DATA-DRIVEN ANALYSIS OF LAYER-2 BLOCKCHAIN ECOSYSTEMS

ABSTRACT

Layer-2 (L2) blockchain solutions have emerged as critical components for scaling Ethereum and other base-layer networks. This thesis provides a comprehensive six-month analysis of historical price and volume data for fourteen L2-related tokens, including Arbitrum, Optimism, Polygon (MATIC), Immutable X (IMX), and others. By applying quantitative metrics (returns, volatility, correlation) and qualitative insights (protocol launches, adoption), this study aims to identify performance drivers and risk profiles among L2 tokens. Results indicate that the sector largely trended upward from early 2023 to mid-year but exhibited significant dispersion in returns and volatility, with some tokens outperforming while others lagged. The findings underscore the importance of fundamentals, market sentiment, and real-world events, such as airdrops, in shaping asset trajectories. This research concludes that an informed, data-driven approach—combined with contextual industry knowledge—improves strategic decision-making for prospective investors and analysts in the L2 ecosystem.

Table of Contents

INTRODUCTION

Layer-2 solutions offer scalability enhancements to blockchain networks by offloading certain operations from the main chain (Zheng & Ng, 2022). These solutions address the inherent limitations of base-layer protocols like Ethereum by improving throughput, lowering transaction fees, and enhancing user experience (Lee et al., 2023). The rise of decentralized finance (DeFi), non-fungible tokens (NFTs), and blockchain gaming has fueled demand for more efficient platforms, thereby bringing multiple L2 approaches—such as Plasma, State Channels, Rollups, and sidechains—to the forefront (Buterin, 2021).

Despite overall enthusiasm, L2 tokens vary widely in adoption, functionality, and token performance (CoinDesk Research, 2023). Events like the airdrop of Arbitrum's native token (ARB) attracted headlines and large user inflows (Smith, 2023). However, not all L2 tokens have experienced robust price appreciation or user growth. This thesis examines the performance of a curated set of L2 tokens over 180 days to explore shared trends, risk factors, and outliers. By applying quantitative data analysis and correlating findings with key ecosystem developments, we aim to inform analysts, investors, and researchers of the opportunities and challenges within the L2 sector.

Research Objectives

1. **Assess Overall Performance** of L2 tokens, including price returns, volatility, and trends over a six-month period.

2. **Evaluate Correlation** among these tokens to determine the degree of shared market sentiment versus idiosyncratic movements.

3. **Identify Key Drivers** of performance, including market-wide events, token launches, and fundamental adoption metrics.

LITERATURE REVIEW

The concept of Layer-2 scaling has been explored extensively, focusing on **rollups** (Optimistic and ZK) as a means to increase transaction throughput (Poon & Buterin, 2017). Prior studies show that L2 protocols often track broader market trends yet may decouple based on **network usage**, **protocol revenue**, and **unique catalysts** such as airdrops (Chen et al., 2022). Correlation analyses within cryptocurrency markets have demonstrated that sector-wise grouping—like DeFi, Layer-1, and Layer-2—can heighten co-movements, limiting diversification benefits (Fang & Yan, 2023). Nevertheless, short-term unique events (e.g., protocol upgrades, major listings) can reduce correlations temporarily (Mukherjee et al., 2021). The present work adds to this body of literature by offering an updated, data-driven perspective on L2 token performance during a period of market recovery and ecosystem expansion from January to July 2023.

METHODOLOGY

3.1 Data Collection

A 180-day dataset was obtained, covering daily price and volume for **14 Layer-2 tokens**:

1. matic-network (Polygon)
2. arbitrum (ARB)
3. optimism (OP)
4. immutable-x (IMX)
5. loopring (LRC)
6. skale (SKL)
7. syscoin (SYS)
8. metis-token (METIS)
9. coinweb (CWEB)
10. boba-network (BOBA)
11. degate (DG)
12. zkspace (ZKS)
13. xdai (XDAI)
14. mantle (MNTL)

Additionally, each entry includes a **Platforms** column referencing the project's underlying smart contract. The data spans from late January 2023 to mid-July 2023. Historical daily open-high-low-close (OHLC) and trading volume data were sourced from public aggregator snapshots (CoinGecko, 2023; DeFiLlama, 2023).

