Cross-Rollup MEV:
Non-Atomic Arbitrage Across L2s

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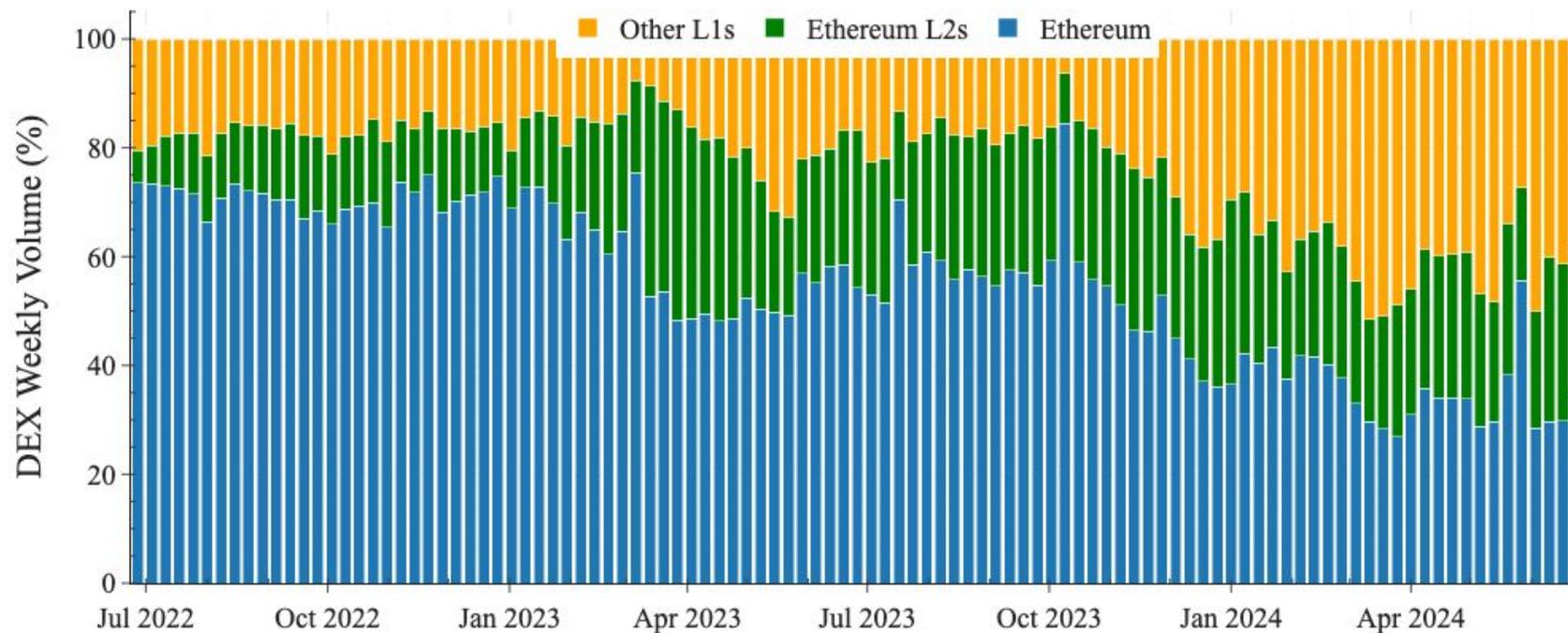Zircuit

