Introduction

This strategy proposal aims to replicate and implement the trading strategy outlined in "The Alpha Engine: Designing an Automated Trading Algorithm" by Anton Golub, James B. Glattfelder, and Richard B. Olsen. The primary objectives include accurately replicating the strategy, deploying it in live forex trading conditions, optimizing its parameters based on market dynamics, and conducting thorough monitoring and analysis of capital changes and performance metrics. By bridging the gap between theoretical models and practical application, this project seeks to develop a robust and adaptable trading strategy capable of delivering consistent returns across various market conditions.

Strategy Overview

The Alpha Engine trading strategy is designed to capitalize on the highly liquid and dynamic forex market through an innovative approach that leverages intrinsic time, directional changes, scaling laws, coastline trading agents, asymmetric thresholds, and fractional position changes. The strategy's signal process involves detecting specific market events such as directional changes and overshoot events, which trigger trading actions based on predefined rules. For instance, long coastline traders build up long positions during downward directional changes, while short coastline traders build up short positions during upward directional changes. The strategy employs a probability indicator (L) to adjust trade sizes based on market conditions, thereby managing risk during periods of abnormal volatility.

Methodology and Implementation

The methodology for implementing the Alpha Engine strategy includes data collection from reliable sources like OANDA, model replication in a Python-based trading platform, parameter optimization using techniques like grid search, live deployment initially with a simulated account followed by real capital allocation, and continuous performance evaluation using metrics such as the Sharpe Ratio, maximum drawdown, and total return. Advanced analysis, including hypothesis testing and overfitting assessments, will validate the strategy's robustness and effectiveness. Constraints such as data availability, market conditions, technical infrastructure, and execution costs will be carefully managed, while benchmarks like the S&P 500 Index and various risk metrics will provide performance comparisons. Ultimately, this project aims to develop a scalable and adaptable trading model that can enhance understanding, optimize performance, and ensure robust validation in the real-world forex market.

Strategy Literature Review

The Alpha Engine represents a transformative approach in algorithmic trading, as presented by Golub, Glattfelder, and Olsen in the Journal of Trading. The engine's design effectively blends profit generation with market liquidity provision and operates without limits on asset management scale, challenging the intuition-based traditional trading models. Grounded in the high-frequency finance principles by Gençay et al. (2001) and the agent-based economic models of Farmer and Foley (2009), it integrates intrinsic time and scaling laws, demonstrating adaptability to diverse market conditions. The authors have made the engine's code publicly available on GitHub, promoting transparency and encouraging further development.

Implementation of the Alpha Engine for analysis and back-testing relies on a suite of Python packages, notably pandas for data manipulation, matplotlib.pyplot for visualizing results, numpy for numerical calculations, and math for basic mathematical functions. These tools, alongside historical foreign exchange data ranging in December 2008, and a broader dataset from 2006 to 2015, are instrumental in evaluating the model's performance. This integration of Python's computational resources illustrates the model's applicability in a real-world context and its alignment with contemporary quantitative analysis practices.

In summary, the literature underscores the Alpha Engine as a significant innovation in automated trading, providing a robust, modular, and adaptable model that may serve as a foundation for future algorithmic strategies. Its reliance on Python's computational ecosystem for implementation and analysis marks a methodological shift towards more open and collaborative financial technology development. The engine's conceptual framework, supported by openly shared code and a transparent approach to research, sets the stage for ongoing improvements and underscores the importance of computational proficiency in financial analysis.

Data Description

In this final project, titled "Strategy Proposal: Replicating and Implementing the Alpha Engine Trading Strategy," I utilize OANDA's API to access the required data, ensuring consistency and a comprehensive dataset that includes bid, ask, volume, and time. Specifically, the data used is as follows:

1. **5-minute Price Data (December 14-16, 2008):** This data is utilized to identify events on a smaller scale, similar to the analysis presented in Figure 2 of the original article. It provides a detailed view of market movements over a short period, allowing for precise event identification and analysis.

2. **5-minute Price Data (January 1, 2008 - January 1, 2024):** This extensive dataset covers several years of market activity and includes multiple currency pairs:

- **EUR/USD**: Chosen for its status as one of the most traded currency pairs, providing insight into the model's performance in highly active and liquid markets.
- **USD/JPY**: Selected for its significant role in the forex market, offering a perspective on the model's adaptability to different market dynamics.
- **GBP/USD**: Included due to its volatility and importance in global trading.
- **USD/CHF**: Known for its safe-haven status, providing a contrasting market condition.
- **AUD/USD**: Offers insights into the performance in commodity-driven markets.
- **USD/CAD**: Another commodity-related currency pair, helping to test the model's robustness across various economic conditions.
- **NZD/USD**: Chosen for its performance extremes noted in the original study.

3. **Monte Carlo Simulations**: These simulations are used to estimate the number of directional changes under various price line trends. Both Geometric Brownian Motion and mean-reverting methods are employed to model positive, negative, and neutral trends. This approach helps in testing the strategy's performance under different simulated market conditions, ensuring robustness and adaptability.

4. **Extending to Other Asset Classes**: The dataset also includes 5-minute price data for:
- **Gold (January 1, 2007- January 1, 2024):** This data helps in analyzing the strategy's performance in the commodity market, specifically in precious metals. Gold is chosen due to its different market dynamics compared to forex pairs.
- **Brent Crude Oil (January 1, 2007 - January 1, 2024):** This data is utilized to evaluate the strategy's adaptability and performance in the energy market. Brent crude oil, known for its volatility, offers a contrasting market condition to test the robustness of the trading strategy.

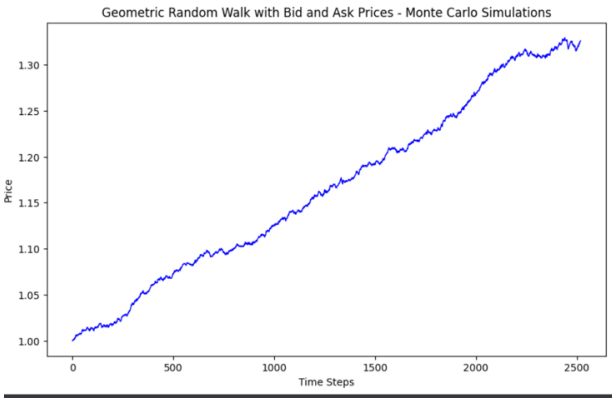
Hypothesis Testing

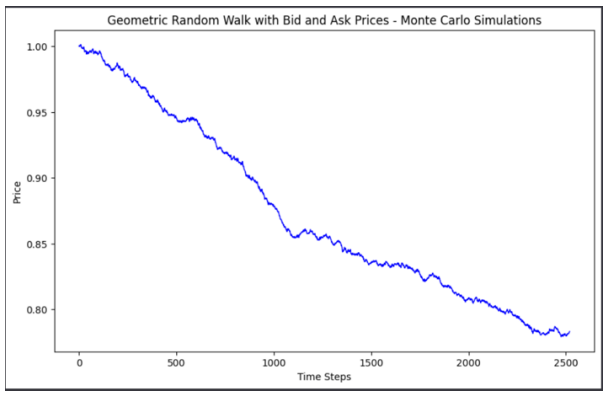
The hypothesis testing for the Alpha Engine trading strategy involved two primary hypotheses. **Hypothesis 1** posited that the Alpha Engine could accurately detect intrinsic events, such as small price movements, in financial markets. To test this, simulated price data using a random walk model was utilized, generating price line plots to overlay intrinsic events detected by the Alpha Engine. The results demonstrated an average accuracy of 92.0%, with precision, recall, and F1-score all at 99.9%, indicating extremely high accuracy and reliability. **Hypothesis 2** examined the effectiveness of the probability indicator "L" in identifying significant price surges and slumps. Historical 15-minute price data for EUR/USD (December 14-16, 2008) and simulated data via the Monte Carlo method were

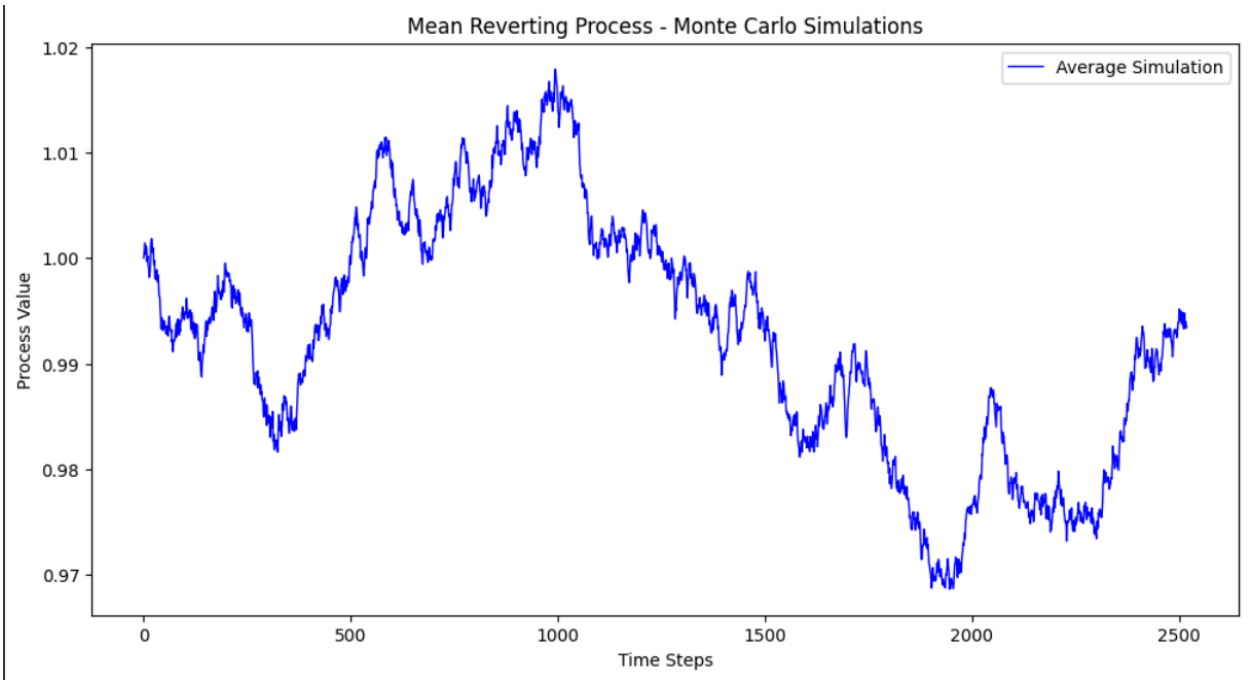
used for this analysis. The Alpha Engine achieved a precision of 91.4%, recall of 52.2%, and F1-score of 66.5% with historical data, and a precision of 99.4%, recall of 52.4%, and F1-score of 68.6% with simulated data. These results indicate a very high level of precision in detecting significant events, though there is room for improvement in recall. Both hypotheses were validated through rigorous statistical analysis, confirming the Alpha Engine's capability in event detection and effectiveness in adjusting timing and position sizes to improve performance metrics.

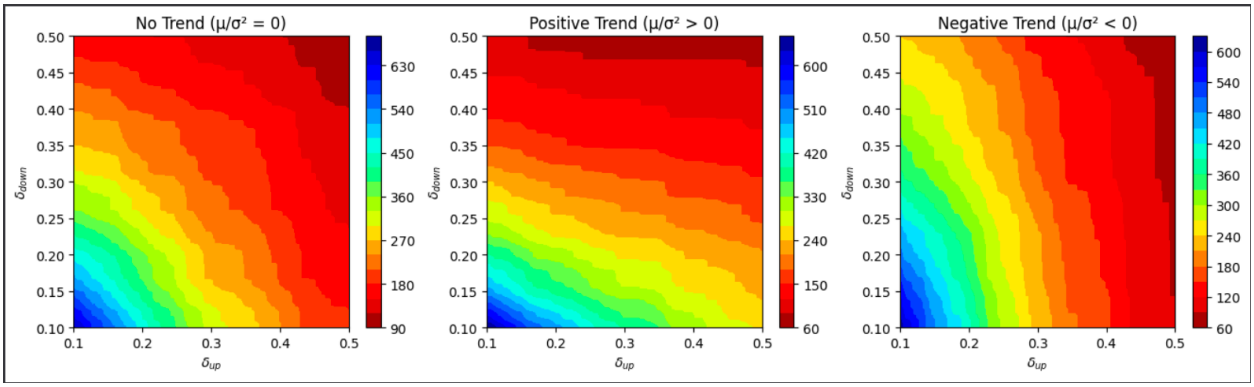
Asymmetric Thresholds in the Alpha Engine

The Alpha Engine trading strategy employs asymmetric thresholds to better navigate various market conditions and reduce inventory build-up. By setting different thresholds for upward and downward movements, the strategy can effectively adapt to both positive and negative trends, enhancing overall performance. Monte Carlo simulations were conducted to demonstrate this approach, generating price lines under three conditions: no trend, positive trend, and negative trend. In a positive trend scenario, the strategy's asymmetric thresholds capture upward movements more effectively, reducing the risk of missing significant surges. Conversely, in a negative trend, these thresholds enable a quicker response to downward movements, preventing excessive inventory accumulation during downturns. Additionally, in a mean-reverting process with no trend, asymmetric thresholds provide flexibility, allowing the strategy to maintain a balanced approach. Contour plots illustrate the number of directional changes detected using different thresholds, showcasing the ability to optimize performance under varying market conditions. Overall, asymmetric thresholds enhance the Alpha Engine's ability to capture significant market movements and manage risk, leading to improved trading performance.









