Combining Regression Price Channels and Directional Indicator for Unleveraged Mean-Reversion Strategy in Forex

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Abstract:

This research paper is to develop and further analyze a long-only trading strategy in the Foreign Exchange (FX) market by combining dynamic linear regression channels and the Aroon indicator.

The objective is to determine the feasibility of capitalizing on the FX market's volatility and mean-reverting tendencies in the short-term.This strategy was developed through analyzing market characteristics, and was backtested over 2 years (20 May 2022 - 20 May 2024) on 5 major FX pairs (EUR/USD, AUD/USD, JPY/USD, GBP/USD, CAD/USD).

Overall, the study reveals that the trading strategy can effectively capitalize on uptrends for most currency pairs, but comes short when faced with a strong downtrend. More research can be done regarding shorting in the FX market, as data with short positions included have shown promising returns. Improvements can also be made on the speed of trend recognition in order to further optimize and utilize the trading strategy.

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1. Introduction:

1.1 FX Market

The FX market is a highly volatile market with more liquidity compared to the stock market [4]. It is also more flexible, as it's open 24 hours on weekdays. There is no centralized exchange for FX, as currencies are traded mainly through banks, brokers and commercial companies.

Additionally, despite the market's high volatility, it exhibits a historical tendency to revert back to a certain mean price [5].

1.2 Strategy idea and Objective

The analysis of this strategy is based on the volatility and mean-reverting characteristics of the FX market. Its high volatility is due to it being primarily influenced by the state of the global economy and politics, so currency prices can shift dramatically in a short period of time.

In lieu of this, our objective is to find out if it is possible to take advantage of the FX market's high volatility and mean-reverting characteristics in the short-term.

1.3 Definitions

1.3.1 CAGR (Compound Annual Growth Rate)

The Compound Annual Growth Rate (CAGR) is the mean annual growth rate of a portfolio over a period longer than one year [7].

$$CAGR = (EV / BV)^{1/N} - 1$$

EV = Ending value of portfolio
BV = Beginning value of portfolio
N = Portfolio trading period (in years)

1.3.2 MDD (Maximum Drawdown)

The Maximum Drawdown (MDD) is the maximum loss from a peak to a trough of a portfolio, before a new peak is attained. Maximum drawdown is an indicator of downside risk over a specified time period [8].

$$MDD = TV / PV - 1$$

PV = Peak value
TV = Trough value following a peak value PV

1.3.3 MAR ratio(Minimum Acceptable Return ratio)

The Minimum Acceptable Return (MAR) ratio is a measurement of risk-adjusted returns that can be used to evaluate the performance of trading strategies. The MAR ratio is calculated by dividing the CAGR of a strategy by its most significant drawdown (MDD). The higher the ratio, the better the risk-adjusted returns[6].

$$MAR = CAGR / abs(MDD)$$

1.3.4 Aroon Indicator

The Aroon indicator is a technical indicator used to identify the strength of a price trend, and whether the trend is upwards or downwards. The indicator measures the time between highs and the time between lows over a time period. The idea is that strong uptrends will regularly see new highs, and strong downtrends will regularly see new lows [9].

The indicator consists of the "Aroon up" line (AU), which measures the strength of the uptrend, and the "Aroon down" line (AD), which measures the strength of the downtrend.

$$AU = [1 - (P_{High} / AL)] \times 100$$
$$AD = [1 - (P_{Low} / AL)] \times 100$$

AL = Lookback period of the Aroon Indicator
P_{High} = Periods since last High within the lookback period AL
P_{Low} = Periods since last Low within the lookback period AL

The case where AU > 70 and AD < 30 indicates a strong uptrend. On the other hand, the case where AD > 70 and AU < 30 indicates a strong downtrend [10]. For this study, we are only concerned with the former, as we are doing strictly long positions, so we are only looking to trade in periods with a strong uptrend.

2. Methodology:

2.1 Data collection

Hourly data is collected from Yahoo Finance, and the time period is the past 730 days (2 years). The specific time period we will backtest on is 20 May 2022 to 20 May 2024. The top 5 traded FX pairs were

chosen for this strategy to minimize slippage and maximize liquidity. The pairs are EURUSD, AUDUSD, JPYUSD, GBPUSD and CADUSD [3].

2.2 Strategy and backtest design

2.2.1 Parameters and sensitivity testing

In order to facilitate thorough data analysis and prove robustness, sensitivity tests on the parameters are executed for each FX pair. These are the parameters, along with the range of values to be checked. (Note that **[a:b:c]** refers to a range from **a** to **b** with intervals of **c**)

X1 = Stop loss % ([0.01 : 0.05 : 0.01], **5 values**)
X2 = Lookback period for linear regression ([24 : 120 : 4], **25 values**)
X3 = Standard deviation multiplier ([0.5 : 2.5 : 0.5], **5 values**)
X4 = Aroon Indicator lookback period ([0.5 : 3.0 : 0.5], **6 values**)

- Stop loss (X1) decides our risk tolerance on each trade.
- Lookback period (X2) refers to how many past data points are observed to calculate the linear regression channel best fit line.
- SD multiplier (X3) determines how far the calculated channel lines are from the current price trend and directly impacting the frequency of trades.
- Aroon indicator lookback period (X4) refers to how many past data points are observed to calculate AU and AD

2.2.2 Strategy idea and design

Initial idea

Initially, we incorporated **shorting** into the strategy with the assumption that the process was similar to the stock market. However, after doing some research on shorting in the FX market, we concluded that it was quite complicated and incurs a lot of expenses. Shorting in the FX market requires trading complicated contracts called CFDs (Contract For Differences) [11]. This would incur potentially high borrowing expenses and daily interest fees. As a result, we have disabled short positions for the strategy. However, backtest results with shorting enabled will be presented in the first part of the data analysis, Data Analysis I.

Strategy overview

Over 2 years of historical hourly data, we execute linear regression at each point to estimate the best fit line over a certain lookback period X2 by using np.polyfit from the numpy library. Upper and lower boundaries are created by adding and subtracting X3 * standard deviation of the prices in the lookback period respectively.

If the current price crosses the upper boundary, we enter a buy order to enter our position. If the current price crosses the lower boundary, we enter a sell order to exit our position. We will also liquidate our position if the unrealized loss exceeds the stop loss percentage X1.

For higher confluences and increased probability of winning trades, we have incorporated the use of the Aroon Indicator. At each point, the indicator returns two values, indicating the strength of an uptrend (AU) and strength of a downtrend (AD) respectively.

In order to enter trades, the market should be in a relatively strong uptrend, which is represented by the rule AU > 70 AND AD < 30. Hypothetically, this makes the chances of winning in a long/buy position much higher.

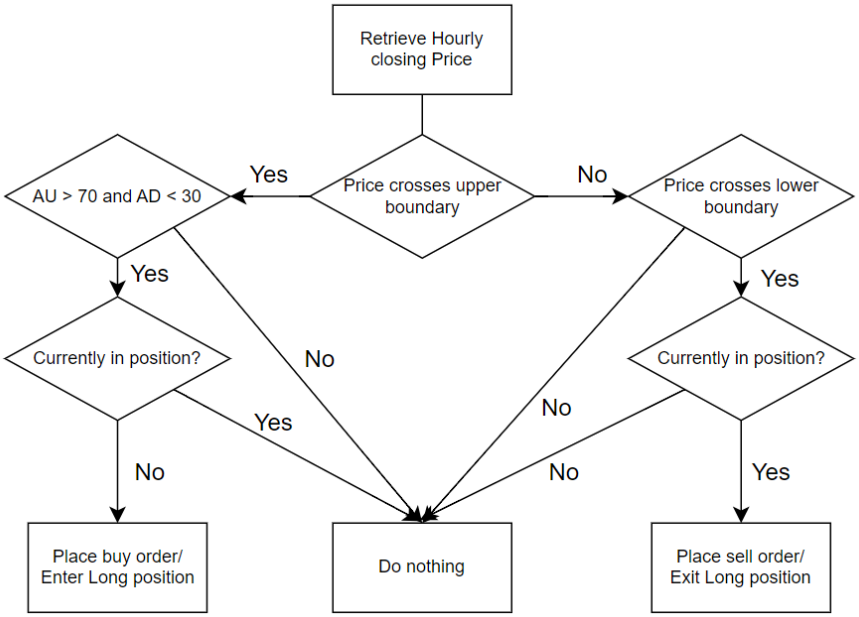

Figure 2.2.2a) - Flowchart of strategy

Hypothesis on Aroon Indicator

From above, the idea of the Aroon Indicator is to enhance the returns of the strategy. To test this hypothesis, on each FX pair, we backtested 625 (5*25*5) portfolios (with changing values for X1, X2, X3) ***without the Aroon indicator***, and 6 sets of 625 backtests ***with the Aroon indicator***. The 6 sets are represented by the range of values of the Aroon indicator lookback period X4.

