Legal Disclaimer

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.

Bollinger Breakout v.1

Investment Strategy Testing Summary

Bollinger Breakout strategy is a **trend-following trading technique** that uses **the Bollinger Bands** to identify price breakouts outside their range. Such a breakout can signal **the beginning of a new trend** or **the continuation of an existing one**. The key assumption of the strategy is **to open long positions when the price closes above the upper band** and **short positions when the price closes below the lower band.**

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 1.0% of the capital value;
- **CAGR:** 13.1%;
- **MAR:** 0.27;
- **Maximum drawdown:** 47.7%.

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 duration can be up to several dozen months,** which may cause great discomfort in using this strategy and growing concerns about its effectiveness;
- **Significant increase in drawdown in Walk Forward Analysis tests** compared to in-sample and out-of-sample data;
- **Relatively low MAR** achieved in Walk Forward Analysis tests compared to other trend following strategies.

Despite these limitations, the Bollinger Breakout v.1 strategy **can be an effective tool for traders who prefer trend following strategies**, as it remains relatively stable in a variety of market conditions and a wide range of parameters. **I cannot** emphasize enough that for **the 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."

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

The Bollinger Breakout strategy is a **trend-following strategy** that is based on identifying moments when **the price of a financial instrument breaks out of the range defined by the Bollinger Bands**. The Bollinger Bands are dynamic support and resistance levels that adjust to market volatility.

The strategy assumes that **a price breakout beyond the bands may signal the beginning of a new trend or the continuation of an existing one**, which creates an opportunity to generate profits by following the price movement.

Basic assumptions of the strategy:

- **A long position** is opened when **the price closes above the upper Bollinger Band**;
- **A short position** is opened when **the price closes below the lower Bollinger Band**.

The Bollinger Breakout strategy uses the premise that **Bollinger Bands are effective at identifying periods of low volatility** that often **precede a sharp price move.** When price breaks outside the bands, there is a high probability of continuing the move in the direction of the breakout, providing an advantage in the market.

Characteristics of the strategy and its strengths and weaknesses:

- **Simplicity and clarity:** The rules of the Bollinger Breakout strategy are clearly defined, which minimizes the risk of subjective decisions. The strategy is easy to understand and implement, even for novice investors.
- **Leveraging Volatility:** Bollinger Bands are a dynamic tool that automatically adjusts to changing market volatility, making the strategy adaptive to different market conditions.
- **Risk mitigation:** The strategy involves the use of stop loss orders, which allows for effective risk management and capital protection in the event of unfavorable price movements.
- **Sensitivity to false signals:** During periods of low volatility or in sideways trends, the strategy may generate false breakout signals, leading to losing trades.
- **No Advantage in Sideways Trends:** The Bollinger Breakout strategy is not optimal in situations where the market is moving in a sideways trend, where the price is oscillating around the moving average, causing numerous false breakouts.

Bollinger Breakout strategy is **a simple but effective trend-following system** that works best in markets with clear price movements. Its main advantage is **its ability to catch large trends**, but its effectiveness can be **limited during periods of consolidation**.

Step 2: Define investment principles

Below is **the pseudocode** for the **Bollinger Breakout strategy** on daily data:

1. **Calculate Bollinger Bands:**
   - Calculate the XX-day moving average (SMA) of the closing price.
   - Calculate the XX-day standard deviation of the closing price.
   - Determine the upper Bollinger Band: SMA + Y * standard deviation.
   - Determine the lower Bollinger Band: SMA - Y * standard deviation.
   - Determine the middle Bollinger band: SMA +/- Z * standard deviation.

2. **Check buy signal:**
   - If yesterday (D-1) the closing price was below the upper Bollinger Band and today (D) the closing price is above the upper Bollinger Band – **take a long position for the opening of the next day.**
   - Stay Long – Hold the long position until the closing price is below the middle Bollinger Band; if the closing price is below the middle Bollinger Band, **close the position at the next day's open.**

3. **Check sell signal:**
   - If yesterday (D-1) the closing price was above the lower Bollinger Band and today (D) the closing price is below the lower Bollinger Band – **take a short position for the opening of the next day.**
   - Stay Short – Keep the short position until the closing price is above the middle Bollinger Band; if the closing price is above the middle Bollinger Band, **close the position at the next day's open.**

4. **Close previous position –** before opening a new position (long or short), close the previous opposite position (if any).

5. **Monitor signals every day –** calculate Bollinger Bands every day and check conditions based on the above rules to decide whether to enter or exit a position.

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 strategy assumes having, at the time of opening the position, **an exit order at the level of the middle Bollinger band** (according to the pseudocode above). Based on this data, we can calculate the position risk. Tests are performed assuming that **the risk of one position is 1.0% of the total capital.**

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 e-mini S&P 500.** At the beginning of January 2008, **a sell signal was generated – the closing price was below the lower Bollinger Band** (in this case, the lower band was **two standard deviations away from the mean**). Two candles were marked in the rectangle on the left side of the chart – **the first generates the signal, while the second indicates the day the position was opened** (we take the position at the opening of the next session). **The system worked correctly.**

At the end of May 2008, **a signal was generated to close a short position – the closing price was above the middle Bollinger Band** (in this case, it was the moving average). Two candles were marked in the rectangle on the right side of the chart – **the first one generates a signal, and the second one is the day of closing** the position (we close the position at the opening of the next session). **The system worked correctly.**

The next transaction is **the purchase of a corn futures contract**. At the beginning of March 2018, **a buy signal was generated – the closing price was above the upper Bollinger Band (in this case, the upper band was 2.5 standard deviations away from the average).** Two candles were marked in the rectangle on the left side

of the chart – **the first generates a signal, and the second indicates the day the position was opened** (we take a position at the opening of the next session). **The system worked correctly.**

At the beginning of June 2018, **a signal was generated to close a long position – the closing price was below the middle Bollinger Band** (in this case, it was 0.5 standard deviations away from the average). Two candles were marked in the rectangle on the right side of the chart – **the first one generates a signal, and the second one indicates the day of closing the position** (we close the position at the opening of the next session). **The system worked correctly**.

Once we are sure that the trades 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 basic parameters**, which – according to my assessment – should 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:

- **Moving average:** 200;
- **Upper/Lower Bollinger Band:** 2.00;
- **Middle Bollinger Band:** 0.00;
- **Position size:** corresponding to a risk of **1.0% of capital value;**
- **Opening a position:** at the opening price of the next day.

The test result is shown below.

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

Performance Curve - Log Scale with Drawdowns
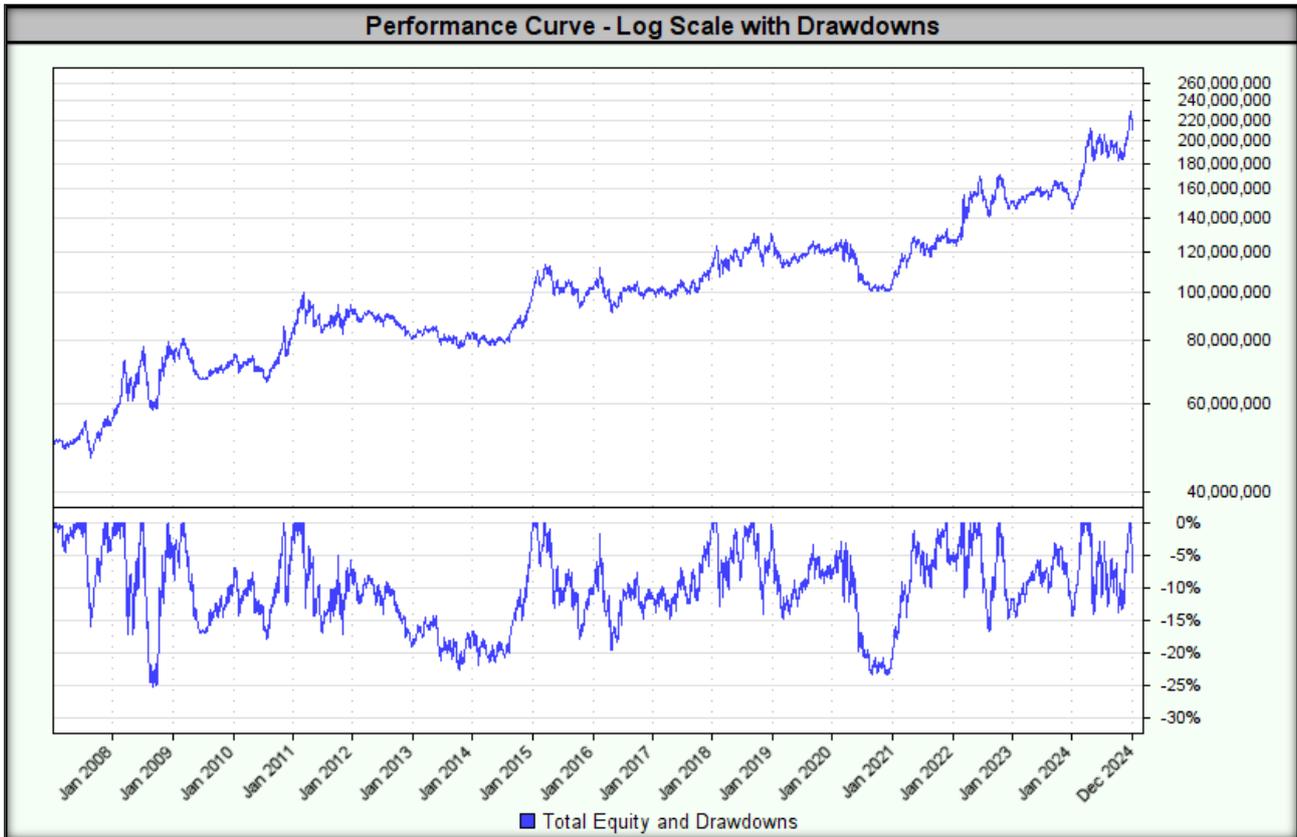
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Indicators/Measures	Bollinger Breakout
CAGR%	8.6%
MAR Ratio	0.34
RAR%	5.9%
R-Cubed	0.15
Robust Sharpe Ratio	0.36
Max Drawdown	25.3%
Wins	38.6%
Losses	61.4%
Average Win%	2.07%
Average Loss%	0.77%
Win/Loss Ratio	2.61
Average Trade Duration (days)	184
Percent Profit Factor	1.68
SQN	0.63
Number of transactions	552

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

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**. <u>**I cannot**</u> <u>emphasize enough that for</u> **a strategy to work** <u>in real conditions, it must also work</u> <u>on</u> **suboptimal parameters** <u>and in</u> **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."

<u>**My goal is not**</u> <u>to find</u> **optimal parameter values** – <u>**my goal**</u> <u>is to find</u> **a wide range of parameters** <u>for which</u> <u>the strategy will generate</u> **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**

The Bollinger Breakout v.1 strategy in this version assumes **the optimization of parameters using The Grid Search** method. It consists in **the 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:

- **Moving average:** range **170-260 days (step: 5);**
- **Upper/Lower Bollinger Bands:** range **1.50-2.30 (step: 0.05);**
- **Middle Bollinger Band:** range **0.00-1.00 (step: 0.05).**

The lowest MAR value of 0.13 was achieved for the following parameters:

- **Moving average:** 235;
- **Upper/Lower Bollinger Bands:** 2.20;
- **Middle Bollinger Band:** 0.65.

Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades
4949	235	2.20	0.65	$112,464,963.76	4.61%	0.13	0.37	0.40	34.3%	86.8	521
4613	230	2.25	0.65	$110,945,440.22	4.53%	0.14	0.37	0.40	33.1%	86.8	500
4255	225	2.25	0.60	$110,374,533.55	4.50%	0.14	0.37	0.40	31.5%	85.9	503
4634	230	2.30	0.65	$106,735,105.24	4.30%	0.14	0.37	0.43	30.1%	86.8	473
3856	220	2.15	0.60	$120,293,431.31	5.00%	0.14	0.38	0.39	34.7%	85.0	565
4256	225	2.25	0.65	$108,637,020.58	4.41%	0.14	0.36	0.39	30.5%	85.8	512
4970	235	2.25	0.65	$116,033,220.21	4.79%	0.14	0.39	0.42	33.0%	86.8	489
6421	255	2.30	0.75	$118,621,385.21	4.92%	0.15	0.41	0.44	33.0%	86.8	442
4234	225	2.20	0.60	$120,753,530.72	5.02%	0.15	0.39	0.42	33.6%	86.7	527
4550	230	2.10	0.65	$120,152,068.14	4.99%	0.15	0.37	0.41	33.4%	84.9	584
4235	225	2.20	0.65	$117,305,706.84	4.85%	0.15	0.38	0.41	32.4%	86.5	538
3898	220	2.25	0.60	$107,406,727.25	4.34%	0.15	0.36	0.41	28.9%	84.1	511

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

Performance Curve - Log Scale with Drawdowns

The highest MAR value of 0.52 was achieved for the following parameters:

- **Moving average:** 260;
- **Upper/Lower Bollinger Bands:** 1.55;
- **Middle Bollinger Band:** 0.70.

The highest MAR value was accompanied by **a drawdown of 31.8%**.

Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades
6462	260	1.55	0.70	$788,371,711.30	16.56%	0.52	0.75	0.76	31.8%	41.8	816
1170	185	1.70	0.70	$587,983,138.23	14.68%	0.51	0.68	0.68	28.6%	35.6	972
835	180	1.75	0.75	$520,737,565.91	13.90%	0.51	0.66	0.63	27.4%	37.3	981
6104	255	1.55	0.65	$703,766,660.20	15.83%	0.51	0.74	0.74	31.3%	41.4	796
6084	255	1.50	0.70	$763,042,221.57	16.35%	0.50	0.71	0.69	32.6%	38.9	877
1107	185	1.55	0.70	$640,466,805.34	15.22%	0.50	0.65	0.58	30.5%	33.9	1137
1169	185	1.70	0.65	$542,911,757.74	14.17%	0.50	0.67	0.66	28.5%	42.5	946
1484	190	1.60	0.65	$580,244,243.44	14.59%	0.50	0.66	0.57	29.4%	35.0	1013
6454	260	1.55	0.30	$570,817,570.42	14.49%	0.50	0.77	0.76	29.2%	42.5	628
855	180	1.80	0.70	$507,090,527.33	13.74%	0.50	0.67	0.66	27.7%	44.7	914
814	180	1.70	0.75	$535,557,487.20	14.08%	0.49	0.65	0.61	28.6%	36.2	1035
856	180	1.80	0.75	$520,235,696.11	13.90%	0.49	0.67	0.67	28.2%	37.3	934