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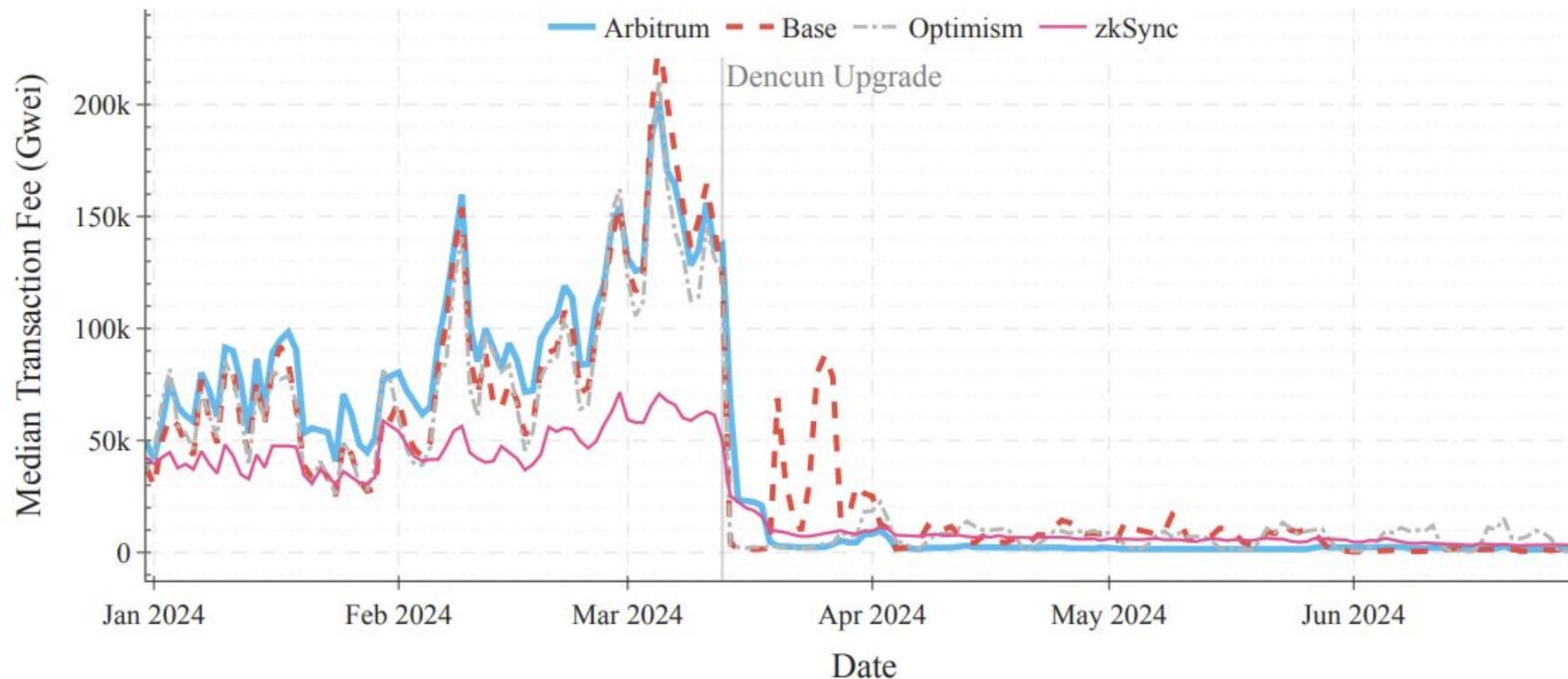
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Liquidity is migrating to rollups

— DEX growth on Ethereum was hindered by the high gas costs.

— Ethereum L2s emerged as a secure scaling solution.

— Trading activity and liquidity are moving to Ethereum's L2 blockchains.

Liquidity is migrating to rollups

- Swaps on L2 occur **2–3× more frequently** on L2s than on Ethereum
- Median swap size is **~5× smaller**
- Dencun upgrade → sharply reduced L2 gas fees

Research Questions

Open Question

If liquidity fragments across DEXs on rollups, who keeps prices aligned?

We ask four questions:

**RQ1:** How large is non-atomic arbitrage between L2 AMMs and CEX?

RQ2: How persistent are price misalignments on rollups?

RQ3: How large is cross-rollup arbitrage?

RQ4: Does classical LVR overestimate arbitrage on rollups?

What is Arbitrage?

