

Zero Computing: Analysis of Scroll Prover Dynamics

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Goal

In this report, we develop an economic model for the Scroll zkEVM, considering on-chain data and actual proof costs, to have a better understanding of the potential revenue of the protocol and the provers. Our analysis also provides an overview of the main factors influencing revenue and helps to understand under which circumstances and on-chain dynamics the provers need to be incentivized.

Analyzed Data

The data related to transactions, blocks, and batches for the period 1 Nov 2023 to 24 January 2024 has been sourced from Scroll explorers (dashboards and csv files). The data on how many chunks each batch contains on average has been collected manually by checking 50-100 batches to find the chunk count it includes. An estimated median of 10 chunks per batch was used for the analysis. This could be further fine-tuned if we can receive additional data on this from the Scroll team. For the data related to transaction fees, we extracted approximately 7K transactions from 29/30/31 Jan 2024 from Scrollscan. The proof cost is based on the benchmarks of Zero Computing for the Scroll prover.

Assumptions

- It takes an equal amount of time to generate a chunk proof and a batch proof, and both cost the same to generate
- All provers are working uninterruptedly

Variable Elements

- Time to generate a proof, currently 20 minutes per proof (reported average)
- Revenue shared with the provers, currently 100
- Based on approximately 7K transactions on 29/30/31 Jan 2024, the average L2 execution fee of \$0.1411 per transaction was used to calculate protocol revenue.

Table 1: Average transaction fees

Average of L2 ExecutionFee (USD)	Average of L1DataFee (USD)
0.1411	0.4375

Scenarios Analyzed

1. Base scenario: Averages of the base period
2. Scenario 1: Using data on 5 November 2023: Gas utilization, transaction count, and batch count positively correlate with the average → No change in revenue
3. Scenario 2: Using data on 12 Dec 2023: Gas utilization and batch count positively correlate with the average but the transaction count is lower → much lower profit (non-linear)
4. Scenario 3: Using data on 11 Nov 2023: Gas utilization and batch count positively correlate with the average, but transaction count is much higher → linearly higher profit

Analysis

Analysis of Scroll's data since November 2023	Base scenario: Average of last three months	Scenario 1: 05-11-2023 - Gas utilization, tx count and batch count positively correlate with the average => No change in profit	Scenario 2: 12-12-2023 - Gas utilization and batch count positively correlates with the average but the tx count is much lower => much lower profit	Scenario 3: 09-11-2023 - Gas utilization and batch count positively correlates with the average, but tx count is much higher => linearly higher profit
Daily gas utilization (average gas used/gas limit)	6.48%	11.78%	20.54%	16.71%
Txs per day:	141,188	267,360	280,617	434,358
Blocks per day:	26,930	28,555	28,719	28,683
Chunks per day:	6,284	11,960	21,800	17,370
Batches per day:	628	1,196	2,180	1,737
Transactions per chunk	22.47	22.35	12.87	25.01
Transactions per batch	224.67	223.55	128.72	250.06
Average chunks per batch (? - rough estimation) Source: https://scroll.io/rollupscan?page=1&p	10	10	10	10
L2 execution fee collected:				
L2 execution fee per chunk	\$3.17	\$3.15	\$1.82	\$3.53
L2 execution fee per batch	\$31.70	\$31.54	\$18.16	\$35.29
Average proofs the batch fee covers: (10 chunk proofs + the batch proof)	11	11	11	11
Estimated proof cost based on Zero Computing's benchmark analysis	\$1.20	\$1.20	\$1.20	\$1.20
Total proof cost per batch	\$13.20	\$13.20	\$13.20	\$13.20
Net revenue per batch	\$18.50	\$18.34	\$4.96	\$22.09
Proof demand:	Assumption: it takes equal amount of time to generate a chunk proof and a batch proof			
Chunk proofs per day:	6,284	11,960	21,800	17,370
Batch proofs per day:	628	1,196	2,180	1,737
Total proofs per day:	6,913	13,156	23,980	19,107
Necessary prover infrastructure:	Assumption: all provers are working uninterruptedly			
Proving time (minutes)	20	20	20	20
Daily proving capacity per prover	72.00	72.00	72.00	72.00
Provers needed to process demand:	96.01	182.72	333.06	265.38
Potential prover revenue calculation:				
Revenue per batch	\$18.50	\$18.34	\$4.96	\$22.09
Daily L2 revenue	\$11,627.21	\$21,938.90	\$10,820.74	\$38,362.12
Monthly L2 revenue	\$348,816.20	\$658,166.93	\$324,622.19	\$1,150,863.48
Revenue shared with the provers:	100%	100%	100%	100%
Monthly revenue per prover	\$3,633.10	\$3,602.01	\$974.68	\$4,336.74

Figure 1: Analysis of Scroll's data between November 2023 and January 2024

Explorations and Implications

Figure 2 shows that the number of transactions, the number of batches, and the level of gas utilization are in positive, roughly linear correlation.