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

Total Equity and Drawdowns

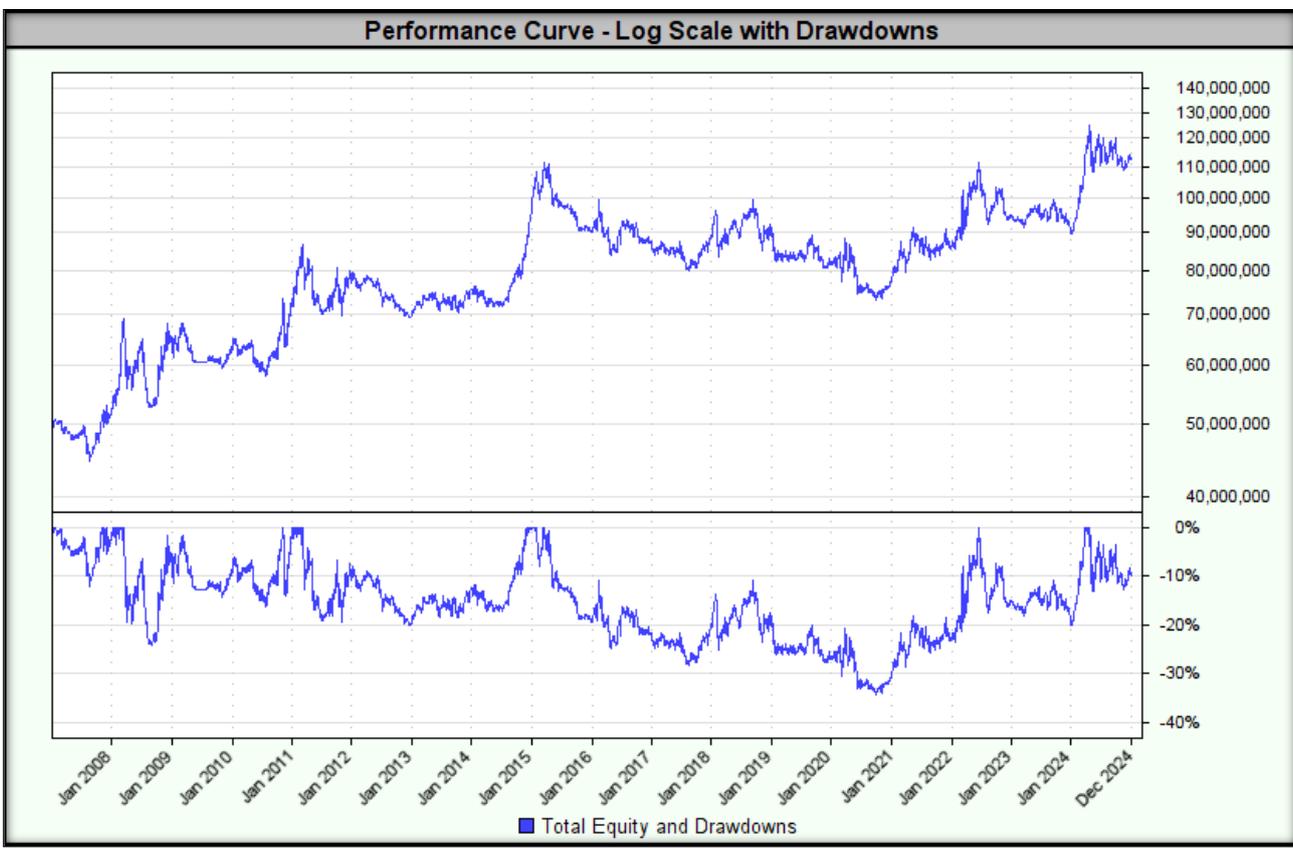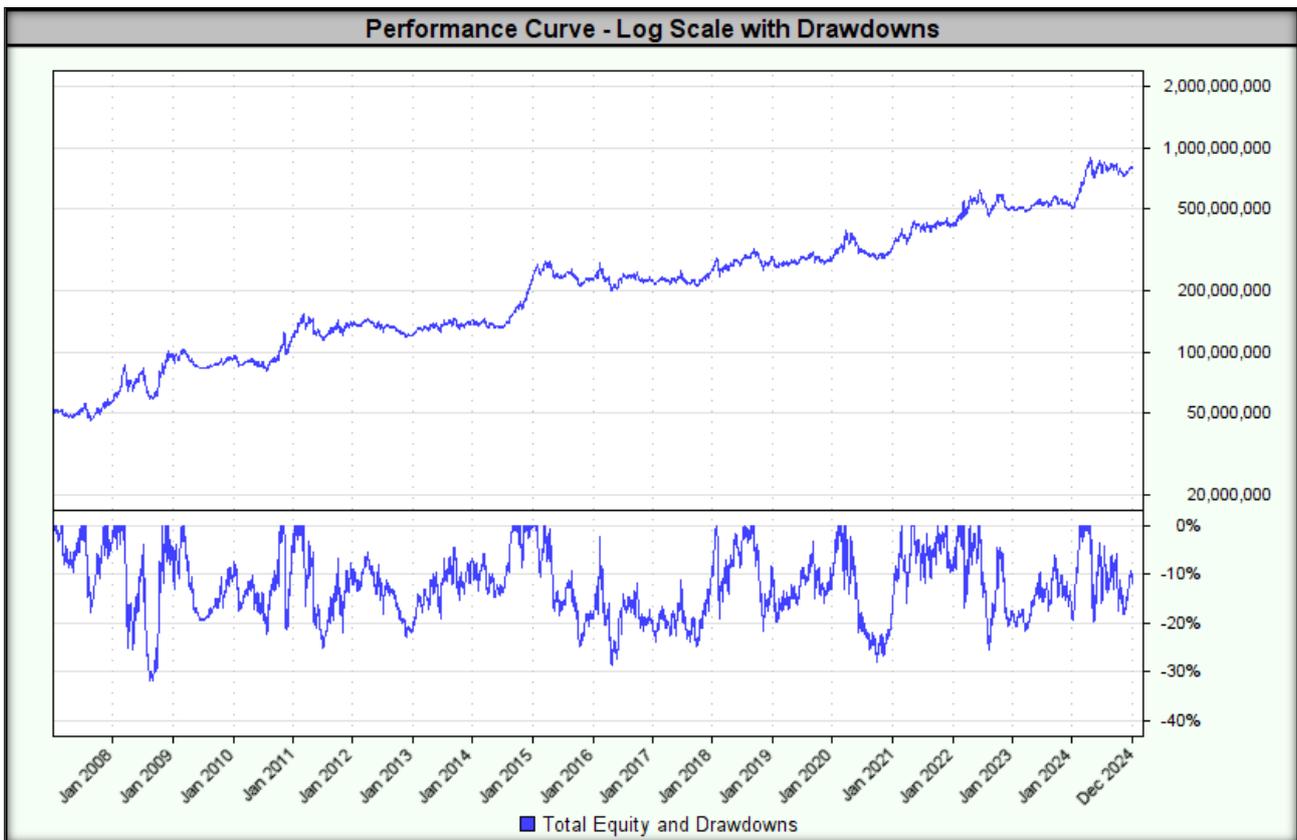For all combinations of tested parameter ranges, **the highest drawdown was 53.6%.**

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

Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades
734	180	1.50	0.95	$530,567,529.45	14.02%	0.26	0.54	0.33	53.6%	46.7	1594
735	180	1.50	1.00	$599,378,632.38	14.80%	0.29	0.55	0.32	51.0%	72.2	1674
733	180	1.50	0.90	$454,379,963.79	13.04%	0.26	0.52	0.33	50.8%	43.4	1522
378	175	1.50	1.00	$448,883,497.78	12.97%	0.26	0.51	0.29	49.5%	71.3	1725
21	170	1.50	1.00	$497,519,349.40	13.62%	0.28	0.52	0.29	48.7%	72.8	1764
4305	230	1.50	1.00	$852,439,425.91	17.07%	0.35	0.63	0.50	48.7%	44.7	1349
377	175	1.50	0.95	$438,699,625.09	12.82%	0.26	0.51	0.31	48.4%	70.1	1634
42	170	1.55	1.00	$383,283,535.72	11.98%	0.25	0.49	0.29	48.3%	71.2	1635
20	170	1.50	0.95	$404,358,946.29	12.31%	0.25	0.50	0.29	48.3%	70.4	1683
755	180	1.55	0.95	$445,951,438.82	12.93%	0.27	0.53	0.34	48.0%	43.3	1483
41	170	1.55	0.95	$340,914,468.06	11.25%	0.23	0.48	0.30	48.0%	70.4	1562
420	175	1.60	1.00	$481,764,828.97	13.41%	0.28	0.54	0.37	48.0%	59.6	1479

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 (**53.6% vs. 31.8%**) – 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 Close Average (days) Varies

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

MAR as Entry Threshold (std. dev.) Varies

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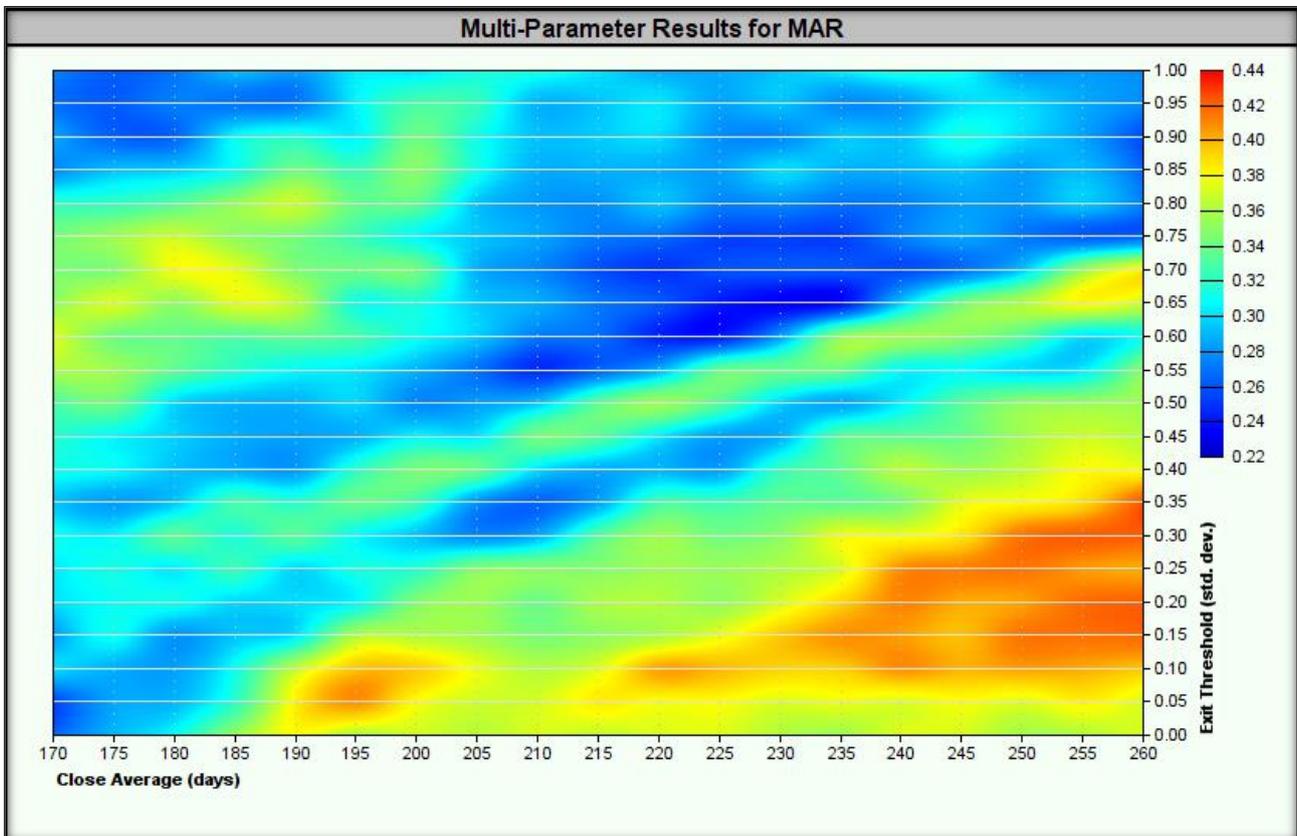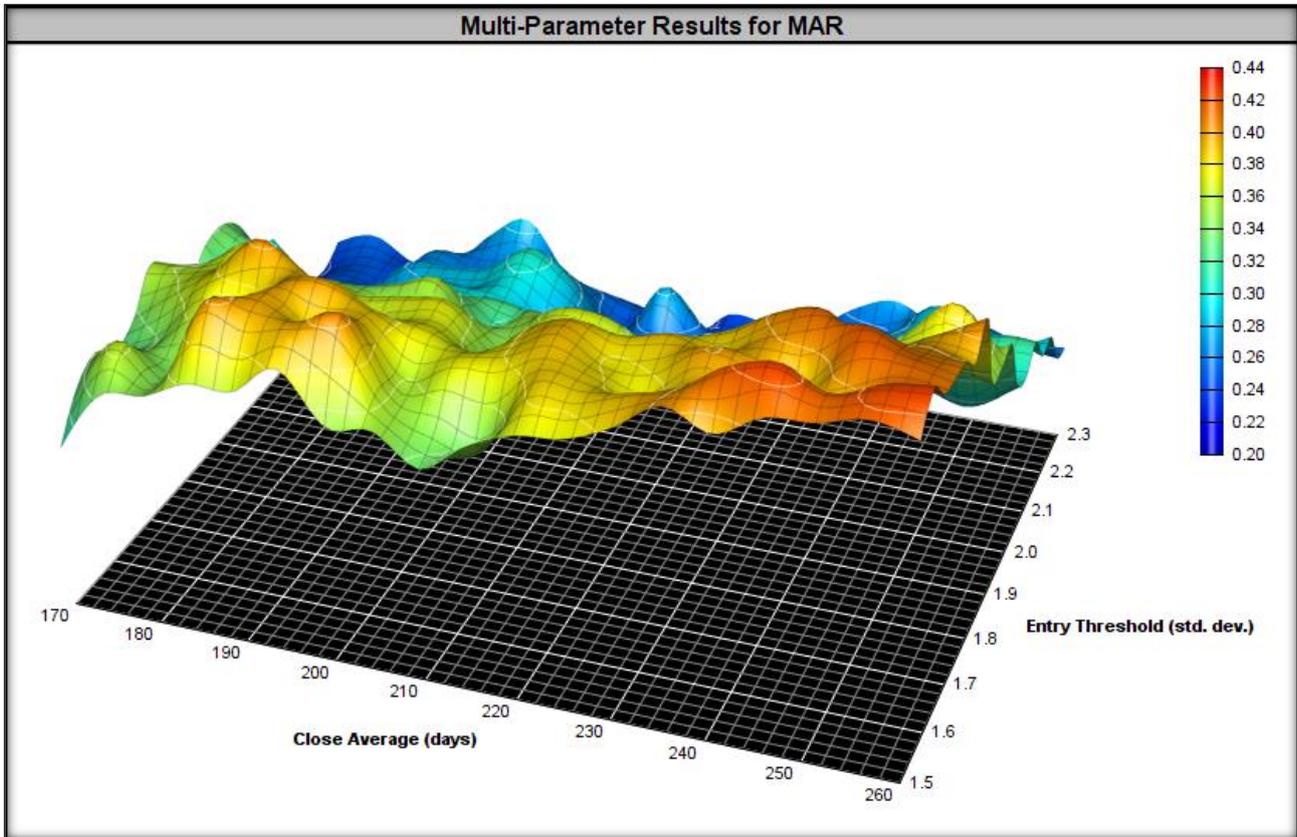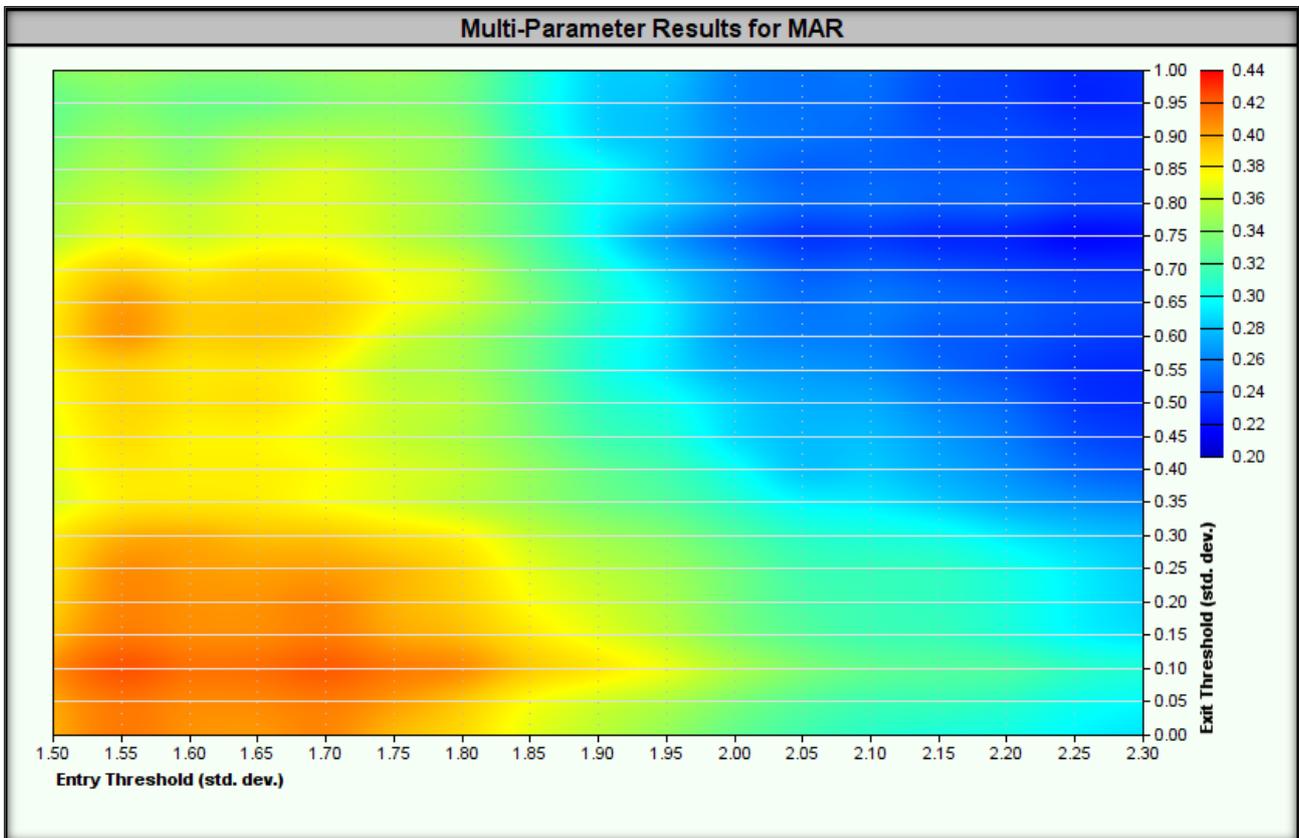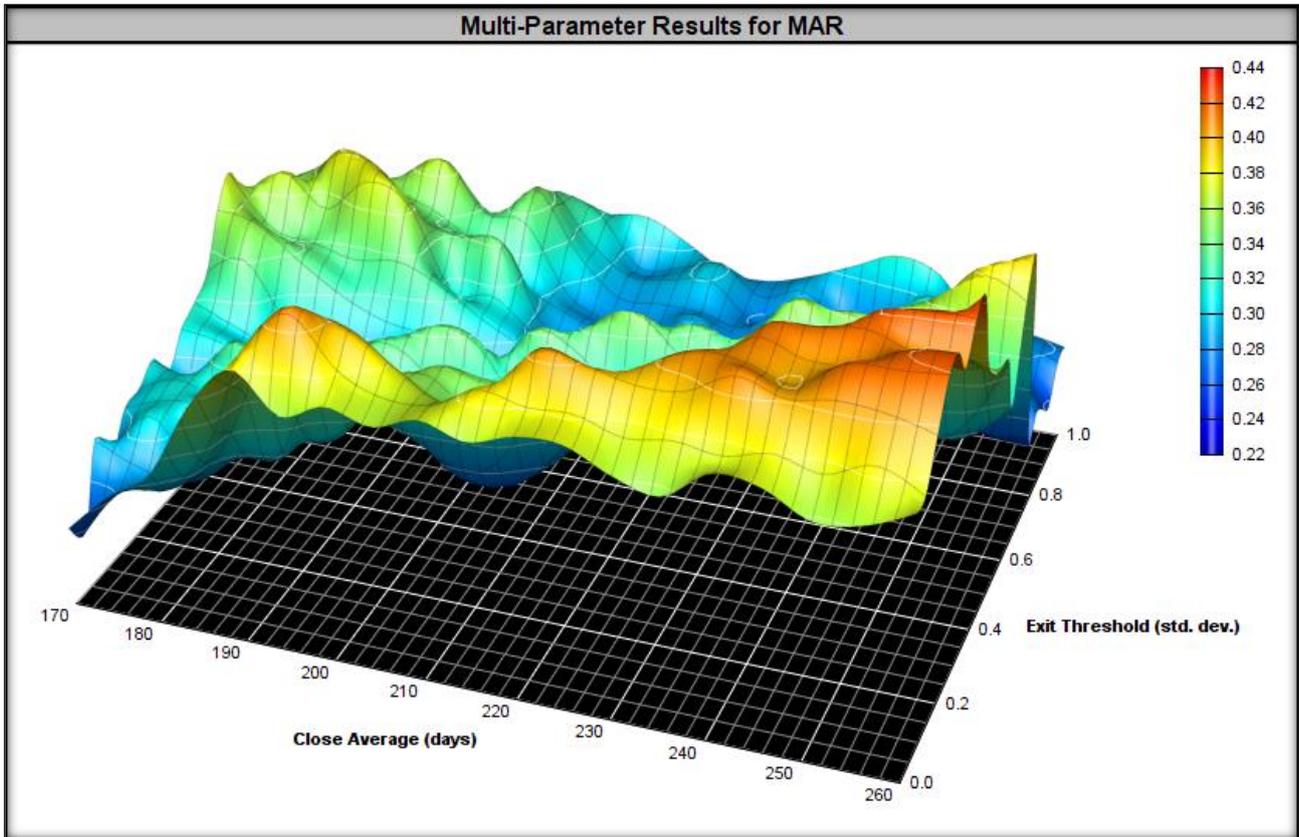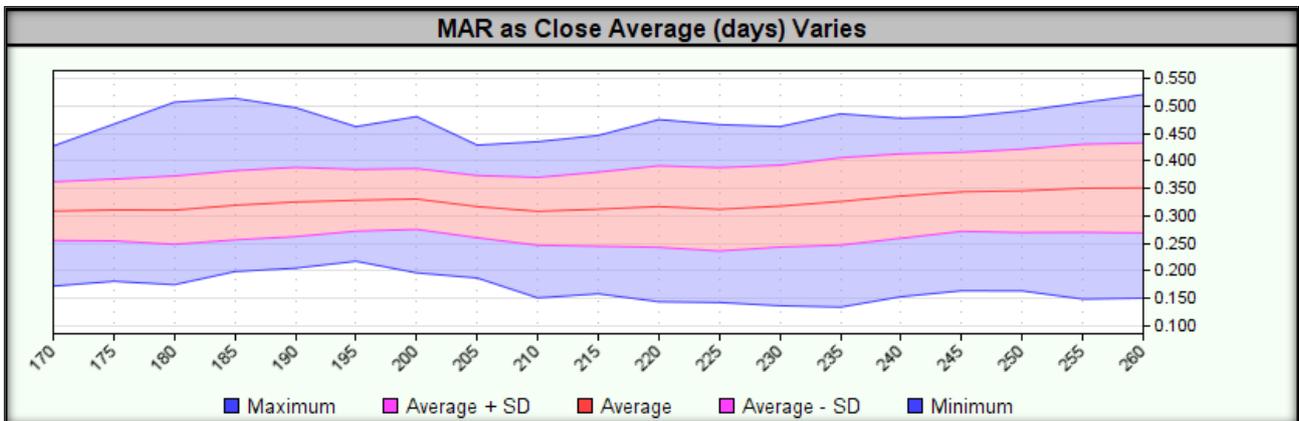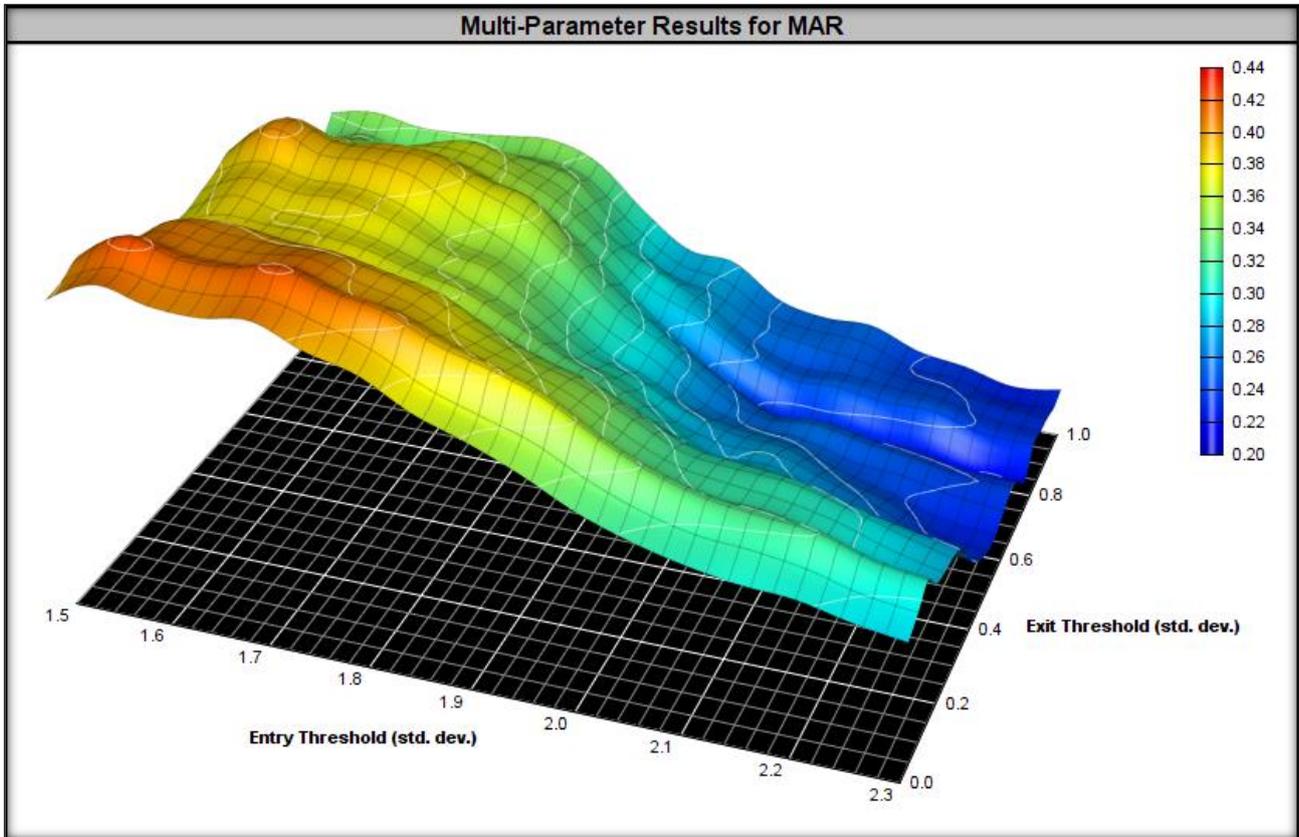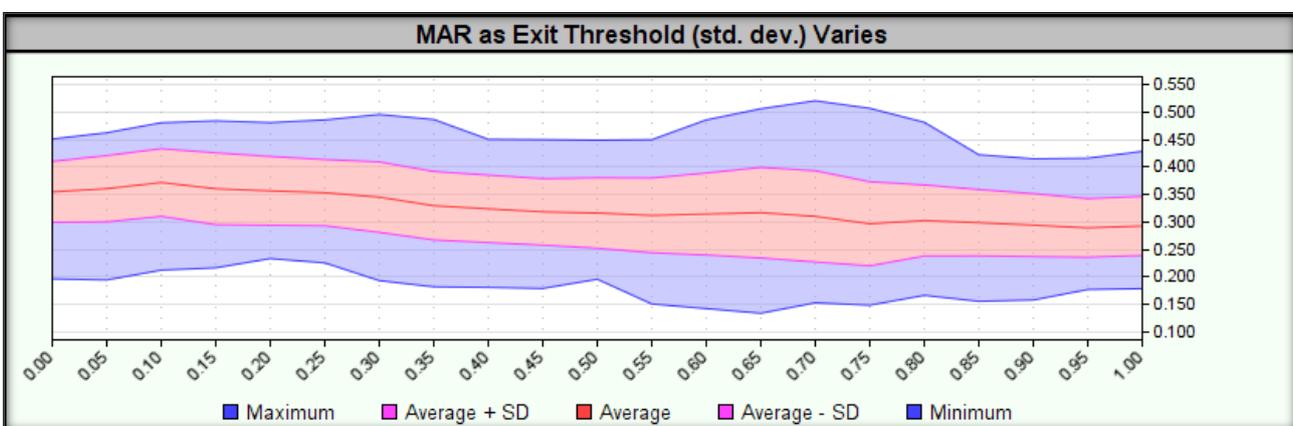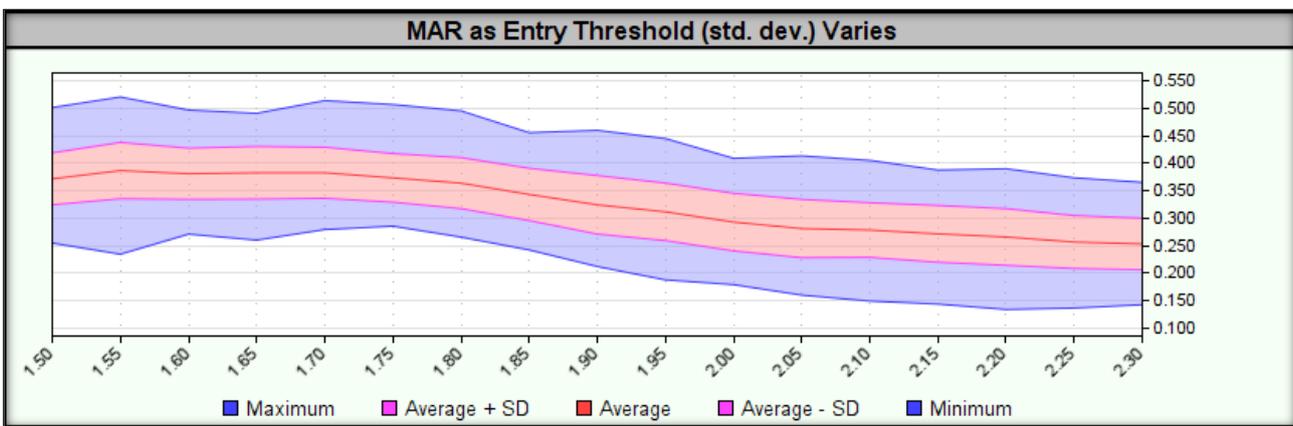
After passing the stability tests on **in-sample data**, it is time perform the same on **out-of-sample data**. For this purpose, we use **the same range of parameters** as on in-sample data:

- **Moving average:** range **170-260 days (step: 5);**
- **Upper/Lower Bollinger Bands:** range **1.50-2.30 (step: 0.05);**
- **Middle Bollinger Band:** range **0.00-1.00 (step: 0.05).**

The lowest MAR value of 0.23 was achieved for the following parameters:

- **Moving average:** 185;
- **Upper/Lower Bollinger Bands:** 2.30;
- **Middle Bollinger Band:** 0.05.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
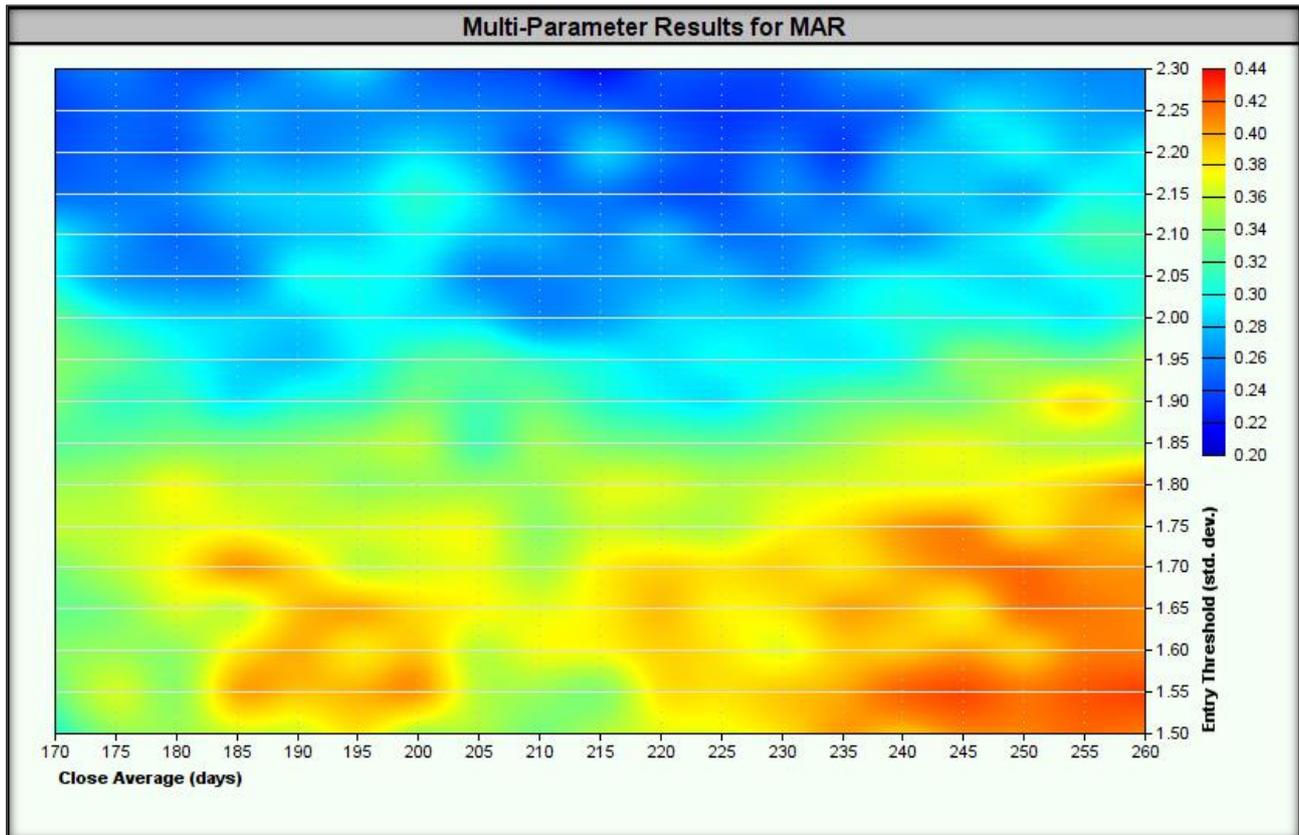
Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades
1409	185	2.30	0.05	$80,406,599.86	5.43%	0.23	0.49	1.09	23.9%	13.7	215
2479	200	2.30	0.00	$79,725,889.00	5.33%	0.23	0.51	0.87	23.3%	20.5	198
1408	185	2.30	0.00	$80,893,047.10	5.50%	0.23	0.51	1.11	23.6%	20.3	212
483	175	1.75	1.00	$99,911,082.30	8.00%	0.23	0.43	0.74	34.3%	17.4	556
1422	185	2.30	0.70	$81,306,710.31	5.56%	0.23	0.48	1.05	23.8%	20.6	254
2495	200	2.30	0.80	$80,702,766.72	5.47%	0.23	0.47	0.94	23.4%	30.0	251
2137	195	2.30	0.75	$79,449,054.73	5.29%	0.24	0.47	0.92	22.1%	30.4	249
2138	195	2.30	0.80	$80,315,200.61	5.41%	0.24	0.47	1.00	22.5%	30.0	253
462	175	1.70	1.00	$108,963,344.38	9.05%	0.24	0.46	0.75	37.6%	16.6	598
2481	200	2.30	0.10	$81,829,908.14	5.63%	0.24	0.52	0.95	23.3%	20.2	203
1765	190	2.30	0.00	$81,377,811.27	5.57%	0.24	0.52	1.01	23.0%	20.4	204

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 0.65 was achieved for the following parameters:

- **Moving average:** 260;
- **Upper/Lower Bollinger Bands:** 1.70;
- **Middle Bollinger Band:** 0.90.

The highest MAR value was accompanied by **a drawdown of 26.2%**.