Arbitrage involves buying an asset where it is underpriced and selling it where it is overpriced, earning the price differential net of costs.
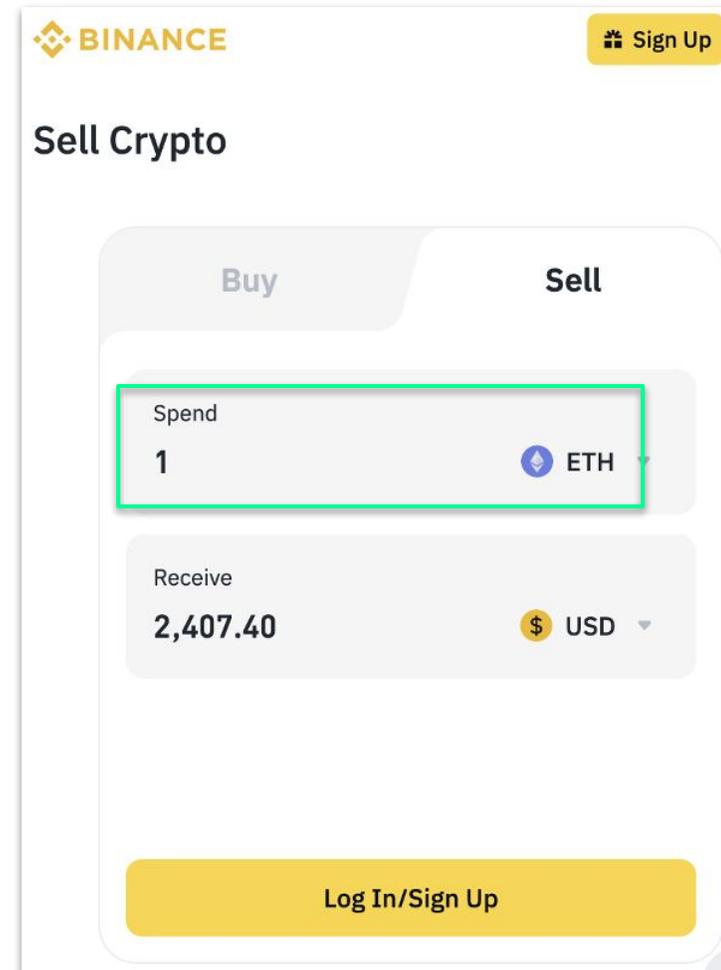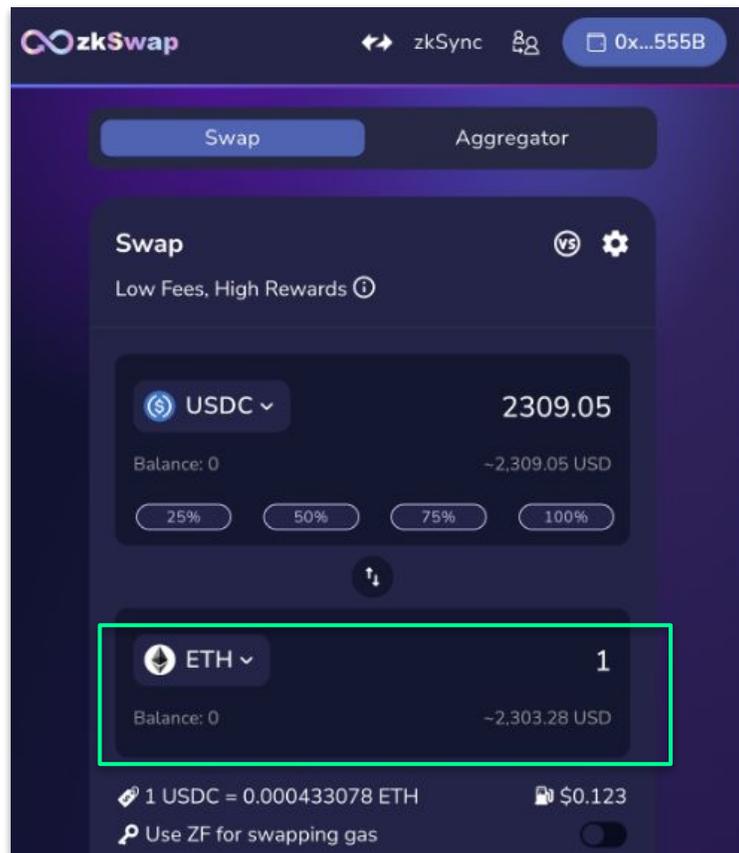
Two types of arbitrage