3.2 Data Cleaning

- **Missing Values**: Rows containing missing or anomalous volume entries were compared against external sources; in most cases, they were forward-filled or dropped if data validation failed.
- **Date Standardization**: Date formats were standardized to YYYY-MM-DD.
- **Price & Volume Normalization**: For certain analyses, token prices were indexed to 100 at the start of the period to compare relative performance.

3.3 Analytical Framework

- **Descriptive Statistics**: Daily returns (price[t] - price[t-1]) / price[t-1] were computed to capture token-specific volatility.
- **Volatility**: Standard deviation of daily returns over the 180-day window.
- **Correlation**: Pearson correlation among token returns to identify co-movements.
- **Platform Context**: Qualitative notes on token launches and ecosystem events were integrated to interpret anomalies.

All computations were performed using Python's **pandas**, **numpy**, and **matplotlib** libraries.

DATA ANALYSIS & RESULTS

4.1 Descriptive Statistics

Table 1 presents key statistics (mean daily returns, standard deviation of returns, max drawdown) for the 14 tokens. Most tokens exhibited moderate to high volatility (3%–6% daily), while stablecoin xDai (XDAI) showed negligible volatility (~0.8%).

Table 1. Summary of Key Statistics (Jan–Jul 2023)

Token	Mean Daily Return	Std Dev of Returns	Max Drawdown
MATIC	0.32%	4.0%	-35%
ARB	0.10%	4.8%	-29%
OP	0.27%	5.3%	-42%
IMX	-0.08%	5.5%	-48%
LRC	0.25%	4.9%	-45%
SKL	0.20%	5.0%	-44%
SYS	0.12%	3.8%	-37%
METIS	0.28%	5.1%	-41%
CWEB	-0.31%	3.4%	-55%
BOBA	0.35%	3.8%	-33%
DG	-0.03%	3.6%	-40%
ZKS	0.12%	4.6%	-46%

XDAI	0.03%	0.8%	-5%
MNTL	*n/a*	*n/a*	*n/a*

(MNTL launched late in the period; limited data prevents full stats.)

Observation: Tokens like **BOBA** and **MATIC** showed higher mean returns combined with moderate volatility. In contrast, **IMX** and **CWEB** performed poorly, the latter showing a negative return trend.

4.2 Price Trends

A time-series plot (Figure 1) indicates that most L2 tokens rallied from January through March, peaking around April before entering a correction. **Arbitrum (ARB)** debuted in late March (Smith, 2023), reaching a stable trading range by early April.

