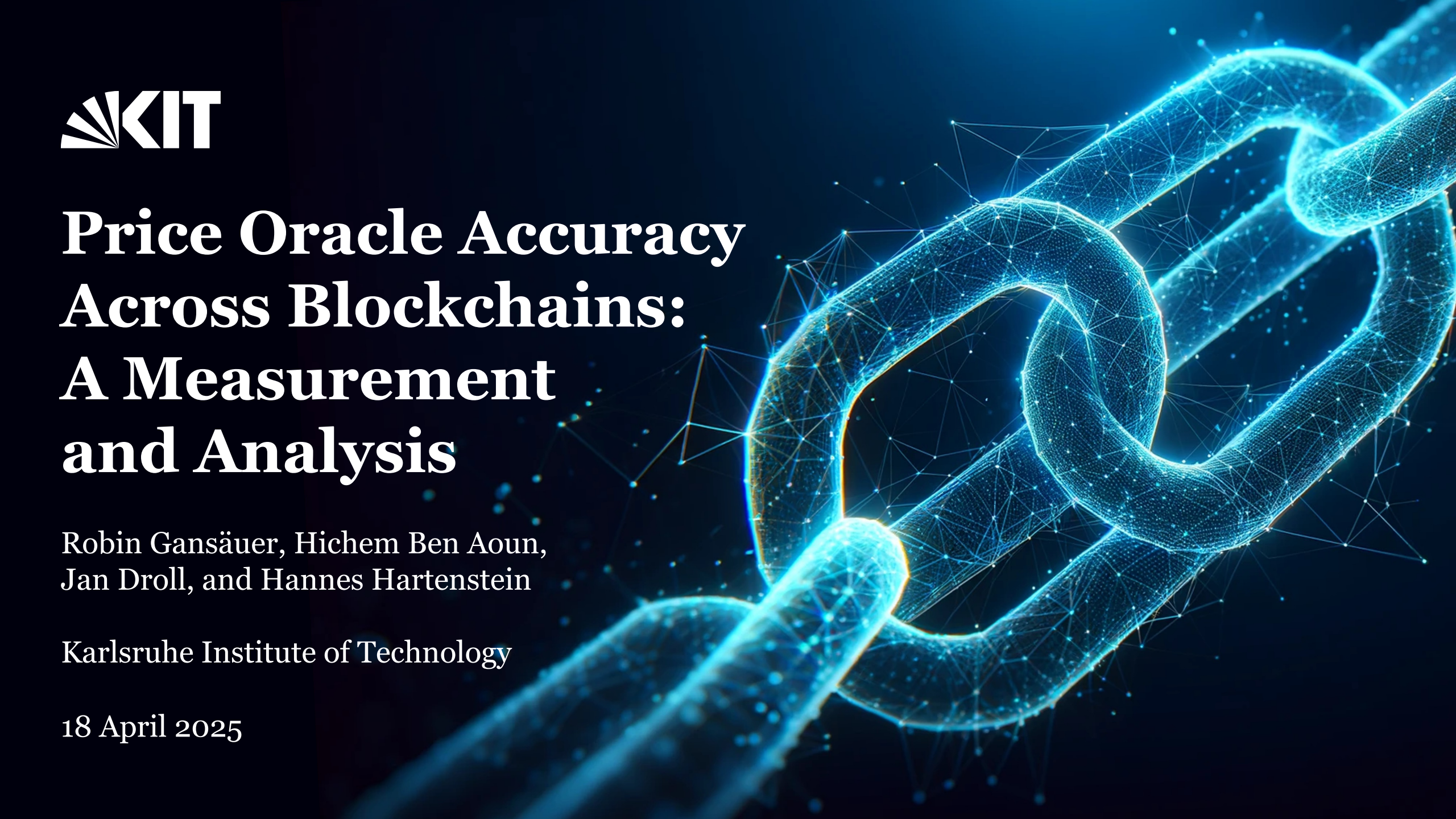

Price Oracle Accuracy Across Blockchains: A Measurement and Analysis

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Why Oracle Accuracy Is Fundamental to DeFi

