

DATA SCIENCE IN FINANCIAL MARKETS

Network and Hurst Exponent Based Portfolio Optimization of Cryptocurrencies

GROUP-18

Presented by
Uday Sushanth
Mohnit Akula
Sai Ram Aditya

Problem Statement

Challenges in Cryptocurrency Portfolio Optimization

- Cryptocurrencies exhibit high volatility, making risk evaluation and portfolio optimization complex.
- Traditional approaches fail to reflect:
 - **Dynamic Relationships:** Constantly changing interactions between cryptocurrencies.
 - **Market Patterns:** Temporal properties like persistence or stochastic trends in price changes.
- Investors require innovative tools to identify trends, assess risks, and maximize gains.

Objectives

Understand Interrelationships:

- Analyze connections and dependencies between cryptocurrencies using network analysis.

Measure Trend Persistence:

- Use the Hurst exponent to assess market memory and predictability.

Develop Portfolio Strategies:

- Create a framework combining network analysis and the Hurst exponent.

Mitigate Investment Risks:

- Enhance risk management through advanced analytics.

Facilitate Implementation:

- Provide actionable insights for real-world cryptocurrency portfolio optimization.

Literature Review

Paper Link	Author(s)	Model Used	Conclusion Drawn
Transitions in the cryptocurrency market during the COVID-19 pandemic: A network analysis	David Vidal-Tomás	Network Analysis, Network Topology, Multiple Spanning Tree	This study analyzes the impact of COVID-19 on cryptocurrency markets using network analysis, focusing on degree and betweenness centrality metrics to understand market synchronization and transitions. The findings highlight increased interconnectedness during the pandemic's peak, reflecting herding behavior and reduced diversification opportunities.
The cryptocurrency market: A network analysis	Carlos Jaureguizar Francés Pilar Grau-Carles Diego Jaureguizar Arellano	Minimum Spanning Tree , Pearson Correlation	The provided problem statement explores the dependencies and relationships within the cryptocurrency market using advanced network analysis techniques.
Cryptocurrencies and Long-Range Trends	Monica Alexiadou, Emmanouil Sofianos , Periklis Gogas and Theophilos Papadimitriou	R/S , DFA for Hurst exponent	The innovation of this research is that they employ the Hurst exponent to identify long-range properties, a tool that is seldomly used in analysis of this market. Furthermore, the use of both the R/S and the DFA analysis

Methodology

Data Collection:

- Used Yahoo Finance to collect daily price data of six cryptocurrencies (BTC, ETH, XRP, LTC, BCH, ADA) for 2020–2021.
- Data Preprocessing:
- Addressed missing values using linear interpolation.
- Computed logarithmic returns for analysis.

Core Techniques:

Network Analysis:

- Constructed a Minimum Spanning Tree (MST) for clustering and identifying key market nodes.

Hurst Exponent Analysis:

- Determined market behavior (mean-reverting, random walk, or trending).

Evaluation Metrics:

- Analyzed centrality, clustering, and Hurst trends pre- and post-COVID.

Results

Network Analysis:

- Clusters and central nodes in the cryptocurrency market were identified, aiding diversification.

Hurst Exponent Analysis:

Pre-COVID:

- Markets exhibited higher randomness and fewer trends.

COVID:

- Increased trend persistence due to higher market integration.

Portfolio Insights:

- Network analysis helped optimize diversification, while the Hurst exponent indicated more predictable assets.

Impact of Market Shocks:

- COVID-19 revealed structural changes, emphasizing the need for adaptive strategies.