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

Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades
6529	260	1.70	0.90	$206,496,698.85	17.09%	0.65	0.89	2.26	26.2%	11.1	363
5054	240	1.60	0.65	$225,371,597.14	18.23%	0.64	0.91	1.43	28.5%	21.2	357
6172	255	1.70	0.90	$197,013,390.43	16.48%	0.63	0.86	1.90	26.0%	11.2	374
1880	195	1.70	0.50	$197,892,066.04	16.53%	0.63	0.88	1.45	26.2%	20.5	353
4761	235	1.75	0.70	$200,864,930.29	16.73%	0.63	0.92	1.67	26.6%	21.0	328
5075	240	1.65	0.65	$212,172,630.65	17.44%	0.63	0.91	1.43	27.8%	21.0	338
6151	255	1.65	0.90	$196,600,959.83	16.45%	0.63	0.82	1.63	26.3%	11.3	395
4403	230	1.75	0.65	$193,942,269.09	16.27%	0.62	0.92	1.56	26.2%	21.2	324
1879	195	1.70	0.45	$190,596,275.25	16.05%	0.62	0.87	1.50	25.9%	20.5	343
4760	235	1.75	0.65	$196,388,791.81	16.43%	0.62	0.91	1.46	26.6%	21.0	317
6530	260	1.70	0.95	$196,478,277.36	16.44%	0.62	0.83	2.28	26.6%	11.1	381

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

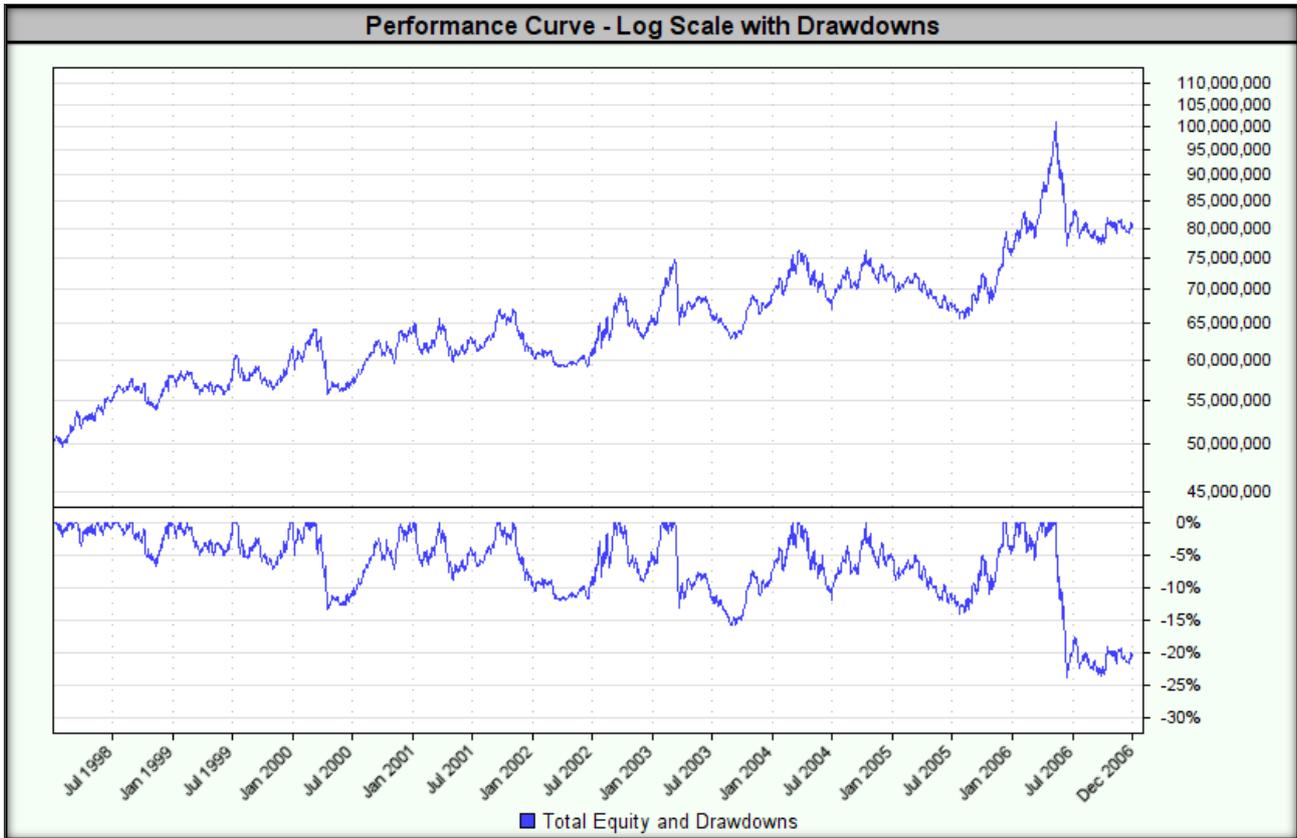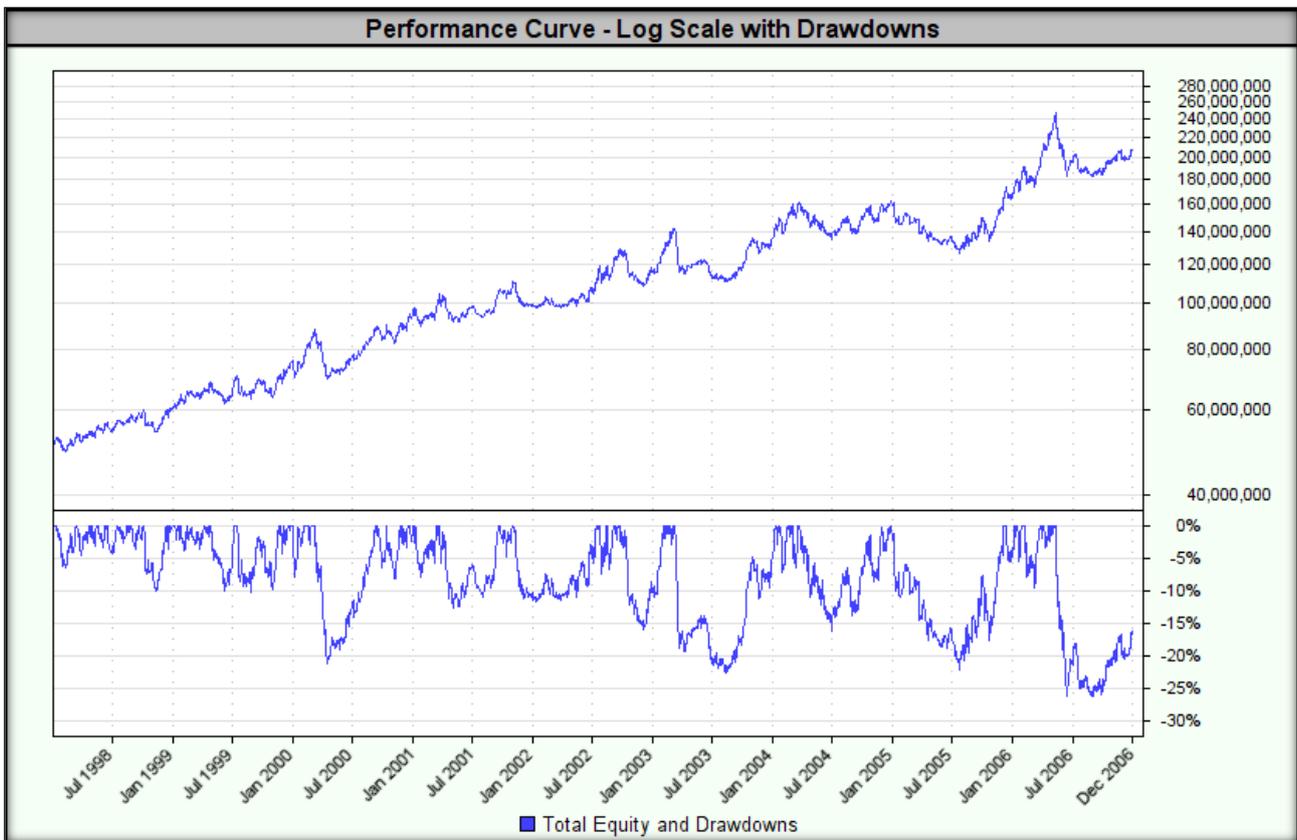For all combinations of tested parameter ranges, **the highest drawdown was 44.3%.**

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

Test	Close Average (days)	Entry Threshold (std. dev.)	Exit Threshold (std. dev.)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE ... ▽	Longest DD	Trades
378	175	1.50	1.00	$126,372,310.47	10.86%	0.24	0.47	0.82	44.3%	15.0	760
21	170	1.50	1.00	$155,013,372.43	13.41%	0.30	0.54	1.15	44.0%	24.2	774
1092	185	1.50	1.00	$132,403,114.16	11.44%	0.26	0.49	0.85	43.2%	13.1	725
735	180	1.50	1.00	$141,404,180.73	12.26%	0.30	0.51	0.84	41.3%	24.2	742
732	180	1.50	0.85	$163,447,930.62	14.08%	0.34	0.60	1.30	41.0%	24.2	621
5733	250	1.50	1.00	$209,446,080.36	17.27%	0.42	0.69	1.36	41.0%	22.5	575
20	170	1.50	0.95	$139,713,105.94	12.11%	0.30	0.51	0.85	41.0%	15.2	735
734	180	1.50	0.95	$142,037,961.23	12.31%	0.30	0.52	0.88	40.9%	24.1	704
377	175	1.50	0.95	$137,134,418.45	11.88%	0.29	0.51	0.78	40.6%	15.0	719
399	175	1.55	1.00	$138,115,802.90	11.96%	0.29	0.51	1.08	40.6%	15.9	699
1449	190	1.50	1.00	$142,072,816.34	12.32%	0.30	0.52	0.89	40.5%	22.1	705