1 DeFi Needs Reliable Data

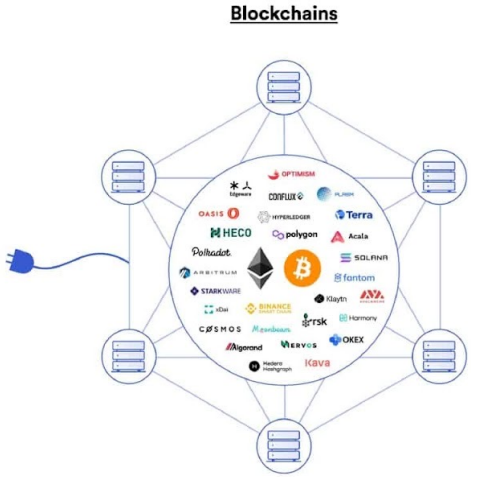
- **Smart contracts** often need real-world data (e.g., prices, events)
- Oracles bridge **off-chain data** to make it **available on-chain**
- **Inaccurate oracle data** could trigger **incorrect liquidations**, **faulty trades**, or **stalled contracts**

2 Risks of Inaccurate Oracles

- **Price discrepancies** could lead to exploitation (e.g., arbitrage)
- **Market manipulation** occurs when oracles can be gamed
- **Inaccurate prices** could trigger cascading failures across protocols

3 Our Research Contribution

- First **cross-chain**, **empirical study** of **Chainlink** across 8 blockchains
- **Benchmark** based on **high-frequency price data** from major **CEXs**
- **Comparison** of **Chainlink** price feeds and **CEX prices** (Coinbase, Kraken) for **BTC/USD** & **ETH/USD**



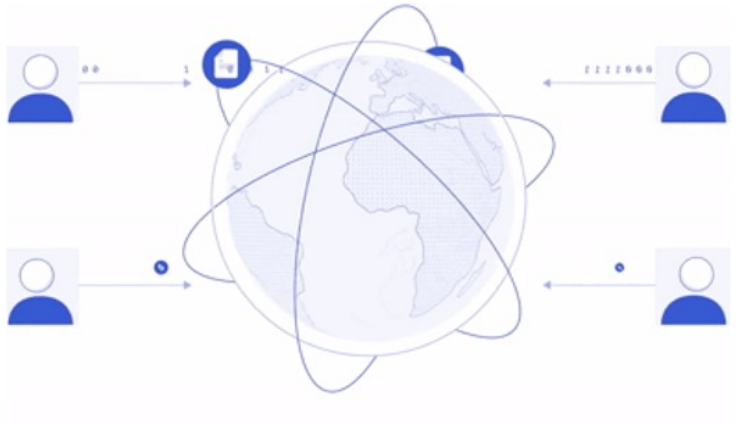
How We Measured Oracle Accuracy Across Blockchains

Research Questions

RQ1: How do blockchain, deviation threshold, and heartbeat affect Chainlink price updates?
RQ2: How accurately do Chainlink Price Feeds reflect off-chain CEX prices?

Scope and Setup

Assets: BTC/USD and ETH/USD – high liquidity, widely used in DeFi
Period: Full month of December 2024



