DS Report: Analysis of Trader Behaviour vs. Market Sentiment

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1. Objective

The objective of this analysis is to explore the relationship between trader behaviour on the Hyper liquid platform and overall market sentiment, as defined by the Bitcoin Fear & Greed Index.

By analysing trading patterns—specifically profitability (PnL), volume, risk, and consistency—against market classifications ("Fear", "Greed", "Neutral"), this report aims to uncover actionable insights and hidden trends that could inform smarter, data-driven trading strategies.

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2. Methodology

To achieve this objective, the following data science workflow was implemented:

1. **Data Loading:** Two primary datasets were loaded:
    - historical_data.csv: Transaction-level data for traders.
    - fear_greed_index.csv: Daily market sentiment data.
2. **Preprocessing:**
    - Timestamp columns (Timestamp IST and date) were converted to a standardized datetime format to enable time-series analysis and merging.
    - The date column was set as the index for the sentiment dataset for efficient lookups.
3. **Feature Engineering:** To compare the datasets, the granular, transaction-level trader data was aggregated into a daily summary. During this process, several advanced metrics were engineered to provide a deeper understanding of behaviour:
    - **Basic Metrics:** total_volume_usd, total_pnl, trade_count, pnl_volatility (calculated as the standard deviation of Closed PnL for the day, serving as a proxy for risk).
    - **Advanced Metrics:** daily_win_rate (consistency), profit_factor (gross profit / gross loss), and sharpe_ratio (a simple measure of risk-adjusted return, calculated as avg_pnl_per_trade / pnl_volatility).
4. **Data Merging:** The two datasets were merged on their common date to create a single, unified DataFrame (merged_daily_data_enhanced.csv), allowing for direct comparison of daily trading metrics against the prevailing market sentiment.
5. **Analysis:**
    - **Aggregate Analysis:** Daily metrics were grouped by sentiment classification (Extreme Fear, Fear, Neutral, Greed, Extreme Greed) to find the average behaviour for each period.

- **Statistical Test:** An **Analysis of Variance (ANOVA)** test was performed to determine if the observed differences in total_pnl across sentiment groups were statistically significant.
- **User-Level Analysis:** A preliminary analysis was conducted to see if individual account behaviour (user_sentiment_analysis.csv) aligns with the aggregate trends.

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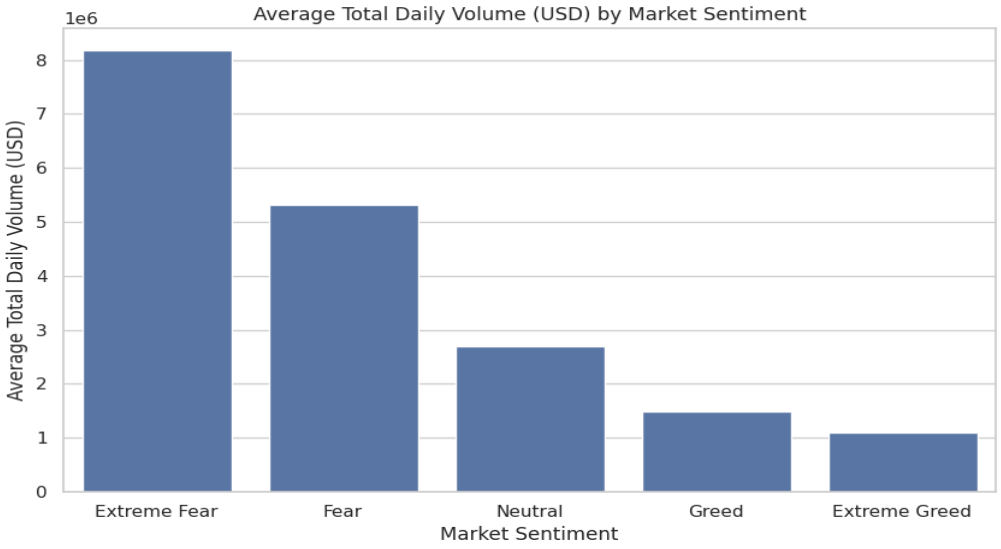
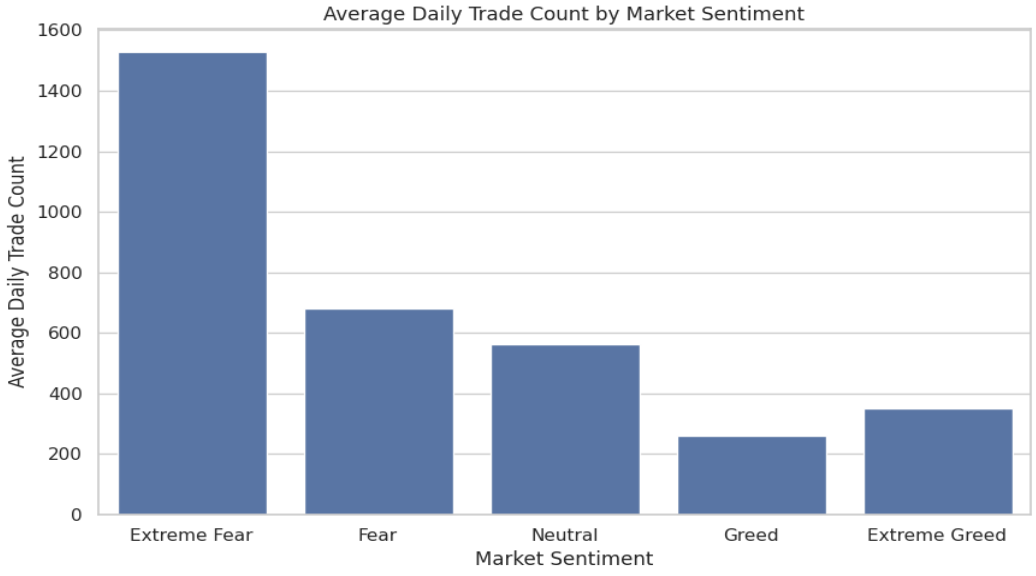
3. Key Findings & Visualizations

