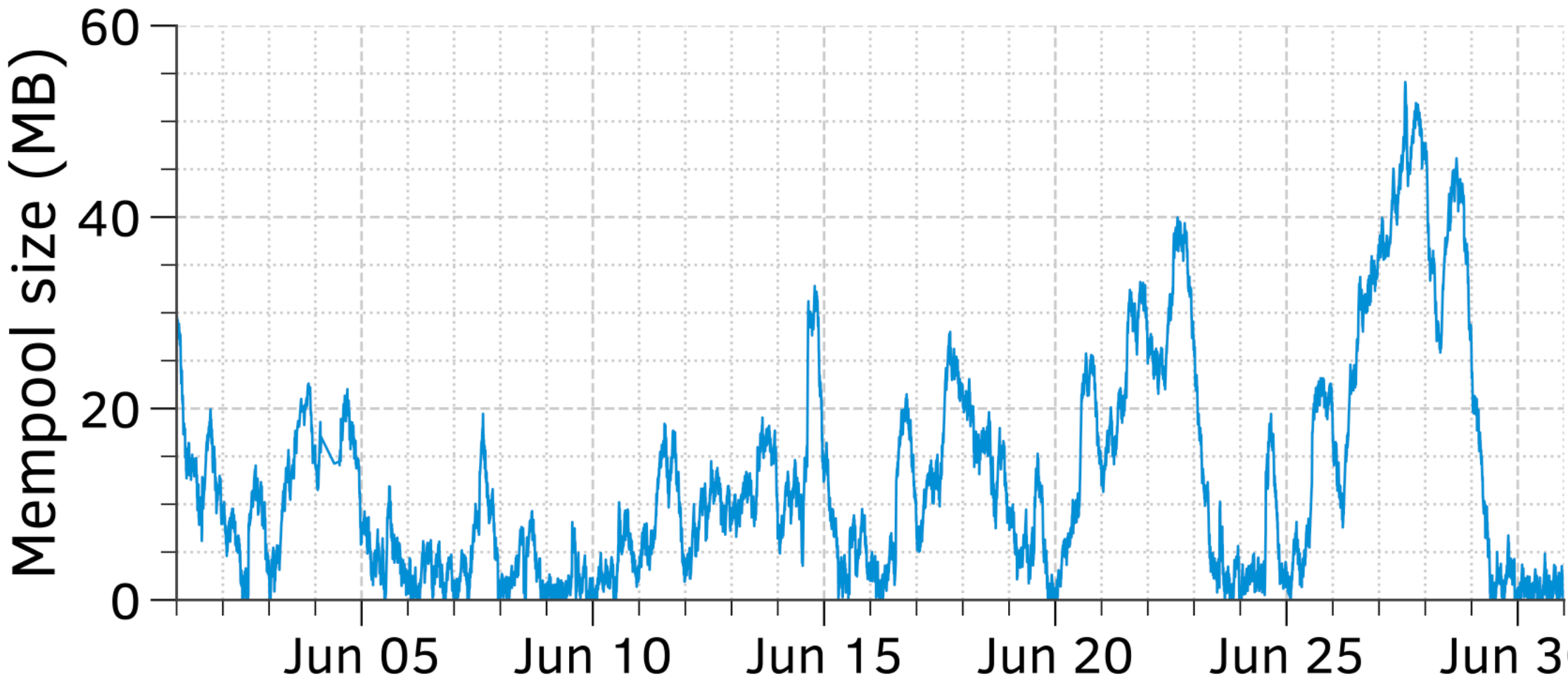
- ▶ We deploy a Bitcoin Full-Node
 - ▶ Gather data from Mempool!

<i>Attributes</i>	<i>Data set A</i>	<i>Data set B</i>
Times span	Feb. 20th – Mar. 13th, 2019	Jun.1st – 30th, 2019
#trans. committed	6,816,375	10,487,966
#blocks	3,119	4,522
#empty-blocks	38	18