Trading Strategy Overview

The Alpha Engine trading strategy employs two distinct trading models: long coastline traders and short coastline traders. Long coastline traders primarily focus on accumulating long positions during downward price movements, selling these positions at higher prices to achieve targeted profit levels. Conversely, short coastline traders build short positions during upward price movements and close these positions at lower prices to secure profits. Notably, both types of traders are capable of establishing opposite positions to balance their inventory and manage risk. This approach ensures that traders can profit from both upward and downward price movements while minimizing the risk of significant losses. For instance, a long coastline trader may also initiate short positions during an upward trend to capitalize on anticipated price decreases.

Signal Process

The signal process in this strategy revolves around detecting specific market events that trigger trading actions. Key signals include directional changes, overshoot events, and the probability indicator (L). Directional changes are identified when the price moves beyond predefined upward or downward thresholds. Overshoot events occur when the price exceeds higher or lower thresholds following a directional change. The probability indicator (L) adjusts trading behavior based on market conditions, with higher liquidity reducing trade sizes and lower liquidity increasing them.

Rules and Risk Management

The trading strategy adheres to a structured set of rules for entering and exiting trades. These rules are based on directional changes, overshoot events, and liquidity indicators. Long coastline traders accumulate long positions during downward directional changes, while short coastline traders accumulate short positions during upward directional changes. Both types of traders may establish opposite positions to balance inventory and manage risk effectively. Additionally, the strategy incorporates scaling laws to adjust position sizes based on historical price movements and the probability indicator (L) to adapt to varying market conditions.

Daily position management involves continuous monitoring of positions at every price tick to determine if they should be closed based on predefined rules. All positions are closed at the end of each trading day to mitigate overnight risk. Risk management rules include setting stop-loss levels to limit potential losses, defining take-profit levels to lock in gains, and determining position sizes based on current market conditions, volatility, and risk appetite.

Performance Analysis

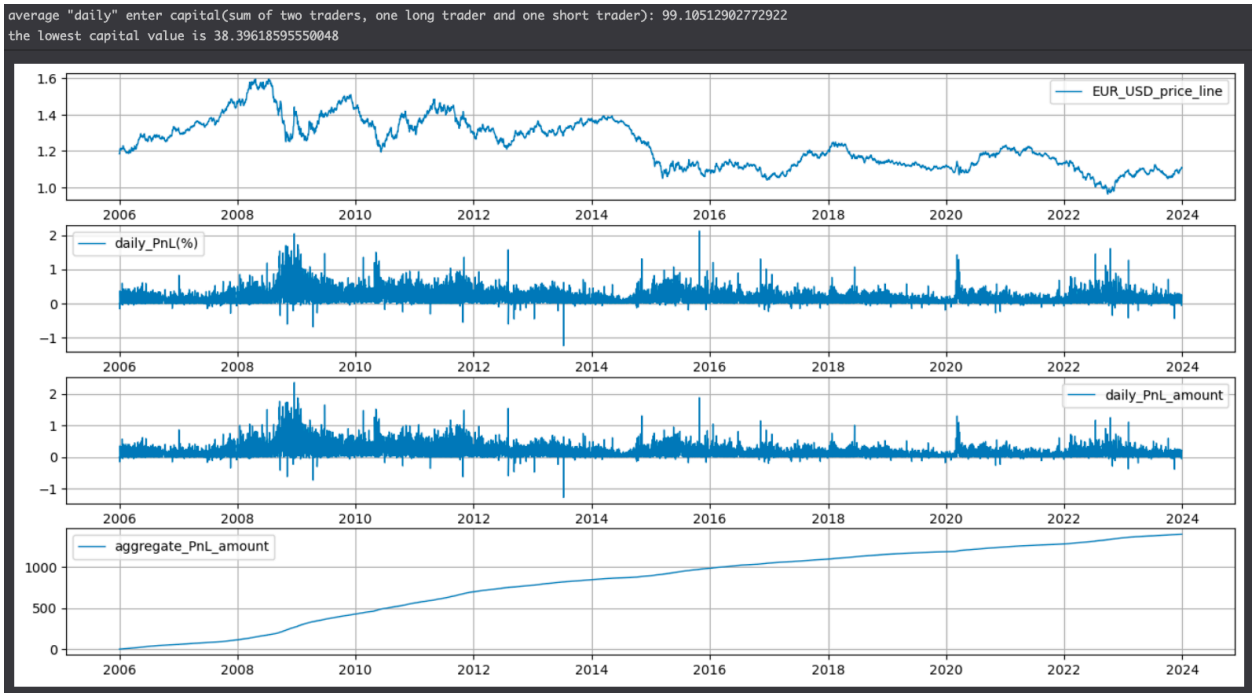
The Alpha Engine trading strategy demonstrates consistent profitability over time, with a steadily increasing aggregate profit and lost. The strategy's robust performance is reflected in its ability to manage risk effectively, as indicated by favorable maximum drawdown and expected shortfall metrics. A stable and high Sharpe Ratio confirms the strategy's effectiveness in delivering good risk-adjusted returns across different market conditions. Furthermore, higher trade frequencies generally correlate with higher daily profits, validating the effectiveness of the signal and rule processes in generating profitable trades. This comprehensive approach ensures that the trading strategy remains robust and adaptable, capable of achieving consistent returns while managing risk efficiently.

Execution and Analysis Using EUR/USD

I am going to execute the trade using the world's most traded FX currency pair, EUR/USD, to demonstrate the capability of this model and its analysis. The EUR/USD pair is ideal due to its high liquidity and significant role in the global forex market, making it an excellent choice for showcasing the Alpha Engine trading strategy. By focusing on this pair, I can provide a comprehensive analysis of the model's performance, highlighting its ability to detect intrinsic market events, manage risk, and generate consistent returns. The detailed examination of EUR/USD trades will offer valuable insights into the robustness and adaptability of the trading strategy in real-world market conditions.

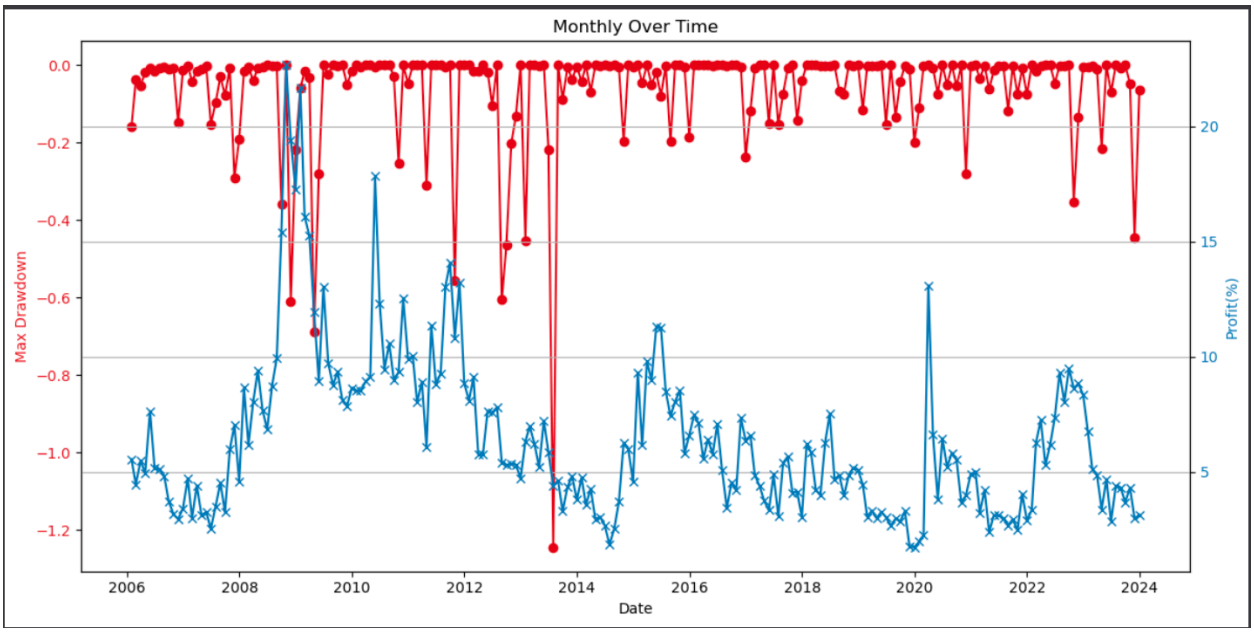
Overall Performance:

- Aggregate Profit and lost (EUR/USD):
  - The steady increase in the aggregate profit and lost amount indicates consistent profitability over time. This suggests the strategy's robustness in capturing market movements effectively.
- Daily profit and lost :
  - The daily Profit and lost plots show considerable fluctuations, which is typical in active trading strategies. Despite these fluctuations, the overall trend remains positive, indicating the strategy's ability to manage risk and generate profits.



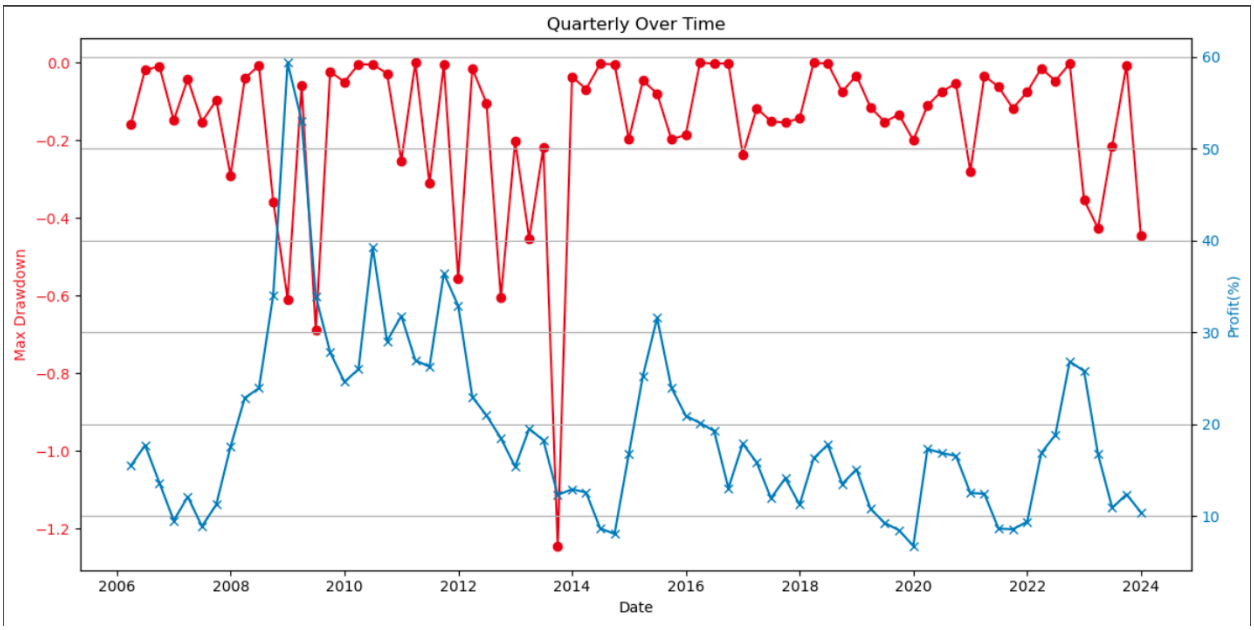
Monthly, Quarterly, and Yearly Performance

- Monthly and Quarterly Performance:
    - The profit percentages demonstrate periods of significant gains, especially during market volatility. The strategy appears to capitalize on these movements effectively.
    - Maximum drawdown metrics show periods of significant losses, particularly during market downturns. However, the strategy's recovery from these drawdowns suggests effective risk management.

