Spam, Revert, and MEV: An Empirical Study of MEV Strategies on Ethereum Rollups [Draft]

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Abstract

In this paper, we examine the current state of transaction revert rates in blockchain ecosystems. As rollups gain popularity, the MEV trilemma becomes increasingly relevant. Although mempools are often encrypted and follow a first-come, first-served order, low gas fees make spamming the mempool an appealing strategy. We evaluate the effectiveness of this approach using empirical data and develop a theoretical model to estimate how this strategy can be optimized with the introduction of revert protection mechanisms on rollups.

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1 Introduction

The evolution of MEV extraction has undergone significant transformations, beginning with Ethereum's early days. The introduction of MEV Boost mechanisms, followed by Proposer-Builder Separation (PBS), marked a pivotal shift in how MEV was captured on Ethereum, and now, with the rise of rollups, layer-2 (L2) blockchains, history appears to be repeating itself.

Rollups are gaining traction, reshaping transaction execution and settlement dynamics. However, MEV remains an inherent challenge, leading to what is often described as the MEV trilemma—where avoiding MEV extraction entirely is nearly impossible. The Duncan upgrade resulted in a significant reduction in gas fees on L2 and a surge in the transaction revert rate, highlighting the ongoing evolution of MEV strategies.

Looking ahead, major developments such as Unichain, the proposed sequencer-builder separation, and MEV tax could introduce new paradigms for MEV extraction on L2s. Additionally, Uniswap v4 introduced hooks, further influencing how liquidity and transactions interact within Uniswap. Another recent innovation is the introduction of revert protection mechanisms. Although initially blob transactions were relatively inexpensive, their rising costs could pose new challenges for rollup scalability and MEV extraction strategies.

This paper explores these developments, analyzing the reverted transaction on L2s, their link with MEV extraction, and the impact of revert protection on the broader Ethereum ecosystem.

Related Work.

The study of MEV, especially on layer-2 blockchains, remains relatively underexplored in the academic literature. Heimbach et al. [?] conducted a Systematization of Knowledge (SoK) on MEV prevention mechanisms in Layer 1 blockchains, while Heimbach et al. [?] also examined non-atomic arbitrage strategies on Ethereum. Torres et al. [?] analyzed atomic arbitrage on rollups, whereas Gogol et al. [?] and Oz et al. [?] investigated non-atomic arbitrage strategies on rollups and estimated the potential for cross-rollup MEV extraction. Despite these contributions, the question of high revert transaction rates, their origins, and their destinations remains largely unanswered.

Contribution.

The contributions of this research are as follows.

- We analyze user behavior related to reverted transactions and map it to MEV strategies and taxonomy, particularly liquidation and arbitrage (atomic and non-atomic).
- We conduct an empirical analysis of reverted transactions on Ethereum rollups and estimate the amount of MEV extracted through arbitrage. Additionally, we assess the profitability of MEV strategies on L2s.
- We evaluate the impact of revert protection on MEV strategies, rollups, and the underlying L1 consensus, particularly in relation to blob pricing.

Paper Organization.

Section 2 provides an overview of rollup mechanisms and a concise taxonomy of MEV. Sections 3, 4 and 5 present an empirical analysis of reverted transactions on L2s and extracted MEV. Section 6 examines the impact of reverted-transaction protections on the profitability of MEV searcher, and blob prices of L1. Finally, Sections 7 and 8 include the discussion and conclusions.

2 Background

2.1 Layer-2 and Rollup

This subsection explains what is layer-1 and layer-2 blockchain scaling, what is rollups and how does it work.

2.2 MEV Taxonomy

For the evaluations conducted in this paper, it is necessary to summarize the terminology and strategies associated with Maximum Extractable Value (MEV).

Classification by Transaction Ordering

MEV strategies can be categorized based on how transactions are ordered within a block:

- **Front-running**: Placing a transaction before a target transaction to capitalize on price movements.
- **Back-running**: Placing a transaction immediately after a target transaction to extract value.
- **Combinations of front- and back-running**: Includes strategies like sandwich attacks, where an attacker places both a front-running and a back-running transaction around a target transaction.

Classification by Impact on Target Transaction

MEV strategies can also be classified based on their effect on the target transaction:

- **Positive**: Some strategies, such as Just-in-Time (JIT) liquidity provisioning, can have a beneficial effect on the target swap transaction (though they negatively impact liquidity providers in the pool).
- **Negative**: Some forms of MEV extraction harm users, including fatal cases where the target transaction fails to execute entirely.

Rollup	Reverted Transactions	Swaps	Blocks	Block Range
Arbitrum (ARB)	–	–	–	–
Base (BASE)	–	–	–	–
Optimism (OP)	–	–	–	–
Scroll (SCROLL)	–	–	–	–
ZKsync (ZKSYNC)	–	–	–	–

Table 1 Overview of analyzed reverted transactions across Ethereum rollups, spanning 2024–2025.

- **Neutral**: Certain strategies, such as oracle-extractable value (OEV), liquidity arbitrage back-running, and general arbitrage back-running, do not directly affect the target transaction.

Classification by DeFi Protocols

Different MEV strategies can be associated with specific types of decentralized finance (DeFi) protocols:

- **Liquidations**: Occur in DeFi lending protocols and are often considered a form of **Oracle-Extractable Value**, as they originate from price updates. This is a form of back-running.
- **Arbitrage**: Involves capturing price discrepancies between different liquidity pools and is also a form of back-running.
- **Sandwich Attacks** and **JIT Liquidity**: These involve a combination of front-running and back-running in automated market makers (AMMs).

Types of Arbitrage

Arbitrage strategies can be further categorized based on their execution properties:

- **Atomic Arbitrage**: Executed within a single blockchain transaction, such as DEX-DEX arbitrage or triangular arbitrage within the same blockchain.
- **Non-Atomic Arbitrage**: Involves arbitrage across different platforms or chains, such as CEX-DEX arbitrage or arbitrage between DEXs on different blockchains, where execution is not guaranteed within a single transaction.

3 Data Collection

This study analyzes reverted transaction data and swap data from major Ethereum rollups, including Arbitrum, Base, and Optimism (optimistic rollups), as well as ZKsync Era (a ZK-rollup).

The dataset is sourced from blockchain archive nodes provided by [to be decided] [**?**]. The analyzed swaps, transactions, and block ranges are detailed in Table 1. Using event logs from the *Swap* method, historical spot prices and liquidity levels within liquidity pools are recalculated. For Uniswap v3, the spot price after a swap is extracted from the *sqrtPriceX96* field in the event logs. Market data for the ETH-USDC exchange rate on centralized exchanges (CEXs) is obtained from Binance APIs [**?**].

4 Methodology

To analyze MEV-related strategies, we employ a matching approach that links failed transactions to subsequent successful ones. When a transaction succeeds, event logs from Uniswap, Aave or other DeFi protocols can be accessed, allowing for the extraction of exact parameters and the calculation of the profitability of the executed strategy. The process for each rollup follows these steps:

1. Identify all reverted transactions and group them by destination address.
2. Determine the most frequently used destination addresses, such as Uniswap pools and Aave pools.
3. Identify the primary senders of these transactions.
4. Locate successful transactions originating from the same senders within the relevant DeFi pools and extract the corresponding event logs (as event logs are not available for reverted transactions).
5. Assess the profitability of the identified strategy, determining whether the transactions are linked to MEV extraction.

5 Results

Presentation and discussion of empirical results.

6 Impact of Revert Protection

7 Discussion

8 Conclusions

References