Blockchain Data Set



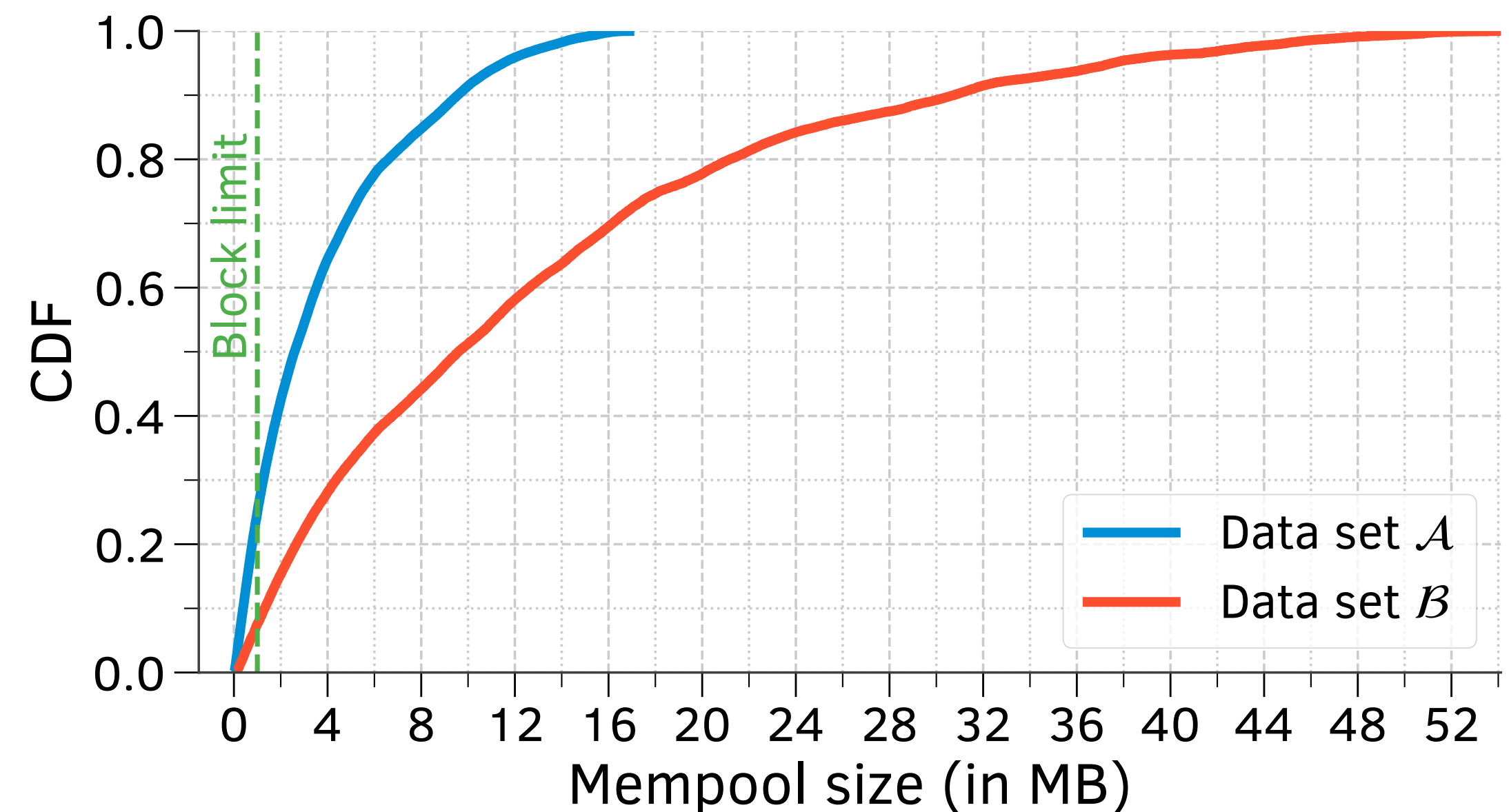
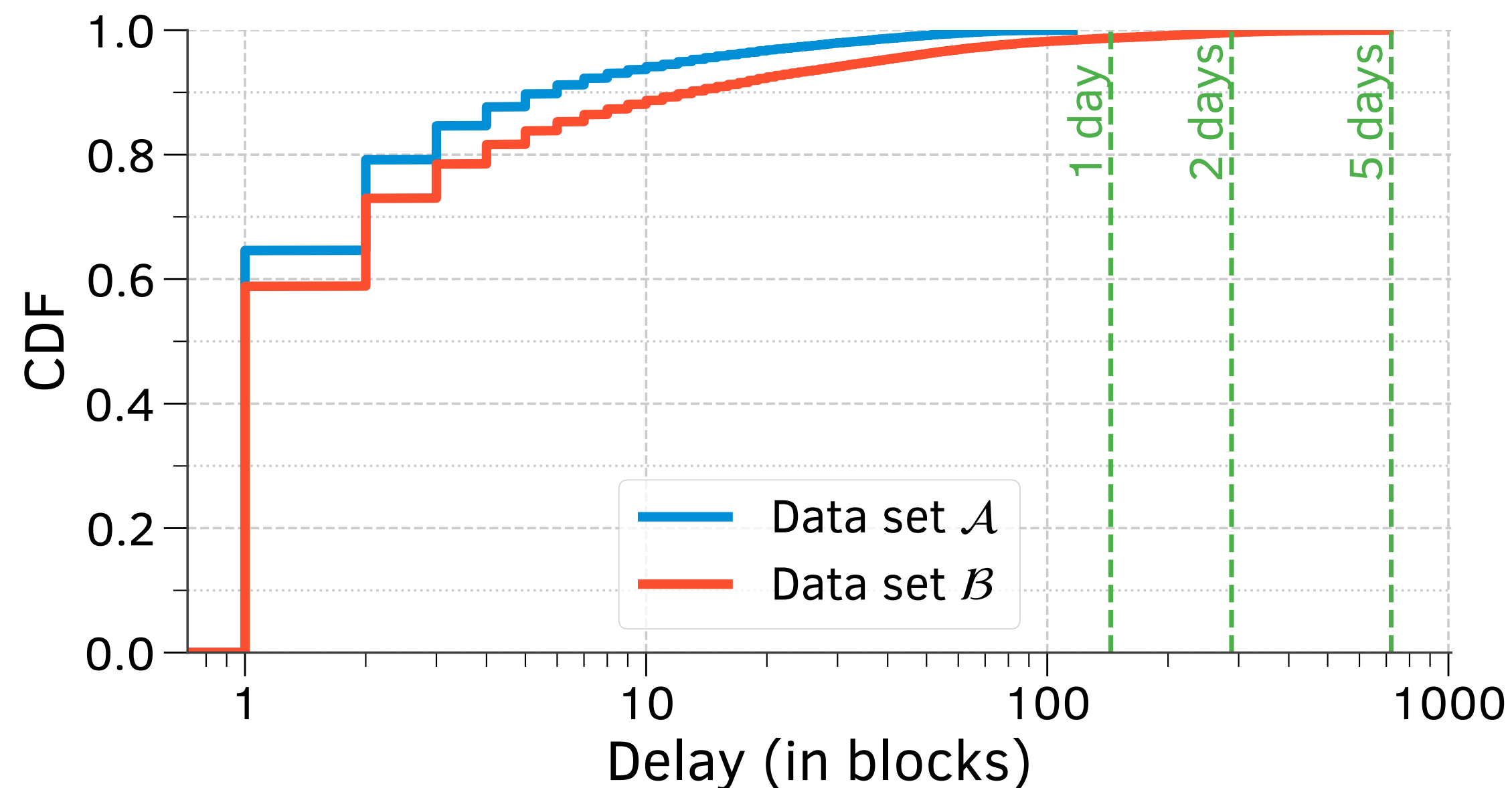
Data set *A*



Data set *B*

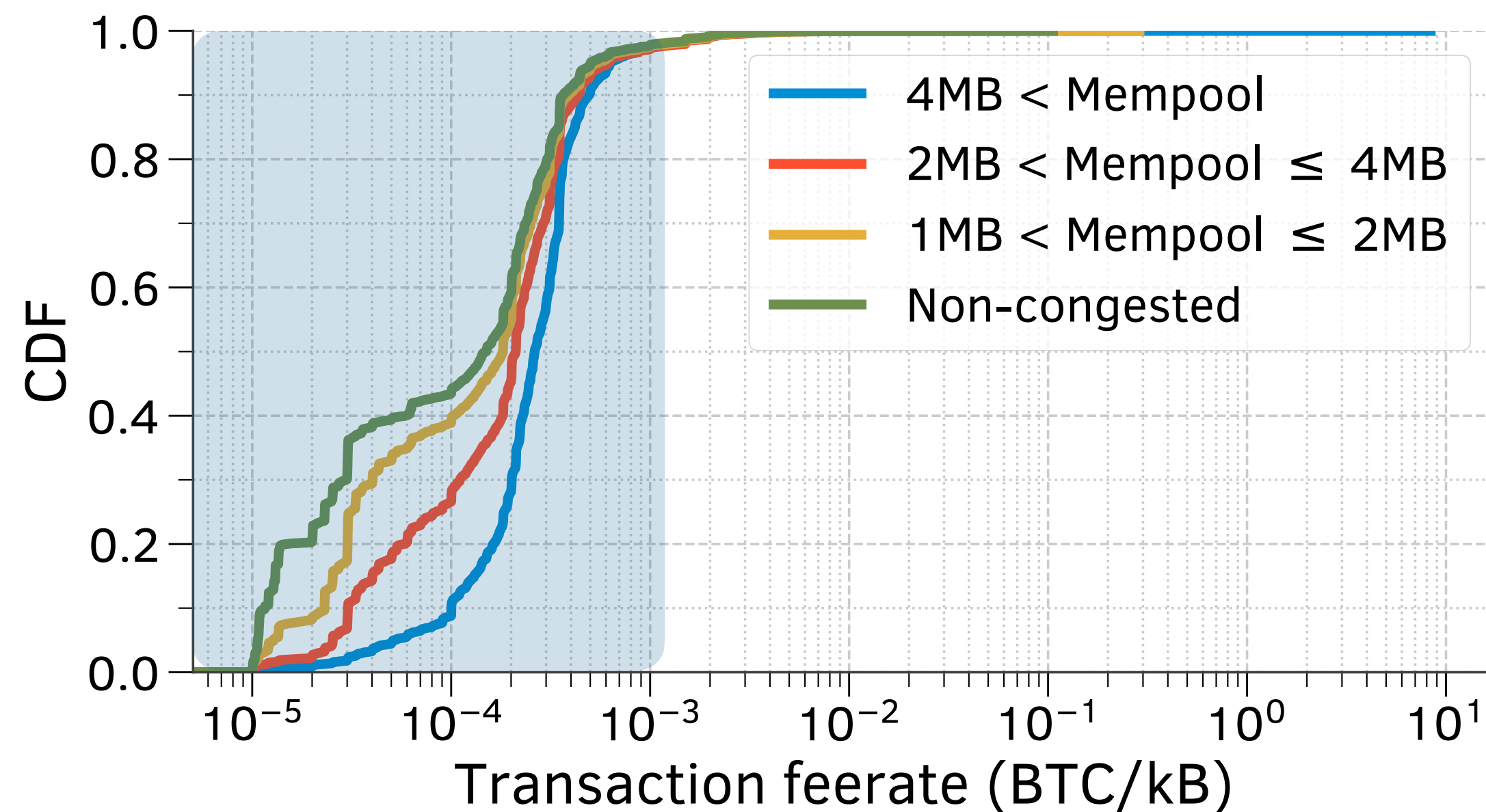
Is Mempool Congested?

