

Backtesting Report

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1. Report Details

1.1 Data

All of the data used in this report was collected from Yahoo Finance [1] via the YFinance python package [3]. All of the reproductions are done using daily bars of either SPY or NASDAQ since their inception. The forex data consists of hourly bars and was collected for 10 currency pairs with USD: AUD, CHF, CAD, EUR, GBP, HKD, JPY, MXN, NZD, and SEK. Each of the currency pairs data dates back to October 10th, 2022 because that was as far back as the Yahoo Finance API would provide hourly bars.

1.2 Backtesting

The backtesting was done using the Backtrader package [10]. This is an open source package with a lot of in depth documentation and usage available online. Much of the code written in combination with this report sits on top of Backtrader, providing a higher level interface for using it.

1.3 Generative AI

Some of the code that accompanies this report was assisted by GPT-4o [9] and Perplexity [2]. It is indicated in the code itself where that occurred.

2. Strategy Overview and History

This report explores the effectiveness of four different trading strategies on the data discussed in section 1.1. Each strategy is publicly available and I include a reference to source of the particular rules as well the history of the indicator or strategy.

2.1 Williams %R

Equation 1 shows the equation for calculating Williams %R. The rules for trading are as follows [6]:

1. We enter a long position when the indicator crosses below -90
2. Exit the long position when the indicator crosses above -30 or when the close is higher than yesterday's high

$$\%R = -100((\text{last } n \text{ days high} - \text{close}) / (\text{last } n \text{ days high} - \text{last } n \text{ days low})) \quad (1)$$

There are a few tunable parameters for this strategy. There are the two levels that the indicator crossing will cause a position change. For this strategy we used the two levels shown above. The third parameter is the lookback period for determining the previous high and low.

2.1.1 History

The William's %R indicator was originally developed by trader named Larry Williams in 1973[4, 16]. The goal of the indicator is to measure and quantify overbought and oversold securities. Readings between 0 and -20 are typically referred to as overbought and reading between -80 and -100 are typically referred to as oversold. The originally formula printed in William's book actually multiplied the formula by a positive 100, however, it has since been multiplied by -100 and proliferated as such.

In his publication, William utilized a lookback period of 10 trading days and did not directly trade on the oversold and overbought thresholds. He instead utilized the following rules:

1. Buy On:
 - (a) %R reaches -100%
 - (b) Five trading days pass since -100% was last reached
 - (c) %R rises above -95% or -85%.
2. Sell On:
 - (a) %R reaches 0%
 - (b) Five trading days pass since 0% was last reached
 - (c) %R drops below -5% or -15%

2.2 Commodity Channel Index

Equation 2 shows the equation for calculating the CCI. The rules for trading are as follows [5]:

1. We enter a long position when the indicator crosses below -90
2. Exit the long position when the close is higher than the previous days high.

$$CCI = \frac{\text{Typical Price} - \text{SMA of Typical Price}}{0.015 \times \text{Mean Deviation}} \quad (2)$$

Where:

1. Typical Price (TP):

$$\text{Typical Price} = \frac{\text{High} + \text{Low} + \text{Close}}{3}$$

2. SMA of Typical Price: The simple moving average of the Typical Price over a specified period.

3. Mean Deviation:

$$\text{Mean Deviation} = \frac{1}{n} \sum_{i=1}^n |TP_i - \text{SMA of Typical Price}|$$

4. Constant (0.015): Used to scale CCI values.

There are two tunable parameters for this strategy. There is the lowerbound level, which triggers a long position when the CCI falls below it, and the period which is used in the CCI equation.

2.2.1 History

The CCI was introduced by Donald Lambert in 1980 [15]. Lambert, a commodities trader and mathematician, published his work in the October 1980 issue of Commodities magazine (now known as Futures magazine)[8]. His goal was to create a reliable method for identifying cyclical trends in commodity prices, based on the idea that markets move in cyclical patterns.

Initially designed for commodity markets, the CCI gained popularity among traders across various financial instruments. Its versatility became apparent, and it was adopted for use in stocks, forex, and futures markets. The indicator's ability to adapt to different markets and timeframes contributed to its widespread acceptance.

In the original implementations of the CCI strategy, there was a third tunable parameter that my strategy does not include: an upperbound level. When the indicator crosses above the upperbound level it triggers a closing of the long position. In general the rules were the following:

1. Buy On:
 - (a) CCI falls below -100
2. Sell On:
 - (a) CCI climbs above 100

2.3 Stochastic Indicator

Equation 3 shows the equation for the fast stochastic indicator. There is also a slow stochastic indicator which is generally the same with a period of 3. This strategy utilizes the following rules [11]:

1. Enter a long position when the stochastic indicator falls below 25
2. Exit long position when close is higher than previous days high

$$\%K = 100 \times \frac{C - L}{H - L} \quad (3)$$

Where:

1. C = The most recent closing price
2. L = The lowest price traded of the n previous trading sessions
3. H = The highest price traded during the same n period

This strategy has two tunable parameters. The look back period for the stochastic indicator and the lowerbound level which triggers a long position when the stochastic indicator falls below it.

2.3.1 History

The stochastic oscillator, a popular momentum indicator in technical analysis, was developed by George Lane in the late 1950s [7]. Lane, a financial analyst and innovator, created this tool based on his observation that during uptrends, prices tend to close near their highs, while in downtrends, they often close near their lows [13].

The indicator quickly gained popularity among traders and analysts for its ability to generate overbought and oversold signals within a bounded range of 0 to 100. Over time, the stochastic oscillator has been refined and adapted, but its core principles remain largely unchanged from Lane's original concept.

2.4 Turnaround Tuesday

This strategy is very simple and does not come with any complex indicators. The rules are as follows [12]:

1. Enter a long position when it's Monday and the close is lower than the previous trading day's close
2. Exit the long position after 5 trading days or when the close is higher than the previous days high

There is not naturally any easily tunable parameters to this strategy. However, I will optimize over the number of trading days to wait before exiting in section 4.

2.4.1 History

The Turnaround Tuesday trading strategy has been a well-known phenomenon in the stock market for decades. This strategy is based on the observation that markets often reverse direction on Tuesdays, particularly after a significant decline on Monday [14].

The concept gained prominence following the "mother of all Turnaround Tuesdays" on October 20, 1987 [12]. After the dramatic Black Monday crash on October 19, 1987, the market rebounded 5.3% on Tuesday and 9.1% on Wednesday. This event solidified the idea of Turnaround Tuesday in traders' minds.

Over the years, various iterations of the strategy have been developed and tested. The basic premise involves buying an index ETF, such as the SPY (S&P 500 ETF), at the close of trading on Monday or the open on Tuesday, particularly when Monday shows a downturn. Traders then typically exit their positions at the close of trading on Tuesday.

3. Strategy Reproduction

This section describes the process taken to reproduce the results of each strategy discussed in section 2. Unfortunately, not enough information about each strategies backtesting parameters. The rules for the strategy and the security used are the only parameters consistently given. Other necessary information to reproduce such as commission, position sizing, end date, or buy on close or open. Through experimentation, I found that the closest reproduction came from the following setup:

- 0 commission
- Article publish date as the end of data
- Use adjusted close value
- Invest everything into every position
- Buy on the close price¹

¹Except for stochastic indicator, described in more detail in 3.3

3.1 Williams %R

3.1.1 Original Strategy Performance

Figure 1 shows the equity curve of the original strategy performance on SPY. They tested over the entire lifetime of the SPY. This strategy used the same rules I described above and they tested lookback periods of 2 to 25. This curve shows their best performance which was using a lookback period of 2. Their worst performance was using a lookback period of 25 which leads me to believe that the strategy gets progressively worse with longer lookback periods.

The statistics for their backtest are as follows:

- Market exposure: 22%
- Number of trades: 598
- Average gain per trade: 0.6%
- Max drawdown: 17%
- Profit factor: 2.2
- Risk adjusted return: 52%

They also noted that it performed exceptionally well during the GFC in 2008/09 and during Covid. In 2008 and 2020 it had a 98.9% and 43.2% returns respectively as well as a 15.7% return during the bear market of 2022.

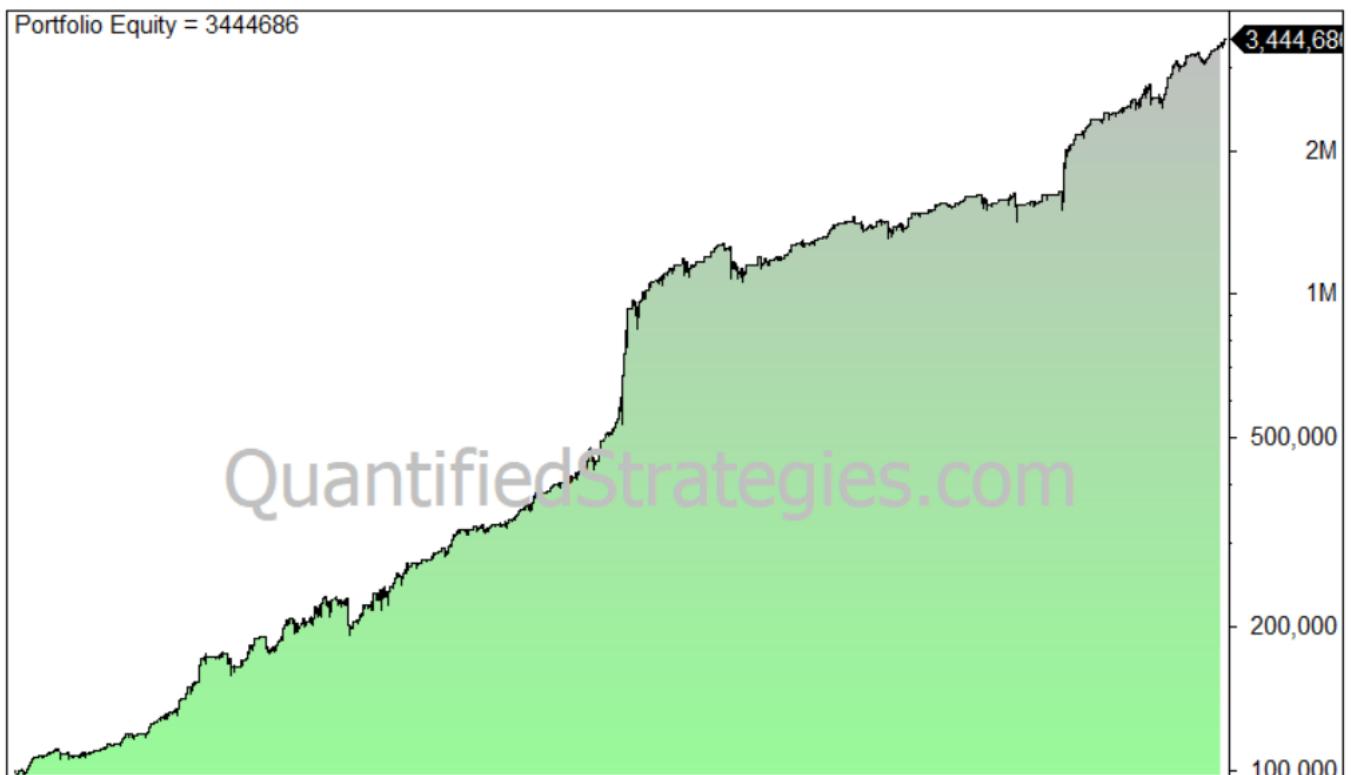


Figure 1: Equity curve of original Williams %R strategy performance on the SPY. The Y-axis uses a logarithmic scale.

3.1.2 Reproduced Results

Figure 2 shows the equity curve for my reproduction of the Williams %R strategy as well as the buy-and-hold of SPY. In general we see a very similar structure to the curve. Additionally, the statistics are also very similar with my reproduction showing a slightly higher profit factor and risk adjusted return. As described by the source [6], this is a fairly strong strategy when doing cheat on close which would not be possible in a real application of this strategy. An average gain of 0.59% per trade does give some buffer room for commission fees and slippage making this still a worthwhile strategy to explore deeper.

The statistics for my backtest are as follows:

- Market exposure: 21.58%
- Number of trades: 583
- Average gain per trade: 0.59%
- Max drawdown: 16.24%
- Profit factor: 2.44
- Risk adjusted return: 53.31%

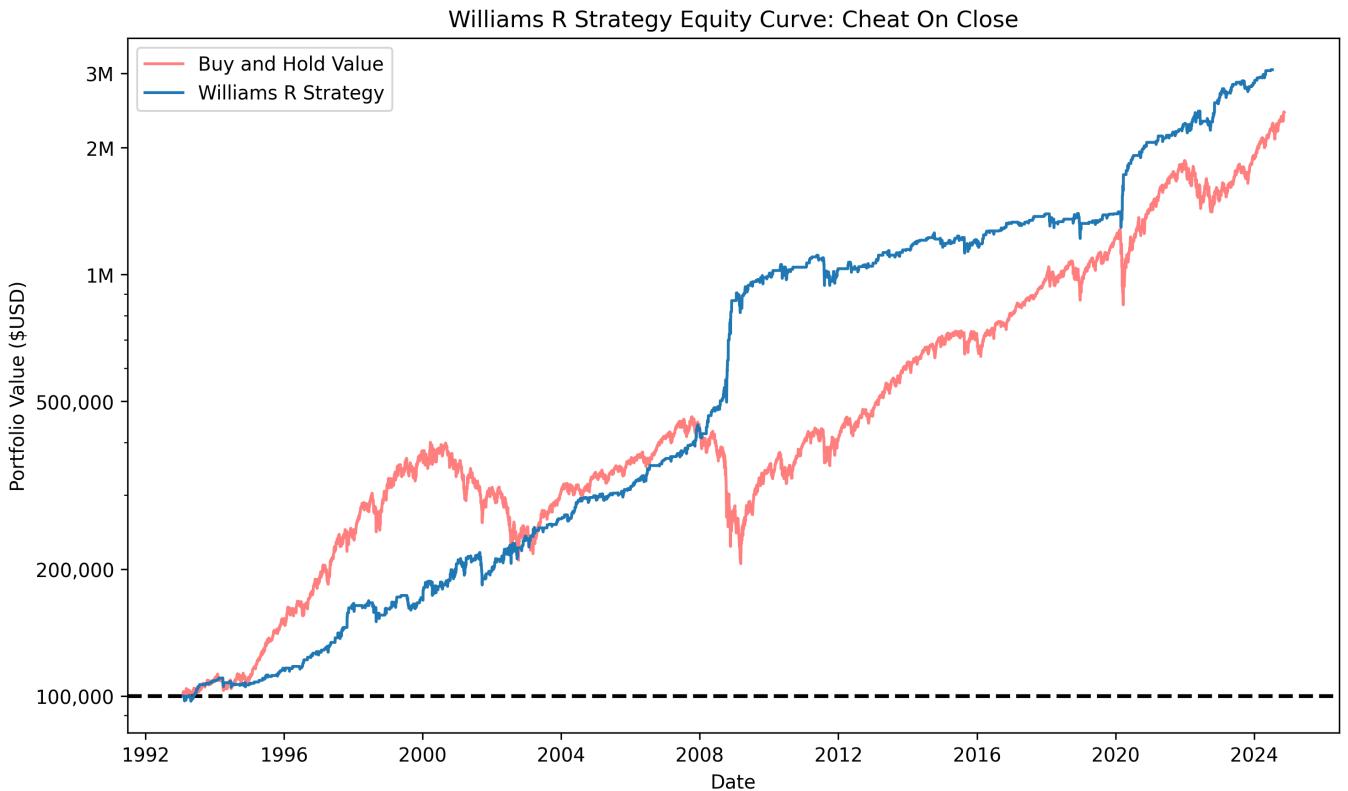


Figure 2: Equity curve of original Williams %R strategy performance on the SPY. The Y-axis uses a logarithmic scale.