Based on this, we could estimate Scroll's theoretic maximum transaction capacity:

- 6.48% gas utilization → 141K transactions per day
- 70% gas utilization → 1.52M transactions per day
- 100% gas utilization → 2.17M transactions per day

Some days show characteristics different from the average. The block count is almost constant throughout the scenarios and does not influence revenue. The batch count linearly correlates with the gas utilization and has an almost constant impact on revenue. The main impact factor: the transaction count per batch is a factor with major impact. Batches including proportionally fewer transactions result in an above-linear drop of revenues and profits while batches with transactions above average result in revenue increase, as shown in Table 2.

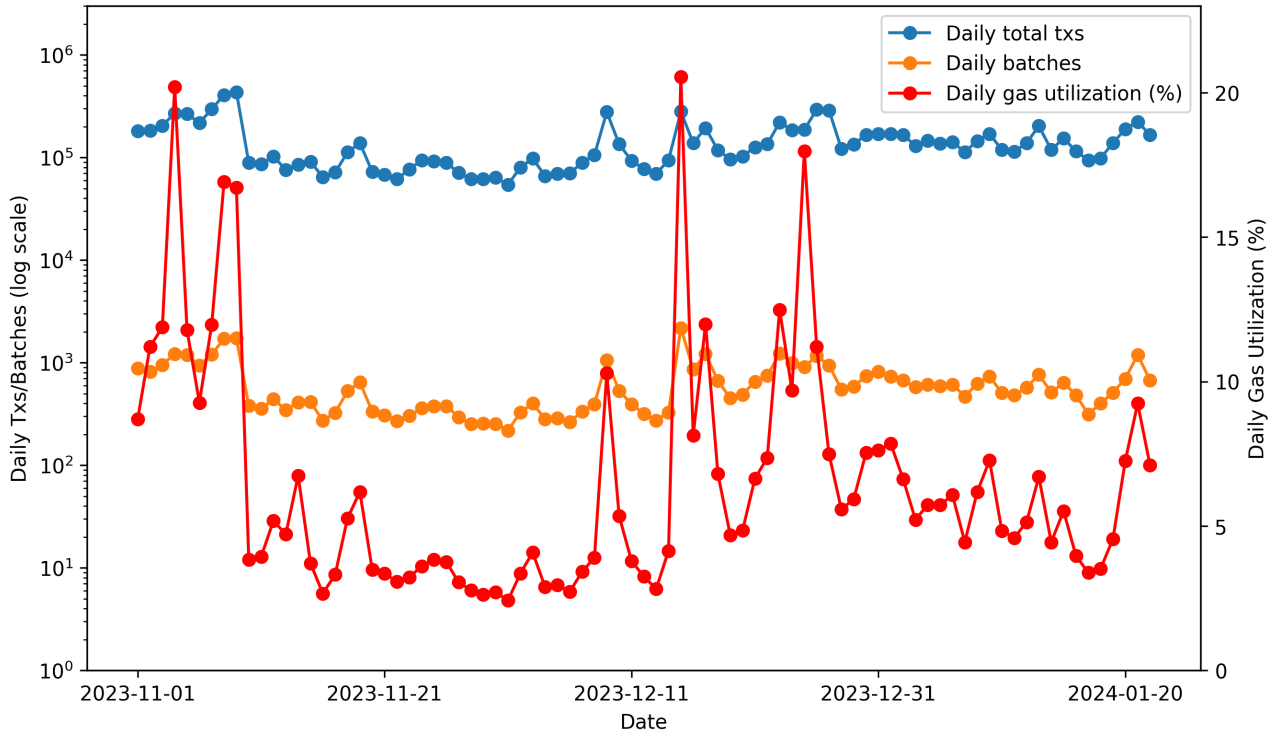


Figure 2: Correlation between transactions, batches and gas utilization

Future Directions

Our analysis could provide more accurate insights if we could receive more data for the entire base period, including transaction fees (both L2 and L1) and chunks as well, instead of the 3-day data we worked with from 29/30/31 Jan 2024, and if the Scroll team could provide more information regarding the necessary compute resources related to chunk proofs vs. batch proofs and any other information needed to estimate the cost and time of proof generation for both of these proofs (e.g. a unit of measurement, such as clock cycles or constraints per chunk proof or batch proof, etc.). Further modeling around prover demand/supply under projected transaction volume and consideration of the impacts of different proving times (e.g., 15 mins, 10 mins). For instance, Figure 3 shows the projections for prover demand with higher transaction volumes. We could also expand in areas such as.

- Conduct additional economic modeling for potential token allocation to provers.
- Explore further modeling with a focus on Scroll's preferred prover coordination mechanism.