- ▶ The fear of the ever-growing commit times
- ▶ Transaction **commit times vary!**
- ▶ Mempool is **congested in** at least **75%**, and **92%** for data sets $\mathcal{A}$ and $\mathcal{B}$, respectively!

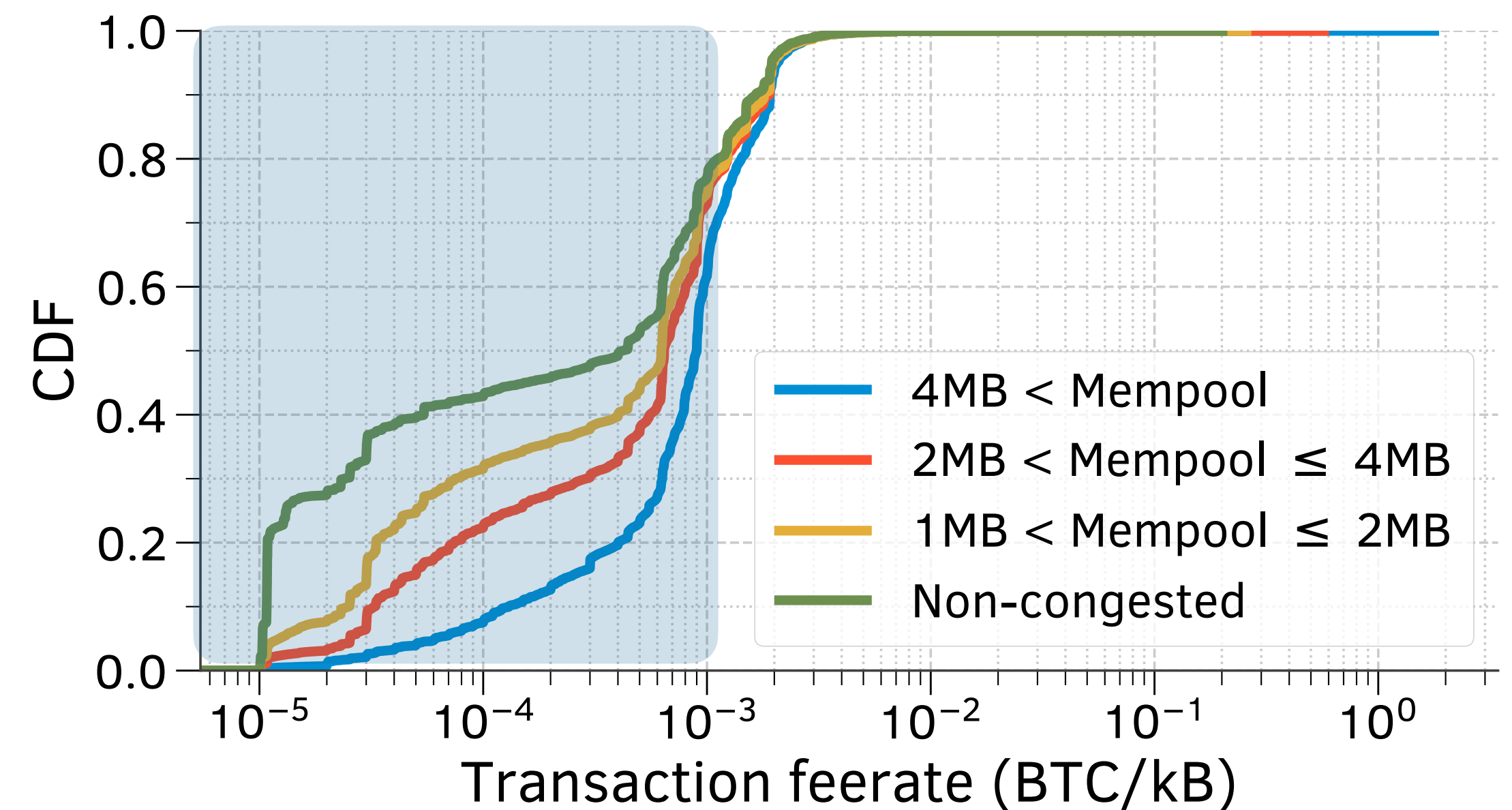


Do People Pay More When There Is Congestion?

- ▶ Fee rate increases during periods of congestion.
- ▶ Transactions fee rate increases proportionally to the level of congestion.