After running all simulations, we determined the optimal X4 for each FX pair in the tests involving the Aroon indicator. This was achieved by identifying portfolios with the top 10 MAR values among the 625*6 portfolios. We then recorded the X4 value that appeared most frequently in these top-performing portfolios. Thus, narrowing down the simulations to 625 by picking the set represented by the optimal X4. For better illustration, here is an example using CAD/USD.

	aroon_lb	MAR
670	1800	1.696260
1420	1800	1.628749
796	1800	1.551524
316	1800	1.505023
706	1800	1.475403
2920	1800	1.445861
2170	1800	1.445861
3670	1800	1.445861
1792	1800	1.412944
408	360	1.386400

Figure 2.2.2b) - Top 10 MAR results of CAD/USD

With CAD/USD's top 10 portfolios ranked by MAR ratio, the value of X4 that appears the most is 1800 hours (appearing 9/10 times), which is 2.5 months. After choosing 2.5 months as the optimal X4 value, only the portfolios with aroon_lb = 1800 hours are selected, leaving us with 625 total portfolios (with Aroon Indicator, simulated with aroon_lb = 1800 hours) for a fair comparison to the 625 simulated portfolios (without Aroon indicator).

Below are the results represented by box-and-whisker diagrams of each pair to show the Upper Quartiles (UQ), Lower Quartiles (LQ), Medians and Outliers. The metric used to evaluate portfolio performance is the MAR ratio.

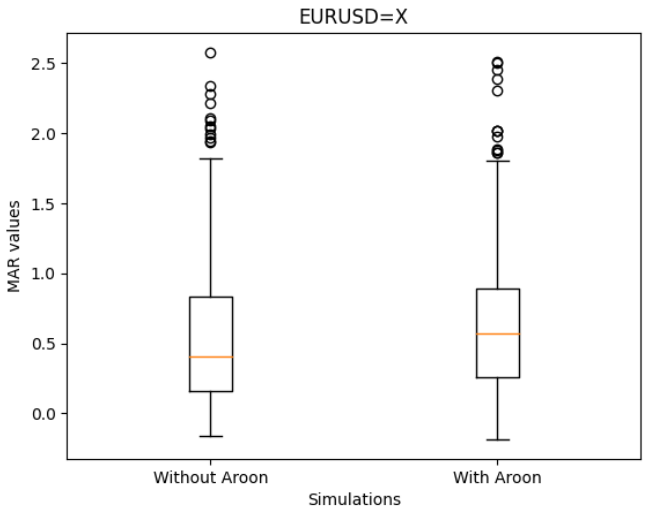

Figure 2.2.2c) - EUR/USD (chosen aroon_lb = 1800 hours OR 2.5 months)

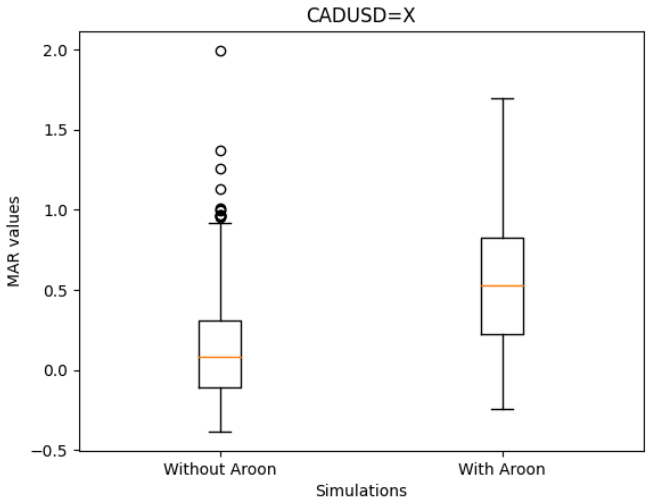

Figure 2.2.2d) - CAD/USD (chosen aroon_lb = 1800 hours OR 2.5 months)

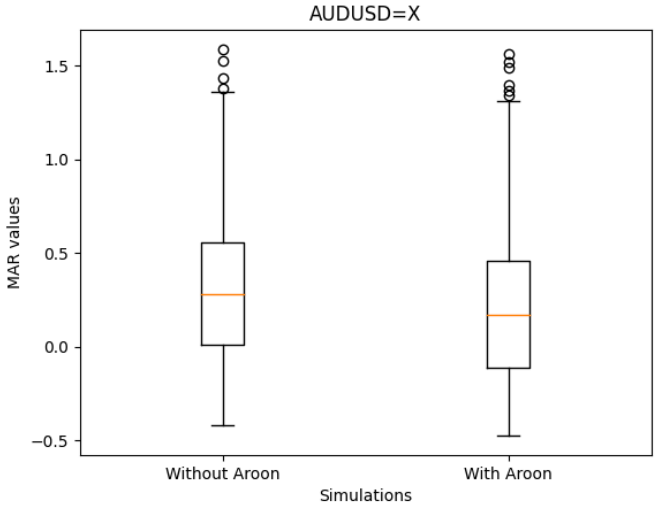

Figure 2.2.2e) - AUD/USD (chosen aroon_lb = 2160 hours OR 3.0 months)

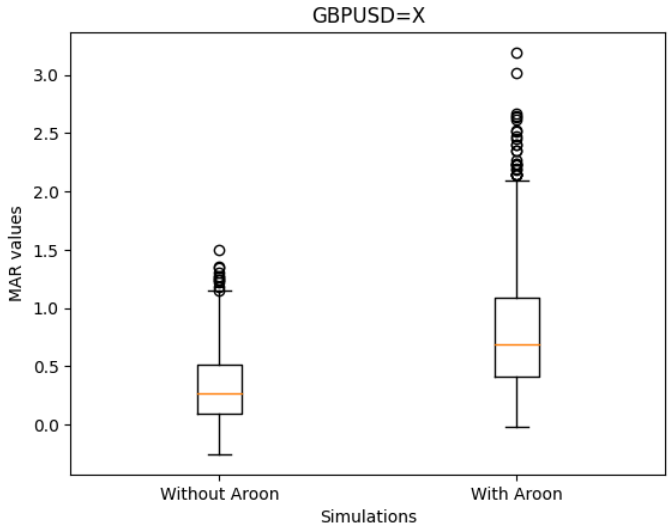

Figure 2.2.2f) - GBP/USD (chosen aroon_lb = 720 hours OR 1.0 months)

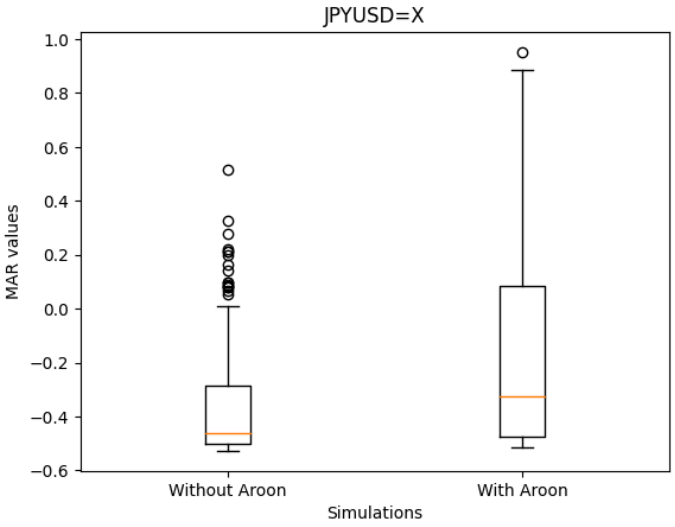

Figure 2.2.2g) - JPY/USD (chosen aroon_lb = 720 hours OR 1.0 months)

From the results, we can see that the Aroon indicator **enhances** the performance of the strategy with higher medians, UQ and LQ of MAR ratios for most of the FX pairs.

Final strategy

To conclude, the final strategy will utilize **dynamic linear regression channels** and the **Aroon indicator**. Trading will be **unleveraged**, with **only long positions**.

2.2.3 Backtesting

The account starts off with 1,000,000 USD. The vectorbt library in python is used to simulate the portfolio over the specified period.

```
pf = vbt.Portfolio.from_signals(
    close = close,
    entries = long_entries,
    exits = long_exits,
    freq = interval,
    fees = 0.00002,
    sl_stop = params['sl_stop'],
    init_cash = 1_000_000,
)
```

Figure 2.2.3a) - Example of portfolio parameters

close = Closing prices of the FX pair for the period
entries = Instructions on when to enter a position with a buy order
exits = Instructions on when to exit a position with a sell order
freq = Granularity of data (hourly)
fees = Fees per trade [2]
sl_stop = Stop loss X1
init_cash = Initial capital of the portfolio

3. Data Analysis:

3.1 Analysis Techniques and Metrics

To justify and increase credibility of the trading strategy, we executed sensitivity tests on all 5 FX pairs, and produced heatmaps. The following sections **Data Analysis I** and **Data Analysis II** present data on the strategy with shorting and without shorting respectively.

Data will be analyzed and evaluated on CAGR, MDD and the MAR ratio, with the MAR ratio being the most significant.