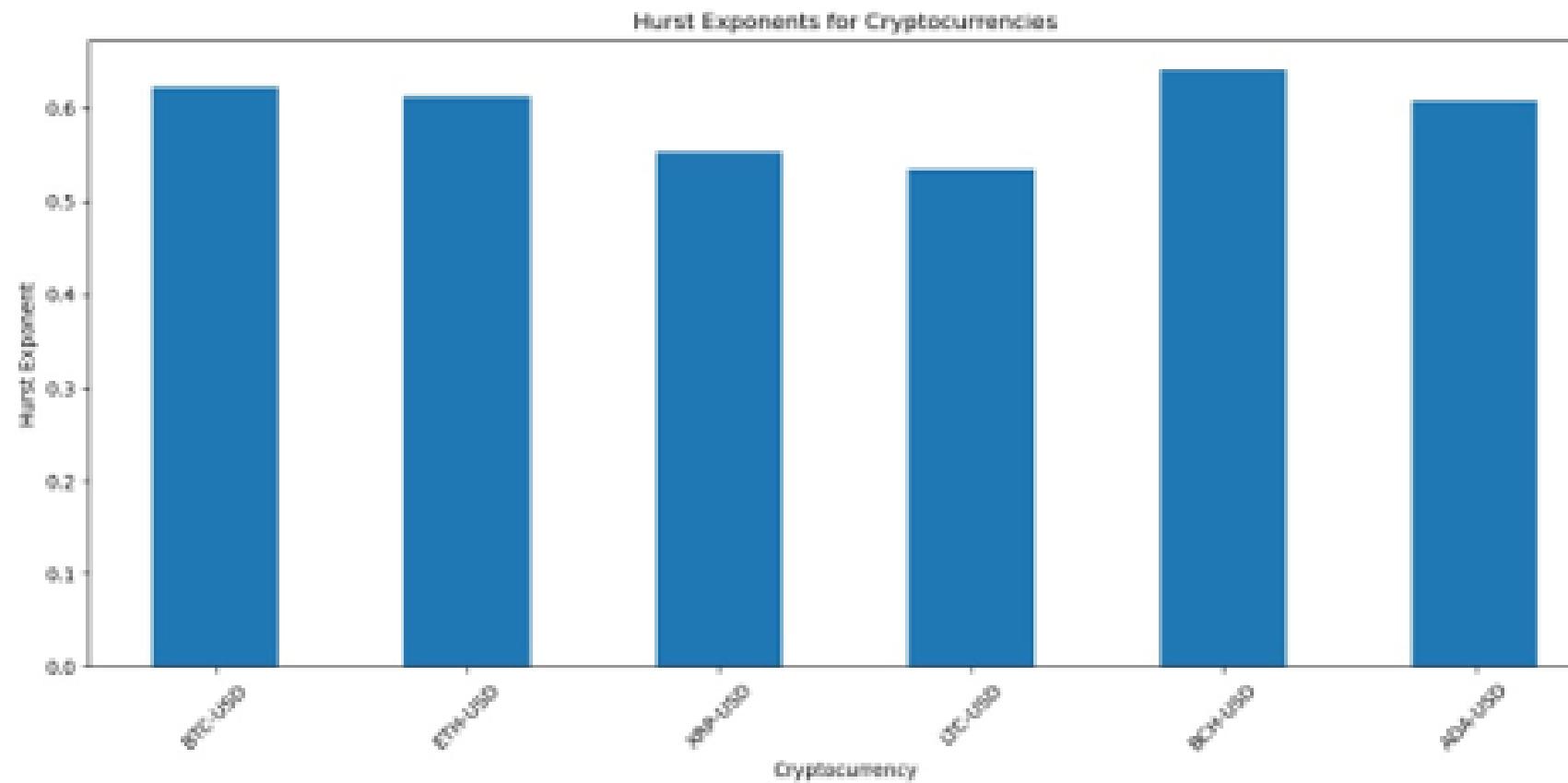


Figure 2: Hurst Exponents in Pre-Covid period

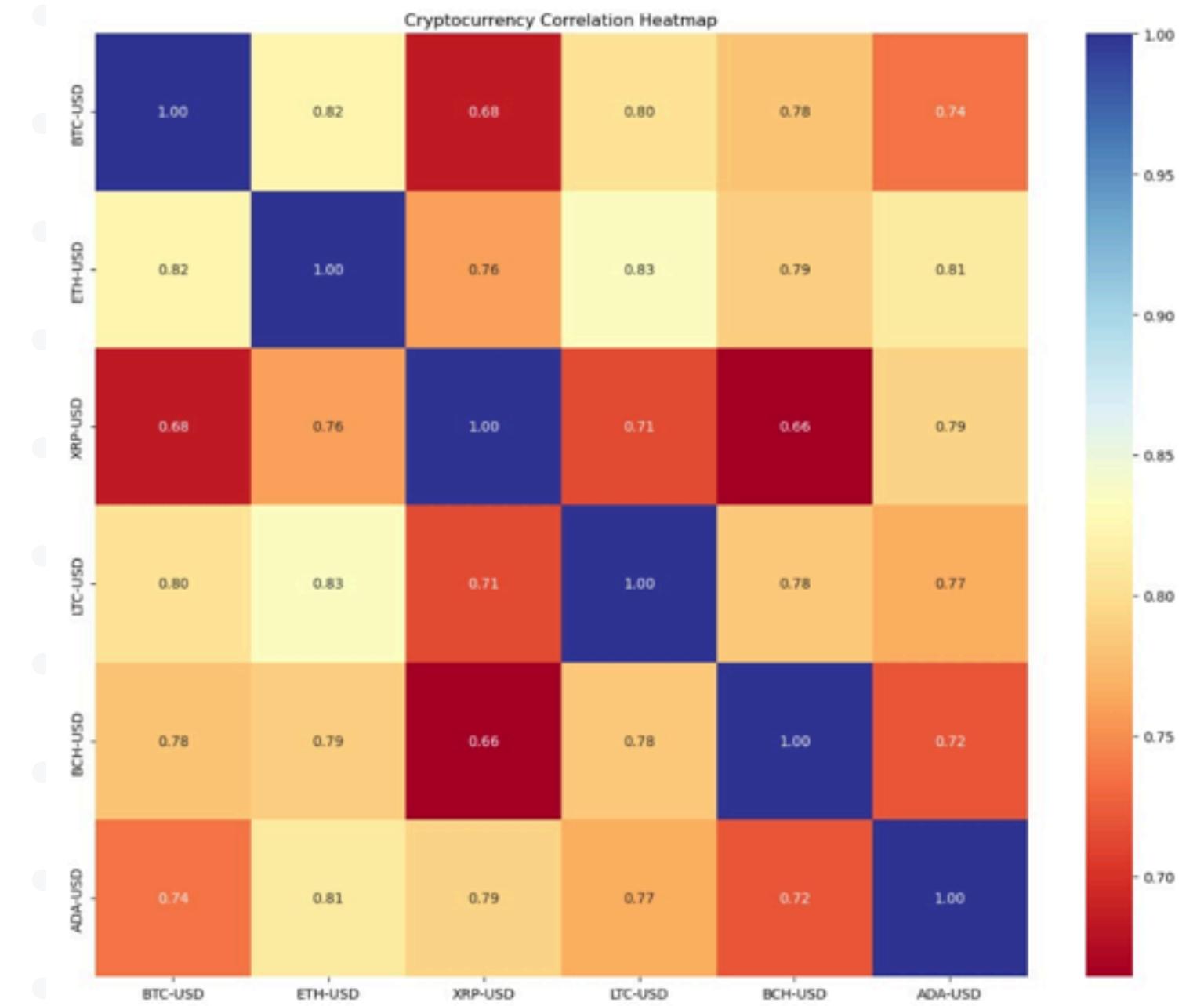


Figure 3: Correlation between Cryptocurrencies Pre-Covid

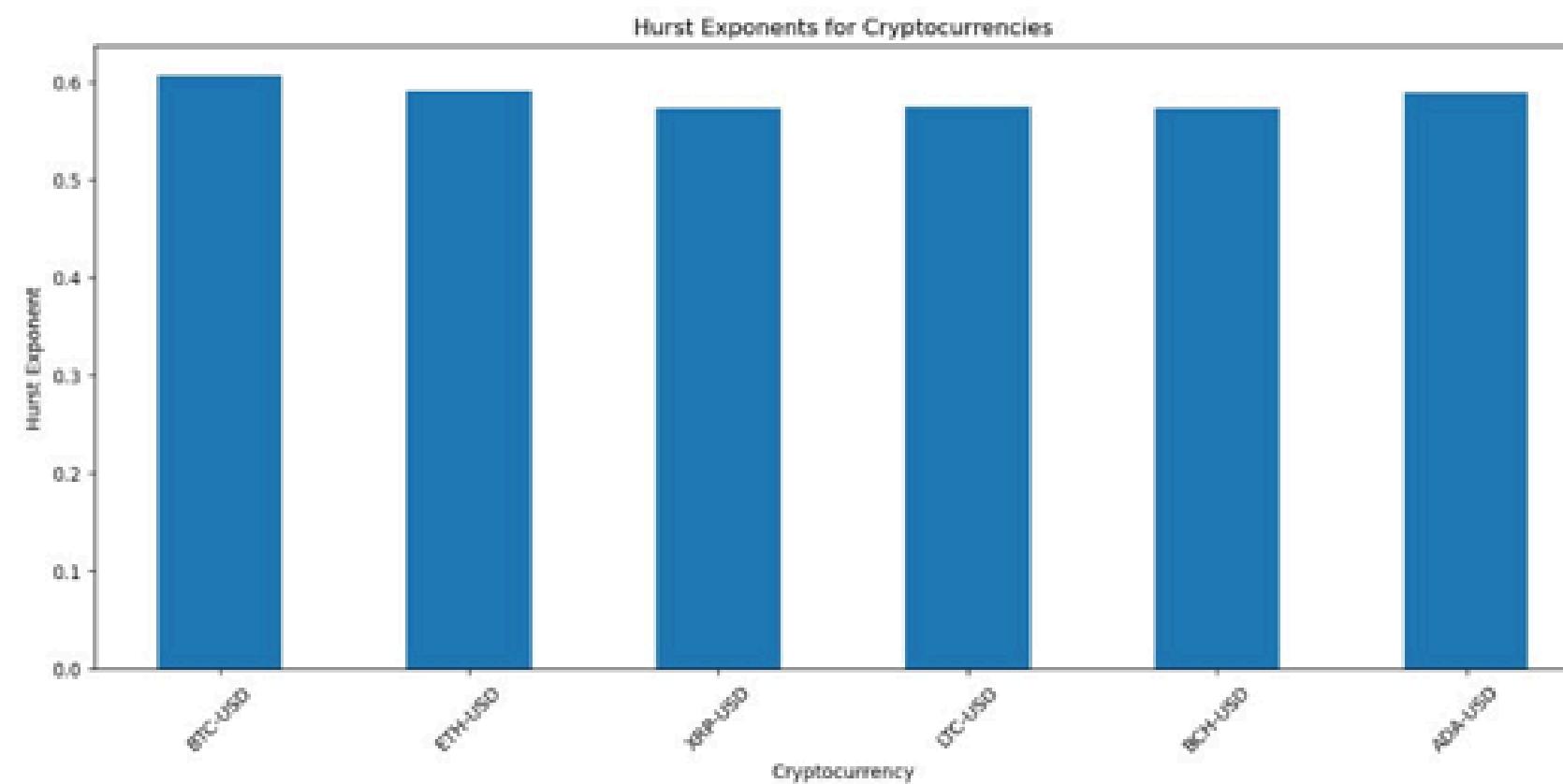