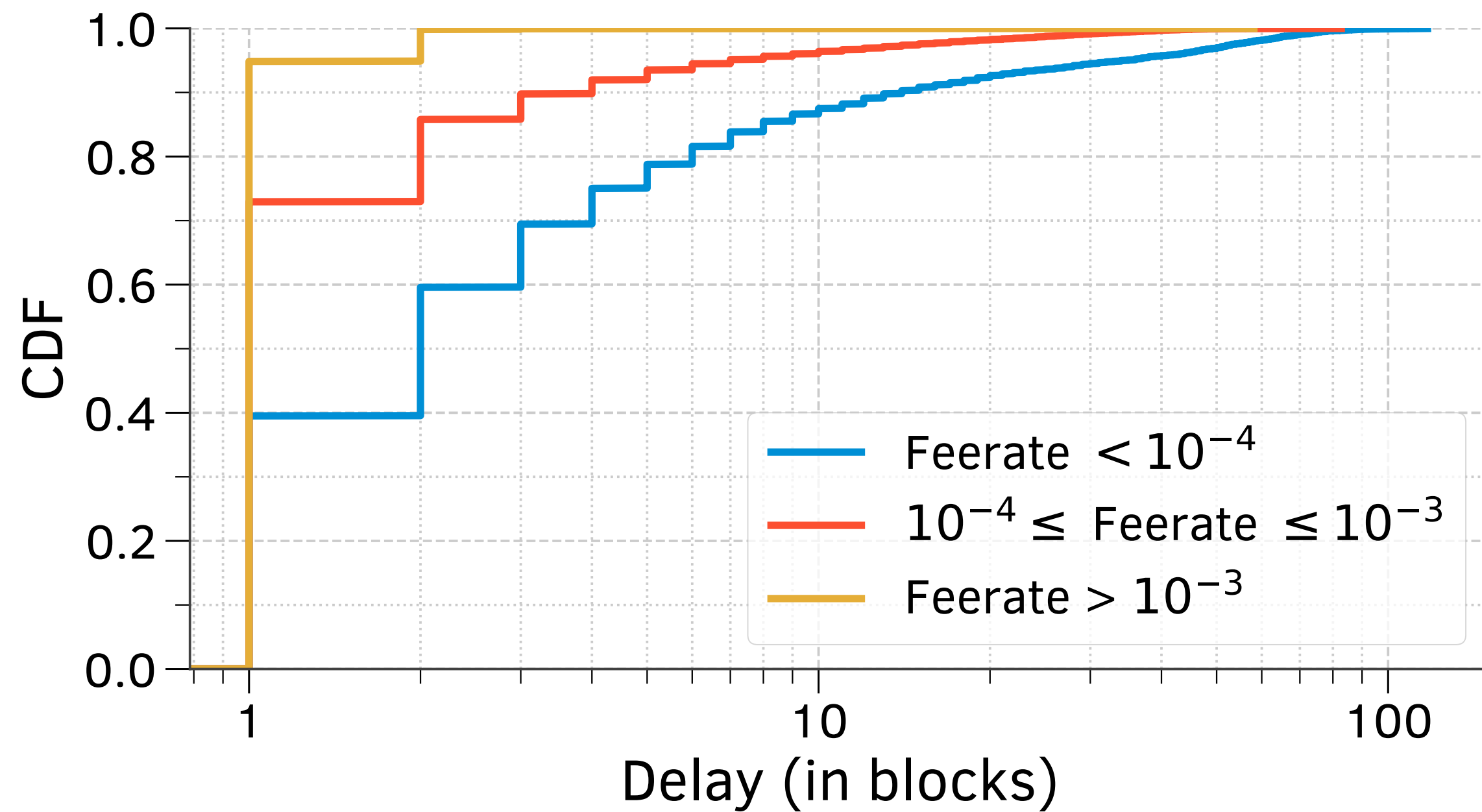
Dataset *A*



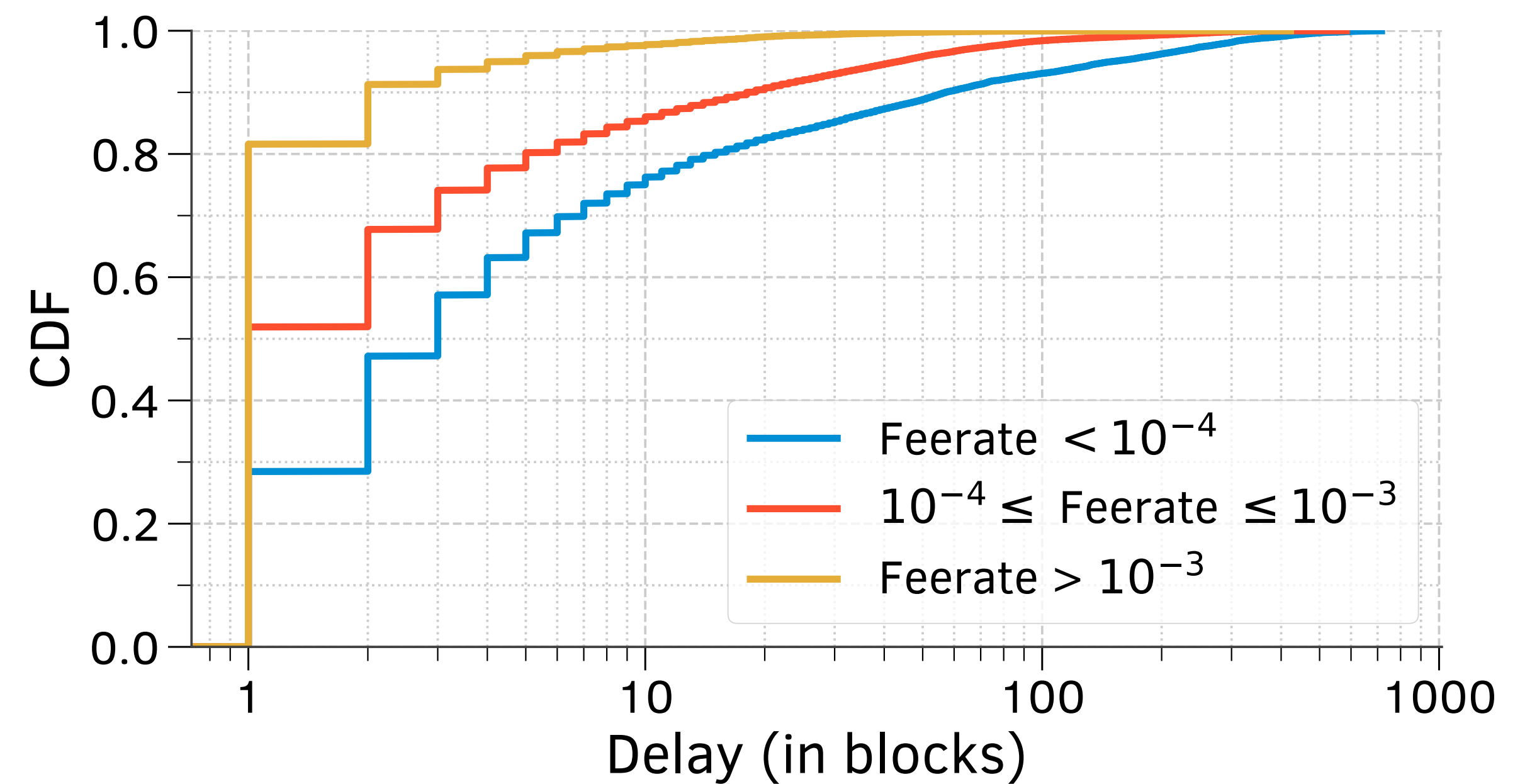
Dataset *B*

Do High Feerate Transactions Suffer Fewer Delays?