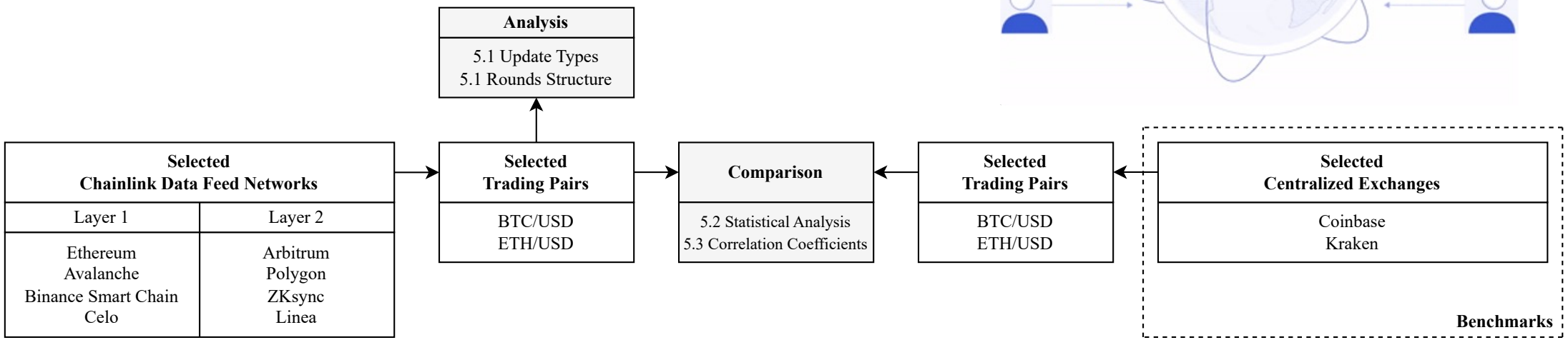


Fig. 1. *Comparison Framework: Analyzing Chainlink Feeds Against CEX Benchmarks*

Chainlink Parameters by Network and Trading Pair

Layer 1 Networks				Layer 2 Networks			
Network	**Trading Pair**	**Threshold (%)**	**Heartbeat (s)**	**Network**	**Trading Pair**	**Threshold (%)**	**Heartbeat (s)**
Ethereum	BTC/USD	±0.5	3600	Arbitrum	BTC/USD	±0.05	86400
	ETH/USD	±0.5	3600		ETH/USD	±0.05	86400
Avax	BTC/USD	±0.1	86400	Polygon	BTC/USD	±0.0	60
	ETH/USD	±0.1	86400		ETH/USD	±0.0	60
BSC	BTC/USD	±0.1	60	ZKsync	BTC/USD	±0.5	86400
	ETH/USD	±0.1	60		ETH/USD	±0.5	86400
Celo	BTC/USD	±0.1	86400	Linea	BTC/USD	±0.5	86400
	ETH/USD	±0.1	86400		ETH/USD	±0.5	86400

