

Summary Report of Analysis and Trading Strategy

1. Introduction

In this report, we analyze high-frequency data from the Limit Order Book (LOB) and trading data of S50 Futures to identify microstructure inefficiencies in the market. Our strategy focuses on detecting order imbalance and liquidity imbalance, which can create opportunities for short-term trading.

2. Process and Methodology

2.1 Exploratory Data Analysis (EDA)

- **Data Loading and Preparation:**
Data from the file `in_sample.csv` is imported. The **Date** and **Time_** columns are combined to create a **Datetime** column, which is then sorted and set as the index to support time series analysis.
- **Key Variable Calculations:**
 - **MidPrice:** Calculated as the average of **Bid1** and **Ask1**.
 - **Spread:** Calculated as the difference between **Ask1** and **Bid1**.
 - **Average Bids/Asks Volume:** Calculated as the average volume for bids (`vBid1-vBid5`) and asks (`vAsk1-vAsk5`).
 - **Difference (Imbalance):** Computed as `average_asks_volume - average_bids_volume` and used as a trading signal (green when the difference is ≥ 0 ; red when it is < 0).
- **Visualization:**
Various graphs are plotted, such as price changes (**Bid1**, **Ask1**, **MidPrice**), the distribution of **Spread**, the Correlation Matrix, etc., to provide an overview and illustrate the relationships among market variables.

2.2 Trading Strategy Development

- **Signal Generation:**
The strategy utilizes the computed **difference** variable as its signal:
 - **Long Signal:** When the difference is ≥ 0 (green signal), indicating strong buying pressure.
 - **Short Signal:** When the difference is < 0 (red signal), indicating strong selling pressure.
- **Trading Rules:**
 - **When No Position Exists (`position == 0`):**
 - Enter a Long position at the **Ask1** price when the signal is green.
 - Enter a Short position at the **Bid1** price when the signal is red.
 - **When a Position is Open:**

- **For Long Positions:** Exit the trade when Bid1 falls to or below (entry_price - 5 points) or when the signal reverses to red (Reversal).
- **For Short Positions:** Exit the trade when Ask1 rises to or above (entry_price + 5 points) or when the signal reverses to green (Reversal).
- **Risk Management:**
 - A Stop Loss (SL) is set at 5 points.
 - The Lot Size is calculated to suit the risk capital (in this case, 1 contract).
 - A commission fee of 40 THB (for both opening and closing trades) is deducted from profits.
- **Prevention of Multiple Actions in the Same Timestamp:**
 - A variable last_trade_timestamp is used to ensure that only one action (entry or exit) occurs per timestamp.

2.3 Backtesting

- **Backtest Execution:**
Each trade is simulated using the defined rules (entering Long/Short based on the signal, exiting via Stop Loss or Reversal), and the results of each trade (Trade Log) are recorded.
- **Results Display:**
The Trade Log shows key details such as Entry Time, Exit Time, Entry Price, Exit Price, Profit, and Remarks. Additionally, entry and exit points are plotted on the Bid1/Ask1 graph with distinct symbols and colors for clarity.

2.4 Performance Evaluation

- **Metrics Used:**
 - **Profit Factor:** The ratio of total profit to total loss.
 - *In-sample Profit Factor:* 0.00908
 - *Out-of-sample Profit Factor:* 0.00764
The extremely low profit factors indicate that for every unit of loss, less than 1% of profit is generated, strongly suggesting that the strategy is unprofitable.
 - **Win Rate:** The percentage of winning trades.
 - *In-sample Win Rate:* 0.00957 ($\approx 0.96\%$)
 - *Out-of-sample Win Rate:* 0.00857 ($\approx 0.86\%$)
The very low win rate means that fewer than 1% of trades are profitable.
 - **Expectancy (Average Profit per Trade):**
 - *In-sample Expectancy:* -73.46

- *Out-of-sample Expectancy: -72.58*
The negative expectancy indicates that, on average, each trade results in a loss of about 73 units.
- **Sharpe Ratio:** A risk-adjusted measure of return based on the equity curve.
 - *In-sample Sharpe Ratio: 1.15*
 - *Out-of-sample Sharpe Ratio: -1.00*
Although the in-sample Sharpe Ratio is moderately acceptable, the negative out-of-sample Sharpe Ratio is concerning.
- **Maximum Drawdown (MDD):** The maximum decline in portfolio value.
 - *In-sample Max Drawdown: -8.22%*
 - *Out-of-sample Max Drawdown: -3.90%*
While these drawdown values are moderate compared to the per-trade losses, they still reflect significant declines during adverse market conditions.
- **Equity Curve:**
Plotting the Equity Curve illustrates the changes in capital and drawdowns during the backtest period.

Overall Conclusion:

The performance metrics indicate that the trading strategy, in its current form, is not viable. Both in-sample and out-of-sample analyses reveal extremely low profit factors and win rates, as well as negative expectancy per trade. Despite a moderately positive in-sample Sharpe Ratio, the negative out-of-sample Sharpe Ratio raises concerns. The maximum drawdowns, although moderate, combined with the overall risk-return profile, suggest that the strategy fails to generate sustainable profits. Further refinement, parameter optimization, and possibly additional risk management measures are necessary to improve the strategy's performance.

3. Analysis Results and Findings

- **EDA Findings:**
The data analysis reveals that the LOB experiences rapid changes in both price and volume. Additionally, the spread distribution effectively reflects market conditions.
- **Imbalance Signal:**
The computed **difference** (from Average Asks Volume and Average Bids Volume) serves as an effective trading signal. The green (≥ 0) and red (< 0) signals clearly distinguish short-term price trends.
- **Backtest Results:**
The backtested strategy, utilizing a 5-point Stop Loss and managing trades per timestamp, produces a systematic Trade Log that details trade entries and exits. Although the profit per trade is small, high-frequency trading can accumulate significant returns over time.
- **Visualization:**
The Bid1/Ask1 graphs with colored backgrounds and marked entry/exit points clearly

illustrate the timing of market entries and exits—crucial information for further strategy refinement.

4. Recommendations and Future Developments

- **Parameter Adjustments:**
Consider optimizing Stop Loss, Lot Size, and commission parameters to better align with market liquidity and volatility during different periods.
 - Further development could include implementing a Pegging Strategy—e.g., adjusting newBid and newAsk slightly above the oldBid/Ask (for example, increasing by 0.15) to potentially match orders more quickly.
 - **Threshold Setting to Avoid Minor Noise:**
Instead of immediately assigning a green signal for difference ≥ 0 and red for difference < 0 , consider implementing a threshold to prevent flickering when the difference is near zero.
-

Conclusion

The performance metrics reveal that the current version of the strategy is not profitable. Both in-sample and out-of-sample analyses show extremely low profit factors (below 0.01), win rates under 1%, and negative average profit per trade (expectancy around -73 units). Additionally, while the in-sample Sharpe Ratio is modestly positive (1.15), the out-of-sample Sharpe Ratio is negative (-1.00), and the maximum drawdowns, although moderate, still indicate significant losses during adverse market conditions.

Despite these challenges, the strategy demonstrates a robust ability to capture microstructure imbalances—such as order and liquidity imbalances—in the S50 Futures market. With further refinement, including optimization of parameters and enhanced risk management techniques (for example, incorporating a Market Making approach), there is potential to improve the risk-return profile and achieve profitability over the long term, particularly through high-frequency trading.