3.2 Commodity Channel Index

3.2.1 Original Strategy Performance

Figure 3 shows the equity curve of the original strategies performance on SPY. They tested a variety of periods, buy thresholds, and sell thresholds. They found that the best lookback period was 9, buy threshold of -30 and sell threshold of 30 . The results of that test did not satisfy their minimum profit factor of 1.75 so they reevaluated the sell rule. They decided on the sell rule that was previously described in section 2.2. It is unclear how much they tuned the buy threshold after that.

The statistics for their backtest are as follow:

- Market exposure: 22.05%
- Number of trades: 464
- Average gain per trade: 0.55%
- Max drawdown: 23.69%
- Profit factor: 1.86
- Risk-adjusted return: 37.64%

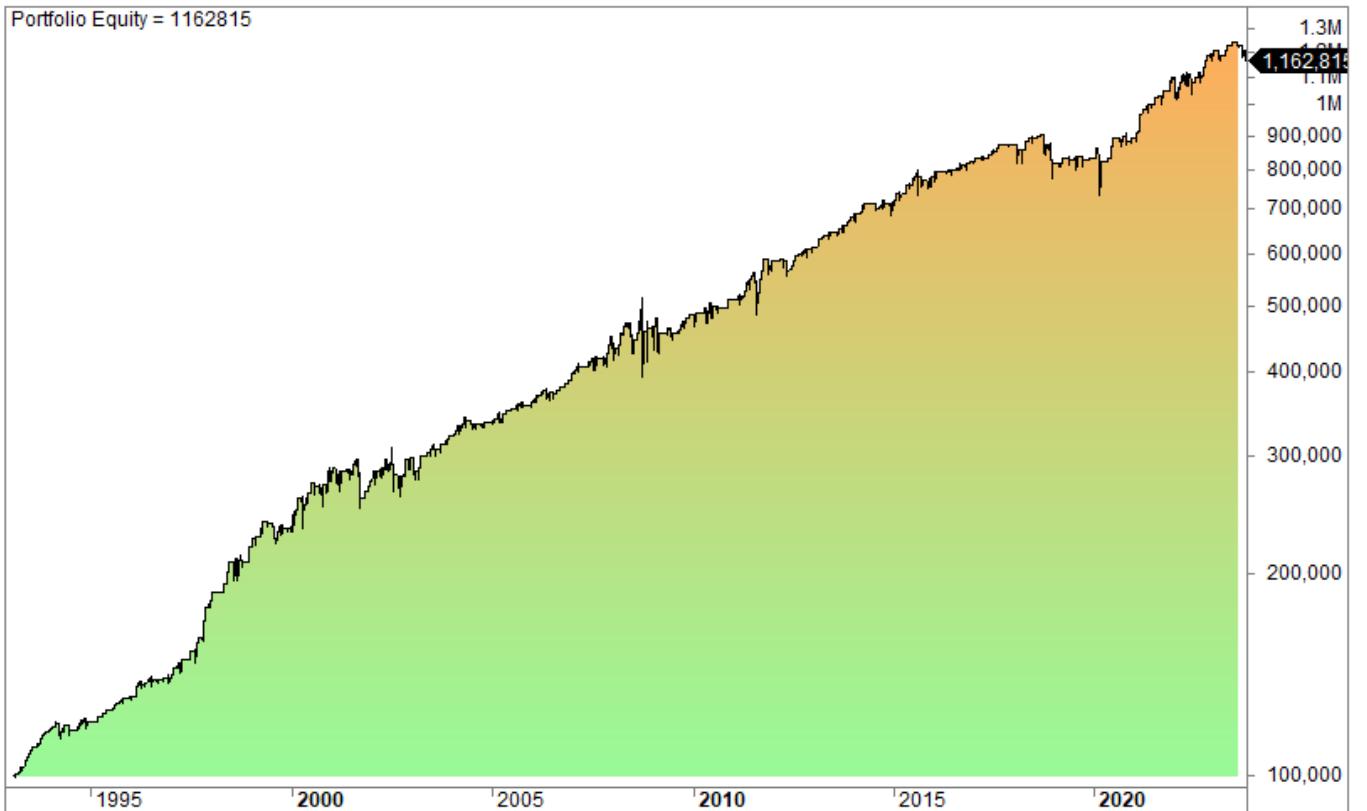


Figure 3: Equity curve of original CCI strategy performance on the SPY. The Y-axis uses a logarithmic scale.

3.2.2 Reproduced Results

Figure 4 shows the results of my backtest using CCI as well as the buy-and-hold of SPY. Obviously we can see that the strategy under performs the buy-and-hold. However, this is not necessarily an immediate rejection of the strategy. This strategy is only invested 16.08% of the time which frees up money for other strategies more than 80% of the time. Therefore this strategy combined with other can still beat a buy-and-hold.

My backtest does also under perform the original backtest in terms of total returns. Looking at the other statistics, my backtest may actually be better. Much lower market exposure, higher profit factor, and essentially the same drawdown. Again, there is another major caveat in that this backtest used buying on the close price which would not be possible in practice.

The statistics for my backtest are as follows:

- Market exposure: 16.09%
- Number of trades: 349
- Average gain per trade: 0.58%
- Max drawdown: 23.75%
- Profit factor: 2.13
- Risk-adjusted return: 41.41%

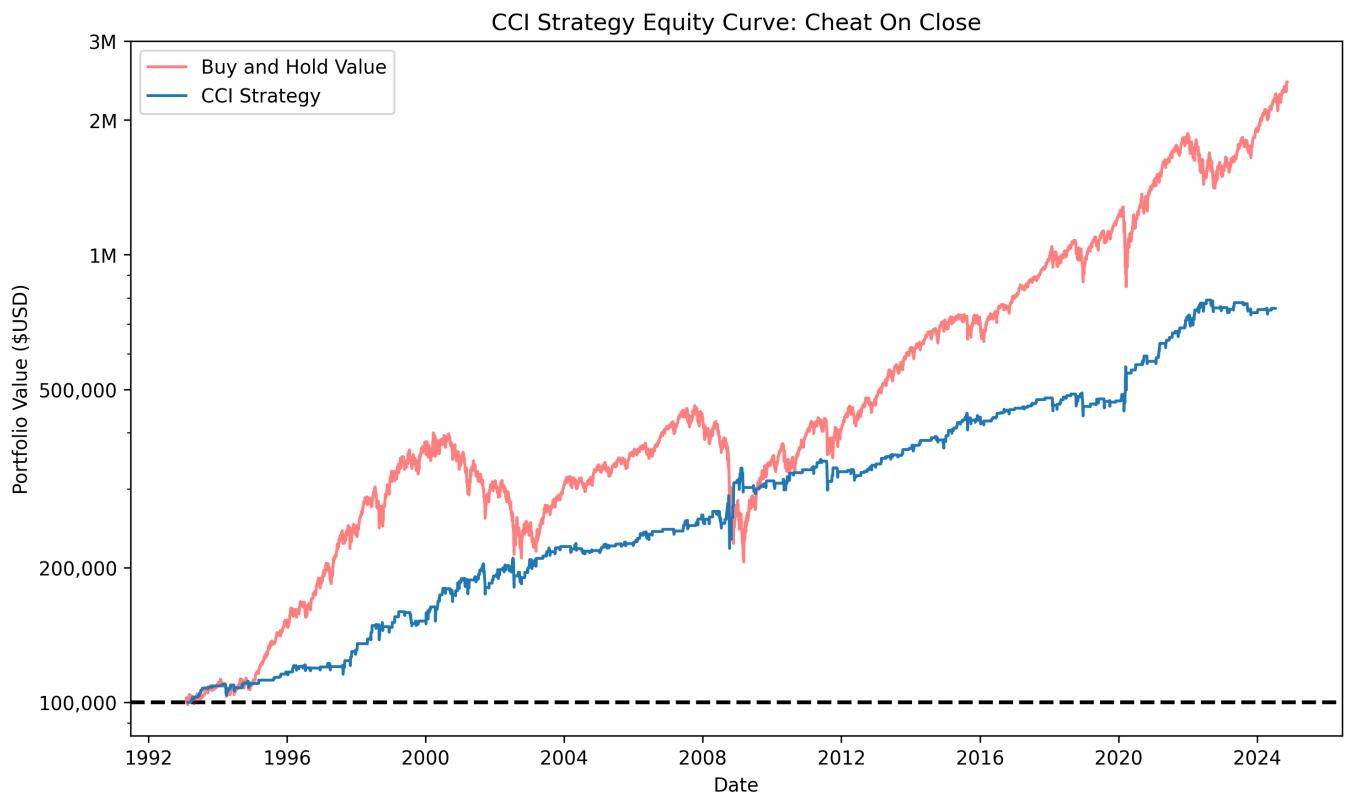


Figure 4: Equity curve of original CCI strategy performance on the SPY. The Y-axis uses a logarithmic scale.

3.3 Stochastic Indicator

3.3.1 Original Strategy Performance

Figure 5 shows the equity curve of the original strategies performance on NASDAQ100. There was not much discussion provided by the source about their optimization process or how they settled on these parameters. However, this was the one strategy in this report that does not seem to have bought on the closing price making it the most accurate backtest.

The statistics for their backtest are as follow:

- Market exposure: 26.44%
- Number of trades: 458
- Average gain per trade: 0.76%
- Max drawdown: 31.83%
- Profit factor: 2.24
- Risk-adjusted return: 53.09%

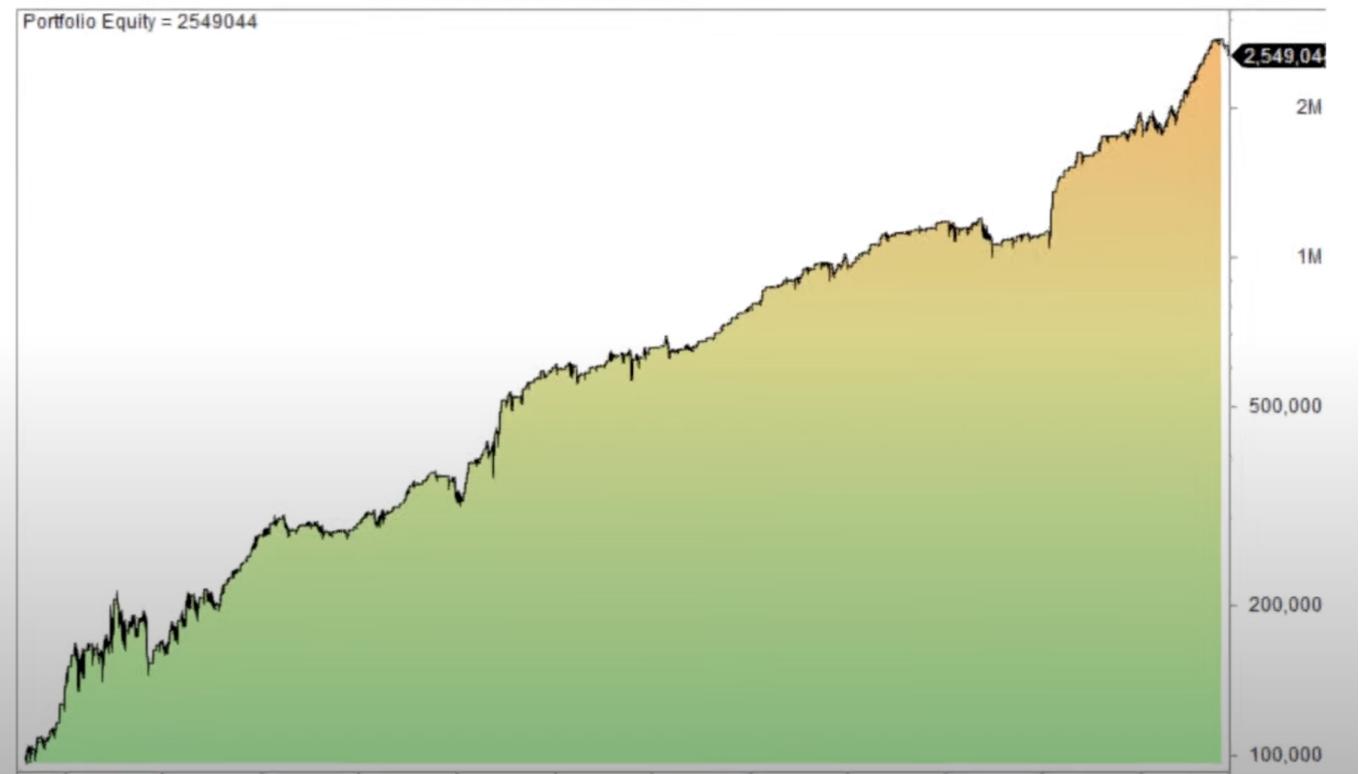


Figure 5: Equity curve of original Stochastic Indicator strategy performance on the NASDAQ100. The Y-axis uses a logarithmic scale.

3.3.2 Reproduced Results

The reproduction of this strategy is unique because unlike the other strategies, a more realistic backtest matched the original results closer. Instead of doing a buy on close, for this backtest we report the results of buying on open only when open is less than or equal to the close price. This is a symptom of going all in on every trade. The order is placed at the close price but it is rejected if the open price is higher because the order can't get filled. It is unclear whether this is how the original strategy did it but this was the closest to their results of my methods.

Figure 6 shows the results of my backtest and the buy-and-hold of NASDAQ100. This strategy also underperforms the buy-and-hold but for the same reasons as above, this is not necessarily a bad thing. The market exposure is only 20.57% which is much lower than the original strategy's performance of 26.44% despite having 71 more trades. The biggest red flag with this strategy is the 44.57% max drawdown, which we can see in the graph lasted for about 8 years before getting back above 100k in the middle of 1995.

The statistics for my backtest are as follows:

- Market exposure: 20.57%
- Number of trades: 529
- Average gain per trade: 0.57%
- Max drawdown: 44.57%
- Profit factor: 2.24
- Risk-adjusted return: 39.26%

3.4 Turnaround Tuesday

3.4.1 Original Strategy Performance

Figure 7 shows the equity curve of the original strategy's performance on NASDAQ100. There was a variety of different implementations of this strategy described by the original source [12]. Some included the Internal Bar Strength indicator, but their best performing strategy did not and that is what we use here. This strategy has pretty moderate results but a very high number of shortly held trades.