Table 1. *Chainlink Data Feed Network and Trading Pair Configuration*

Threshold and Heartbeat Update Patterns Across Networks

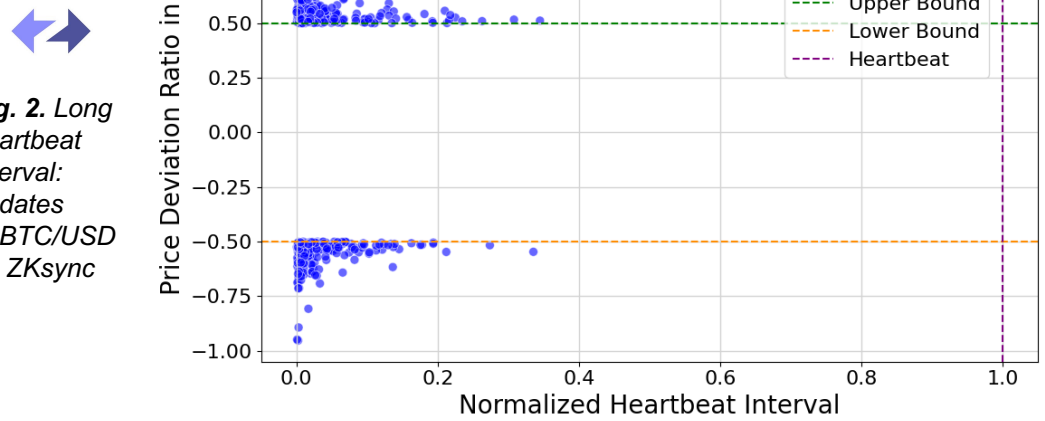


Fig. 2. *Long heartbeat interval: updates of BTC/USD on ZKsync*

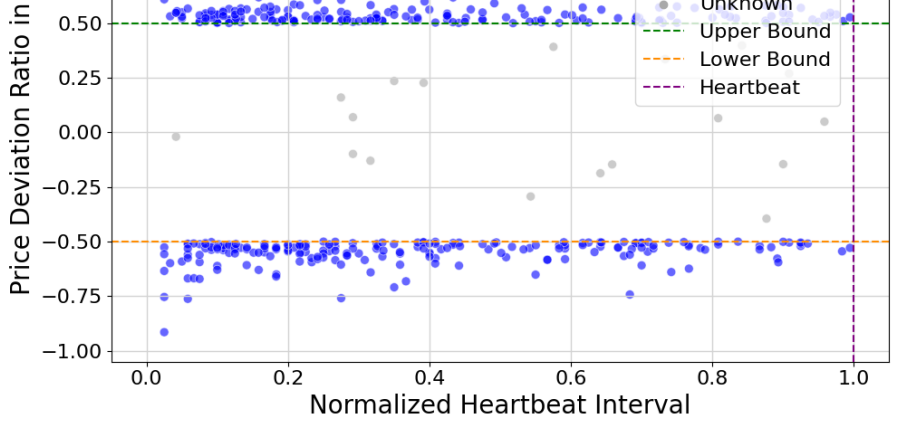


Fig. 3. *Moderate heartbeat interval: updates of BTC/USD on Ethereum*

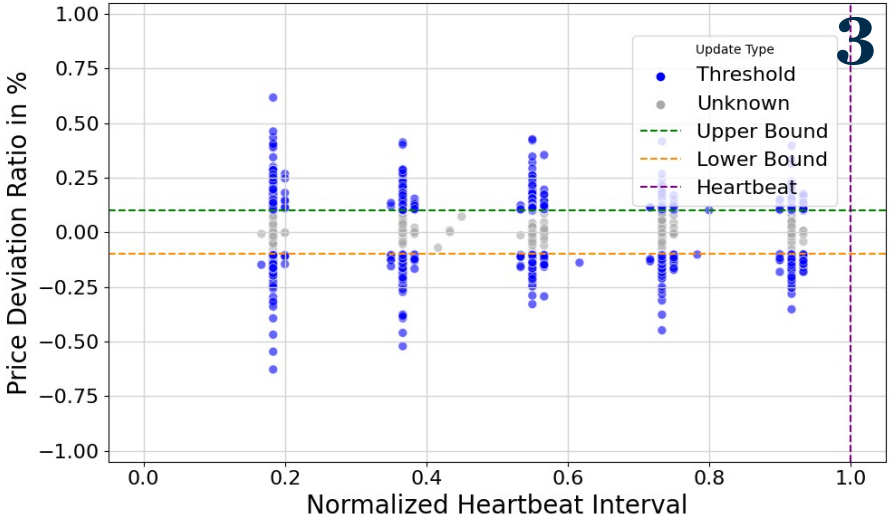