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 (44.3% vs. 53.6%)** – which means an acceptable risk of capital drawdown.
- **The decrease in the maximum MAR value on out-of-sample data was less than 50% relative to the in-sample test results (0.65 vs. 0.52)** – indicating that the strategy can achieve good results 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
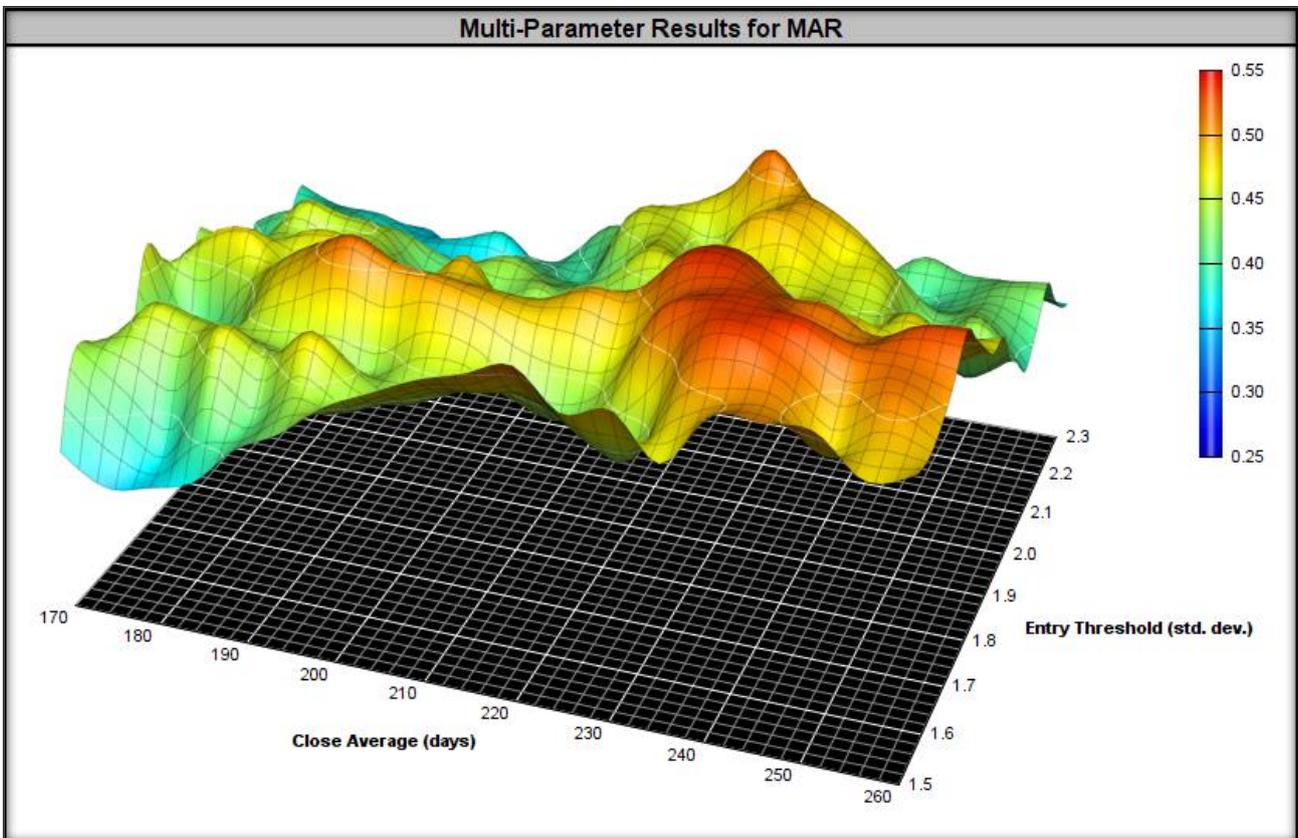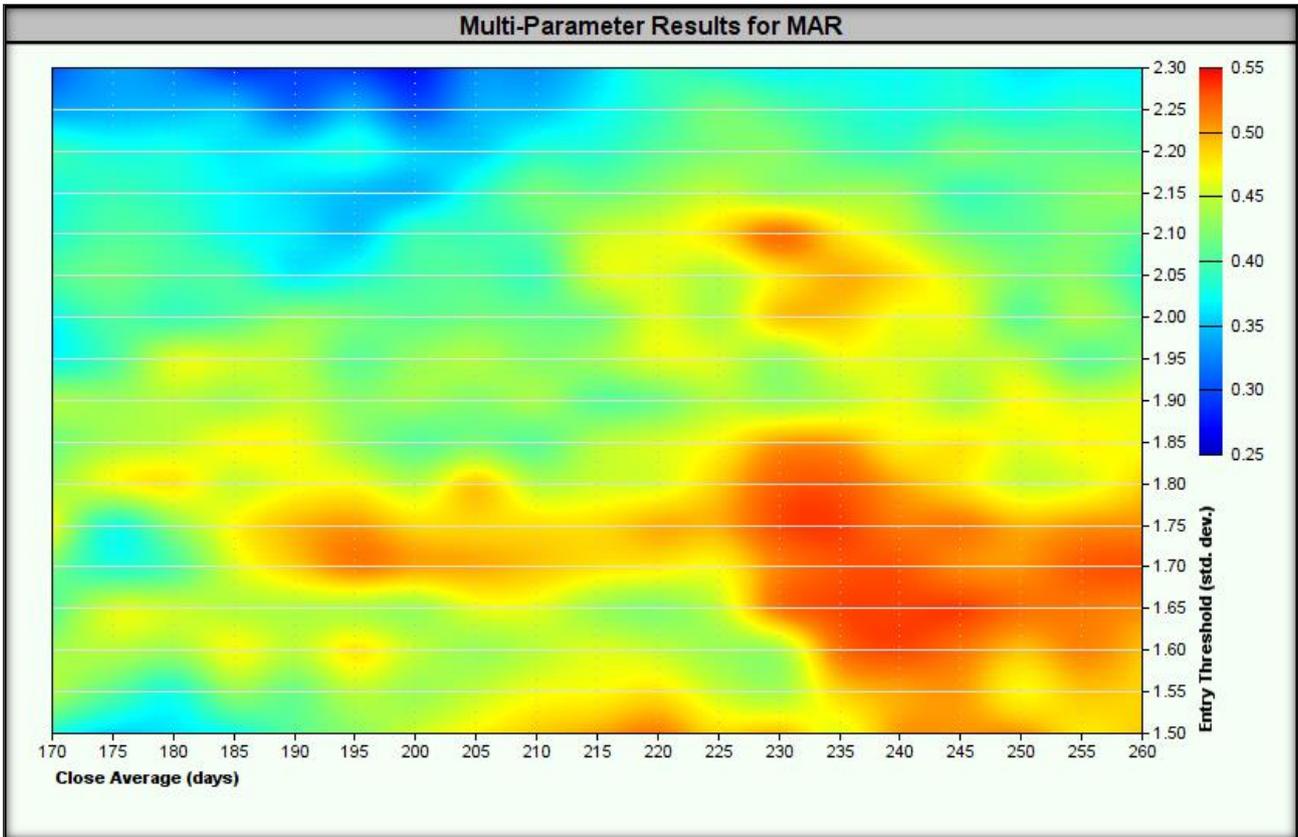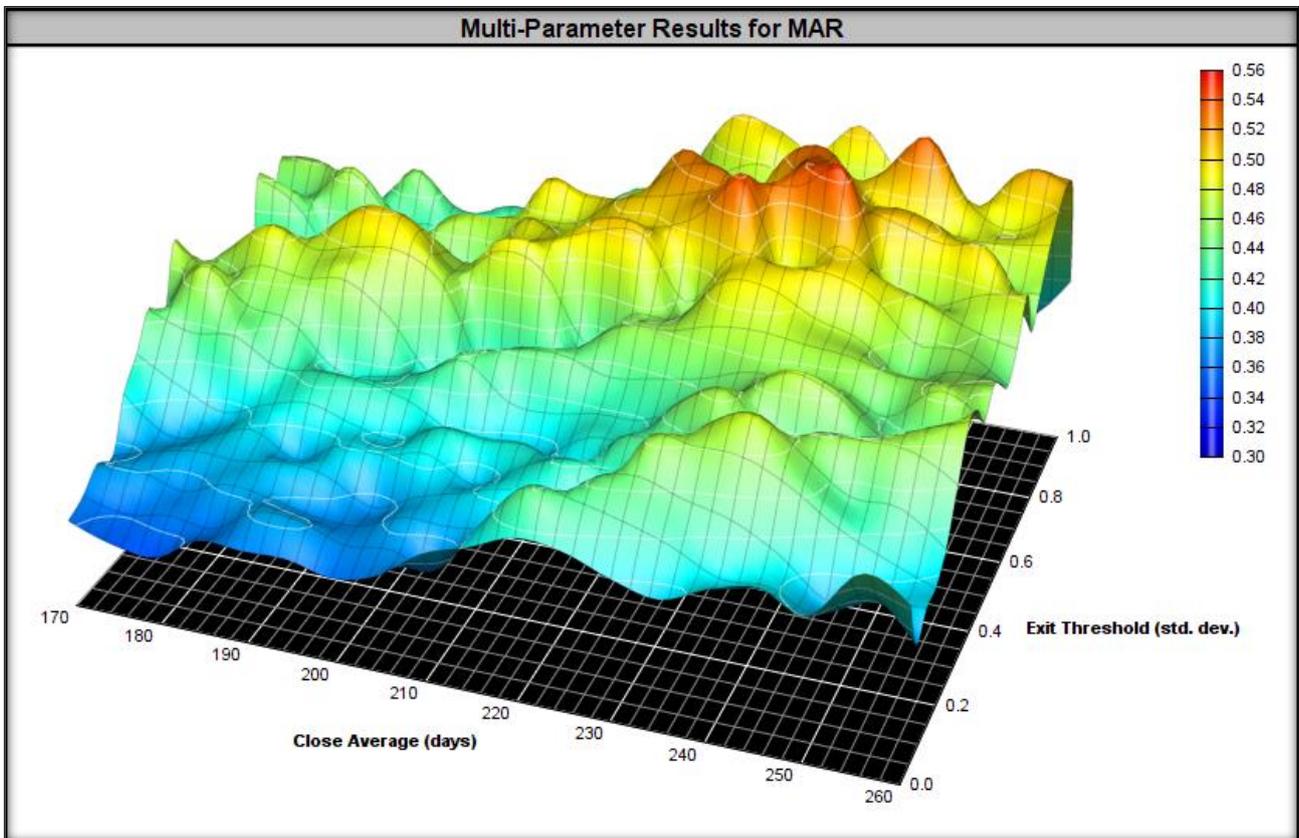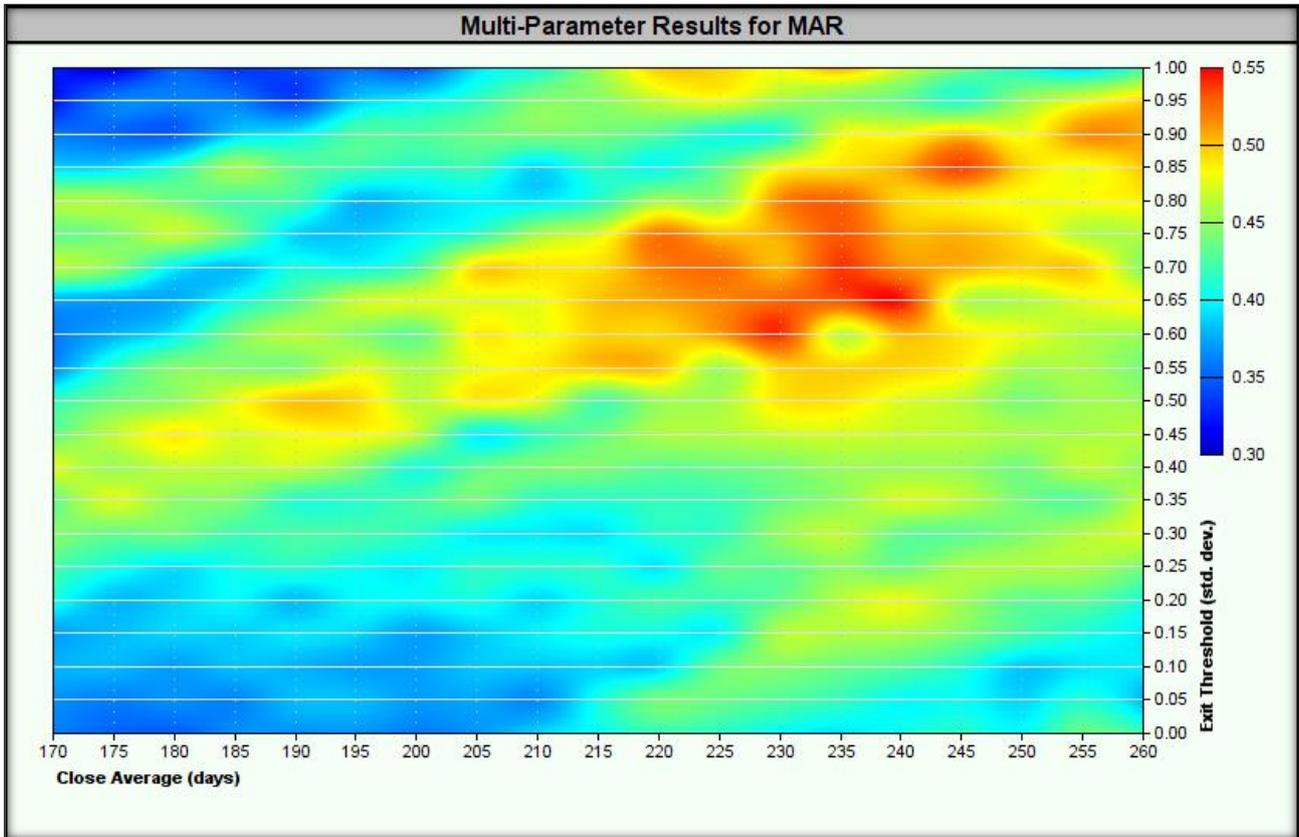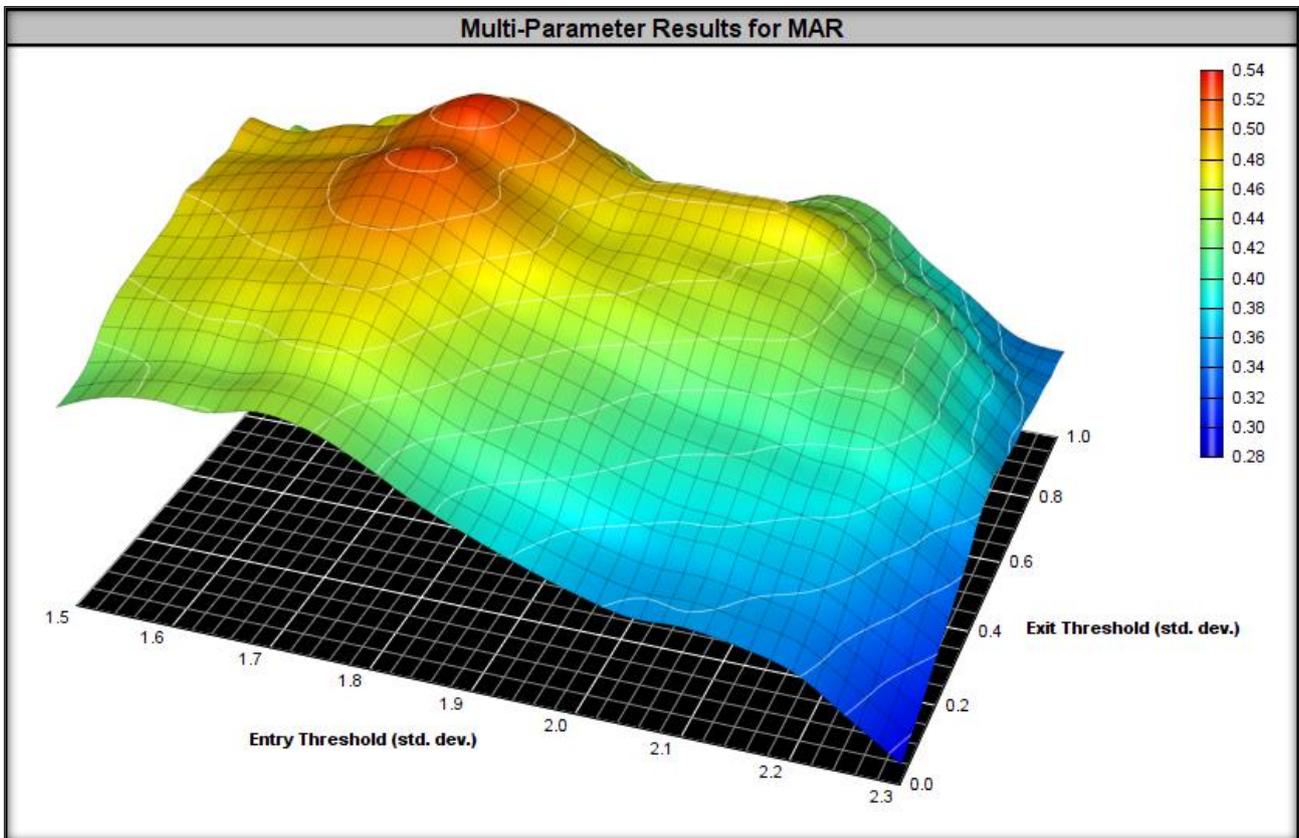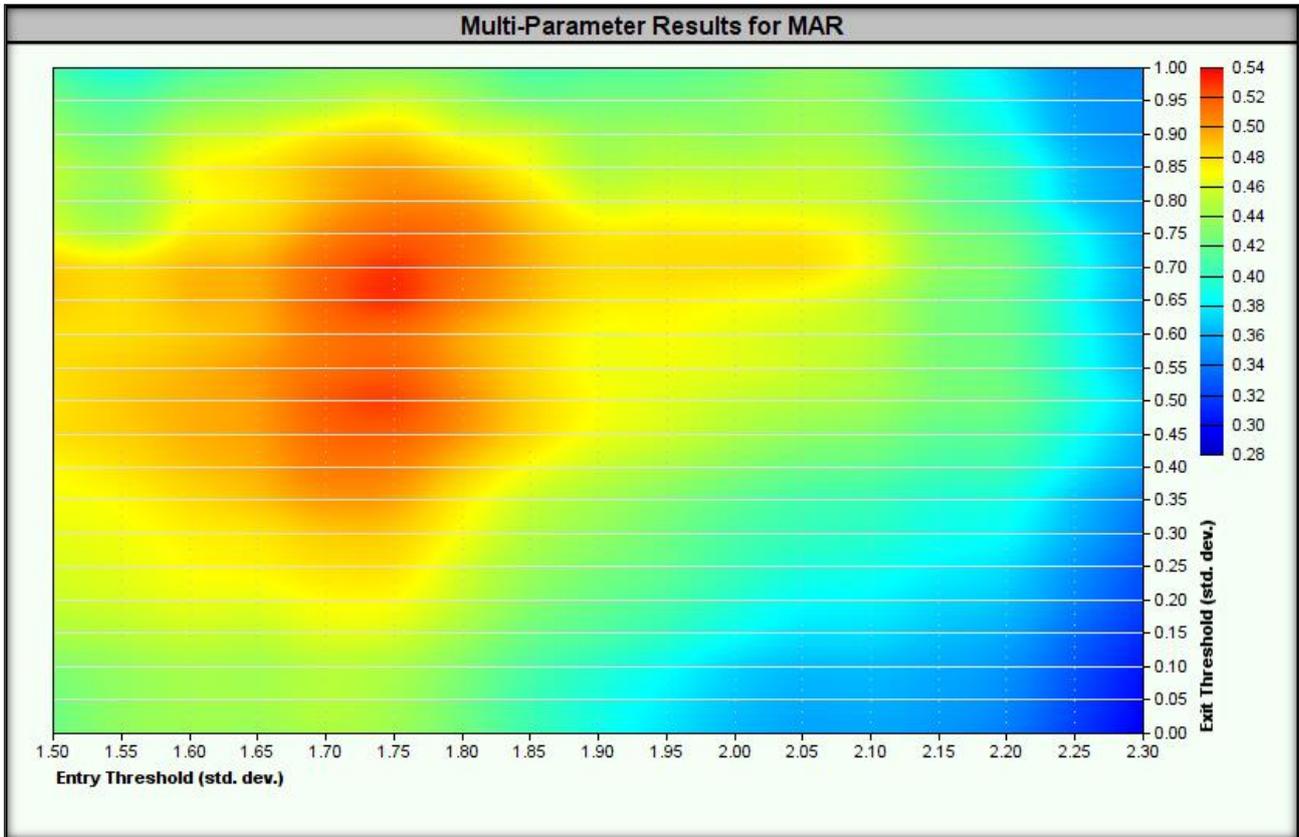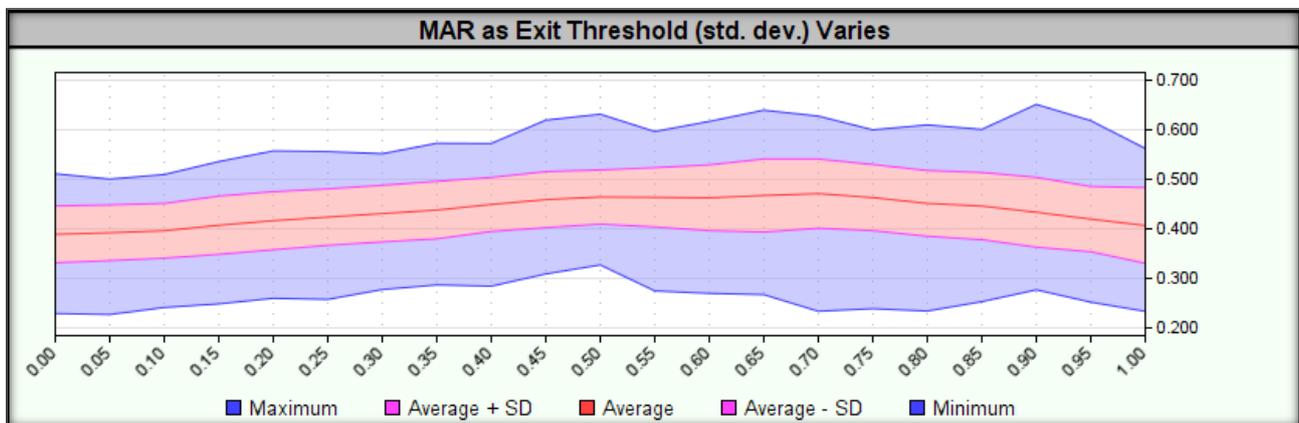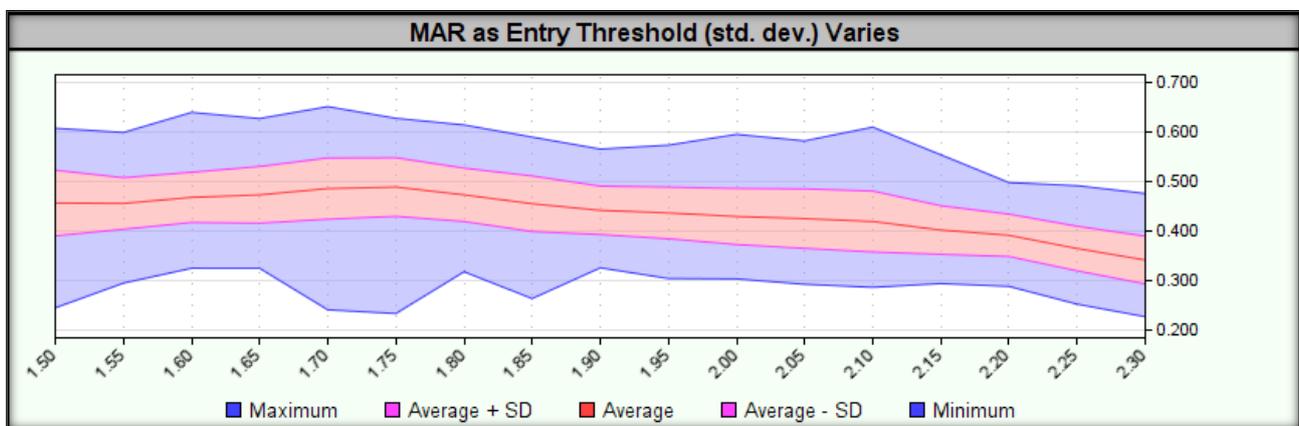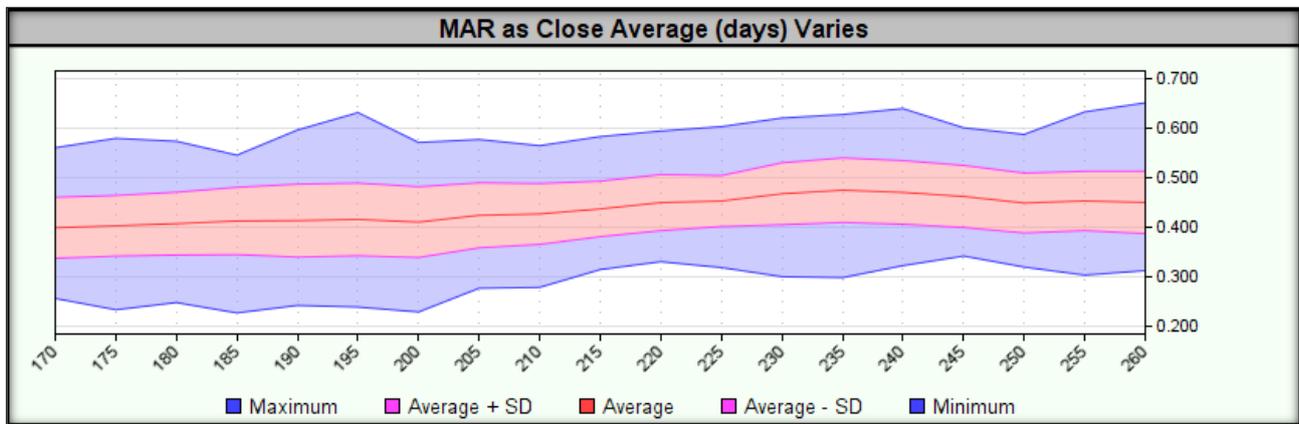
After passing **the stability test in a wide range of optimized parameters,** we can proceed to **stability testing using Monte Carlo simulation.** The conditions for passing this test are similar to those required in the above step.