The statistics for their backtest are as follows:

- Market exposure: 24.17%
- Number of trades: 639
- Average gain per trade: 0.51%
- Max drawdown: 23.69%
- Profit factor: 2.02
- Risk-adjusted return: 44.18%

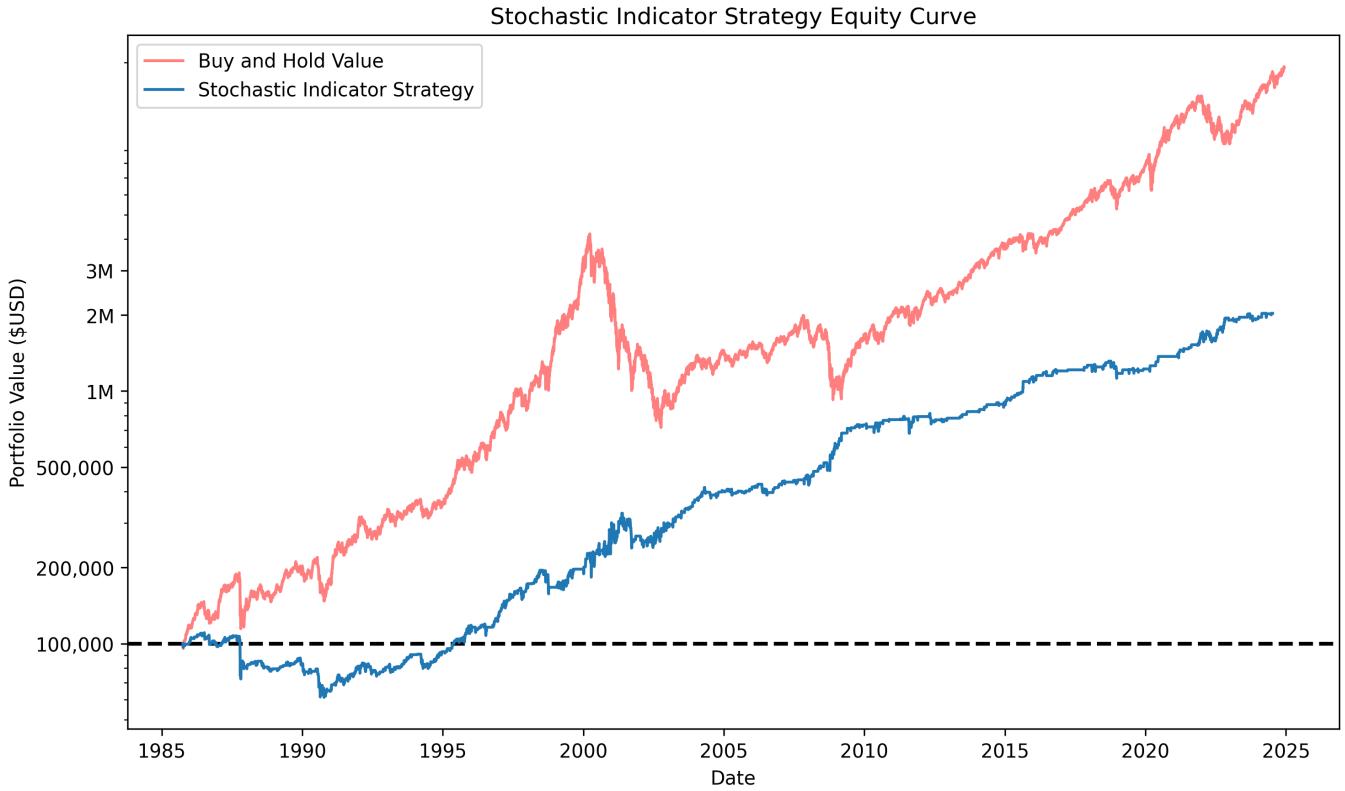


Figure 6: Equity curve of original Stochastic Indicator strategy performance on the NASDAQ100. The Y-axis uses a logarithmic scale.

3.4.2 Reproduced Results

Figure 8 shows the results of my backtest and the buy-and-hold of SPY. There is nothing notable to mention here that I have not already discussed about previous strategies. The results of this backtest are very similar to the original backtest with the only large difference being the max drawdown which is just under 10% lower in my backtest.

The statistics for my backtest are as follows:

- Market exposure: 20.64%
- Number of trades: 570
- Average gain per trade: 0.48%
- Max drawdown: 14.24%
- Profit factor: 2.07
- Risk-adjusted return: 44.30%

4. Strategy on Forex Data

In this section I explore the performance of each of these strategies on the Forex data mentioned in section 1.1. In each section I designated certain ranges for each of the parameters and ran

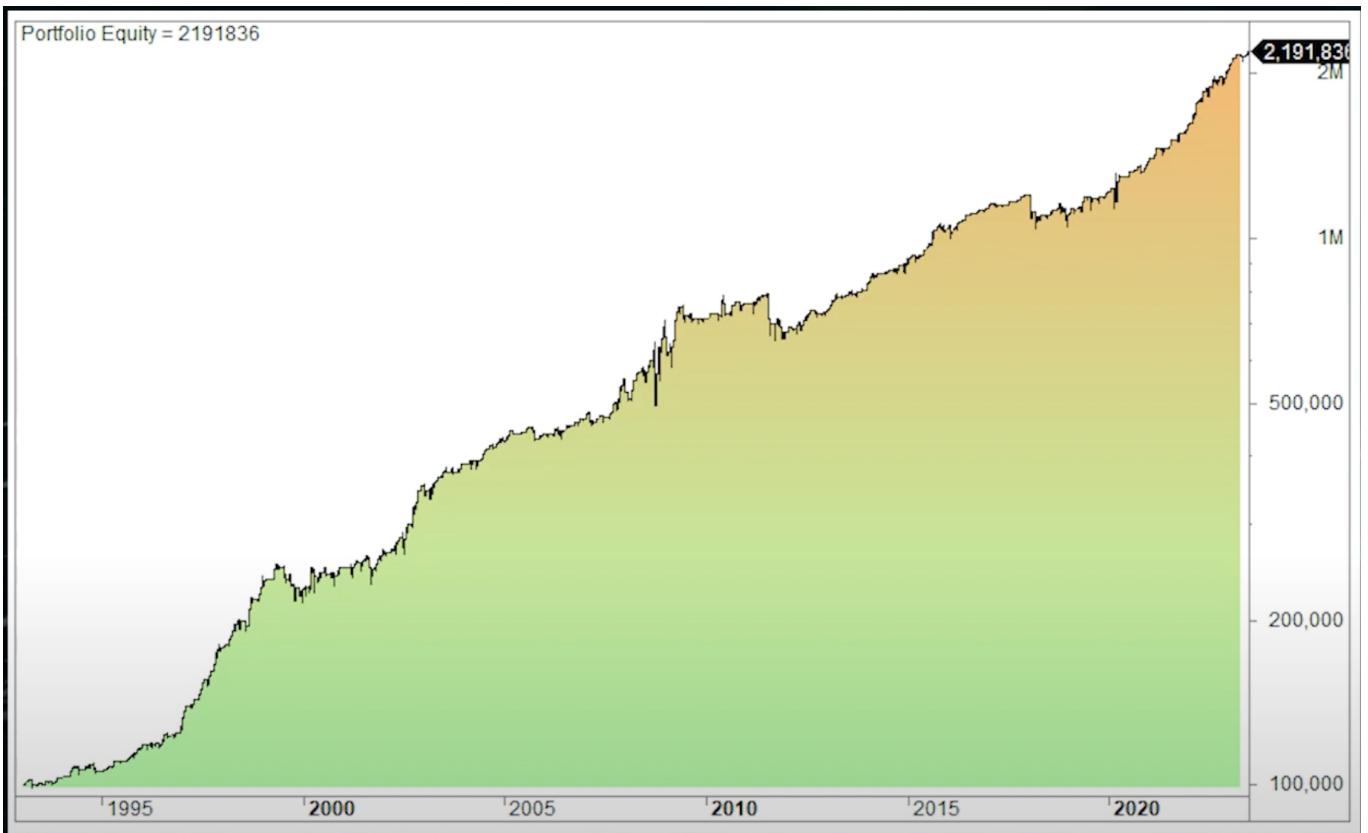


Figure 7: Equity curve of original Turnaround Tuesday strategy performance on the SPY. The Y-axis uses a logarithmic scale.

backtests for each combination. The parameters were optimized on data from 10/09/2022 23:00:00 to 05/14/2024 10:00:00 using both CAGR and Sharpe ratio. These are two of the many possible choices of statistics to optimize a strategy for.

The optimal parameters were chosen as the set of parameters with the highest average target statistic in a neighborhood of 5 points. A neighborhood of 5 is a collection of points within 5 steps of any of the parameters. The step size of each parameter varies depending on the parameter. An example² of a neighborhood can be seen in Figure 9. The lighter color represent a more desirable CAGR and as a result we would want to select a parameter towards the center of the yellow zone on the bottom right

The number of points to average is a slightly arbitrary choice and realistically something that should also be optimized using a validation set. Given that the data was a bit restricted, only going back to the end of 2022, I did not perform that optimization.

Each of the optimal parameters for each currency pair was then tested on unseen data from 05/14/2024 11:00:00 to 11/08/2024 22:00:00. This was to simulate how this strategy might perform if actually put into practice following the optimization.

All of the strategies were run using buy on the open price. This has the drawback of ignoring any potential slippage, but is much more realistic than buy on close. Regardless of the open price relative to the close price, if the strategy decided to buy based on the close price, it will buy no matter what the open price is. All strategies invested 100% into every position. Lastly, there was no commission charge and each strategy started with 100,000.

The subsections will show the results and describe the necessary information needed to recreate

²All of the optimiztion universes will be shown in Appendix A.1

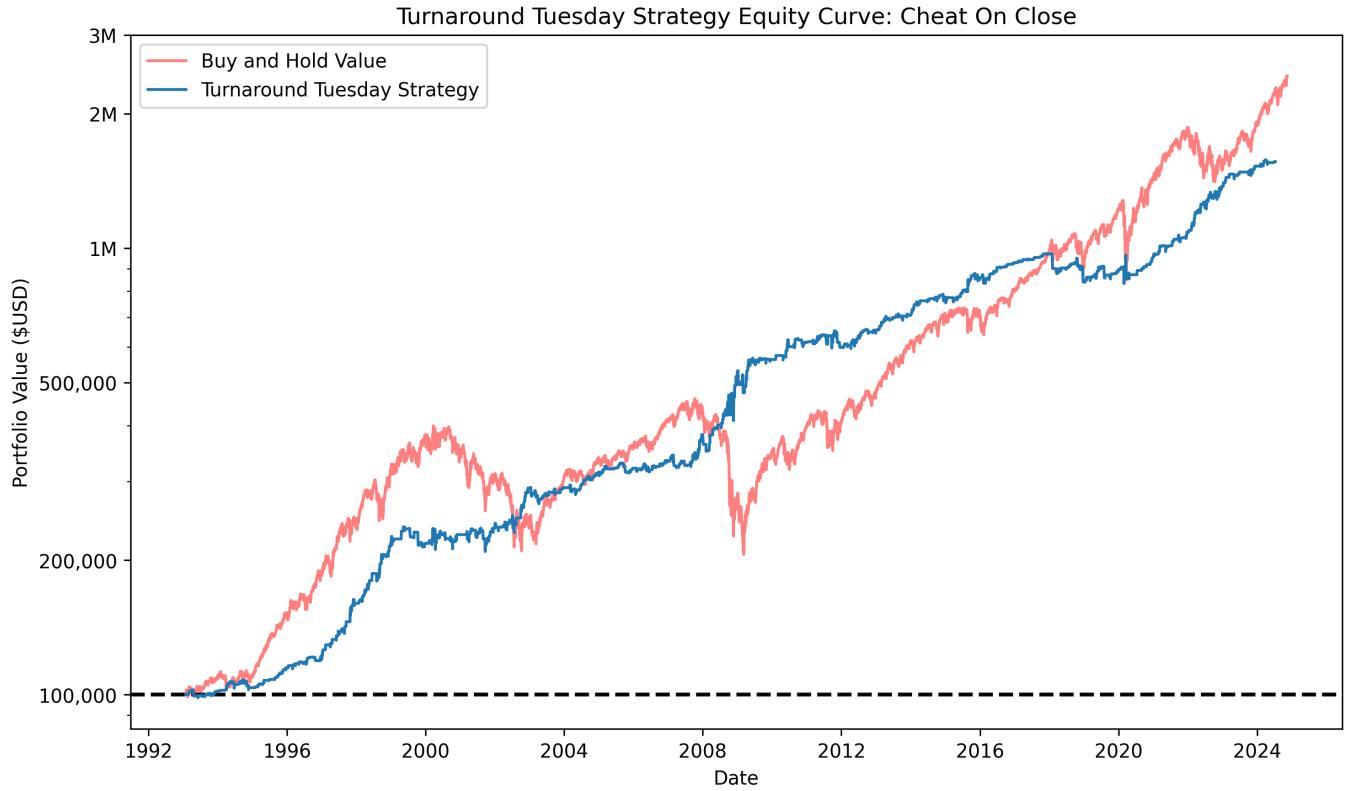


Figure 8: Equity curve of original Turnaround Tuesday strategy performance on the SPY. The Y-axis uses a logarithmic scale.

the results. Most of the discussion of the results will be in section 5.

4.1 Williams % R

This strategy had 3 parameters that were optimized over: lowerbound, upperbound, and period. Each had the following ranges [low,high,step]:

- Lowerbound: [-100, -70, 5]
- Upperbound: [70, 100, 5]
- Period: [2,20,1]

Table 1 and 2 and Figure 10 shows the results of the CAGR Ratio optimized parameters on the Williams %R strategy. Table 3 and 4 and Figure 11 shows the results of the Sharpe Ratio optimized parameters on the Williams %R strategy.

