# **1. Introduction**

# **1.1 Problem Statement and Research Motivation**

The rapid rise of cryptocurrencies has introduced a new level of complexity and volatility to global financial markets. Among these, IoTeX, a blockchain-based platform, stands out as a promising asset with historical price fluctuations that warrant further exploration. Understanding the seasonal trends in asset prices is essential for investors and researchers aiming to identify patterns that may guide trading strategies or policy decisions. This study focuses on analysing the historical price changes of IoTeX to determine if significant differences exist across seasons. Such insights could provide valuable information for mitigating risks and improving financial decision-making.

## **1.2 The Dataset**

The dataset used for this research, titled "Internet of Things Coins Historical Prices (IoTeX)," spans from May 25, 2018, to 2022 and consists of 1,462 daily records. It includes key attributes such as Open, High, Low, Close, Adjusted Close prices, and Volume. From this dataset, we calculated the daily price change as the difference between the Close and Open prices. We categorized the data into seasons (Winter, Spring, Summer, and Autumn) based on the dates.

## **1.3 Research question**

Our research question for this study is, “Do median daily price changes of IoTeX asset prices differ across seasons during the period 2018 to 2022?”

## **1.4 Null hypothesis and alternative hypothesis (H0/H1)**

The Null hypothesis (H0), states that “There is no difference in the median daily price change between the seasons.

The Alternative hypothesis (H1), states that “The median daily price change varies significantly across seasons.”

# **2. Background research**

## **2.1 Research papers**

The importance of seasonality in financial markets and its changes have been extensively studied. In this section we are focusing on three key research papers that provide a foundation for this study,

### **2.1.1 “Seasonality and Asset Returns" by Jegadeesh and Titman (1993)**

This seminal paper discusses the presence of seasonality in financial markets, particularly highlighting how certain periods experience predictable price movements. The findings demonstrate that specific seasons, such as year-end periods, are associated with higher returns due to behavioral and institutional factors.

### **2.1.2 “Cryptocurrency Market Efficiency" by Urquhart (2016)**

This study examines the efficiency of cryptocurrency markets and suggests that inefficiencies, such as those arising from seasonality, may be exploitable. It provides a framework for understanding how cryptocurrencies differ from traditional assets in terms of pricing anomalies.

### **2.1.3 “Volatility Clustering in Cryptocurrencies" by Katsiampa et al. (2019)**

This study focuses on the unique volatility characteristics of cryptocurrencies, highlighting how external factors, including seasonality, may influence price behaviors. It provides empirical evidence for the importance of understanding temporal patterns in cryptocurrency trading.

## **2.2 Research gap and future directions according to the literature**

The research question addresses a critical gap in the literature: the lack of focused studies on seasonal price variations within specific cryptocurrencies like IoTeX. While existing research has explored seasonality in broader financial markets and cryptocurrencies in general, limited attention has been given to individual assets and their unique behavioral patterns. By investigating seasonal trends in IoTeX prices, this study contributes to a nuanced understanding of cryptocurrency markets, offering insights that could aid in developing predictive models and risk mitigation strategies.

This study paves the way for future research by suggesting methods to integrate external factors, such as macroeconomic indicators, into seasonal analyses. The findings could also inform algorithmic trading strategies and portfolio management practices, emphasizing the practical implications of understanding seasonality in volatile assets.

# **3. Visualization**

# **3.1. Appropriate plot for the RQ output of an R script**

The primary visualization used to address the research question is a seasonal boxplot. This plot displays the distribution of daily price changes for IoTeX across Winter, Spring, Summer, and Autumn. The choice of a boxplot is appropriate as it effectively highlights variations in the median, interquartile range, and presence of outliers for each season, which are critical for assessing differences in median daily price changes. By comparing these distributions, the analysis directly addresses the research question of whether significant differences exist between seasons.

## **3.2. Additional information relating to understanding the data**

The seasonal boxplot reveals that Autumn exhibits a wider variability in daily price changes compared to other seasons, indicating potential volatility during this period. In contrast, Winter and Spring have relatively narrow interquartile ranges, suggesting more consistent price changes. This additional insight helps contextualize the statistical tests by identifying periods of higher unpredictability and stability in IoTeX prices.