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%.**

The simulation with sample replacement are presented below.

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
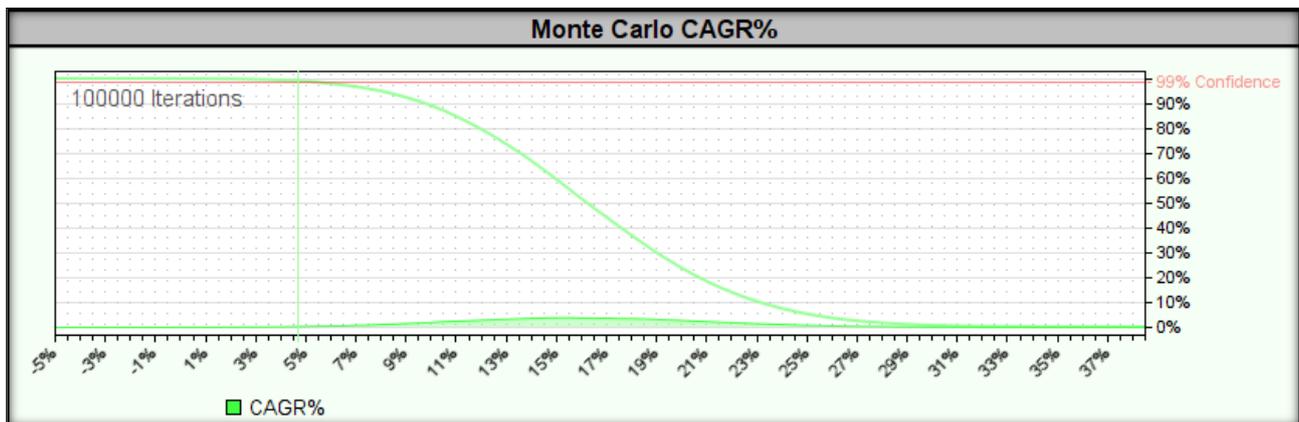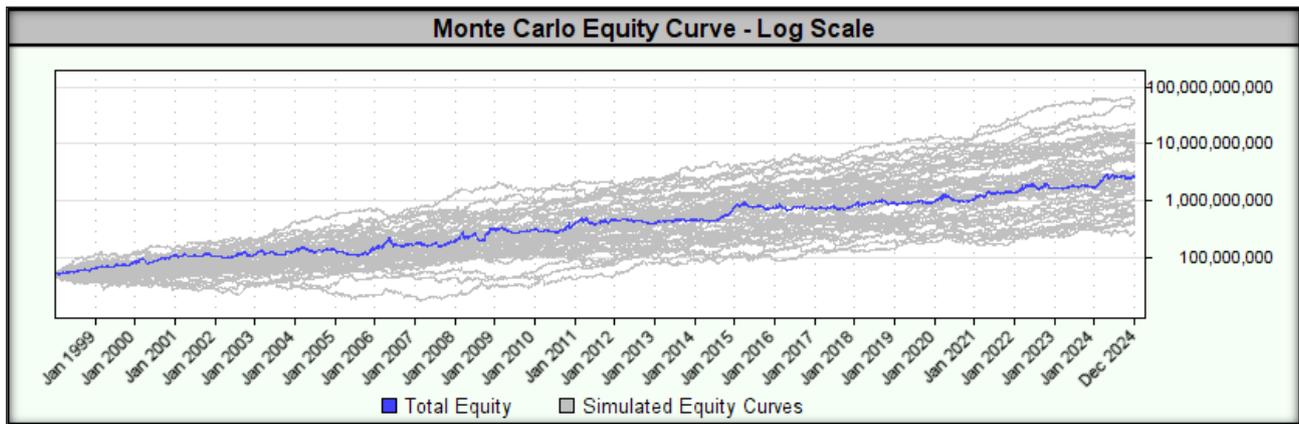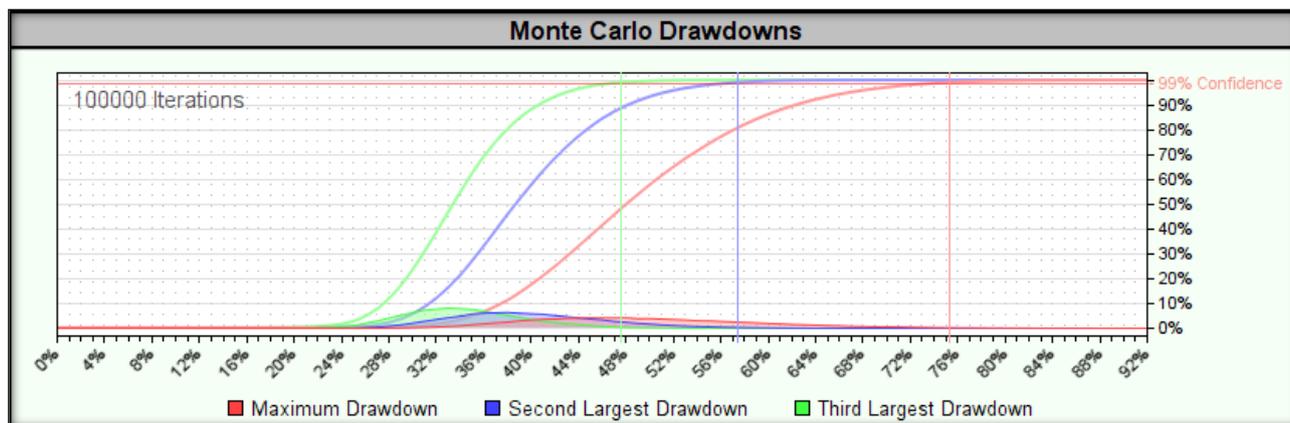
- **CAGR%** – In 99% of simulations achieved **a rate of return equal to or higher than 4.5%**.
- **Drawdown** – in 99% of simulations, **drawdown equal to or lower than 75% was achieved**. For parameters optimized on in-sample data, drawdown was 32.7%.

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	$66,602,734.40	33.23%	3.95	2.72	2.00	8.4%	1.9	46	46.94	18.25	2.86	0.69
2	19990101	$57,831,355.53	15.72%	1.42	1.02	NA	11.1%	5.0	50	-0.33	-0.16	1.72	0.32
3	20000101	$58,376,210.42	16.97%	1.41	1.18	NA	12.0%	4.9	48	17.47	12.73	1.76	0.37
4	20010101	$51,364,212.05	2.73%	0.22	0.23	1.99	12.3%	5.8	45	7.55	4.83	1.13	0.06
5	20020101	$54,295,508.60	8.60%	0.47	0.52	1.99	18.2%	4.7	49	1.97	1.48	1.35	0.19
6	20030101	$55,334,316.18	10.68%	0.54	0.54	2.00	19.7%	9.9	55	-10.13	-7.73	1.42	0.21
7	20040101	$50,884,716.19	1.77%	0.14	0.19	NA	13.0%	6.5	66	-1.99	-0.98	1.04	0.02
8	20050101	$54,203,983.95	8.51%	0.54	0.51	NA	15.8%	8.0	58	-5.48	-5.05	1.33	0.20
9	20060101	$55,477,517.35	10.99%	0.53	0.70	2.00	20.8%	7.7	51	4.70	3.87	1.49	0.22
10	20070101	$57,881,533.48	15.77%	0.89	0.93	2.00	17.8%	3.8	55	-2.24	-1.13	1.69	0.32
11	20080101	$72,862,845.30	45.76%	1.53	1.10	NA	30.0%	7.7	68	5.08	5.85	2.74	0.70
12	20090101	$51,670,318.29	3.34%	0.28	0.38	1.99	12.2%	9.8	40	-8.33	-3.58	1.29	0.10
13	20100101	$65,864,916.77	31.85%	1.49	1.10	NA	21.3%	7.9	64	18.64	17.95	1.96	0.52
14	20110101	$55,670,164.15	11.48%	0.69	0.60	NA	16.6%	6.6	48	1.56	0.85	1.59	0.25
15	20120101	$44,692,189.86	-10.65%	-0.60	-0.97	NA	17.8%	8.9	44	-17.07	-13.39	0.48	-0.24
16	20130101	$56,175,358.99	12.36%	1.08	1.07	2.00	11.4%	3.9	49	8.48	7.22	1.47	0.26
17	20140101	$84,423,893.76	68.91%	8.15	2.11	2.00	8.5%	5.0	57	47.87	32.39	3.70	1.25
18	20150101	$45,700,853.30	-8.60%	-0.39	-0.60	-2.00	22.1%	8.6	55	-14.06	-13.35	0.68	-0.16
19	20160101	$50,318,452.56	0.64%	0.03	0.14	NA	24.3%	10.6	61	-6.09	-3.84	1.04	0.02
20	20170101	$57,648,680.55	15.35%	1.09	1.21	2.00	14.1%	5.9	52	-5.46	-4.68	1.61	0.30
21	20180101	$50,766,617.31	1.53%	0.09	0.17	1.97	17.5%	7.1	71	-11.92	-7.97	1.05	0.02
22	20190101	$48,039,025.27	-3.92%	-0.29	-0.24	-2.01	13.6%	7.1	56	-7.72	-3.66	0.85	-0.09
23	20200101	$59,461,577.95	18.94%	0.71	0.76	NA	26.7%	9.3	67	-0.45	-0.62	1.47	0.27
24	20210101	$54,816,658.71	9.67%	0.73	0.68	NA	13.2%	4.8	55	6.81	6.59	1.36	0.19
25	20220101	$60,643,489.36	21.56%	0.86	0.86	NA	25.0%	6.6	63	17.20	19.56	1.66	0.35
26	20230101	$50,165,063.93	0.33%	0.02	0.08	1.92	13.8%	3.6	55	5.80	6.01	1.05	0.03
27	20240101	$60,532,956.11	21.08%	1.69	1.46	NA	12.5%	5.7	52	6.53	6.15	1.97	0.41

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	$110,454,432.11	30.32%	1.31	1.57	12.95	23.2%	6.0	117	6.74	26.30	2.74	0.81
2	19990101	$73,562,321.80	13.75%	0.68	0.75	0.92	20.1%	7.3	120	3.86	18.84	1.74	0.37
3	20000101	$61,997,921.17	7.45%	0.40	0.47	0.96	18.8%	9.4	127	1.46	6.97	1.36	0.19
4	20010101	$64,101,838.39	8.64%	0.42	0.49	1.51	20.3%	9.9	129	0.92	5.04	1.40	0.22
5	20020101	$65,396,836.96	9.37%	0.46	0.52	2.27	20.3%	10.4	142	1.76	10.36	1.34	0.21
6	20030101	$57,711,455.25	4.91%	0.17	0.33	1.07	29.5%	22.0	155	-0.10	-0.51	1.21	0.13
7	20040101	$63,416,333.30	8.27%	0.27	0.45	0.71	30.8%	13.8	153	1.75	8.86	1.38	0.22
8	20050101	$75,428,724.00	14.73%	0.45	0.70	1.63	32.6%	19.7	142	2.58	16.05	1.70	0.37
9	20060101	$100,239,219.80	26.14%	0.82	0.87	1.08	31.8%	19.7	152	2.74	15.76	2.20	0.57
10	20070101	$92,639,189.97	22.84%	0.72	0.80	0.84	31.8%	9.9	134	5.37	30.80	2.21	0.57
11	20080101	$93,201,934.25	23.09%	0.77	0.81	1.18	30.0%	19.2	144	2.28	14.14	2.13	0.52
12	20090101	$76,950,174.02	15.50%	0.62	0.71	1.42	25.2%	9.9	126	3.54	17.89	1.85	0.40
13	20100101	$66,057,906.57	9.74%	0.39	0.50	0.54	25.2%	21.9	131	3.38	17.97	1.50	0.27
14	20110101	$57,539,723.16	4.81%	0.26	0.37	0.37	18.5%	17.1	126	0.12	0.63	1.27	0.14
15	20120101	$86,177,347.33	19.93%	1.12	1.03	0.65	17.8%	17.1	135	1.11	5.00	2.07	0.56
16	20130101	$90,262,287.85	21.78%	0.88	0.99	0.79	24.9%	11.2	137	6.51	31.57	2.12	0.61
17	20140101	$80,858,435.64	17.41%	0.61	0.76	0.52	28.5%	21.4	148	4.50	21.27	1.96	0.49
18	20150101	$51,815,161.73	1.20%	0.04	0.15	0.13	29.2%	32.6	148	-1.71	-6.18	1.08	0.04
19	20160101	$63,555,068.65	8.33%	0.34	0.50	1.46	24.3%	22.9	157	0.97	3.96	1.35	0.18
20	20170101	$65,517,169.35	9.44%	0.44	0.62	1.53	21.7%	15.7	145	2.14	9.68	1.39	0.23
21	20180101	$60,770,378.89	6.72%	0.24	0.45	1.15	28.0%	11.2	167	0.99	7.72	1.21	0.12
22	20190101	$69,746,301.22	11.74%	0.43	0.65	0.98	27.2%	11.1	157	1.81	12.52	1.44	0.27
23	20200101	$91,193,995.29	22.22%	0.83	0.91	9.46	26.7%	10.9	165	3.64	24.19	1.77	0.44
24	20210101	$67,564,032.54	10.56%	0.42	0.59	1.00	25.0%	18.6	159	2.67	14.66	1.41	0.23
25	20220101	$93,477,322.58	23.26%	0.93	0.98	0.98	25.0%	19.9	152	3.69	20.91	1.98	0.53

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

- **For the one-year test window (365/365): 24 out of 27 periods** ended with a positive rate of return **(89%)**.
- **For the three-year test window (1095/365): 25 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 Bollinger Breakout Strategy (1998-2024):

- **Total number of transactions: 1181**
- **Long trades: 654 (55.4%)**
- **Short trades: 527 (44.6%)**

The trade distribution is 55.4%/44.6%, 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	18	39.1%	28	60.9%	46	217	67.0%	107	33.0%	2.16%	0.83%	0.34%	1.68
CC	13	20.3%	51	79.7%	64	210	64.8%	114	35.2%	6.44%	0.96%	0.54%	1.71
CFI	11	37.9%	18	62.1%	29	260	80.2%	64	19.8%	4.28%	0.80%	1.13%	3.28
CL	12	26.1%	34	73.9%	46	224	69.1%	100	30.9%	4.92%	0.87%	0.64%	1.99
CT	11	22.0%	39	78.0%	50	212	65.4%	112	34.6%	5.47%	0.79%	0.59%	1.96
DX	12	22.6%	41	77.4%	53	211	65.1%	113	34.9%	4.32%	0.77%	0.38%	1.64
EBL	12	28.6%	30	71.4%	42	234	72.2%	90	27.8%	3.60%	0.84%	0.43%	1.72
ES	19	38.0%	31	62.0%	50	216	66.7%	108	33.3%	2.04%	0.79%	0.28%	1.57
FDX	20	45.5%	24	54.5%	44	226	69.8%	98	30.2%	1.65%	0.83%	0.30%	1.65
FLG	17	36.2%	30	63.8%	47	218	67.3%	106	32.7%	2.26%	0.82%	0.30%	1.57
GC	15	30.0%	35	70.0%	50	211	65.1%	113	34.9%	2.80%	0.82%	0.27%	1.47
HG	15	31.2%	33	68.8%	48	226	69.8%	98	30.2%	3.83%	0.83%	0.63%	2.09
HSI	17	40.5%	25	59.5%	42	222	68.5%	102	31.5%	1.31%	0.59%	0.18%	1.51
KC	14	26.4%	39	73.6%	53	224	69.1%	100	30.9%	3.43%	0.89%	0.25%	1.39
LCO	15	30.0%	35	70.0%	50	222	68.5%	102	31.5%	4.33%	0.86%	0.70%	2.17
LGO	17	42.5%	23	57.5%	40	228	70.4%	96	29.6%	4.14%	0.88%	1.25%	3.48
NG	15	28.3%	38	71.7%	53	204	63.0%	120	37.0%	1.92%	0.78%	-0.01%	0.97
NIY	10	28.6%	25	71.4%	35	252	77.8%	72	22.2%	3.37%	0.89%	0.33%	1.52
NQ	16	33.3%	32	66.7%	48	216	66.7%	108	33.3%	3.47%	0.69%	0.69%	2.50
OJ	15	27.3%	40	72.7%	55	207	63.9%	117	36.1%	2.80%	0.90%	0.11%	1.16
PA	15	34.1%	29	65.9%	44	226	69.8%	98	30.2%	3.46%	0.90%	0.59%	2.00
S	18	40.9%	26	59.1%	44	233	71.9%	91	28.1%	2.34%	0.88%	0.44%	1.84
SB	16	34.0%	31	66.0%	47	218	67.3%	106	32.7%	2.79%	0.82%	0.41%	1.76
TY	19	40.4%	28	59.6%	47	214	66.0%	110	34.0%	2.63%	0.82%	0.57%	2.16
W	16	29.6%	38	70.4%	54	204	63.0%	120	37.0%	1.47%	0.75%	-0.09%	0.82