4.2 Commodity Channel Index

This strategy had 2 parameters that were optimized over: lowerband and period. Each had the following ranges [low,high,step]:

- Lowerband: [-100, -10, 10]
- Period: [10,20,1]

Symbol	Period	Lowerband	Upperband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	2	-95	75	15.357	0.746	-0.698	269	4.026	1.046
usdnzd	18	-95	70	14.128	2.245	0.257	300	5.677	1.137
usdmxn	2	-95	70	13.162	2.624	0.161	161	3.263	1.275
usdjpy	2	-95	70	7.838	1.716	0.029	157	4.737	1.189
usdhkd	2	-95	70	10.985	0.135	-13.281	149	0.388	1.151
usdgbp	20	-95	70	14.586	0.089	-0.645	271	4.203	1.007
usdeur	20	-95	70	14.860	0.259	-0.602	258	3.680	1.022
usdchf	2	-95	70	13.528	2.866	0.753	228	1.941	1.349
usdcad	2	-95	70	4.475	0.172	-1.004	73	1.601	1.075
usdaud	20	-95	70	11.578	3.682	1.627	209	2.713	1.289

Table 1: Performance metrics for different currency symbols using CAGR optimized parameters for Williams %R strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Upperband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	2	-95	75	16.309	0.556	0.002	83	2.850	1.038
usdnzd	18	-95	70	14.781	-1.466	-0.007	86	3.681	0.879
usdmxn	2	-95	70	8.445	2.717	0.010	47	2.147	1.328
usdjpy	2	-95	70	9.250	-6.795	-0.026	49	6.000	0.525
usdhkd	2	-95	70	13.055	-0.122	-0.003	59	0.491	0.897
usdgbp	20	-95	70	14.617	1.850	0.010	90	1.788	1.191
usdeur	20	-95	70	13.571	-1.295	-0.009	75	2.353	0.835
usdchf	2	-95	70	19.194	-6.969	-0.032	85	5.801	0.531
usdcad	2	-95	70	3.655	0.227	0.004	17	0.556	1.162
usdaud	20	-95	70	9.647	-0.365	-0.002	51	1.367	0.944

Table 2: Performance metrics for different currency symbols using CAGR optimized parameters for Williams %R strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Upperband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	2	-95	75	15.357	0.746	-0.698	269	4.026	1.046
usdnzd	20	-95	70	13.815	3.590	1.008	296	4.859	1.224
usdmxn	3	-95	70	13.657	4.143	0.392	173	2.636	1.444
usdjpy	2	-95	70	7.838	1.716	0.029	157	4.737	1.189
usdhkd	10	-95	70	6.926	-0.023	-8.608	105	0.496	0.966
usdgbp	20	-95	70	14.586	0.089	-0.645	271	4.203	1.007
usdeur	20	-95	70	14.860	0.259	-0.602	258	3.680	1.022
usdchf	2	-95	70	13.528	2.866	0.753	228	1.941	1.349
usdcad	2	-95	70	4.475	0.172	-1.004	73	1.601	1.075
usdaud	20	-95	70	11.578	3.682	1.627	209	2.713	1.289

Table 3: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Williams %R strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Heatmap of CAGR for each lowerbound, upperbound, and period: usdhkd

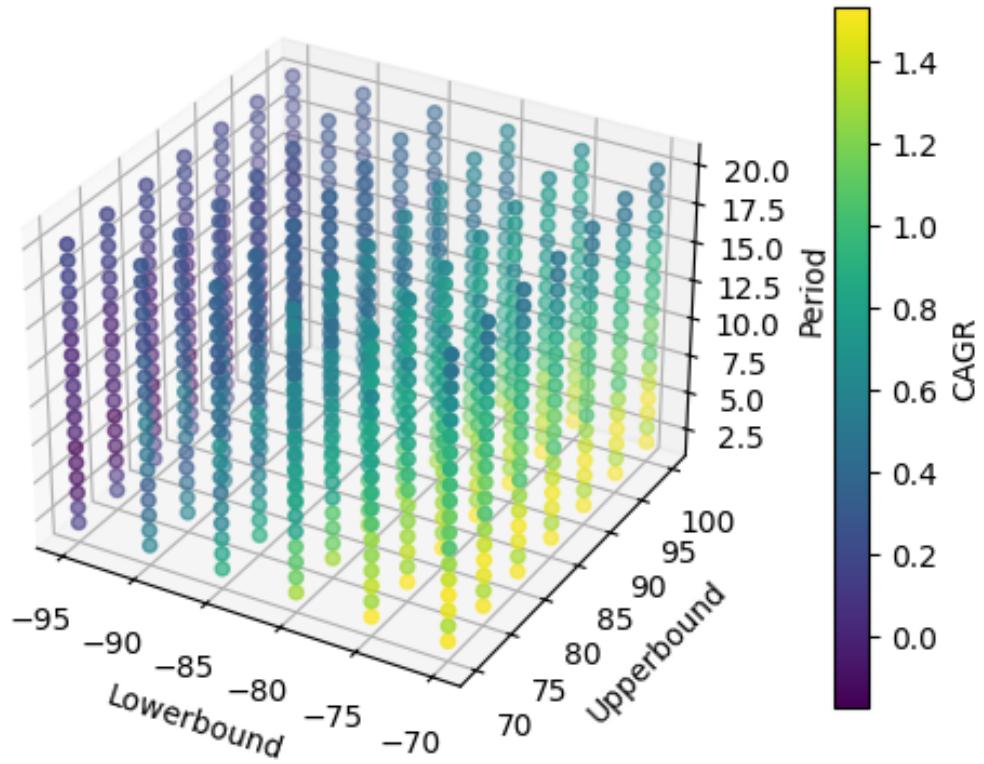


Figure 9: Optimization universe for Williams %R strategy on USDHKD currency pair. Used to demonstrate the neighborhood example and how to spot a strong neighborhood.

Table 5 and 6 and Figure 10 shows the results of the CAGR Ratio optimized parameters on the CCI strategy. Table 7 and 8 and Figure 13 shows the results of the Sharpe Ratio optimized parameters on the CCI strategy.

4.3 Stochastic Indicator

This strategy had 3 parameters that were optimized over: lowerband, period, and period fast. Each had the following ranges [low,high,step]:

- Lowerband: [20, 50, 5]
- Period: [2,15,1]
- Period Fast: [2,15,1]

Table 9 and 10 and Figure 14 shows the results of the CAGR Ratio optimized parameters on the Stochastic strategy. Table 11 and 12 and Figure 15 shows the results of the Sharpe Ratio optimized parameters on the Stochastic strategy.

4.4 Turnaround Tuesday

This strategy had only 1 parameters to optimize: wait days. It had the following range [low,high,step]:

- Wait Days: [1, 10, 1]

Symbol	Period	Lowerband	Upperband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	2	-95	75	16.309	0.556	0.002	83	2.850	1.038
usdnzd	20	-95	70	14.748	-1.085	-0.005	86	4.177	0.911
usdmxn	3	-95	70	10.988	2.501	0.008	53	2.529	1.246
usdjpy	2	-95	70	9.250	-6.795	-0.026	49	6.000	0.525
usdhkd	10	-95	70	10.117	0.537	0.027	46	0.121	2.055
usdgbp	20	-95	70	14.617	1.850	0.010	90	1.788	1.191
usdeur	20	-95	70	13.571	-1.295	-0.009	75	2.353	0.835
usdchf	2	-95	70	19.194	-6.969	-0.032	85	5.801	0.531
usdcad	2	-95	70	3.655	0.227	0.004	17	0.556	1.162
usdaud	20	-95	70	9.647	-0.365	-0.002	51	1.367	0.944

Table 4: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Williams %R strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	10	-20	41.578	4.729	0.950	789	7.845	1.097
usdnzd	10	-100	18.052	6.431	1.416	405	3.652	1.317
usdmxn	10	-20	49.475	2.445	0.246	717	5.983	1.059
usdjpy	10	-100	17.651	1.824	0.045	345	8.253	1.092
usdhkd	10	-20	49.122	1.153	-1.536	681	0.454	1.344
usdgbp	19	-20	39.984	0.757	-0.195	830	6.410	1.022
usdeur	19	-20	40.935	0.776	-0.268	803	4.778	1.025
usdchf	19	-20	40.026	5.517	0.907	747	6.033	1.180
usdcad	19	-20	39.421	2.952	1.670	722	2.801	1.129
usdaud	19	-100	14.715	5.682	3.075	312	2.953	1.354

Table 5: Performance metrics for different currency symbols using CAGR optimized parameters for CCI strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	10	-20	41.174	0.335	0.001	226	5.538	1.009
usdnzd	10	-100	19.751	-4.160	-0.016	113	5.289	0.784
usdmxn	10	-20	42.321	-3.440	-0.005	211	6.978	0.935
usdjpy	10	-100	18.532	-9.290	-0.026	103	7.888	0.632
usdhkd	10	-20	46.116	0.232	0.004	212	0.616	1.069
usdgbp	19	-20	38.980	4.851	0.018	268	2.724	1.210
usdeur	19	-20	39.438	1.994	0.008	221	3.625	1.105
usdchf	19	-20	41.042	-8.373	-0.027	208	9.061	0.721
usdcad	19	-20	35.999	2.502	0.015	208	1.628	1.168
usdaud	19	-100	13.865	1.194	0.006	78	1.963	1.118

Table 6: Performance metrics for different currency symbols using CAGR optimized parameters for CCI strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	10	-20	41.578	4.729	0.950	789	7.845	1.097
usdnzd	19	-100	14.169	4.731	2.126	326	4.611	1.265
usdmxn	19	-100	21.646	-1.759	-1.449	289	4.348	0.894
usdjpy	10	-100	17.651	1.824	0.045	345	8.253	1.092
usdhkd	17	-90	24.051	0.009	-4.270	331	0.769	1.005
usdgbp	19	-20	39.984	0.757	-0.195	830	6.410	1.022
usdeur	19	-20	40.935	0.776	-0.268	803	4.778	1.025
usdchf	10	-100	22.090	3.601	1.791	403	3.791	1.201
usdcad	18	-100	16.168	2.732	1.585	287	2.122	1.280
usdaud	19	-100	14.715	5.682	3.075	312	2.953	1.354

Table 7: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for CCI strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	10	-20	41.174	0.335	0.001	226	5.538	1.009
usdnzd	19	-100	12.688	0.173	0.001	84	2.995	1.014
usdmxn	19	-100	16.400	7.698	0.020	81	4.365	1.449
usdjpy	10	-100	18.532	-9.290	-0.026	103	7.888	0.632
usdhkd	17	-90	22.095	0.540	0.017	97	0.207	1.462
usdgbp	19	-20	38.980	4.851	0.018	268	2.724	1.210
usdeur	19	-20	39.438	1.994	0.008	221	3.625	1.105
usdchf	10	-100	23.649	-7.365	-0.030	119	6.563	0.639
usdcad	18	-100	13.969	-0.955	-0.009	67	1.062	0.837
usdaud	19	-100	13.865	1.194	0.006	78	1.963	1.118

Table 8: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for CCI strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Period Fast	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	4	20	2	27.739	2.233	0.094	510	6.983	1.073
usdnzd	19	20	2	21.966	5.065	1.371	514	4.437	1.193
usdmxn	2	20	3	18.374	2.776	0.205	245	3.801	1.203
usdjpy	2	20	2	19.971	-0.243	-0.329	404	6.568	0.989
usdhkd	4	20	2	17.175	0.439	-14.092	270	0.405	1.319
usdgbp	9	20	9	12.926	2.716	0.455	285	2.178	1.374
usdeur	19	20	2	24.142	2.662	1.258	481	3.501	1.145
usdchf	2	20	2	23.278	4.975	2.105	426	2.906	1.314
usdcad	19	20	10	12.489	-0.798	-1.610	232	3.616	0.899
usdaud	19	20	14	11.346	4.836	0.714	265	2.694	1.408

Table 9: Performance metrics for different currency symbols using CAGR optimized parameters for Stochastic strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Period Fast	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	4	20	2	28.859	-4.866	-14.115	153	5.150	0.828
usdnzd	19	20	2	22.106	-1.757	-17.125	150	4.555	0.921
usdmxn	2	20	3	13.466	2.172	-15.622	72	3.903	1.168
usdjpy	2	20	2	22.646	-10.231	-13.261	128	7.295	0.640
usdhkd	4	20	2	22.161	0.583	-163.762	103	0.236	1.470
usdgbp	9	20	9	12.557	0.986	-34.887	93	1.024	1.141
usdeur	19	20	2	23.839	-0.968	-26.945	133	2.851	0.925
usdchf	2	20	2	30.233	-4.067	-18.219	151	5.343	0.801
usdcad	19	20	10	9.791	-0.935	-63.308	53	1.250	0.749
usdaud	19	20	14	11.216	4.461	-29.966	79	1.711	1.574

Table 10: Performance metrics for different currency symbols using CAGR optimized parameters for Stochastic strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Period Fast	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	4	20	2	27.739	2.233	0.094	510	6.983	1.073
usdnzd	2	20	4	13.360	0.706	-0.730	292	4.813	1.049
usdmxn	2	20	2	31.626	1.294	-0.053	427	4.491	1.053
usdjpy	19	20	14	7.685	-1.792	-1.073	163	7.506	0.813
usdhkd	17	20	10	7.815	0.075	-3.568	121	0.531	1.105
usdgbp	11	20	12	10.932	3.934	1.050	256	1.997	1.634
usdeur	19	20	2	24.142	2.662	1.258	481	3.501	1.145
usdcad	19	20	2	20.441	1.816	0.098	381	3.073	1.145
usdchf	2	20	2	23.278	4.975	2.105	426	2.906	1.314
usdaud	10	20	9	11.014	3.280	0.346	238	2.860	1.325

Table 11: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Stochastic strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Period	Lowerband	Period Fast	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	4	20	2	28.859	-4.866	-0.014	153	5.150	0.828
usdnzd	2	20	4	16.579	-2.893	-0.014	99	3.694	0.791
usdmxn	2	20	2	27.291	1.781	0.004	136	4.526	1.055
usdjpy	19	20	14	10.303	-4.173	-0.013	66	5.595	0.770
usdhkd	17	20	10	8.257	-0.064	-0.002	42	0.458	0.932
usdgbp	11	20	12	11.282	-0.948	-0.006	72	2.306	0.872
usdeur	19	20	2	23.839	-0.968	-0.005	133	2.851	0.925
usdcad	19	20	2	16.319	-2.095	-0.019	84	2.342	0.683
usdchf	2	20	2	30.233	-4.067	-0.015	151	5.343	0.801
usdaud	10	20	9	11.184	0.722	0.004	73	2.422	1.084

Table 12: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Stochastic strategy on the test data. Sharpe calculate with risk free rate of 0.01.