Atomic

- Executed within one block

- No state risk

- Example: cyclic arbitrage within one DEX or DEXs on the same chain

Non-atomic

- Requires multiple blocks or chains

- Exposed to state (price) drift

- Example: Rollup ↔ Binance or Rollup A ↔ Rollup B
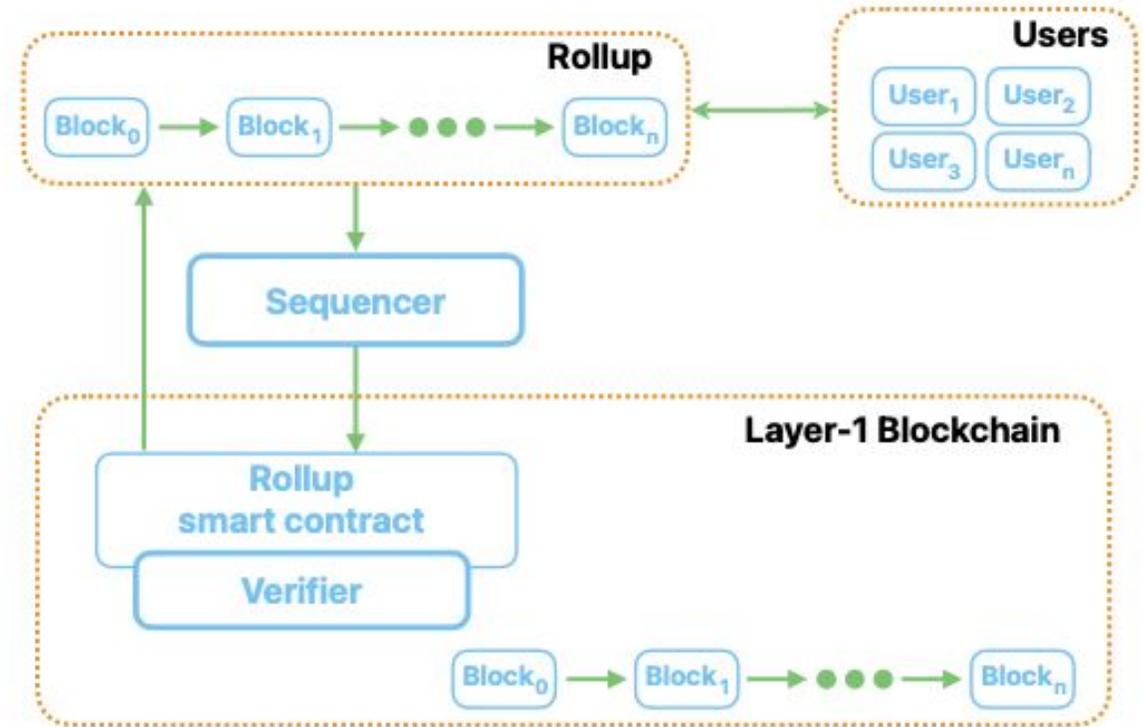
Rollup Architecture & MEV Context

Arbitrage on Ethereum is executed via MEV (auctions)

How rollups differ from Ethereum

- Centralized sequencers
- No MEV auctions
- Faster blocks (0.25–2 sec vs 12 sec)
- Soft finality before L1 settlement

Implication: Arbitrage on rollups:

- Faster execution
- Lower gas
- Higher state-drift risk
- No auction-based ordering

High Level Rollup Architecture

Dataset

Period: Dec 31, 2023 – Apr 30, 2024

Chains: Ethereum and L2s

Pool: WETH–USDC (Uniswap v3)

CEX benchmark: Binance (1-second resolution)

| Chain	Swaps	Transactions	Blocks	Block Range
Ethereum	761,005	749,818	475,409	18,908,896–19,771,559
Arbitrum	2,400,000	2,367,361	1,709,619	187,373,628–206,540,031
Arbitrum (USDC.e)	2,258,469	2,232,543	1,648,839	165,788,868–206,540,037
Base	1,687,530	1,636,196	1,145,789	8,638,929–13,866,123
Optimism (USDC.e)	1,186,780	1,136,839	902,789	114,234,215–119,461,410
ZKsync Era (USDC.e)	46,417	46,379	45,364	22,909,923–32,843,035

Cross-Rollup Price Disparities

- Persistent cross-rollup price spreads exist

- Largest average discrepancies (~20 bps) involve **ZKsync**, driven by lower liquidity.