- ▶ High fee rate results in decreasing the commit delays!
- ▶ In both data sets



Dataset *A*

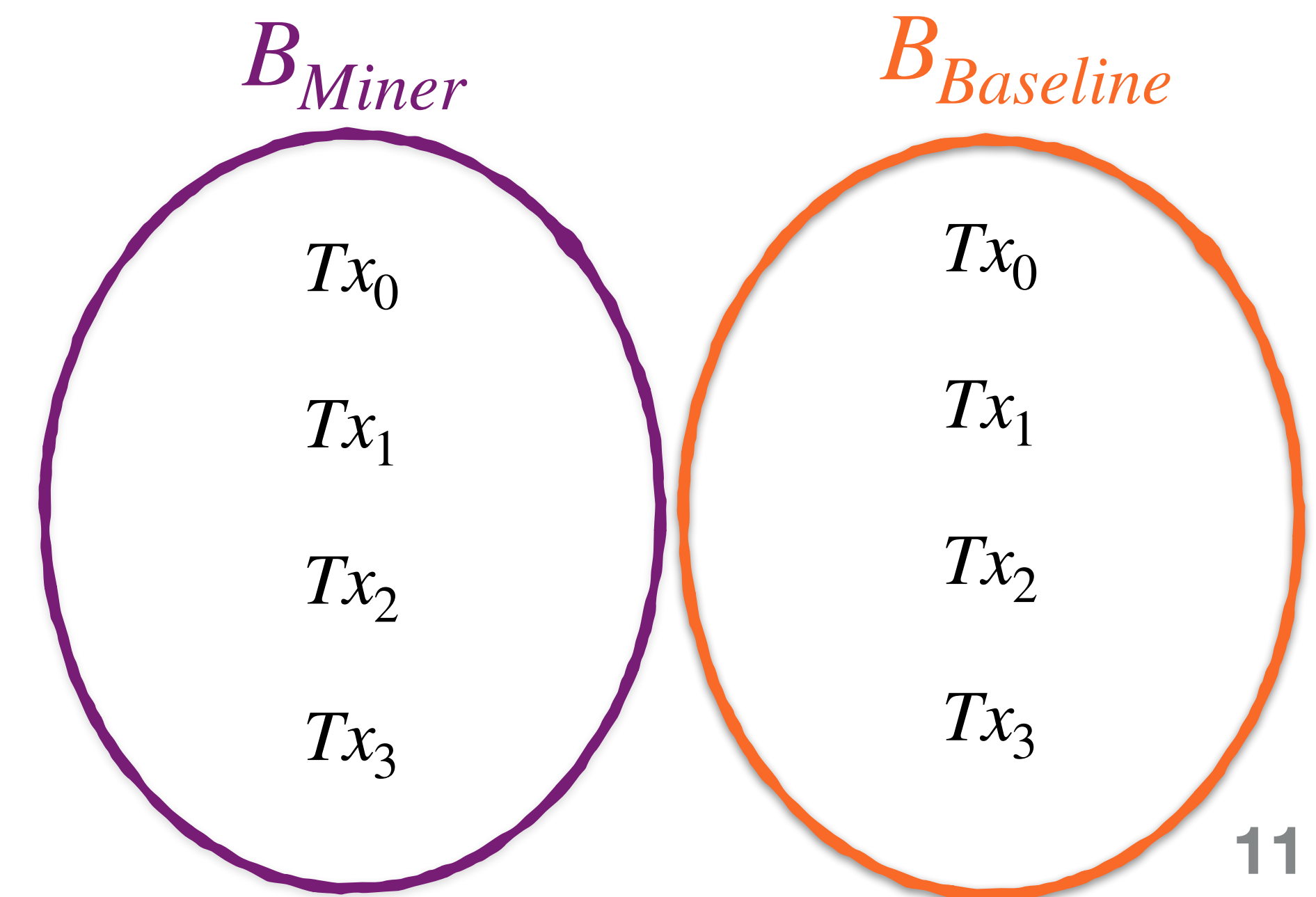


Dataset *B*

**Do Miners Follow the
Common Wisdom?**

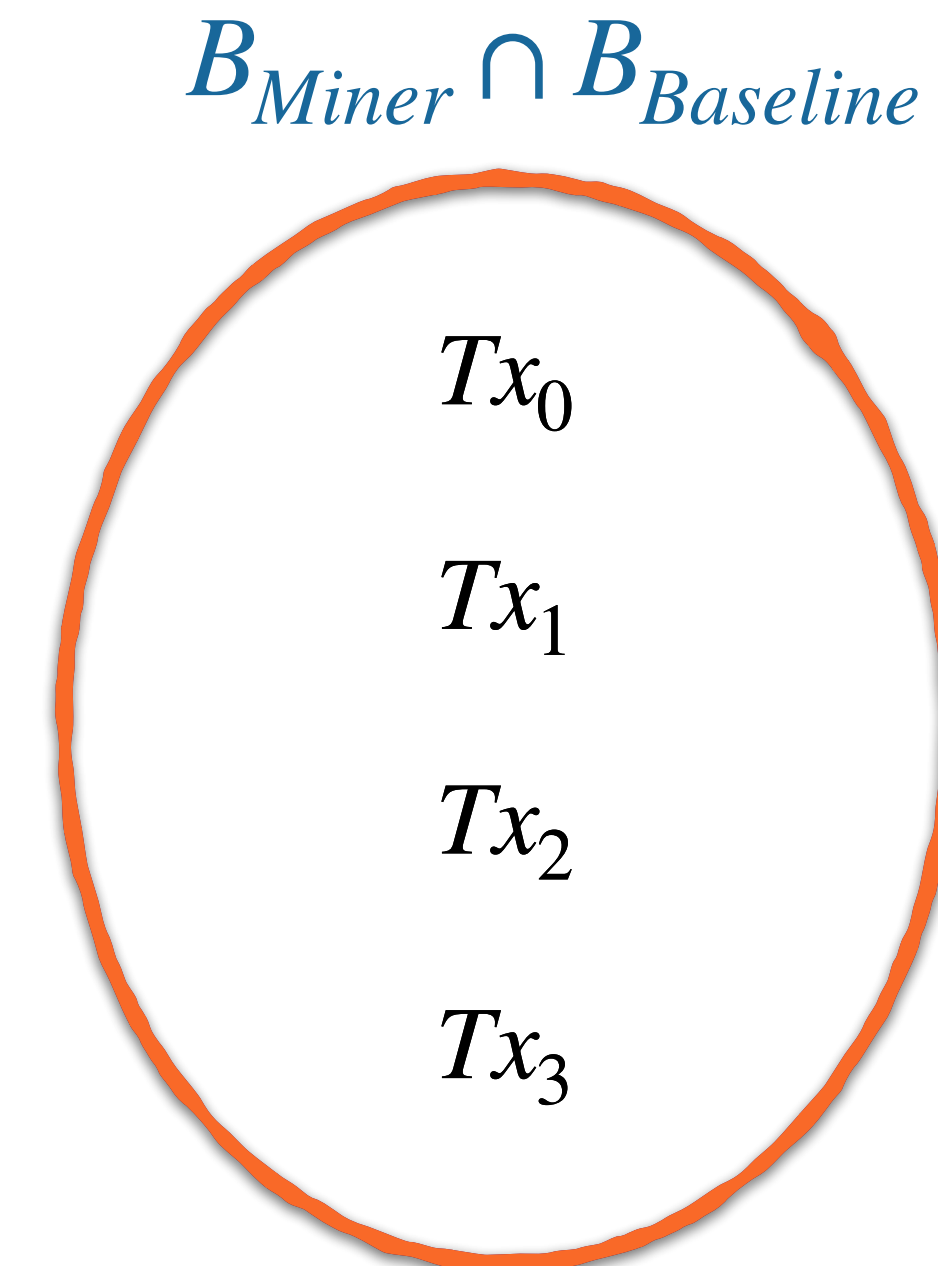
Establishing a Baseline

- ▶ Actual block: B_{Miner}
- ▶ Baseline (fee-per-byte ordering): $B_{Baseline}$



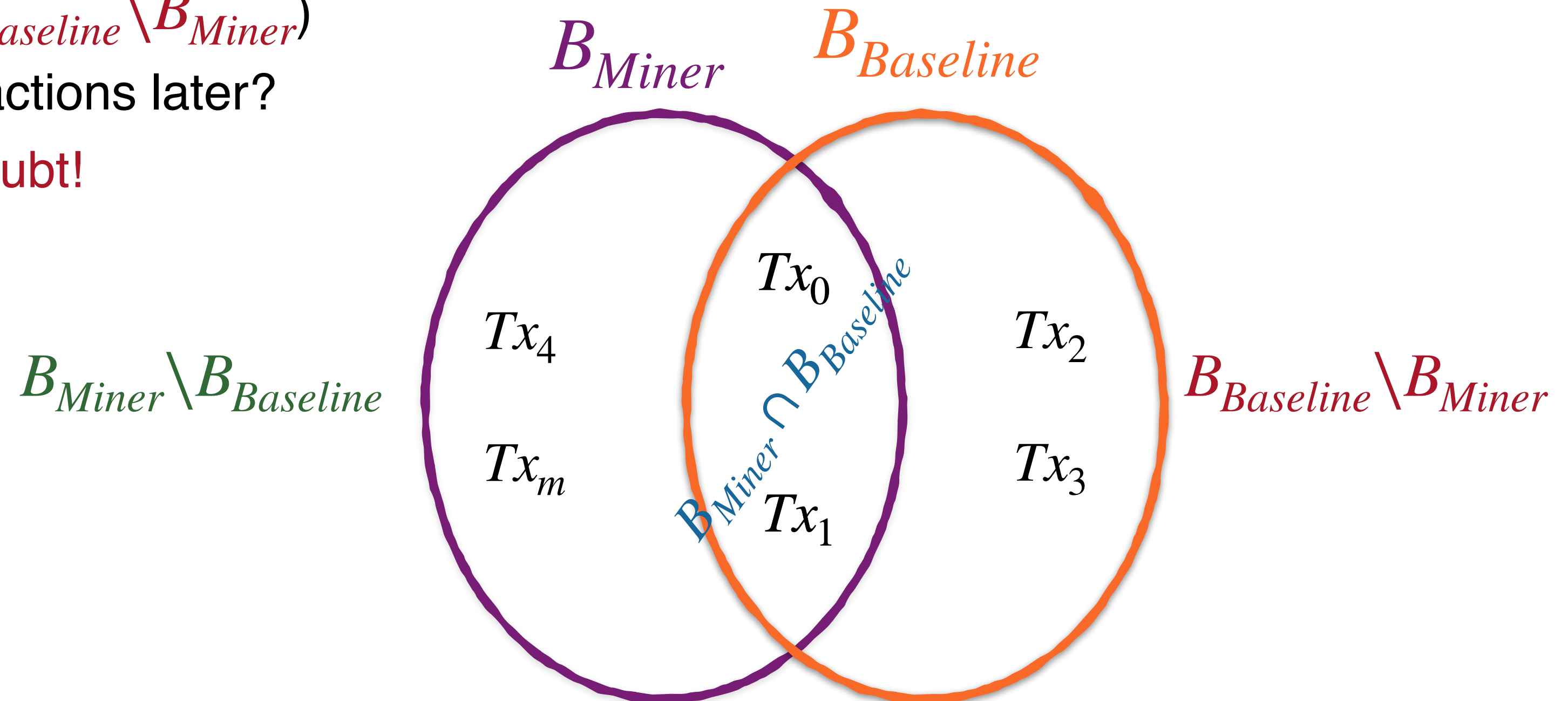
Establishing a Baseline

- ▶ Actual block: B_{Miner}
- ▶ Baseline (fee-per-byte ordering): $B_{Baseline}$
- ▶ Miners follow the fee-per-byte ordering ($B_{Miner} \cap B_{Baseline} = 100\%$)