3.2 Data Analysis I (Shorting Enabled, Long-short strategy)

As mentioned above, the initial strategy included shorting. Originally, there were 3 parameters to go through such that the strategy would best fit multiple currency pairs, as the lookback for the Aroon Indicator (X4) was initially fixed at 720 hours (1 month). The 3 varying parameters were the SD multiplier (X3), lookback (X2) and Stop Loss (X1). We iterated through 10*25*10 portfolios with the following values for each:

X1 = Stop loss % ([0.01 : 0.10 : 0.01], **10 values**)
X2 = Lookback period for linear regression ([24 : 120 : 4], **25 values**)
X3 = Standard deviation multiplier ([0.5 : 2.5 : 0.25], **10 values**)

The results for this testing were evaluated with the MAR ratio. A generally "good" MAR ratio is 1.5 or more as it suggests that the investment has achieved a return (CAGR) that is 1.5x as high as its maximum drawdown (MDD).

Below are the heatmaps and top 5 results for each pair.

lookback	sd_mult	sl_stop	CAGR	MDD	MAR
36	2.0	0.04	0.18516676553880700	-0.04495248457329630	4.119166433100870
36	2.0	0.05	0.18516676553880700	-0.04495248457329630	4.119166433100870
36	2.0	0.03	0.1804057037290580	-0.049839093271669500	3.619762958882080
36	2.0	0.01	0.17925344327891000	-0.05054740910224010	3.5462439413332200
48	1.5	0.01	0.13167101590006500	-0.04063079362686320	3.240670539425810

Figure 3.2a) - EUR/USD Top 5 MAR results

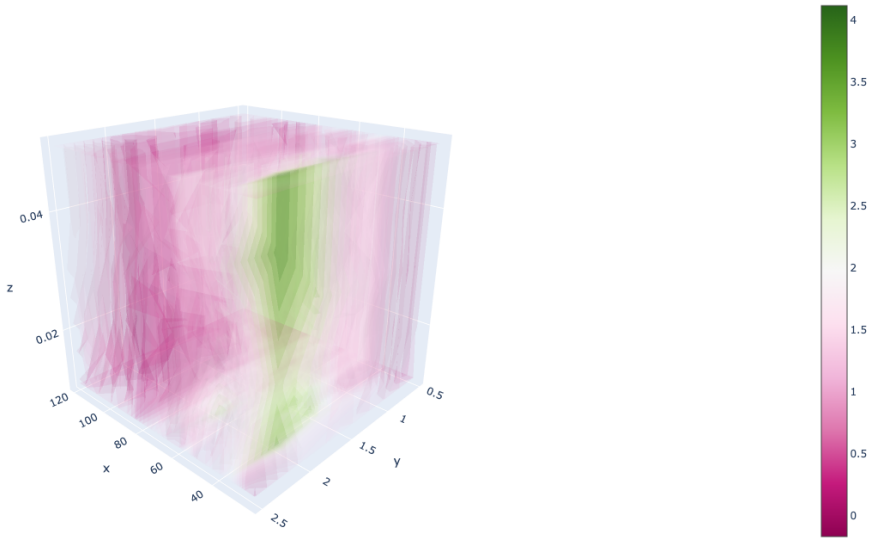

Figure 3.2b) - EUR/USD MAR heatmap

lookback	sd_mult	sl_stop	CAGR	MDD	MAR
36	1.0	0.02	0.14790694850559100	-0.055509007683990700	2.66455760383281
56	1.5	0.03	0.15261993072145200	-0.06270075552686370	2.434100345984870
36	1.0	0.05	0.1412943791901470	-0.058551054477968000	2.413182485779390
32	2.0	0.02	0.1444533227631530	-0.06007844423100670	2.4044118420862800
36	1.0	0.03	0.14059967176020300	-0.05855105447797290	2.4013174999793800

Figure 3.2c) - GBP/USD Top 5 MAR results

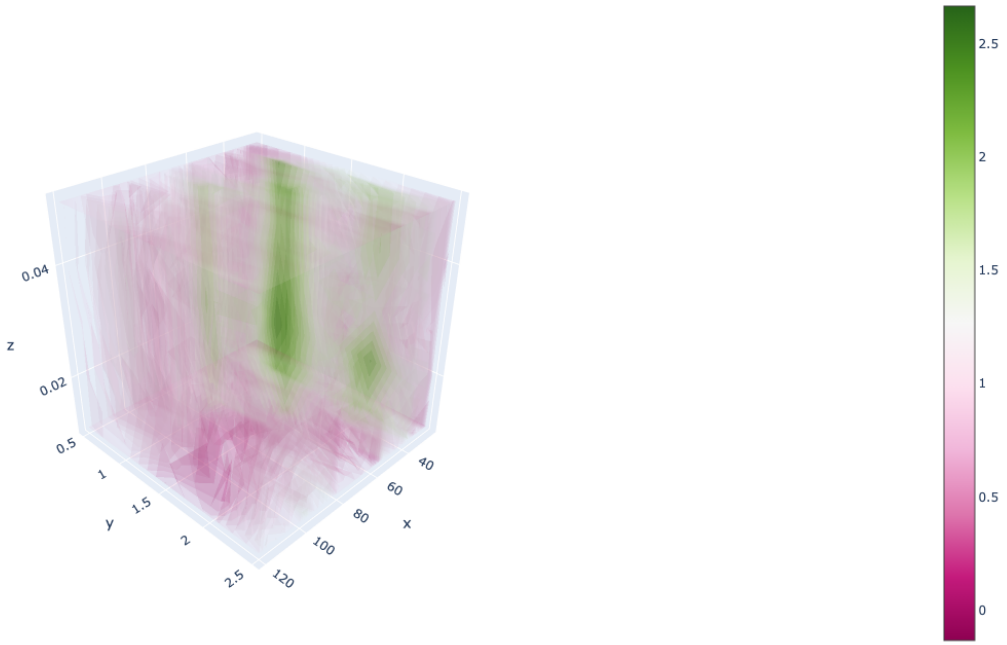

Figure 3.2d) - GBP/USD MAR heatmap

lookback	sd_mult	sl_stop	CAGR	MDD	MAR
120	1.0	0.03	0.16411435613533000	-0.05971214260413250	2.748425177494330
120	1.0	0.04	0.16123845198408600	-0.06367091968385740	2.532371964857370
120	1.0	0.01	0.15773057098394700	-0.062319514102803600	2.530998087112030
120	1.0	0.02	0.1404448589065820	-0.06075164348935600	2.3117869878069800
120	1.0	0.05	0.1619514406991540	-0.07118543275889540	2.2750643554796100

Figure 3.2e) - AUD/USD Top 5 MAR results

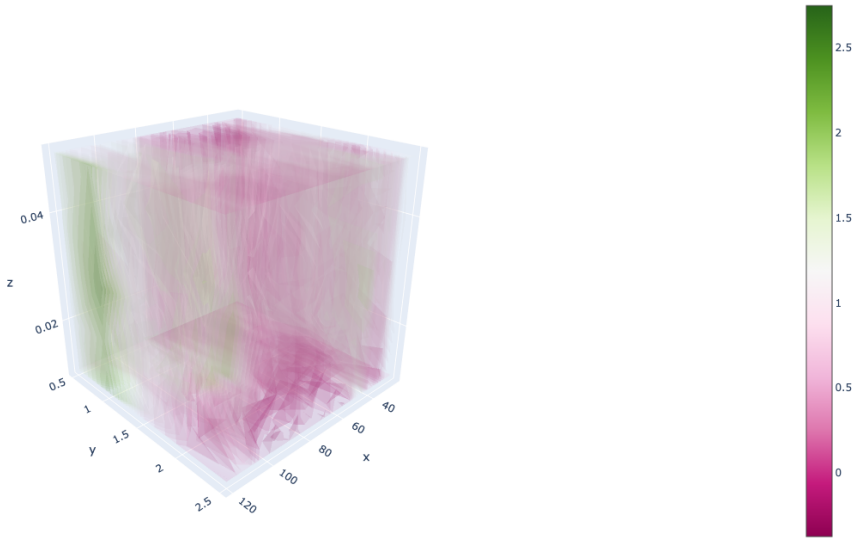

Figure 3.2f) - AUD/USD MAR heatmap

lookback	sd_mult	sl_stop	CAGR	MDD	MAR
60	2.0	0.03	0.09157087540353160	-0.03750383985987030	2.44163999594916
60	2.0	0.04	0.09157087540353160	-0.03750383985987030	2.44163999594916
60	2.0	0.05	0.09157087540353160	-0.03750383985987030	2.44163999594916
60	2.0	0.02	0.08517088285801220	-0.03750383985986720	2.270991001888140
108	1.5	0.02	0.08364846111778770	-0.039510542198756700	2.1171175201037800