- Rollup–rollup spreads frequently exceed rollup–CEX spreads.
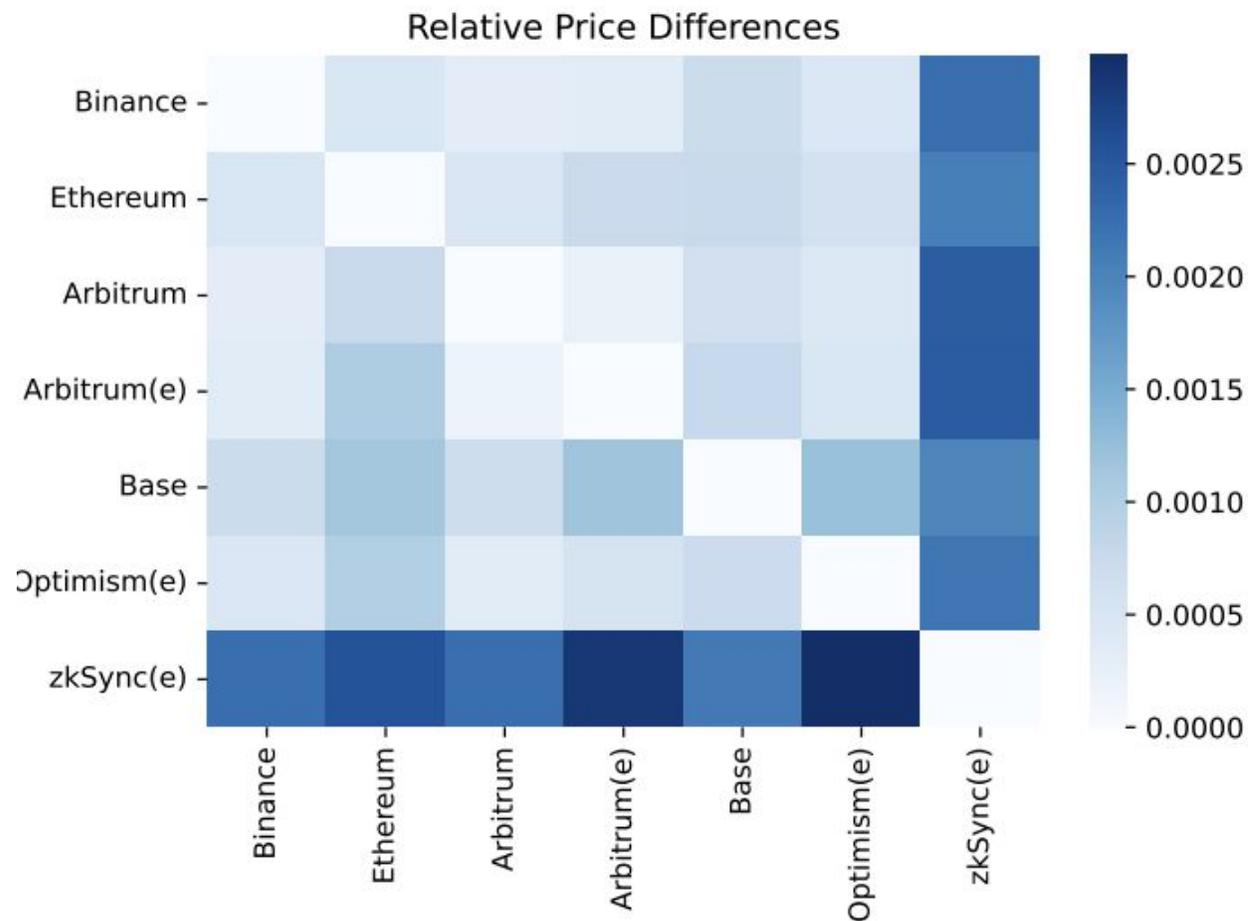
Uniswap v3 USDC-WETH pools

Cross-Rollup Arbitrage

- Cross-rollup inefficiencies are already economically meaningful

- Certain rollup pairs generate opportunities exceeding **$1M**.