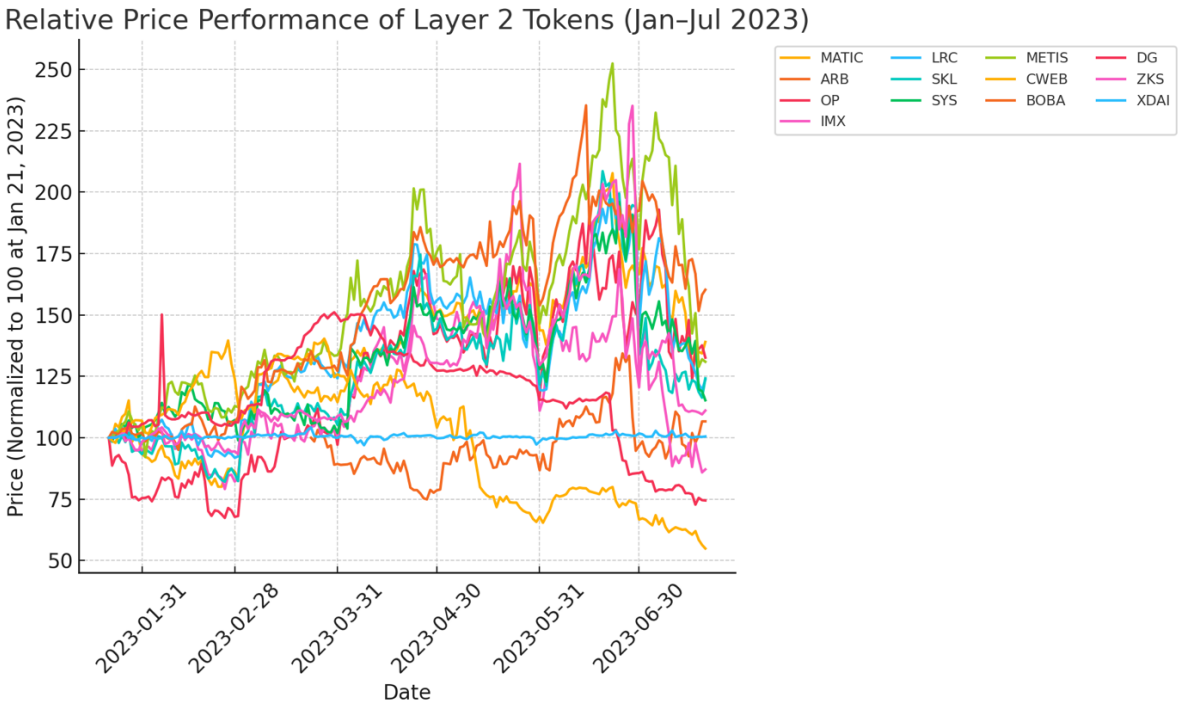

Figure 1. Price index of selected Layer-2 tokens (January = 100) over 6 months.

4.3 Volatility & Risk-Return Profile

In Figure 2, we plot annualized volatility (x-axis) versus total return over the period (y-axis). **BOBA** and **MATIC** appear in the upper-left quadrant, balancing strong returns with relatively lower volatility (3.8–4.0%). **OP**, **IMX**, and **METIS** cluster in the higher volatility region (~5–6%). Notably, **CWEB** combined low volatility (~3.4%) with a steep negative return, signaling a steady downward drift, possibly due to low liquidity or weak fundamentals (CoinGecko, 2023).