Table 2: Main impact factor on prover revenue: Transaction count per batch

	Base scenario Average of last three months	Scenario 1 05-11-2023	Scenario 2 12-12-2023	Scenario 3 09-11-2023
Daily gas utilization (%)	6.48	11.78	20.54	16.71
Txs per day	141,188	267,360	280,617	434,358
Blocks per day	26,930	28,555	28,719	28,683
Chunks per day	6,284	11,960	21,800	17,370
Batches per day	628	1,196	2,180	1,737
Transactions per chunk	22.47	22.35	12.87	25.01
Transactions per batch	224.67	223.55	128.72	250.06
Average chunks per batch	10	10	10	10
Potential prover revenue calculation:				
Revenue per batch (\$)	18.50	18.34	4.96	22.09
Daily L2 revenue (\$)	11,627.21	21,938.90	10,820.74	38,362.12
Monthly L2 revenue (\$)	348,816.20	658,166.93	324,622.19	1,150,863.48
Revenue shared with the provers (%)	100	100	100	100
Monthly revenue per prover (\$)	3,633.10	3,602.01	974.68	4,336.74

- Investigate days with notable deviations from typical patterns to understand underlying causes. For example, analyze the case of 12 Dec 2023, where high gas utilization and batch count were observed alongside a notably lower transaction count compared to similar days with equally high gas utilization.

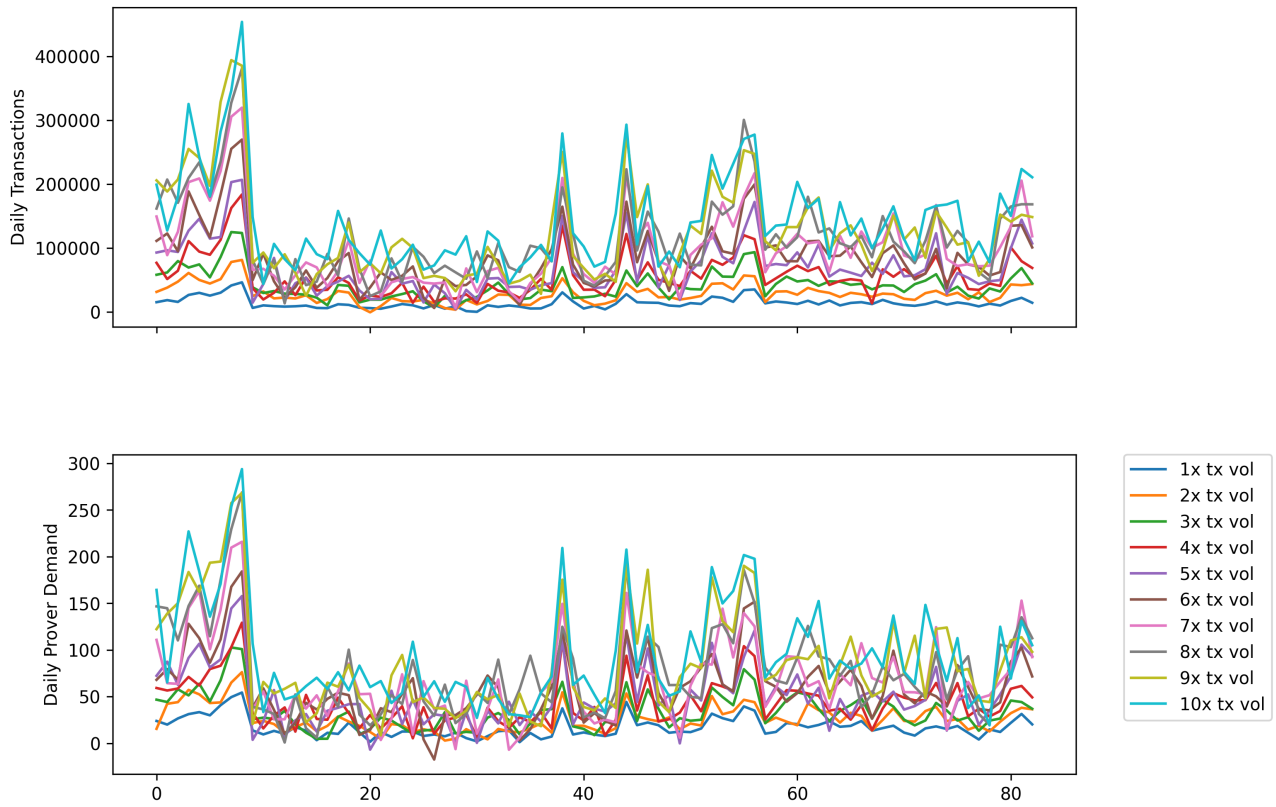


Figure 3: Projected daily transactions and prover demand