Figure 3.2g) - CAD/USD Top 5 MAR results

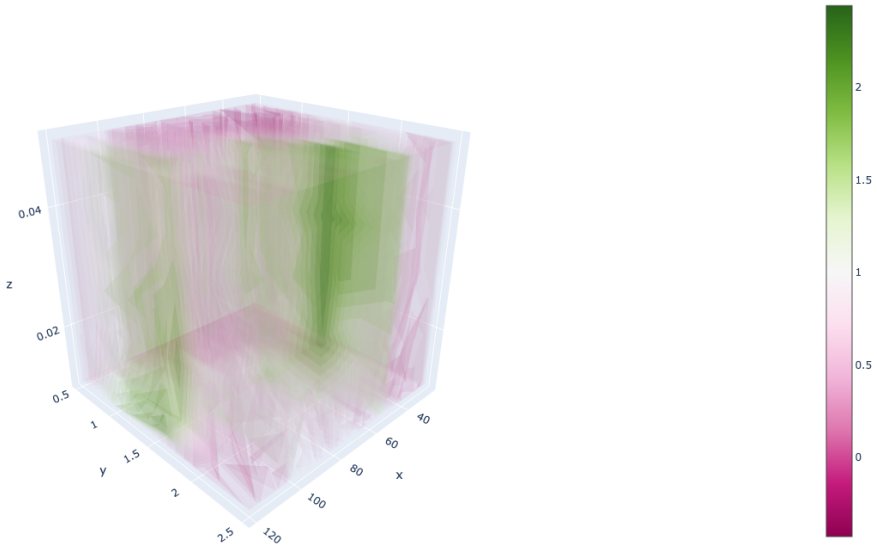

Figure 3.2h) - CAD/USD MAR heatmap

lookback	sd_mult	sl_stop	CAGR	MDD	MAR
120	1.5	0.03	0.11416513348418200	-0.07021525745062750	1.625930568786400
120	1.5	0.01	0.10071122139575600	-0.06929412832320640	1.4533875211765700
120	1.5	0.02	0.09756683782864740	-0.0696597364127387	1.4006202557322000
64	2.0	0.01	0.08189434095568850	-0.059757707596920800	1.3704398018090700
120	1.5	0.04	0.10679762312967500	-0.07824030162479550	1.3649950334014200

Figure 3.2i) - JPY/USD Top 5 MAR results

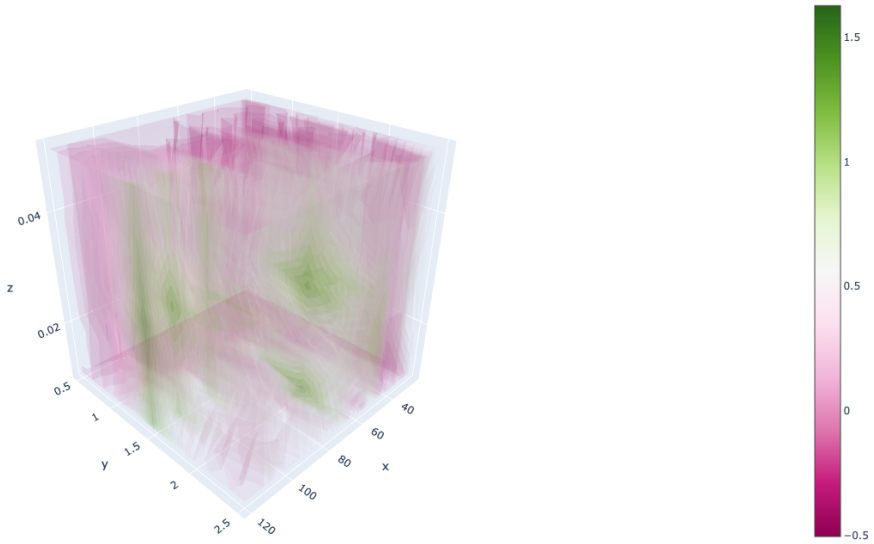

Figure 3.2j) - JPY/USD MAR heatmap

3.2.1 Findings and conclusions for initial strategy (shorting enabled)

Many of the highest results as shown above do not clearly indicate a perfect set for the 3 parameters to do well throughout currency pairs. The final set of "optimal" parameters across all FX pairs were not decided due to the data conflicts for each pair.

However, the data shows that if both long and short positions are possible, the returns are ideal. With the highest MAR throughout all pairs being over 4, indicating the much higher returns when compared to the risks taken. Despite the Aroon indicator lookback period X4 parameter being fixed at 720 hours (1 month), the strategy was still able to achieve returns with a good MAR (>1.5) on all pairs.

This signifies that the strategy is able to identify and capitalize on selling opportunities just as much as buying opportunities, further enhancing the credibility of the strategy.

3.3 Data Analysis II (Shorting Disabled, Long-only strategy)

After the initial testing, shorting was disabled due to the aforementioned issues. So the strategy was run with only long positions, making the CAGR halve on almost all FX pairs. Hence, a second round of testing was required, this time with 4 parameters, introducing X4 as a changeable value. To reduce computing complexity, some of the ranges and intervals were made shorter. Here are the new testing ranges for each parameter:

X1 = Stop loss % ([0.01 : 0.05 : 0.01], **5 values**)
X2 = Lookback period for linear regression ([24 : 120 : 4], **25 values**)
X3 = Standard deviation multiplier ([0.5 : 2.5 : 0.5], **5 values**)
X4 = Aroon Indicator lookback period ([0.5 : 3.0 : 0.5], **6 values**)

Below are the results of testing the strategy with 4 parameters and shorting disabled:

:

sl_stop	lookback	sd_mult	aroon_lb	CAGR	MDD	MAR	Return
0.01	36	2.0	720	0.10126733877404900	-0.04018957396106540	2.5197415347610700	0.21771289042765000
0.01	48	2.0	1800	0.10424845021211700	-0.04153441106316290	2.5099296593752800	0.2244534759345920
0.02	36	2.0	1800	0.10781686934365200	-0.04309286415203480	2.5019657306431500	0.2325469901148120
0.01	52	2.0	1800	0.09417251970689370	-0.03834644052902010	2.4558347113241200	0.2017471663453730
0.01	36	2.0	1800	0.11519338507099700	-0.048288739445668700	2.3855123656852800	0.24936389676163100
0.01	56	2.0	1080	0.07854272485819090	-0.03327347132767780	2.360520911229870	0.16695414082272400
0.03	36	2.0	1800	0.10088285505527900	-0.04374670659823950	2.30606742541251	0.21684491731859600
0.01	36	2.0	2160	0.1059587744136060	-0.048288739445668700	2.1942750138015900	0.22832925870509300
0.02	36	2.0	720	0.08058574434897410	-0.03683420615712850	2.1877964195891400	0.17147241441093000
0.01	52	2.0	1440	0.08915422505875830	-0.041985092951416600	2.1234733280672700	0.1905192358795080

Figure 3.3a) - EUR/USD Top 10 MAR results

sl_stop	lookback	sd_mult	aroon_lb	CAGR	MDD	MAR	Return
0.01	28	1.5	720	0.102036858	-0.031961194	3.192523378	0.219294319
0.01	32	1.5	720	0.092123168	-0.030573476	3.013172866	0.197015911
0.02	36	1.5	720	0.088976779	-0.033317275	2.670589893	0.189989023
0.01	32	2	720	0.091446695	-0.034555842	2.646345478	0.195503352
0.02	56	1.5	720	0.096955094	-0.036738374	2.639068757	0.207848221
0.01	36	1	720	0.084372635	-0.032222606	2.618429884	0.179744529
0.02	72	1	720	0.094056951	-0.037270723	2.523614882	0.201345133
0.01	36	1.5	720	0.081056592	-0.032272908	2.511598627	0.172394115
0.03	76	1	720	0.088419588	-0.035673982	2.478545541	0.188746839
0.02	52	1.5	720	0.090013702	-0.036738374	2.450127576	0.192302473

Figure 3.3b) - GBP/USD Top 10 MAR results

sl_stop	lookback	sd_mult	aroon_lb	CAGR	MDD	MAR	Return
0.01	112	2.5	360	0.06270632960111210	-0.03877315803948260	1.6172613419123200	0.13258604807133100
0.02	72	1.5	1800	0.085912843471311	-0.05324312418840930	1.6135950844525000	0.18379555889475100
0.01	44	2.5	1800	0.06741498829679780	-0.04307631132839660	1.5650130249745100	0.14288292389246800
0.05	84	1.5	2160	0.07707035588681950	-0.049258107322594900	1.5646227611239700	0.1641463584296040
0.01	84	1.5	2160	0.07817809650518500	-0.051485036189941800	1.5184624949425200	0.16659869078524300
0.03	84	1.5	2160	0.07319556336064580	-0.049258107322596800	1.4859597199153400	0.1555890502135030
0.03	72	1.5	1800	0.07490534578560990	-0.050594114594494300	1.4805150042839400	0.15936104819679500
0.05	72	1.5	1800	0.07265133108527970	-0.050594114594494300	1.435964077394600	0.15438972362347200
0.04	84	1.5	2160	0.06886753424324520	-0.0492581073225995	1.3980954199523	0.14606896653047500
0.02	72	1.5	2160	0.0728081542404988	-0.05324312418840920	1.36746585310914	0.15473525003244600

