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

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Abstract

As Ethereum rollups gain adoption, the dynamics of Maximum Extractable Value (MEV) on Layer-2 (L2) blockchains are evolving, creating new challenges and opportunities for arbitrageurs, liquidators, and sequencers. While L2 mempools are often encrypted and operate on a first-come, first-served basis, low gas fees make mempool spamming an attractive MEV extraction strategy. In this research, we analyze the effectiveness of spam-based MEV strategies using empirical data from major rollups and DeFi protocols. Additionally, we evaluate how these strategies can be optimized with revert protection mechanisms.

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1 Introduction

The evolution of Maximum Extractable Value (MEV) has undergone significant transformations, beginning with Ethereum's early days. The introduction of MEV Boost mechanisms, followed by Proposer-Builder Separation (PBS), transformed how MEV was captured on Ethereum, and now, with the rise of rollups [14], Layer-2 (L2) scaling solutions for Ethereum, history appears to be repeating itself.

Rollups are gaining traction, reshaping transaction execution and settlement dynamics. On average, rollups process 30 times more transactions per second (TPS) than Ethereum [12], offer 55 times higher gas per second (GPS) [2] and, consequently, have attracted a growing number of Decentralized Finance (DeFi) users and protocols, further driving Total Value Locked (TVL) on L2s [12]. However, despite these advancements, MEV remains an inherent challenge, leading to what is often described as the *MEV trilemma*—where avoiding MEV extraction entirely is impossible.

In March 2024, the Dencun upgrade [3] introduced *blobs* [4], temporary data storage designed to optimize rollups' scalability, which resulted in a significant reduction in gas fees on L2 [9]. At the same time, we observed a surge in the transaction revert rate [5] that might indicate the spam-based MEV strategies on L2s. Although initially blob transactions were relatively inexpensive, their rising costs could pose new challenges for rollups' scalability and MEV extraction strategies.

Looking ahead, major developments such as Unichain [1] with the proposed sequencer-builder separation, MEV tax [13] and the revert protection mechanism, can introduce new paradigms for MEV extraction on L2s. This research explores these developments and analyzes the reverted transactions on L2s with the goal of attributing them to MEV extraction strategies.

Related Work.

Brian et al. (2024, October) [16] developed a game-theoretic model to explain the behavior of MEV searchers in prioritizing transactions. The model considers scenarios with and without revert protection, showing that revert protection increases auction revenue, enhances market efficiency, and optimizes blockspace usage.

The empirical study of MEV, especially on L2 blockchains, remains relatively underexplored. Heimbach et al. (2024, January) [10] evaluated the non-atomic arbitrage on Ethereum. Gogol et al. (2024, March) [8] estimated the non-atomic arbitrage between CEX and L2 DEX, and Torres et al. (2024, April) [15] quantified the extracted atomic arbitrage on rollups. Subsequently, Gogol et al. (2024, June) [7] and Oz et al. (2025, January) [17] investigated non-atomic arbitrage strategies on L2s and estimated the potential size of cross-rollup MEV.

We extend these contributions with the empirical analysis that answers the questions about high revert transaction rates on L2, their origins, destinations and link with the MEV extraction strategies.

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, such as atomic and non-atomic arbitrage or liquidations.
- 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 spam-based MEV strategies on L2s.
- We evaluate the impact of revert protection on MEV strategies, rollups, and Ethereum, 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 MEV. For more detailed information, we refer the reader to Systematization of Knowledge (SoK) on MEV prevention mechanisms (on L1) [11], and DeFi SoK [6].

Classification by Transaction Ordering.

MEV strategies can be categorized based on how transactions are ordered within a block [11]:

- **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.

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.

- **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 DeFi Protocols.

Different MEV strategies can be associated with specific types of DeFi protocols [6]:
- **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 [6]:
- **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 from major EVM-compatible rollups, such as Arbitrum, Optimism, Base, and ZKsync. The dataset is sourced from blockchain archive nodes from the Dencun upgrade (March 2023) until today. The analyzed transactions and block ranges are detailed in Table 1. For the executed transaction, event logs of Uniswap V2, V3, V4, or other DeFi protocols are parsed to retrieve the DeFi transaction details. Binance (with 1s data granularity) is used as a source of off-chain market prices and acts as a benchmark CEX.

4 Methodology

The major challenge of this research is the fact that DeFi smart contracts do not register event logs of failed transactions. Thus, the failed transactions must be matched to subsequent successful ones. When a transaction succeeds, event logs from Uniswap, Aave, or other DeFi protocols can be parsed, allowing for the extraction of exact transaction parameters and the calculation of the profitability of the executed MEV strategy. The process follows these steps:

1. Identify all reverted transactions and group them by sender and 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

Based on the empirical findings, we simulate how the effectiveness and profitability of spam-based MEV strategies can be optimized with the revert protection mechanisms.

7 Discussion

8 Conclusions

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