Fig. 4. *Short heartbeat interval: updates of BTC/USD on BSC*

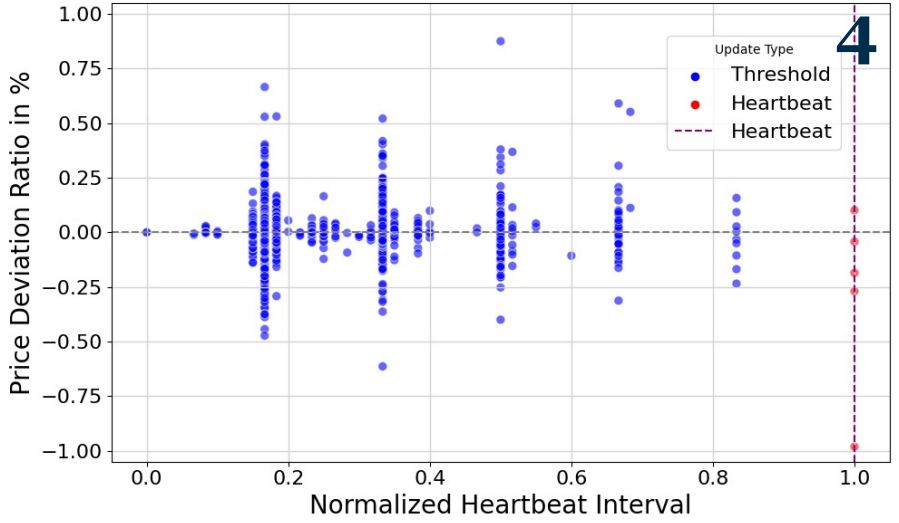


Fig. 5*. Short heartbeat interval: updates of BTC/USD on Polygon*

Chainlink vs. CEX: Price Accuracy Across Networks

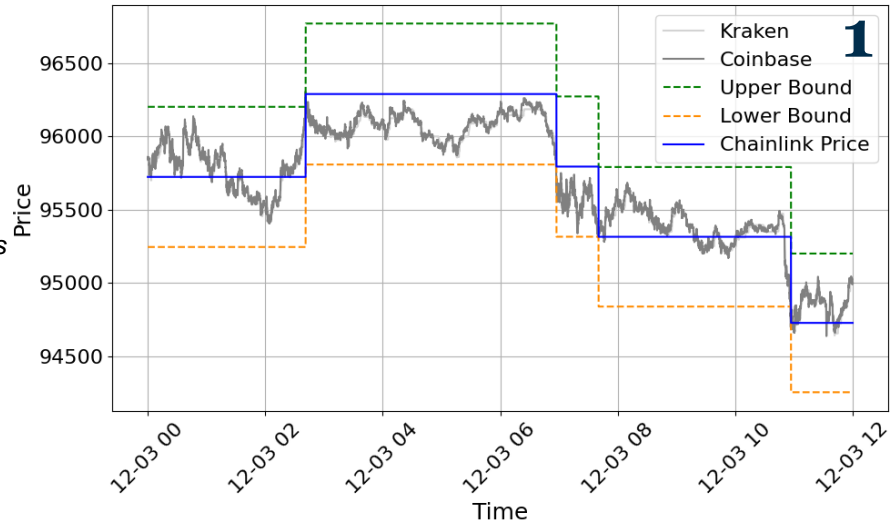


Fig. 6. *Price and thresholds of BTC/USD on ZKsync*

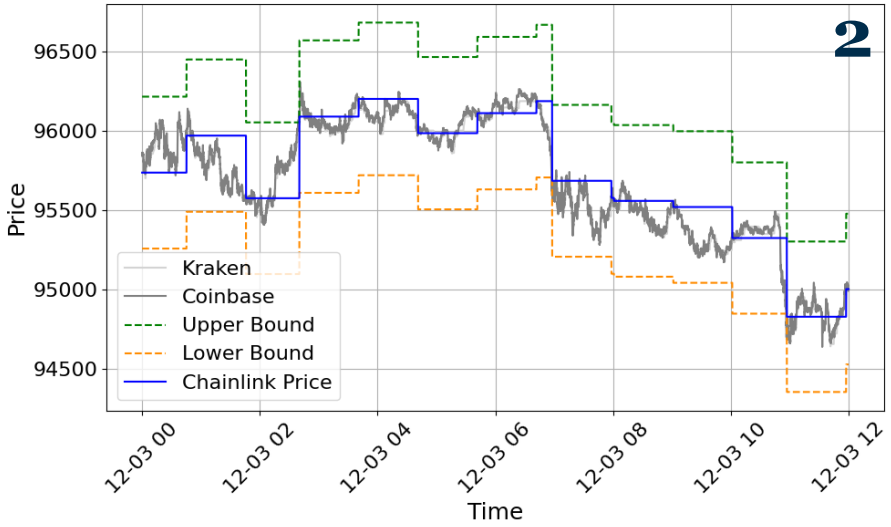


Fig. 7. *Price and thresholds of BTC/USD on Ethereum*

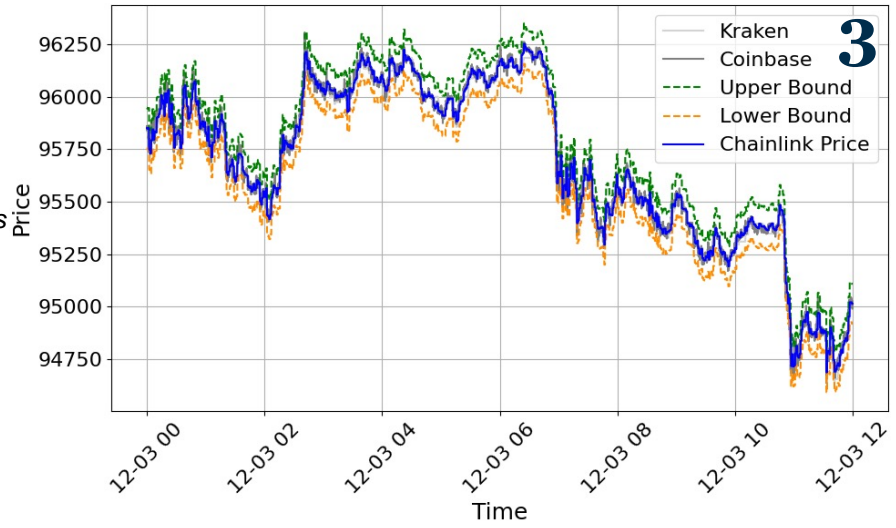