Figure 3.3c) - AUD/USD Top 10 MAR results

sl_stop	lookback	sd_mult	aroon_lb	CAGR	MDD	MAR	Return
0.01	112	1.0	1800	0.05069563971420180	-0.029886708587105300	1.6962603816492000	0.10674506087279700
0.02	112	1.0	1800	0.05208089419029130	-0.03197601354546540	1.6287488156157900	0.10973974466705500
0.02	28	1.5	1800	0.04125049997382750	-0.026587089736601800	1.5515237050198400	0.08643678545937020
0.01	64	1.5	1800	0.0503462447504226	-0.0334521383484887	1.5050232133425700	0.10599038340193600
0.01	116	1.5	1800	0.042589777883778900	-0.02886654644328150	1.4754026072173800	0.08930468113916140
0.03	112	1.0	1800	0.05084648842050640	-0.035166914986438400	1.4458614990855600	0.10707096884940800
0.04	112	1.0	1800	0.05084648842050640	-0.035166914986438400	1.4458614990855600	0.10707096884940800
0.05	112	1.0	1800	0.05084648842050640	-0.035166914986438400	1.4458614990855600	0.10707096884940800
0.03	60	2.0	1800	0.047835880689978800	-0.03385546378654850	1.4129441850678500	0.10057586533194600
0.01	76	2.0	360	0.03616044564003530	-0.026082268332997500	1.3863995714777400	0.07557241094277310

Figure 3.3d) - CAD/USD Top 10 MAR results

sl_stop	lookback	sd_mult	aroon_lb	CAGR	MDD	MAR	Return
0.02	84	2.5	720	0.04136502903238350	-0.04347280155286070	0.9515151440627930	0.08570643910043650
0.02	104	2.5	720	0.039134189643153400	-0.04410887812597790	0.887217977555076	0.08099306736596000

0.01	64	2.0	720	0.04356294172052700	-0.05983299388282190	0.7280755799357370	0.09036041245671460
0.03	120	1.5	720	0.04576891270683150	-0.06628875304634460	0.6904476340780300	0.09504159941501130
0.01	84	2.5	720	0.035508195846284200	-0.05237280762485440	0.677989159959283	0.0733541657610437
0.03	84	2.5	720	0.0352756542613577	-0.05434673871856790	0.6490850250284770	0.07286520642371360
0.01	68	2.0	720	0.0349413685557276	-0.05712716943206590	0.6116418667877280	0.07216251021964930
0.03	108	1.5	720	0.032983818307183600	-0.059210327825986800	0.5570619099444900	0.06805226408361410
0.04	84	2.5	720	0.03003444955131300	-0.05525195951542770	0.5435906674572620	0.061874624655367400
0.04	120	1.5	720	0.03814589059709240	-0.07578615567929630	0.5033358699247670	0.07890828888823800

Figure 3.3e) - JPY/USD Top 10 MAR results

To generate 3D heatmaps with 4 parameters, one parameter will need to be fixed. After analyzing the data, stop loss parameter X1 is the best one to fix and at 1% or 0.01. This is because sl_stop=0.01 occurs the most in the top MAR results in each currency apart from JPY/USD where it is the 3rd most occurring. Fixing this value at 0.01, heatmaps can be generated to visualize the data and better help understand the data. To better help visualization, a different heatmap format is used.