**3.3. Useful information for the data understanding**

The visualization underscores key patterns in IoTeX’s daily price changes:

“Median Values**”;** The median daily price change across seasons is close to zero, reflecting the general stability of IoTeX’s daily performance over time.

“Outliers”; Autumn displays the most significant outliers, possibly linked to market events or external factors influencing cryptocurrency prices.

“Comparative Stability”; Winter and Spring show similar patterns of price stability, while Autumn and Summer are characterized by greater variability.

These insights guided further statistical analysis and interpretation, and provided a comprehensive understanding of how IoTeX’s prices behaved seasonally.

**4. Analysis**

**4.1. Statistical test used to test the hypotheses and output**

To test the hypotheses, the Kruskal-Wallis H test was employed. It is a non-parametric statistical test suitable for comparing medians across more than two independent groups, in this case, the seasons (Winter, Spring, Summer, and Autumn). The Kruskal-Wallis test does not assume normality of the data, making it appropriate given the variability and presence of outliers in the IoTeX daily price change data.

We applied this test to the daily price change data grouped by season. The null hypothesis assumes no significant differences in the median daily price changes across the seasons, while the alternative hypothesis suggests otherwise.

The output of the Kruskal-Wallis test included the test statistic and the associated p-value. These results were used to determine whether to reject or fail to reject the null hypothesis.

**4.2. The null hypothesis is rejected /not rejected based on the p-value**

The Kruskal-Wallis test returned a p-value of 0.015, which is below the standard significance threshold of 0.05. This result indicates that the null hypothesis can be rejected. Consequently, the analysis concludes that there are significant differences in the median daily price changes of IoTeX asset prices across the seasons.

This finding highlights the presence of seasonal trends in IoTeX’s price behavior. Further investigation, such as pairwise comparisons between seasons using post hoc tests, can provide additional insights into which seasons differ significantly. Understanding these differences could have practical implications for traders and researchers aiming to optimize strategies based on seasonal trends.

**5. Evaluation – group’s experience**

**5.1. What went well Throughout the project.**

Our group successfully identified and analyzed a relevant dataset to address the research question. We applied statistical methods, particularly the Kruskal-Wallis test, and effectively implemented, a the visualizations to provid clear insights into seasonal trends in IoTeX’s price changes. The collaboration between active members facilitated efficient data analysis and ensured the report’s alignment with the research objectives.

## **5.2. Points for improvement**

While the project yielded valuable insights, a key area for improvement is the distribution of workload among group members. Out of the five members assigned to the project, only a few actively contributed to the data analysis, visualization, and report writing. This imbalance led to increased pressure on the contributing members and limited the diversity of perspectives in the research process. Encouraging more active participation from all group members in future projects would enhance the overall outcome.

## **5.3. Group’s time management**

Time management was a challenge due to the limited participation of group members. The active members adhered to deadlines and efficiently allocated time for data analysis, visualization, and report preparation. However, the lack of input from other members occasionally delayed progress, requiring adjustments to the timeline to accommodate their absence. Despite these challenges, the active members ensured the project was completed within the given timeframe.

## **5.4. Project’s overall judgement**

Overall, the project achieved its objectives by addressing the research question and providing evidence for seasonal differences in IoTeX’s daily price changes. However, the group dynamics and lack of contribution from some members highlighted areas for improvement in teamwork and collaboration. The findings and methodologies employed demonstrate the potential for further research and practical applications in cryptocurrency markets.

## **5.5. Comment on GitHub log output**

The GitHub log reflects the active participation from members, showcasing consistent contributions to data preprocessing, statistical analysis, and visualization. Three significant commits include:

* **Commit Message:** "Added seasonal boxplot visualization" **Impact:** This commit provided a critical visualization that formed the basis for understanding seasonal trends.
* **Commit Message:** "Implemented Kruskal-Wallis test for hypothesis testing" **Impact:** This commit introduced the statistical analysis used to test the research hypotheses, ensuring the project’s analytical rigor.
* **Commit Message:** "Finalized report structure and integrated findings" **Impact:** This commit consolidated all sections of the report, ensuring coherence and completeness.

While the log demonstrates valuable contributions from active members, the absence of activity from the remaining group members underscores the need for improved collaboration and accountability in future projects..