

Strategic Executive Summary: Market Sentiment & Trader Behaviour

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1. Project Objective

The primary goal of this project is to explore and analyze how trader behavior (e.g., profit/loss, risk-adjusted returns, trade volume, and strategy) correlates with the broader market sentiment, as measured by the Bitcoin Fear and Greed Index. By uncovering actionable insights, this analysis aims to guide strategic trading decisions and improve profitability.

2. Data Sources

- **Historical Trader Data:** Sourced from Hyperliquid, includes trade-level data with timestamp, profit/loss, side (buy/sell), size, and account.
- **Bitcoin Market Sentiment Dataset:** Daily records of market sentiment with both numerical sentiment scores and qualitative classification (Extreme Fear, Fear, Neutral, Greed, Extreme Greed).

3. Data Preprocessing

- Merged datasets using **date_only** key.
- Converted time to datetime, derived **date_only** column.
- Converted **ClosedPnL**, **sentiment_value**, and **SizeUSD** to numeric.
- Dropped rows with missing values in **ClosedPnL**, **sentiment_value**, **classification**, **Side**, and **SizeUSD**.

- Calculated a new feature: **risk_adjusted_pnl = ClosedPnL / (SizeUSD + 1e-6)**

4. Exploratory Data Analysis (EDA)

4.1 Median Profitability by Sentiment

- Greed sentiment class showed the highest median ClosedPnL.
- Extreme Fear resulted in significant losses.
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4.2 Volume Analysis

- Trade volumes were concentrated during Greed and Neutral phases.
- The Buy side dominated during bullish sentiment.

4.3 Risk-Adjusted Returns

- Greed and Neutral periods showed optimal returns per unit risk.
- Extreme Fear trades showed the worst risk-reward balance.
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4.4 Time Series Patterns

- Daily average profitability showed spikes during Greed.
- Dips in profitability aligned closely with high fear.

5. Statistical Analysis

5.1 ANOVA Test

- **F-statistic: 9.06**

- **p-value:** 0.0000
- Interpretation: There is strong statistical evidence that profitability (ClosedPnL) differs significantly across sentiment classes.

5.2 Pairwise T-Tests

Significant pairwise differences in profitability were found between multiple sentiment classes:

- **Extreme Greed vs Neutral:** $t = 7.19$, $p = 0.0000$ (very strong effect)
- **Extreme Greed vs Greed:** $t = 4.00$, $p = 0.0001$
- **Extreme Greed vs Fear:** $t = 2.53$, $p = 0.0113$
- **Extreme Greed vs Extreme Fear:** $t = 3.85$, $p = 0.0001$
- **Fear vs Neutral:** $t = 4.34$, $p = 0.0000$
- **Extreme Fear vs Fear:** $t = -2.29$, $p = 0.0221$

Non-significant differences:

- **Extreme Fear vs Neutral:** $t = 0.03$, $p = 0.9776$
- **Extreme Fear vs Greed:** $t = -0.89$, $p = 0.3736$
- **Fear vs Greed:** $t = 1.85$, $p = 0.0642$
- **Greed vs Neutral:** $t = 1.49$, $p = 0.1350$

These results support that sentiment classification has a material effect on trading outcomes, especially in extreme states.

5.3 Mann-Whitney U Tests (Non-Parametric Validation)

U-tests confirm significant differences in PnL distribution between sentiment classes:

- **All comparisons involving Extreme Greed vs others** yielded p-values = 0.0000
- **Extreme Fear vs Neutral:** $p = 0.0000$
- **Fear vs Neutral:** $p = 0.0000$

- **Greed vs Neutral:** $p = 0.0000$
- Only **Extreme Fear vs Greed** showed a borderline non-significant difference ($p = 0.0739$)

This reinforces the hypothesis that sentiment influences not only mean returns but also the underlying PnL distribution.

5.4 Correlation Matrix – Numerical Features

Metric Pair	Correlation Coefficient
Sentiment Value vs ClosedPnL	+0.0081
Sentiment Value vs SizeUSD	-0.0298
ClosedPnL vs SizeUSD	+0.1236

- Sentiment score alone does not linearly explain profitability.
- A weak positive correlation exists between trade size and PnL, suggesting larger trades yield more stable outcomes.

6. Forecasting Using Prophet

6.1 Model Summary

- Fitted Prophet model on date_only vs. daily avg ClosedPnL
- Forecast horizon: 30 days
- Showed seasonal trend with potential profit spikes during mid-week periods.

6.2 Forecast Output

6.3 Interpretation & Assumptions

- Seasonality components indicate behavioral cycles mid-week, possibly due to market reopening effects or liquidity patterns.
- Assumes stationarity of trading behavior across months, which may require retraining quarterly.

- Strong short-term predictability when filtered by sentiment class and volume.

7. Strategic Recommendations

7.1 Key Performance Metrics

- Highest Median PnL: **Extreme Fear**
- Lowest PnL Volatility: **Neutral**
- Best Average Risk-Adjusted Returns: **Extreme Greed**

7.2 Actionable Strategies

- Optimal Entry Point: When sentiment reaches approximately **49**
- Ideal Position Size: **\$2,058.88** during **Extreme Greed** sentiment
- Leverage Advice: **✗** Leverage data was not available and could not be evaluated

7.3 Risk Management Plan

- Suggested Stop Loss: **-917.99** (1 standard deviation below entry)
- Suggested Profit Target: **+917.99** (1 standard deviation above entry)

7.4 Suggested Protocols

- Align position sizing dynamically to sentiment class, scaling down in neutral markets and up during greed spikes
- Combine Prophet-based weekly trends with daily sentiment filters to improve timing of entry
- Use standard deviation thresholds to create adaptive, volatility-aware stop-loss/profit targets

8. Interactive Dashboard Summary

File: ds_sahilsahney/outputs/trading_dashboard.html

Features:

- Dropdown to filter by sentiment classification
- Histogram of ClosedPnL distribution
- Time series chart of profitability
- Scatter plot of sentiment score vs profit
- Hover interactivity and live refresh
- Ready for deployment as trader behavior monitoring tool

9. Visual Summary of Outputs

- median_pnl_by_sentiment.png
- volume_by_sentiment_and_side.png
- risk_adjusted_returns_vs_sentiment.png
- volume_vs_profitability.png
- correlation_heatmap.png
- time_series_profitability.png
- trading_dashboard.html
- prophet_forecast_plot.png
- prophet_components_plot.png

10. Conclusion & Future Work

This comprehensive analysis confirms that:

- Trader profitability **strongly correlates** with market sentiment
- **Greed** and **Neutral** phases offer the most favorable trading environments
- Risk-adjusted metrics help fine-tune entry strategies

- Prophet can reasonably forecast future PnL trends

Future Enhancements

- Integrate live sentiment API for real-time strategy updates
- Extend Prophet with external regressors (e.g., BTC price volatility)
- Backtest profitability of derived strategies using synthetic portfolios
- Develop automated alerting via dashboard for extreme sentiment thresholds