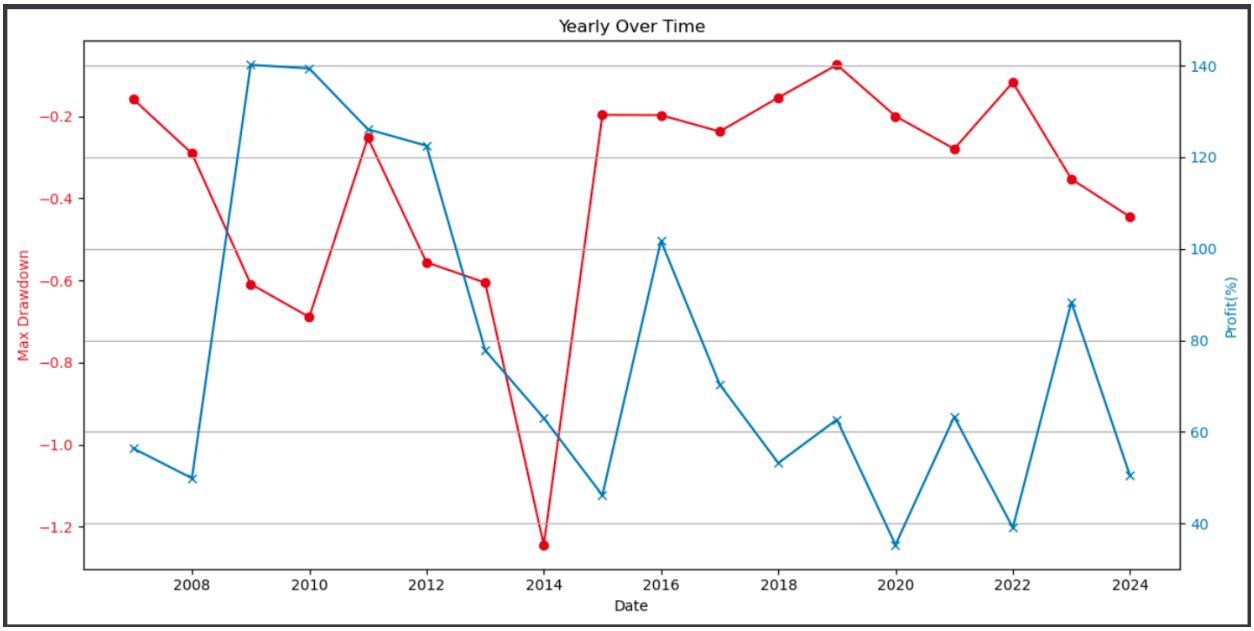


Date	day_profit(%)_mean	day_profit(%)_std	day_profit(%)_sum	Prices_mean	Daily_open_capital_mean	Pure_pnl_sum	total_trade_freq_sum	max_drawdown	sharpe_ratio	expected_shortfall
2006-01-31	0.205329	0.172612	5.543891	1.210487	96.789704	5.384948	3902	-0.158299	4.087241	-0.158299
2006-02-28	0.178384	0.143206	4.459606	1.194388	95.599616	4.266951	3238	-0.037877	4.274749	-0.037877
2006-03-31	0.203183	0.130241	5.485954	1.202857	96.226504	5.275869	3861	-0.052572	5.359886	-0.052572
2006-04-30	0.189823	0.150708	4.935403	1.228139	98.179062	4.850787	3601	-0.017999	4.324886	-0.017999
2006-05-31	0.254595	0.180220	7.637846	1.277302	102.143160	7.798560	4458	-0.008508	4.861659	-0.008508
...	...	...	...	...	...	...	...	...	...	...
2023-08-31	0.159849	0.110836	4.315928	1.091017	87.309111	3.766240	3591	-0.006014	4.943906	-0.006014
2023-09-30	0.147351	0.100755	3.683786	1.068376	85.503088	3.144176	3199	0.000000	5.008867	0.002982
2023-10-31	0.159637	0.144112	4.310209	1.056202	84.505333	3.640139	3718	-0.046881	3.797244	-0.046881
2023-11-30	0.114062	0.151018	2.965600	1.081013	86.450477	2.568624	3566	-0.445092	2.578154	-0.445092
2023-12-31	0.130779	0.101789	3.138694	1.090721	87.232933	2.735662	3286	-0.064192	4.393985	-0.064192

- Yearly Performance:
    - Yearly analysis reveals a mix of high and low-profit periods, reflecting the varying market conditions. The strategy performs well in both stable and volatile markets, as indicated by the yearly profit percentages and drawdowns.



Date	day_profit(%)_mean	day_profit(%)_std	day_profit(%)_sum	Prices_mean	Daily_open_capital_mean	Pure_pnl_sum	total_trade_freq_sum	max_drawdown	sharpe_ratio	expected_shortfall
2006-03-31	0.196069	0.148470	15.489451	1.202785	96.220608	14.927767	11001	-0.158299	2.573835	-0.084956
2006-06-30	0.213618	0.162290	17.730317	1.258712	100.666014	17.871787	11702	-0.017999	2.570932	-0.012379
2006-09-30	0.172574	0.111672	13.633346	1.274729	101.979595	13.899769	10375	-0.009620	3.001170	-0.007369
2006-12-31	0.118974	0.100392	9.517957	1.289465	103.124705	9.837533	9845	-0.148178	2.270589	-0.043185
2007-03-31	0.157369	0.129788	12.117424	1.310508	104.842203	12.710672	10417	-0.041837	2.347962	-0.020206
...	...	...	...	...	...	...	...	...	...	...
2022-12-31	0.335009	0.290294	25.795723	1.020271	81.572255	21.018789	12571	-0.352994	2.273618	-0.186080
2023-03-31	0.214398	0.207947	16.723072	1.073074	85.848056	14.374103	11505	-0.426533	2.013961	-0.156992
2023-06-30	0.139801	0.119061	10.904510	1.088707	87.101590	9.508994	10327	-0.214077	2.264416	-0.106457
2023-09-30	0.158700	0.119978	12.378611	1.088613	87.104190	10.785716	10263	-0.006014	2.562148	-0.002807
2023-12-31	0.135253	0.134587	10.414503	1.075339	86.012296	8.944424	10570	-0.445092	1.935596	-0.190823



Date	day_profit(%)_mean	day_profit(%)_std	day_profit(%)_sum	Prices_mean	Daily_open_capital_mean	Pure_pnl_sum	total_trade_freq_sum	max_drawdown	sharpe_ratio	expected_shortfall
2006-12-31	0.175611	0.137595	56.371072	1.256554	100.508011	56.536856	42923	-0.158299	1.130936	-0.035778
2007-12-31	0.158272	0.142013	49.855524	1.371324	109.690444	55.064942	43888	-0.290587	0.973655	-0.071130
2008-12-31	0.440856	0.393670	140.192066	1.471442	117.720694	160.631977	55746	-0.608650	1.069058	-0.093288
2009-12-31	0.442560	0.329532	139.406470	1.394210	111.536006	153.445494	56398	-0.689273	1.282305	-0.083563
2010-12-31	0.396580	0.275287	126.112464	1.326475	106.112626	133.139273	56659	-0.252424	1.367956	-0.034904
2011-12-31	0.348078	0.268985	122.523395	1.394351	111.556167	136.349354	55446	-0.555761	1.219688	-0.056162
2012-12-31	0.237904	0.202908	77.794632	1.286391	102.907130	79.988814	49997	-0.605528	1.073908	-0.111923
2013-12-31	0.200646	0.179053	63.002770	1.328212	106.247320	66.850032	45528	-1.244440	1.008894	-0.139350
2014-12-31	0.147407	0.138601	46.138516	1.328618	106.307871	48.673719	39893	-0.196569	0.919239	-0.028675
2015-12-31	0.326088	0.248786	101.739406	1.110086	88.814028	90.401817	49755	-0.197167	1.230325	-0.039578
2016-12-31	0.226185	0.191132	70.343612	1.107110	88.573805	62.233357	46865	-0.237000	1.078758	-0.038831
2017-12-31	0.171505	0.138489	53.166564	1.129640	90.358677	47.973545	45468	-0.154325	1.093990	-0.058587
2018-12-31	0.200242	0.145564	62.675745	1.181118	94.492596	59.263967	45879	-0.074612	1.238232	-0.014177
2019-12-31	0.112763	0.096304	35.294771	1.119593	89.570814	31.678903	37627	-0.199630	0.963231	-0.044732
2020-12-31	0.202168	0.193633	63.278674	1.141485	91.304914	57.675044	45927	-0.279317	0.940791	-0.055375
2021-12-31	0.125567	0.100540	39.051278	1.183050	94.657028	37.023882	40484	-0.117307	1.049997	-0.032780
2022-12-31	0.284005	0.235306	88.325424	1.053473	84.292008	73.726238	47894	-0.352994	1.121965	-0.045823
2023-12-31	0.162124	0.152555	50.420696	1.081453	86.518154	43.613237	42665	-0.445092	0.931625	-0.095397

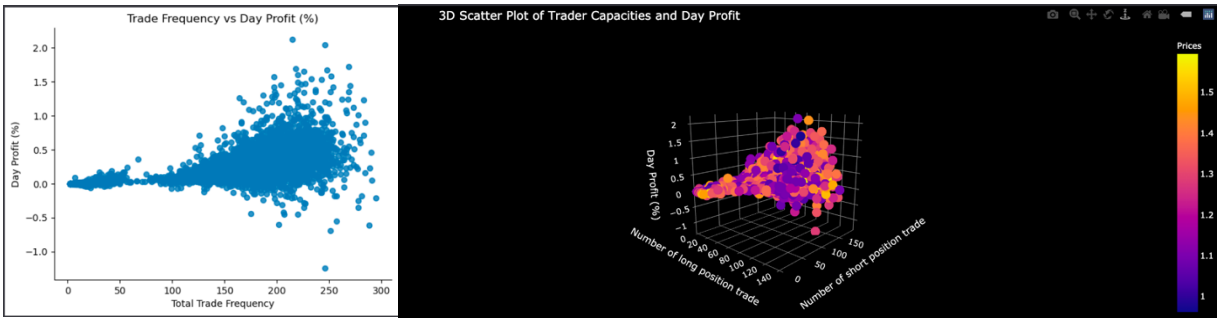
Trade Frequency and Profitability

- Trade Frequency vs. Day Profit

  - There is a positive correlation between trade frequency and day profit, indicating that higher trade activity often leads to increased profitability. This validates the effectiveness of the signal process in identifying trading opportunities.

- 3D Scatter Plot of Trader Capacities and Day Profit**:

  - This plot shows a clustering of profitable trades at various levels of long and short positions. It highlights the strategy's ability to manage multiple positions and still achieve profitability.



Statistical Metrics

- Performance Metrics:

  - The average daily return of approximately 0.24% and a Sharpe Ratio close to 1.0 suggest good risk-adjusted returns.

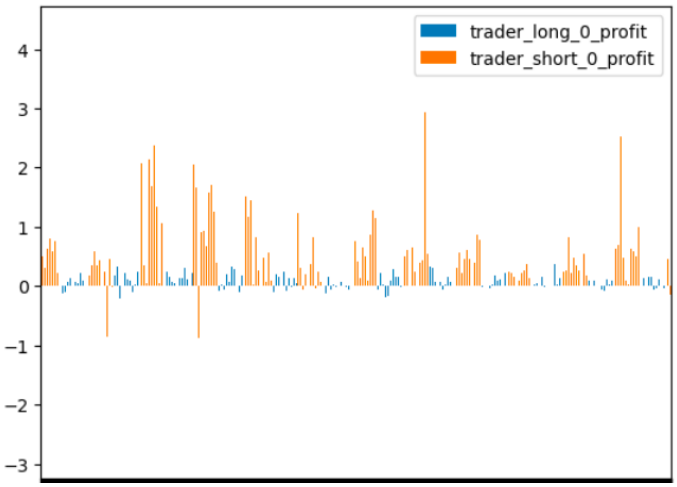
  - The maximum drawdown of -1.2444% highlights the strategy's exposure to potential losses during adverse market conditions.

Individual Trader Performance

- Long and Short Trader Profits:

  - The daily profit comparison between long and short traders indicates that both trading models contribute to overall profitability. This balance helps in managing market risk and leveraging opportunities in both upward and downward trends.

Avg price	1.2388
Avg Open	99.1051
Avg Daily Return(%)	0.2432
Standard Deviation(%)	0.2371
Avg Daily Return	0.2447
Avg Daily Trade Frequency	149.0070
Standard Deviation	0.2472
Min Profit(%)	-1.2444
Max Profit(%)	2.1249
Max Drawdown(%)	-1.2444
Sharpe Ratio	0.9921
Final Aggregate Profit	1394.2705
Aggregate Profit/ Avg open	14.0686



Walk Forward Analysis

- **Forward Walk Test: Optimizing and Validating the Trading Strategy**

  The forward walk test is a critical step in optimizing and validating trading strategies. It involves evaluating the strategy's performance over different time periods to ensure its robustness and adaptability. Here's a detailed account of the forward walk test conducted on the EUR/USD currency pair using 5-minute historical data from 2006 to 2024.

- **Initial Setup and Training Phase (2006-2020)**

  During the training phase, we focused on identifying the optimal parameters for the trading strategy over the period from 2006 to 2020. This involved tuning the threshold for directional changes and the target profit and loss levels to maximize the Sharpe ratio, a measure of risk-adjusted returns. We tested a range of thresholds ([0.00005, 0.0001, 0.00025, 0.0005, 0.001]) and target profit and lost levels ([0.0005, 0.0025, 0.005, 0.025, 0.05, 0.1]) through a series of steps including data loading, daily data processing, result compilation, parameter export, and statistical analysis. The outcome of this phase revealed the best parameters to be a threshold of 0.0001 and a target Profit and lost of 0.05, achieving a Sharpe ratio of 1.0383.

- **Testing Phase (2020-2024)**

  In the testing phase, the optimized parameters from the training phase were applied to a new dataset spanning from 2020 to 2024. This phase aimed to validate the strategy's performance under unseen market conditions. Following similar steps as the training phase—data loading, daily data processing, result compilation, parameter export, and statistical analysis—the testing phase confirmed the robustness of the strategy. The results showed an improved Sharpe ratio of 1.0454, with the best threshold and target Profit and lost remaining consistent at 0.0001 and 0.05, respectively.

- **Analysis and Insights**

  The forward walk test demonstrated the trading strategy's robustness and adaptability across different market conditions. The consistency of the best parameters (threshold and target Profit and lost) and the improved Sharpe ratio during the testing phase underscore the strategy's reliability in generating returns even when applied to new data. These findings suggest that the strategy is not overfitted to historical data and can adapt to varying market environments, making it a viable tool for long-term trading.