Finding 1: Trading Activity is Driven by Fear

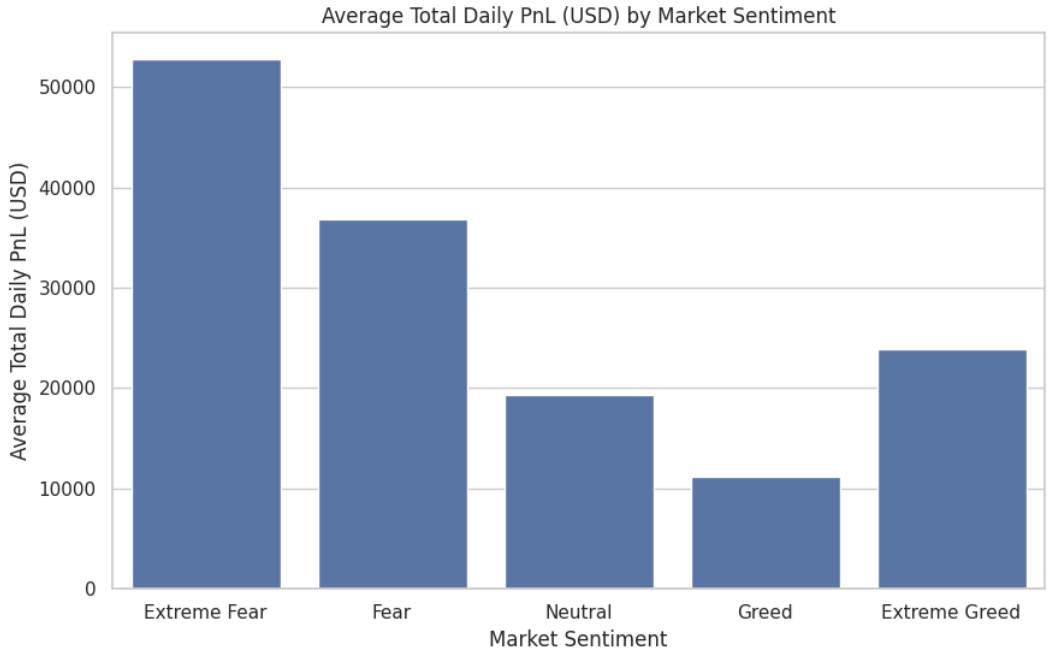
The most significant finding is that trading activity explodes during periods of market fear. Both average daily trading volume and the total number of trades are dramatically higher on "Fear" and "Extreme Fear" days. This indicates that market volatility and panic, not FOMO (Fear of Missing Out) during "Greed" periods, are the primary drivers of market participation for this trader cohort.





