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Methodology

TradingEdge.Pro's methodology describes a multi-step process for building and validating trading strategies, structured into two parts: strategy development and testing, and practical use. In the testing phase, a strategy is defined as a set of objective rules, validated through initial tests, optimised, and assessed for stability (robustness), and then evaluated using Walk-Forward Analysis. The detailed testing assumptions (including the instrument universe, in-sample/out-of-sample periods, data sources, transaction costs, and execution rules) are described in the "Testing Specification" document. The full methodology and metric definitions are available on the TradingEdge.Pro "Methodology" page.

Tri-Zone Reversal v.1

Investment Strategy Testing Summary

Tri-Zone Reversal strategy is a **trend-following trading technique with a mean-reversion element,** developed by **Art Collins.** It uses the occurrence of **several closely grouped lows or highs** as a signal of the formation of a support or resistance zone. The aim of the strategy is to capture a reversal of the dominant trend, which often **occurs after a series of unsuccessful attempts to break out of a given support or resistance zone.**

The optimal optimization window for WFA tests is **1095/365 days,** and the results for the period **01/01/1995 – 31/12/2024** were:

- **Item size:** the position corresponds to a risk of 0.5% of the capital value, with a hypothetical stop loss order distant from the position opening point by 2 x ATR (40 days)
- **CAGR:** 12.5%;
- **MAR:** 0.50;
- **Maximum drawdown:** 24.8%.

Ultimately, **position sizing should be adjusted to an acceptable drawdown level consistent with your individual risk profile.**

The strategy passed both the stability tests as well as the Walk-Forward Analysis (WFA) tests. However, **it has some significant limitations** that should be taken into account:

- **The drawdown may last up to several dozen months,** which may cause great discomfort in using this strategy and growing concerns about its effectiveness.
- **A very small number of profitable transactions,** about 20%; this is the specificity of the trend-following strategy.

Despite these limitations, the **Tri-Zone Reversal strategy can be an effective tool for investors who prefer trend following strategies,** as it remains relatively stable in various market conditions and a wide range of parameters. Our goal is to have a strategy that remains **profitable and effective in a wide range of parameters,** because the market is a volatile organism, and optimal parameters can change in different periods. <u>I cannot</u> emphasize enough that for **a strategy to work** <u>in real conditions, it must also work on</u> <u>suboptimal parameters</u> <u>and in</u> <u>suboptimal conditions.</u> In a word - **it must be stable** to changing market conditions.

I don't know who said these words, but they perfectly reflect the problem of many optimizations:

"I've never seen a strategy that didn't work in backtests."

We don't know the future, we don't know future market conditions, but if we know that our strategy **has historically generated acceptable results** in various market conditions and across various parameter ranges, then we are **one step ahead of other** market participants.

Contents

Step 1: Formulate an investment strategy

Tri-Zone Reversal strategy is a **trend-following trading technique with a mean-reversion element,** developed by **Art Collins.** It uses the occurrence of **several closely grouped lows or highs** as a signal of the formation of a support or resistance zone. The aim of the strategy is to capture a reversal of the dominant trend, which often **occurs after a series of unsuccessful attempts to break out of a given support or resistance zone.**

For the purpose of the initial test, we analyze **the last three sessions (days),** measuring the distance between the extreme lows/highs. If this distance does not exceed **20% of the total range of these three days, i.e. the last three lows/highs fall in a narrow price range, creating a local "triple bottom"/"triple top",** we consider it a cluster that may announce a return to the trend. The transaction is opened at the opening of the next session, **only in the direction consistent with the price position relative to the 200-day moving average.**

The strategy uses:

- **Grouping of three lows/highs** to identify local support/resistance zones;
- **Percentage threshold of 20% of the total volatility over the last 3 days** as a narrow cluster criterion;
- **Trend filter:** long positions only above and short positions only below the 200-SMA;
- **Market orders at the opening of the session** following the fulfilment of the condition;
- **Initial stop loss and trailing stop at 200-SMA level.**

Why might a grouping of three lows/highs be effective? Multiple failed attempts to break out of the same zone indicate a supply or demand exhaustion. According to Steidlmayer's "auction theory," a market that can't sell/buy at a given level will move activity in the opposite direction. The 200-SMA filter eliminates trades that are counter to the main trend, increasing the likelihood that a reversal will turn into an impulsive move.

Characteristics of the strategy and its strengths and weaknesses:

- **Reactive to market structure** – based on geometric candle patterns rather than forecasts;
- **Defined risk** – precise stop loss at 200-SMA;
- **Long-term filter** – 200-SMA improves signal selection;
- **No need for a direction forecast** – the decision depends on price behavior, not opinion;
- **Potential false clusters** – missed signals may occur in high noise conditions;
- **Delayed trailing stop** – a trailing stop distant from the 200-SMA level may give away a significant part of the profit;
- **20% threshold, SMA, number of candles forming a cluster** – requires calibration.

Tri-Zone Reversal combines the simplicity of a logical candlestick layout with a trend filter, offering a clear decision-making process and transparent risk management. However, the effectiveness depends on the appropriate tuning of the strategy parameter to be stable in a real trading environment.

Step 2: Define investment principles

Below is **the pseudocode** for the **Tri-Zone Reversal v.1 strategy** on daily data:

1. **Calculating Indicators:**
   a. **NDayHighs/NDayLows** – collect N consecutive highest (high) and lowest (low) prices from the last N sessions. For example, if N = 3, determine what all three maximums and all 3 minimums were from the last 3 sessions. We use the maximums to open short positions, and the minimums to open long positions.
   b. **NDayRange –** volatility measured as the difference between the highest high and the lowest low over the last N days.
   c. **X-day moving average (SMA)** – determines the dominant trend in a given instrument.
2. **Generating Entry Signals (at the start of the day):**
   a. **Check cluster condition every day:**
      i. **Buy signal** – the difference between the highest and lowest of **three consecutive lows** does not exceed **Y percent** of the entire N-day price range (**NDayRange**).
      ii. **Sell signal** – the difference between the highest and lowest of **three consecutive highs** does not exceed **Y percent** of the entire N-day price range (**NDayRange**).
   b. **Trend Filter:**
      i. consider **buying** if the closing price is **above** the X-day moving average.
      ii. consider **selling** if the closing price is **below** the Y-day moving average.
   c. If both conditions (cluster and trend filter) are met, open a position in the appropriate direction at the **opening price** in the next session.
3. **Risk Management Rules -** set the initial **stop loss** and **trailing stop** at **the level of the X-day moving average.**
4. **Generating Exit Signals –** the position is closed when the price breaches **the X-day moving average.**
5. **Daily Monitoring –** every day:
   - **Update data for the last N sessions** and the total N-day range.
   - **Calculate new values of the X-day moving average;** move **the trailing stop** according to its current level.
   - Every day, **verify cluster condition and trend filter;** set orders for upcoming session.

The above rules have been described in a way that allows them to be directly converted into a script in the chosen testing platform, which ensures the accuracy of the historical simulation and the reliability of the test results.

The tests are carried out assuming that the risk of one position is **0.5% of the total capital,** with **a hypothetical stop loss order located 2 x ATR (40 days)** away from the position opening point.

Step 3: Conduct a preliminary test of the investment strategy

Below are some purchase and sale transactions that allow you to verify the following aspects:

- **Correctness of generated signals;**
- **Direction of opening position;**
- **Moment of opening a position;**
- **Position opening price;**
- **Moment of closing the position;**
- **Closing price of the position;**
- **Compliance of the transaction with the theoretical assumptions of the investment strategy.**

At this stage **it does not matter** whether the transactions are **profitable,** what **instrument was used** or whether they took place **recently** or **in the distant past.** The key is **to check whether the transactions are generated correctly** and in accordance with the assumptions described in the previous step.

The first transaction was made on a futures contract for the S&P500 index. In mid-June 2012, the quotes were in an upward trend (above the 200-day moving average) and **three consecutive price lows** (the first three candles in the rectangle on the left) **fell within a narrow price range (price cluster)** – the difference between the highest low and the lowest low was less than 20% of the price range of those three days (calculations omitted for clarity). **Therefore, the conditions for opening a position were met and a long position was opened the next day for opening.**

Stop loss, as well as **the trailing stop, were set at the level of the moving average** (red dots). S&P500 quotes were rising for several months, but at the beginning of October 2012, the quotes entered a correction phase. At the beginning of November 2012, the quotes fell dynamically to the level of the moving average, **executing the stop loss order** - **the position was closed. The system worked correctly.**

The second transaction was made on a futures contract for EU CO2 emission allowances. In mid-June 2024, the prices were in a downward trend (below the 200-day moving average) and **the three subsequent price maximums** (the first three candles in the rectangle on the left) **fell within a narrow price range. (price**

cluster) – the difference between the highest high and the lowest high was less than 20% of the price range of those three days (calculations omitted for clarity). **Therefore, the conditions for opening a position were met and a short position was opened the next day for the opening.**

Stop loss, as well as **the trailing stop, were set at the level of the moving average** (red dots). Despite the initial decline in EUA quotes, at the beginning of July 2024 the quotes dynamically rose to the level of the moving average, **executing the stop loss order** - **the position was closed. The system worked correctly.**

Once we are sure that the transactions are generated correctly, we can proceed to the first test of the strategy on the full **in-sample data set.** These tests are performed on **the base parameters,** which in my opinion correspond to the assumed goals of the strategy.

First of all, **we reject strategies that linearly lose capital.** If a strategy exhibits such a pattern, it is a clear signal that any parameter optimization does not make sense.

Our basic expectation is that the strategy generates **positive results,** even if they are at a low level.

Tested base parameters:

- **Number of days constituting the price formation:** 3 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 20%;
- **Moving average:** 200 days;
- **Initial stop loss and trailing stop loss:** moving average;
- **Method of opening a position:** at the opening price;
- **Position size:** corresponding to the risk of 0.5% of the total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening position;
- **Position direction:** long (buy) and short (sell) positions.

The test result is shown below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
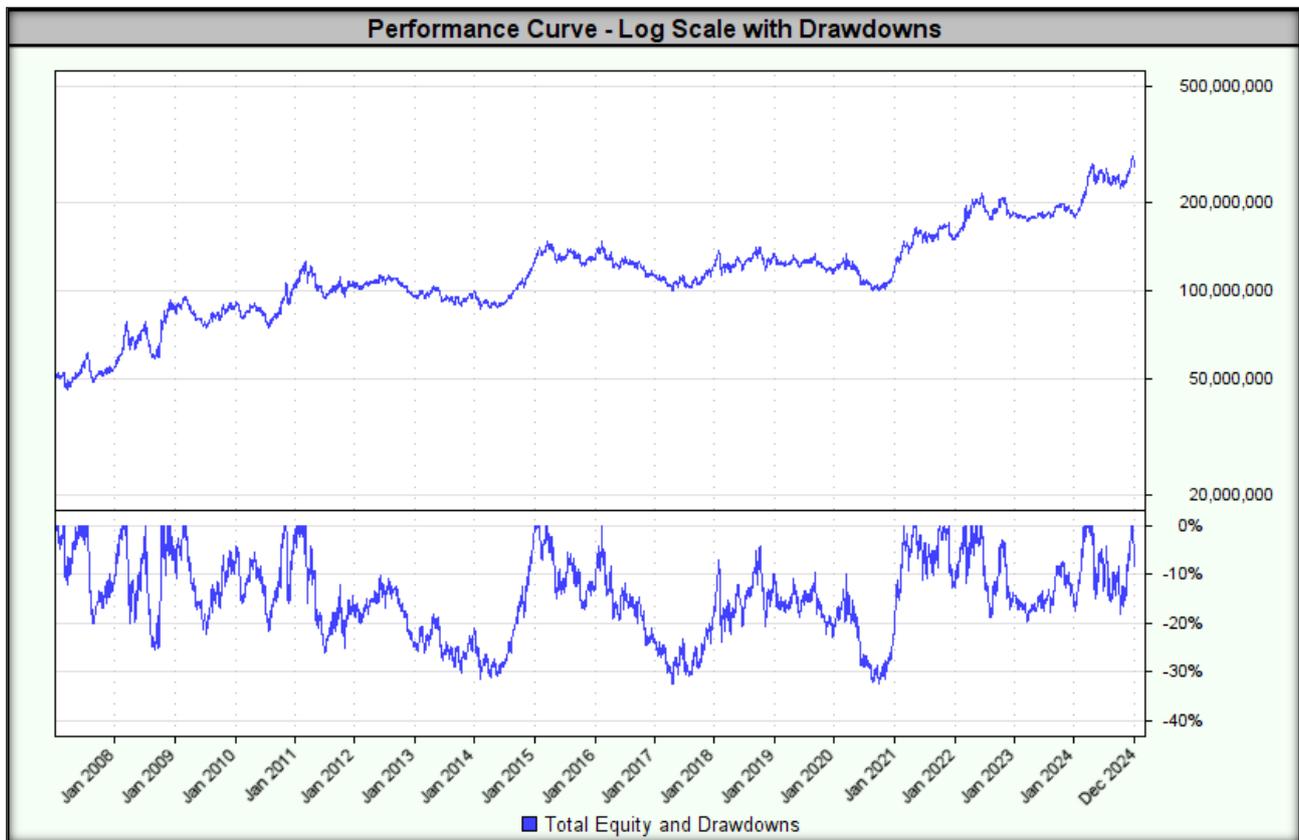
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Indicators/Measures	Concluding a transaction at the opening price
CAGR%	10.0%
MAR Ratio	0.31
RAR%	6.3%
R-Cubed	0.10
Robust Sharpe Ratio	0.31
Max Drawdown	32.4%
Wins	16.1%
Losses	83.9%
Average Win%	2.18%
Average Loss%	0.29%
Win/Loss Ratio	7.42
Average Trade Duration (days)	59
Percent Profit Factor	1.42
SQN	0.41
Number of transactions	2222

In summary, the system works properly and generates signals as expected. Additionally, tests on basic parameters yielded good results. We can therefore move on to the most interesting stage of creating an investment strategy – **optimization.**

Step 4: Optimization and assessment of investment strategy stability

This stage of strategy creation and testing is **crucial,** as it determines how **effective** the strategy will be in **real conditions. I cannot** emphasize enough that for **a strategy to work** in real conditions, it must also work on **suboptimal parameters** and in **suboptimal conditions.** In a word – **it must be stable** to changing market conditions.

I don't know who said these words, but they perfectly reflect the problem of many optimizations:

"I've never seen a strategy that didn't work in backtests."

My goal is not to find **optimal parameter values** – **my goal** is to find **a wide range of parameters** for which the strategy will generate **acceptable results. We don't know the future,** we don't know future market conditions, but if we know that our strategy **has historically generated acceptable results** in various market conditions and across various parameter ranges, then we are **one step ahead of other** market participants.

What **parameters to choose** for the next period is the subject of consideration in **Step 5 of the "Walk-Forward Analysis,"** but before we get to that, **we need to know whether our strategy is stable** at all.

1. **Stability across a wide range of optimized parameters**

Tri-Zone Reversal v.1 strategy in this version assumes **the optimization of parameters proposed by the creator of the strategy, Art Collins, and the addition and optimization of parameters for the moving average** filtering out transactions that are inconsistent with the dominant trend. We will optimize using **The Grid Search** method, which consists in **full optimization of all indicated parameters by creating a wide range of possible combinations.** Our goal is to find such **parameter ranges** that **the strategy remains stable (robust),** which will allow us to assess its usefulness in real market conditions.

The key criterion for assessing stability is that all test results must show a positive MAR value and the maximum drawdown must not exceed 250% of the drawdown value for the result with the highest MAR. If any test generates a negative MAR value or if the drawdown exceeds 250% of the drawdown value for the result with the highest MAR, the strategy is rejected completely.

In the first step, we test the stability of parameters on **in-sample** data. For this purpose, we determine **the ranges of parameter values** so that **the quotient of the highest and lowest value of the range is at least 150%.**

In the tested strategy, the ranges defined in this way are:

- **Number of days forming a price formation:** range **2-4 days (step: 1);**
- **Maximum range of the price cluster relative to the entire price range of the price formation:** range **15%-30% (step: 2.5 pp);**
- **Moving average:** range **150-250 days (step: 5).**

The lowest MAR value of 0.08 was achieved for the following parameters:
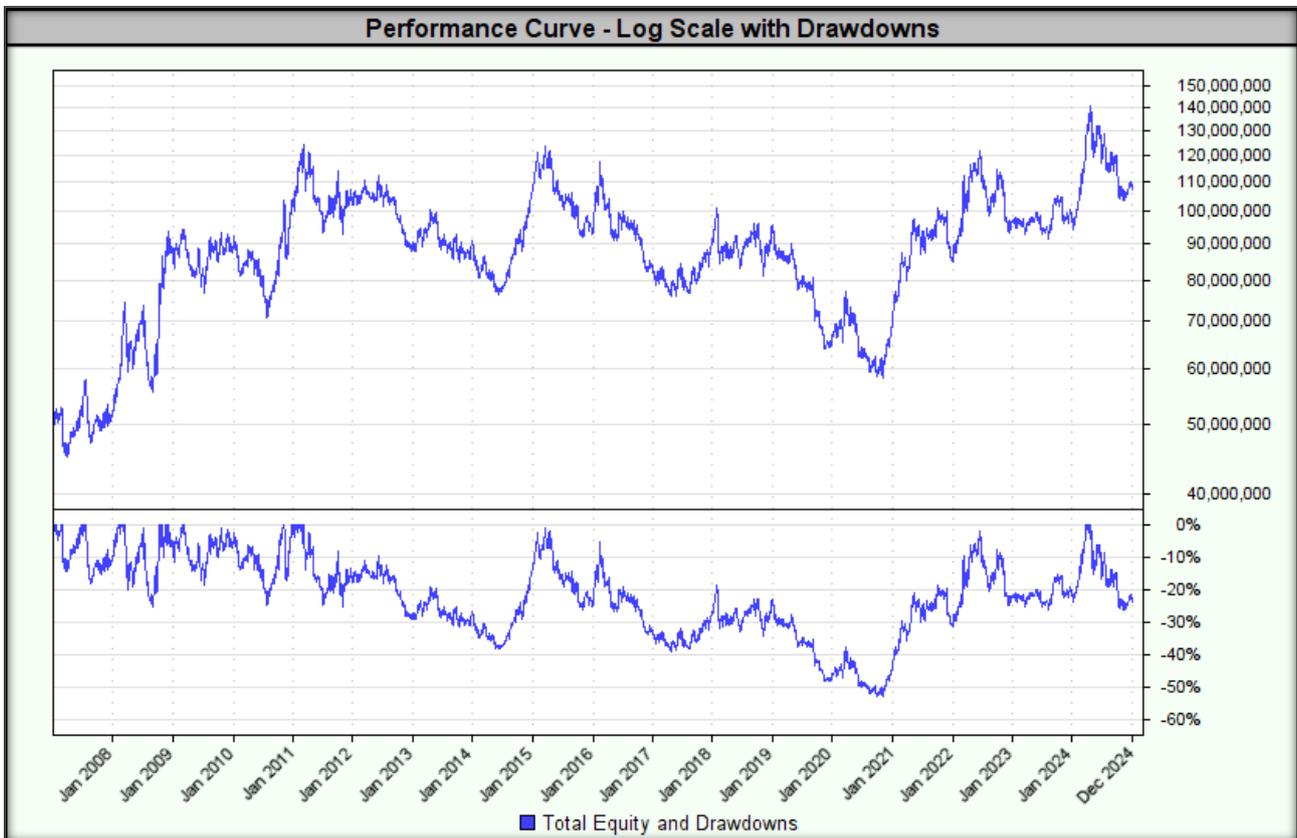
- **Number of days constituting the price formation:** 2 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 15%;
- **Moving average:** 160 days.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
3	2	15.0%	160	$107,099,322.62	4.32%	0.08	0.30	0.23	53.0%	156.6	4158	0.02	1.62
150	3	15.0%	160	$119,094,530.01	4.94%	0.09	0.34	0.27	54.6%	156.5	1922	0.02	1.82
24	2	17.5%	160	$119,257,232.68	4.95%	0.10	0.33	0.26	50.7%	86.7	4496	0.02	2.35
2	2	15.0%	155	$122,914,986.17	5.12%	0.10	0.34	0.27	50.2%	85.6	4161	0.03	2.63
66	2	22.5%	160	$122,967,411.57	5.13%	0.10	0.34	0.28	49.2%	86.7	5123	0.03	2.56
45	2	20.0%	160	$125,842,340.73	5.26%	0.10	0.34	0.28	50.1%	86.7	4796	0.03	2.74
151	3	15.0%	165	$129,404,860.20	5.43%	0.11	0.37	0.30	51.7%	135.2	1861	0.03	2.47
87	2	25.0%	160	$124,811,208.28	5.21%	0.11	0.34	0.29	47.0%	85.0	5374	0.03	2.81

Below is a graph of the equity curve for **the strategy with the lowest MAR.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

The highest MAR value of 0.48 was achieved for the following parameters:

- **Number of days forming the price formation:** 4 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 22.5%;
- **Moving average:** 220 days.