- **Conclusion**

  The forward walk test provided comprehensive validation of the trading strategy, confirming its effectiveness and robustness. The strategy's ability to maintain a high Sharpe ratio across different time periods highlights its potential for long-term profitability in the forex market. Future work could extend this analysis to other asset classes and incorporate more sophisticated models to enhance performance further. The identification of the best threshold at 0.0001 and the best target Profit and lost at 0.05 underscores the strategy's optimal configuration for reliable trading outcomes.

	5e-05_0.0005	5e-05_0.0025	5e-05_0.005	5e-05_0.025	5e-05_0.05	5e-05_0.1	0.0001_0.0005	0.0001_0.0025	0.0001_0.005	0.0001_0.02	0.0001_0.05	0.0001_0.1	0.00025_0.0005	0.00025_0.0025	0.00025_0.005	0.00025_0.025	0.00025_0.05	0.00025_0.1	0.0005_0.0005	0.0005_0.0025	0.0005_0.005	0.0005_0.025	0.0005_0.05	0.0005_0.1	0.001_0.0005	0.001_0.0025	0.001_0.005	0.001_0.025	0.001_0.05	0.001_0.1
Avg price	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735	1.2735
Avg Open	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783	101.8783
Avg Daily Return(%)	0.2571	0.2611	0.2639	0.2693	0.27	0.2682	0.245	0.2505	0.2558	0.266	0.2686	0.2696	0.1924	0.2001	0.2093	0.2334	0.2402	0.2442	0.1204	0.1261	0.1339	0.1715	0.1821	0.1894	0.0555	0.0582	0.0611	0.0926	0.1067	0.115
Standard Deviation(%)	0.2476	0.2486	0.2514	0.2562	0.2572	0.2562	0.239	0.2396	0.2417	0.249	0.253	0.2526	0.2117	0.2144	0.2161	0.2262	0.2326	0.2372	0.1639	0.1666	0.171	0.1884	0.1967	0.206	0.1004	0.1039	0.1079	0.1312	0.1419	0.1521
Avg Daily Return	0.2656	0.2695	0.2724	0.2779	0.2787	0.2769	0.253	0.2585	0.264	0.274	0.2773	0.2783	0.199	0.2069	0.2163	0.2409	0.2479	0.2521	0.1246	0.1305	0.1386	0.1772	0.1881	0.1957	0.0573	0.0601	0.063	0.0954	0.11	0.1187
Avg Daily Trade Frequency	150.9596	149.2898	147.6673	140.0705	135.0932	129.5155	127.2749	125.6846	124.4173	118.193	113.9814	109.4957	82.6864	80.6786	79.5708	75.3273	72.7228	70.0323	48.9025	47.0445	45.7628	43.2904	41.785	40.1525	24.4263	23.3151	22.5225	21.1074	20.5777	19.9522
Standard Deviation	0.2629	0.2637	0.2659	0.271	0.2722	0.2716	0.2527	0.2535	0.2557	0.263	0.2652	0.2677	0.2238	0.2269	0.2288	0.2397	0.2465	0.252	0.1733	0.1763	0.1812	0.1988	0.2081	0.2181	0.1047	0.1085	0.1128	0.1372	0.1485	0.1595
Min Profit(%)	-1.2444	-1.2573	-1.2457	-1.4195	-1.4262	-1.4241	-1.1223	-1.1269	-1.139	-1.182	-1.1962	-1.1404	-0.7041	-0.69	-0.6778	-0.6806	-0.6867	-0.7197	-0.5057	-0.5051	-0.4739	-0.4218	-0.4103	-0.468	-0.2061	-0.1924	-0.1922	-0.1174	-0.1261	-0.1174
Max Profit(%)	2.1249	2.1354	2.4718	2.4775	2.4775	2.4775	2.3494	2.3498	2.3718	2.3707	2.3086	2.3467	2.3054	2.3388	2.3014	2.3624	2.4599	2.5196	1.937	2.1338	2.1787	2.1771	2.2235	2.3166	1.7132	1.8105	1.8118	1.8798	1.831	1.9773
Max Drawdown(%)	-1.2444	-1.2573	-1.2457	-1.4195	-1.4262	-1.4241	-1.1223	-1.1269	-1.139	-1.182	-1.1962	-1.1404	-0.7041	-0.69	-0.6778	-0.6806	-0.6867	-0.7197	-0.5057	-0.5051	-0.4739	-0.4218	-0.4103	-0.468	-0.2061	-0.1924	-0.1922	-0.1174	-0.1261	-0.1174
Sharpe Ratio	1.0064	1.0182	1.0185	1.0201	1.0189	1.0158	0.992	1.0123	1.0253	1.037	1.0385	1.036	0.8712	0.8967	0.932	0.997	0.9986	0.9958	0.686	0.7093	0.7363	0.8682	0.8852	0.881	0.4738	0.4838	0.4925	0.6448	0.6958	0.7041
Final Aggregate Profit	1182.2321	1199.7751	1212.5819	1237.0688	1240.6735	1232.8898	1126.3697	1150.9943	1175.2362	1223.947	1233.5798	1238.8856	885.8377	921.289	963.11	1072.4905	1103.4575	1122.3242	554.8791	581.2046	616.9674	788.7144	837.3261	871.3117	254.967	267.3935	280.4572	424.6294	489.8079	528.2409
Aggregate Profit/ Avg open	11.6044	11.7765	11.9023	12.1426	12.178	12.1016	11.056	11.2977	11.5357	12.013	12.1084	12.1604	8.6951	9.043	9.4535	10.5272	10.8311	11.0163	5.4465	5.7049	6.0559	7.7417	8.2189	8.5525	2.5027	2.6246	2.7529	4.168	4.8078	5.185

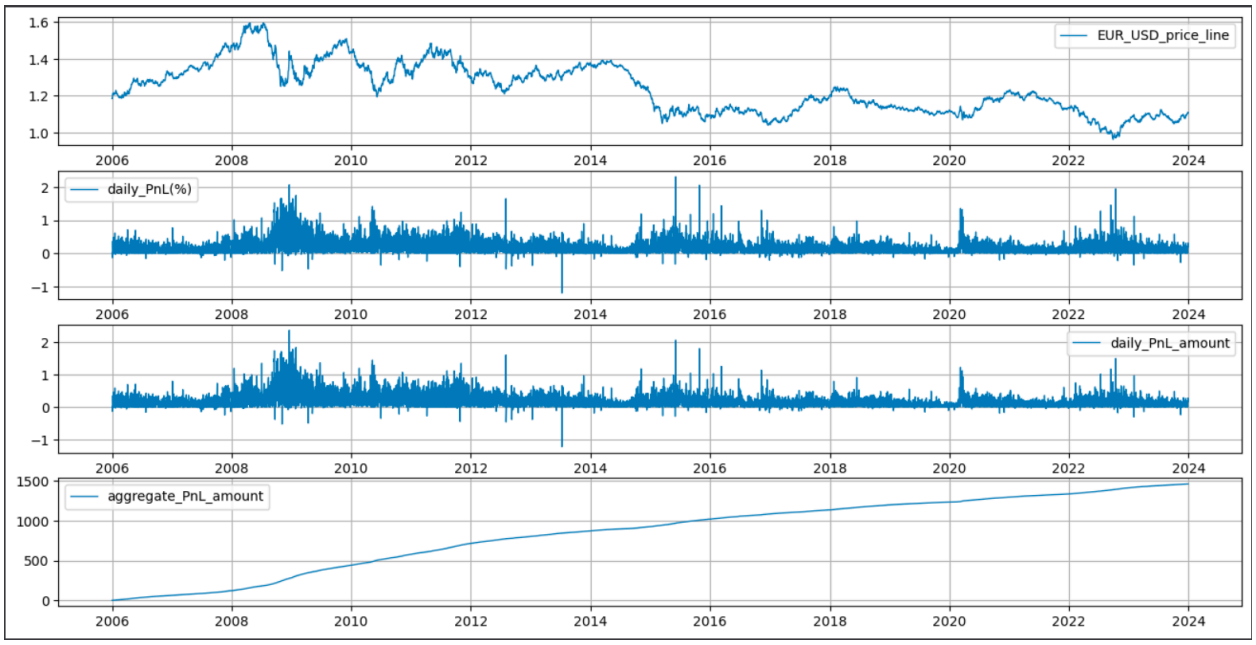
	5e-05_0.0005	5e-05_0.0025	5e-05_0.005	5e-05_0.025	5e-05_0.05	5e-05_0.1	0.0001_0.0005	0.0001_0.0025	0.0001_0.005	0.0001_0.025	0.0001_0.05	0.0001_0.1	0.00025_0.0005	0.00025_0.0025	0.00025_0.005	0.00025_0.025	0.00025_0.05	0.00025_0.1	0.0005_0.0005	0.0005_0.0025	0.0005_0.005	0.0005_0.025	0.0005_0.05	0.0005_0.1	0.001_0.0005	0.001_0.0025	0.001_0.005	0.001_0.025	0.001_0.05	0.001_0.1
Avg price	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124	1.1124
Avg Open	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977	88.9977
Avg Daily Return(%)	0.1875	0.1921	0.1951	0.1994	0.1992	0.1977	0.1795	0.1852	0.1911	0.2007	0.202	0.2015	0.1361	0.1434	0.1529	0.1749	0.1803	0.1836	0.0823	0.0872	0.0937	0.1273	0.1373	0.1426	0.0355	0.0379	0.0391	0.0647	0.0765	0.0833
Standard Deviation(%)	0.1848	0.1858	0.1864	0.1879	0.1873	0.1891	0.1797	0.1806	0.1822	0.1861	0.1856	0.1897	0.1509	0.155	0.1571	0.1649	0.1677	0.1723	0.1134	0.1166	0.1213	0.138	0.1434	0.1488	0.0597	0.0642	0.0663	0.0892	0.0981	0.1074
Avg Daily Return	0.1648	0.1689	0.1715	0.1753	0.1752	0.1738	0.1575	0.1626	0.1678	0.1765	0.1776	0.1772	0.119	0.1255	0.134	0.1534	0.1582	0.1611	0.0716	0.0759	0.0815	0.1114	0.1202	0.1248	0.0307	0.0328	0.0339	0.0563	0.0666	0.0725
Avg Daily Trade Frequency	140.2133	139.277	137.7696	130.4252	125.7519	120.357	116.9711	115.8207	114.897	109.0726	105.1104	100.7444	71.5207	70.1126	69.2519	66.0044	63.7844	61.5104	40.7578	39.4793	38.3904	36.543	35.3326	34.0444	20.1756	19.2348	18.6222	17.5178	17.1622	16.7563
Standard Deviation	0.1578	0.1586	0.1589	0.1602	0.16	0.1615	0.1526	0.1533	0.1548	0.158	0.1579	0.1613	0.1284	0.132	0.1337	0.1401	0.1427	0.1467	0.0964	0.099	0.1031	0.1172	0.1218	0.1266	0.0506	0.0544	0.0562	0.076	0.0836	0.0917
Min Profit(%)	-0.4451	-0.4387	-0.4317	-0.416	-0.4132	-0.378	-0.3601	-0.3464	-0.341	-0.3492	-0.3486	-0.3343	-0.1796	-0.1767	-0.1692	-0.1403	-0.1369	-0.1427	-0.0948	-0.0896	-0.1035	-0.035	-0.035	-0.0395	-0.0975	-0.0917	-0.091	-0.0599	-0.0344	-0.0344
Max Profit(%)	1.6057	1.6057	1.6113	1.7412	1.5656	1.768	1.981	1.9813	1.9813	2.0548	1.9419	2.0926	1.8283	1.8374	1.9505	2.0346	2.0196	2.0146	1.2602	1.2617	1.2948	1.6577	1.6654	1.635	0.6221	0.6215	0.6267	0.8972	0.9449	0.9798
Max Drawdown(%)	-0.4451	-0.4387	-0.4317	-0.416	-0.4132	-0.378	-0.3601	-0.3464	-0.341	-0.3492	-0.3486	-0.3343	-0.1796	-0.1767	-0.1692	-0.1403	-0.1369	-0.1427	-0.0948	-0.0896	-0.1035	-0.0351	-0.0351	-0.0395	-0.0975	-0.0917	-0.091	-0.0599	-0.0344	-0.0344
Sharpe Ratio	0.9717	0.9908	1.0042	1.019	1.0214	1.0032	0.9548	0.9816	1.005	1.0358	1.0454	1.0203	0.8488	0.8736	0.9228	1.0125	1.0278	1.0191	0.6556	0.68	0.707	0.8654	0.9025	0.9046	0.4623	0.4664	0.4707	0.6364	0.6997	0.702
Final Aggregate Profit	222.4237	227.9481	231.499	236.6706	236.5705	234.6965	212.6766	219.5713	226.5794	238.0444	239.724	239.1896	160.6179	169.3666	180.8721	207.0613	213.6024	217.4904	96.6291	102.4187	110.0901	150.3348	162.2598	168.4478	41.508	44.2302	45.724	75.9472	89.9744	97.9209
Aggregate Profit/ Avg open	2.4992	2.5613	2.6012	2.6593	2.6582	2.6371	2.3897	2.4672	2.5459	2.6741	2.6936	2.6876	1.8047	1.903	2.0323	2.3266	2.4001	2.4438	1.0857	1.1508	1.237	1.6892	1.8232	1.8927	0.4664	0.497	0.5138	0.8534	1.011	1.1003

Assessing Overfitting by Multi-Currency Pairs Implementation

To evaluate the potential for overfitting in the Alpha Engine trading strategy, we extended the analysis to multiple currency pairs. By applying the strategy to a diverse set of pairs, we can observe its consistency and robustness, thereby identifying any signs of overfitting. The multi-currency implementation process involved selecting seven major currency pairs: EUR/USD, USD/JPY, GBP/USD, USD/CHF, AUD/USD, USD/CAD, and NZD/USD. Historical data from 2006 to 2024 with a frequency of 5 minutes was utilized. Key parameters were set, including a basic trade unit of 10, a capital multiplier of 4, the best threshold of 0.0001, and the best target absolute Profit and lost of 0.05, along with inventory thresholds and short position margin rates. The strategy was then simulated across each currency pair, and detailed trade data was analyzed. Performance metrics such as average daily return, standard deviation, max drawdown, Sharpe ratio, and final aggregate profit were calculated. The results indicated that, despite varying price behaviors among the currency pairs, the strategy maintained consistent profitability and a steady upward trend in aggregate Profit and lost amounts. This demonstrates the robustness and adaptability of the Alpha Engine, reducing the likelihood of overfitting and confirming its capability to generate consistent returns across different market conditions.