Fig. 8. *Price and thresholds of BTC/USD on BSC*

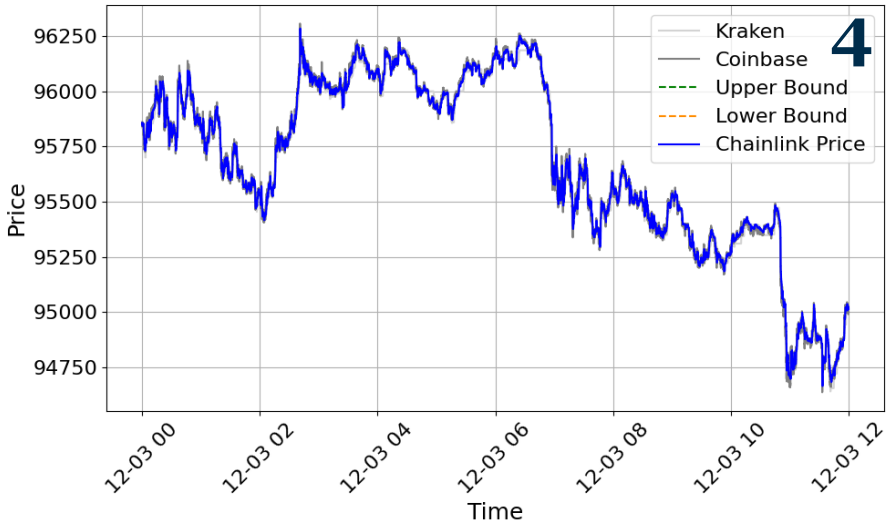


Fig. 9. *Price and thresholds of BTC/USD on Polygon*

Comparative Accuracy Across Networks

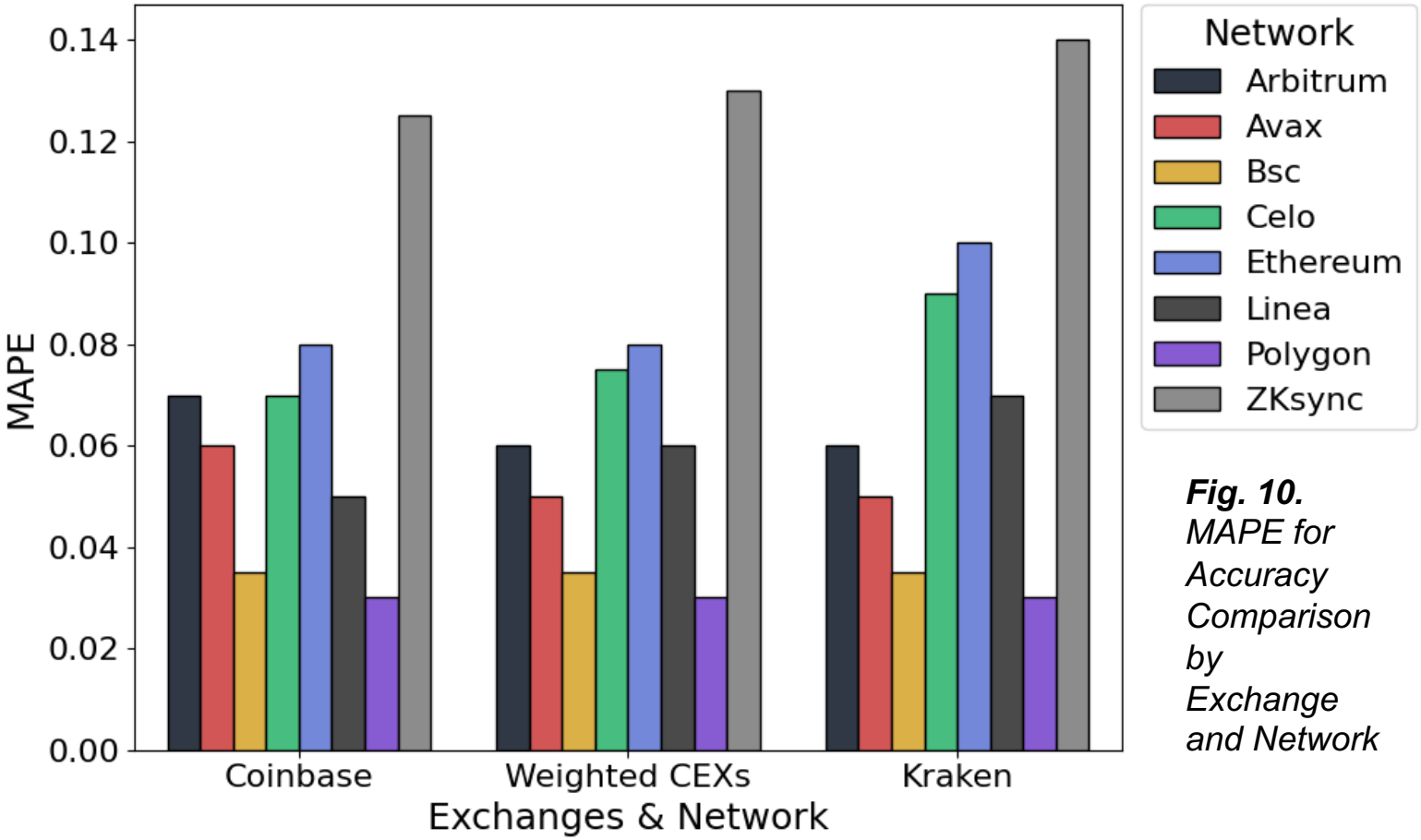


Fig. 10. *MAPE for Accuracy Comparison by Exchange and Network*

Cross-Chain Accuracy Breakdown

Polygon & BSC
Lowest MAPE due to frequent, regular time-based updates

Avax, Celo & Arbitrum
Moderate accuracy with balanced configurations

ZKsync
High MAPE from long heartbeats and wide thresholds causing delays

- Oracle accuracy varies by blockchain
- **Network-specific configuration is key:**
  - block time
  - gas cost
  - protocol usage

Oracle Trade-Offs: Accuracy, Cost, and the Case for Adaptive Design

1 Cost vs. Accuracy

What drives the trade-off between accuracy and cost?