The highest MAR value was accompanied by **a drawdown of 26.5%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
372	4	22.5%	220	$430,138,918.23	12.70%	0.48	0.73	0.73	26.5%	44.8	1361	0.28	10.21
371	4	22.5%	215	$428,216,977.69	12.67%	0.48	0.73	0.74	26.5%	44.8	1379	0.29	10.22
373	4	22.5%	225	$423,742,402.47	12.61%	0.47	0.72	0.68	26.8%	44.8	1357	0.27	10.19
370	4	22.5%	210	$373,762,100.99	11.82%	0.45	0.70	0.73	26.0%	44.8	1397	0.23	9.21
329	4	17.5%	215	$384,908,817.30	12.01%	0.45	0.75	0.78	26.5%	28.1	917	0.35	10.05
374	4	22.5%	230	$409,343,579.64	12.39%	0.45	0.71	0.65	27.3%	44.8	1331	0.24	10.02
415	4	27.5%	225	$427,179,477.41	12.66%	0.44	0.69	0.65	28.5%	45.7	1846	0.19	9.34
414	4	27.5%	220	$416,024,804.44	12.49%	0.44	0.69	0.67	28.3%	45.4	1850	0.20	9.40

Below is a graph of the equity curve for **the strategy with the highest MAR.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

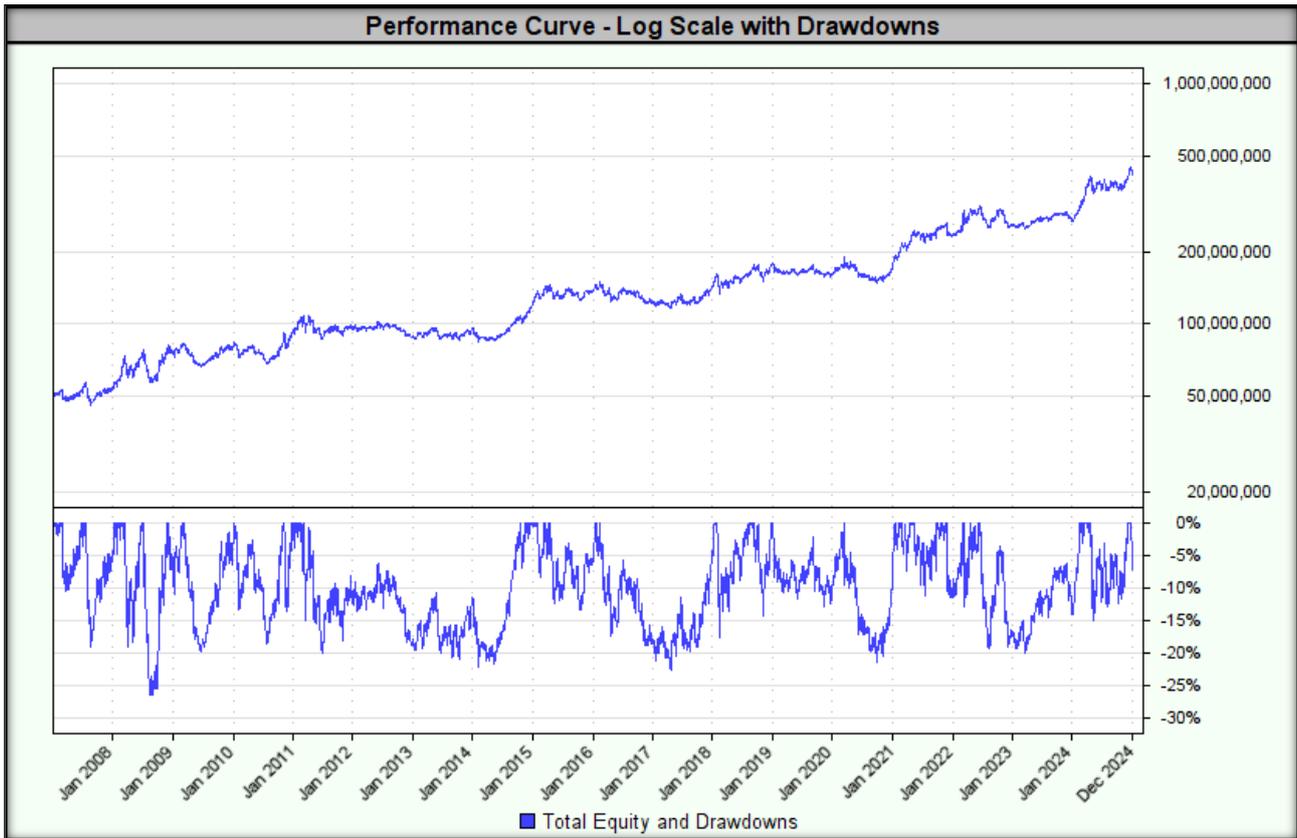For all combinations of tested parameter ranges, **the highest drawdown was 54.6%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD ▽	Longest DD	Trades	R3	RAR [%]
150	3	15.0%	160	$119,094,530.01	4.94%	0.09	0.34	0.27	54.6%	156.5	1922	0.02	1.82
3	2	15.0%	160	$107,099,322.62	4.32%	0.08	0.30	0.23	53.0%	156.6	4158	0.02	1.62
213	3	22.5%	160	$142,829,142.70	6.01%	0.12	0.38	0.30	52.1%	86.7	2951	0.03	2.81
151	3	15.0%	165	$129,404,860.20	5.43%	0.11	0.37	0.30	51.7%	135.2	1861	0.03	2.47
192	3	20.0%	160	$142,645,361.00	6.00%	0.12	0.39	0.31	51.4%	86.7	2595	0.03	2.81
24	2	17.5%	160	$119,257,232.68	4.95%	0.10	0.33	0.26	50.7%	86.7	4496	0.02	2.35
2	2	15.0%	155	$122,914,986.17	5.12%	0.10	0.34	0.27	50.2%	85.6	4161	0.03	2.63
45	2	20.0%	160	$125,842,340.73	5.26%	0.10	0.34	0.28	50.1%	86.7	4796	0.03	2.74

In summary, the strategy **passed the stability test** over a wide range of optimized parameters on in-sample data because:

- **All test results showed a positive MAR value** – which indicates the stability of the strategy in various market conditions.

- **The maximum drawdown did not exceed 250% of the drawdown value** for the result with the highest MAR (**54.6% vs. 26.5 %**) – which means an acceptable risk of deep capital drawdowns.

Heatmaps for the tested ranges are presented below.

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

MAR as Tri-Zone Bars Varies

■ Maximum ■ Average + SD ■ Average ■ Average - SD ■ Minimum

MAR as Tri-Zone compression Varies

MAR as Moving Average (bars) Varies
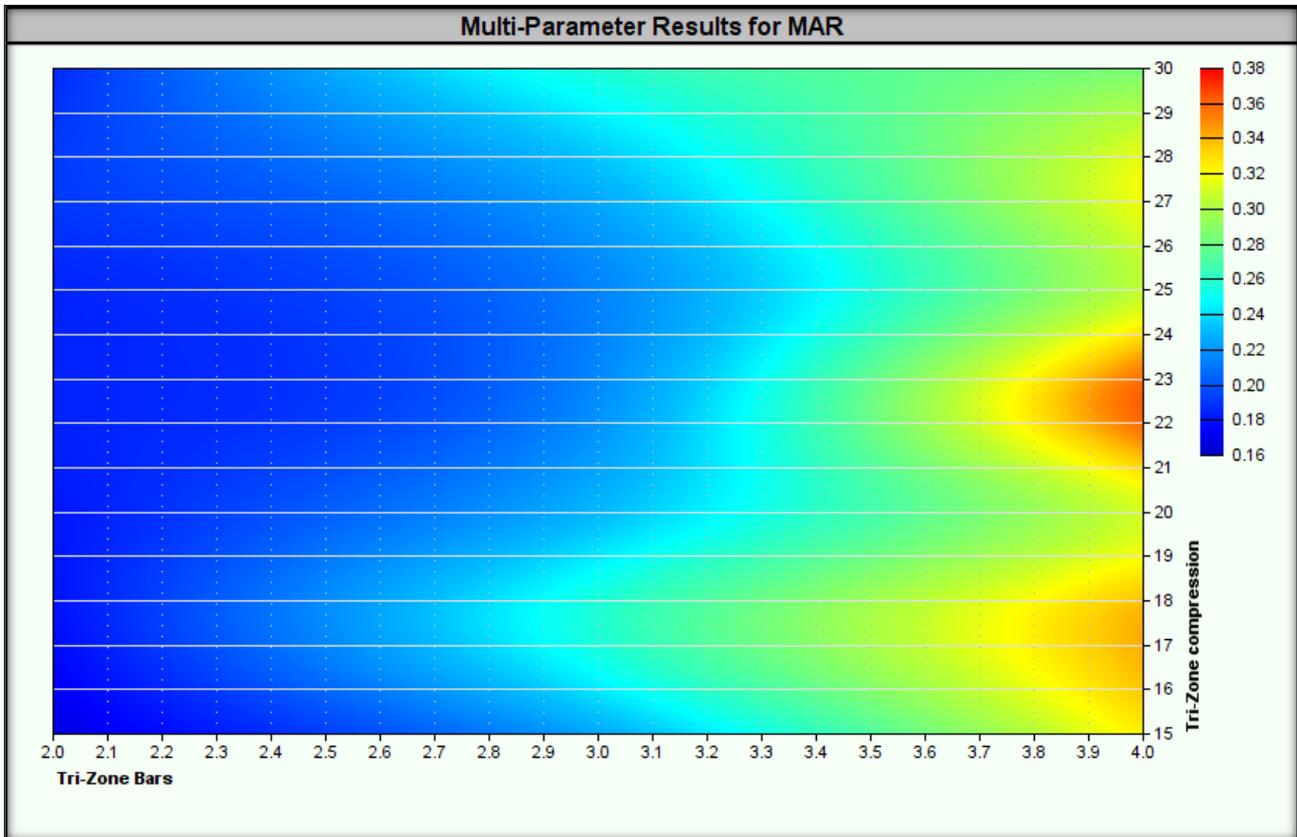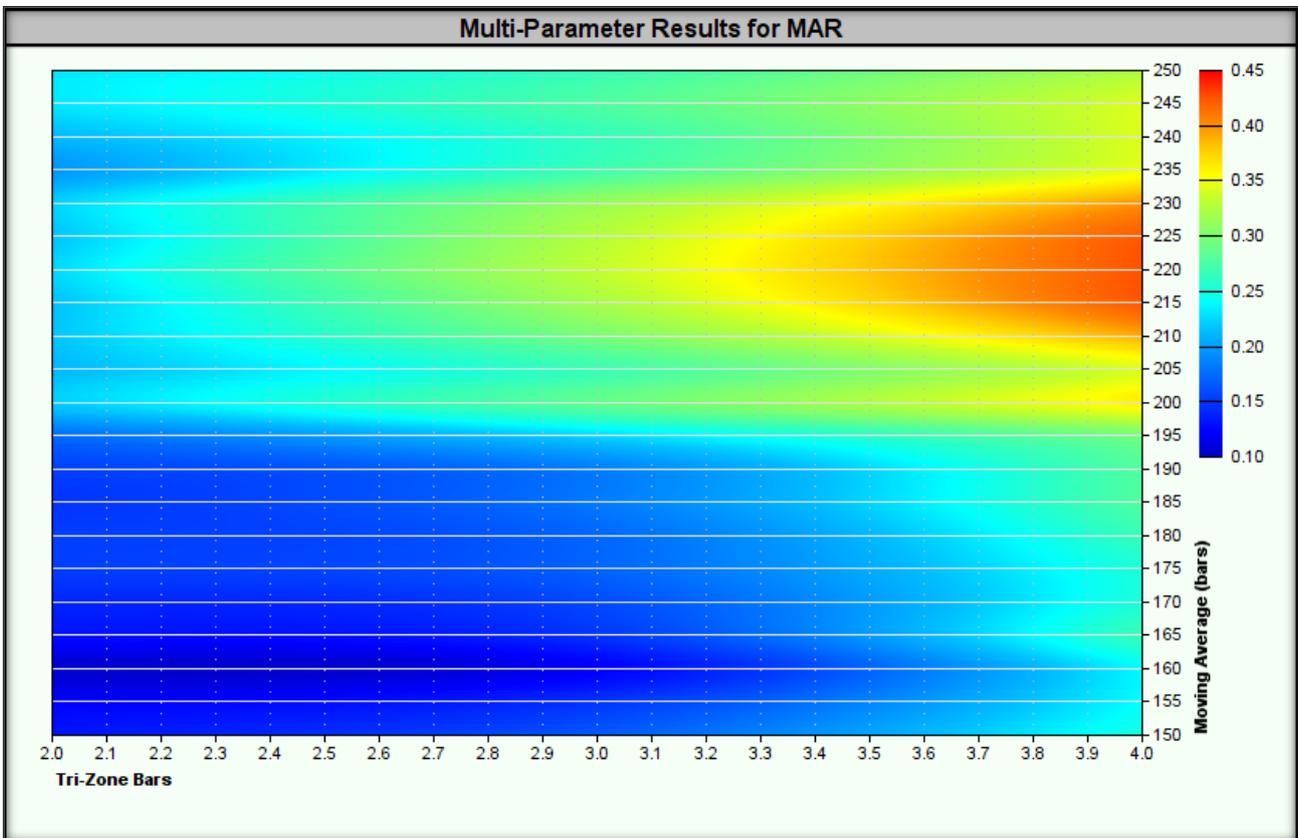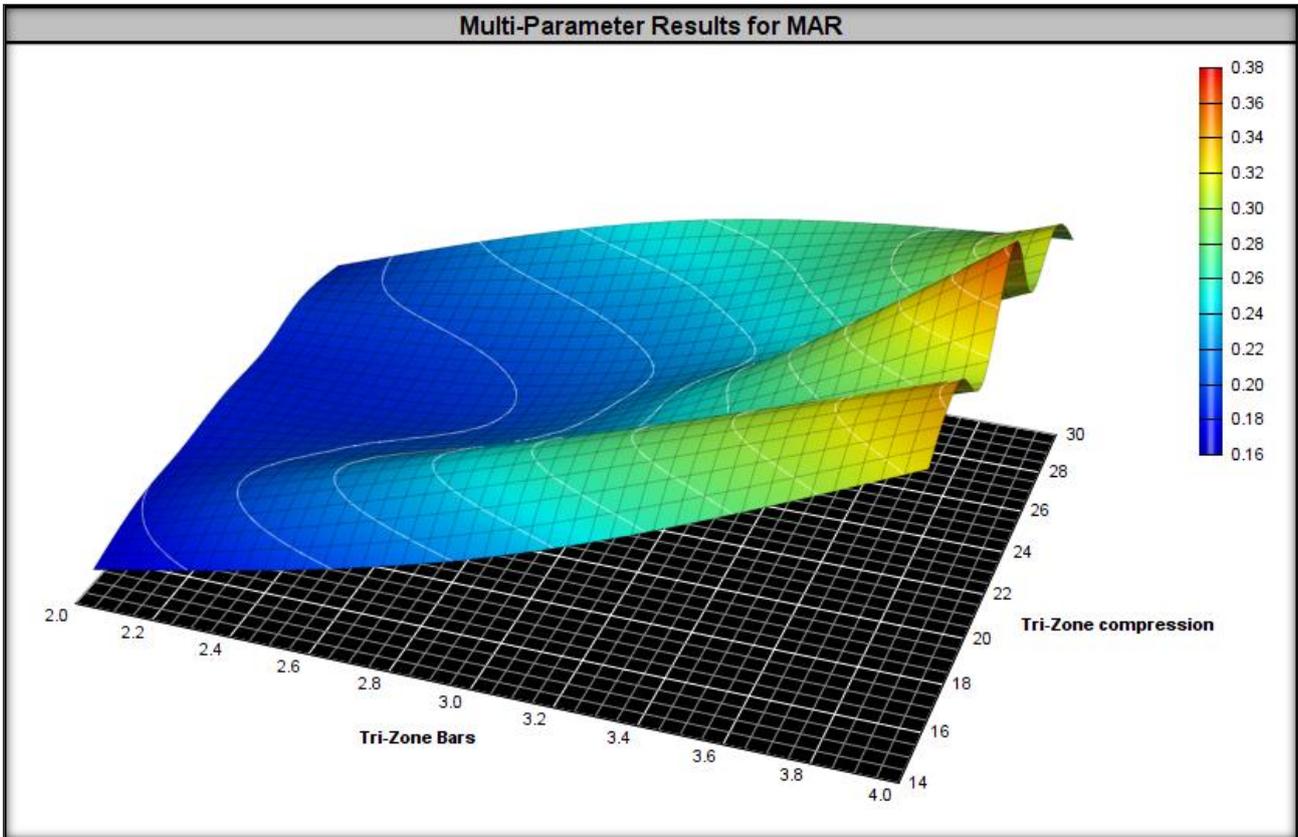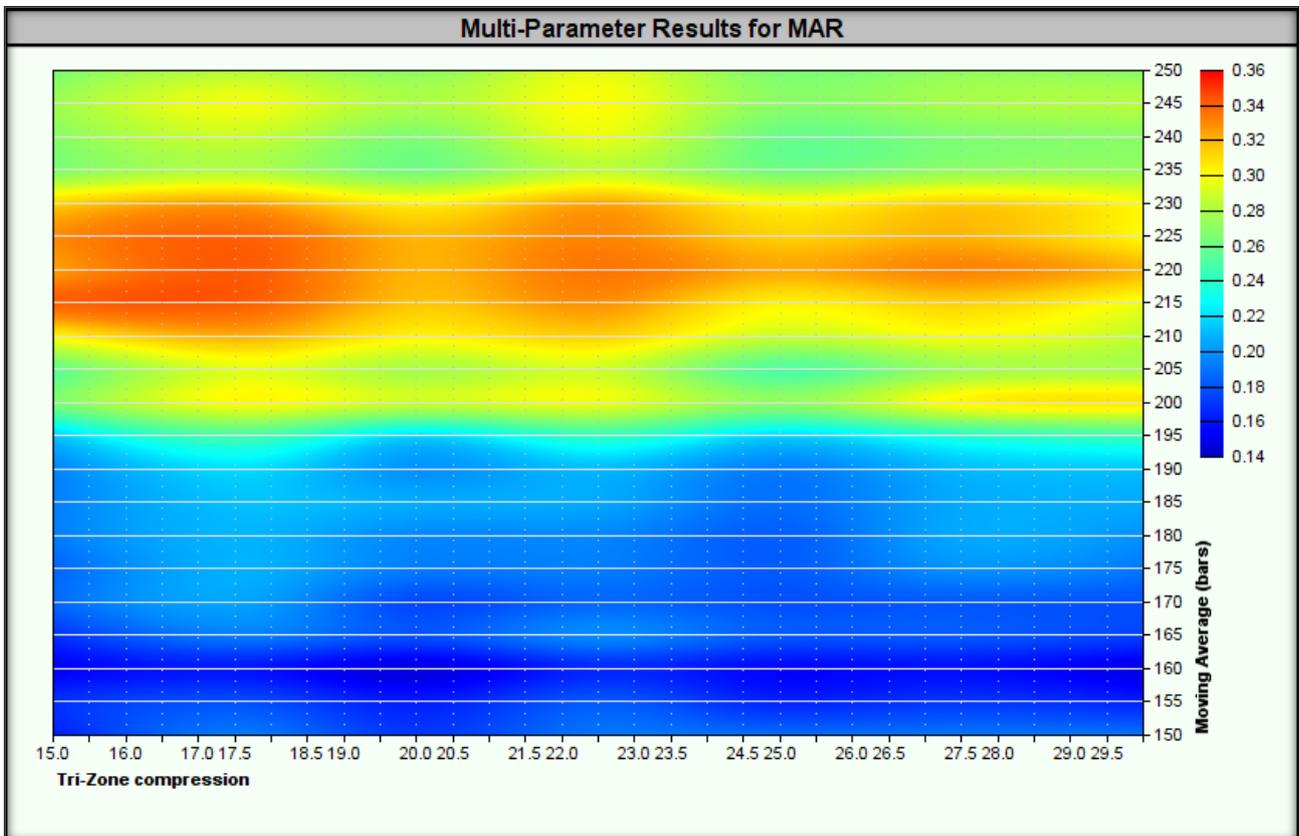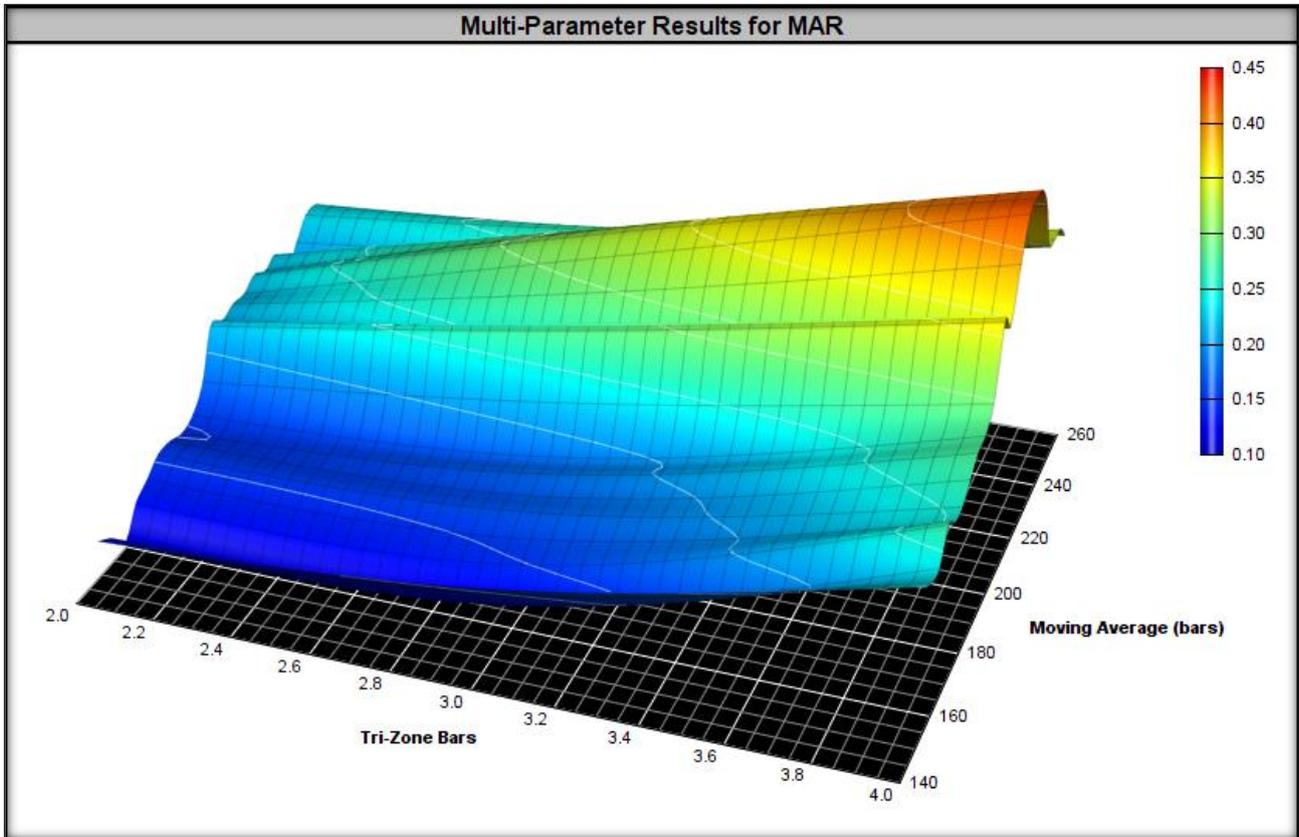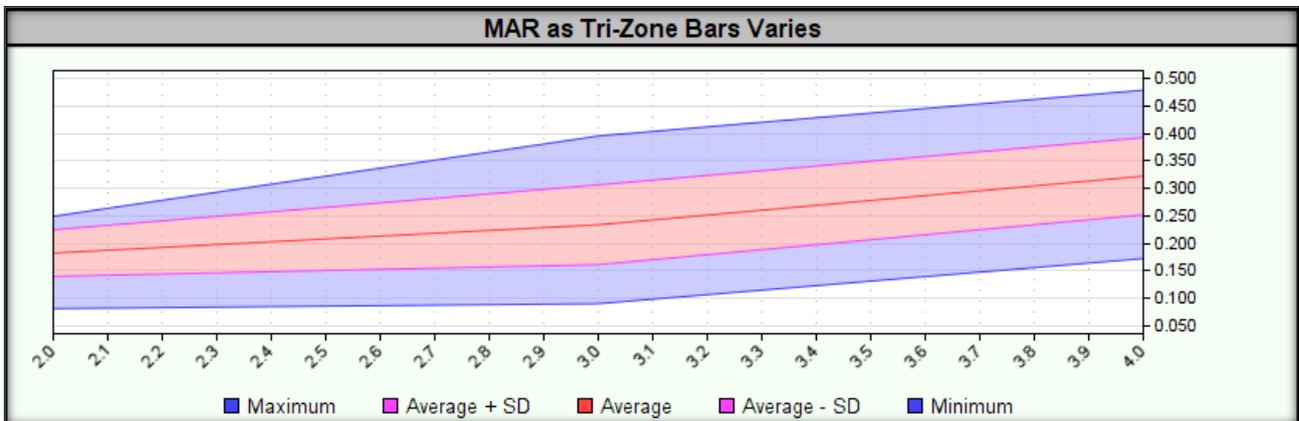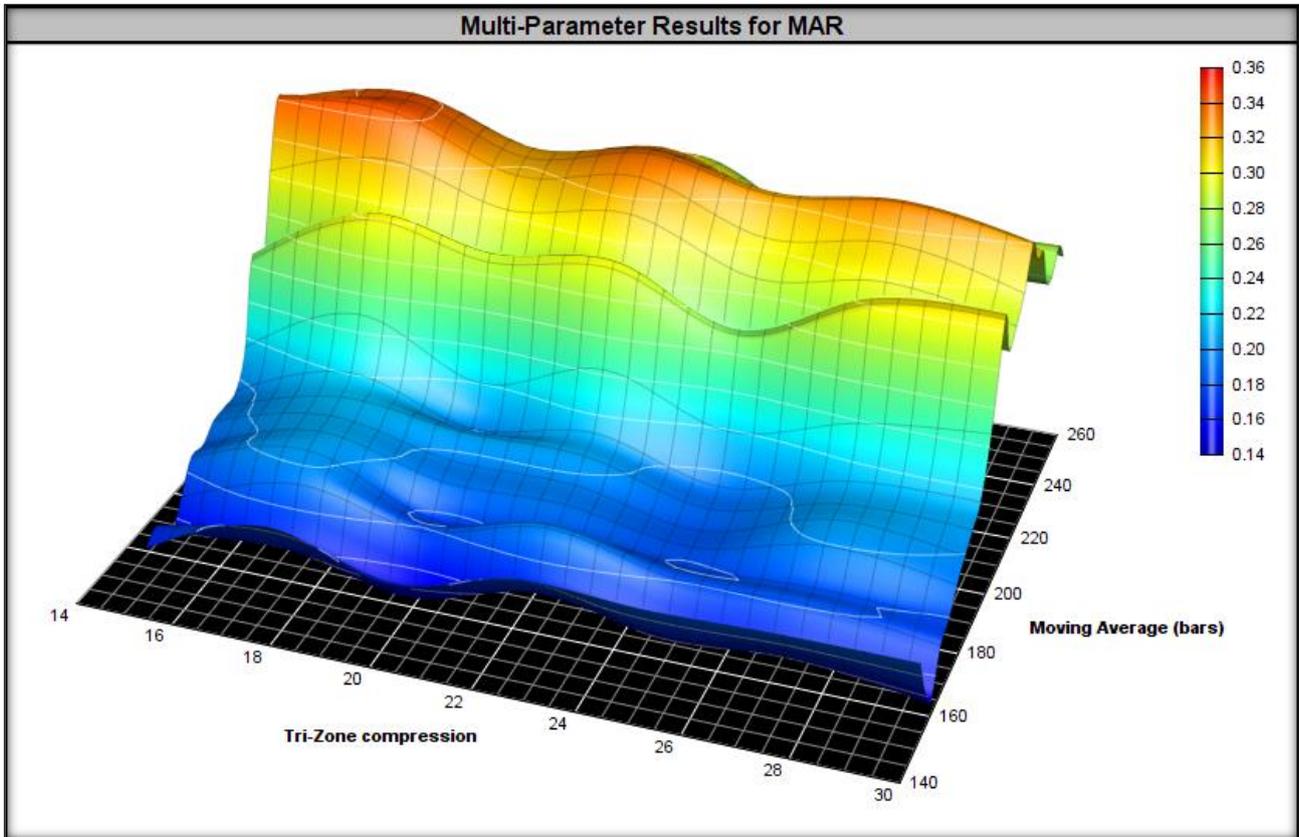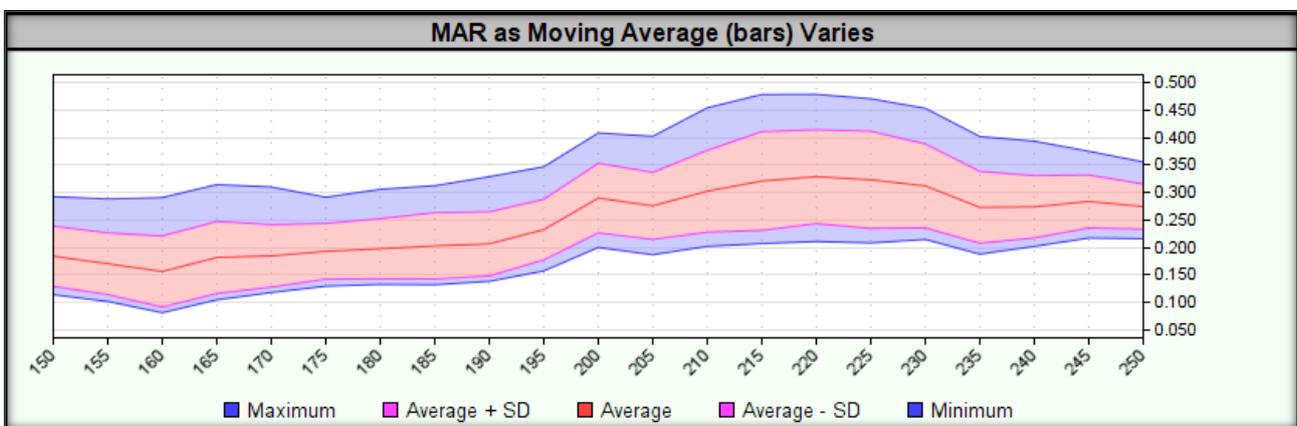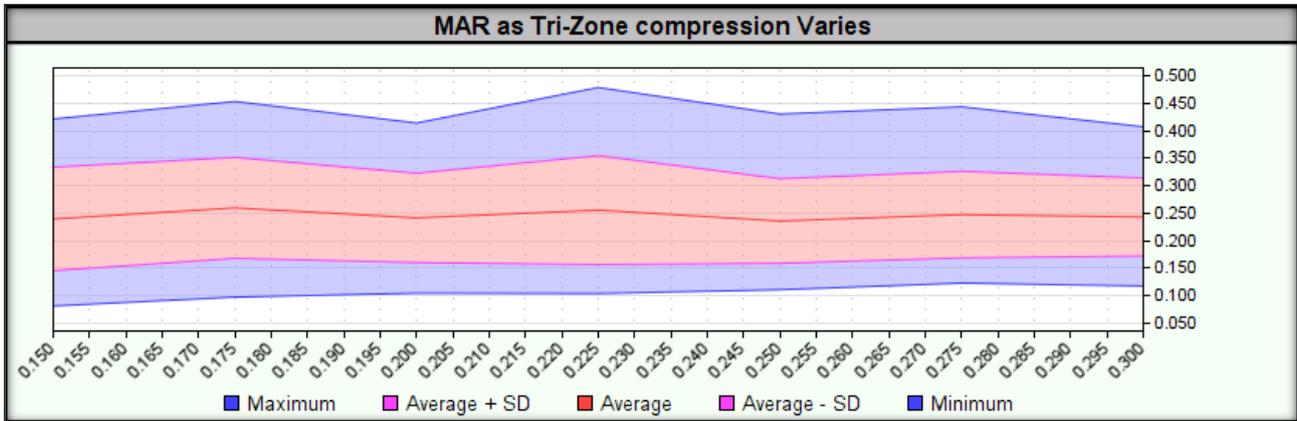
After passing the stability tests on **in-sample data,** it is time perform the same on **out-of-sample data.** For this purpose, we use **the same range of parameters** as on in-sample data:

- **Number of days forming a price formation:** range **2-4 days (step: 1);**
- **Maximum range of the price cluster relative to the entire price range of the price formation:** range **15%-30% (step: 2.5 pp);**
- **Moving average:** range **150-250 days (step: 5).**

The lowest MAR value of 0.26 was achieved for the following parameters:

- **Number of days forming the price formation:** 4 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 17.5%;
- **Moving average:** 160 days.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
318	4	17.5%	160	$88,528,724.66	6.56%	0.26	0.54	0.62	25.7%	35.4	411	0.25	3.74
358	4	22.5%	150	$85,923,296.19	6.21%	0.26	0.46	0.87	23.8%	21.3	698	0.24	3.95
317	4	17.5%	155	$87,304,695.21	6.40%	0.29	0.53	0.66	21.8%	27.3	427	0.30	4.06
316	4	17.5%	150	$86,503,371.74	6.29%	0.30	0.54	0.70	21.2%	27.3	431	0.33	4.27
296	4	15.0%	155	$77,235,951.73	4.96%	0.30	0.48	0.74	16.2%	19.4	313	0.25	3.51
339	4	20.0%	160	$92,659,397.25	7.10%	0.31	0.53	0.68	23.1%	27.5	539	0.21	3.50
148	3	15.0%	150	$100,408,033.04	8.06%	0.31	0.54	0.74	26.0%	31.2	806	0.28	5.56
319	4	17.5%	165	$103,077,007.07	8.38%	0.32	0.65	0.75	26.1%	28.6	407	0.38	5.23
337	4	20.0%	150	$90,918,326.80	6.88%	0.32	0.53	0.87	21.3%	21.3	566	0.25	4.43
338	4	20.0%	155	$92,517,470.64	7.08%	0.32	0.54	0.77	21.8%	22.9	559	0.24	4.01

Below is a graph of the equity curve for **the strategy with the lowest MAR.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Performance Curve - Log Scale with Drawdowns

Total Equity and Drawdowns

The highest MAR value of 0.72 was achieved for the following parameters:

- **Number of days constituting the price formation:** 4 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 25%;
- **Moving average:** 235 days.

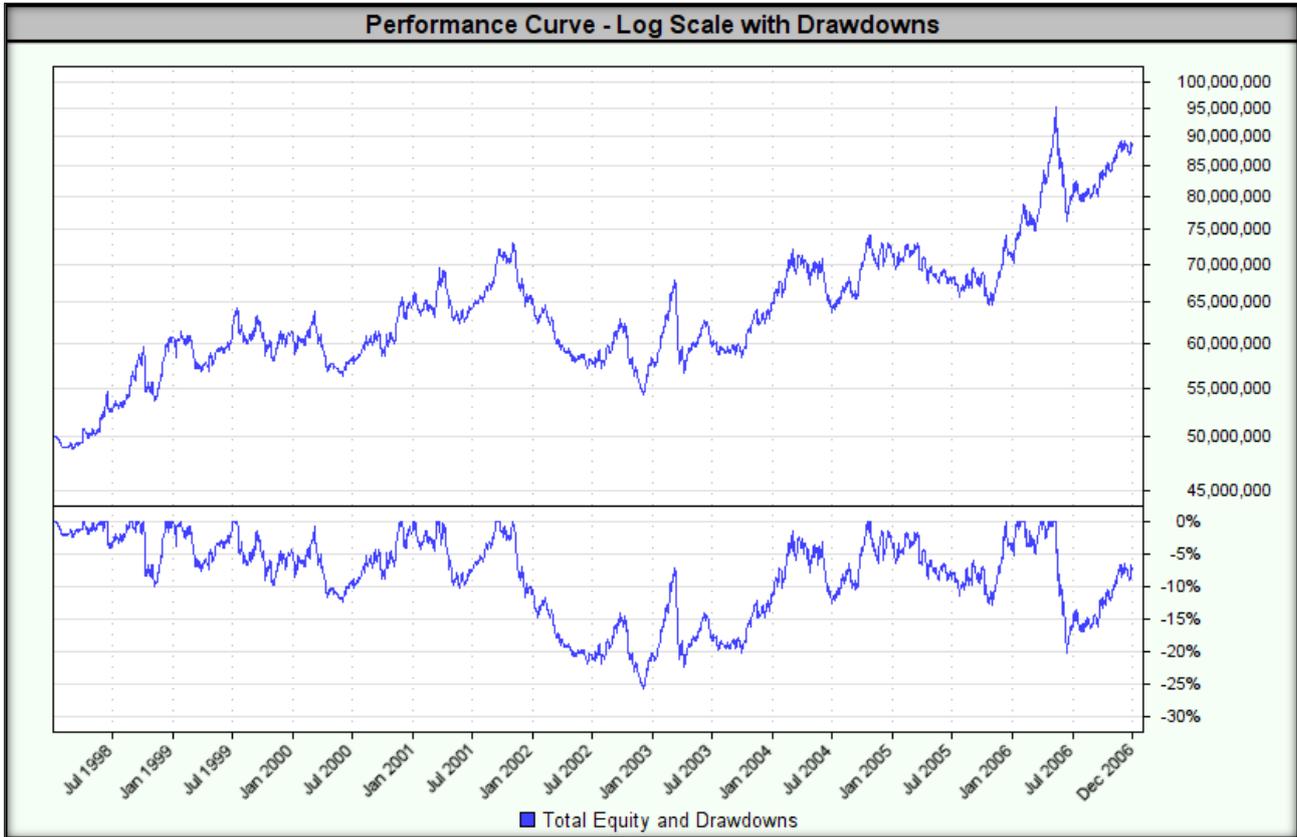**The highest MAR value** was accompanied by **a drawdown of 24.8%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
396	4	25.0%	235	$220,571,429.80	17.95%	0.72	1.02	2.09	24.8%	9.8	565	1.48	16.15
395	4	25.0%	230	$218,195,852.59	17.81%	0.72	1.01	1.98	24.7%	12.1	577	1.46	16.10
375	4	22.5%	235	$197,773,428.35	16.53%	0.71	0.97	1.91	23.4%	10.4	479	1.54	14.58
374	4	22.5%	230	$193,548,320.11	16.25%	0.70	0.96	1.88	23.2%	10.4	489	1.51	14.36
249	3	25.0%	235	$237,943,660.92	18.95%	0.70	0.99	1.31	27.3%	18.0	967	1.21	17.03
17	2	15.0%	230	$245,195,672.60	19.34%	0.70	0.99	1.14	27.8%	19.8	1259	0.92	16.72
291	3	30.0%	235	$237,914,408.32	18.95%	0.69	0.98	1.19	27.5%	18.5	1181	1.14	16.90
417	4	27.5%	235	$219,285,495.42	17.87%	0.69	0.99	1.96	26.0%	9.8	660	1.45	16.35
416	4	27.5%	230	$216,458,899.30	17.70%	0.68	0.98	1.84	25.9%	9.8	682	1.41	16.21
38	2	17.5%	230	$237,296,393.05	18.91%	0.68	0.96	1.12	27.8%	19.8	1358	0.85	16.33

Below is a graph of the equity curve for **the strategy with the highest MAR.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Performance Curve - Log Scale with Drawdowns
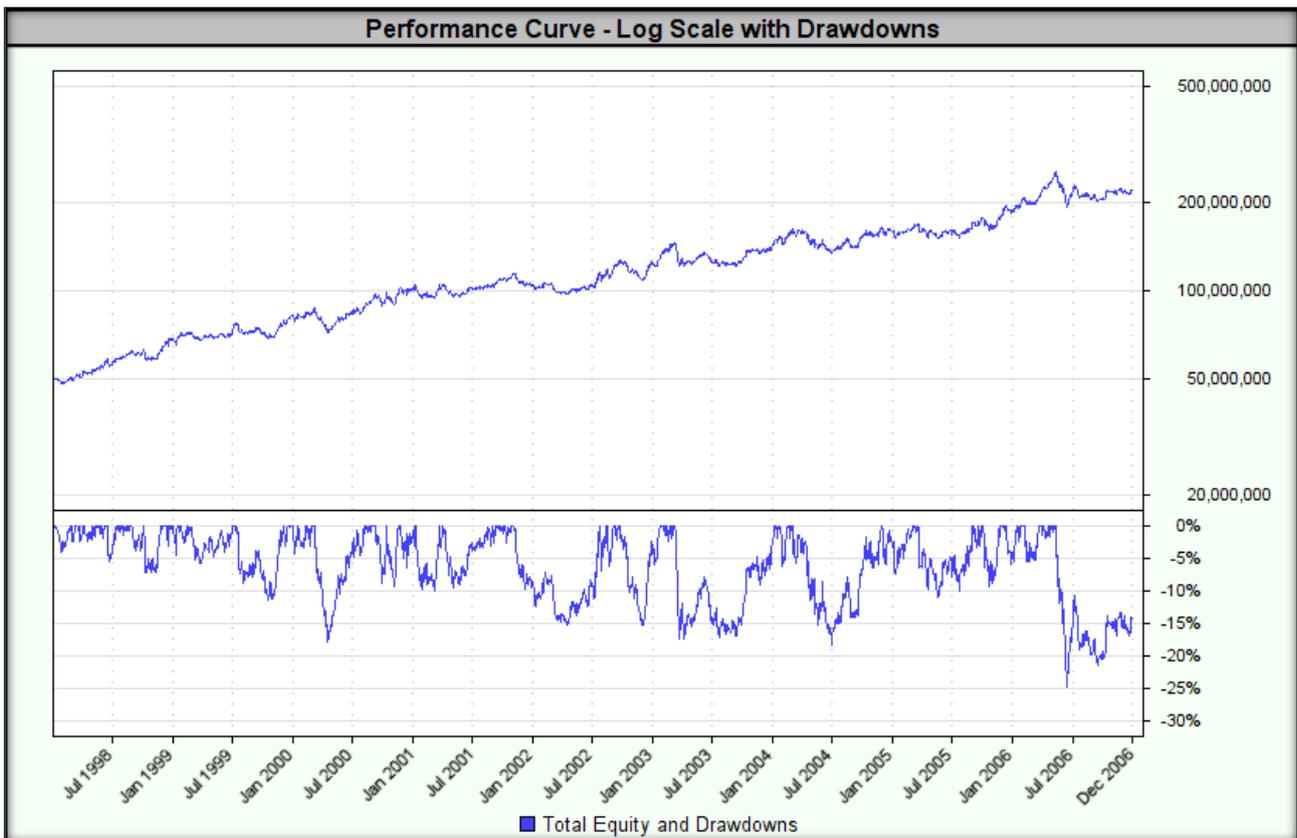
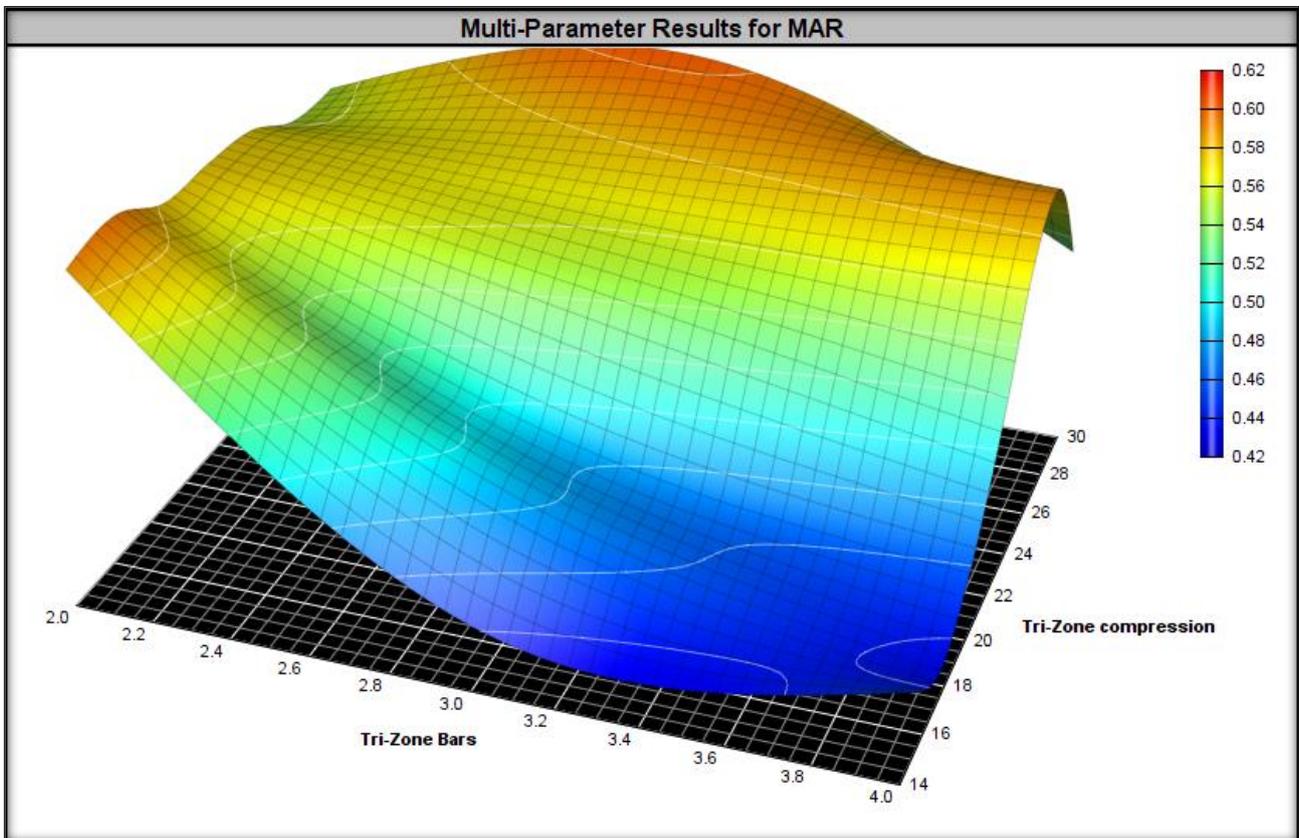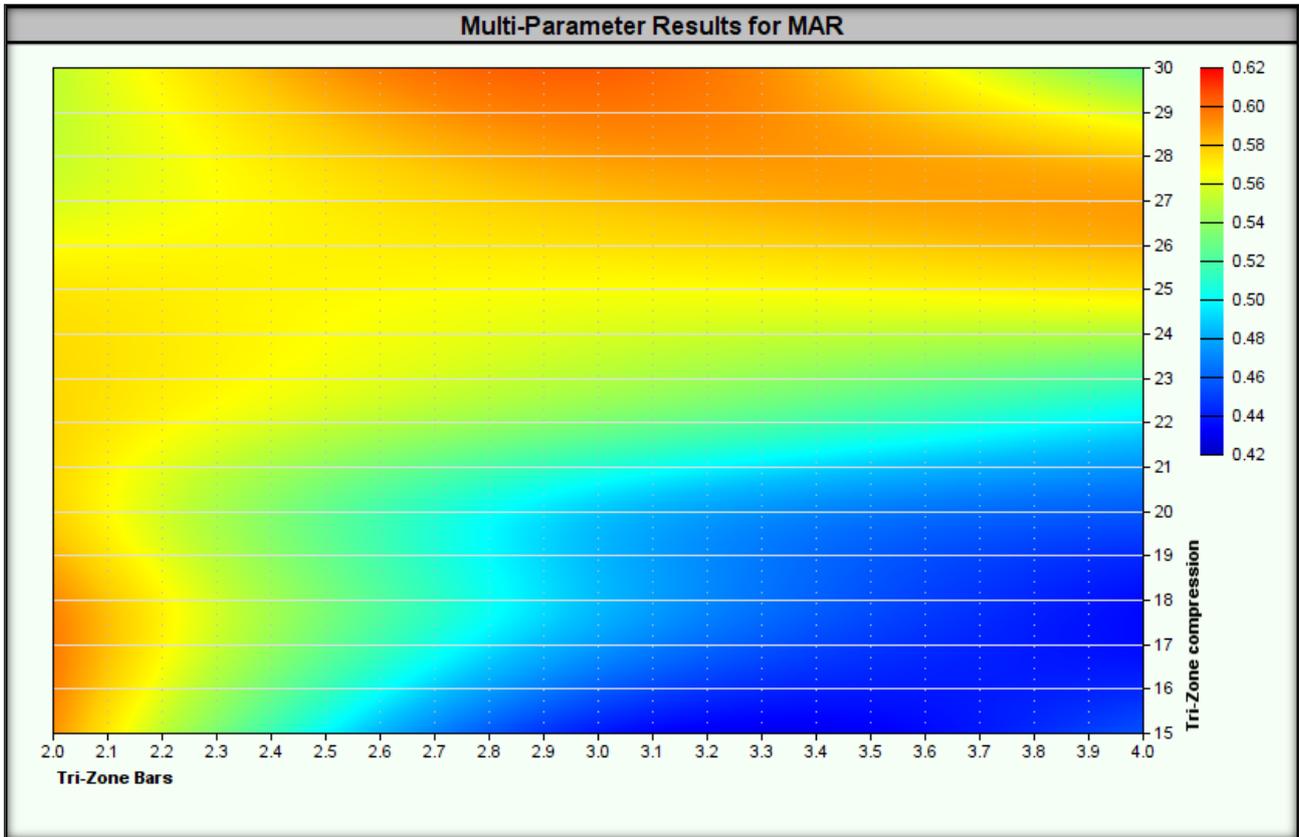For all combinations of tested parameter ranges, **the highest drawdown was 30.3%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Test	Tri-Zone Bars	Tri-Zone compression	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
129	2	30.0%	160	$150,807,931.53	13.06%	0.43	0.70	0.82	30.3%	24.8	2315	0.36	9.29
127	2	30.0%	150	$163,557,418.92	14.09%	0.47	0.76	0.98	29.8%	24.2	2386	0.47	10.15
22	2	17.5%	150	$163,581,272.44	14.09%	0.48	0.78	1.03	29.6%	24.2	1837	0.48	10.29
108	2	27.5%	160	$150,486,876.86	13.04%	0.44	0.70	0.82	29.4%	24.4	2236	0.34	9.12
130	2	30.0%	165	$154,321,727.56	13.35%	0.46	0.71	0.81	29.3%	24.2	2270	0.40	9.25
294	3	30.0%	250	$215,893,108.76	17.67%	0.61	0.92	1.15	28.9%	19.1	1149	0.88	15.40
202	3	20.0%	210	$170,501,467.28	14.62%	0.51	0.82	1.14	28.9%	18.3	845	0.67	12.01
201	3	20.0%	205	$155,596,780.10	13.46%	0.47	0.76	1.04	28.8%	20.4	870	0.56	10.83
128	2	30.0%	155	$157,697,230.02	13.63%	0.47	0.73	0.85	28.8%	24.2	2337	0.42	9.59
121	2	27.5%	225	$201,829,385.69	16.79%	0.58	0.87	1.01	28.8%	21.6	1790	0.59	13.80

In summary, the strategy **passed the stability test** over a wide range of optimized parameters on out-of-sample data because:

- **All test results showed a positive MAR value** – which indicates the stability of the strategy in various market conditions.
- **The maximum drawdown on out-of-sample data did not exceed 150% of the maximum drawdown value on in-sample data (30.3 % vs. 54.6 %)** – which means an acceptable risk of capital drawdown.
- **The decrease in the maximum MAR value on the out-of-sample data was less than 50% relative to the in-sample test results (0.72 vs. 0.48)** – indicating that the strategy can perform well in a variety of market conditions.