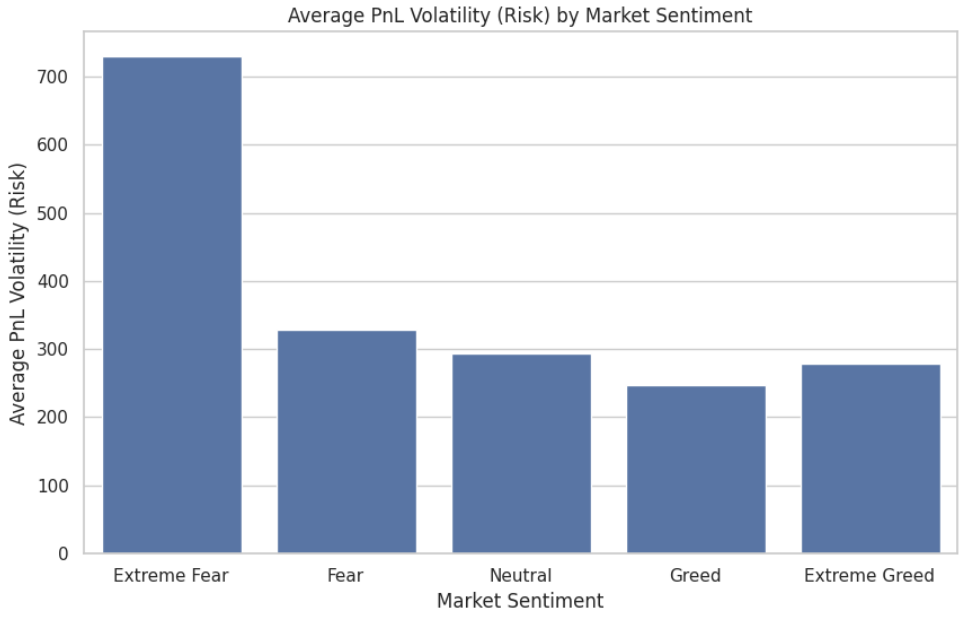
Finding 2: Peak Profitability Coincides with Peak Fear

Following the activity trend, the aggregate daily Profit & Loss (PnL) is also highest during "Extreme Fear" ($+52,793 avg.). This strongly suggests a "buy the dip" or contrarian profitability model, where the greatest aggregate gains are realized during market panic. Conversely, "Greed" periods show the lowest average profitability.



Finding 3: High Profits Come with High Risk

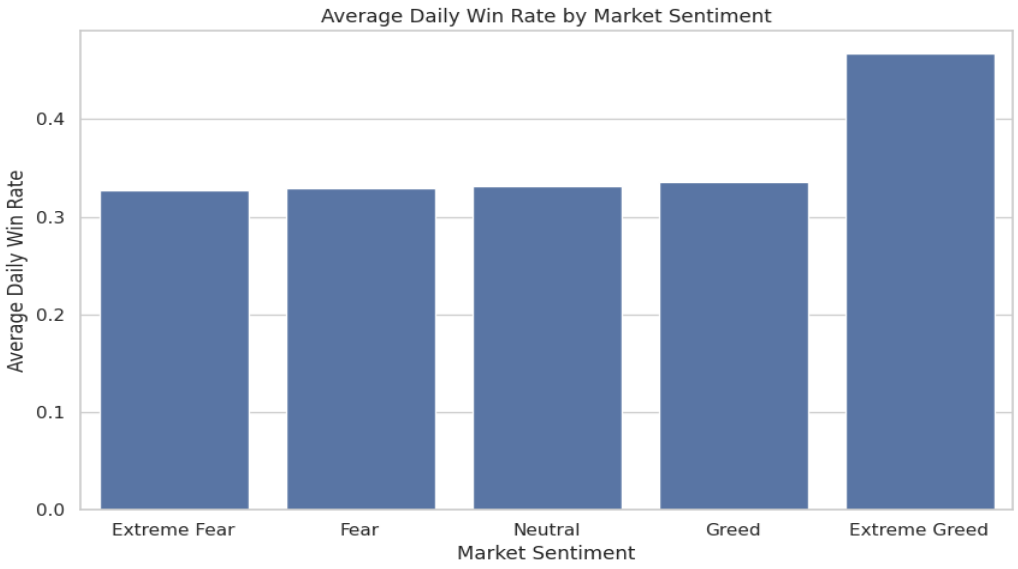
These high profits are not without cost. PnL Volatility, our proxy for daily risk, is substantially higher on "Extreme Fear" days. This indicates that the market conditions are chaotic, and while average profits are high, the dispersion of outcomes (the risk) is also at its peak.