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	14	41.2%	20	58.8%	34	237	73.1%	87	26.9%	1.46%	0.81%	0.13%	1.27
CC	10	28.6%	25	71.4%	35	249	76.9%	75	23.1%	4.08%	0.86%	0.55%	1.91
CFI	6	35.3%	11	64.7%	17	280	86.4%	44	13.6%	3.59%	0.66%	0.84%	2.99
CL	13	50.0%	13	50.0%	26	252	77.8%	72	22.2%	2.03%	0.86%	0.58%	2.35
CT	9	30.0%	21	70.0%	30	239	73.8%	85	26.2%	3.29%	0.64%	0.54%	2.20
DX	8	28.6%	20	71.4%	28	251	77.5%	73	22.5%	3.69%	0.72%	0.54%	2.06
EBL	10	41.7%	14	58.3%	24	258	79.6%	66	20.4%	1.63%	0.76%	0.24%	1.54
ES	11	37.9%	18	62.1%	29	245	75.6%	79	24.4%	1.45%	0.73%	0.10%	1.22
FDX	10	34.5%	19	65.5%	29	250	77.2%	74	22.8%	1.18%	0.44%	0.12%	1.41
FLG	14	46.7%	16	53.3%	30	240	74.1%	84	25.9%	0.92%	0.65%	0.09%	1.25
GC	9	27.3%	24	72.7%	33	236	72.8%	88	27.2%	1.63%	0.69%	-0.06%	0.88
HG	13	50.0%	13	50.0%	26	257	79.3%	67	20.7%	2.04%	0.74%	0.65%	2.77
HSI	10	33.3%	20	66.7%	30	246	75.9%	78	24.1%	0.78%	0.56%	-0.11%	0.70
KC	8	34.8%	15	65.2%	23	269	83.0%	55	17.0%	2.14%	0.80%	0.22%	1.42
LCO	11	35.5%	20	64.5%	31	249	76.9%	75	23.1%	2.41%	0.78%	0.35%	1.70
LGO	13	48.1%	14	51.9%	27	244	75.3%	80	24.7%	2.71%	0.69%	0.95%	3.67
NG	9	31.0%	20	69.0%	29	246	75.9%	78	24.1%	1.40%	0.68%	-0.04%	0.92
NIY	9	42.9%	12	57.1%	21	266	82.1%	58	17.9%	2.04%	0.70%	0.47%	2.17
NQ	11	35.5%	20	64.5%	31	236	72.8%	88	27.2%	2.39%	0.68%	0.41%	1.93
OJ	11	28.2%	28	71.8%	39	231	71.3%	93	28.7%	1.52%	0.80%	-0.15%	0.75
PA	13	50.0%	13	50.0%	26	249	76.9%	75	23.1%	1.31%	0.73%	0.29%	1.81
S	10	31.2%	22	68.8%	32	245	75.6%	79	24.4%	1.62%	0.68%	0.04%	1.08
SB	12	40.0%	18	60.0%	30	239	73.8%	85	26.2%	1.88%	0.74%	0.31%	1.70
TY	14	46.7%	16	53.3%	30	235	72.5%	89	27.5%	1.66%	0.58%	0.47%	2.51
W	10	27.0%	27	73.0%	37	236	72.8%	88	27.2%	1.01%	0.77%	-0.29%	0.49

For our tested strategy:

- the portfolio with the highest MAR (obtained on IS data) has a percentage of instruments with **profit factor > 1 at the level of 92%.**
- the portfolio with the lowest MAR (obtained on IS data) has a percentage of instruments with **profit factor > 1 at the level of 80%.**

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 **31.8 %.**
- **In-sample and out-of-sample drawdown** for the optimized parameters was **32.7%.**
- **The highest in-sample drawdown** for the tested parameter range was **53.6 %.**
- **The largest out-of-sample drawdown** for the tested parameter range was **44.3 %.**
- **Drawdown in 99% of the Monte Carlo simulations** was equal to or lower than **75.0%.**

Our investment strategy was tested assuming that **the risk of a single position is 1.0% 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 personally, but I will make the final decision after conducting Walk Forward Analysis tests.**

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

- **Moving average:** 260;
- **Upper/Lower Bollinger Bands:** 1.55;
- **Middle Bollinger Band:** 0.70;
- **Position size:** corresponding to a risk of 1.0% of capital value;
- **Opening a position:** at the opening price of the next day.

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 objective function MAR.** However, based on experience and **awareness of the risk of** excessive **portfolio concentration in one direction (long/short)** or **too large 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 it is worth 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%	16.7%	16.1%
MAR Ratio	0.56	0.49
RAR%	14.8%	14.7%
R-Cubed	0.41	0.35
Robust Sharpe Ratio	0.64	0.65
Max Drawdown	30.0%	32.7%
Wins	31.3%	32.3%
Losses	68.7%	67.7%
Average Win%	3.24%	3.12%
Average Loss%	0.81%	0.82%
Win/Loss Ratio	4.01	3.79
Average Trade Duration (days)	108	111
Percent Profit Factor	1.83	1.81
SQN	0.92	0.93
Number of transactions	782	1138

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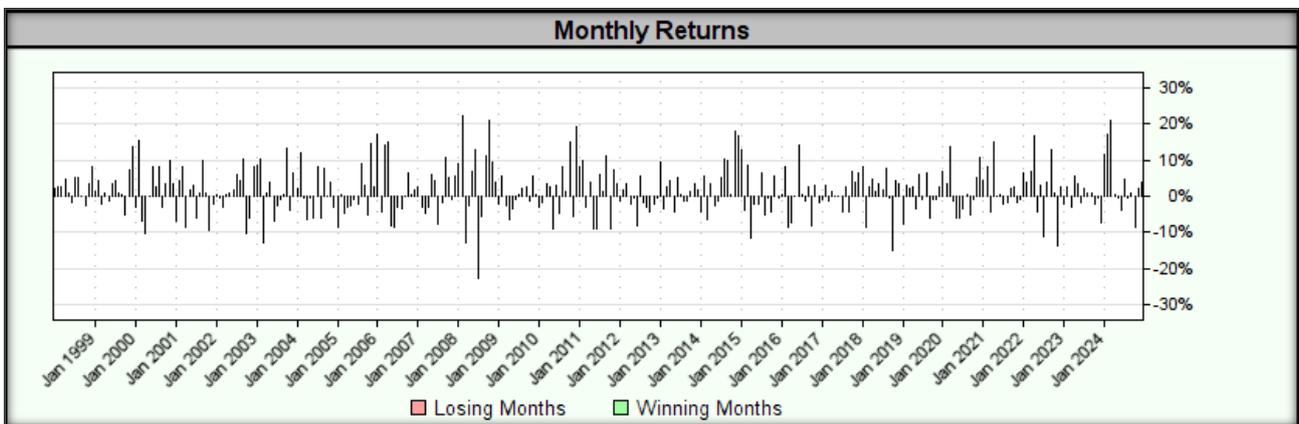
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
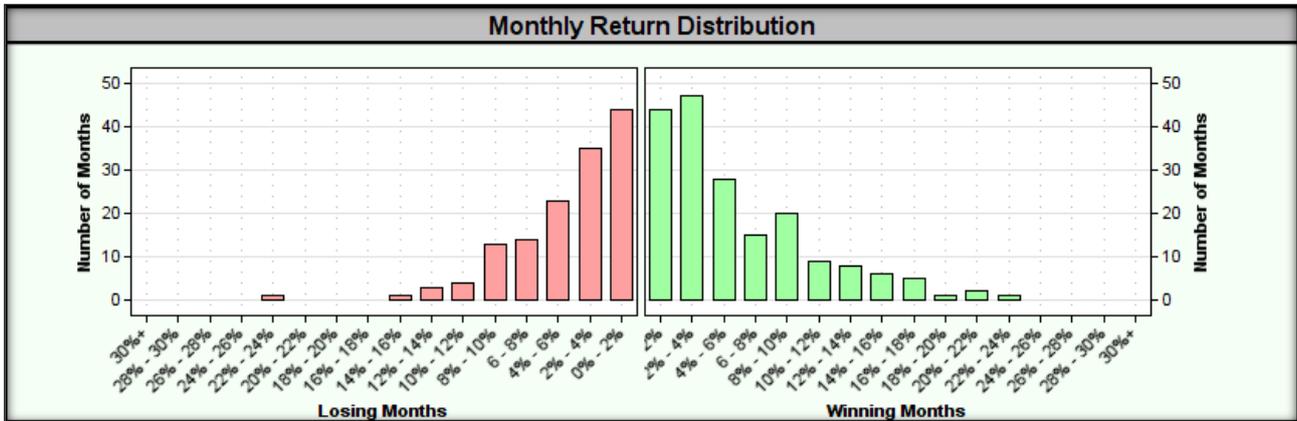
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

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

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

- **Moving average:** 260;
- **Upper/Lower Bollinger Bands:** 1.55;
- **Middle Bollinger Band:** 0.70;
- **Position size:** corresponding to a risk of 1.0% of capital value;

- **<u>Opening a position:</u>** <u>at the opening price of the next day;</u>
- **<u>Maximum number of open positions in different categories:</u>**
  - **<u>Highly correlated instruments:</u>** <u>3 items;</u>
  - **<u>Moderately correlated instruments:</u>** <u>6 items;</u>
  - **<u>Maximum number of positions in one direction:</u>** <u>12 positions.</u>

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:** corresponding to the risk of 1.0% of the capital value
- **Range of optimized parameters:**
    - **Moving average:** range 170-260 days (step: 10)
    - **Upper/Lower Bollinger Bands:** range 1.5-2.3 (step: 0.1)
    - **Middle Bollinger Band:** range 0.0-1.0 (step: 0.1)
- **Position opening method:** at the opening price of the next day
- **Maximum number of open positions in different categories:**
    - **Highly correlated instruments:** 3 items
    - **Medium 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 the 1095/365 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
1,389,769,878	13.10%	0.27	0.50	47.70%	35.52	1,213

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	25.1%	30.7%	9.9%	5.8%	2.53	5.31

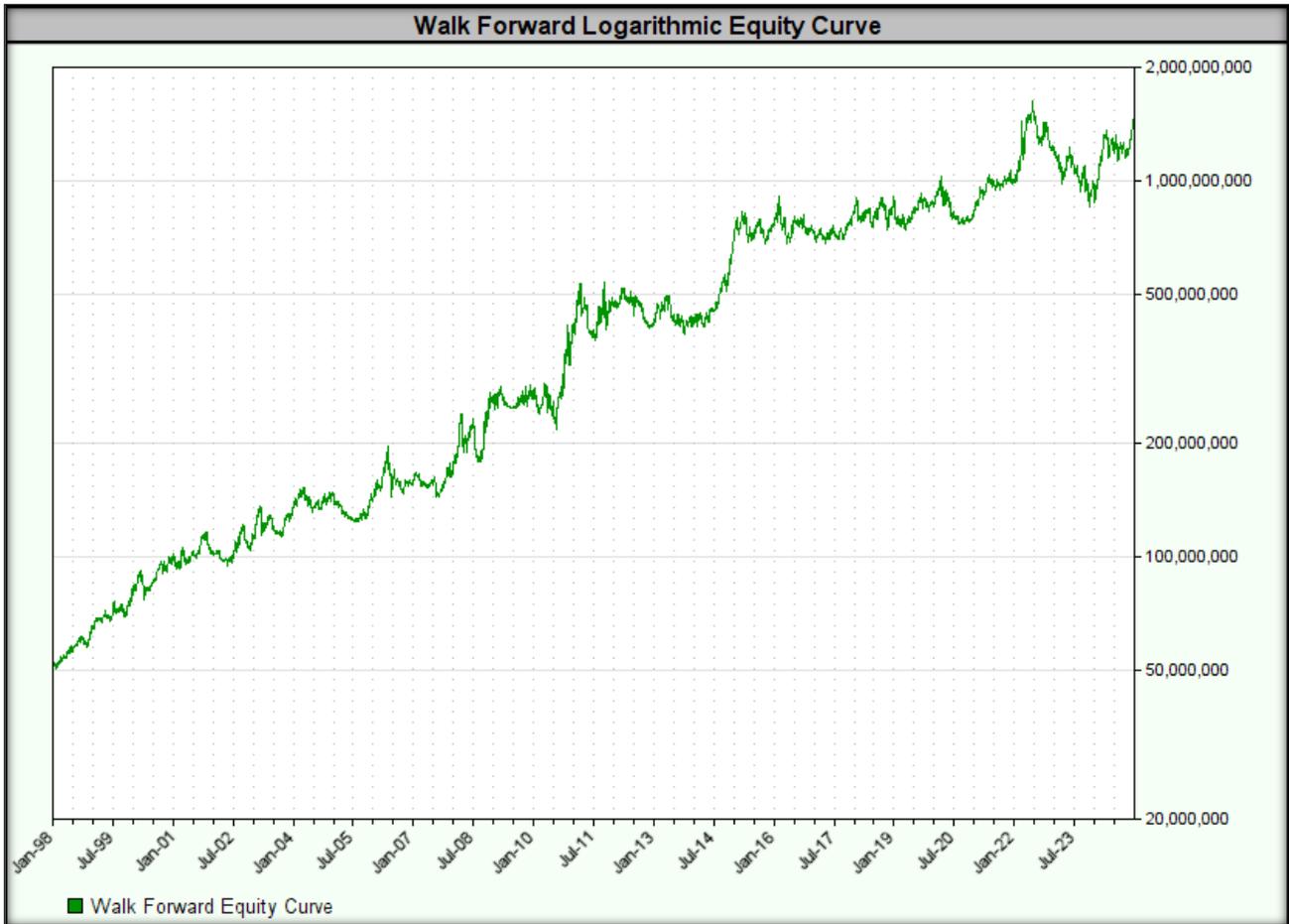|							
19981231	19991230	24.8%	27.4%	7.7%	9.0%	3.23	3.03
19991231	20001229	26.3%	19.2%	8.0%	16.9%	3.28	1.14
20010101	20011228	31.6%	2.8%	19.3%	12.6%	1.64	0.23
20011231	20021227	19.0%	12.7%	17.1%	14.5%	1.11	0.88
20021230	20031229	12.1%	16.4%	13.4%	17.8%	0.90	0.92
20031230	20041228	12.4%	11.3%	14.8%	13.6%	0.84	0.83
20041229	20051228	13.3%	-4.1%	11.5%	16.7%	1.16	- 0.24
20051229	20061228	12.2%	11.8%	11.3%	26.6%	1.08	0.44
20061229	20071228	15.6%	8.1%	21.3%	14.5%	0.73	0.56
20071231	20081226	17.7%	56.0%	26.2%	25.3%	0.68	2.21
20081229	20091225	44.3%	0.2%	30.2%	12.4%	1.47	0.02
20091228	20101227	41.2%	54.0%	32.4%	24.3%	1.27	2.23
20101228	20111227	41.3%	12.0%	23.5%	28.9%	1.76	0.42
20111228	20121226	24.1%	-10.1%	21.7%	22.1%	1.11	- 0.46
20121227	20131226	20.2%	5.0%	24.3%	21.2%	0.83	0.24
20131227	20141226	7.2%	58.0%	15.7%	9.9%	0.46	5.88
20141229	20151225	19.8%	11.1%	14.5%	17.4%	1.36	0.64
20151228	20161223	26.9%	-4.2%	17.3%	25.2%	1.56	- 0.17
20161226	20171225	16.9%	12.4%	16.3%	8.7%	1.04	1.43
20171226	20181225	8.9%	10.8%	21.9%	18.0%	0.40	0.60
20181226	20191225	13.0%	-5.1%	13.7%	18.5%	0.95	- 0.28
20191226	20201224	9.0%	-5.1%	13.7%	25.4%	0.66	- 0.20
20201225	20211224	7.3%	21.1%	23.1%	9.0%	0.31	2.35
20211227	20221223	14.9%	22.8%	23.6%	26.4%	0.63	0.86
20221226	20231222	38.4%	-20.0%	31.3%	30.2%	1.23	- 0.66
20231225	20241223	16.8%	46.0%	17.1%	17.1%	0.98	2.68
Mean		**20.7%**	**14.9%**	**18.6%**	**18.1%**	**0.64**	**0.49**
	WFE:	**71.6%**	**WFE:**	**97.4%**	**WFE:**	**76.8%**	

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.**

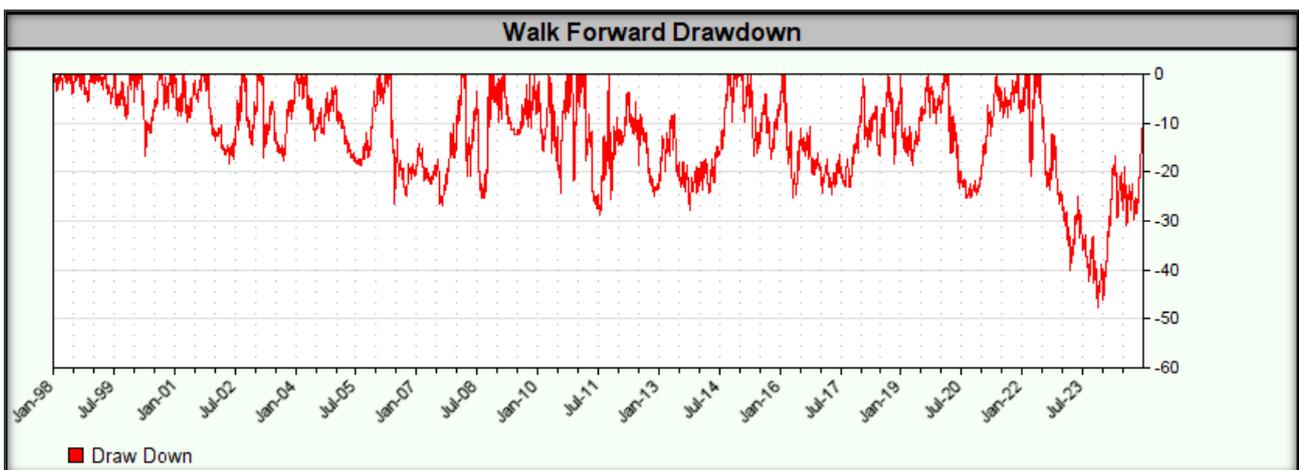*Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.*