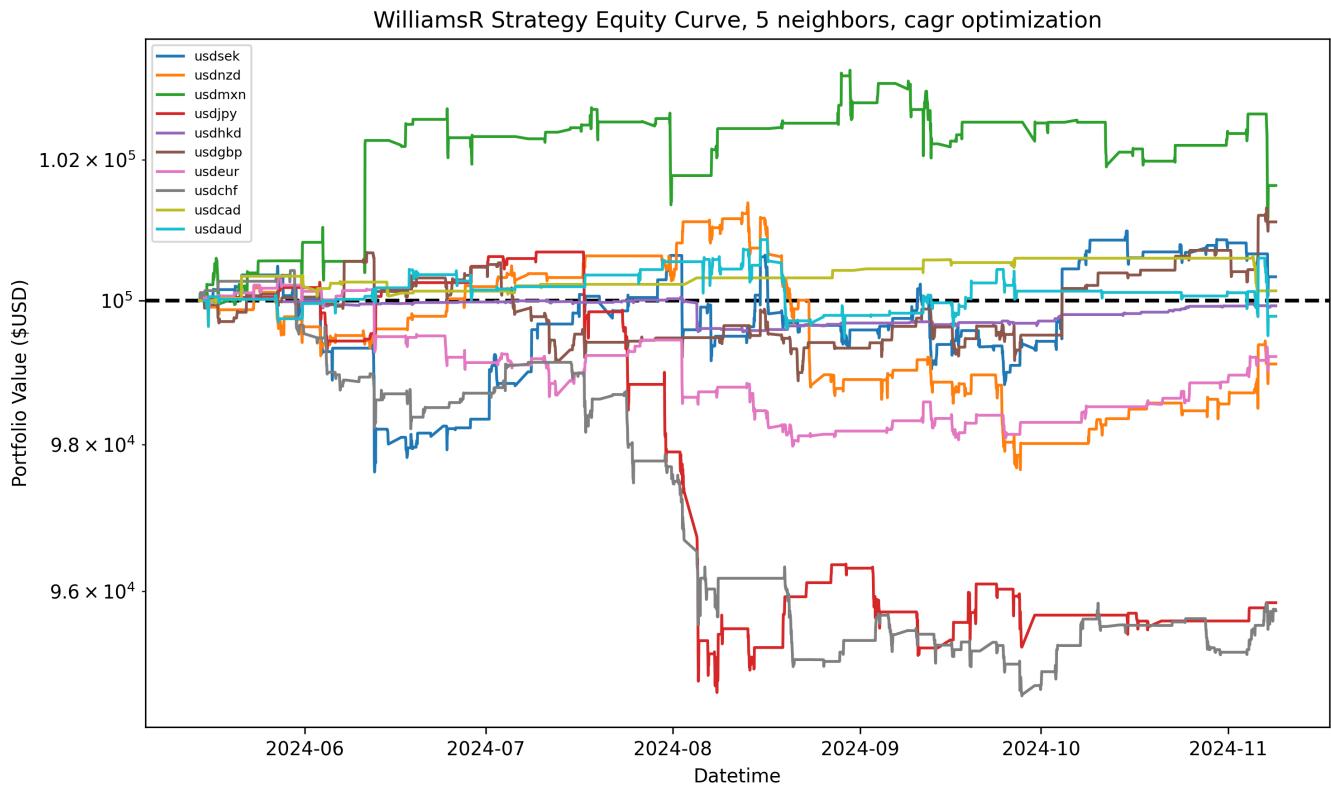


Figure 10: Equity curve of CAGR optimized Williams %R strategy on the test data.

Table 13 and 14 and Figure 16 shows the results of the CAGR Ratio optimized parameters on the Turnaround Tuesday %R strategy. Table 15 and 16 and Figure 17 shows the results of the Sharpe Ratio optimized parameters on the Turnaround Tuesday strategy.

Symbol	Wait Days	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	3	11.009	-0.737	-0.350	421	6.366	0.956
usdnzd	7	14.705	1.319	-0.418	365	3.782	1.085
usdmxn	4	13.192	2.533	0.279	405	3.071	1.165
usdjpy	9	14.566	4.230	5.209	330	2.320	1.401
usdhkd	7	15.650	-0.327	-6.550	317	0.722	0.800
usdgbp	7	14.617	-0.764	-0.627	353	5.766	0.938
usdeur	1	6.650	0.477	-1.304	657	1.905	1.052
usdchf	9	15.793	-0.005	-0.337	330	4.974	0.999
usdcad	9	14.998	1.181	-0.226	306	3.469	1.152
usdaud	1	6.404	-0.271	-3.161	635	3.082	0.981

Table 13: Performance metrics for different currency symbols using CAGR optimized parameters for Turnaround Tuesday strategy on the train data. Sharpe calculate with risk free rate of 0.01.

Symbol	Wait Days	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	3	10.973	1.993	0.012	127	1.490	1.174
usdnzd	7	13.506	2.650	0.015	107	1.912	1.238
usdmxn	4	11.933	3.945	0.012	108	2.923	1.240
usdjpy	9	13.496	2.538	0.010	106	2.863	1.184
usdhkd	7	15.242	-0.249	-0.010	98	0.234	0.830
usdgbp	7	14.094	1.380	0.011	104	1.239	1.180
usdeur	1	6.246	-0.137	-0.002	191	0.702	0.980
usdchf	9	15.427	1.116	0.007	102	1.233	1.128
usdcad	9	14.001	0.690	0.008	95	1.607	1.127
usdaud	1	6.115	0.045	0.000	187	1.315	1.004

Table 14: Performance metrics for different currency symbols using CAGR optimized parameters for Turnaround Tuesday strategy on the test data. Sharpe calculate with risk free rate of 0.01.

Symbol	Wait Days	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	3	11.009	-0.737	-0.350	421	6.366	0.956
usdnzd	7	14.705	1.319	-0.418	365	3.782	1.085
usdmxn	4	13.192	2.533	0.279	405	3.071	1.165
usdjpy	9	14.566	4.230	5.209	330	2.320	1.401
usdhkd	4	13.560	-0.353	-9.480	395	0.702	0.803
usdgbp	7	14.617	-0.764	-0.627	353	5.766	0.938
usdeur	9	15.396	-1.023	-1.061	328	3.312	0.905
usdchf	9	15.793	-0.005	-0.337	330	4.974	0.999
usdcad	9	14.998	1.181	-0.226	306	3.469	1.152
usdaud	9	14.614	-0.162	-1.855	315	2.728	0.988

Table 15: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Turnaround Tuesday strategy on the train data. Sharpe calculate with risk free rate of 0.01.

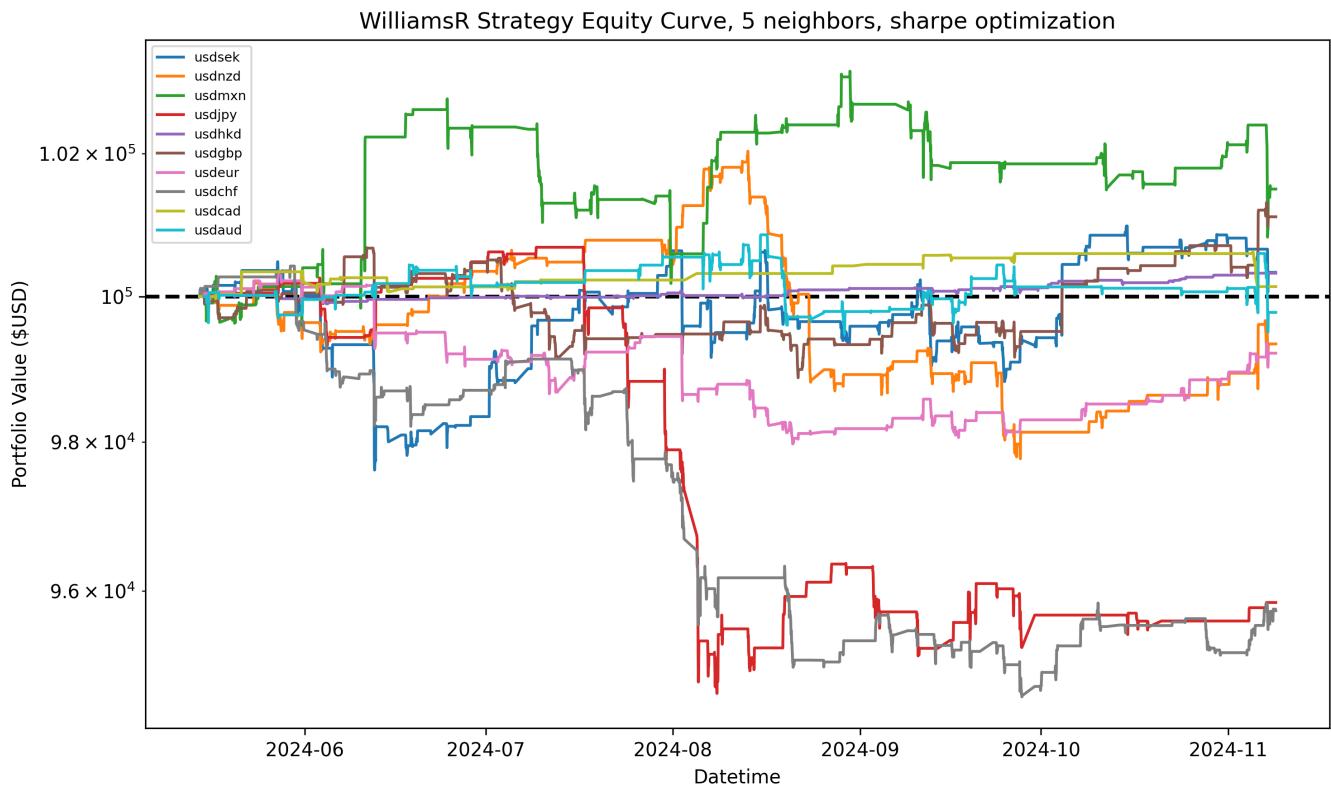


Figure 11: Equity curve of Sharpe Ratio optimized Williams %R strategy on the test data.

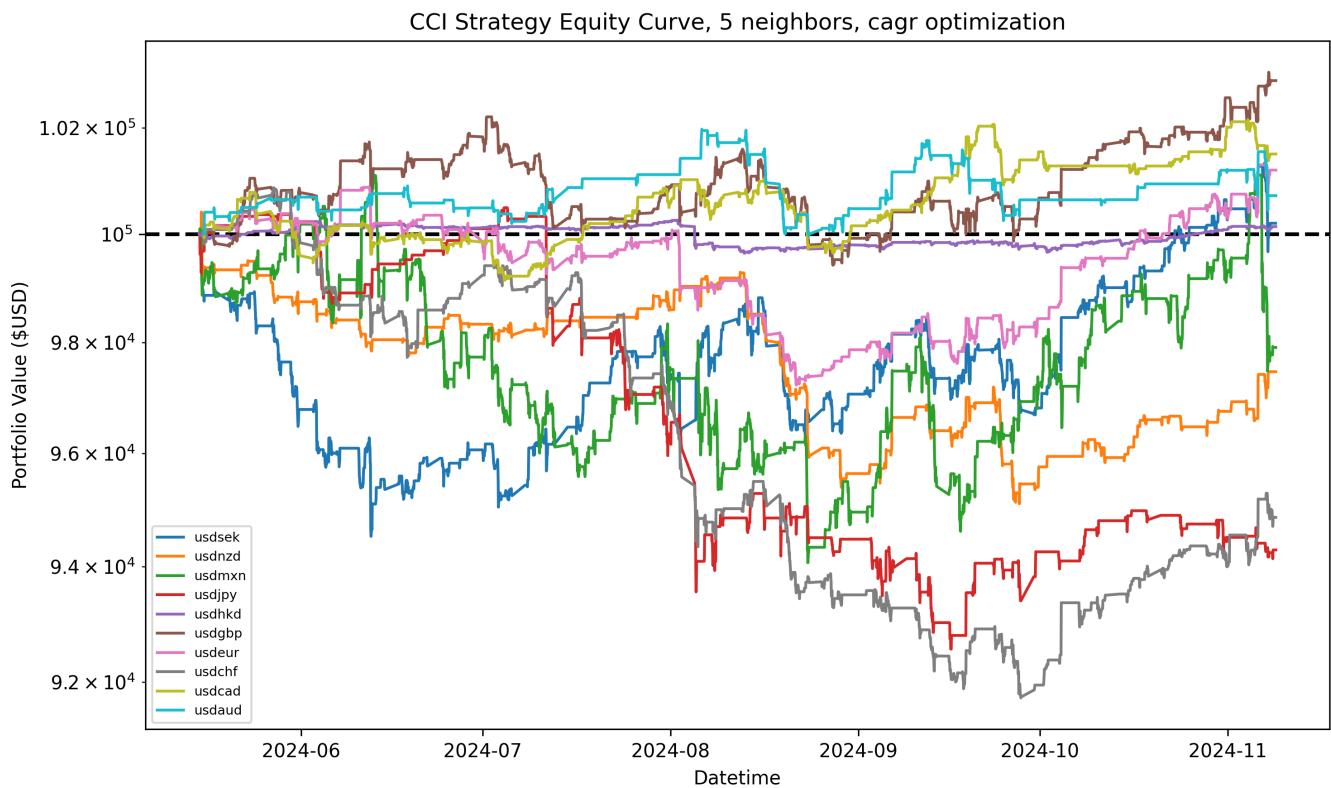


Figure 12: Equity curve of CAGR optimized CCI strategy on the test data.

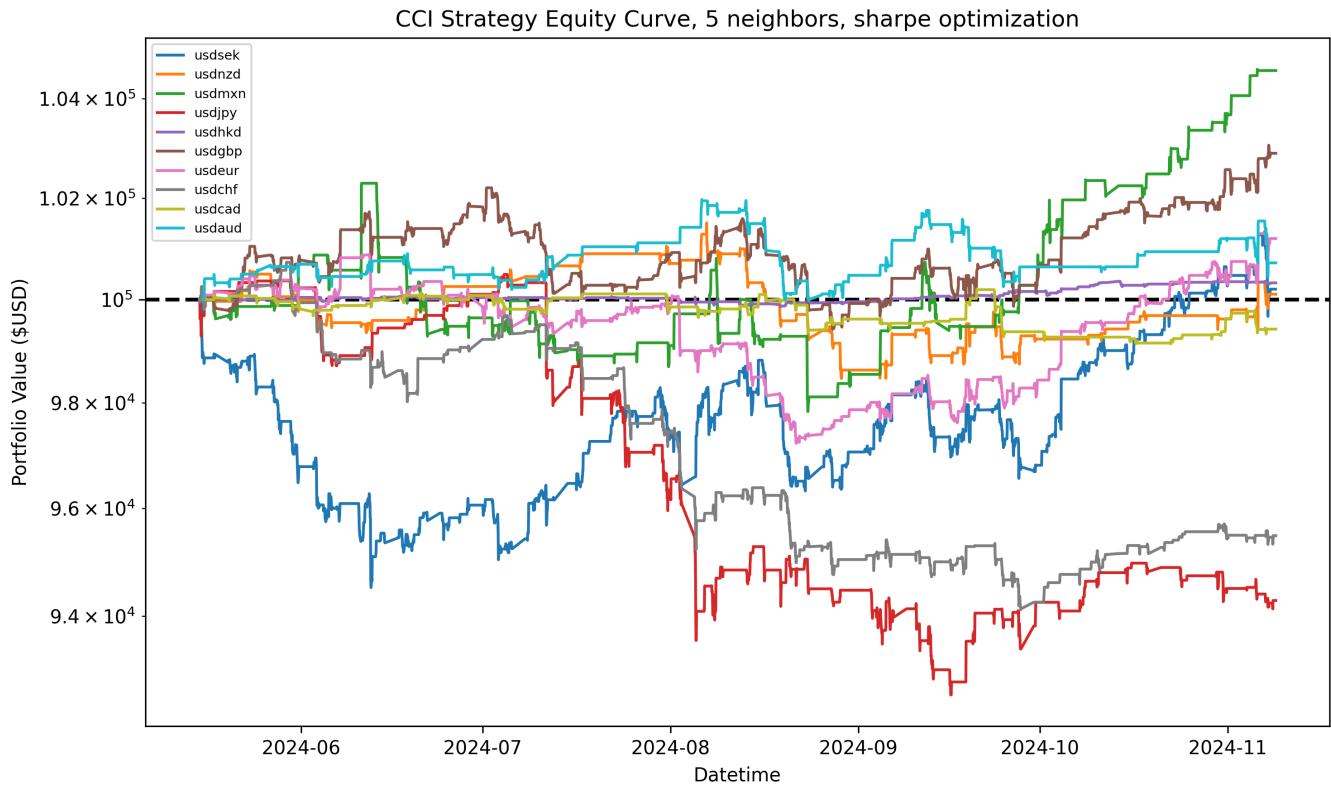


Figure 13: Equity curve of Sharpe Ratio optimized CCI strategy on the test data.