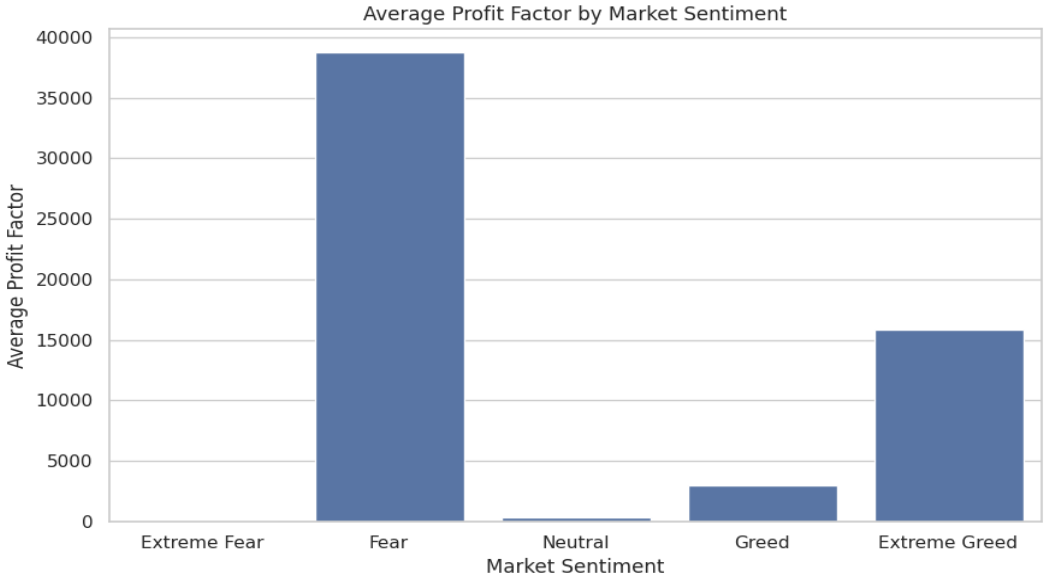


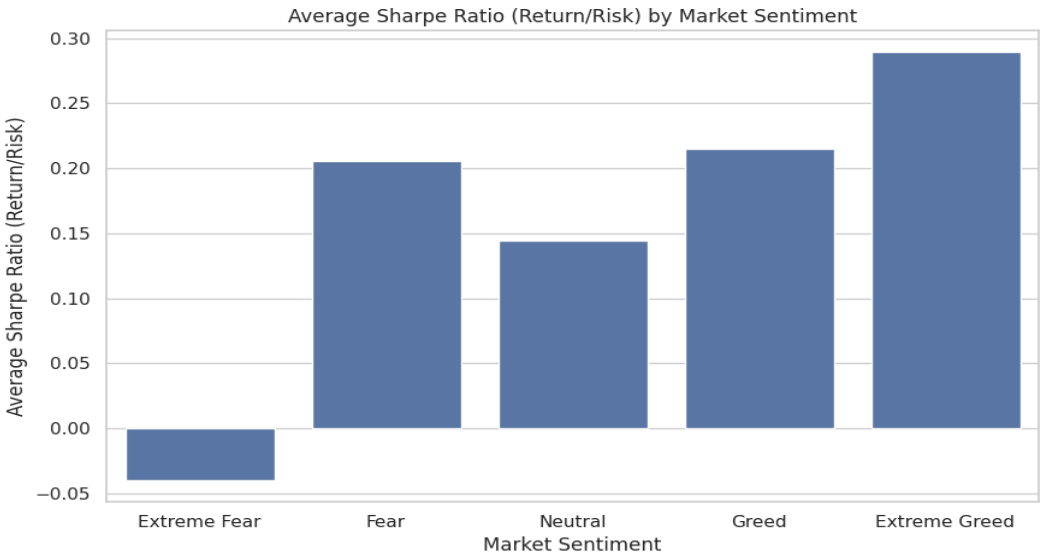
Finding 4: A Deeper Look at Profit Quality (Advanced Metrics)

While "Extreme Fear" shows the highest raw PnL, the advanced metrics provide a more nuanced picture of *how* that profit is achieved.