 - ▶ Do they follow?

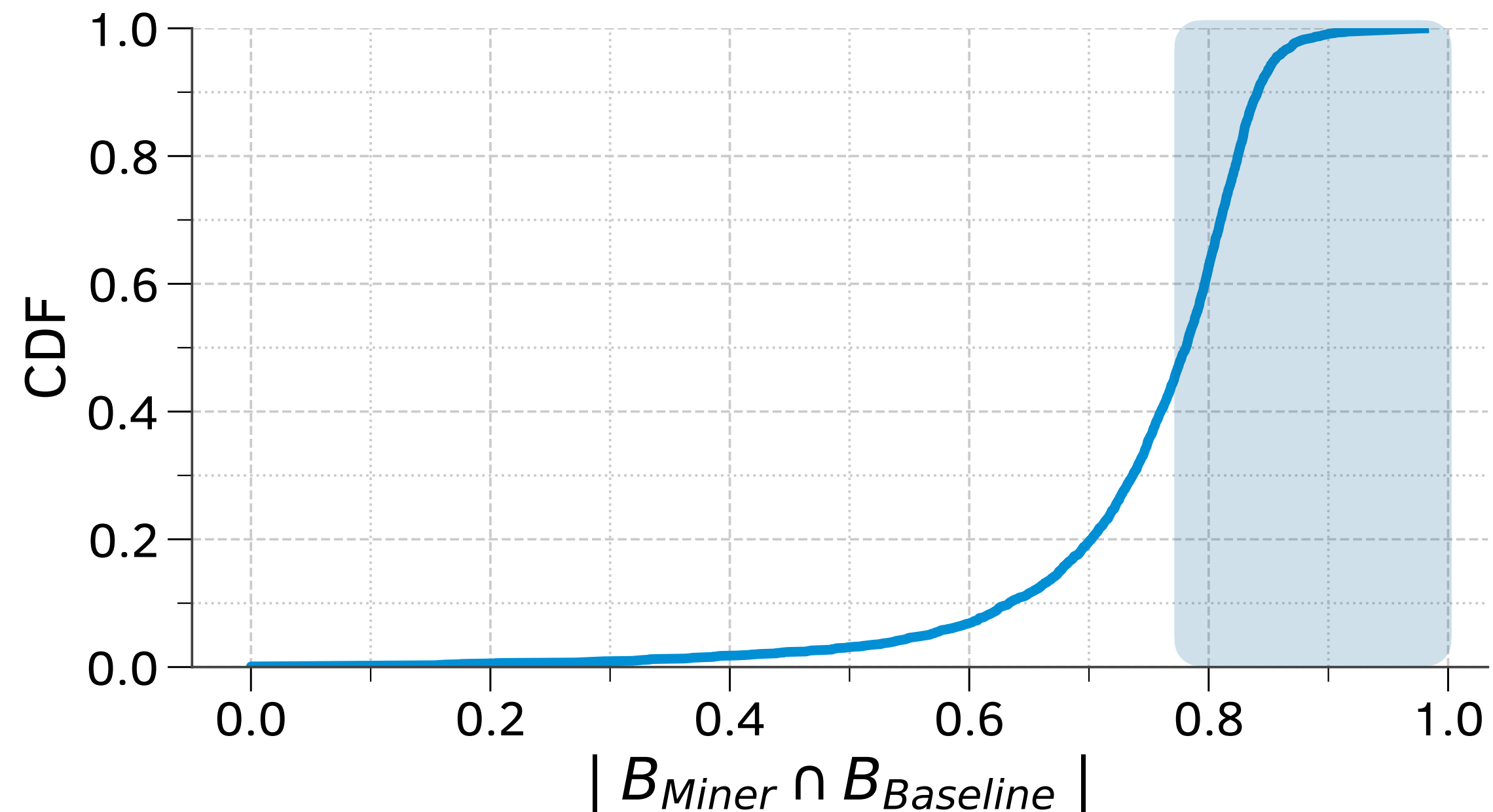


When "our View" Differs

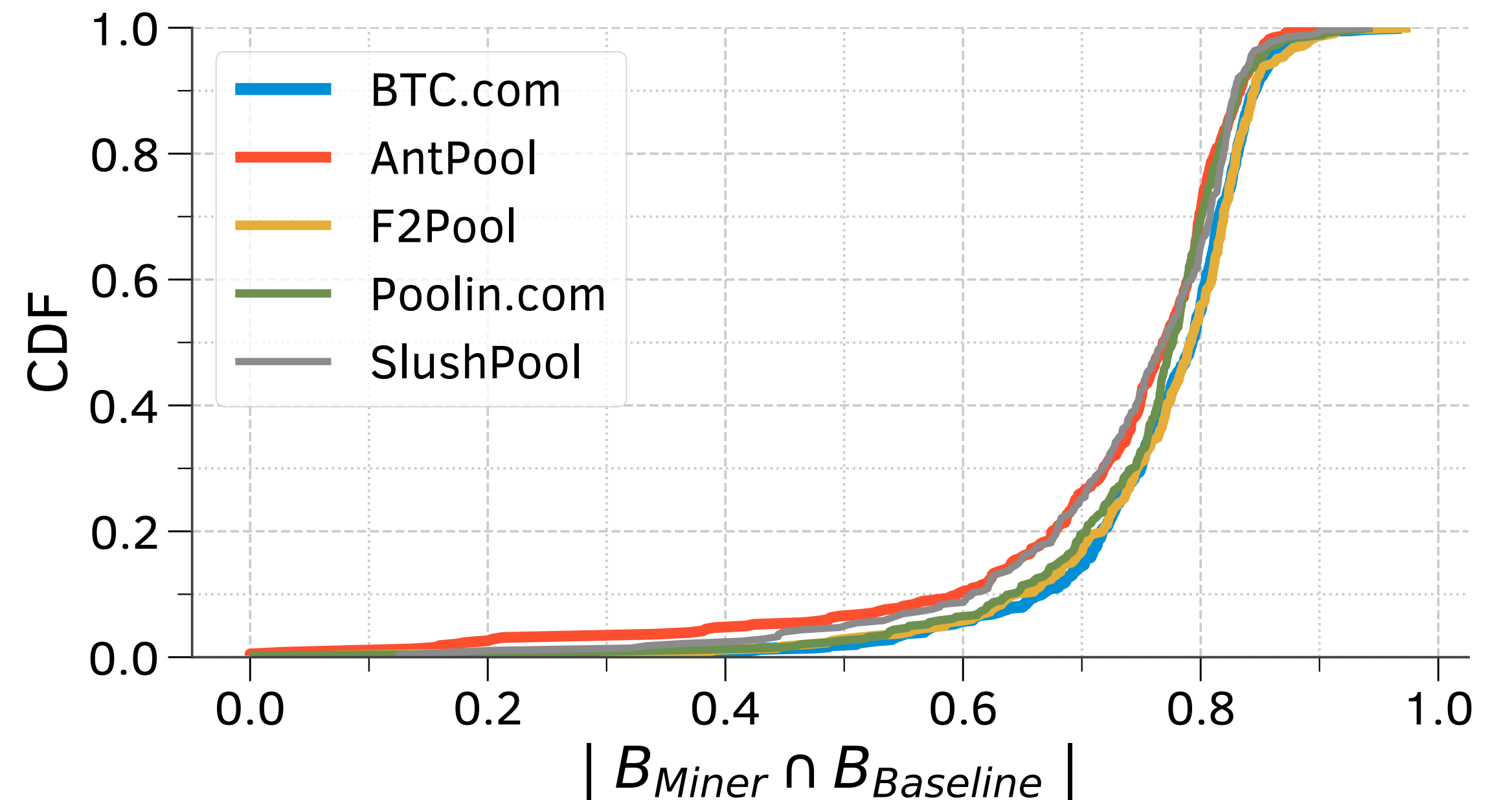
- ▶ Actual block: B_{Miner}
- ▶ Baseline (fee-per-byte ordering): $B_{Baseline}$
- ▶ Miners selected the same transactions as in our baseline ($B_{Miner} \cap B_{Baseline}$)
- ▶ Where "our view" is at fault ($B_{Miner} \setminus B_{Baseline}$)
 - ▶ Did our node receive the transactions later?
- ▶ Where "their view" is at fault ($B_{Baseline} \setminus B_{Miner}$)
 - ▶ Did miners receive the transactions later?
- ▶ We give miners the benefit of doubt!