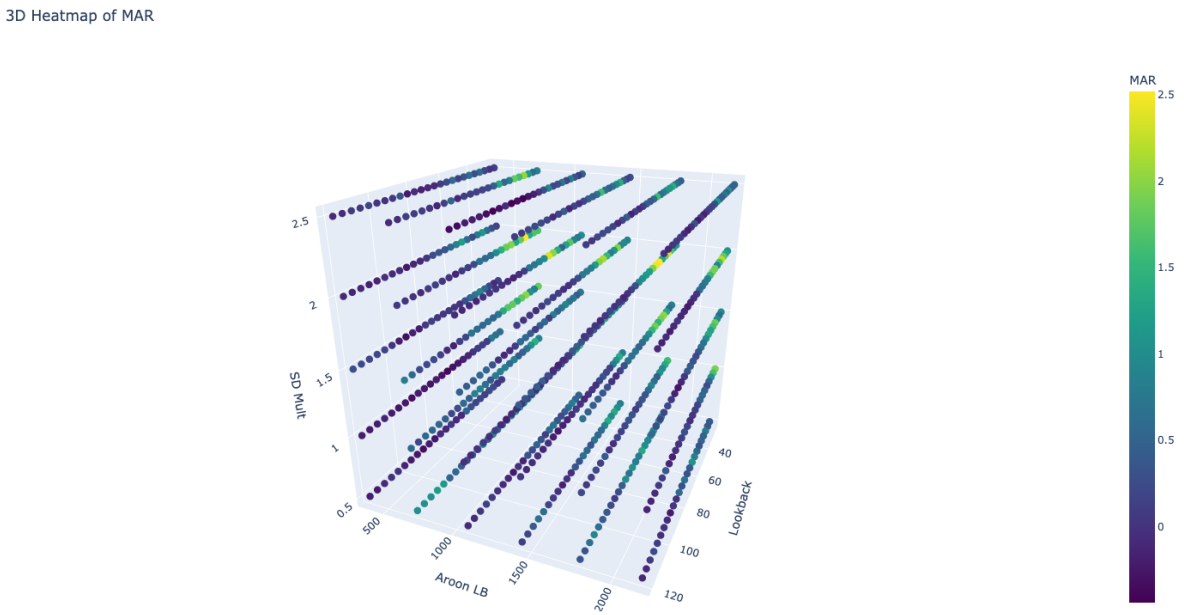

Figure 3.3f) - EUR/USD MAR heatmap

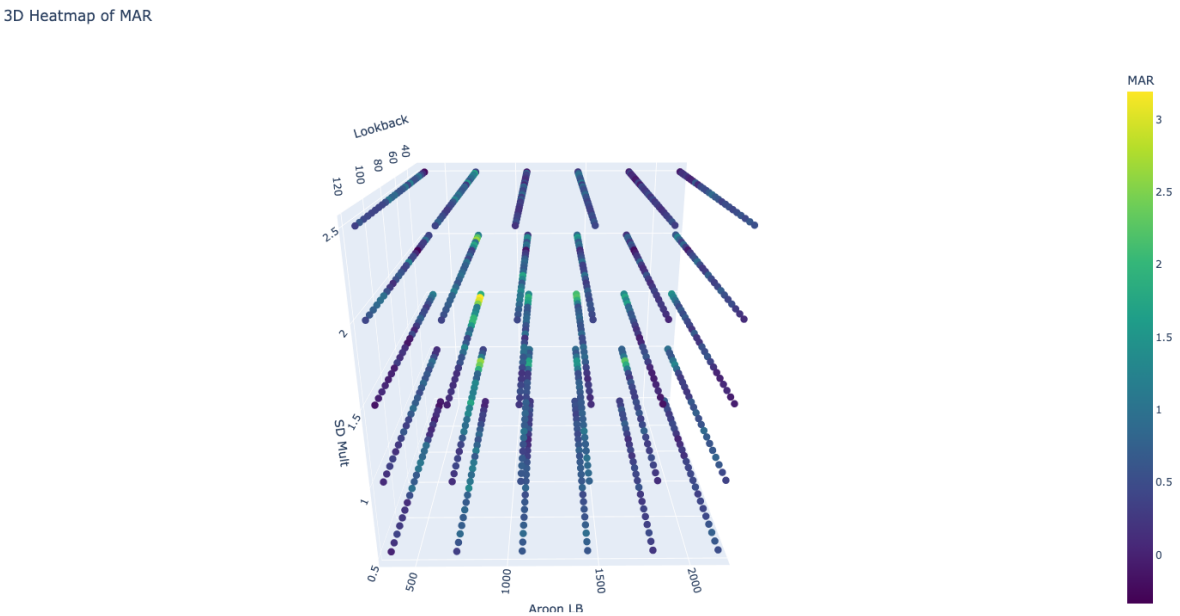

Figure 3.3g) - GBP/USD MAR heatmap

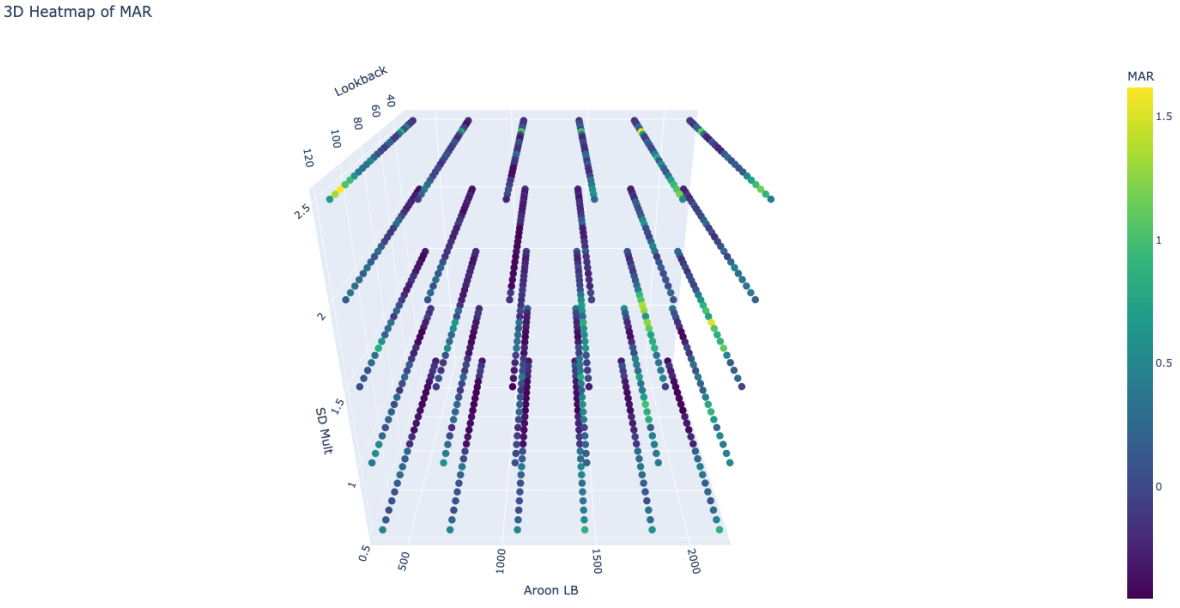

Figure 3.3h) - AUD/USD MAR heatmap

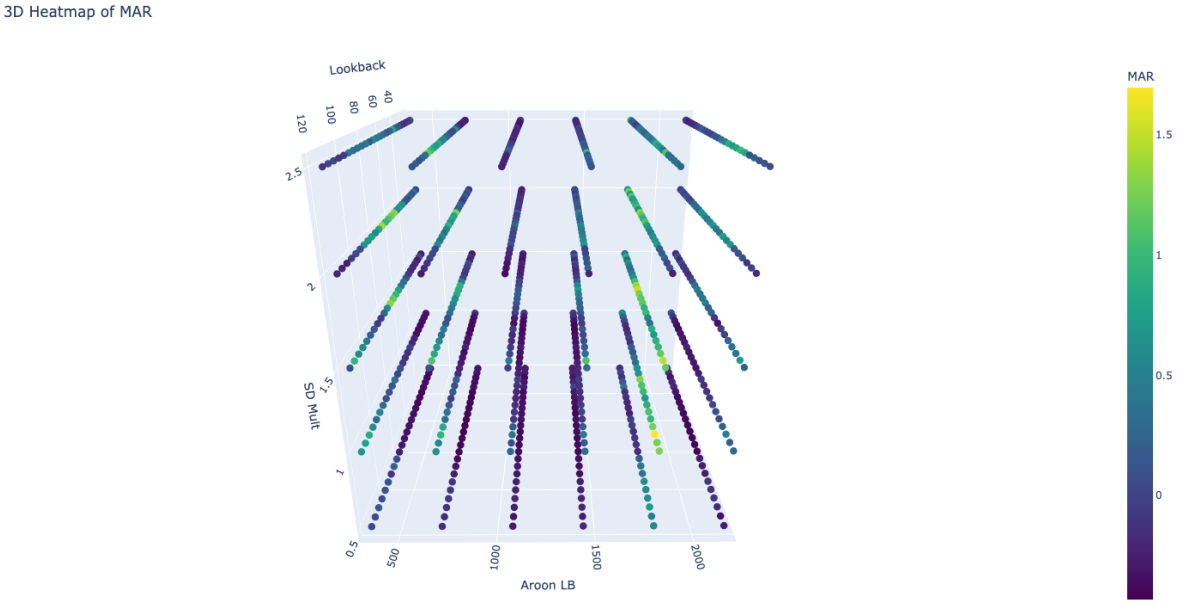

Figure 3.3i) - CAD/USD MAR heatmap

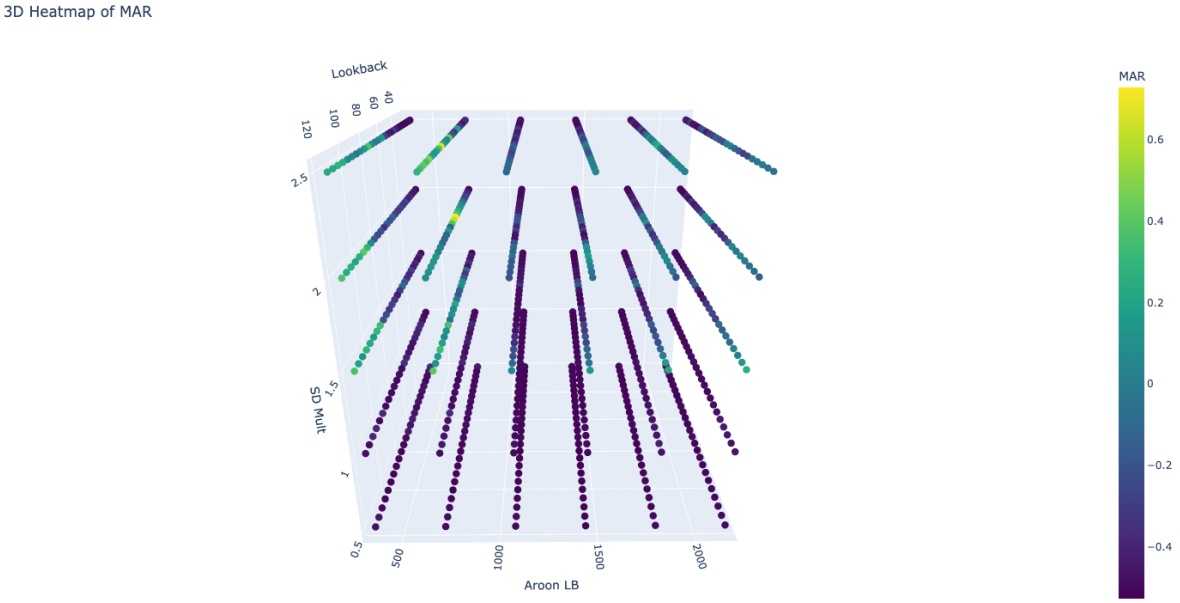

Figure 3.3j) - JPY/USD MAR heatmap

3.3.1 Findings and conclusions for final strategy (shorting disabled)

With the addition of the new parameter X4, the optimal Aroon indicator lookback period is clearly shown for each pair. Despite this, the returns are clearly much lower compared to the initial strategy as this strategy only capitalizes on uptrends instead of both uptrends and downtrends.

Similar to the results in 3.2, JPY/USD performs the worst, while EUR/USD and GBP/USD perform well. However, the performance of AUD/USD and CAD/USD are mediocre. This could indicate that AUD/USD and CAD/USD returns rely more on short positions. On the other hand, EUR/USD and GBP/USD returns may rely more on long positions and are more fitted towards this strategy.

However, the strategy was still able to achieve returns with a good MAR (>1.5) on all pairs except JPY/USD, indicating effective risk management despite a cut in returns and trading opportunities.

This further signifies that the strategy is able to identify and capitalize on buying points, solidifying the scope of the strategy, which was to locate opportunities to take advantage of volatility in the short-term.

3.4 Specific FX pair analysis

Figure 3.4a) - JPY/USD 1 year price movement

The data shows that JPY/USD is the pair where this strategy performs the worst. Looking at the graph of JPY/USD, we can tell why. This strategy trades well on forex pairs that are relatively stable in the sense that the currency's value doesn't differ much when compared to its beginning price.

As it does not show signs of recovering, most of the long orders will hit the stop loss and end up making a loss instead of profit. In addition, since we are only able to enter long positions when the Aroon indicator detects a strong upwards trend, we enter a minimal number of positions so there are less chances to take advantage of the volatility.

Figure 3.4b) GBP/USD 1 year price movement

On the other hand, looking at the better results such as in GBP/USD, we can see how the results of the strategy is affected by the stability of the currency pair. Of course, with shorting included it would be more resistant and less sensitive to stability.

Although there is volatility in the currency price, it still recovers and is relatively stable considering initial and end prices. This shows that stability is a huge factor in this strategy.