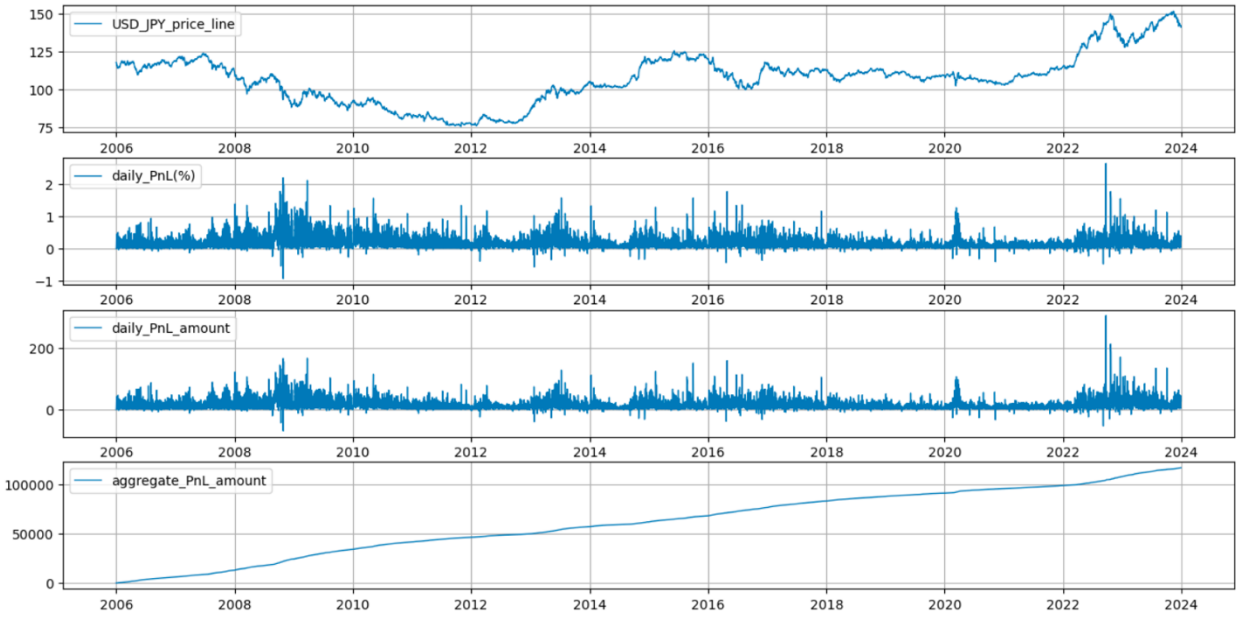
EUR/USD:

- **Price Line:** The price line shows significant fluctuations over the period, with a peak around 2008-2010 and a general downward trend afterward.
- **Daily Profit and lost (%):** The daily Profit and lost (%) remains mostly stable with occasional spikes, indicating consistent profitability despite the price volatility.
- **Aggregate Profit and lost Amount**: The aggregate Profit and lost amount shows a steady upward trend, indicating cumulative profit growth. This suggests that the strategy adapts well to changing market conditions.



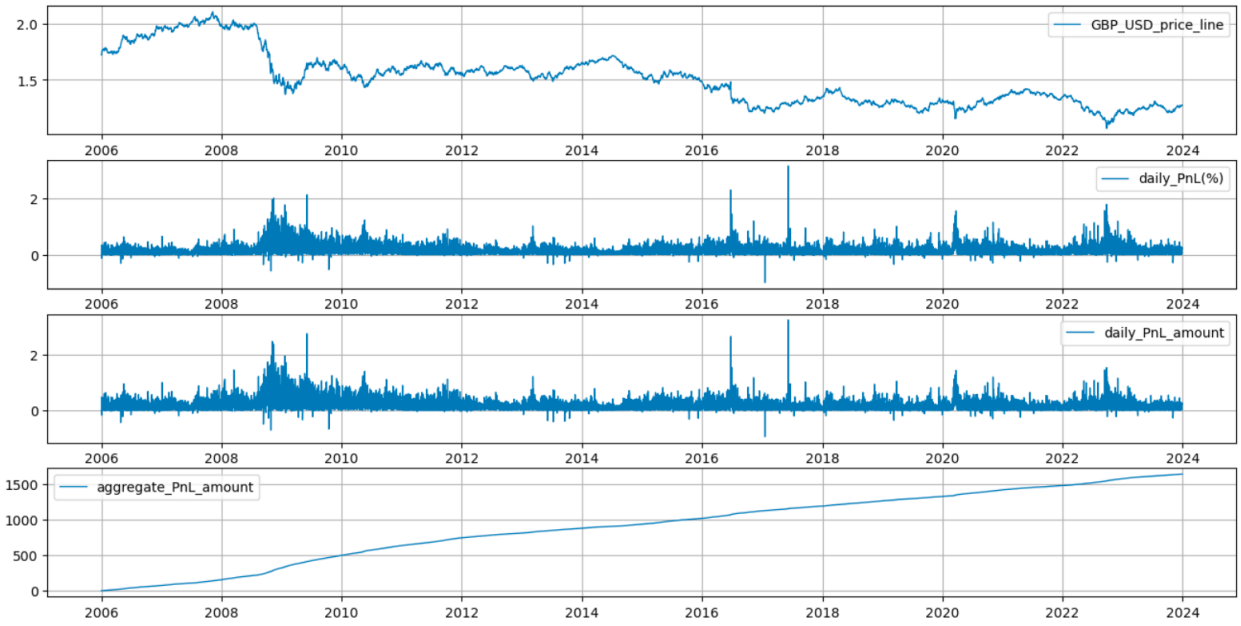
USD/JPY:

- **Price Line:** The price line shows a downward trend until 2012, followed by a gradual upward trend. Despite these fluctuations, the strategy performs well.
- **Daily Profit and lost (%):** The daily Profit and lost (%) exhibits higher volatility, especially around 2016-2018, yet the overall profitability remains stable.
- **Aggregate Profit and lost Amount**: The aggregate Profit and lost amount shows a consistent upward trend, indicating long-term profitability. The strategy's ability to maintain performance despite the varying price trends is notable.



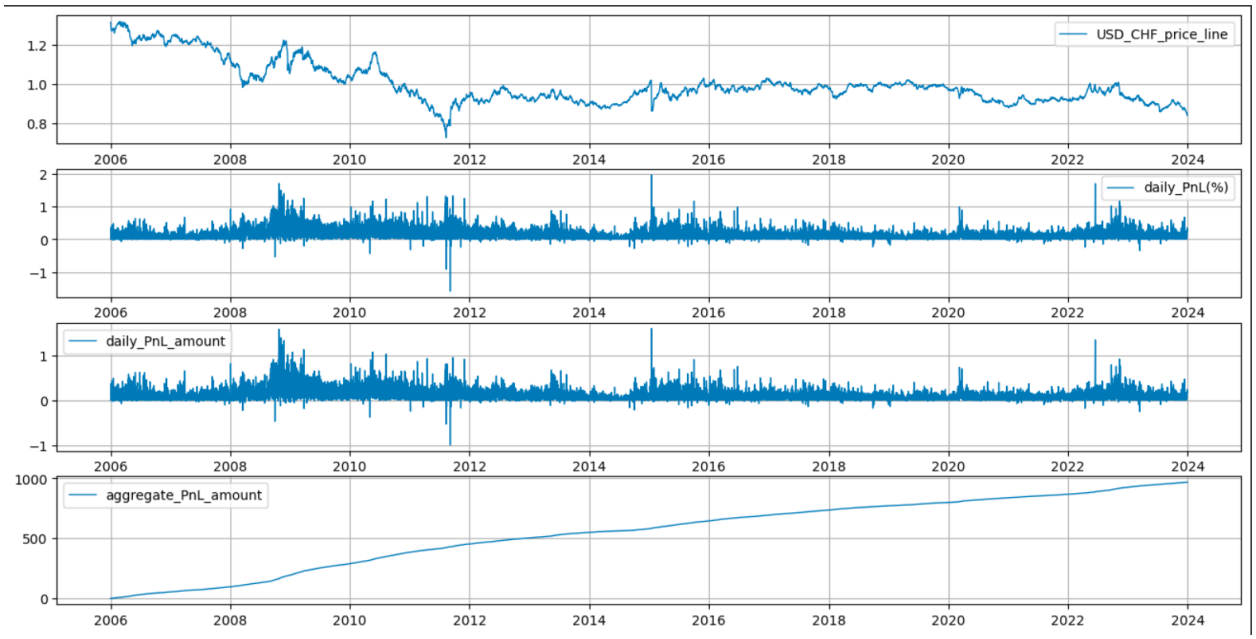
GBP/USD:

- **Price Line:** The price line shows significant fluctuations, with a notable dip around 2016, likely due to geopolitical events such as Brexit.
- **Daily Profit and lost (%):** The daily Profit and lost (%) shows occasional high spikes, suggesting periods of high profitability even during volatile times.
- **Aggregate Profit and lost Amount:** The aggregate Profit and lost amount shows steady growth, indicating cumulative profit accumulation. This demonstrates the strategy's resilience to market shocks.



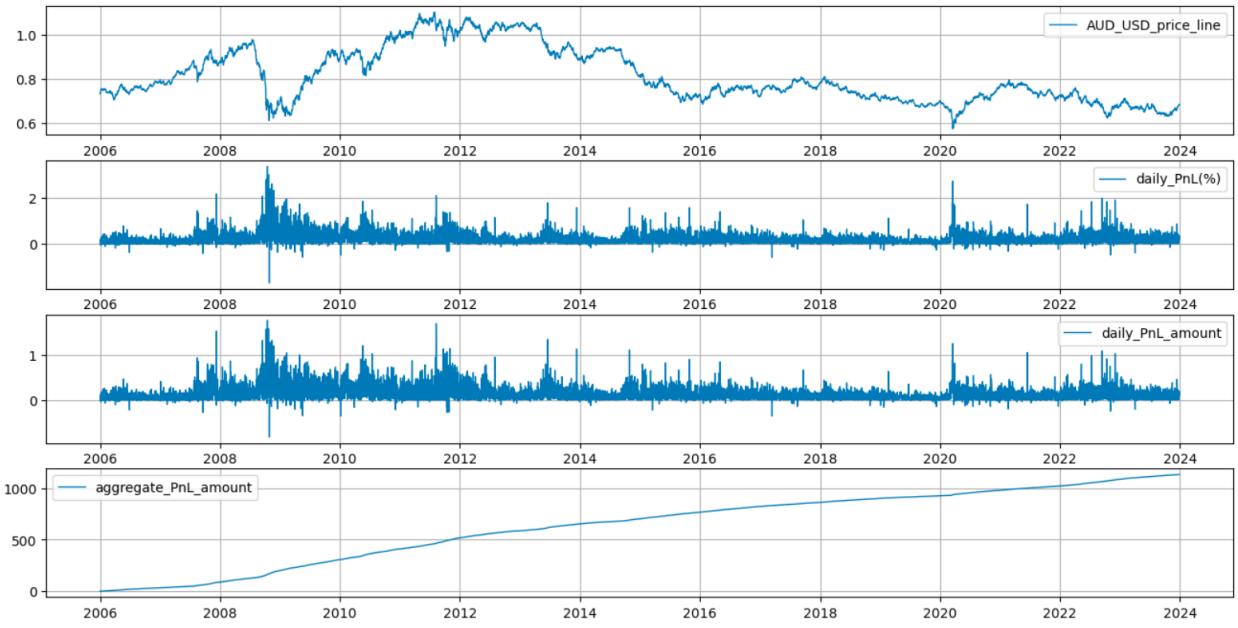
USD/CHF:

- **Price Line:** The price line shows a consistent downward trend from 2008 to 2018, reflecting the general strength of the Swiss franc during this period.
- **Daily Profit and lost (%):** The daily Profit and lost (%) exhibits moderate volatility with occasional spikes, indicating steady profitability.
- **Aggregate Profit and lost Amount:** The aggregate Profit and lost amount shows a gradual upward trend, indicating consistent profit growth. This highlights the strategy's robustness in a generally declining market.