Figure 6: Hurst Exponents in Post-Covid period

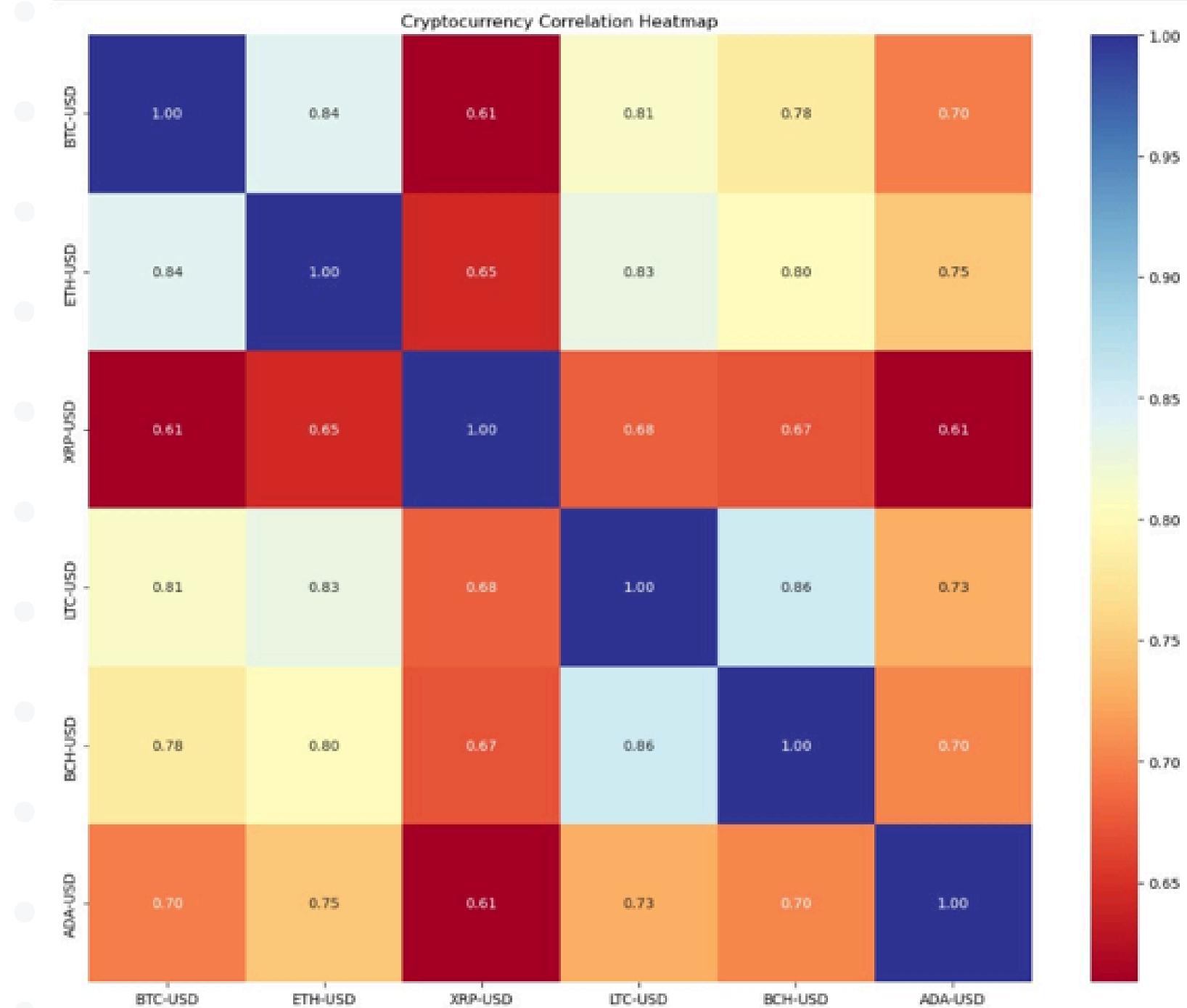


Figure 7: Correlation between Cryptocurrencies Post-Covid

Conclusion and Future Outlook

Conclusion:

- The project successfully demonstrated the use of network analysis and Hurst exponent to optimize cryptocurrency portfolios.
- These methods provide valuable insights into market behavior, enabling better risk management and diversification strategies.

Future Outlook:

- Integrate real-time data for dynamic portfolio adjustments.
- Expand the study to include macroeconomic indicators and sentiment analysis.
- Incorporate advanced machine learning models like anomaly detection for enhanced predictions.

Thank You

Group-18