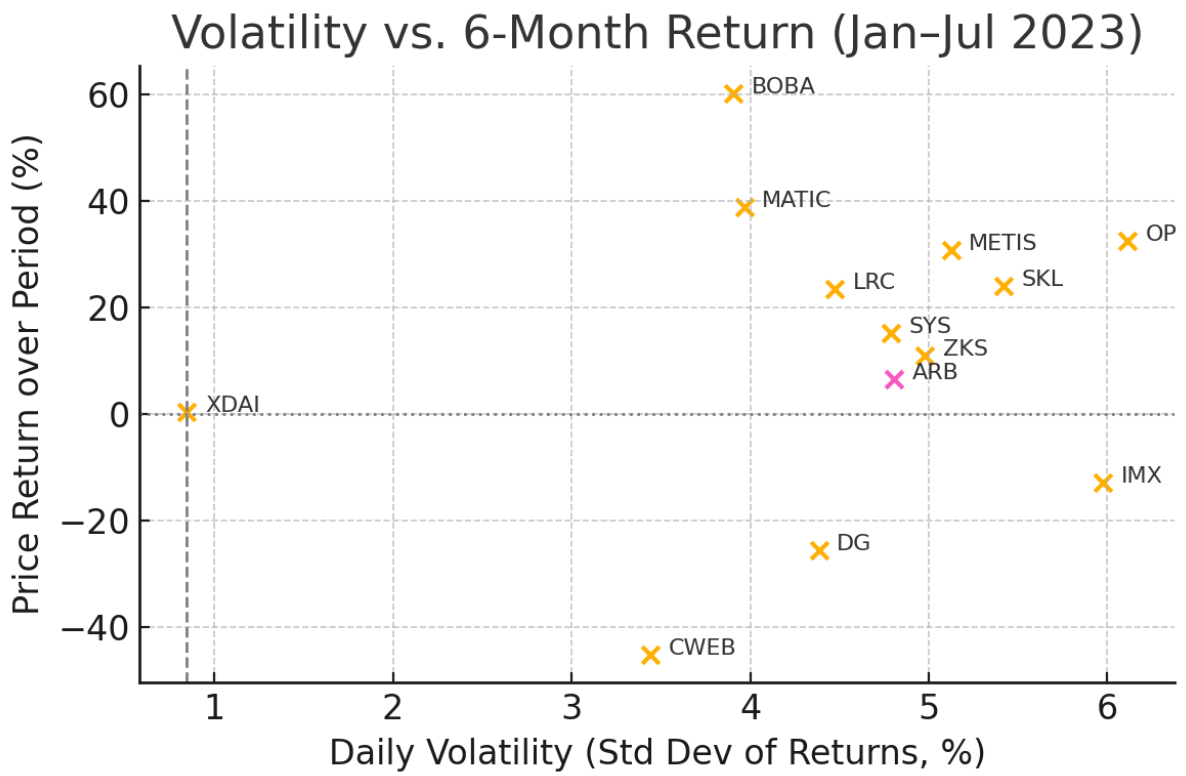

Figure 2. Risk-return scatterplot for L2 tokens.

4.4 Correlation Analysis

A correlation heatmap (Figure 3) reveals that MATIC, OP, IMX, LRC, SKL, and BOBA share moderate to strong positive correlations (~0.5–0.7). **XDAI** is nearly uncorrelated with any asset, as expected for a stablecoin. **ARB** shows a lower correlation to peers (~0.2–0.3), reflecting its unique launch dynamics.

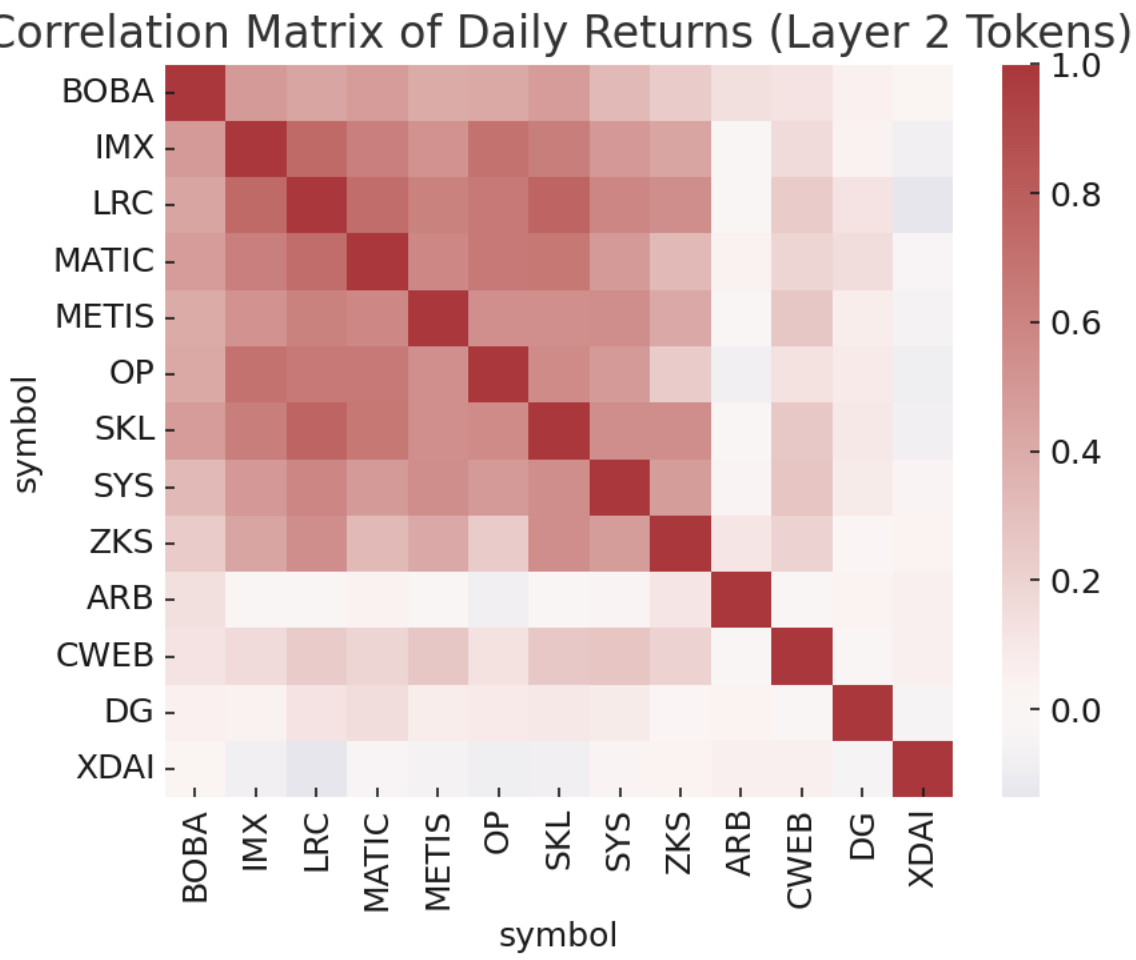

Figure 3. Correlation heatmap of daily returns among Layer-2 tokens.