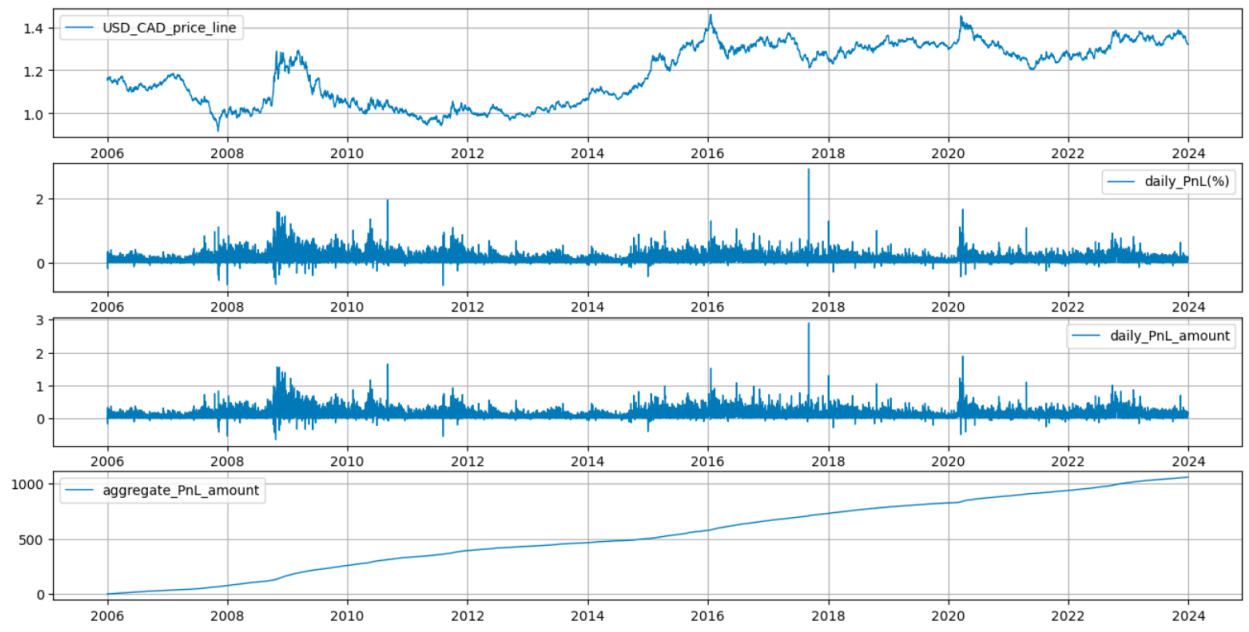
AUD/USD:

- **Price Line**: The price line shows a significant rise until 2012, followed by fluctuations, reflecting the commodity-driven nature of the Australian dollar.
- **Daily Profit and lost (%):**The daily Profit and lost (%) exhibits higher volatility, especially around 2010-2012, yet the profitability remains strong.
- **Aggregate Profit and lost Amount**: The aggregate Profit and lost amount shows a steady upward trend, indicating cumulative profit growth. This suggests that the strategy can capitalize on both rising and falling markets.



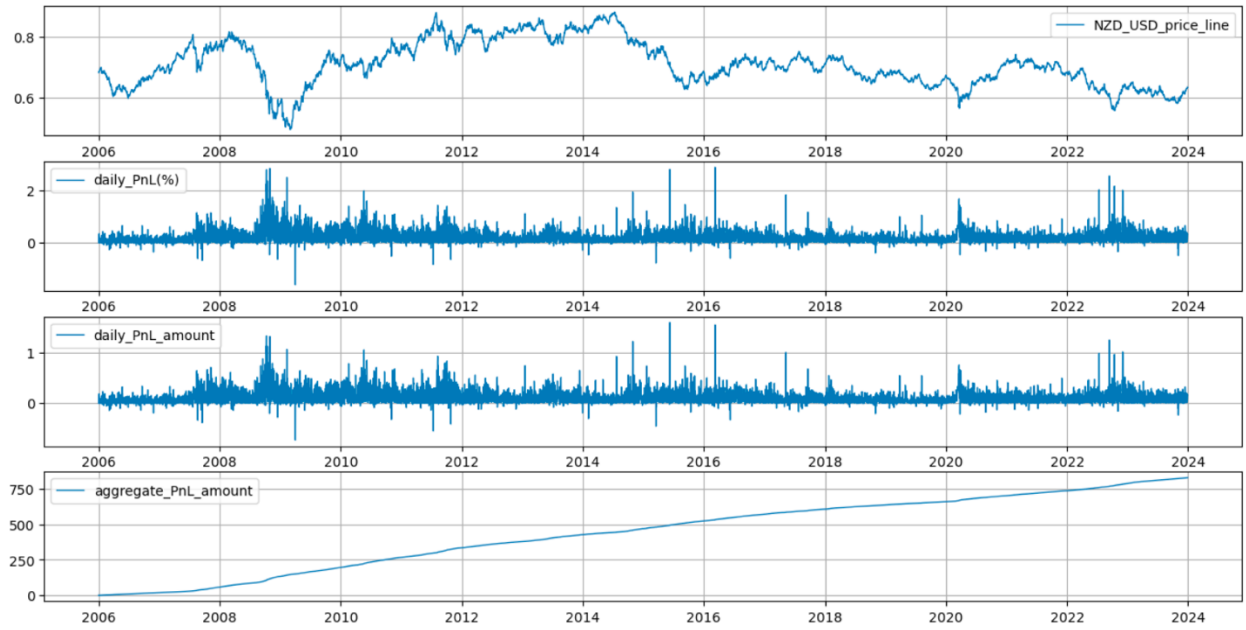
USD/CAD:

- **Price Line:** The price line shows fluctuations with a notable rise around 2015-2018, reflecting changes in oil prices impacting the Canadian dollar.
- **Daily Profit and lost (%):**The daily Profit and lost (%) shows lower volatility compared to other pairs, indicating stable performance.
- **Aggregate Profit and lost Amount:** The aggregate Profit and lost amount shows consistent growth, indicating long-term profitability. The strategy's ability to maintain steady returns despite market fluctuations is impressive.



NZD/USD:

- **Price Line:** The price line shows a significant rise until 2011, followed by fluctuations, reflecting the economic conditions of New Zealand.
- **Daily Profit and lost (%):** The daily Profit and lost (%) exhibits moderate volatility with occasional spikes, indicating steady profitability.
- **Aggregate Profit and lost Amount:** The aggregate Profit and lost amount shows a steady upward trend, indicating cumulative profit growth. This demonstrates the strategy's effectiveness across different market conditions.



Summary:

Despite the differences in price line behaviors for each currency pair, the Alpha Engine trading strategy consistently shows good profitability. The steady upward trend in the aggregate Profit and lost amounts across all pairs indicates that the strategy is robust and adaptable to various market conditions. This robustness reduces the likelihood of overfitting and demonstrates the strategy's ability to generate consistent returns regardless of the underlying price dynamics of each currency pair.

Results from Multi-Currency Implementation

The implementation of the Alpha Engine trading strategy across multiple currency pairs yielded varied yet consistently positive results. The average daily returns ranged from 0.1879% for USD/CAD to 0.3064% for AUD/USD, showcasing the strategy's ability to generate significant returns across different markets. Risk levels, as measured by the standard deviation of daily returns, varied from 0.1488% (NZD/USD) to 0.3119% (AUD/USD), indicating differing levels of volatility among the pairs. The strategy maintained acceptable maximum drawdowns, with the lowest being -0.7177% for USD/CAD and the highest -1.6962% for AUD/USD. The Sharpe ratio, a key metric for risk-adjusted returns, was highest for EUR/USD at 1.0312 and lowest for USD/JPY at 0.9606, demonstrating good performance across all pairs. The final aggregate profit varied significantly, with USD/JPY achieving the highest at 11706.2213 and NZD/USD the lowest at 829.2267. Profitability relative to average open capital was most efficient for AUD/USD at 17.3899 and least for USD/CAD at 11.1701. These results confirm the strategy's robustness and adaptability, indicating it is not overfitted to specific market conditions and performs well in diverse trading environments.

	EUR_USD	USD_JPY	GBP_USD	USD_CHF	AUD_USD	USD_CAD	NZD_USD
Avg price	1.2388	107.0522	1.5094	0.9962	0.8136	1.1834	0.7107
Avg Open	99.1051	8564.4250	120.7593	79.6970	65.0830	94.6764	56.8550
Avg Daily Return(%)	0.2554	0.2417	0.2421	0.2121	0.3064	0.1964	0.2601
Standard Deviation(%)	0.2400	0.2433	0.2278	0.2023	0.3119	0.1932	0.2752
Avg Daily Return	0.2566	20.6048	0.2882	0.1703	0.1988	0.1862	0.1459
Avg Daily Trade Frequency	112.4180	111.6908	109.0728	100.8037	122.7089	99.4307	111.8506
Standard Deviation	0.2495	21.0530	0.2684	0.1663	0.1975	0.1855	0.1488
Min Profit(%)	-1.1962	-0.9378	-0.9843	-1.5803	-1.6962	-0.7177	-1.6267
Max Profit(%)	2.3086	2.6347	3.1434	1.9550	3.3703	2.9282	2.8849
Max Drawdown(%)	-1.1962	-0.9378	-0.9843	-1.5803	-1.6962	-0.7177	-1.6267
Sharpe Ratio	1.0312	0.9606	1.0282	1.0093	0.9570	0.9754	0.9161
Final Aggregate Profit	1461.9531	117076.2213	1638.2902	967.3868	1131.7846	1057.5468	829.2267
Aggregate Profit/ Avg open	14.7515	13.6701	13.5666	12.1383	17.3899	11.1701	14.5849

Extend The Analysis With Other Asset Class

Analysis of Gold Trading Performance

The analysis evaluates the trading performance of gold (XAU/USD) from 2007 to 2024, focusing on return percentages and risk measurements. The trading strategy includes both long and short positions, with an emphasis on the sum of daily profit percentages and associated risks.

Key Findings

1. **Daily Profit Percentage**:

   The daily profit percentage remains positive for the majority of the period, with several spikes indicating substantial returns. The sum of daily profit percentages shows consistent growth over time.

2. **Risk Measurement**:

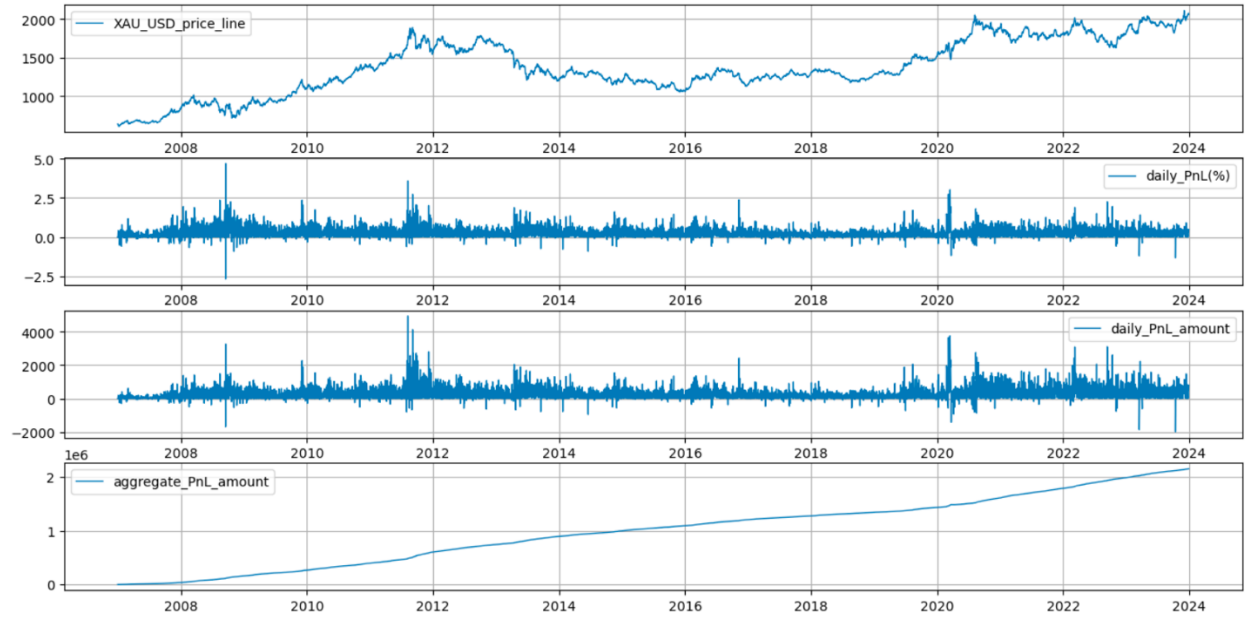
   - **Max Drawdown**: The maximum drawdown percentage is a critical risk measure. The analysis shows controlled max drawdown percentages, indicating effective risk management. The highest recorded drawdown is -2.6849%, with an average around -1.0%, highlighting periods of minimal loss.
   - **Sharpe Ratio**: The Sharpe Ratio, which measures risk-adjusted return, is 0.9767, reflecting a strong return relative to the risk taken.
   - **Expected Shortfall**: This metric provides an estimate of the potential loss in extreme scenarios. The expected shortfall values are relatively low, indicating that extreme losses are well-managed.