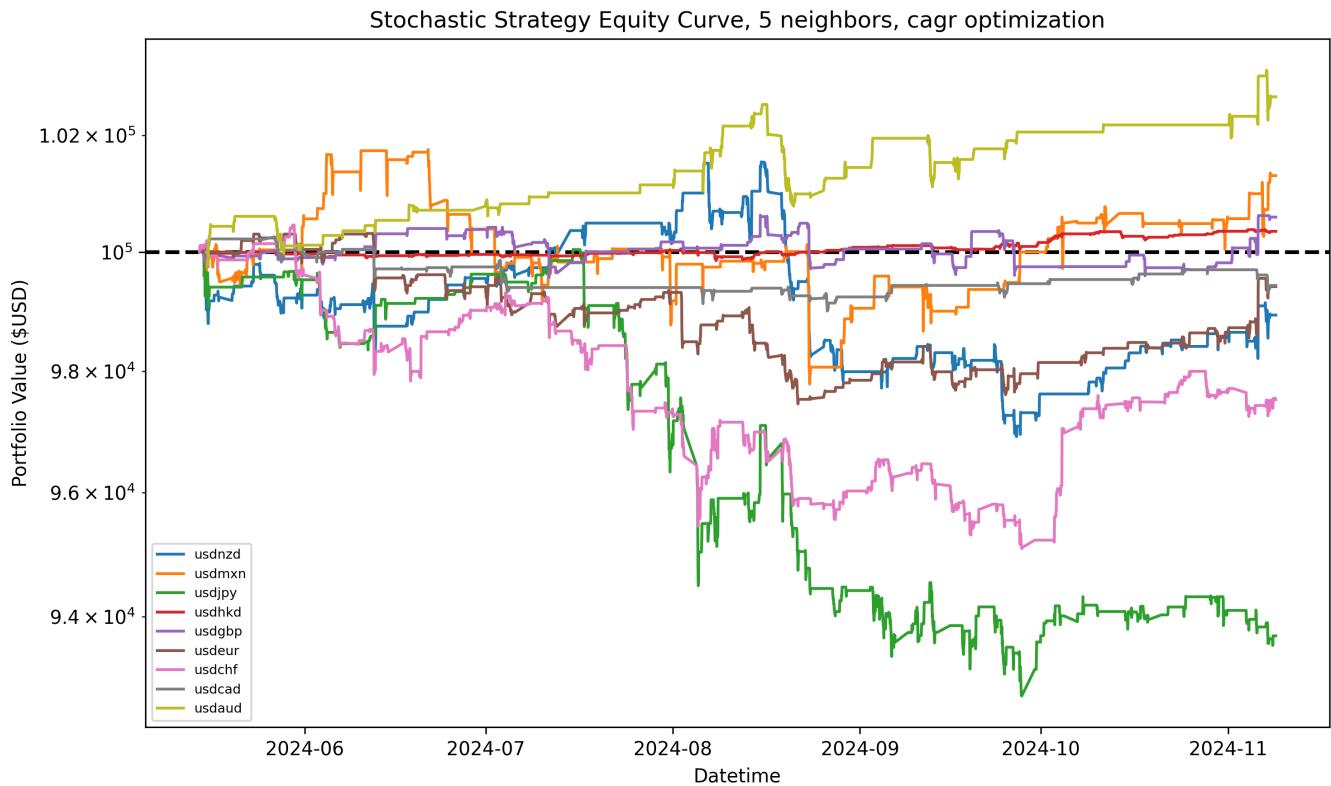


Figure 14: Equity curve of CAGR optimized Stochastic strategy on the test data.

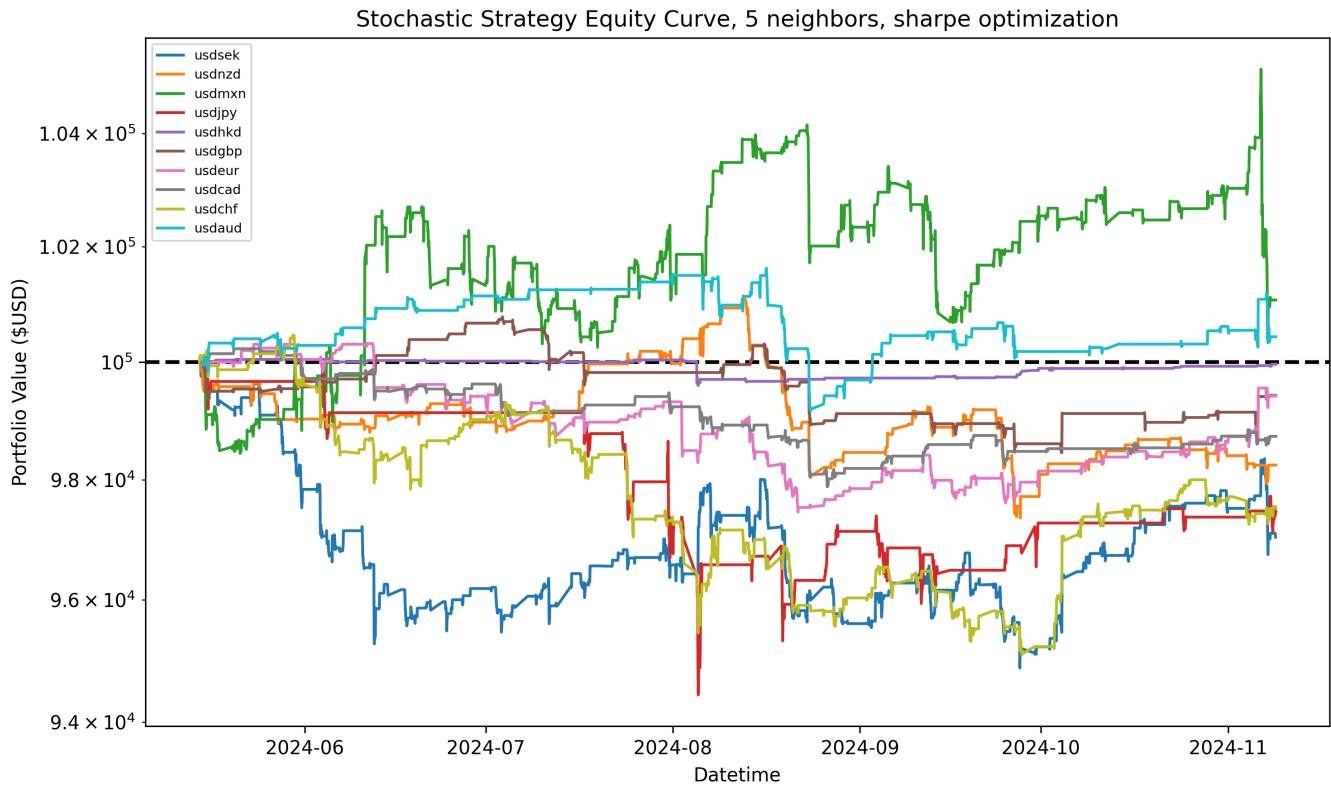


Figure 15: Equity curve of Sharpe Ratio optimized Stochastic strategy on the test data.

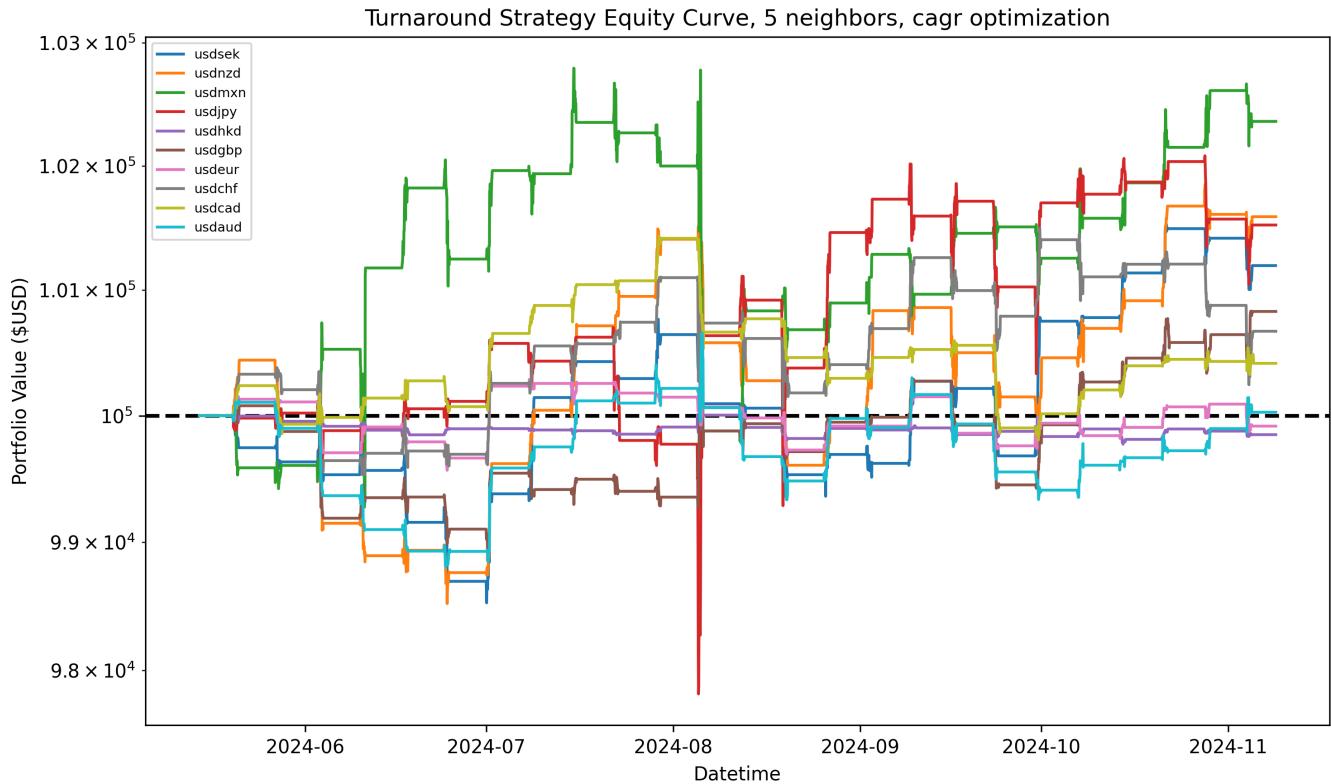


Figure 16: Equity curve of CAGR optimized Turnaround Tuesdays strategy on the test data.

Symbol	Wait Days	Exposure	CAGR	Sharpe	Trades	Max Drawdown	Profit Factor
usdsek	3	10.973	1.993	0.012	127	1.490	1.174
usdnzd	7	13.506	2.650	0.015	107	1.912	1.238
usdmxn	4	11.933	3.945	0.012	108	2.923	1.240
usdjpy	9	13.496	2.538	0.010	106	2.863	1.184
usdhkd	4	13.055	-0.256	-0.010	120	0.256	0.833
usdgbp	7	14.094	1.380	0.011	104	1.239	1.180
usdeur	9	14.356	0.874	0.008	93	1.108	1.150
usdchf	9	15.427	1.116	0.007	102	1.233	1.128
usdcad	9	14.001	0.690	0.008	95	1.607	1.127
usdaud	9	14.192	0.807	0.004	96	2.185	1.076

Table 16: Performance metrics for different currency symbols using Sharpe Ratio optimized parameters for Turnaround Tuesday strategy on the test data. Sharpe calculate with risk free rate of 0.01.

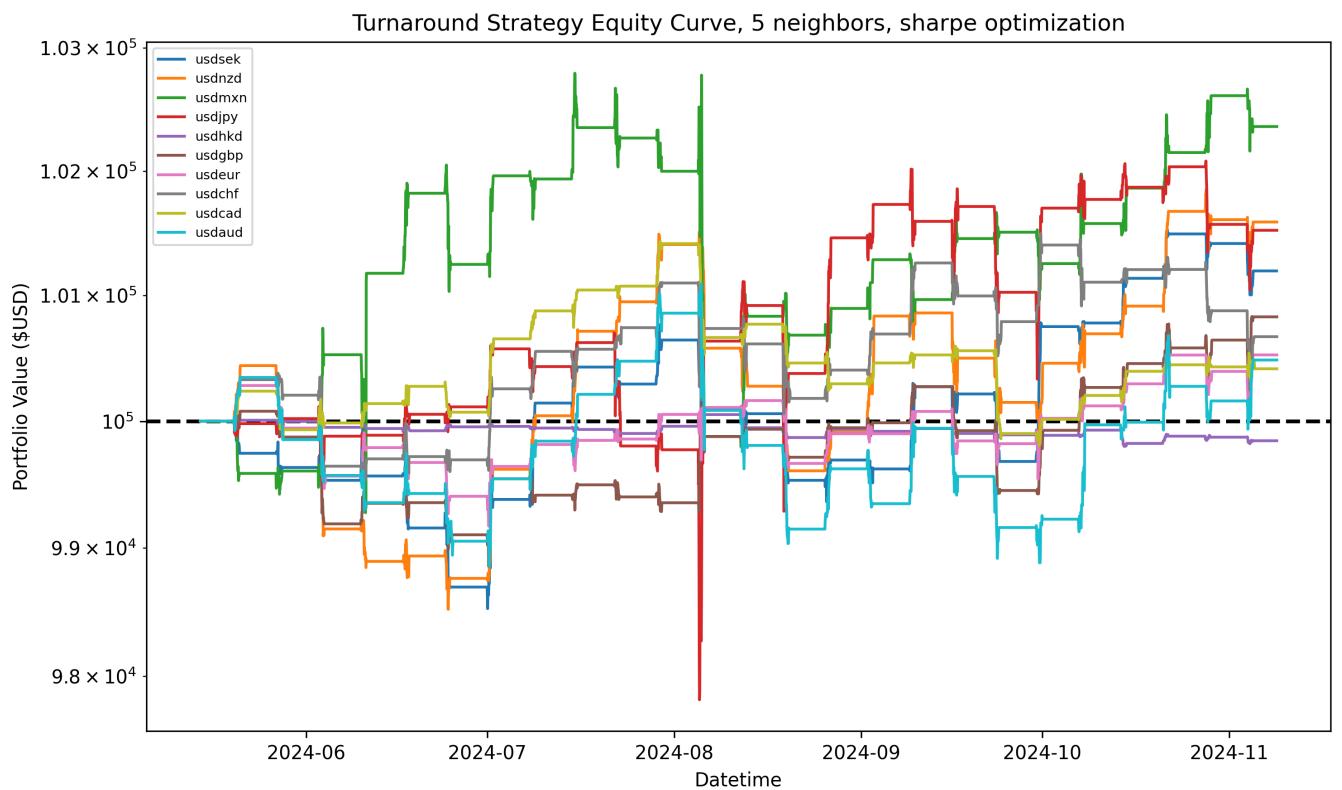


Figure 17: Equity curve of Sharpe Ratio optimized Turnaround Tuesday strategy on the test data.