3.5 Top performance portfolios

Further breakdown of the profiles for each currency with the best performance (based on MAR ratio) is shown below. (Reminder: Backtests were over a 2-year period)

3.5.1 EUR/USD

Stop loss X1	Lookback X2	SD multiplier X3	Aroon lookback X4
1%	36 hours	2.0	720 hours (1 month)

Win rate	Backtest returns	CAGR	MDD	MAR
72.28%	21.77%	10.12%	-4.019%	2.518

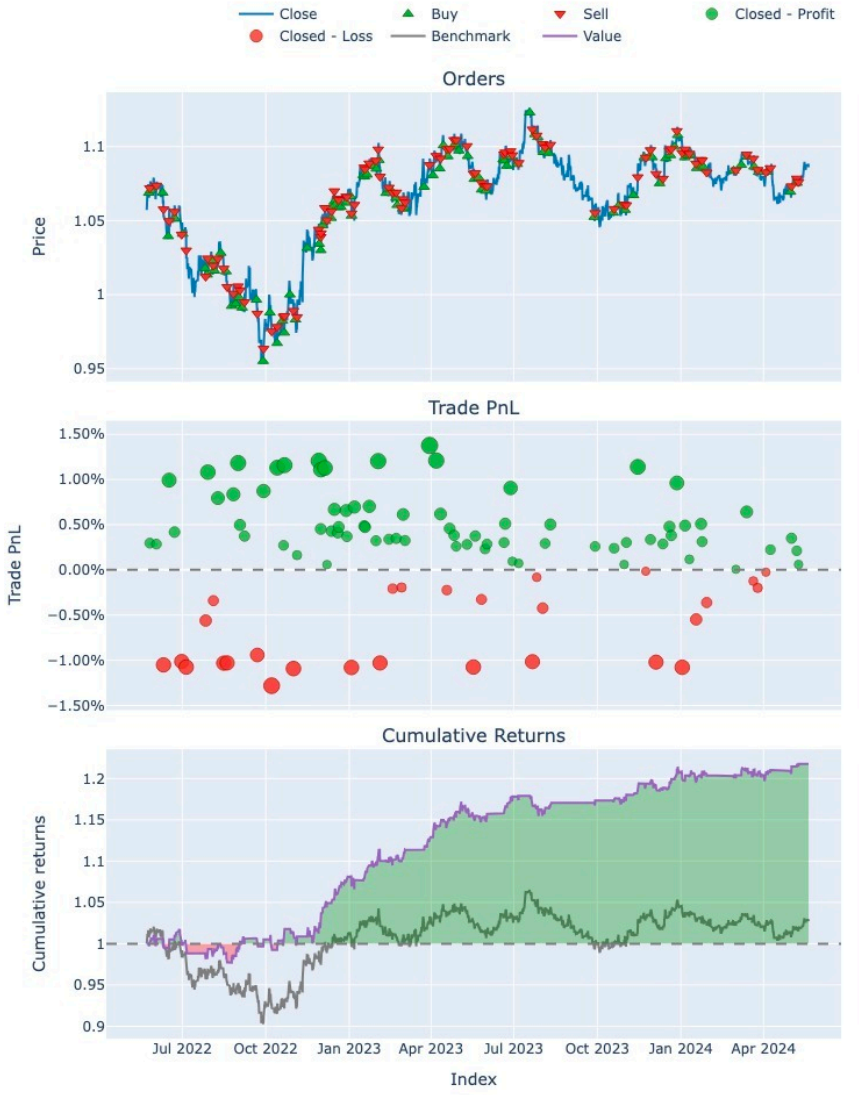

Figure 3.5.1a) - EUR/USD top MAR portfolio

3.5.2 GBP/USD

Stop loss X1	Lookback X2	SD multiplier X3	Aroon lookback X4
1%	28 hours	1.5	720 hours (1 month)

Win rate	Backtest returns	CAGR	MDD	MAR
67.94%	21.93%	10.19%	-3.196%	3.189

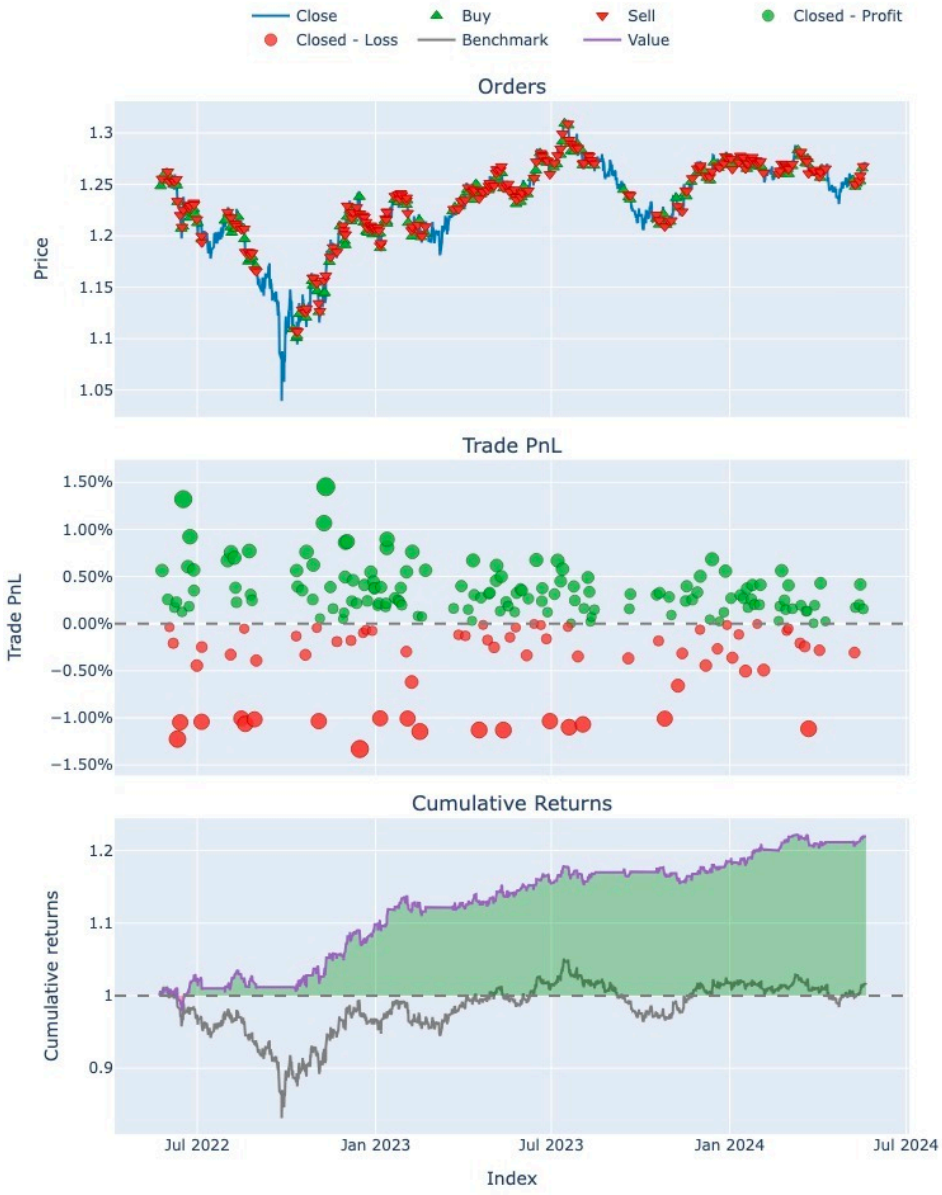

Figure 3.5.2a) - GBP/USD top MAR portfolio

3.5.3 AUD/USD

Stop loss X1	Lookback X2	SD multiplier X3	Aroon lookback X4
1%	112 hours	2.5	360 hours (0.5 months)

Win rate	Backtest returns	CAGR	MDD	MAR
46.88%	13.263%	6.26%	-3.877%	1.616

Figure 3.5.3a) - AUD/USD top MAR portfolio

3.5.4 CAD/USD

Stop loss X1	Lookback X2	SD multiplier X3	Aroon lookback X4
1%	112 hours	1.0	1800 hours (2.5 months)

