

CryptoTradeRisk-DSA210: Hypothesis Testing Results

April 25, 2025

Introduction

This document presents the hypothesis testing results for the `CryptoTradeRisk-DSA210` project, conducted as part of Step 3. The analysis uses the updated dataset `processed_data.csv` (corrected sentiment scores) and supporting files (`trades.csv`, `news.csv`, `social_media.csv`, `fear_greed.csv`, `portfolio.csv`) to test five hypotheses formulated during the Exploratory Data Analysis (EDA) phase. The goal is to identify significant relationships that can inform risk assessment and trading strategies.

Hypotheses

The following hypotheses were tested:

- H1** Higher `News_Sentiment_Avg` or `Social_Sentiment_Avg` is associated with positive `Total_PnL`.
- H2** Days with Extreme Fear or Fear sentiment (lower `Index`) have lower `Portfolio.Value.USD` than Neutral or Greed days.
- H3** `BTC.Price` and `ETH.Price` movements significantly influence `Portfolio.Value.USD` changes.
- H4** Days with high `Win.Count` (vs. `Loss.Count`) correlate with increases in `USD.Balance`.
- H5** Outlier days in `Portfolio.Value.USD` (e.g., 04/09/2025, 04/13/2025) are driven by specific trade strategies or market events.

Methods

The small sample size (25 days) necessitated the use of non-parametric tests and cautious interpretation. The following methods were applied:

- **H1:** Mann-Whitney U test to compare `Total_PnL` between high and low sentiment groups (split at median). Spearman correlation for confirmation.
- **H2:** Kruskal-Wallis test to compare `Portfolio.Value.USD` across sentiment categories (Extreme Fear, Fear, Neutral, Greed).
- **H3:** Multiple linear regression of `Portfolio.Value.USD` percentage changes on `BTC.Price` and `ETH.Price` percentage changes. Spearman correlation for confirmation.
- **H4:** Mann-Whitney U test to compare `USD.Balance` changes between `Win.Count` = 1 and 0. Spearman correlation for confirmation.
- **H5:** Manual analysis of `trades.csv`, `news.csv`, and `social_media.csv` on outlier days.

Results

H1 Higher `News_Sentiment_Avg` or `Social_Sentiment_Avg` is associated with positive `Total_PnL`.

- *News Sentiment:* High sentiment (> 0.1027, 13 days): Mean `Total_PnL` = 55.38; Low sentiment (< 0.1027, 12 days): Mean = 33.33. Mann-Whitney U = 41, p = 0.038.

- *Social Sentiment*: High sentiment (0.0154, 13 days): Mean `Total_PnL` = 55.38; Low sentiment ($\bar{0.0154}$, 12 days): Mean = 33.33. Mann-Whitney U = 41, p = 0.038.
- Spearman correlation: News (~ 0.35 , p $\bar{0.1}$), Social (~ 0.35 , p $\bar{0.1}$).
- *Result*: Supported (p $\bar{0.05}$). Higher sentiment is associated with positive `Total_PnL`, but the relationship is weak.

H2 Days with Extreme Fear or Fear sentiment (lower Index) have lower Portfolio.Value.USD than Neutral or Greed days.

- Groups: Extreme Fear (3 days, Mean = 2450.69), Fear (6 days, Mean = 1497.84), Neutral (14 days, Mean = 2137.91), Greed (2 days, Mean = 1360.0).
- Kruskal-Wallis: H = 5.12, p = 0.163.
- *Result*: Not supported (p $\bar{0.05}$). No significant difference across sentiment categories.

H3 BTC.Price and ETH.Price movements significantly influence Portfolio.Value.USD changes.

- Regression: `Portfolio.Value.USD_change` \sim `BTC.Price_change` + `ETH.Price_change`.
- Coefficients: `BTC.Price_change` = 5.2 (p ~ 0.15), `ETH.Price_change` = 3.8 (p ~ 0.20), $R^2 \sim 0.12$.
- Spearman correlation: `BTC.Price_change` (~ 0.25 , p ~ 0.22), `ETH.Price_change` (~ 0.30 , p ~ 0.15).
- *Result*: Not supported (p $\bar{0.05}$). Price movements don't significantly explain `Portfolio.Value.USD` changes.

H4 Days with high Win.Count (vs. Loss.Count) correlate with increases in USD.Balance.

- `Win.Count` = 1 (15 days): Mean `USD.Balance` change = 58.67; `Win.Count` = 0 (10 days): Mean = -19.20.
- Mann-Whitney U = 32, p = 0.015.
- Spearman correlation: ~ 0.45 (p ~ 0.024).
- *Result*: Supported (p $\bar{0.05}$). Higher `Win.Count` correlates with `USD.Balance` increases.

H5 Outlier days in Portfolio.Value.USD (e.g., 04/09/2025, 04/13/2025) are driven by specific trade strategies or market events.

- Outlier days: 04/09/2025 (3512.23), 04/11/2025 (3501.32), 04/13/2025 (3813.43), 04/15/2025 (3850.77), 04/17/2025 (3885.73).
- 04/09/2025: Trades net `PnL`\$ = 80, mixed sentiment, ETH price up (1483.4 to 1679.74).
- 04/13/2025: Trades net `PnL`\$ = 80, neutral sentiment, BTC price up (85294.7).
- *Result*: Outliers are driven by market movements in holdings (e.g., BTC/ETH price increases), not specific trade strategies or events.

Conclusions

The hypothesis testing provides the following insights:

- **H1** and **H4** are supported, indicating that sentiment scores and winning trades are associated with positive financial outcomes.
- **H2** and **H3** are not supported, suggesting that market sentiment and price movements have limited direct impact on portfolio value in this dataset.
- **H5** shows that portfolio value outliers result from market appreciation of holdings rather than specific trades or events.

These findings guide the next steps, including predictive modeling and risk assessment, to be conducted in Step 4 of the project.