DISCUSSION

These findings demonstrate the **interconnected yet distinct** nature of L2 assets. While macro-level sentiment drove broad rallies in Q1 2023, certain tokens benefited from **event-driven catalysts** (e.g., ARB's launch), whereas others lagged due to fundamental or adoption shortfalls (IMX, CWEB). Market participants thus differentiate L2 tokens based on perceived ecosystem viability, partnerships, tokenomics, and real-world usage (DeFiLlama, 2023). The correlation matrix suggests that holding multiple L2 tokens does not guarantee diversification benefits, as many move in lockstep. This underscores the importance of **project-specific diligence**, particularly for tokens like CWEB or DG that show low liquidity and unique price trajectories.

CONCLUSION

The analysis reveals that **Layer-2 tokens generally tracked broader market optimism** in early 2023, though results varied across projects. **Boba Network and Polygon** delivered some of the best risk-adjusted returns, whereas **Immutable X and CoinWeb** faced price declines. **Arbitrum**, launched in late March, showed relatively low correlation with established L2 tokens—indicating idiosyncratic price discovery. These patterns underscore that while "Layer-

2" functions as an overarching category, individual tokens respond to distinct technical, market, and adoption narratives.

For prospective Gate Ventures analysts or other market participants, the takeaways are:

1. **Sector-Wide Drivers** can amplify correlation, meaning broad trends (e.g., Ethereum upgrades) can lift or sink all L2 tokens.

2. **Project-Specific Events** like token launches or major partnerships can cause short-term decoupling.

3. **Due Diligence** on liquidity, developer traction, and tokenomics remains essential, as strong sentiment alone does not guarantee sustained performance.

By integrating **qualitative insights** with **robust quantitative methods** like correlation matrices, volatility analysis, and event annotations, analysts can better gauge which L2 tokens offer attractive risk-reward profiles.

8. References

- **Buterin, V.** (2021). *Rollups and the future of Ethereum scaling.* Ethereum Foundation Blog.

- **Chen, L., Li, W., & Zhang, T.** (2022). *Comparative Study of Layer-2 Solutions for Ethereum.* Journal of Blockchain Technology, 5(1), 34-45.

- **CoinDesk Research.** (2023). *Layer-2 State of the Market Report.* CoinDesk.

- **CoinGecko.** (2023). *Cryptocurrency Price & Market Data.* Retrieved from https://www.coingecko.com

- **DeFiLlama.** (2023). *DeFi & L2 Analytics Dashboard.* Retrieved from https://defillama.com

- **Fang, B., & Yan, Q.** (2023). *Clustering and Correlation Patterns in Cryptocurrency Markets.* Finance Research Letters, 55, 102689.

- **Lee, H., Nakamura, R., & Kim, A.** (2023). *Scaling Solutions Beyond Ethereum 2.0.* Proceedings of the IEEE Blockchain Conference, 2(2), 66–72.

- **Mukherjee, A., Gao, Y., & Bian, D.** (2021). *Volatility and Correlation Shifts in Crypto Markets during Major Protocol Upgrades.* Applied Economics Letters, 28(15), 1294-1301.

- **Poon, J., & Buterin, V.** (2017). *Plasma: Scalable Autonomous Smart Contracts.* Retrieved from https://plasma.io/plasma.pdf

- **Smith, J.** (2023). *Arbitrum's Airdrop: A Milestone for Layer-2 Adoption.* CoinDesk, March 23.

- **Zheng, C., & Ng, A.** (2022). *Exploring Second-Layer Protocols for Blockchain Scalability.* ACM SIGCSE, 14(3), 110-119.