Heatmaps for the tested ranges are presented below.

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

Multi-Parameter Results for MAR

MAR as Tri-Zone Bars Varies

MAR as Tri-Zone compression Varies

MAR as Moving Average (bars) Varies
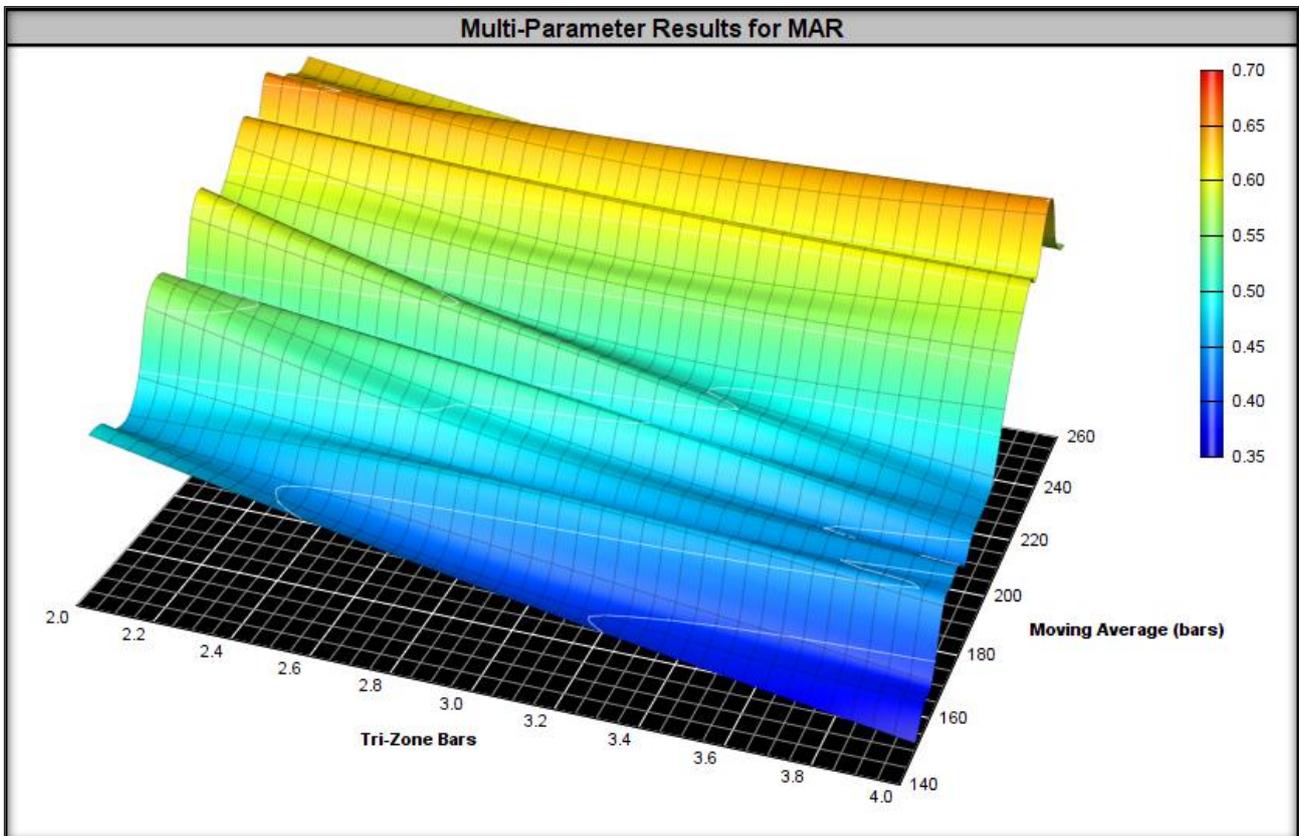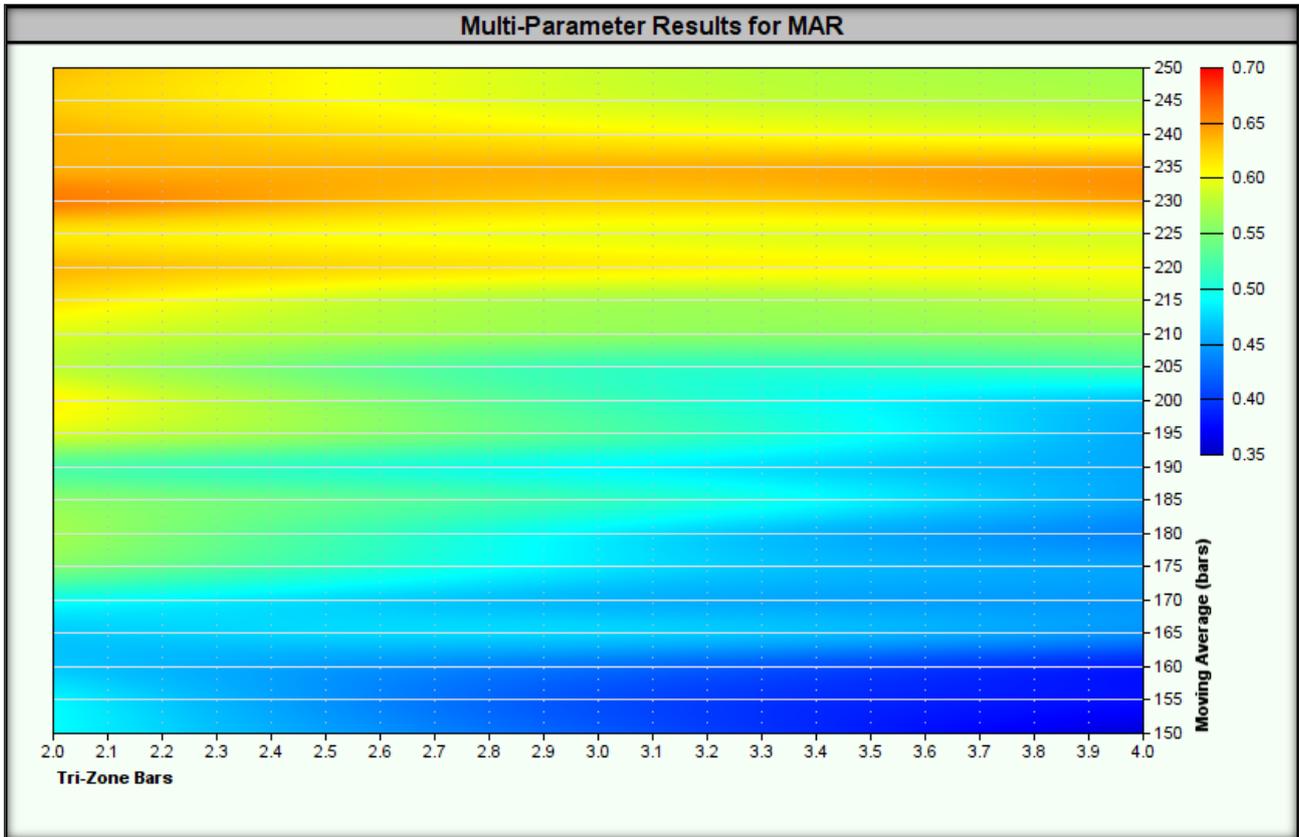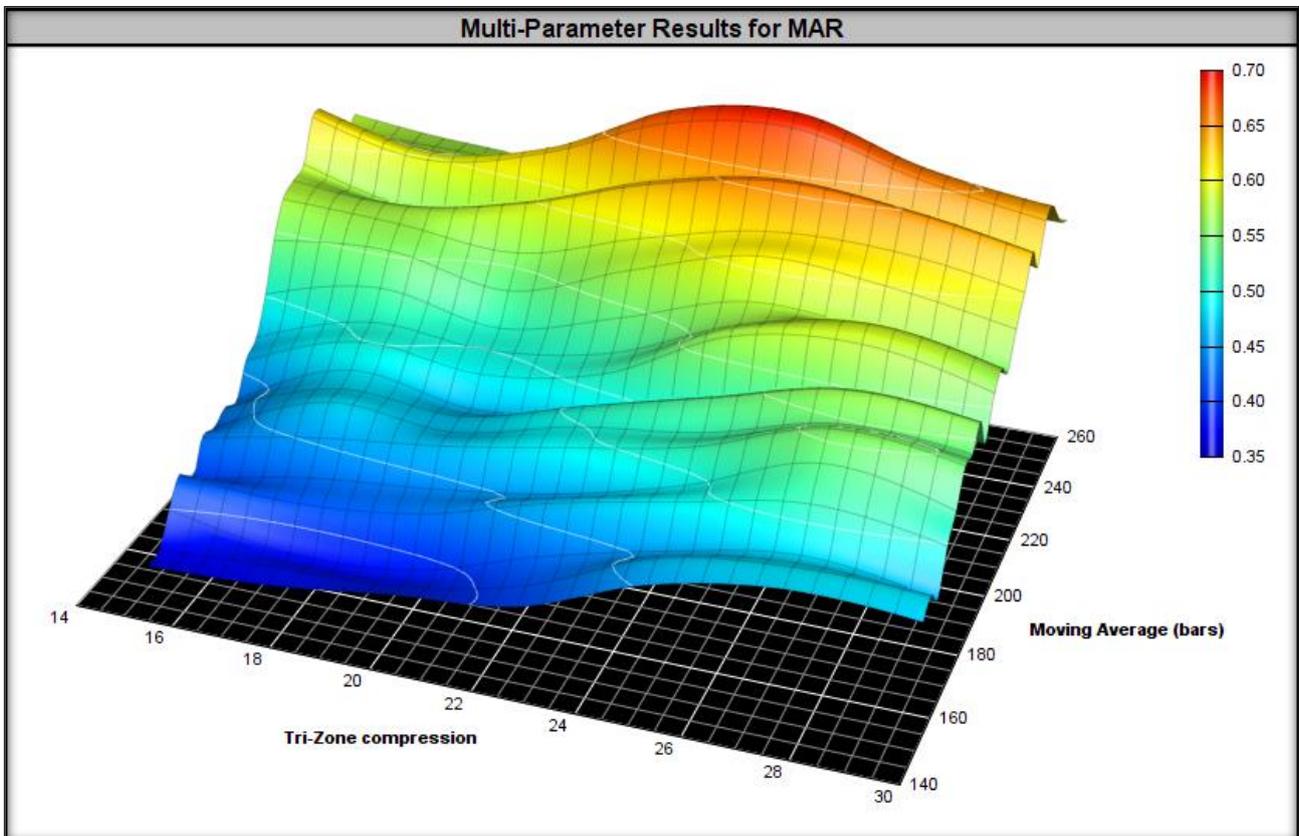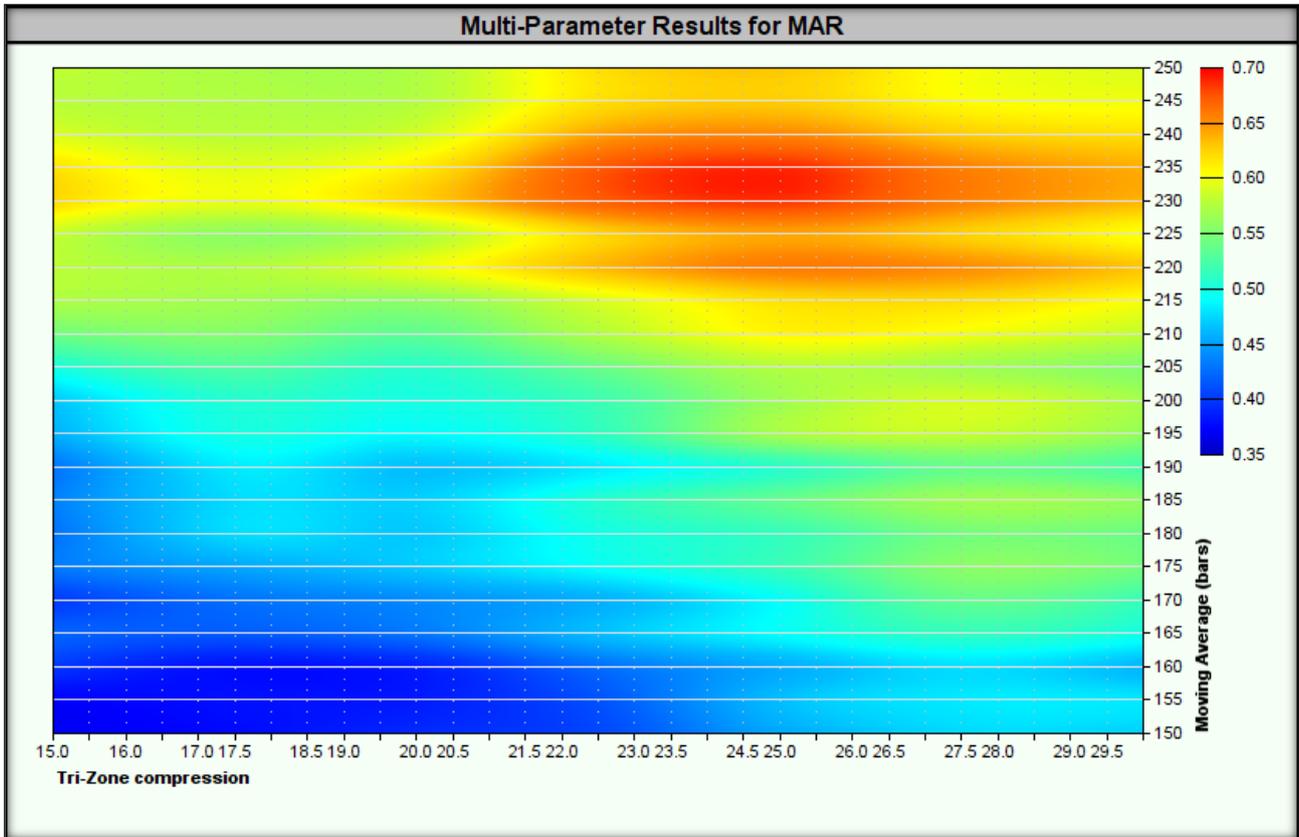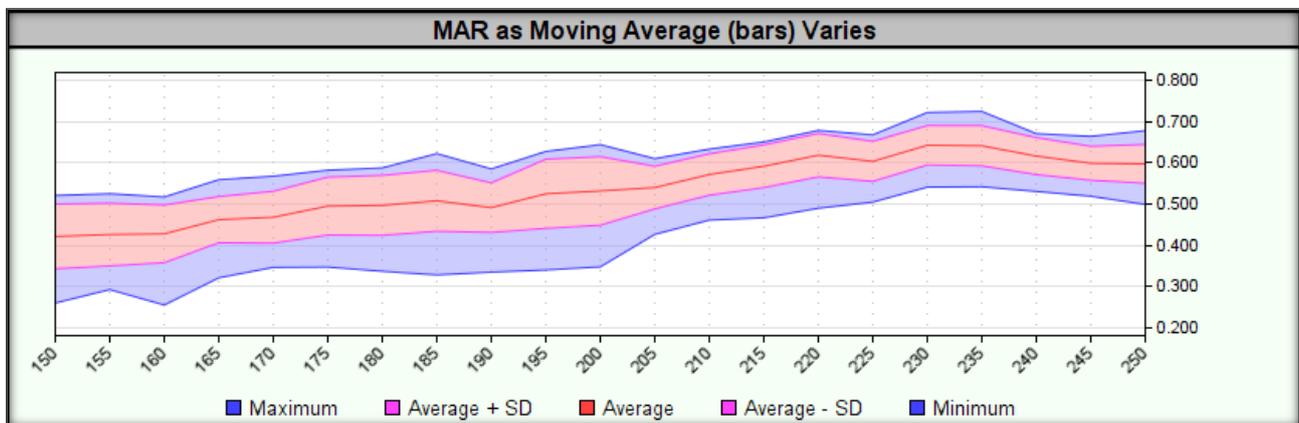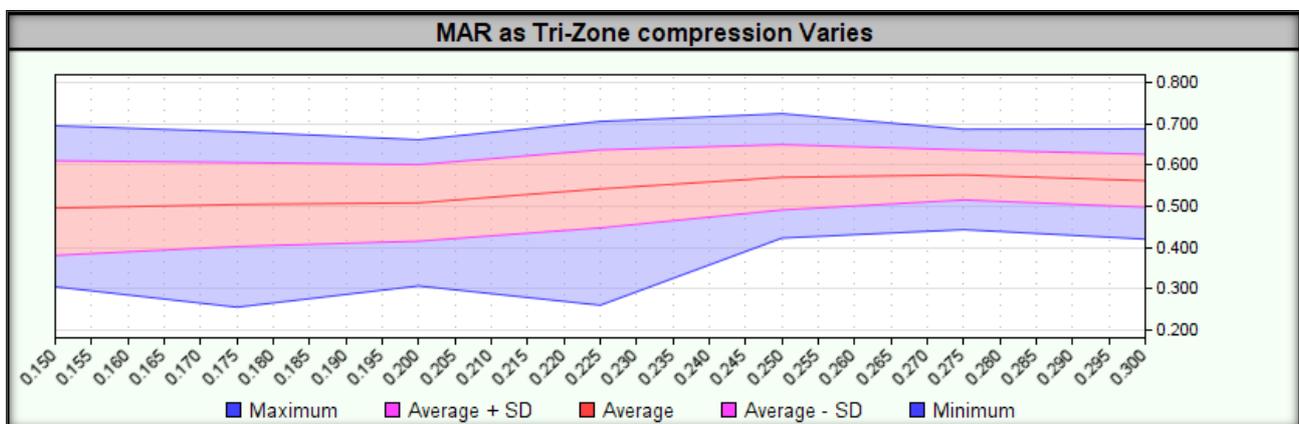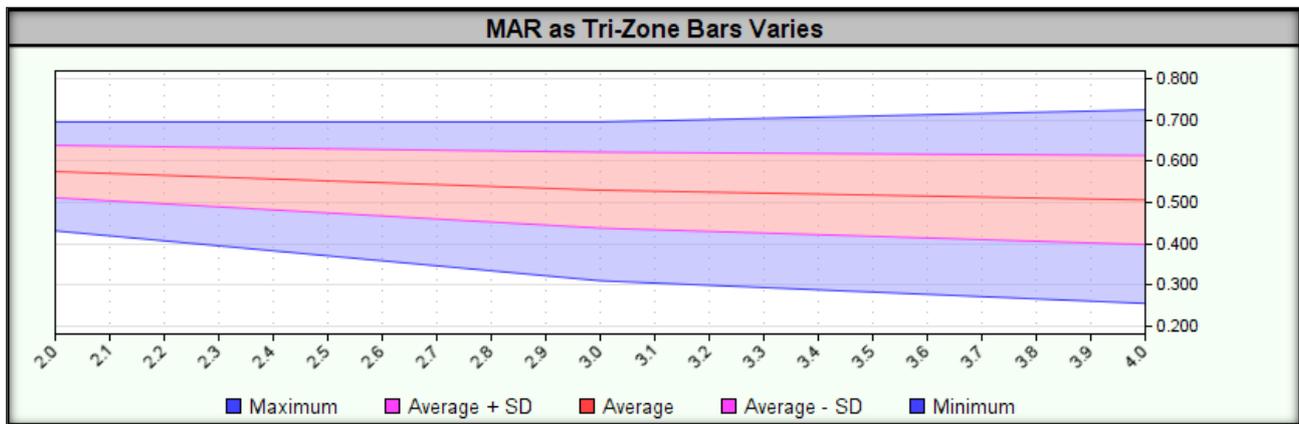
After passing **the stability test in a wide range of optimized parameters,** we can proceed to **stability testing using Monte Carlo simulation.** The conditions for passing this test are similar to those required in the above step.

2. **Monte Carlo simulation**

Monte Carlo simulation involves running multiple simulations to examine how a strategy might perform in different market scenarios. The key objective of this method is to assess the potential **drawdown** of an optimized strategy. **Monte Carlo simulation** better reflects the possible swings of the equity curve and the depth of the potential **drawdown,** allowing for a more realistic risk assessment. It is also an ideal opportunity

to compare **the drawdown** obtained in tests on optimized parameter ranges with the results of **the Monte Carlo simulation,** using **a 99% confidence interval.**

A strategy considered to be **stable (robust)** should achieve **a drawdown in a Monte Carlo simulation** that does not exceed **250% of the drawdown** size **from total tests in-sample and out-of-sample** (for parameters optimized on IS data). Furthermore, the **MAR indicator** should remain positive within the chosen confidence interval.