5. Conclusion

There was a lot of data collected and visualized in this paper and I will highlight three main themes that I saw. The first thing that we can see in when optimizing the strategy parameters is that the choice of target statistic is very important. For example, Figures 14 and 15 both show the results of the Stochastic strategy on the same data but the optimized parameters for USDMXN using CAGR and Sharpe Ratio are very different. Optimized for CAGR it is the worst performing currency pair, while optimizing for Sharpe Ratio makes it the best performing currency pair.

Another common theme is that it is very clear a strategy may not perform consistently across securities even when optimizing it for that specific security. Across every strategy we see some currency pairs that perform very poorly even when the strategy is optimized for them such as USDHKD in Table 5. Conversely in the same table we see USDAUD performs quite well. Just because a strategy works well on one security does not mean it will transfer even if you re-optimize it. However, starting from a strategy that performs well on something is probably a good starting point.

The last common theme that we see is that almost universally strategies perform worse on the test data than on the train data. This is a very common finding in machine learning and statistics in general. The neighborhood approach to choosing the optimal parameters attempts to reduce this a bit but it does not remove it completely. This is representative of how a strategy is likely to perform in practice and clearly shows why it's important to split data into train and test. Furthermore, the highest performing strategy on the test data on average was the Turnaround Tuesday strategy. In both optimization schemes almost all of the currency pairs generated a positive return. This also happens to be the strategy with the least number of optimization parameters: only one! The lack of parameters makes it much harder to overfit this strategy to the train data likely resulting in it's consistent performance on the test data. It seems that simple strategies prevail.

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A. Appendix

A.1 Optimization Universes

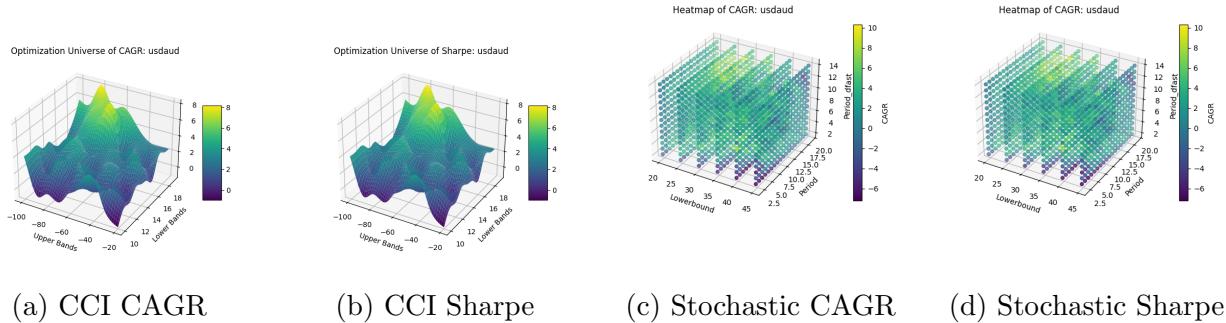


Figure 18: USD/AUD Optimization Universes (Part 1)

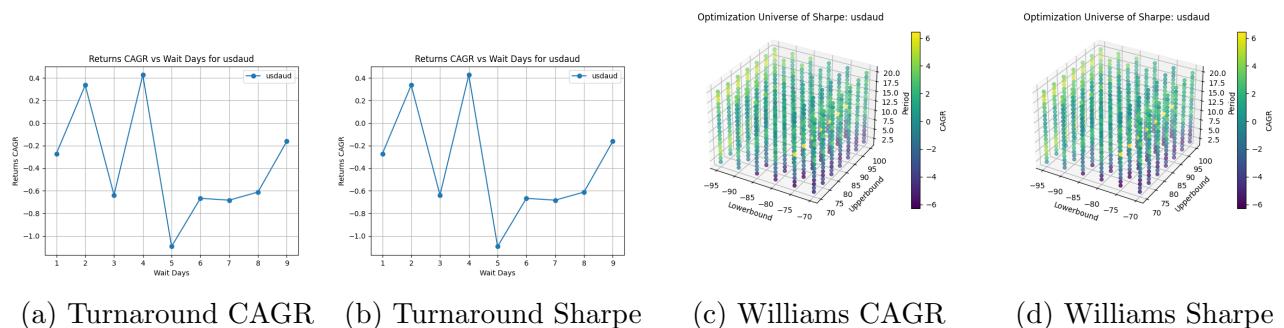


Figure 19: USD/AUD Optimization Universes (Part 2)

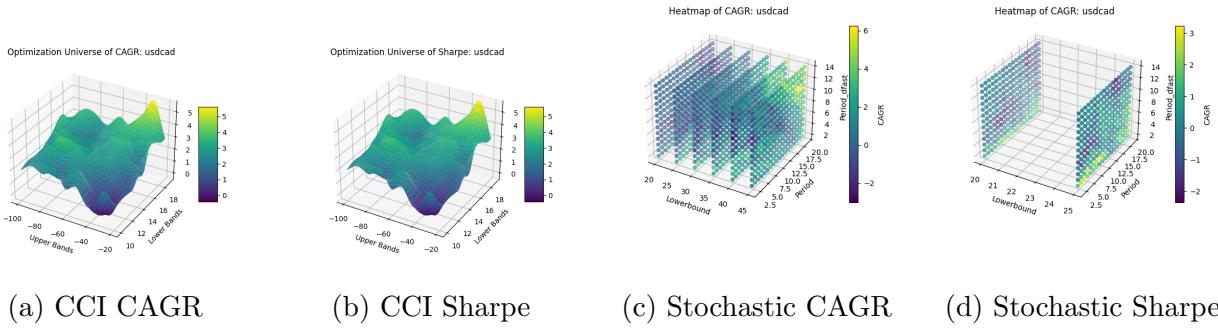


Figure 20: USD/CAD Optimization Universes (Part 1)

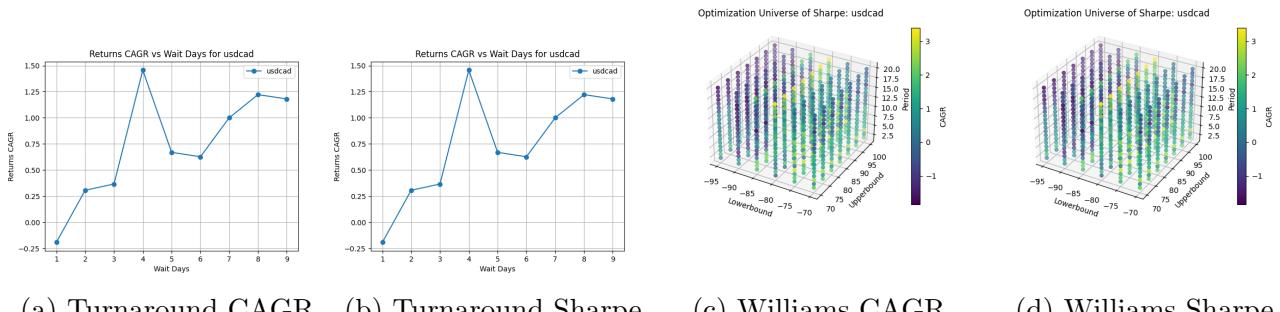


Figure 21: USD/CAD Optimization Universes (Part 2)

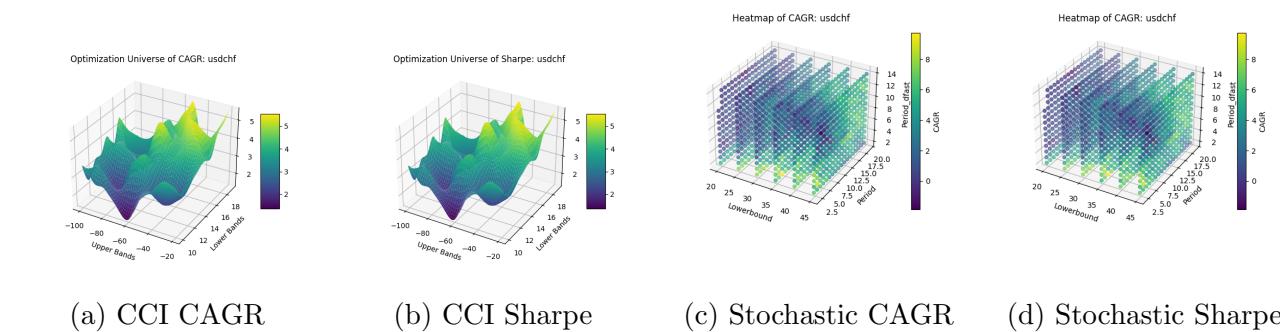


Figure 22: USD/CHF Optimization Universes (Part 1)

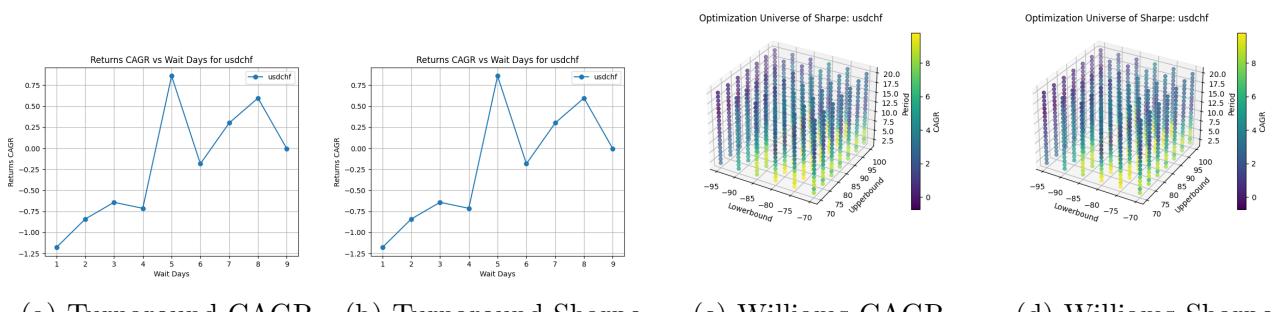


Figure 23: USD/CHF Optimization Universes (Part 2)

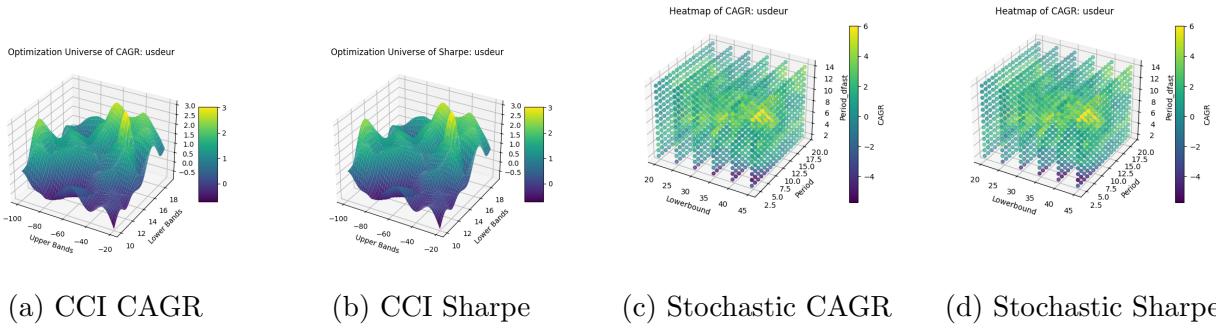


Figure 24: USD/EUR Optimization Universes (Part 1)

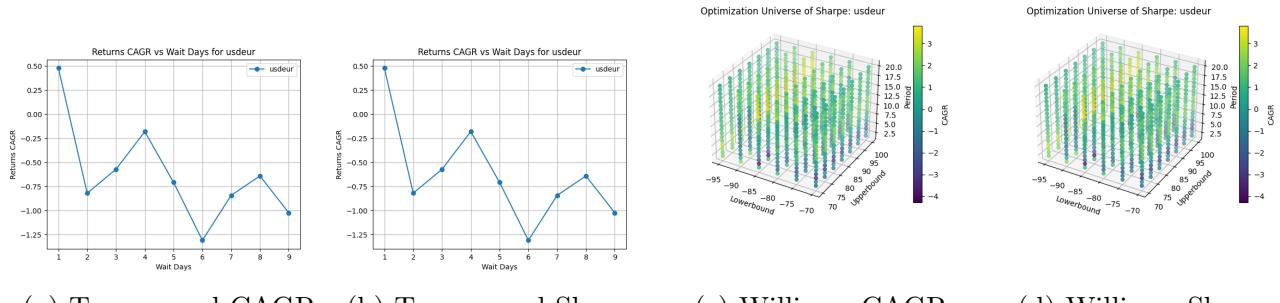


Figure 25: USD/EUR Optimization Universes (Part 2)

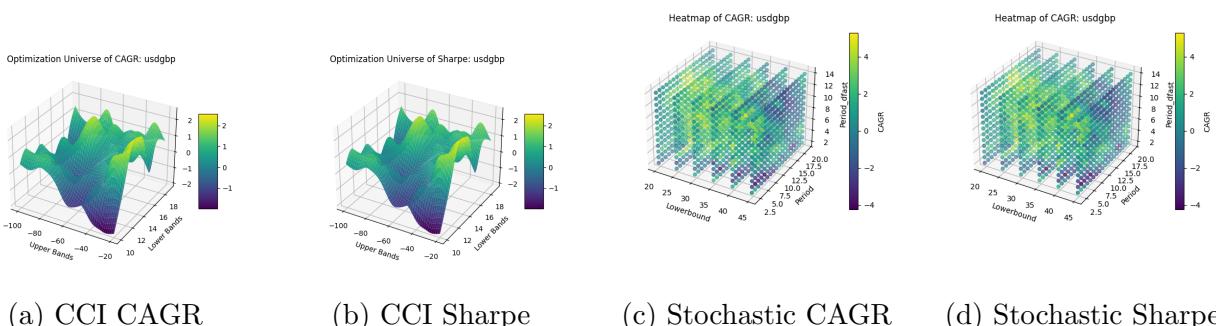


Figure 26: USD/GBP Optimization Universes (Part 1)