Win rate	Backtest returns	CAGR	MDD	MAR
67.01%	10.566%	5.02%	-3.877%	1.679

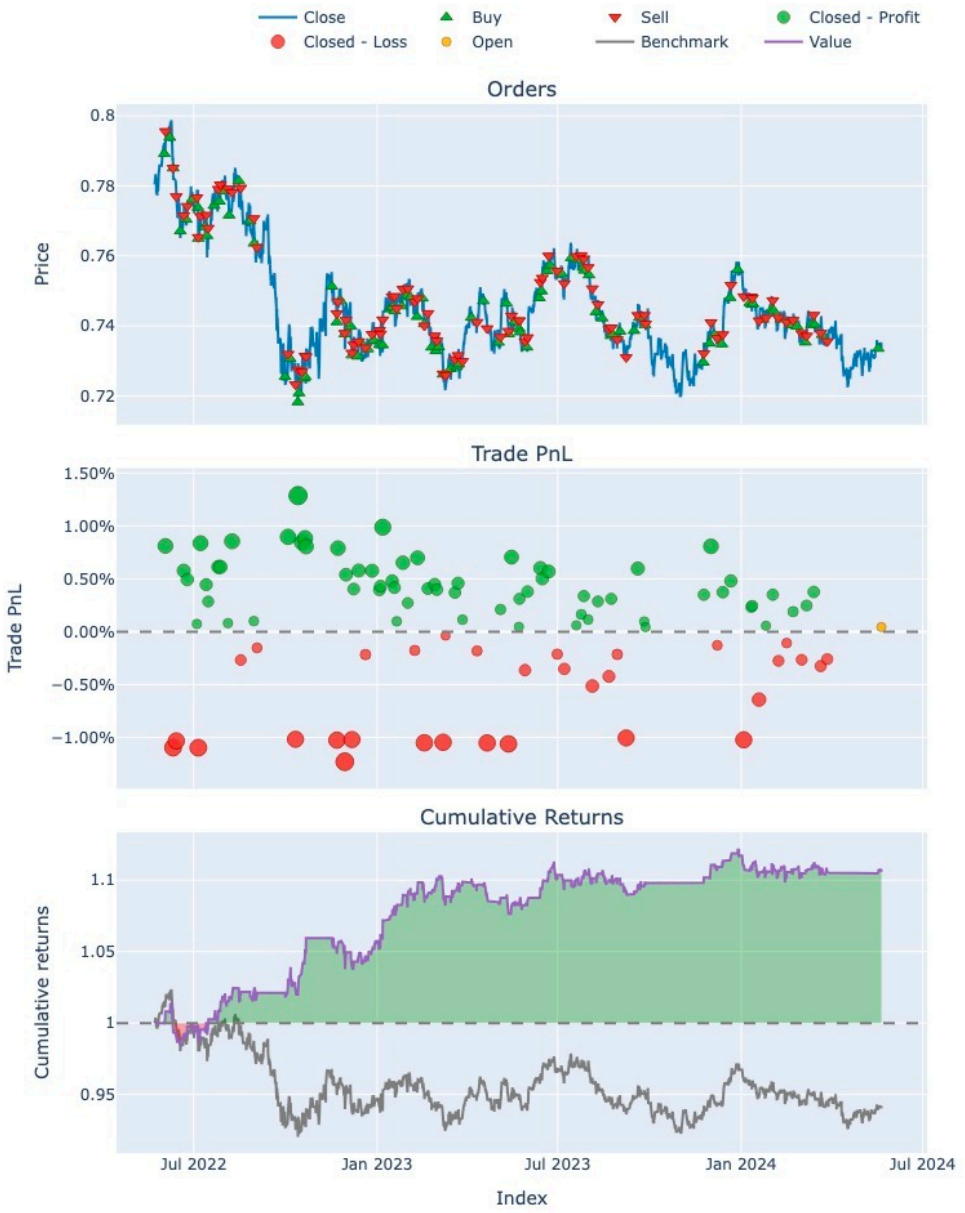

Figure 3.5.4a) - CAD/USD top MAR portfolio

3.5.5 JPY/USD

Stop loss X1	Lookback X2	SD multiplier X3	Aroon lookback X4
2%	84 hours	2.5	720 hours (1 month)

Win rate	Backtest returns	CAGR	MDD	MAR
55.0%	8.571%	4.13%	-4.34%	0.95

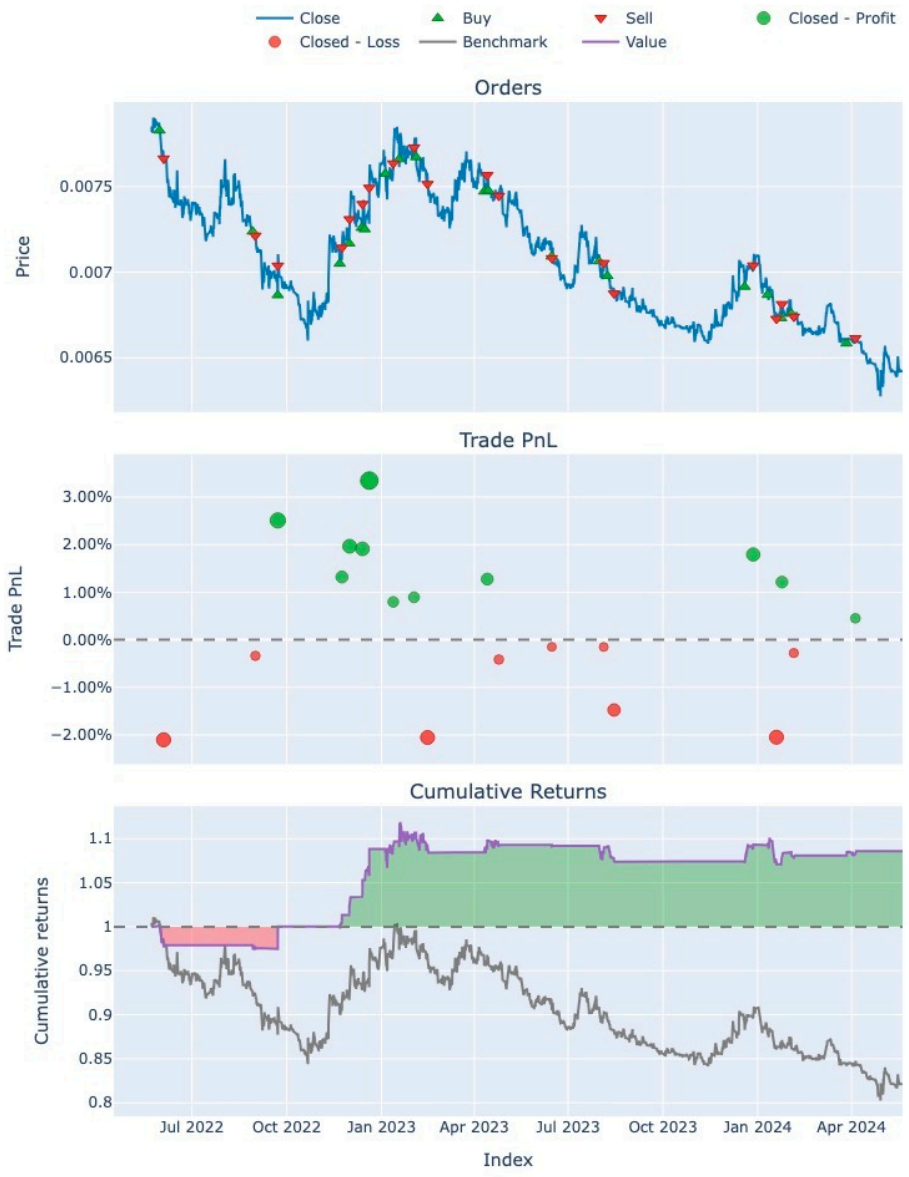

Figure 3.5.5a) - JPY/USD top MAR portfolio

4. Performance Evaluation:

To evaluate performance, our trading strategy will be compared to SPY. For our top result on each currency pair, the CAGR, MAR and MDD are as follows:

FX Pair	CAGR	MDD	MAR
EUR/USD	0.1012	-0.04019	2.518
GBP/USD	0.1019	-0.03196	3.189
AUD/USD	0.0626	-0.03877	1.616
CAD/USD	0.0502	-0.02989	1.679
JPY/USD	0.0413	-0.04347	0.95
SPY	0.1020 [12]	-0.3070[13]	0.332

According to the MAR, this trading strategy involves a lot less risk than the SPY, with significantly lower maximum drawdowns . However, the average CAGR of this strategy is not as good as SPY especially considering AUD/USD, CAD/USD and JPY/USD. Although GBP/USD is almost as good as SPY, it still does not beat it. However, this trading strategy is considerably less risky and thus it is a very safe strategy that reduces risk and maximizes profits.

Overall, this strategy has an average CAGR of 7.144% across all currencies tested and is not able to beat the SPY's CAGR of 10.20%. However, it has an average MDD of 3.69% which is 8.3 times less than SPY's MDD of 30.7%. As a result, the strategy's MAR beats SPY's MAR by a large margin since the disparity between MDD is much larger than that of the disparity between CAGR.

5. Improvements:

Although our findings regarding the trading strategy are solid and well-justified, there are still some improvements that can be made.

5.1 Quicker trend identification

We have observed that the Aroon indicator tends to identify an uptrend only when it is already halfway through the upward movement. As a result, there is room for improvement in terms of the indicator's speed and efficiency in identifying trends.

One potential enhancement we can consider is pairing the Aroon Indicator with the Average Directional Index (ADX), which could provide a faster and more effective assessment of trend strength. The ADX is a technical indicator commonly used in financial analysis to evaluate the strength of a trend. A higher ADX value suggests a stronger trend, while a lower value indicates a weaker or non-existent trend.

By incorporating the ADX into our analysis, we can potentially enhance our ability to assess trend strength more promptly and accurately.

5.2 Wider range of parameter values

With limited time and resources, we had to limit the values of parameters for sensitivity testing. This constraint has the potential to decrease the overall data quality and may have resulted in overlooking significant findings. In order to avoid this, we could shorten the intervals between parameter values, e.g. the lookback period X2 could range from 1 to 300 with intervals of 1 hour, as compared to the original range from 24 to 120 with intervals of 4 hours. These changes could make results and findings more robust and persuasive.

5.3 Shorting in the FX Market

Since our strategy only incorporates long positions, we are losing out on potential shorting opportunities. As shown in the cumulative returns graph for JPY, our strategy remains stagnant for the period where the price falls consistently. With more research into shorting in the FX market and incorporating short positions into our trading strategy, we will be able to capitalize on both uptrends and downtrends in the market.

6. Conclusion:

The study reveals that the long-only trading strategy utilizing linear regression channels and the Aroon indicator can effectively capitalize on buying opportunities for most currency pairs, but comes short when facing downtrends. However, the strategy does not capture the full swing of the uptrend, as the Aroon indicator identifies the uptrend only halfway through.

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