For data covering the period from **01.01.1998 to 31.12.2024, a Monte Carlo simulation** was performed on **optimal strategy parameters.** The Monte Carlo simulation was performed **100,000 times,** testing **the variant with replacement (more conservative),** and **the confidence interval was set to 99%.**

Test results for **the simulation with sample replacement are presented below.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Monte Carlo Drawdowns
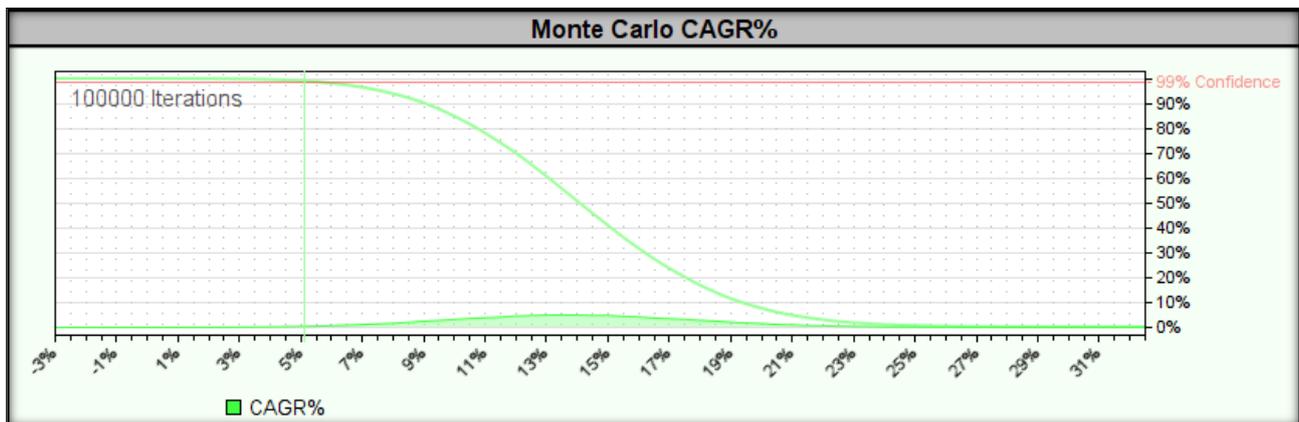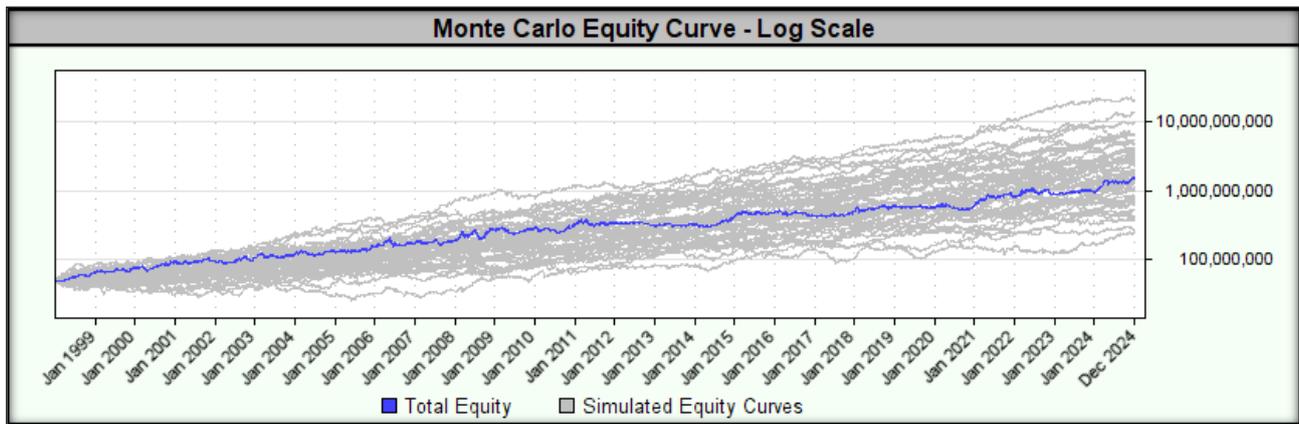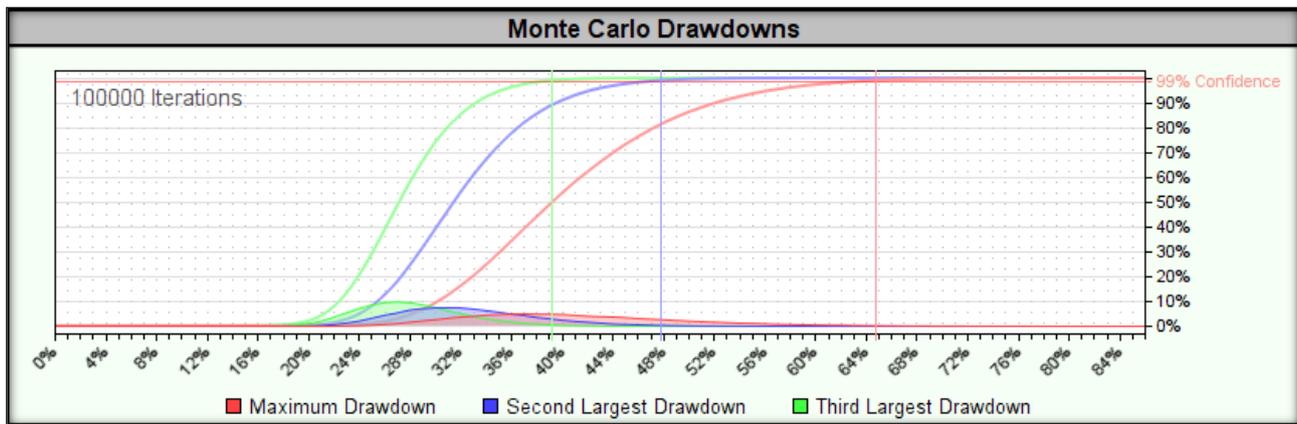
- **CAGR%** – In 99% of simulations achieved **a rate of return equal to or higher than 5.0%.**
- **Drawdown** – in 99% of simulations, **drawdown equal to or lower than 65% was achieved.** For parameters optimized on in-sample data, drawdown was 26.5%.

The strategy stability criteria were met, as **the drawdown in the Monte Carlo simulation** did not exceed **250% of the drawdown** value from tests on **optimized parameters.** In addition, the **MAR indicator** remained positive in **99%** of tests, which was also a condition for the strategy stability.

Now that we know the strategy is **stable** across **wide data ranges** and **a changing environment,** it's time to test its **stability** over **different time periods.**

3. **Stability over a moving time window**

Rolling window stability testing involves **evaluating one-year and three-year returns in time windows that move by one year** (for both in-sample and out-of-sample data). This process involves **applying strategy parameters optimized on the in-sample data,** setting a one-year or three-year trading window, and moving it by one year.

We then analyze what portion of these one- and three-year periods showed positive returns. **A strategy considered stable (robust) should achieve profitable results in at least 70% of the one- and three-year periods.**

For data covering the period from **01/01/1998 to 31/12/2024, testing of optimized parameters** was performed on **a moving data window.**

Two variants of test windows were tested:

- **Annual testing window (365 days),** tested **every 365 days** – this means that **we measure the annual rate of return every year.**
- **Three-year testing window (1095 days),** tested **every 365 days** – this means **we measure a three-year rate of return every year.**

A one-year (365/365) testing window are shown below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

	Test Start Date	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF	Expectancy
1	19980101	$66,656,332.32	33.34%	4.16	2.36	2.00	8.0%	3.0	47	80.74	26.43	3.87	0.76
2	19990101	$56,868,628.56	13.79%	1.09	1.02	NA	12.7%	5.7	60	4.15	1.96	1.56	0.23
3	20000101	$60,884,474.83	22.05%	1.79	1.40	NA	12.3%	3.8	69	21.42	18.19	1.81	0.43
4	20010101	$55,331,455.96	10.67%	1.00	0.68	2.00	10.6%	5.1	55	25.51	11.92	1.66	0.24
5	20020101	$56,187,577.70	12.38%	0.77	0.62	2.00	16.1%	5.2	69	10.68	7.36	1.56	0.27
6	20030101	$53,089,528.91	6.18%	0.39	0.46	1.99	15.7%	9.8	72	-13.28	-8.23	1.19	0.09
7	20040101	$53,067,675.19	6.14%	0.45	0.48	NA	13.6%	7.6	83	-3.13	-2.23	1.24	0.11
8	20050101	$56,554,852.77	13.27%	1.48	0.96	NA	9.0%	6.4	86	4.75	3.44	1.49	0.22
9	20060101	$53,378,833.11	6.78%	0.39	0.56	2.00	17.5%	7.7	88	1.31	0.85	1.29	0.11
10	20070101	$54,130,610.45	8.27%	0.43	0.60	2.00	19.1%	5.7	97	-4.38	-2.28	1.27	0.12
11	20080101	$60,421,062.90	20.86%	0.88	0.77	NA	23.6%	4.3	75	0.05	0.05	1.96	0.33
12	20090101	$49,207,138.31	-1.59%	-0.06	0.01	-2.02	27.1%	10.0	79	-15.82	-15.79	1.07	0.03
13	20100101	$59,820,882.82	19.72%	1.28	0.91	NA	15.4%	5.6	92	5.24	3.68	1.72	0.35
14	20110101	$48,678,747.94	-2.67%	-0.15	-0.09	NA	17.4%	8.7	100	-17.96	-12.80	0.95	-0.03
15	20120101	$45,116,794.84	-9.80%	-0.72	-0.79	NA	13.6%	7.0	89	-8.41	-7.41	0.66	-0.17
16	20130101	$54,761,912.23	9.53%	0.88	0.92	2.00	10.8%	7.1	115	-0.53	-0.19	1.26	0.14
17	20140101	$63,839,340.60	27.70%	2.55	1.51	2.00	10.9%	7.3	96	22.42	19.15	1.92	0.47
18	20150101	$52,628,829.54	5.26%	0.35	0.35	1.99	15.2%	8.6	74	-1.17	-0.67	1.23	0.08
19	20160101	$44,547,168.44	-10.94%	-0.65	-0.58	NA	16.7%	10.6	107	-15.21	-12.19	0.64	-0.16
20	20170101	$58,964,432.82	18.00%	2.02	1.53	2.00	8.9%	4.3	90	7.89	5.27	1.74	0.30
21	20180101	$56,785,021.79	13.58%	0.93	0.81	2.00	14.6%	5.5	83	1.57	1.06	1.48	0.21
22	20190101	$47,869,870.47	-4.26%	-0.37	-0.28	-2.01	11.7%	3.9	98	-5.62	-3.13	0.85	-0.08
23	20200101	$55,953,812.86	11.92%	0.66	0.75	NA	18.1%	8.3	85	-6.11	-5.63	1.49	0.23
24	20210101	$63,925,748.62	27.96%	2.19	1.35	NA	12.8%	3.6	73	38.69	27.46	2.40	0.49
25	20220101	$54,354,597.89	8.82%	0.46	0.51	NA	19.0%	6.5	85	9.25	7.64	1.41	0.17
26	20230101	$52,701,886.55	5.42%	0.66	0.59	2.00	8.2%	1.4	91	18.96	12.52	1.22	0.11
27	20240101	$65,513,698.93	31.05%	2.76	2.09	NA	11.2%	4.7	88	20.62	14.30	2.56	0.58

A three-year testing window (1095/365) are shown below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

	Test Start Date	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF	Expectancy
1	19980101	$95,251,621.57	24.03%	1.42	1.55	3.65	17.0%	5.2	150	7.42	20.30	2.46	0.67
2	19990101	$69,998,377.68	11.88%	0.75	0.77	1.39	15.8%	7.2	162	3.41	14.78	1.57	0.29
3	20000101	$69,426,971.80	11.59%	0.69	0.70	1.35	16.7%	10.0	170	2.04	9.56	1.63	0.31
4	20010101	$68,876,413.91	11.28%	0.66	0.66	2.27	17.1%	10.1	170	2.20	9.46	1.65	0.30
5	20020101	$68,844,514.33	11.26%	0.68	0.65	13.92	16.7%	10.3	195	2.25	12.07	1.53	0.29
6	20030101	$67,832,319.01	10.72%	0.64	0.72	2.79	16.8%	10.3	212	1.45	8.23	1.48	0.24
7	20040101	$70,168,688.00	11.99%	0.50	0.78	2.81	24.1%	7.6	227	2.69	13.01	1.55	0.26
8	20050101	$69,968,153.22	11.88%	0.49	0.76	2.16	24.2%	19.7	243	2.19	11.61	1.49	0.26
9	20060101	$81,522,096.36	17.73%	0.67	0.79	1.16	26.4%	13.7	232	2.89	14.69	1.80	0.39
10	20070101	$80,649,814.46	17.29%	0.65	0.78	1.12	26.5%	10.0	214	3.73	20.70	1.86	0.38
11	20080101	$74,672,189.75	14.31%	0.61	0.68	2.40	23.6%	9.9	210	1.21	7.49	1.81	0.35
12	20090101	$59,192,103.20	5.80%	0.21	0.38	0.74	27.1%	20.1	240	1.60	8.91	1.32	0.15
13	20100101	$57,076,376.77	4.51%	0.22	0.33	0.40	20.1%	21.9	248	2.10	9.83	1.19	0.11
14	20110101	$48,281,372.58	-1.16%	-0.06	-0.02	-0.18	18.2%	32.8	278	-1.70	-3.92	0.97	-0.02
15	20120101	$62,466,818.30	7.72%	0.47	0.60	0.51	16.6%	27.1	272	-0.45	-1.59	1.34	0.19
16	20130101	$77,633,554.89	15.81%	1.20	0.92	1.62	13.2%	8.6	251	5.56	21.24	1.74	0.41
17	20140101	$63,713,804.36	8.43%	0.45	0.51	0.54	18.8%	10.6	247	3.31	17.45	1.47	0.24
18	20150101	$55,524,281.77	3.56%	0.16	0.30	0.33	22.1%	32.6	241	-1.09	-4.41	1.16	0.07
19	20160101	$64,470,981.41	8.85%	0.43	0.60	0.59	20.6%	22.7	247	0.78	3.22	1.46	0.23
20	20170101	$67,140,973.07	10.34%	0.56	0.71	0.80	18.6%	12.0	235	3.44	14.03	1.51	0.27
21	20180101	$57,380,971.05	4.70%	0.22	0.38	0.52	21.5%	14.1	237	0.77	4.72	1.20	0.11
22	20190101	$68,012,473.60	10.81%	0.51	0.71	0.75	21.2%	10.2	228	2.38	12.42	1.63	0.34
23	20200101	$81,222,208.44	17.58%	0.92	0.93	1.93	19.2%	8.5	217	5.47	25.58	2.00	0.51
24	20210101	$72,784,036.67	13.34%	0.66	0.78	1.25	20.1%	18.6	231	3.14	13.16	1.68	0.31
25	20220101	$90,887,284.58	22.10%	1.12	1.16	0.87	19.8%	20.0	238	3.84	14.97	2.27	0.61

In both cases, **success** is the completion of at least **70% of the periods** (both **365-day** and **1095-day) with positive returns.**

- **For the one-year test window (365/365): 22 out of 27 periods** ended with a positive rate of return (**81%**).
- **For the three-year test window (1095/365): 24 out of 25 periods** ended with a positive rate of return (**96%**).

Thus, **the test of the strategy's stability on a moving data window was passed.**

4. **Long/short stability**

In the case of many instruments, markets have **a natural tendency** to move in an upward direction (so-called **Long Bias),** which makes investing in upside scenarios often easier than betting on downside. **Optimizing a strategy** for a downside scenario, which is usually implied by the data used for optimization, can lead to

problems when markets enter **a long-term downward trend.** In such conditions, the strategy can generate **significant losses.**

To check if **a strategy** is prone to **Long Bias** or (less often) **Short Bias,** you need to look at **the distribution of historical** buys and sells. Ideally, this distribution should be around **50%/50%.** However, if one side is significantly favored (e.g. **70%/30%)**, the strategy may be **unstable** in a real market environment.

A strategy considered stable (robust) should show a maximum of **60% tendency (bias)** in one direction.

Results for Tri-Zone Reversal Strategy (1998-2024):

- **Total number of transactions: 1869**
- **Long trades: 953 (51.0%)**
- **Short trades: 916 (49.0%)**

The trade distribution is 51.0%/49.0%, which is within the acceptable range, meaning that the strategy **does not exhibit excessive bias** and can be considered stable under various market conditions.

5. **Stability in the portfolio of financial instruments**

In this step, we want to examine **how the strategy's performance is distributed across different instruments in the portfolio.** Our goal is **to avoid a situation where the strategy's positive performance comes only from a small group of exceptionally well-performing instruments.**

To check this, for **both in-sample and out-of-sample data,** we analyze **what percentage of instruments achieved a profit factor value above 1** (which means a positive contribution to the strategy's result).

We expect that:

- **For the portfolio with the highest MAR** (obtained on IS data), the percentage of instruments with **profit factor > 1 will be at least 80%.**
- **For the portfolio with the lowest MAR** (obtained on IS data), the percentage of instruments with **profit factor > 1 will be at least 70%.**

If the above conditions are met, **we can consider that the strategy is stable on a wide basket of financial instruments.**

The profit factor for the instruments included in the portfolio using the highest MAR is presented below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Instrument Performance Summary

Symbol	Wins	%	Losses	%	Trades	Win Months	%	Loss Months	%	Avg. Win %	Avg. Loss %	Avg. Trade %	Profit Factor
C	17	24.6%	52	75.4%	69	181	55.9%	143	44.1%	2.38%	0.34%	0.33%	2.31
CC	14	16.7%	70	83.3%	84	188	58.0%	136	42.0%	5.75%	0.41%	0.62%	2.81
CFI	8	12.7%	55	87.3%	63	227	70.1%	97	29.9%	4.82%	0.34%	0.32%	2.09
CL	19	22.6%	65	77.4%	84	182	56.2%	142	43.8%	2.34%	0.37%	0.25%	1.87
CT	15	18.8%	65	81.2%	80	171	52.8%	153	47.2%	3.04%	0.41%	0.24%	1.70
DX	16	22.9%	54	77.1%	70	182	56.2%	142	43.8%	3.01%	0.39%	0.39%	2.30
EBL	12	14.8%	69	85.2%	81	188	58.0%	136	42.0%	3.15%	0.36%	0.16%	1.50
ES	18	24.3%	56	75.7%	74	191	59.0%	133	41.0%	2.15%	0.35%	0.26%	1.97
FDX	19	35.2%	35	64.8%	54	194	59.9%	130	40.1%	1.74%	0.45%	0.32%	2.11
FLG	20	29.4%	48	70.6%	68	182	56.2%	142	43.8%	1.47%	0.41%	0.15%	1.51
GC	15	16.5%	76	83.5%	91	162	50.0%	162	50.0%	2.20%	0.40%	0.03%	1.10
HG	16	17.2%	77	82.8%	93	162	50.0%	162	50.0%	2.64%	0.37%	0.15%	1.49
HSI	15	32.6%	31	67.4%	46	207	63.9%	117	36.1%	1.59%	0.59%	0.12%	1.31
KC	14	18.4%	62	81.6%	76	198	61.1%	126	38.9%	2.18%	0.40%	0.08%	1.24
LCO	14	17.1%	68	82.9%	82	184	56.8%	140	43.2%	3.57%	0.32%	0.35%	2.31
LGO	15	19.5%	62	80.5%	77	185	57.1%	139	42.9%	3.30%	0.41%	0.31%	1.95
NG	13	19.7%	53	80.3%	66	183	56.5%	141	43.5%	2.25%	0.40%	0.12%	1.38
NIY	11	16.2%	57	83.8%	68	218	67.3%	106	32.7%	2.60%	0.41%	0.08%	1.22
NQ	15	22.1%	53	77.9%	68	195	60.2%	129	39.8%	3.03%	0.39%	0.37%	2.21
OJ	19	23.8%	61	76.2%	80	182	56.2%	142	43.8%	2.11%	0.42%	0.18%	1.58
PA	12	15.4%	66	84.6%	78	206	63.6%	118	36.4%	3.32%	0.31%	0.25%	1.96
S	20	24.4%	62	75.6%	82	177	54.6%	147	45.4%	1.40%	0.31%	0.10%	1.44
SB	16	22.9%	54	77.1%	70	185	57.1%	139	42.9%	2.69%	0.42%	0.29%	1.89
TY	19	21.6%	69	78.4%	88	170	52.5%	154	47.5%	2.19%	0.34%	0.21%	1.77
W	15	19.5%	62	80.5%	77	179	55.2%	145	44.8%	1.57%	0.42%	-0.03%	0.91

The profit factor for the instruments included in the portfolio **using the lowest MAR** is presented below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Instrument Performance Summary

Symbol	Wins	%	Losses	%	Trades	Win Months	%	Loss Months	%	Avg. Win %	Avg. Loss %	Avg. Trade %	% Profit Factor
C	33	12.5%	232	87.5%	265	158	48.8%	166	51.2%	1.55%	0.19%	0.03%	1.18
CC	24	8.9%	246	91.1%	270	143	44.1%	181	55.9%	2.93%	0.23%	0.05%	1.25
CFI	25	12.2%	180	87.8%	205	209	64.5%	115	35.5%	1.86%	0.21%	0.05%	1.26
CL	36	14.2%	218	85.8%	254	163	50.3%	161	49.7%	1.70%	0.20%	0.07%	1.42
CT	31	15.0%	175	85.0%	206	162	50.0%	162	50.0%	2.03%	0.21%	0.13%	1.70
DX	34	14.3%	204	85.7%	238	174	53.7%	150	46.3%	2.00%	0.18%	0.13%	1.82
EBL	27	12.1%	196	87.9%	223	164	50.6%	160	49.4%	2.01%	0.23%	0.05%	1.23
ES	31	12.4%	218	87.6%	249	165	50.9%	159	49.1%	1.57%	0.21%	0.01%	1.07
FDX	31	13.7%	196	86.3%	227	167	51.5%	157	48.5%	1.50%	0.21%	0.02%	1.11
FLG	33	13.9%	205	86.1%	238	146	45.1%	178	54.9%	1.37%	0.23%	-0.01%	0.97
GC	31	10.9%	254	89.1%	285	147	45.4%	177	54.6%	1.42%	0.19%	-0.01%	0.92
HG	32	12.5%	225	87.5%	257	155	47.8%	169	52.2%	1.70%	0.20%	0.04%	1.22
HSI	29	17.0%	142	83.0%	171	161	49.7%	163	50.3%	1.53%	0.29%	0.02%	1.09
KC	28	12.8%	190	87.2%	218	175	54.0%	149	46.0%	1.55%	0.22%	0.00%	1.02
LCO	31	13.7%	196	86.3%	227	170	52.5%	154	47.5%	1.96%	0.21%	0.08%	1.46
LGO	32	15.1%	180	84.9%	212	170	52.5%	154	47.5%	2.30%	0.22%	0.16%	1.82
NG	30	15.2%	168	84.8%	198	166	51.2%	158	48.8%	1.58%	0.22%	0.05%	1.27
NIY	18	8.2%	202	91.8%	220	181	55.9%	143	44.1%	2.04%	0.24%	-0.06%	0.75
NQ	36	14.8%	208	85.2%	244	174	53.7%	150	46.3%	1.43%	0.19%	0.05%	1.32
OJ	38	20.1%	151	79.9%	189	177	54.6%	147	45.4%	1.49%	0.27%	0.08%	1.39
PA	27	11.6%	206	88.4%	233	171	52.8%	153	47.2%	1.98%	0.19%	0.06%	1.37
S	34	14.9%	194	85.1%	228	163	50.3%	161	49.7%	1.67%	0.19%	0.08%	1.51
SB	30	13.6%	190	86.4%	220	164	50.6%	160	49.4%	2.08%	0.22%	0.09%	1.49
TY	30	11.8%	224	88.2%	254	165	50.9%	159	49.1%	1.73%	0.18%	0.04%	1.27
W	37	14.7%	214	85.3%	251	156	48.1%	168	51.9%	1.03%	0.20%	-0.02%	0.89

For our tested strategy:

- **The portfolio with the highest MAR** (obtained on IS data) has a percentage of instruments with **a profit factor > 1 at the level of 96%.**
- **The portfolio with the lowest MAR** (obtained on IS data) has a percentage of instruments with **profit factor > 1 at the level of 84%.**

Thus, **the test of the stability of the strategy on the portfolio of financial instruments was passed.**

6. **Money Management (Position Sizing)**

Once **stability testing is complete,** we now know **what range of results we can expect from our strategy,** and more importantly – **what amount of capital loss (drawdown).**

Previous tests show that:

- **The in-sample drawdown** for optimized parameters was **26.5 %.**
- **in-sample and out-of-sample drawdown** for the optimized parameters was **26.5%.**
- **The largest in-sample drawdown** for the tested parameter range was **54.6%.**
- **The largest out-of-sample drawdown** for the tested parameter range was **30.3%.**
- **Drawdown in 99% of the Monte Carlo simulations** was equal to or lower than **65.0%.**

Our investment strategy was tested assuming that **the risk of a single position is 0.5% of total capital.**

With the above information in mind, you should consider **whether the risk of a single position is acceptable, taking into account the possible drawdown.**

At this stage, **this position size is acceptable to me.**

To summarize, at this point **the strategy has been optimized to the following parameters:**

- **Number of days forming the price formation:** 4 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 22.5%;
- **Moving average:** 220 days;
- **Position size:** each position represents a risk of 0.5% of the total capital, with a hypothetical stop loss order placed 2 x ATR (40 days) away from the position opening position.