- Arbitrage magnitude reaches up to **~40 bps of trading volume**.
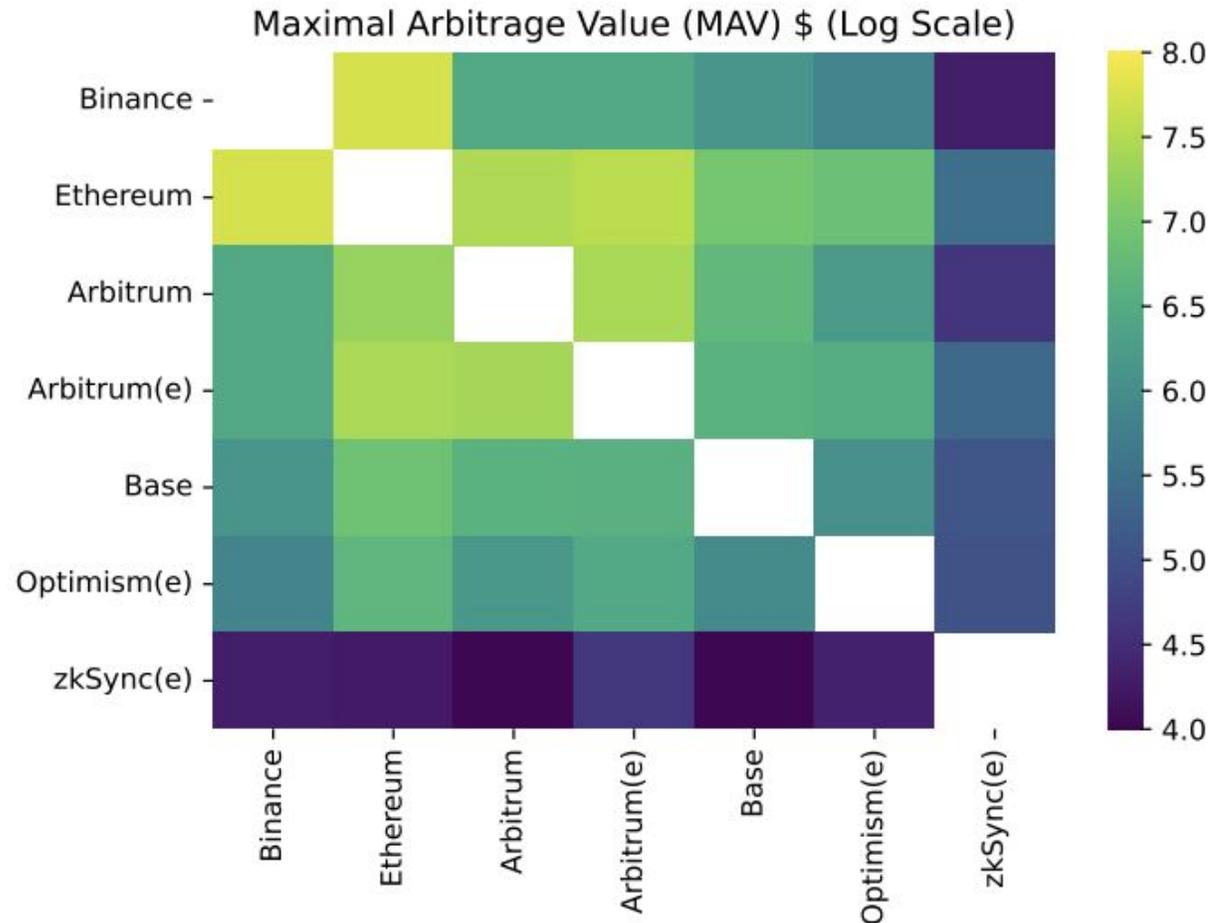
Uniswap v3 USDC-WETH pools

Decay Time of Misalignment

We measure how long price discrepancies persist before re-alignment below threshold

Chain	Points	Avg MAV	V_{max}	Avg Decay (s)
Ethereum	71,135	737.87	499,667.10	31
Arbitrum	137,162	19.68	56,476.35	6.9
Arbitrum (USDC.e)	164,080	16.50	41,370.11	8.8
Base	75,729	17.08	22,620.17	420
Optimism (USDC.e)	113,428	6.09	8,477.60	19
ZKsync Era (USDC.e)	3,970	5.07	1,966.76	370

- Misalignments persist across **10–20 blocks on average**.
- Faster block times do not imply faster economic alignment.
- Liquidity fragmentation slows arbitrage convergence.

Maximal Arbitrage Value (MAV)

Why not use LVR?

LVR assumes:

- Prices re-align continuously or every block

But on rollups:

- Misalignments last **multiple blocks**

- LVR estimates are approximately **5× larger** than arbitrage on rollups
(according to our results)

Our approach

For each misalignment episode (spanning cross multiple blocks):

- Record only the **maximum MAV**
- Avoid double-counting

Maximal Arbitrage Value (MAV)
 = Maximum profit from a price discrepancy given AMM reserves and fees in a specific

Why Does Arbitrage Persist?

Structural reasons

1. No shared sequencer
2. No L2 MEV auctions
3. Capital fragmentation
4. Bridging risk
5. State drift risks

Design Implication

Shared sequencer could

- Make cross-rollup arbitrage atomic
- Reduce inefficiencies and price disparities

Rollups do not simply scale Ethereum.

They reshape arbitrage dynamics.

Key Takeaways

- **>500,000 unexploited arbitrage opportunities** in studied 6 month period
- misalignments persist **10–20 blocks**
- LVR, if applied naively, overestimates arbitrage on L2

As L2 liquidity grows:

- Cross-rollup arbitrage will increase
- Shared sequencing becomes strategic infrastructure
- MEV/order flow design becomes market design

Access the full paper here

Thank you

Jan Gorzny

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