Do Miners Deviate?

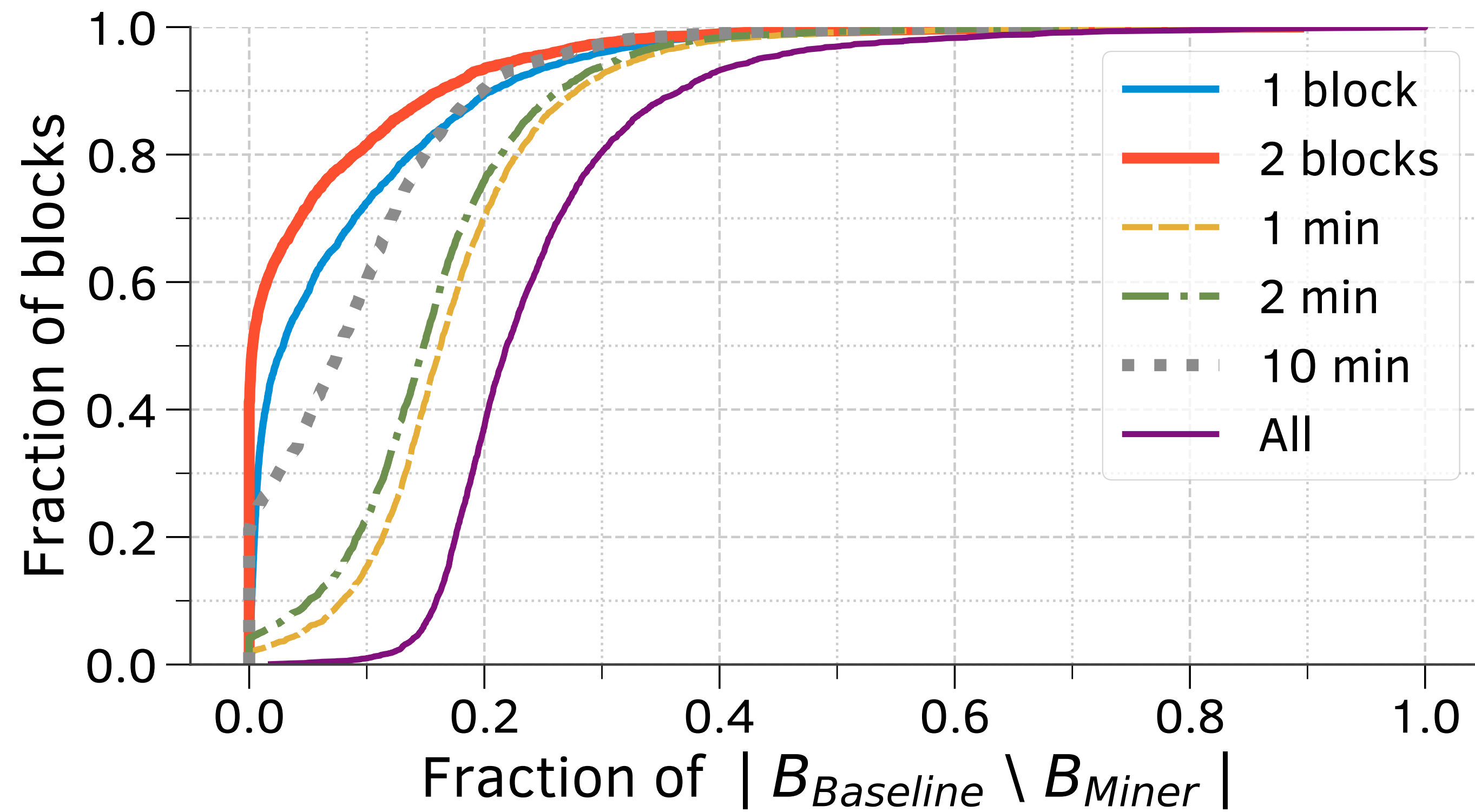


In the median, **78%** of the transactions in baselines appear in the corresponding actual blocks



Observations are consistent across the top-5 mining-pool operators.