7. **Strategy Risk Management**

In addition to defining **the maximum size of a single position,** we can implement additional mechanisms that **will improve risk control** in the investment strategy. Key elements include:

- **Maximum number of open positions in highly correlated instruments,**
- **Maximum number of open positions in moderately correlated instruments,**
- **Maximum number of open positions in one direction,**
- **Maximum risk value of all positions,**
- **Drawdown – position reduction mechanism.**

The optimal values for these parameters can be determined by **maximizing the MAR objective function.** However, based on experience and **awareness of the risk of** excessive **portfolio concentration in one direction (long/short)** or **too much exposure to correlated instruments,** I adopt **certain arbitrary concentration limits.**

These are not the "best" optimal values for all market conditions – as with position size, sometimes **it is worth reducing it and sometimes increasing it.** However, the key goal is **to avoid a drawdown** that could force you **to end your strategy for financial or emotional** reasons.

Too much concentration in correlated instruments or in one market direction can undermine diversification, which is one of the strategy's key sources of advantage.

Therefore, **I assume the following concentration limits without optimization:**

- **Maximum number of open positions in highly correlated instruments: 3 positions,**
- **Maximum number of open positions in moderately correlated instruments: 6 positions,**
- **Maximum number of open positions in one direction: 12 positions.**

After this step, we have already **optimized all the elements of the investment strategy.** We can finally **analyze the results generated by the strategy in more detail.**

We haven't done this before because our goal **was not to optimize the parameters themselves and look for the "best" set,** but **to build a stable strategy.**
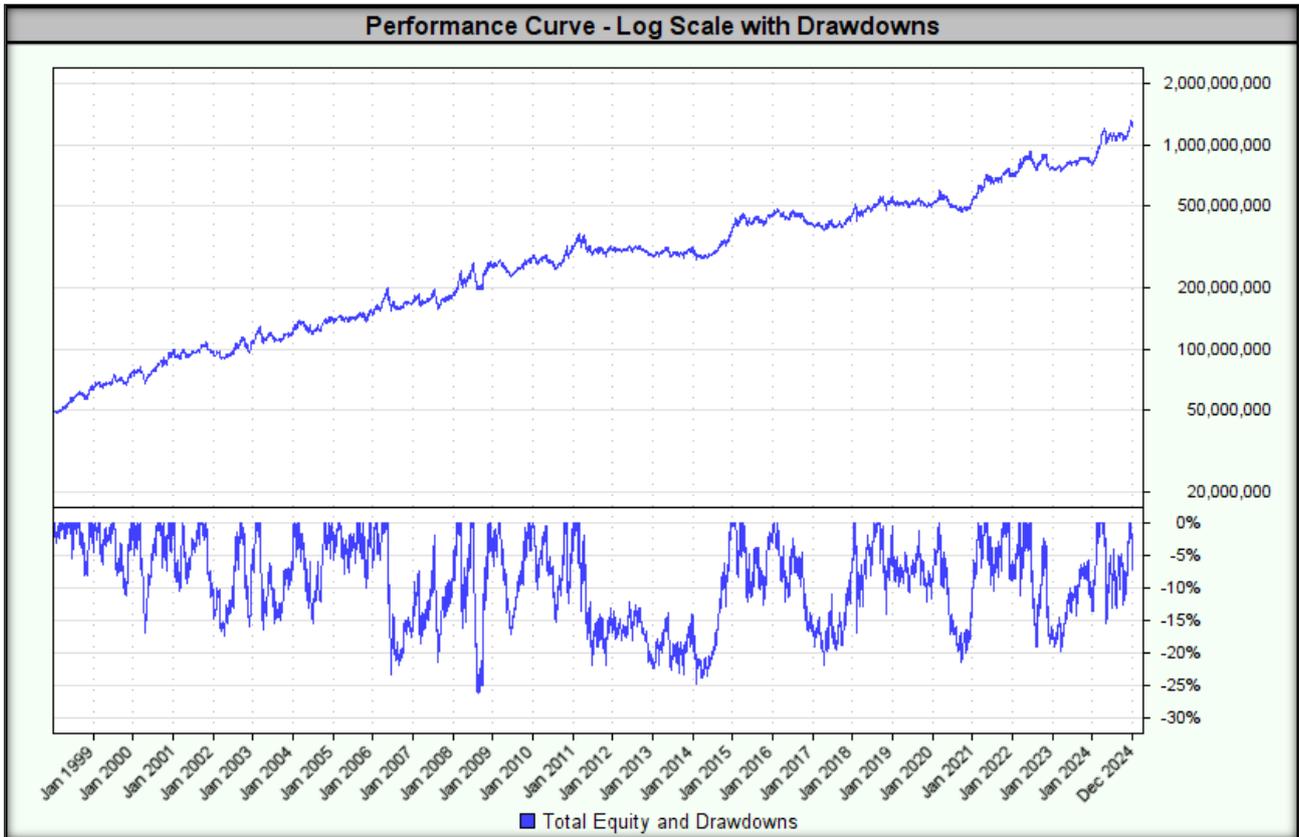
Importantly, **we will not use the parameters optimized in back-tests in the end,** because **they serve only as a reference point. The parameters used in real transactions will be determined during the Walk-Forward Analysis.**

Before we move on to this step, **let us summarize the results on the in-sample data and on the combined in-sample and out-of-sample data.**
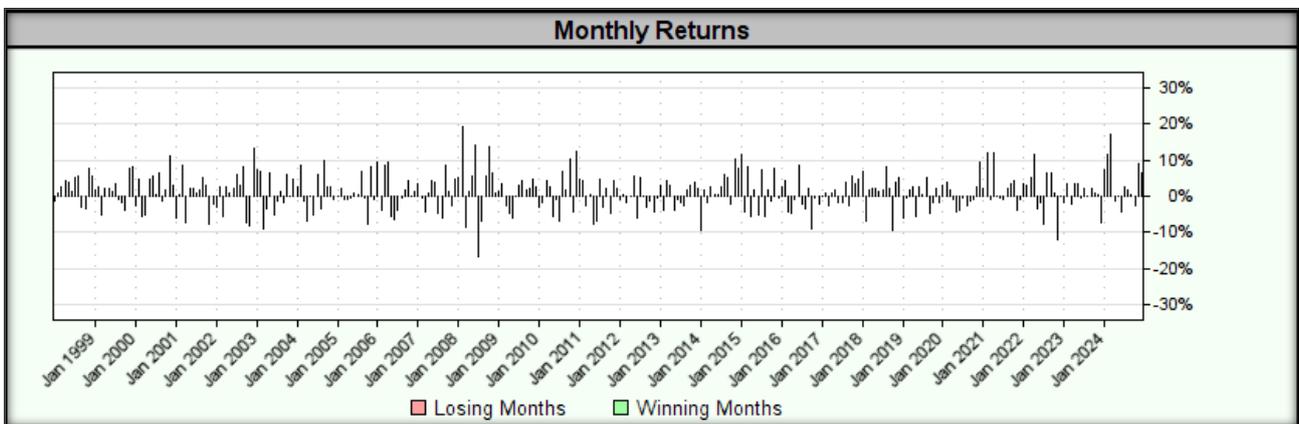
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Indicators/Measures	In-sample	In-sample & Out-of-sample
CAGR%	11.7%	12.7%
MAR Ratio	0.45	0.49
RAR%	9.2%	10.5%
R-Cubed	0.24	0.26
Robust Sharpe Ratio	0.52	0.60
Max Drawdown	26.2%	26.2%
Wins	19.5%	20.6%
Losses	80.5%	79.4%
Average Win%	2.63%	2.61%
Average Loss%	0.39%	0.39%
Win/Loss Ratio	6.83	6.63
Average Trade Duration (days)	85	90
Percent Profit Factor	1.65	1.72
SQN	0.69	0.77
Number of transactions	1258	1739

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Performance Curve - Log Scale with Drawdowns

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Monthly Returns

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
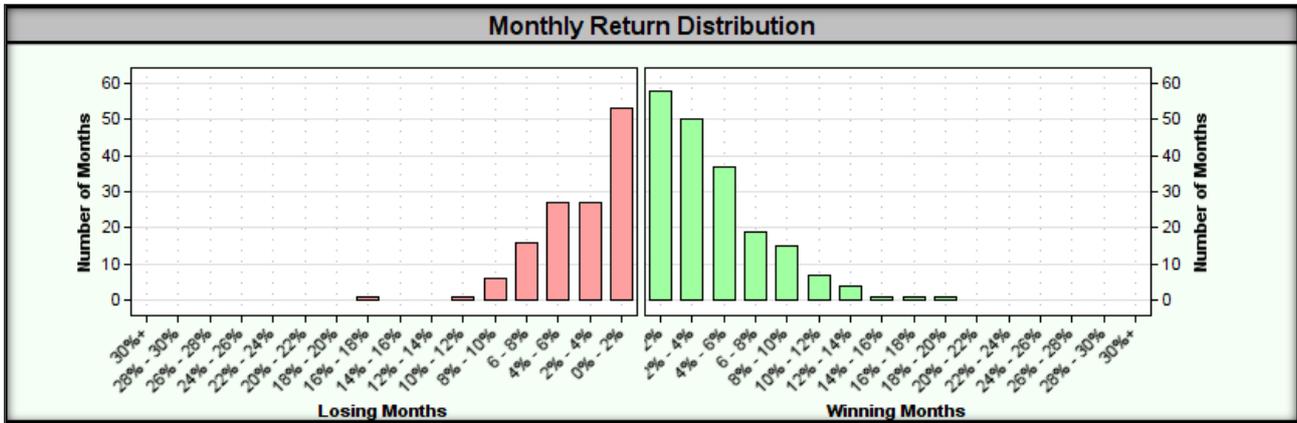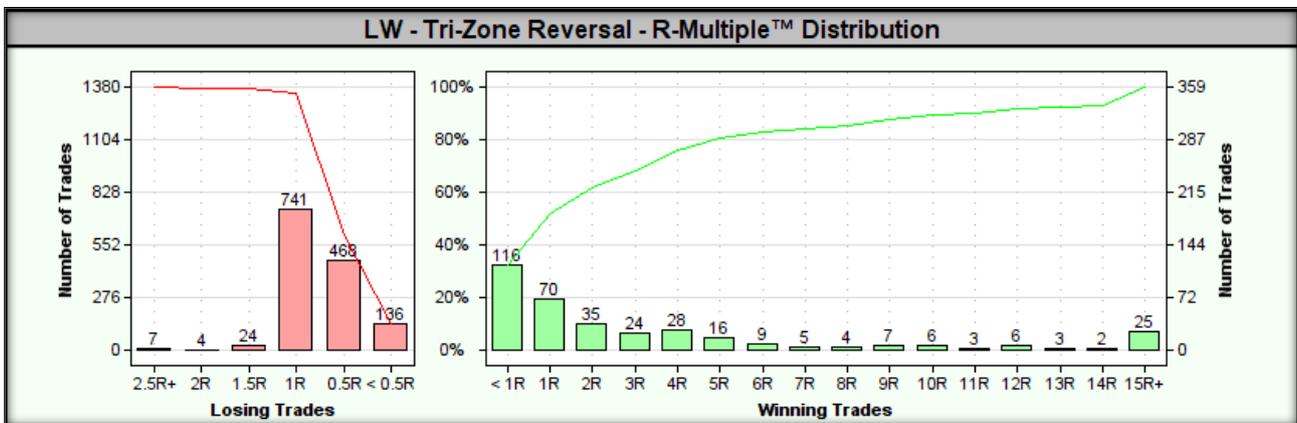

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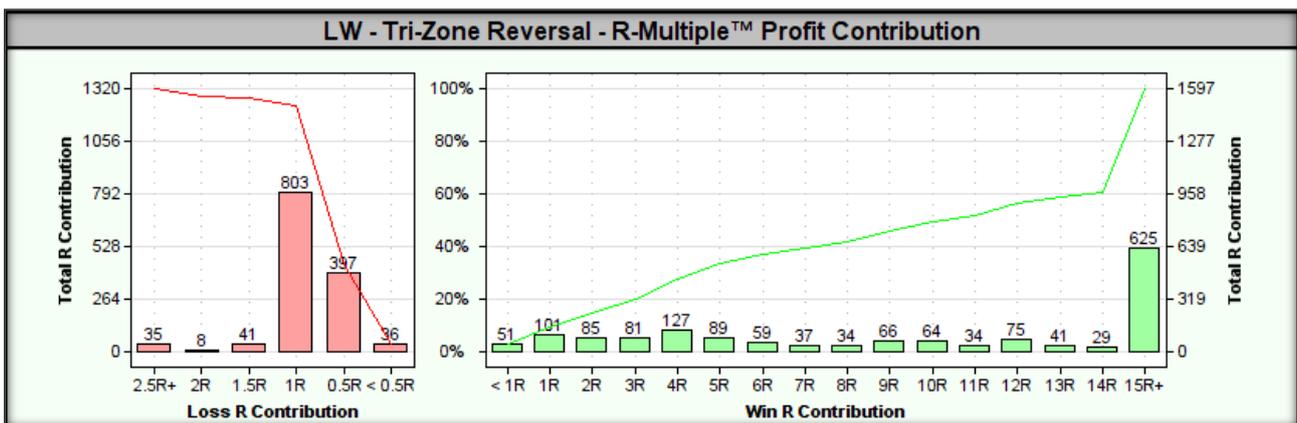
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

To summarize, at this point **the strategy has been optimized to the following parameters:**

- **Number of days forming the price formation:** 4 days;
- **Maximum range of the price cluster relative to the entire price range of the price formation:** 22.5%;
- **Moving average:** 220 days;

- **Position size:** each position represents a risk of 0.5% of the total capital, with a hypothetical stop loss order placed 2 x ATR (40 days) away from the position opening position;
- **Maximum number of open positions in different categories:**
  - **Highly correlated instruments:** 3 items;
  - **Moderately correlated instruments:** 6 items;
  - **Maximum number of positions in one direction:** 12 positions.

Step 5: Walk-Forward Analysis

Walk-Forward Analysis (WFA) is a key tool for assessing **a strategy's ability to perform under real market conditions.** It provides **reliable measures of reward and risk** after the optimization process and allows us to answer several key questions:

1. **What rate of return can you expect from the strategy?**
   - The optimization result often overestimates the expected rate of return, which can lead to unrealistic forecasts.
   - WFA provides a more **reliable and realistic measure of return** by minimizing the impact of overfitting to historical data.
2. **What set of parameters should be used in the next period?**
   - Thanks to **WFA,** it is possible **to dynamically adjust the strategy parameters** to **the latest market changes,** increasing its adaptability.

WFA tests the strategy over multiple time periods, which helps **minimize the risk of overfitting** (overfitting the strategy to historical data). The WFA process consists of **two repeated steps:**

1. **Optimization (In-Sample):**
   - The strategy is optimized over a specific **training period** (**in-sample**).
   - In this step, parameters are adjusted to obtain **the best results.**
2. **Testing (Out-of-Sample):**
   - The strategy, using **the parameters optimized in Step 1,** is tested on **a test period** (**out-of-sample**).
   - This stage verifies the effectiveness of the strategy in new market conditions that **were not used** during optimization.

Walk-Forward Efficiency (WFE) is a key metric that assesses whether a strategy has the potential to perform under real market conditions. WFE compares:

- **The rate of return achieved in the in-sample window** (where parameters were optimized)
- **The rate of return in the out-of-sample window** (where the strategy was operating on unknown data)

Similarly, **for the drawdown value,** WFE checks whether the strategy does not lose significant stability outside the optimization period.

A strategy considered **stable (robust) should meet the following conditions:**

- **WFE ≥ 50% for the rate of return** – means that the strategy retains at least half of its effectiveness outside the optimization period.
- **WFE ≤ 150% for drawdown** – means that the drawdown outside the optimization period is not significantly higher than during the optimization period.

The WFA results and an assessment of the strategy's effectiveness according to the Walk-Forward Efficiency measure are presented below.

Walk-Forward Optimization (WFO) parameters:

- **Objective function:** MAR;
- **Position size:** 0.5 % of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- **Range of optimized parameters:**
  - **Number of days forming a price formation:** range **2-4 days (step: 1)**;
  - **Maximum range of the price cluster relative to the entire price range of the price formation:** range **15%-30% (step: 2.5 pp)**;
  - **Moving average:** range **150-250 days (step: 5)**;
- **Maximum number of open positions in different categories:**
  - **Highly correlated instruments:** 3 items;
  - **Moderately correlated instruments:** 6 items;
  - **Maximum number of positions in one direction:** 12 positions;
- **Data period:** 01/01/1995 – 31/12/2024.

Below are the test results for different windows.

1. **Walk Forward Optimization: 1095 days; Walk Forward Out-of-sample: 365 days**

Below are **the results of Walk-Forward Analysis (WFA) for 1095/365 day combinations.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
1,198,080,853	12.47%	0.50	0.59	24.77%	44.85	2,619

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown

■ Draw Down
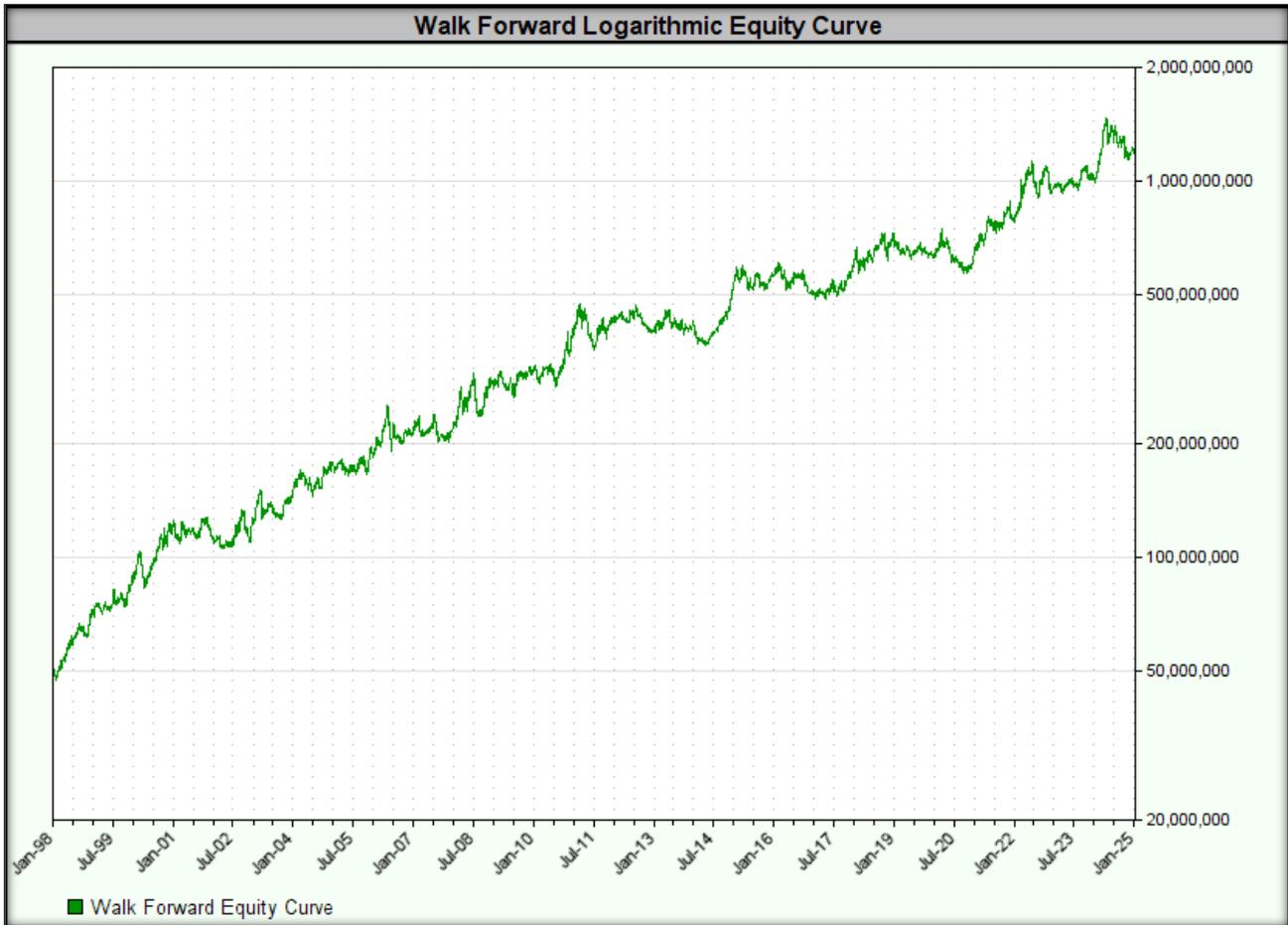
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1095	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19971231	19981230	28.3%	45.0%	9.9%	8.1%	2.86	5.55

19981231	19991230	36.1%	24.3%	9.1%	9.4%	3.98	2.59
19991231	20001229	40.0%	36.5%	9.3%	20.7%	4.29	1.77
20010101	20011228	39.2%	-9.1%	17.2%	13.4%	2.28	- 0.67
20011231	20021227	25.0%	14.4%	18.0%	17.9%	1.38	0.81
20021230	20031229	17.1%	16.7%	14.9%	16.5%	1.15	1.01
20031230	20041228	19.1%	19.3%	16.3%	14.6%	1.17	1.32
20041229	20051228	19.1%	6.4%	16.6%	10.4%	1.15	0.62
20051229	20061228	14.6%	14.4%	14.9%	24.3%	0.98	0.59
20061229	20071228	11.7%	1.5%	20.5%	15.9%	0.57	0.09
20071231	20081226	11.2%	34.7%	15.4%	23.8%	0.73	1.46
20081229	20091225	26.1%	5.9%	21.8%	15.2%	1.20	0.39
20091228	20101227	23.1%	29.3%	22.8%	13.8%	1.01	2.13
20101228	20111227	25.9%	4.3%	20.5%	24.8%	1.26	0.18
20111228	20121226	12.8%	-4.4%	22.9%	14.9%	0.56	- 0.30
20121227	20131226	7.1%	5.5%	19.4%	14.1%	0.37	0.39
20131227	20141226	4.7%	22.1%	10.3%	13.5%	0.45	1.64
20141229	20151225	11.1%	8.5%	11.2%	13.7%	0.99	0.62
20151228	20161223	17.3%	-11.0%	13.7%	17.9%	1.27	- 0.62
20161226	20171225	11.0%	19.8%	13.6%	9.8%	0.81	2.03
20171226	20181225	8.9%	21.2%	15.5%	15.3%	0.58	1.39
20181226	20191225	12.1%	-13.1%	15.4%	14.6%	0.79	- 0.89
20191226	20201224	11.8%	-1.8%	16.0%	23.4%	0.74	- 0.08
20201225	20211224	2.8%	27.5%	20.5%	11.2%	0.14	2.44
20211227	20221223	12.0%	21.6%	20.6%	19.8%	0.58	1.09
20221226	20231222	19.7%	8.3%	19.8%	7.8%	1.00	1.07
20231225	20241223	21.9%	16.8%	16.8%	22.6%	1.31	0.74
Mean		**18.1%**	**13.5%**	**16.4%**	**15.8%**	**0.79**	**0.55**
		WFE:	**74.5%**	**WFE:**	**96.5%**	**WFE:**	**69.0%**