- **Frequent updates** improve accuracy but increase on-chain costs
- **Thresholds** filter noise (*safety*), **heartbeats** ensure liveness
- **Polygon's low-cost success** challenges the need for high thresholds

2 Liquidation Risk

How do oracle updates impact DeFi liquidations?

- **98.68% of AAVE & Compound liquidations** depend on Chainlink
- Bundles combine **oracle updates and liquidations** in the same block
- **Flashbots** exploit stale prices via strategically timed transactions

3 Arbitrage Exploits

What role does arbitrage play in oracle dynamics?

- **Arbitragers** could **exploit inaccuracy** in flashbot & liquidation bundles
- Small **price deviations** could create large **profit windows**
- Even **0.15% deviation** could yield **$15K** per **$10M** trade cycle

4 Ecosystem Implications

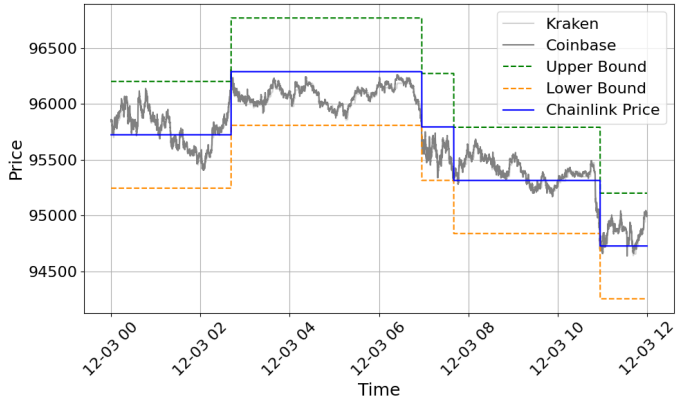
What are broader risks and opportunities for DeFi?

- **Oracle misalignment** could destabilize DeFi protocols
- Raises ethical concerns: **arbitrage as tool or threat?**
- **Public oracle metrics** could improve transparency and trust

Open Questions on Oracle Design and Reliability

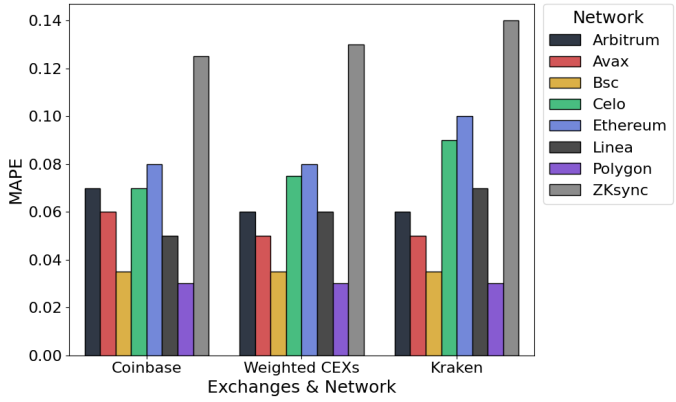
Technical Design & Implementation

Can adaptive thresholds (e.g., **volatility-** or **volume-aware**) be implemented without added **complexity** or **trust assumptions**?



Economic Implications & Risk Management

To what extent can **oracle inefficiencies** be priced into **protocol risk models** or reflected in **yield premiums** (e.g., in lending)?



Systemic Risk & Ecosystem Impact

How do inaccurate oracles affect **DeFi composability and reliability**? Could a **single faulty feed** destabilize the **broader ecosystem**?