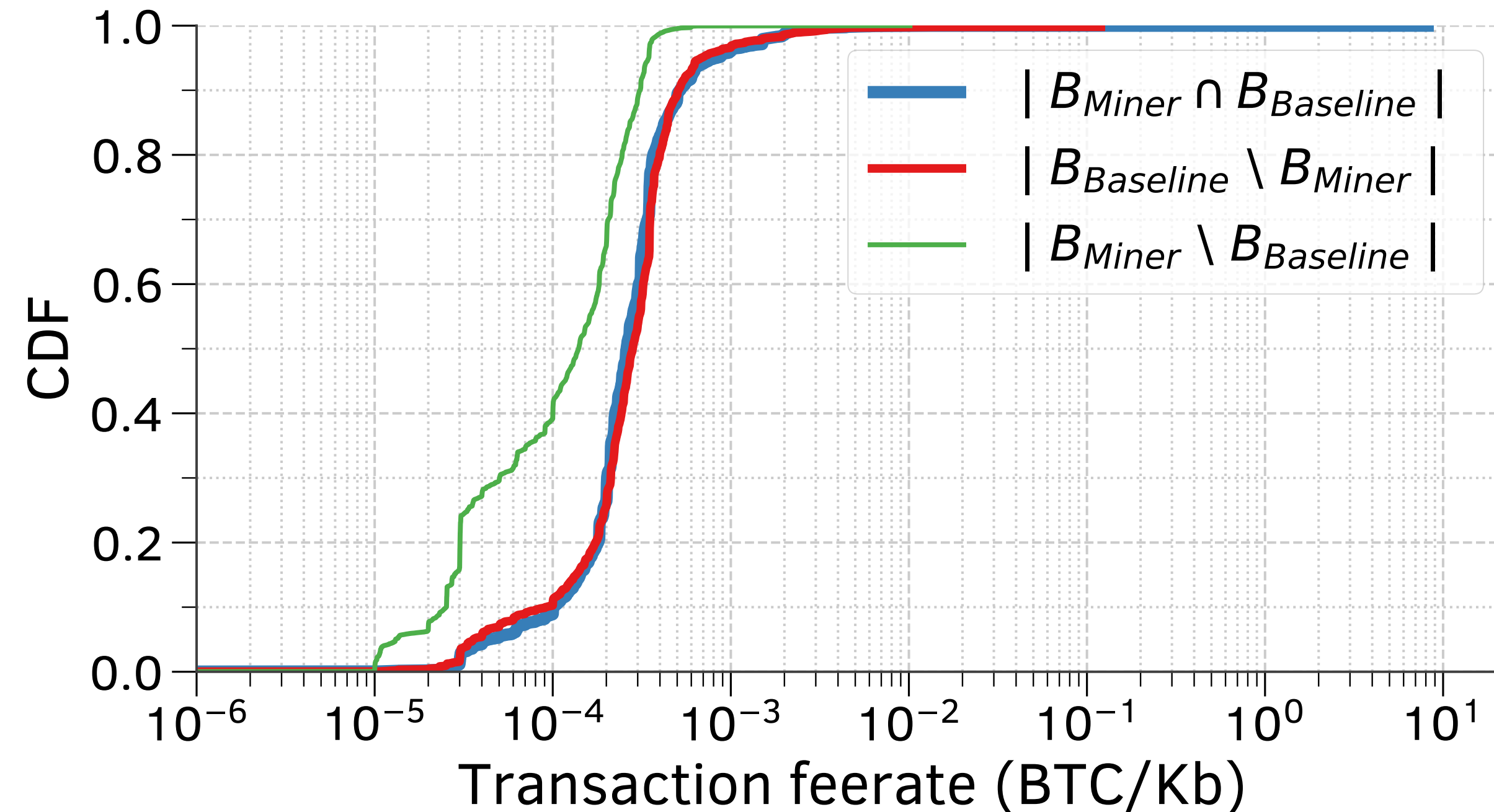
Did Miners Receive the Transactions Later?



Even with a **2-block cutoff** period, miners ignored some transactions

Do Miners Use a Different Protocol?

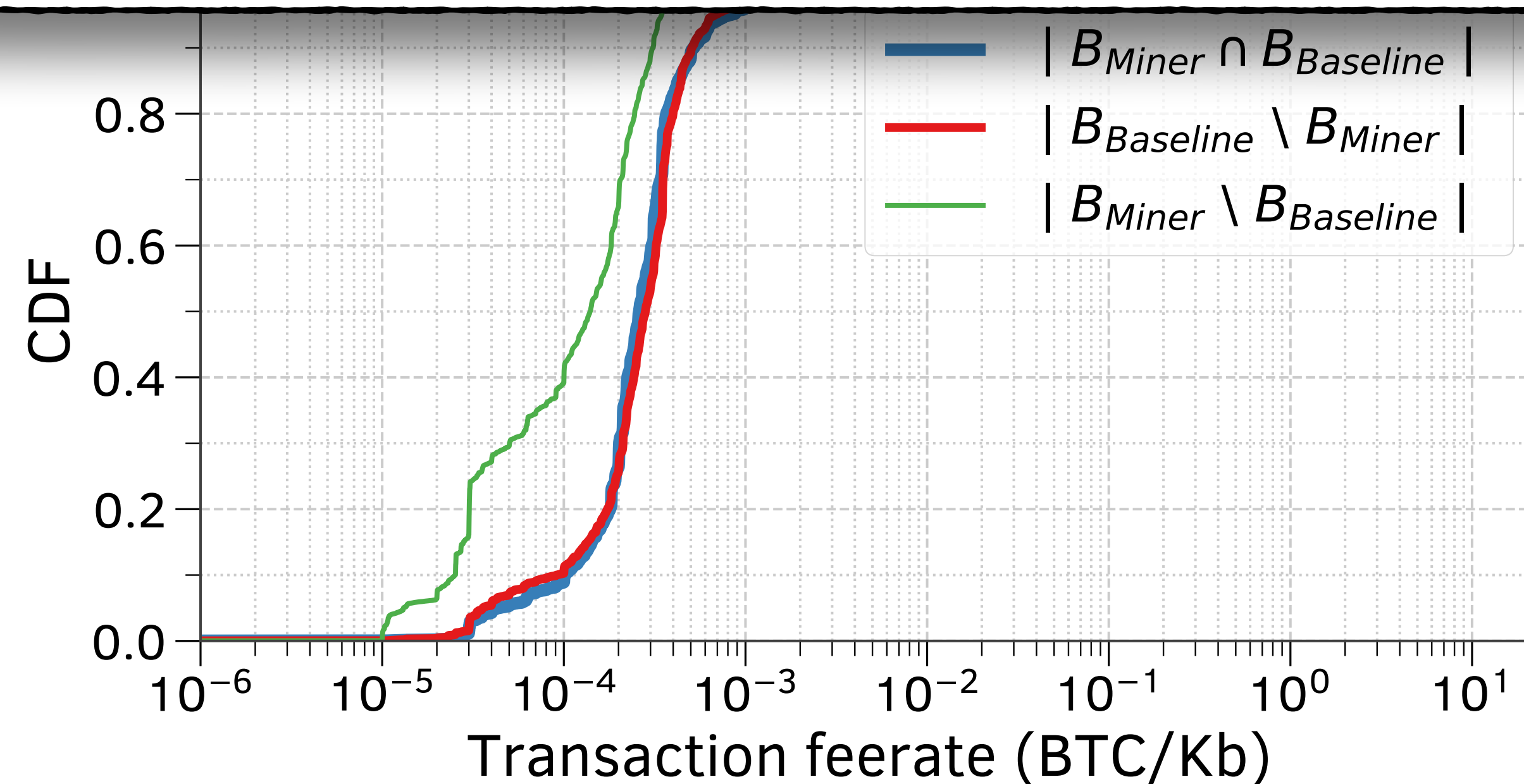
- ▶ Transactions in $B_{Miner} \setminus B_{Baseline}$ have lower *fee-per-byte* compared to those in $B_{Miner} \cap B_{Baseline}$
- ▶ Miners ignore transactions and prioritize others
- ▶ Perhaps miners are using a different protocol, in addition to the fee-per-byte



Do Miners Use a Different Protocol?

- ▶ Transactions in $B_{Miner} \setminus B_{Baseline}$ have lower *fee-per-byte* compared to those in $B_{Miner} \cap B_{Baseline}$
- ▶ Miners ignore transactions and prioritize others
- ▶ Perhaps

Miners somehow deviate!



Conclusion

Conclusions and Future Work

- ▶ Fee-per-byte only does not explain the dequeuing ordering
 - ▶ Users cannot only rely on this metric to offer a proper fee
- ▶ Mining pool operators behaviors do not make their rank ordering transparent
 - ▶ Can we ensure everyone follows the same prioritization?
- ▶ Why do miners deviate?
 - ▶ Could it be due to the stratum protocol?
 - ▶ Could it be due to transactions accelerator services?
- ▶ Apply our methodology on other blockchains (e.g., Ethereum)
- ▶ Build a predictor to help users with the proper transaction fee

thank you!

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