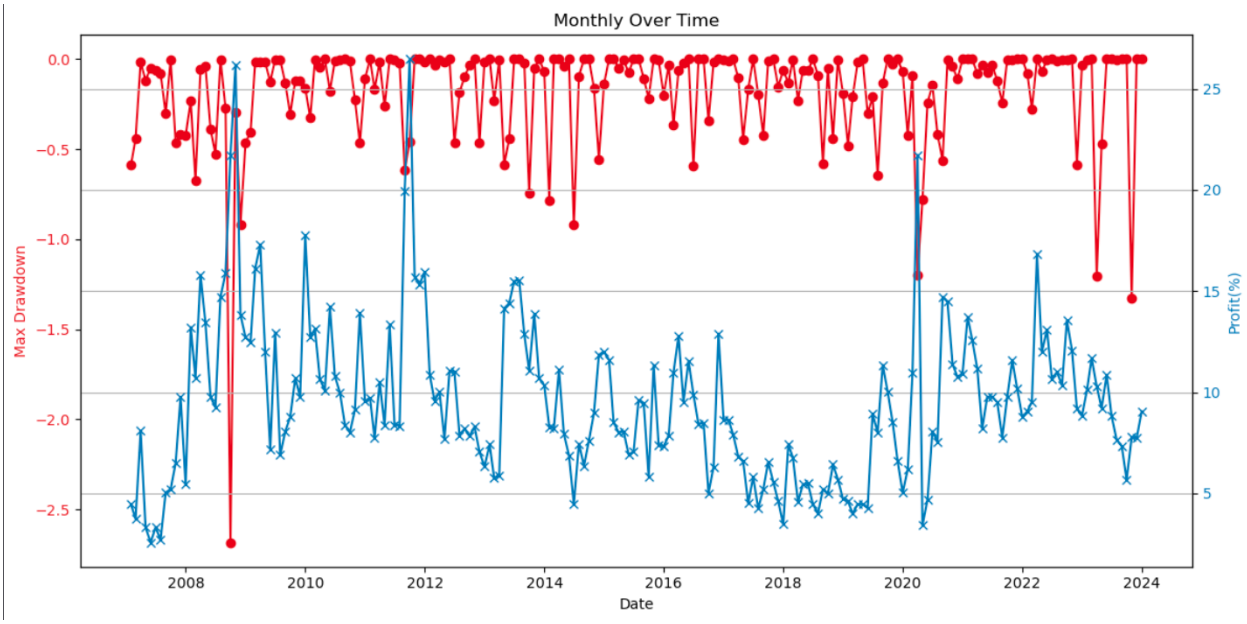
3. **Statistical Summary**:

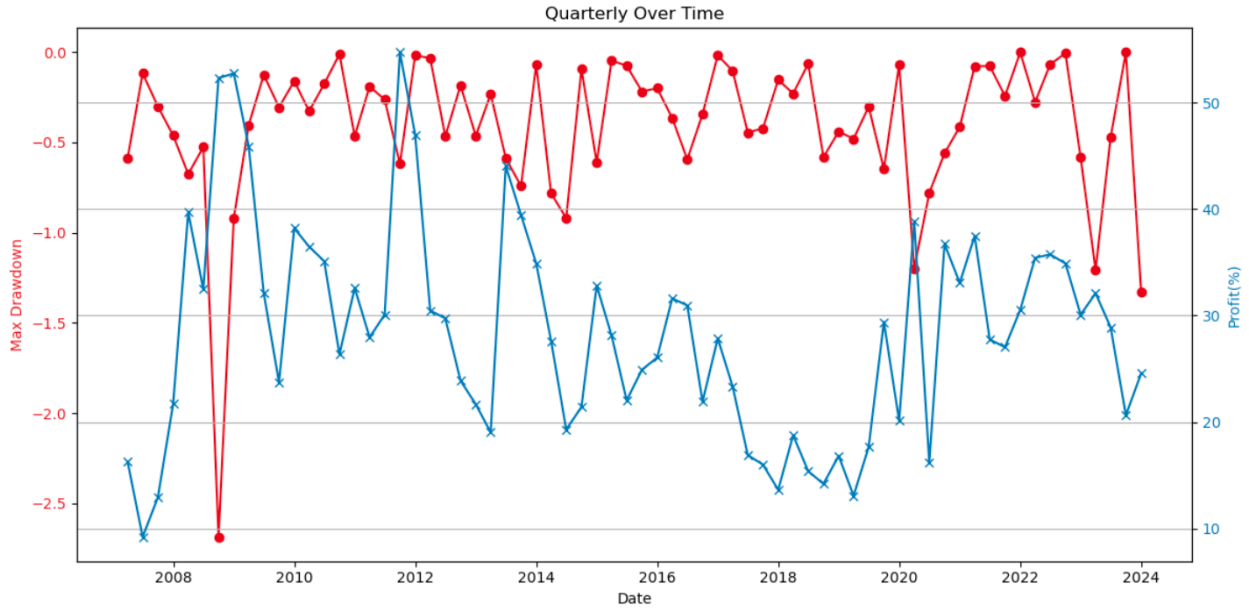
   - **Average Daily Return (%):** 0.3611%
   - **Standard Deviation of Daily Return (%):** 0.3616%
   - **Sharpe Ratio:** 0.9767

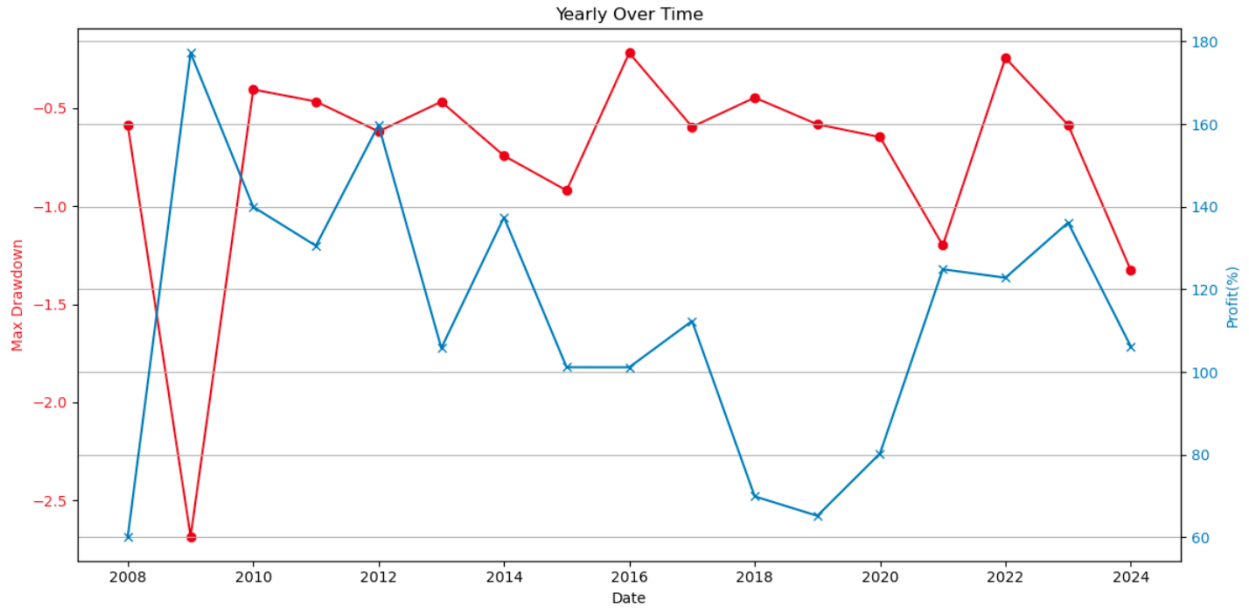
Comparison with FX Market

The trading performance of gold surpasses that of the FX market in terms of return percentage and risk-adjusted return. The Sharpe Ratio is robust, suggesting that gold provides higher returns for each unit of risk compared to typical FX trading strategies.


XAU_USD_price_line
daily_PnL(%)
daily_PnL_amount
aggregate_PnL_amount
1e6


Monthly Over Time
Max Drawdown
Profit(%)
Date





Date	day_profit(%)_mean	day_profit(%)_std	day_profit(%)_sum	Prices_mean	Daily_open_capital_mean	Pure_pnl_sum	total_trade_freq_sum	max_drawdown	sharpe_ratio	expected_shortfall
2007-12-31	0.191537	0.264928	60.142644	697.724240	55787.924841	34214.851685	27833	-0.587093	0.647486	-0.318099
2008-12-31	0.566252	0.608285	177.236783	872.476549	69809.497764	123373.895161	38391	-2.684885	0.898019	-0.564813
2009-12-31	0.444321	0.382749	139.961235	973.578324	77855.838730	109681.144669	37289	-0.404508	1.108615	-0.114413
2010-12-31	0.415753	0.332063	130.546566	1226.238819	98049.519745	127743.944030	38271	-0.465570	1.191803	-0.100580
2011-12-31	0.455175	0.485066	159.766383	1571.753940	125731.834758	206944.491727	41948	-0.618505	0.897146	-0.149446
2012-12-31	0.329544	0.256869	105.783676	1669.882781	133591.721246	141055.744624	36881	-0.466874	1.205068	-0.107600
2013-12-31	0.439087	0.384296	137.434217	1411.006837	112961.309137	151655.205767	39685	-0.742440	1.090532	-0.158952
2014-12-31	0.324195	0.292795	101.148808	1266.059686	101277.714872	102122.000815	36563	-0.919638	1.038935	-0.221624
2015-12-31	0.325191	0.251140	101.134553	1160.807322	92895.063151	94325.221893	35592	-0.218020	1.215224	-0.049451
2016-12-31	0.361214	0.322649	112.337493	1249.045297	99905.807846	112332.200542	38272	-0.594980	1.057540	-0.139905
2017-12-31	0.226124	0.203327	69.872368	1258.264238	100645.312880	70132.416234	33503	-0.445939	1.013759	-0.151313
2018-12-31	0.208919	0.186179	65.182874	1269.280383	101557.429359	66443.719322	34035	-0.582138	1.014717	-0.138067
2019-12-31	0.257263	0.259825	80.265913	1393.562927	111468.226154	91226.360393	35188	-0.647255	0.913162	-0.145131
2020-12-31	0.401470	0.482271	124.857295	1772.131215	141750.441801	178560.806487	39870	-1.199407	0.790988	-0.422969
2021-12-31	0.397433	0.284054	122.806875	1799.309240	143934.239094	176912.772783	41502	-0.243444	1.328736	-0.043288
2022-12-31	0.439221	0.339711	136.158499	1802.034498	144182.102065	197294.897092	44414	-0.584654	1.234052	-0.114417
2023-12-31	0.343721	0.286636	106.209934	1942.959418	155416.573722	165333.672131	40764	-1.326161	1.129382	-0.201346

Analysis of Brent Crude Oil Trading Performance

The analysis evaluates the trading performance of Brent crude oil (BCO/USD) from 2007 to 2024, focusing on return percentages and risk measurements.

Key Findings

1**. Daily Profit Percentage**:

The daily profit percentage for Brent crude oil shows high volatility but remains generally positive. The sum of daily profit percentages indicates growth, albeit with more pronounced fluctuations compared to gold.

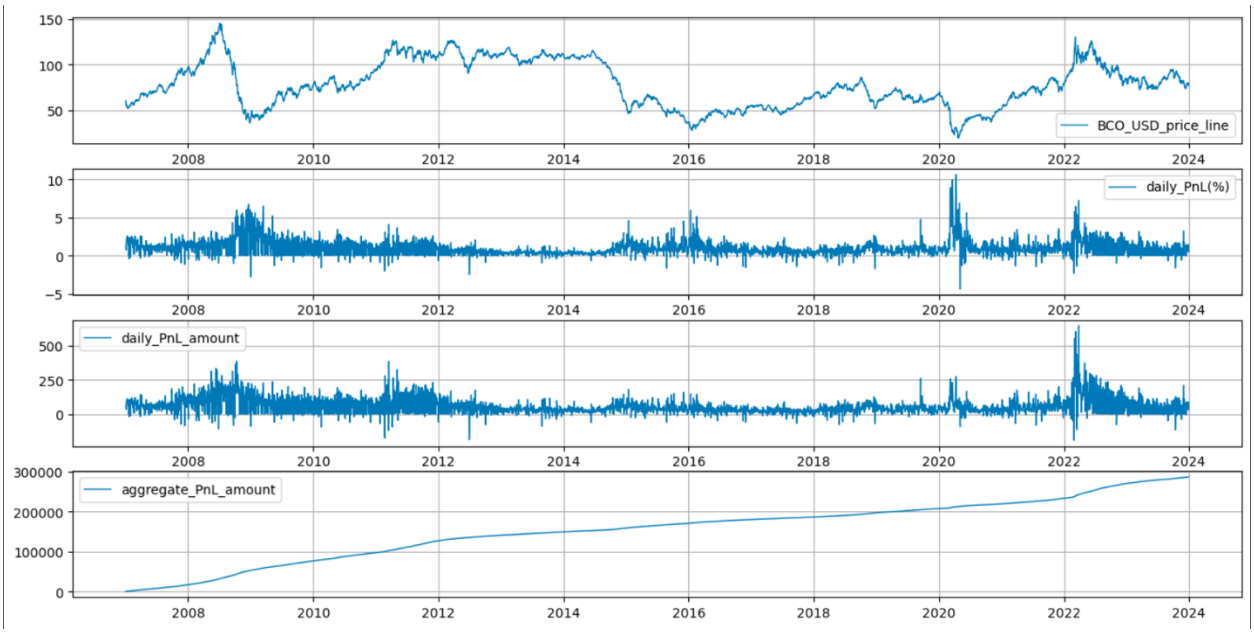
2. **Risk Measurement**:

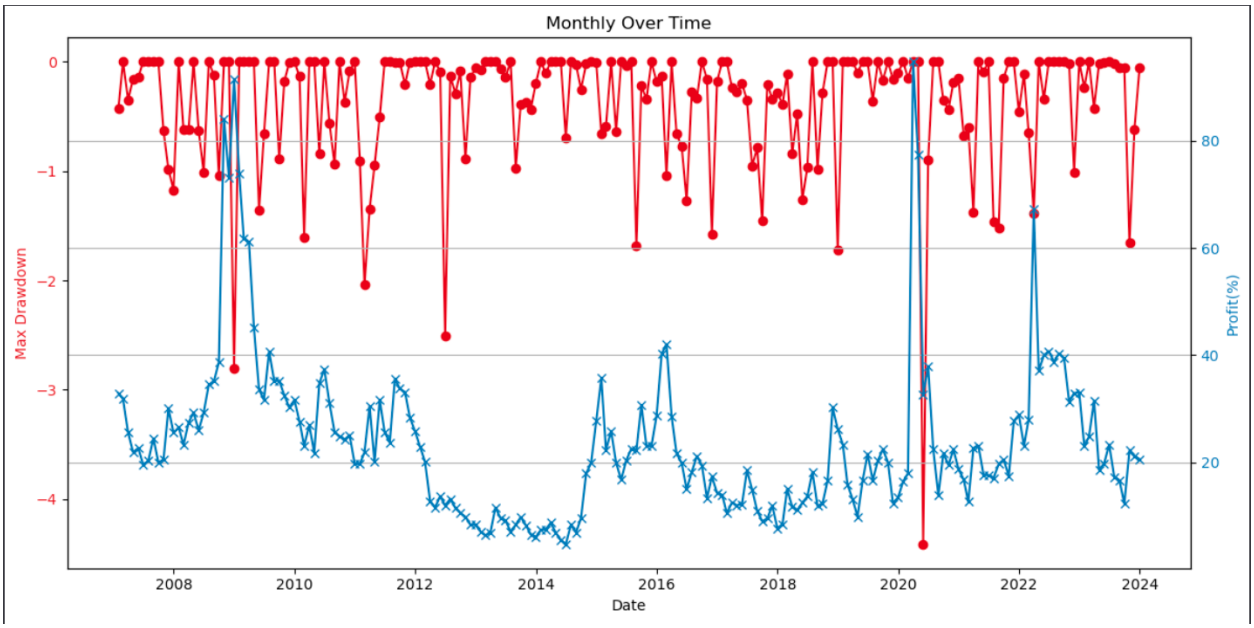
- **Max Drawdown**: The maximum drawdown percentages for Brent crude oil are higher than those for gold, indicating higher risk exposure. The highest recorded drawdown is -4.4111%, with frequent significant drawdowns around -1.0% to -2.0%.
- **Sharpe Ratio**: The Sharpe Ratio for Brent crude oil is 1.0394, suggesting a slightly better risk-adjusted return than gold. However, the increased volatility and drawdowns must be considered.
- **Expected Shortfall**: The expected shortfall values are higher than those for
- gold, indicating greater potential for extreme losses.

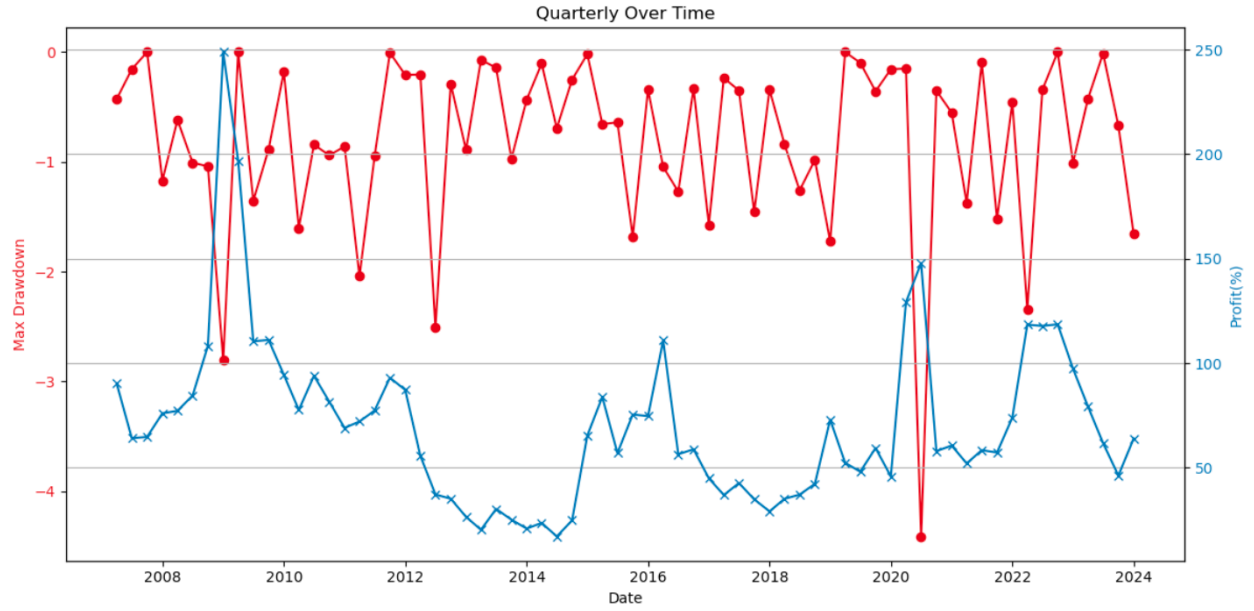
3. **Statistical Summary**:
   - **Average Daily Return (%):** 1.030%
   - **Standard Deviation of Daily Return (%):** 0.9833%
   - **Sharpe Ratio:** .0394

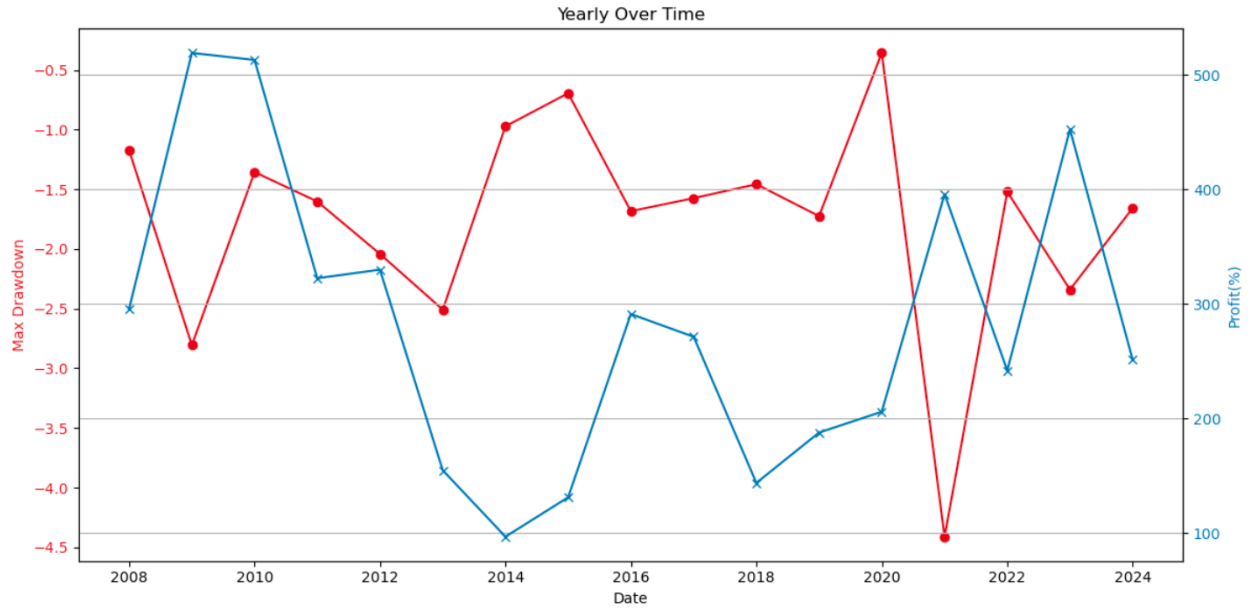
Comparison with FX Market

When comparing Brent crude oil to the FX market, Brent crude oil exhibits a higher average daily return percentage and Sharpe Ratio. However, the increased volatility and drawdowns must be considered. Despite the potential for higher returns, the greater risk and volatility suggest that Brent crude oil is less stable


BCO_USD_price_line
daily_PnL(%)
daily_PnL_amount
aggregate_PnL_amount


Monthly Over Time
Max Drawdown
Profit(%)
Date





Date	day_profit(%)_mean	day_profit(%)_std	day_profit(%)_sum	Prices_mean	Daily_open_capital_mean	Pure_pnl_sum	total_trade_freq_sum	max_drawdown	sharpe_ratio	expected_shortfall
2007-12-31	1.144454	0.689457	295.269227	72.658813	5809.312558	17046.734068	40052	-1.170457	1.630928	-0.406403
2008-12-31	1.827576	1.540482	519.031641	97.902733	7840.839155	35673.763334	42152	-2.805917	1.173383	-0.639682
2009-12-31	1.709770	1.237028	512.931041	62.147928	4969.433333	23853.469394	46930	-1.355418	1.365991	-0.220728
2010-12-31	1.056939	0.770927	322.366513	80.038940	6402.199344	20463.557107	48976	-1.601609	1.345056	-0.406721
2011-12-31	1.070894	0.792398	329.835504	111.480164	8918.075325	29494.960664	50967	-2.041228	1.326220	-0.499800
2012-12-31	0.533530	0.457755	154.723601	112.074124	8963.464690	13923.197280	38860	-2.508435	1.121843	-0.373580
2013-12-31	0.372193	0.269150	96.770108	108.971169	8716.972462	8409.593220	32635	-0.971665	1.308536	-0.245684
2014-12-31	0.508272	0.433045	131.134183	99.556203	7970.368372	9539.418028	34160	-0.694831	1.127533	-0.082386
2015-12-31	1.128386	0.778891	291.123493	53.295493	4265.923256	12195.884578	41086	-1.682949	1.423030	-0.399218
2016-12-31	1.051308	0.890769	271.237345	44.757647	3579.499225	9169.995203	41268	-1.573797	1.157772	-0.689383
2017-12-31	0.559151	0.424831	143.701679	54.546222	4362.373541	6192.688259	36522	-1.457097	1.269095	-0.478780
2018-12-31	0.727385	0.557216	187.665357	71.828961	5749.355039	10593.927892	40544	-1.724755	1.269499	-0.658808
2019-12-31	0.794624	0.505379	205.807647	64.367091	5147.094517	10499.814914	40447	-0.356968	1.532759	-0.070408
2020-12-31	1.527878	1.692481	395.720367	42.948065	3437.252973	11889.552622	44887	-4.411069	0.890927	-0.848206
2021-12-31	0.933730	0.695288	241.836052	71.187521	5690.727722	13838.757866	44996	-1.520164	1.314174	-0.602726
2022-12-31	1.587005	1.148820	452.296536	99.684861	7972.700351	36976.805202	51605	-2.340362	1.364012	-0.475070
2023-12-31	0.818795	0.629338	251.370092	82.397731	6592.614332	16481.062268	45582	-1.657830	1.269263	-0.268581

Comparison of Gold and Brent Crude Oil Trading Performance

The comparative analysis between gold and Brent crude oil trading performance from 2007 to 2024 underscores the versatility and robustness of the Alpha Engine trading strategy across different asset classes. Gold, with an average daily return of 0.3611% and a maximum drawdown of -2.6849%, offers consistent returns with lower risk and volatility, reflected in its Sharpe Ratio of 0.9767. In contrast, Brent crude oil exhibits a higher average daily return of 1.030% but also higher volatility and a maximum drawdown of -4.4111%, leading to a slightly better Sharpe Ratio of 1.0394. Despite the potential for higher returns with Brent crude oil, the increased risk and instability make gold a more stable and reliable choice for long-term trading. This analysis highlights the importance of balancing return percentages with risk management when evaluating trading performance and demonstrates the Alpha Engine's adaptability and effectiveness across different market conditions.

Conclusion

The comprehensive analysis of the Alpha Engine trading strategy reveals its robustness and adaptability across various market conditions and asset classes. The strategy demonstrates consistent profitability with well-managed risk, making it a viable option for diverse trading environments. The application of asymmetric thresholds enhances the strategy's ability to navigate different market trends, reducing the likelihood of overfitting and improving overall performance.

In comparing asset classes, the Alpha Engine strategy shows effective performance in both gold and Brent crude oil markets. While Brent crude oil exhibits higher average daily returns and a slightly better Sharpe Ratio, it also comes with increased volatility and risk. Conversely, gold provides more stable and reliable returns with controlled risk, highlighting the strategy's ability to adapt and perform across different asset classes.

The forward walk test further validates the strategy's effectiveness, confirming its capability to maintain high Sharpe ratios and consistent returns over various time periods. This adaptability underscores the strategy's potential for long-term profitability and its suitability for application in different trading scenarios.

Overall, the Alpha Engine trading strategy proves to be a robust, profitable, and adaptive model, capable of generating consistent returns while managing risk effectively. This highlights its potential for broader application in various asset classes and trading environments, ensuring informed and strategic trading decisions.

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