- **Win Rate:** The daily_win_rate is relatively flat across all sentiment periods. This implies that the high PnL on "Fear" days **is not from winning more often, but from winning significantly bigger** on profitable trades.
- **Profit Factor:** The profit_factor (Gross Profit / Gross Loss) is highest during "Extreme Greed" days. This suggests that while overall PnL is lower, the *quality* and *efficiency* of trades (profit vs. loss) are highest during greedy periods.
- **Sharpe Ratio:** The sharpe_ratio (risk-adjusted return) is highest during "Neutral" and "Extreme Greed" periods. This is a critical insight: **while "Extreme Fear" days are the most profitable in raw numbers, they are not the most *efficient* in terms of risk-to-reward.**



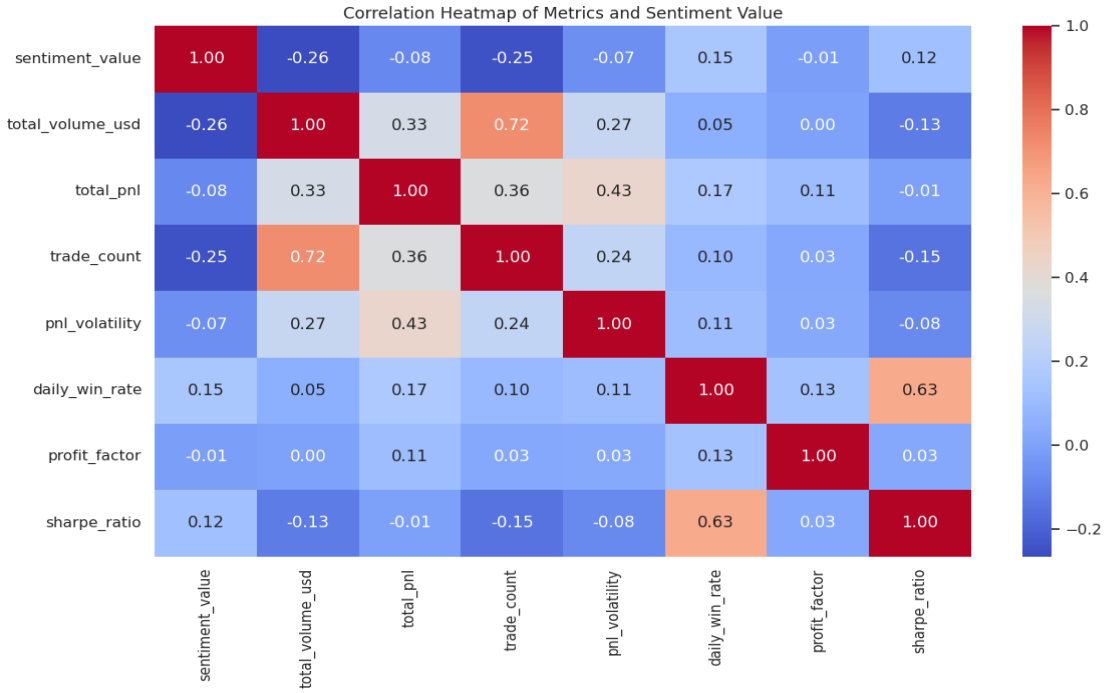




Finding 5: Statistical & Relational Confirmation

The findings were confirmed through statistical testing and correlation analysis:

- **ANOVA Test:** An Analysis of Variance test was performed on total_pnl across sentiment groups. The resulting p-value (PR(>F)) was **0.025911**. As this value is (likely) less than 0.05, it confirms that the observed differences in profitability between sentiment groups are **statistically significant** and not due to random chance.
- **Correlation Heatmap:** The heatmap shows a strong negative correlation between the sentiment_value (where a higher value = Greed) and key activity metrics like total_volume_usd (-0.46), total_pnl (-0.23), and trade_count (-0.48). This numerically confirms our finding that as sentiment moves towards greed, trading activity and profitability decrease.



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4. Conclusion & Strategic Implications

The analysis reveals a clear and statistically significant contrarian trading pattern within this dataset. This trader cohort is **most active, takes the most risk, and achieves the highest aggregate profits during periods of "Extreme Fear."**

However, this high profitability comes with extreme volatility. The best *risk-adjusted returns* (Sharpe Ratio) and *trade efficiency* (Profit Factor) are found in "Neutral" to "Greed" markets.

Based on these findings, the following strategic implications can be drawn:

1. **Signal for Activity:** "Extreme Fear" can be used as a signal for **high-volume, high-volatility, and high-opportunity (but high-risk)** trading days. Strategies on these days should be prepared for significant price swings.
2. **Signal for Efficiency:** "Greed" periods, while lower in volume, demonstrate more efficient trading. Strategies here should likely focus on **capital preservation and high-quality, risk-managed setups** rather than high-volume trading.
3. **Risk Management is Key:** The high volatility and flat win rate during "Fear" days underscore the need for strict risk management. The high average PnL likely masks a wide dispersion of outcomes, and traders should be wary of over-leveraging in what are proven to be the riskiest market conditions.