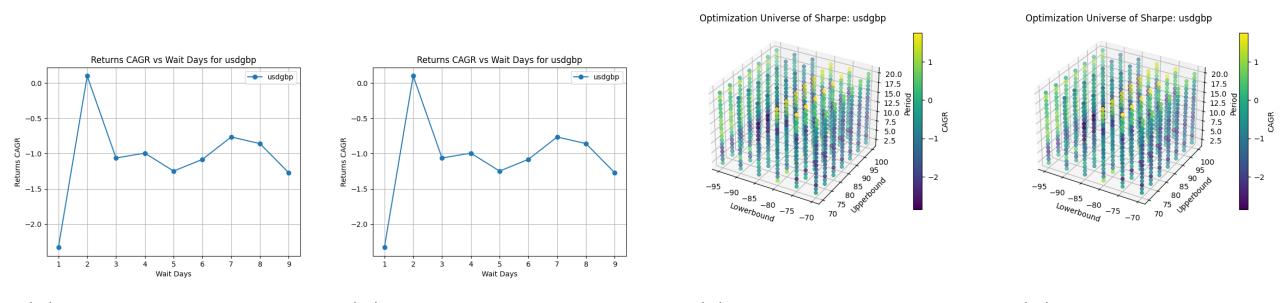


Figure 27: USD/GBP Optimization Universes (Part 2)

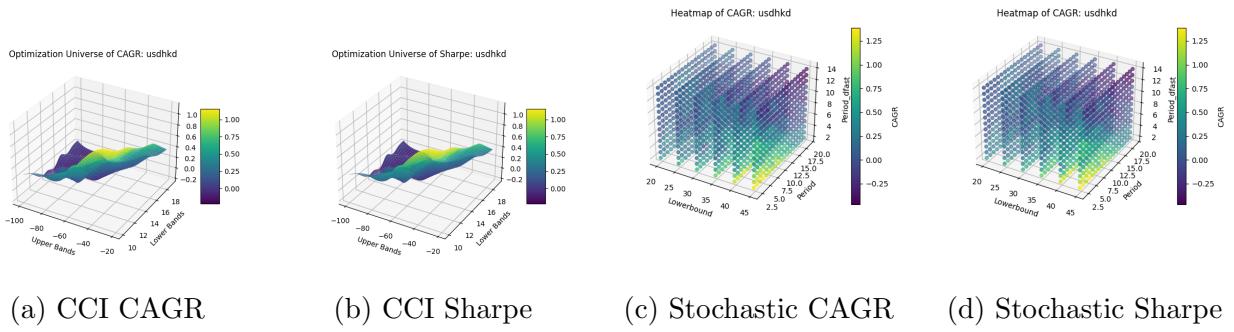


Figure 28: USD/HKD Optimization Universes (Part 1)

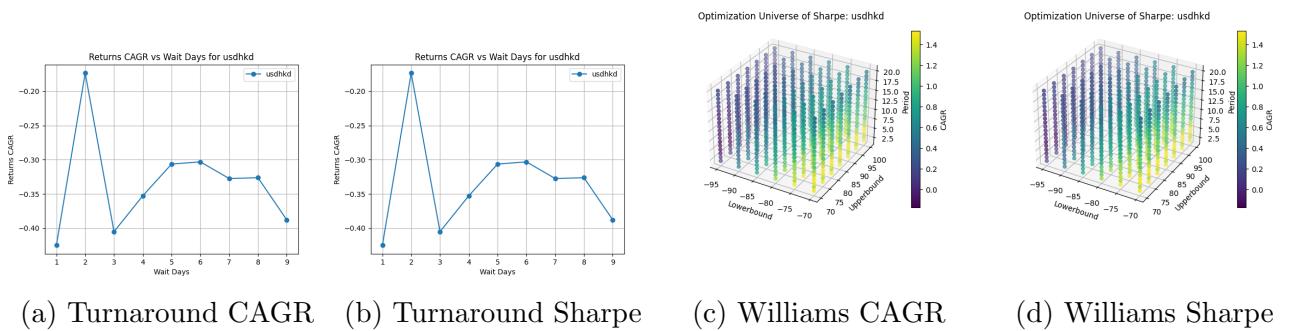


Figure 29: USD/HKD Optimization Universes (Part 2)

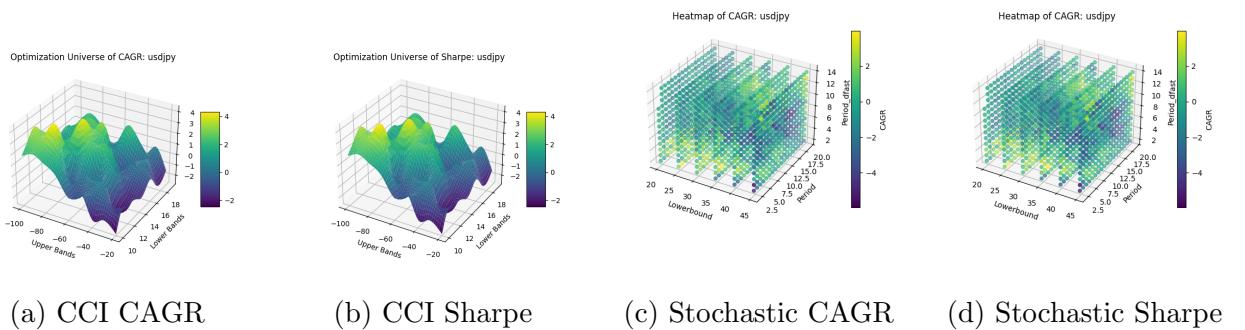


Figure 30: USD/JPY Optimization Universes (Part 1)

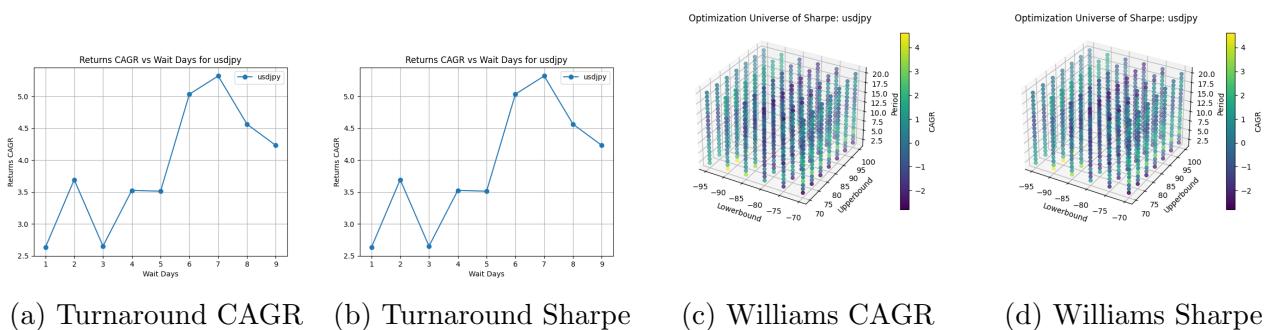


Figure 31: USD/JPY Optimization Universes (Part 2)

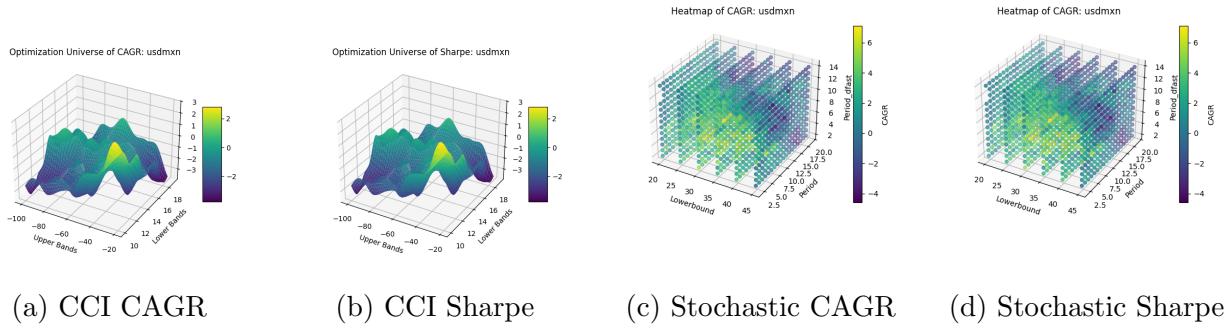


Figure 32: USD/MXN Optimization Universes (Part 1)

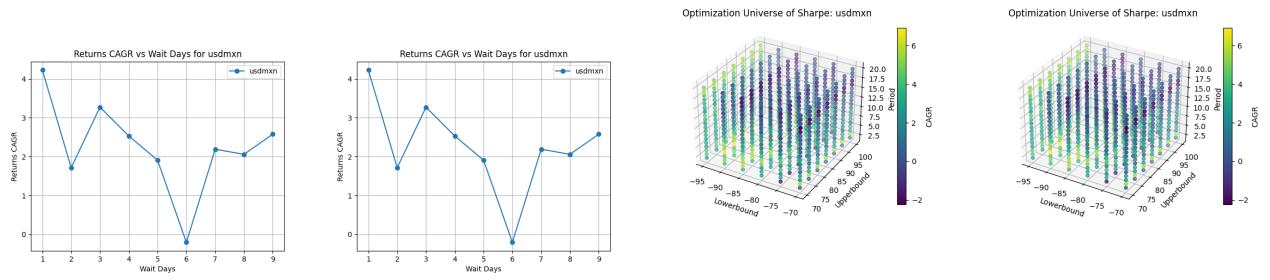


Figure 33: USD/MXN Optimization Universes (Part 2)

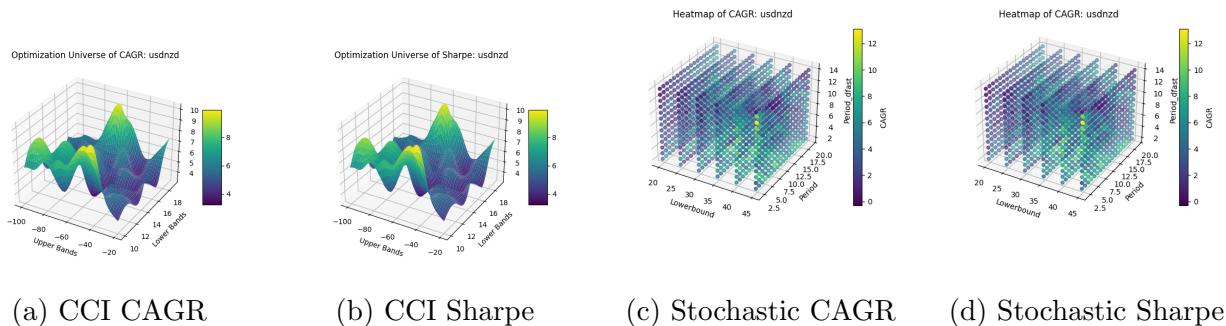


Figure 34: USD/NZD Optimization Universes (Part 1)

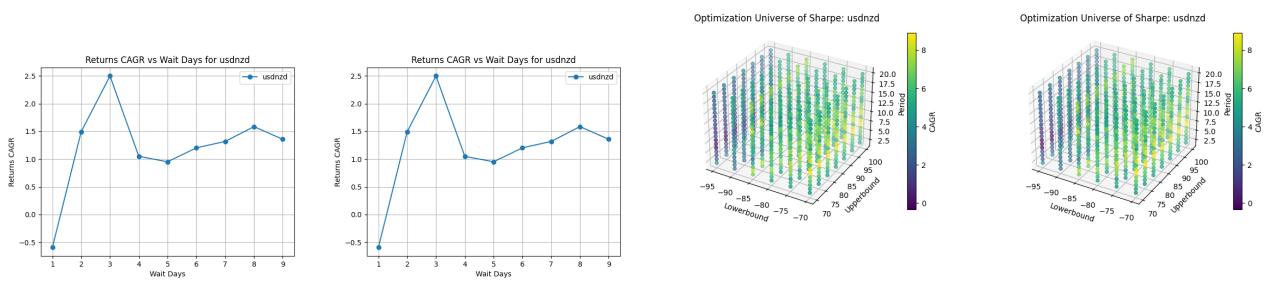


Figure 35: USD/NZD Optimization Universes (Part 2)

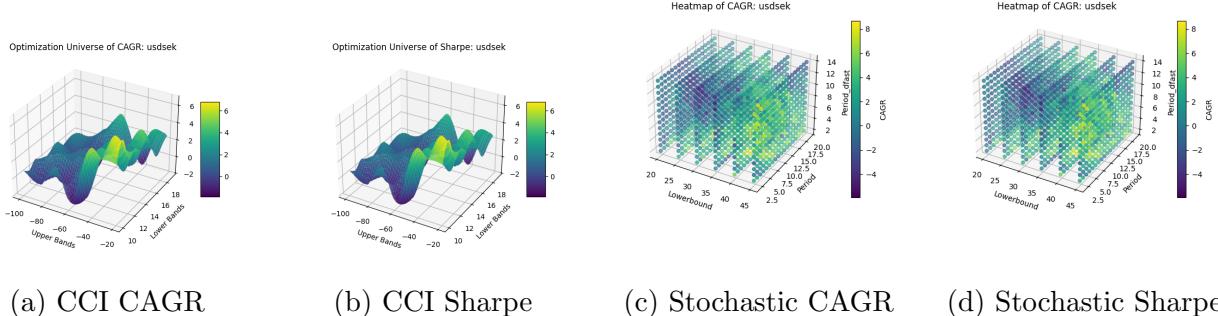


Figure 36: USD/SEK Optimization Universes (Part 1)

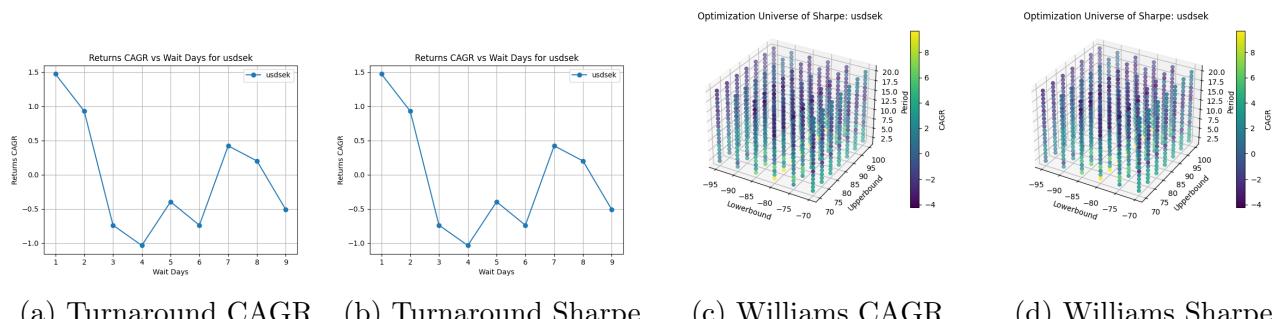


Figure 37: USD/SEK Optimization Universes (Part 2)