2. **Walk Forward Optimization: 1460 days; Walk Forward Out-of-sample: 365 days**

Below are **the results of the Walk-Forward Analysis (WFA) for the 1460/365 day combination.**
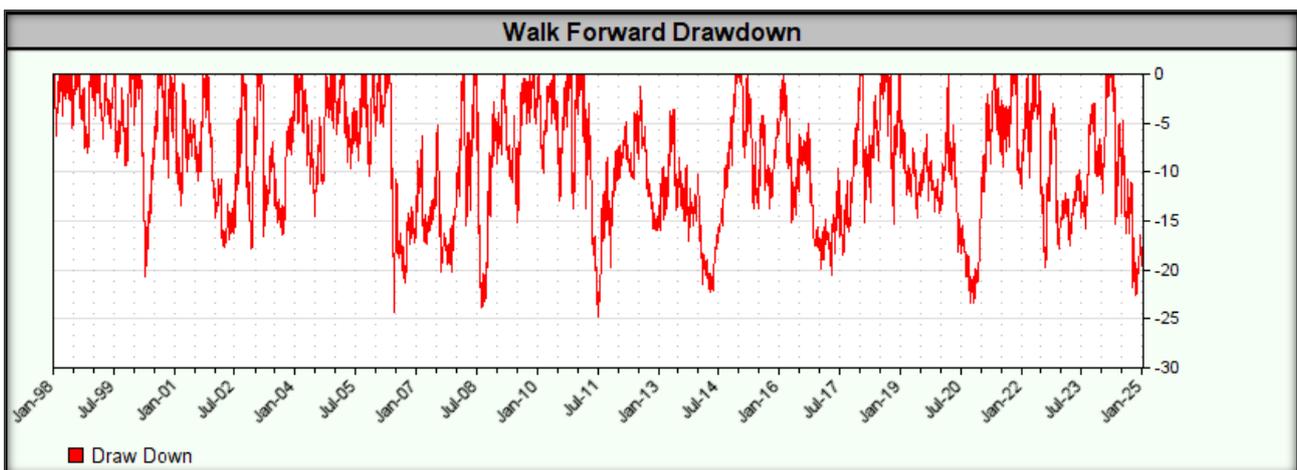
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
804,673,253	11.26%	0.44	0.53	25.86%	44.81	2,428

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown

■ Draw Down
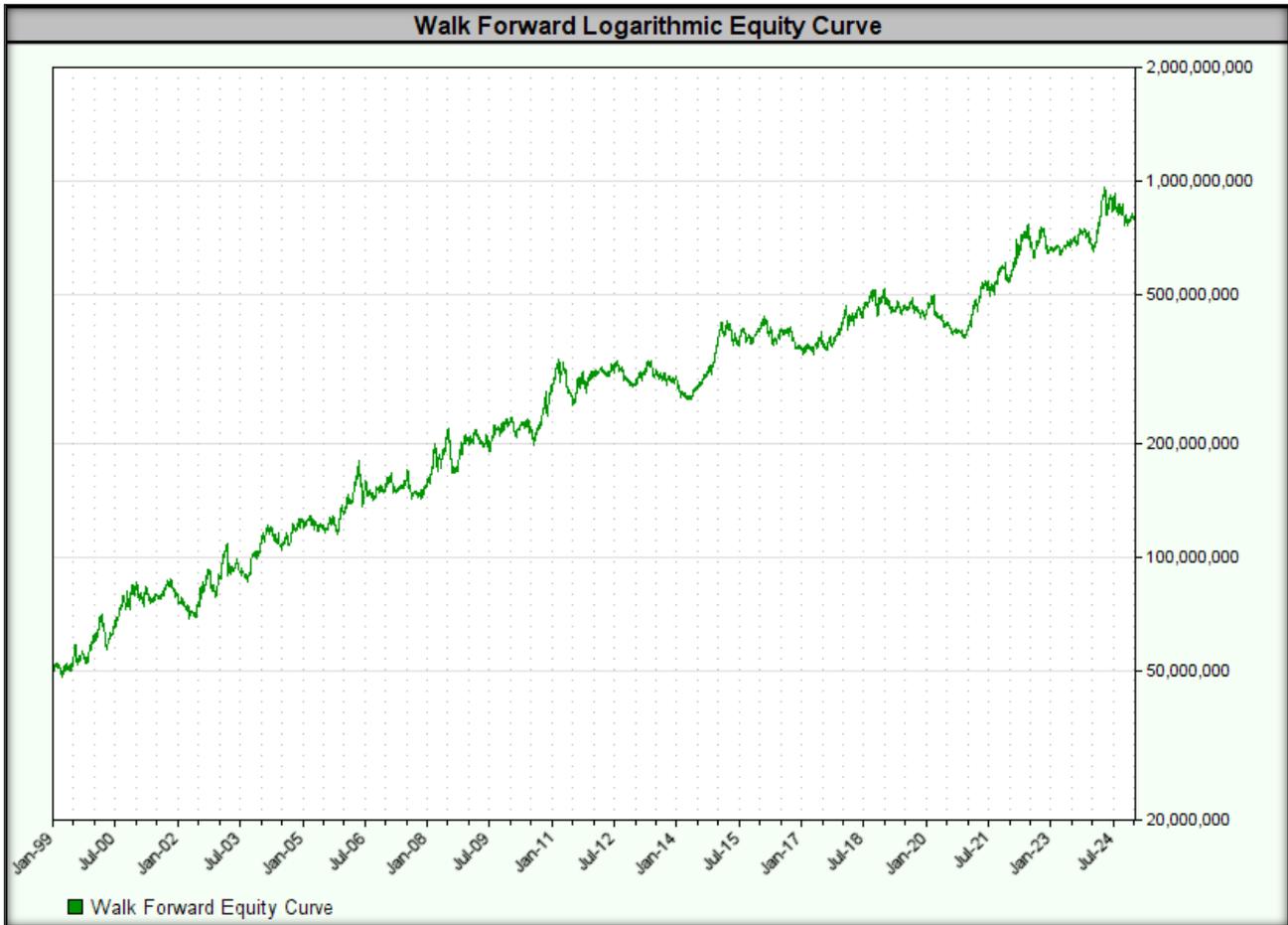
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1460	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19981231	19991230	32.1%	24.5%	9.3%	10.9%	3.44	2.25

19991231	20001229	33.5%	34.5%	9.3%	19.1%	3.60	1.80
20010101	20011228	38.8%	-5.8%	18.5%	13.3%	2.09	- 0.44
20011231	20021227	26.0%	14.1%	17.2%	15.9%	1.51	0.88
20021230	20031229	22.6%	19.3%	18.0%	21.0%	1.26	0.92
20031230	20041228	16.8%	17.6%	16.3%	14.4%	1.03	1.22
20041229	20051228	19.1%	4.7%	16.3%	10.3%	1.17	0.46
20051229	20061228	16.2%	15.9%	16.7%	24.6%	0.97	0.65
20061229	20071228	12.9%	1.5%	20.5%	15.9%	0.63	0.09
20071231	20081226	7.7%	34.7%	15.0%	23.8%	0.51	1.46
20081229	20091225	20.2%	9.7%	23.3%	13.1%	0.87	0.74
20091228	20101227	20.5%	24.9%	21.8%	16.1%	0.94	1.54
20101228	20111227	24.4%	5.9%	22.8%	24.8%	1.07	0.24
20111228	20121226	19.6%	-4.2%	22.9%	14.5%	0.86	- 0.29
20121227	20131226	8.1%	5.1%	22.9%	14.2%	0.35	0.36
20131227	20141226	5.3%	21.9%	14.1%	13.6%	0.38	1.61
20141229	20151225	9.8%	8.4%	10.4%	14.0%	0.94	0.60
20151228	20161223	11.2%	-10.9%	14.1%	18.2%	0.80	- 0.60
20161226	20171225	9.1%	17.8%	14.0%	10.3%	0.65	1.73
20171226	20181225	13.2%	22.3%	15.4%	15.2%	0.86	1.47
20181226	20191225	12.1%	-15.3%	15.5%	17.4%	0.78	- 0.88
20191226	20201224	6.6%	-9.5%	15.4%	22.7%	0.43	- 0.42
20201225	20211224	8.6%	39.0%	20.8%	11.1%	0.42	3.51
20211227	20221223	10.5%	20.9%	20.9%	19.1%	0.50	1.10
20221226	20231222	14.3%	2.3%	20.6%	9.2%	0.70	0.25
20231225	20241223	16.5%	19.1%	19.8%	20.7%	0.84	0.92
Mean		**16.8%**	**12.2%**	**17.4%**	**16.3%**	**0.72**	**0.49**
	WFE:	**73.1%**	WFE:	**93.7%**	WFE:	**68.7%**	

3. **Walk Forward Optimization: 1825 days; Walk Forward Out-of-sample: 365 days**

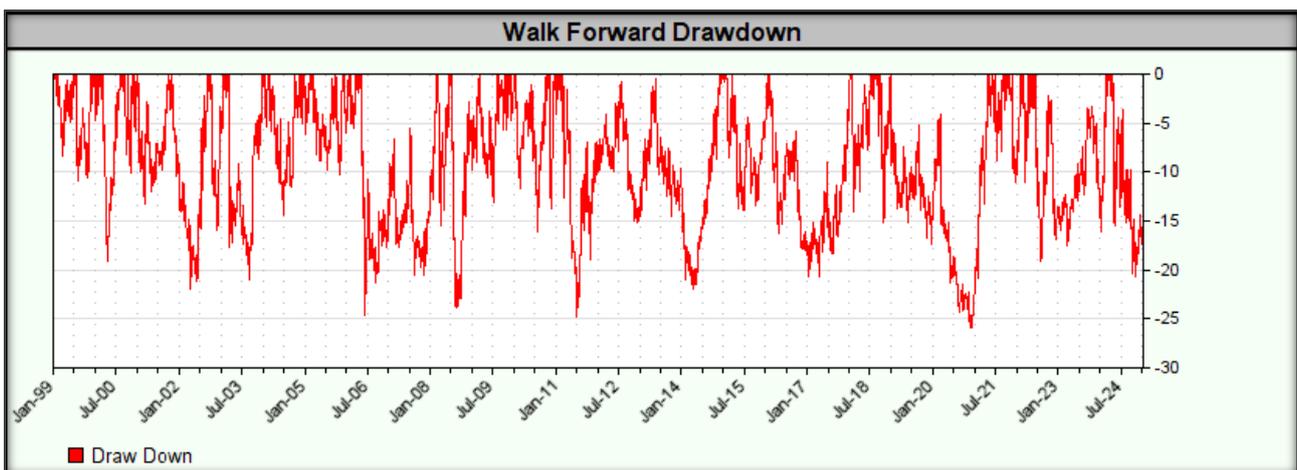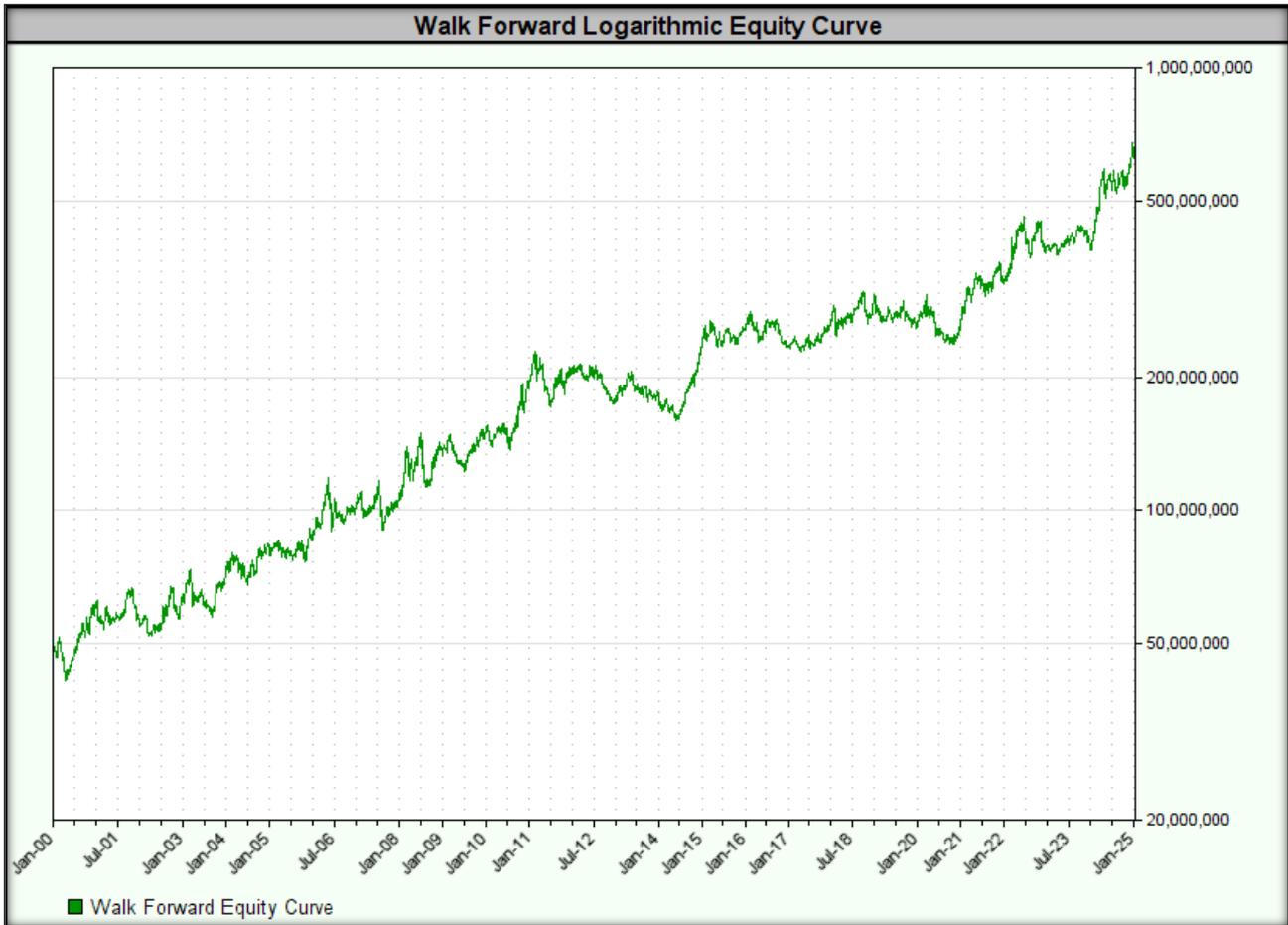Below are **the results of the Walk-Forward Analysis (WFA) for the 1825/365 day combination.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
623,348,711	10.61%	0.35	0.50	30.06%	45.70	2,305

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve
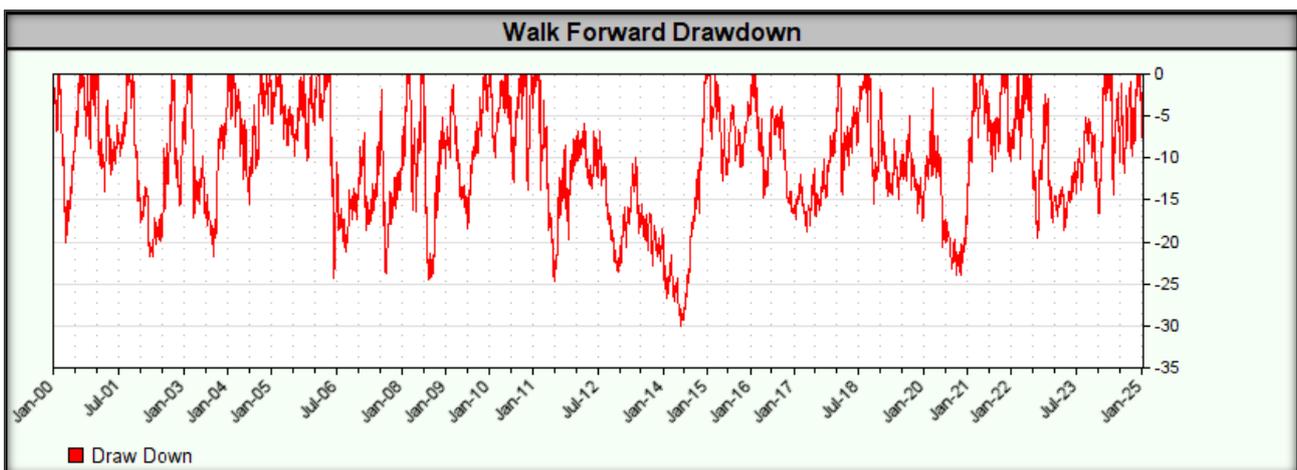
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown

■ Draw Down

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1825	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19991231	20001229	32.2%	22.5%	9.7%	20.1%	3.31	1.12

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20010101 | 20011228 | 32.3% | -8.6% | 17.2% | 16.0% | 1.88 | - 0.54 |
| 20011231 | 20021227 | 29.4% | 15.5% | 19.0% | 15.7% | 1.55 | 0.99 |
| 20021230 | 20031229 | 23.7% | 10.0% | 17.2% | 21.8% | 1.38 | 0.46 |
| 20031230 | 20041228 | 22.6% | 17.6% | 19.1% | 15.4% | 1.18 | 1.15 |
| 20041229 | 20051228 | 17.2% | 4.3% | 16.3% | 10.2% | 1.05 | 0.42 |
| 20051229 | 20061228 | 17.2% | 16.1% | 16.4% | 24.3% | 1.04 | 0.66 |
| 20061229 | 20071228 | 15.6% | 4.0% | 24.6% | 22.3% | 0.64 | 0.18 |
| 20071231 | 20081226 | 8.7% | 32.6% | 15.0% | 24.4% | 0.58 | 1.34 |
| 20081229 | 20091225 | 14.7% | 7.1% | 22.5% | 17.4% | 0.65 | 0.41 |
| 20091228 | 20101227 | 18.0% | 31.1% | 23.3% | 13.9% | 0.77 | 2.24 |
| 20101228 | 20111227 | 21.6% | 4.3% | 21.8% | 24.7% | 0.99 | 0.18 |
| 20111228 | 20121226 | 18.8% | -12.9% | 22.7% | 18.8% | 0.83 | - 0.68 |
| 20121227 | 20131226 | 14.3% | 5.1% | 22.9% | 14.2% | 0.63 | 0.36 |
| 20131227 | 20141226 | 7.4% | 23.7% | 22.9% | 14.3% | 0.32 | 1.66 |
| 20141229 | 20151225 | 9.2% | 11.2% | 14.1% | 12.7% | 0.65 | 0.88 |
| 20151228 | 20161223 | 9.4% | -8.5% | 13.7% | 16.6% | 0.69 | - 0.51 |
| 20161226 | 20171225 | 6.8% | 13.2% | 15.6% | 7.9% | 0.43 | 1.67 |
| 20171226 | 20181225 | 12.9% | 13.0% | 17.2% | 15.5% | 0.75 | 0.84 |
| 20181226 | 20191225 | 14.9% | -12.6% | 15.4% | 15.9% | 0.97 | - 0.79 |
| 20191226 | 20201224 | 7.2% | -0.5% | 16.4% | 22.7% | 0.44 | - 0.02 |
| 20201225 | 20211224 | 4.6% | 25.3% | 21.5% | 11.6% | 0.22 | 2.18 |
| 20211227 | 20221223 | 13.8% | 20.8% | 20.8% | 19.5% | 0.67 | 1.06 |
| 20221226 | 20231222 | 12.7% | 1.5% | 20.9% | 9.2% | 0.60 | 0.17 |
| 20231225 | 20241223 | 11.8% | 64.5% | 20.6% | 14.3% | 0.57 | 4.51 |
| **Mean** | | **15.9%** | **12.0%** | **18.7%** | **16.8%** | **0.65** | **0.49** |
| | **WFE:** | **75.7%** | **WFE:** | **89.8%** | **WFE:** | **75.2%** | |

4. **Walk Forward Optimization: 1644 days; Walk Forward Out-of-sample: 548 days**

Below are **the results of Walk-Forward Analysis (WFA) for the 1644/548 day combination.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
801,776,858	11.49%	0.41	0.54	27.76%	45.80	2,301

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve
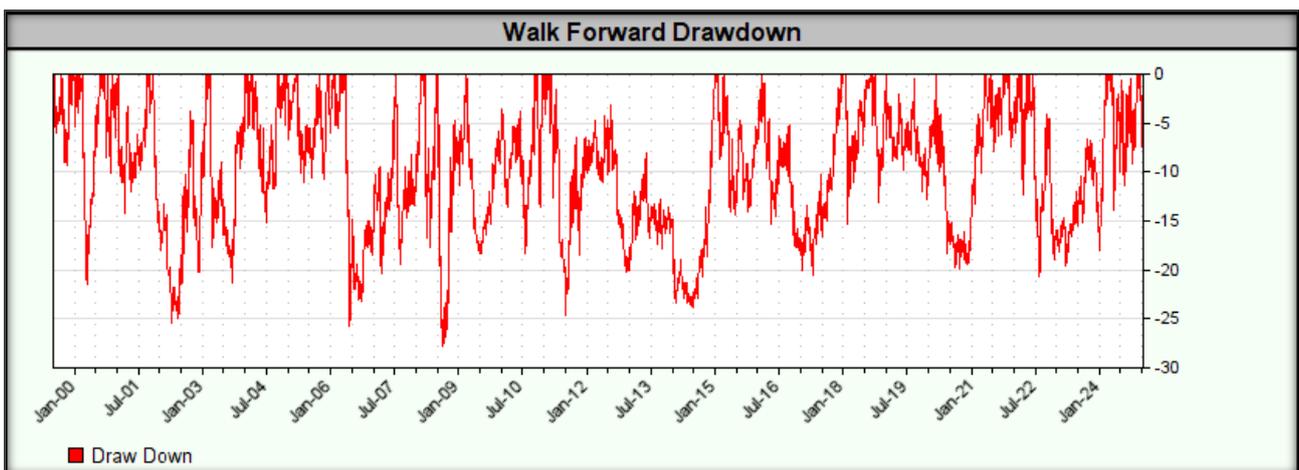
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown

■ Draw Down
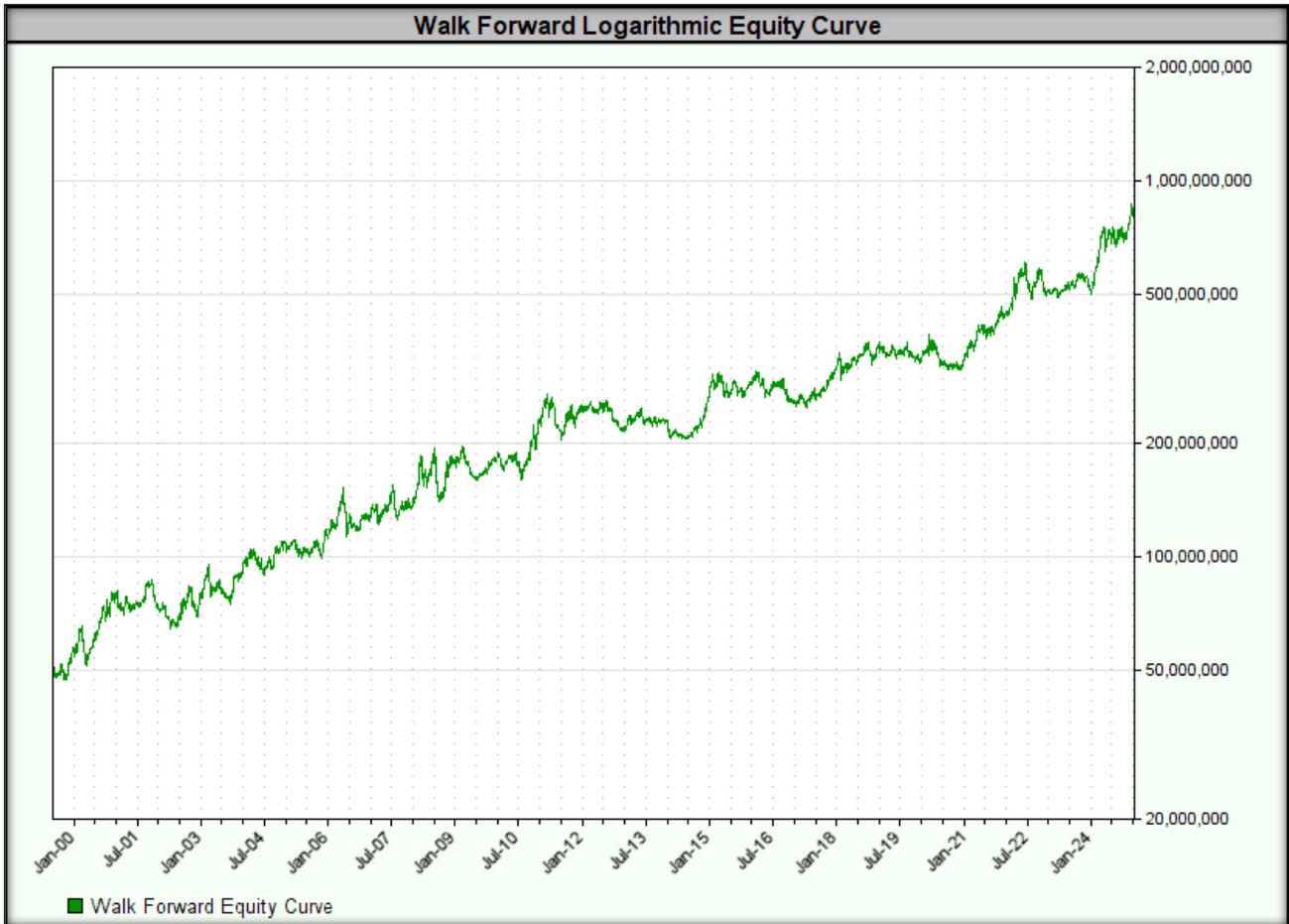
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1644	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
19990705	20001229	33.2%	36.2%	9.9%	21.5%	3.35	1.68

|								
20010101	20020702	32.6%	-7.6%	17.2%	25.5%	1.89	- 0.30
20020703	20040101	22.6%	21.8%	17.2%	21.3%	1.31	1.02
20040102	20050701	23.6%	6.5%	20.0%	15.2%	1.18	0.43
20050704	20070101	16.1%	15.1%	16.5%	25.8%	0.97	0.58
20070102	20080702	15.9%	32.3%	25.5%	19.4%	0.62	1.67
20080703	20100101	15.4%	-4.0%	15.0%	27.8%	1.03	- 0.14
20100104	20110701	22.8%	7.4%	22.1%	24.5%	1.03	0.30
20110704	20130101	17.8%	4.1%	25.1%	17.6%	0.71	0.24
20130102	20140703	9.5%	-2.4%	16.7%	17.1%	0.57	- 0.14
20140704	20160101	4.2%	23.7%	14.1%	14.4%	0.29	1.65
20160104	20170703	12.6%	-5.9%	13.7%	20.5%	0.92	- 0.29
20170704	20190102	8.6%	26.6%	17.2%	15.3%	0.50	1.74
20190103	20200703	18.9%	-9.0%	15.6%	18.3%	1.21	- 0.49
20200706	20211231	5.5%	22.8%	15.2%	8.0%	0.36	2.86
20220103	20230704	15.5%	13.1%	20.7%	20.6%	0.75	0.63
20230705	20250102	14.1%	33.4%	20.5%	13.9%	0.69	2.40
Mean		**17.0%**	**12.6%**	**17.8%**	**19.2%**	**0.67**	**0.45**
		WFE:	**74.1%**	**WFE:**	**108.0%**	**WFE:**	**68.0%**

5. **Walk Forward Optimization: 1918 days; Walk Forward Out-of-sample: 548 days**

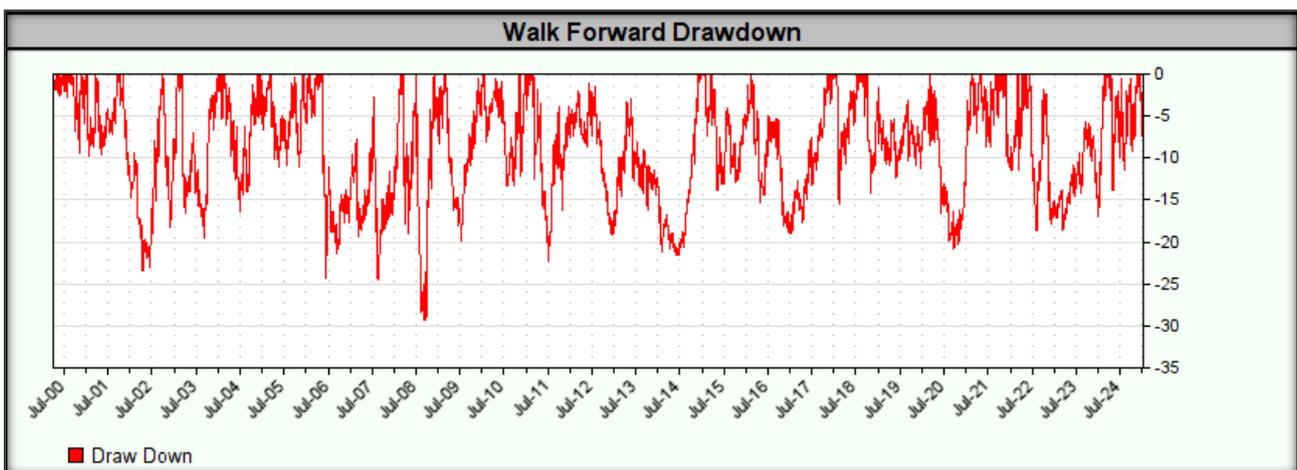Below are **the results of Walk-Forward Analysis (WFA) for the 1918/548 day combination.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
659,753,137	10.98%	0.37	0.52	29.38%	44.85	2,288

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

Walk Forward Equity Curve

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown

Draw Down
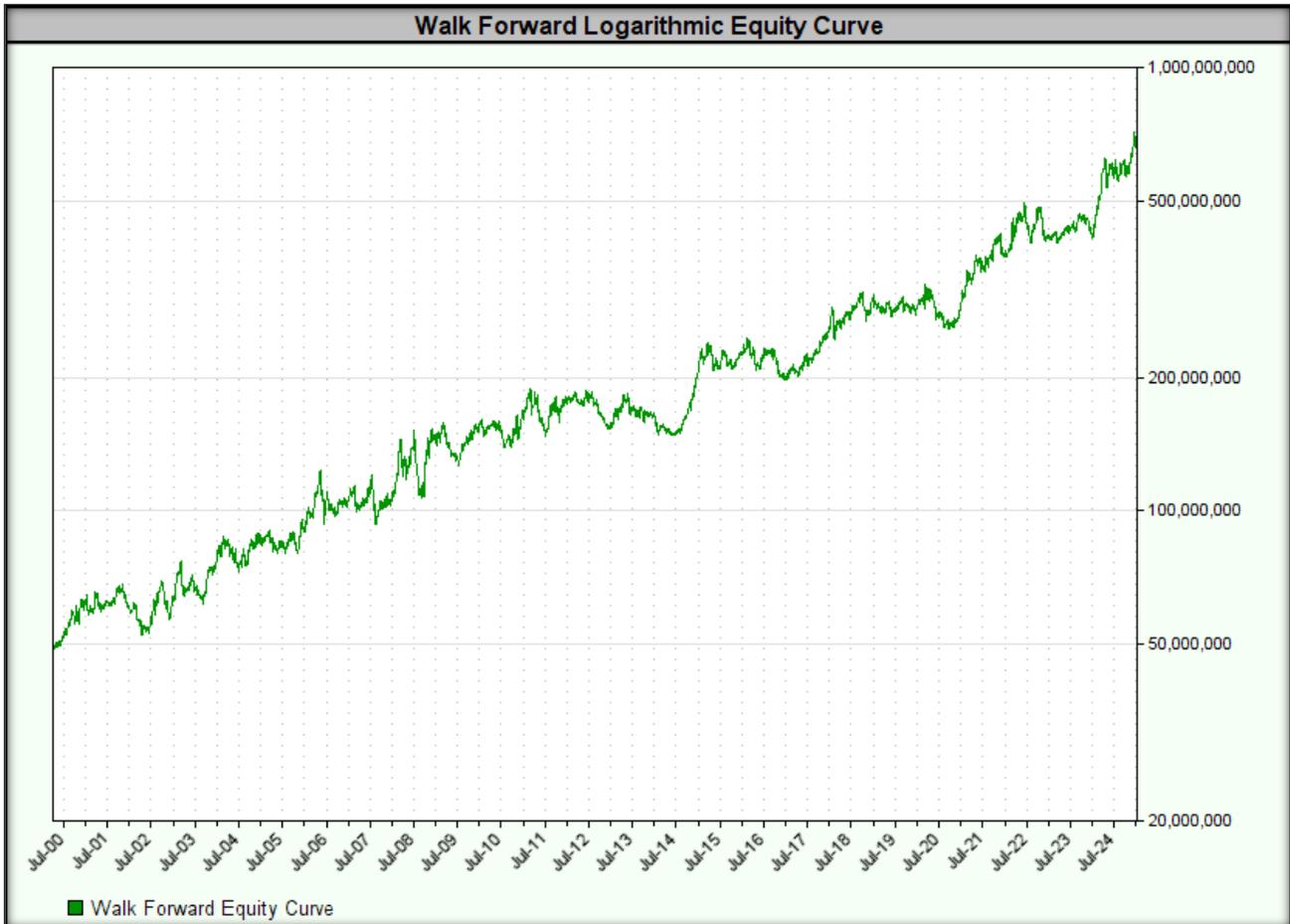
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1918	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20000403	20011001	31.3%	21.8%	11.7%	9.7%	2.66	2.24

|							
20011002	20030402	28.9%	-1.3%	17.2%	23.4%	1.68	- 0.06
20030403	20041001	22.7%	17.4%	17.4%	16.4%	1.30	1.06
20041004	20060331	22.1%	17.5%	20.0%	11.1%	1.11	1.58
20060403	20071002	19.5%	-2.4%	16.4%	24.5%	1.19	- 0.10
20071003	20090402	14.4%	25.7%	25.5%	29.4%	0.57	0.88
20090403	20101001	13.6%	-0.8%	22.5%	13.3%	0.60	- 0.06
20101004	20120402	20.4%	16.2%	23.2%	22.3%	0.88	0.73
20120403	20131002	17.6%	-6.5%	22.8%	18.2%	0.77	- 0.36
20131003	20150403	8.9%	26.2%	16.9%	12.0%	0.53	2.18
20150406	20160930	10.2%	-0.5%	13.3%	15.3%	0.77	- 0.03
20161003	20180403	11.2%	9.9%	15.3%	15.4%	0.73	0.64
20180404	20191003	11.9%	7.9%	17.2%	14.1%	0.69	0.56
20191004	20210402	13.7%	8.4%	15.6%	20.8%	0.88	0.41
20210405	20221003	7.4%	25.2%	21.5%	18.7%	0.34	1.35
20221004	20240403	19.4%	17.2%	20.7%	17.0%	0.94	1.01
20240404	20250110	18.7%	16.1%	20.5%	13.9%	0.91	1.16
Mean		**17.2%**	**11.7%**	**18.7%**	**17.4%**	**0.67**	**0.40**
		WFE:	**67.9%**	**WFE:**	**93.0%**	**WFE:**	**58.9%**

6. **Walk Forward Optimization: 2192 days; Walk Forward Out-of-sample: 548 days**

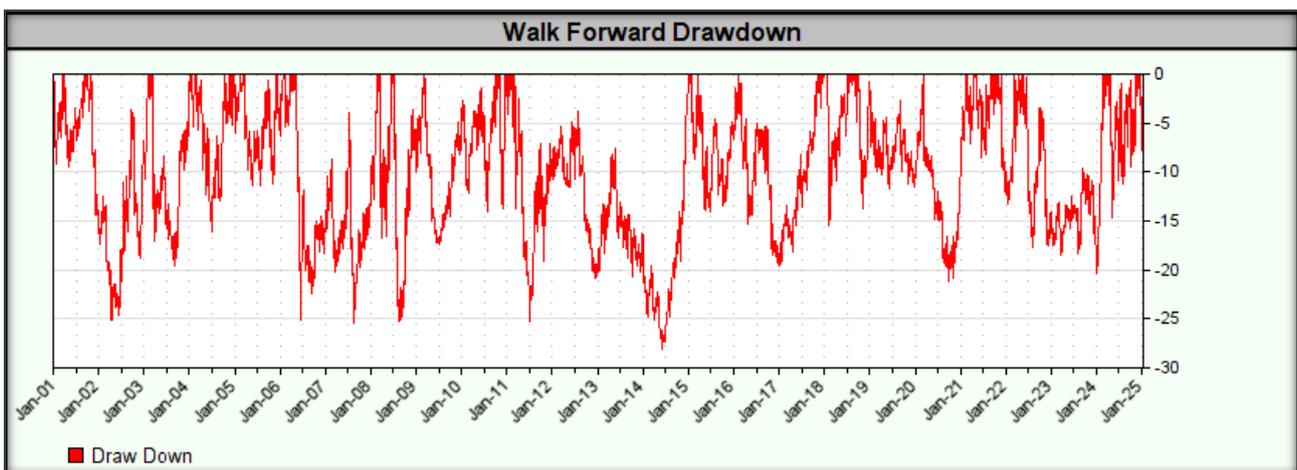Below are **the results of Walk-Forward Analysis (WFA) for the 2192/548 day combination.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
486,882,166	9.94%	0.35	0.48	28.18%	45.93	2,094

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Logarithmic Equity Curve

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Drawdown
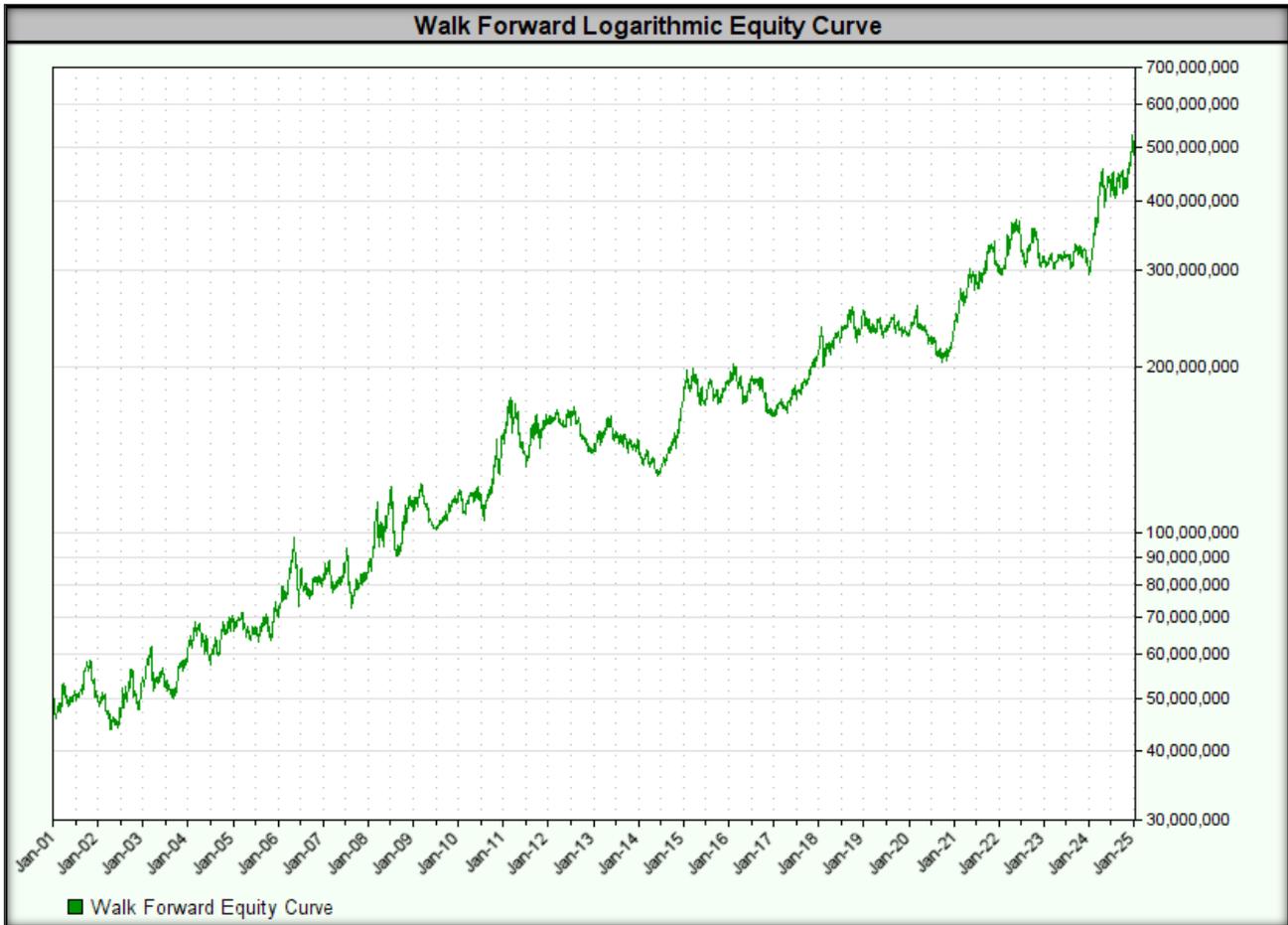
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	2192	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20010101	20020702	31.7%	-2.9%	17.2%	25.1%	1.84	- 0.12

20020703	20040101	25.2%	18.0%	18.8%	19.6%	1.34	0.92
20040102	20050701	23.8%	5.7%	18.5%	16.1%	1.28	0.35
20050704	20070101	19.2%	15.1%	20.0%	25.1%	0.96	0.60
20070102	20080702	16.5%	29.6%	24.6%	22.3%	0.67	1.33
20080703	20100101	14.6%	-2.9%	15.6%	25.3%	0.94	- 0.11
20100104	20110701	14.5%	9.1%	23.7%	25.1%	0.61	0.36
20110704	20130101	19.6%	4.2%	25.1%	17.6%	0.78	0.24
20130102	20140703	13.3%	-4.9%	22.9%	22.3%	0.58	- 0.22
20140704	20160101	7.0%	26.6%	16.5%	14.0%	0.42	1.90
20160104	20170703	8.9%	-3.8%	14.1%	19.5%	0.63	- 0.19
20170704	20190102	8.5%	28.3%	17.3%	15.4%	0.49	1.84
20190103	20200703	13.2%	-8.8%	17.2%	14.9%	0.77	- 0.59
20200706	20211231	10.9%	21.7%	18.5%	12.4%	0.59	1.76
20220103	20230704	8.5%	4.9%	20.3%	18.5%	0.42	0.27
20230705	20250102	16.0%	33.9%	20.7%	14.7%	0.77	2.31
Mean		**15.7%**	**10.9%**	**19.4%**	**19.2%**	**0.63**	**0.43**
		WFE:	**69.2%**	WFE:	**99.1%**	WFE:	**68.6%**

7. Walk-Forward Analysis Summary

The above analysis shows that **regardless of the adopted combination of optimization and testing window lengths,** the **WFE results are good:**

- **WFE for CAGR% remains around 65%-75%,** which indicates good performance of the strategy in real conditions. **All tests had WFE above 50% (CAGR% and MAR).**
- **The WFE for drawdown remains around 100%,** which means that the strategy does not lose significant stability outside of the optimization period.

Considering both **MAR** and **WFE,** the best results were achieved for **the combination of 1095/365 days** (1095 days of optimization, 365 days of testing).

Below is **a comparison of the WFA test results for the 1095/365 combination with the results of the strategy using the optimized parameters from Step 4:**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

	WFA	Optimized
CAGR%	12.5%	12.7%
MAR Ratio	0.50	0.49
Max Drawdown	24.8%	26.2%

The results are similar, which is a positive sign – it means that the strategy remains **stable** and **independent of overfitting to historical data.**

Step 6: Using the strategy in real time

After **extensive testing, implementing a real-time** trading strategy becomes **relatively easy. Buy/sell signals and stop loss orders are generated automatically** by the computer based on pre-established rules and formulas.

The most important element **of strategy execution** is **consistent execution of all signals, without exception. As Larry Williams noted:** *"Trading strategies work. Traders do not."*

Before making **a final decision to implement a strategy,** it is necessary to check **whether it really adds value** to the results of the entire portfolio. It does not make sense to implement a strategy that **generates similar signals** or **is characterized by a similar course of the equity curve.**

Key criteria for evaluating the strategy before implementation:

1. **Daily Return Correlation**
   - The **lower the correlation** with other strategies, the better.
   - **Optimal values:** Correlation **close to zero or negative.**
2. **Reducing maximum drawdown**
   - If adding a strategy to a portfolio results in **a lower maximum drawdown,** this is **a strong positive signal.**
3. **Objective Function Improvement (MAR)**
   - If adding a strategy causes **the MAR to increase,** this indicates that **it has added value** to the portfolio.
4. **Better results in Monte Carlo simulation**
   - Monte Carlo simulation determines the potential **maximum drawdown.**
   - If Monte Carlo results **improve** after adding a strategy, this is **a strong positive signal.**

The above elements are often interrelated – usually **all of them are met** or **none of them are met.**

Once you decide to add a strategy to your portfolio, **the question arises:** *Should you implement your strategy right away or is it better to wait?*

Some studies suggest **an incubation period** of **3-6 months,** during which:

- The strategy is **monitored** but **does not execute real transactions.**
- **Generated signals, positions and results** are observed to detect **potential anomalies.**

In our case, **the incubation period** lasts from the moment **the strategy is launched in a live environment** until **a drawdown occurs at a level of about half of the maximum drawdown** observed in historical data. **Only after reaching this threshold does the strategy begin to be used with real funds.**

Thanks to this:

- **We avoid investing real money in an untested environment.**
- **We wait for a drawdown to occur** before launching the strategy, which **reduces the risk of starting at an unfavorable moment.**

The final decision on its full implementation should be based on **thorough testing and analysis of the value added to the portfolio,** so that the strategy actually supports long-term investment goals and does not increase unnecessary risk.