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
853,357,720	11.53%	0.27	0.46	42.24%	41.66	1,173

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	29.3%	17.1%	9.9%	10.3%	2.96	1.65

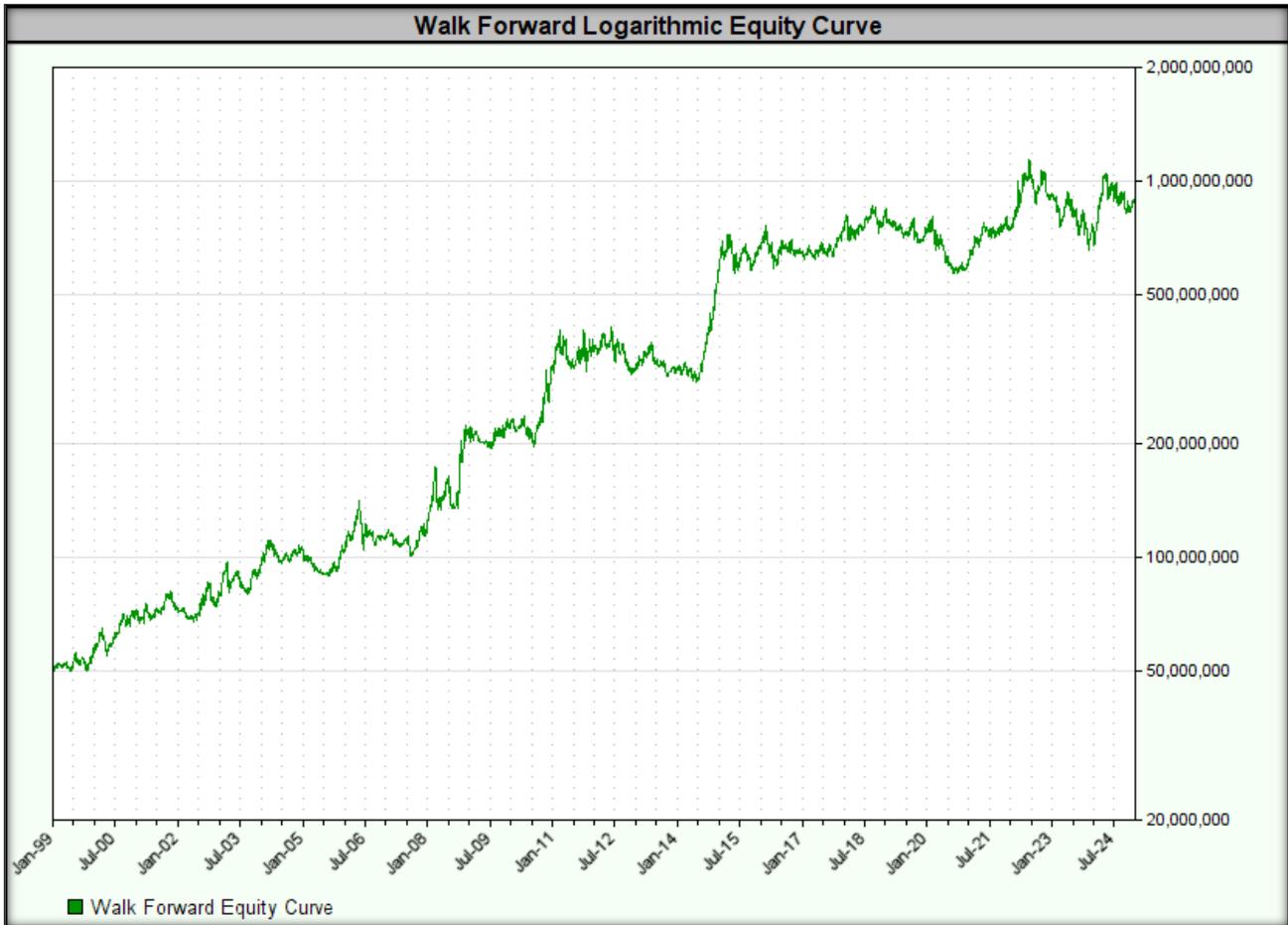|							
19991231	20001229	24.6%	22.0%	7.7%	15.6%	3.20	1.41
20010101	20011228	27.0%	2.0%	17.8%	10.6%	1.51	0.18
20011231	20021227	23.8%	11.7%	19.3%	14.2%	1.23	0.82
20021230	20031229	16.8%	16.0%	16.4%	17.6%	1.03	0.90
20031230	20041228	12.4%	13.3%	14.0%	13.3%	0.89	1.00
20041229	20051228	11.1%	-2.2%	12.2%	16.3%	0.91	- 0.14
20051229	20061228	9.8%	8.9%	10.8%	25.7%	0.91	0.35
20061229	20071228	16.8%	6.0%	21.3%	15.1%	0.79	0.40
20071231	20081226	14.4%	82.7%	25.0%	23.1%	0.58	3.57
20081229	20091225	30.5%	2.8%	25.0%	12.2%	1.22	0.23
20091228	20101227	25.6%	42.0%	24.1%	17.9%	1.07	2.35
20101228	20111227	42.6%	10.2%	30.2%	22.5%	1.41	0.45
20111228	20121226	38.9%	-10.0%	27.2%	24.9%	1.43	- 0.40
20121227	20131226	12.8%	1.2%	18.1%	18.6%	0.70	0.06
20131227	20141226	16.1%	80.6%	24.3%	11.7%	0.66	6.89
20141229	20151225	17.2%	15.3%	15.7%	21.1%	1.09	0.72
20151228	20161223	17.4%	-2.8%	17.2%	23.2%	1.01	- 0.12
20161226	20171225	14.3%	15.6%	16.4%	8.0%	0.87	1.95
20171226	20181225	16.5%	11.5%	17.8%	15.9%	0.93	0.73
20181226	20191225	11.7%	-11.6%	21.9%	18.8%	0.53	- 0.62
20191226	20201224	8.1%	-17.6%	13.7%	29.8%	0.59	- 0.59
20201225	20211224	9.7%	23.2%	23.1%	8.8%	0.42	2.63
20211227	20221223	12.3%	24.2%	23.1%	23.7%	0.53	1.02
20221226	20231222	25.3%	-19.2%	32.1%	30.2%	0.79	- 0.64
20231225	20241223	17.7%	17.3%	25.4%	22.2%	0.69	0.78
Mean		**19.3%**	**13.9%**	**19.6%**	**18.1%**	**0.60**	**0.46**
		WFE:	**71.7%**	WFE:	**92.5%**	WFE:	**76.1%**

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

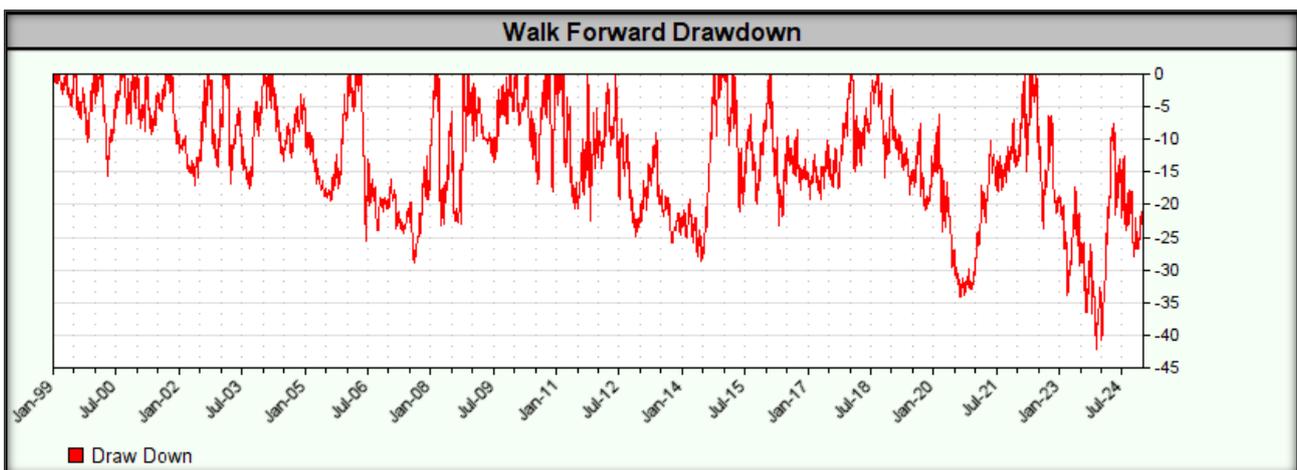Below are **the results of the Walk Forward Analysis (WFA) for the 1825/365 day combination.**

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
940,139,399	12.45%	0.29	0.50	43.04%	70.44	1,126

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	28.9%	15.6%	9.9%	9.2%	2.91	1.70

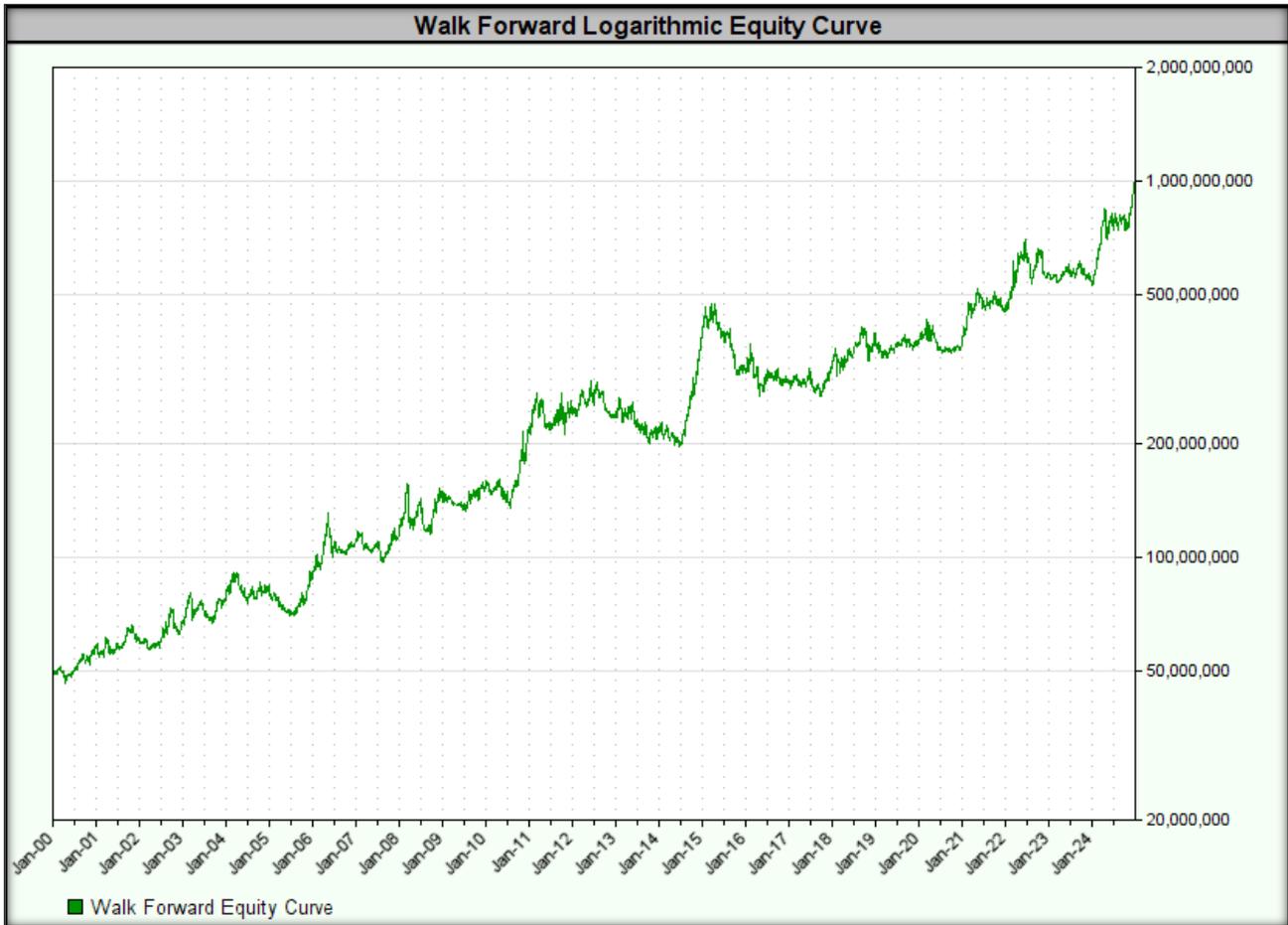|							
20010101	20011228	23.5%	4.0%	16.6%	10.1%	1.41	0.39
20011231	20021227	22.6%	13.5%	18.4%	14.9%	1.23	0.91
20021230	20031229	20.8%	15.6%	18.5%	16.8%	1.12	0.93
20031230	20041228	16.5%	7.1%	16.8%	17.0%	0.98	0.42
20041229	20051228	12.5%	5.4%	13.6%	16.8%	0.92	0.32
20051229	20061228	10.5%	24.8%	14.3%	24.0%	0.73	1.03
20061229	20071228	15.9%	5.1%	21.3%	17.4%	0.75	0.30
20071231	20081226	14.2%	28.0%	22.6%	26.9%	0.63	1.04
20081229	20091225	26.2%	3.1%	25.0%	10.9%	1.05	0.28
20091228	20101227	24.4%	42.0%	25.0%	17.9%	0.97	2.35
20101228	20111227	37.1%	10.2%	30.2%	22.5%	1.23	0.45
20111228	20121226	34.3%	-1.0%	28.2%	20.7%	1.21	- 0.05
20121227	20131226	28.5%	-6.8%	26.9%	24.6%	1.06	- 0.28
20131227	20141226	13.9%	75.8%	24.3%	14.0%	0.57	5.40
20141229	20151225	26.2%	-19.2%	24.3%	35.5%	1.08	- 0.54
20151228	20161223	15.8%	-6.8%	17.2%	27.3%	0.92	- 0.25
20161226	20171225	13.1%	9.2%	22.5%	15.3%	0.58	0.60
20171226	20181225	16.1%	23.3%	18.9%	19.2%	0.85	1.21
20181226	20191225	15.3%	-6.6%	16.3%	14.5%	0.94	- 0.45
20191226	20201224	4.8%	-1.1%	13.6%	18.5%	0.35	- 0.06
20201225	20211224	9.4%	23.7%	23.9%	13.6%	0.39	1.74
20211227	20221223	13.3%	26.6%	23.1%	23.9%	0.58	1.11
20221226	20231222	14.3%	-4.8%	23.6%	11.5%	0.61	- 0.42
20231225	20241223	11.3%	76.6%	20.3%	17.0%	0.56	4.50
Mean		**18.8%**	**14.5%**	**20.6%**	**18.4%**	**0.62**	**0.41**
		WFE:	**77.4%**	**WFE:**	**89.2%**	**WFE:**	**65.9%**

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

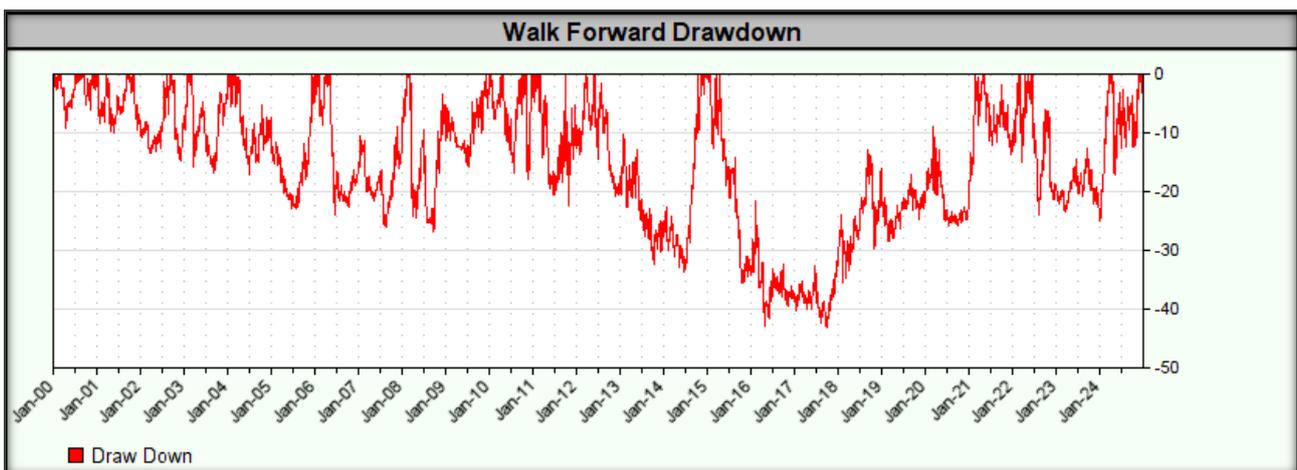Below are **the results of Walk Forward Analysis (WFA) for the 1644/548 day combination.**

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
701,422,395	10.90%	0.29	0.44	37.58%	73.23	1,115

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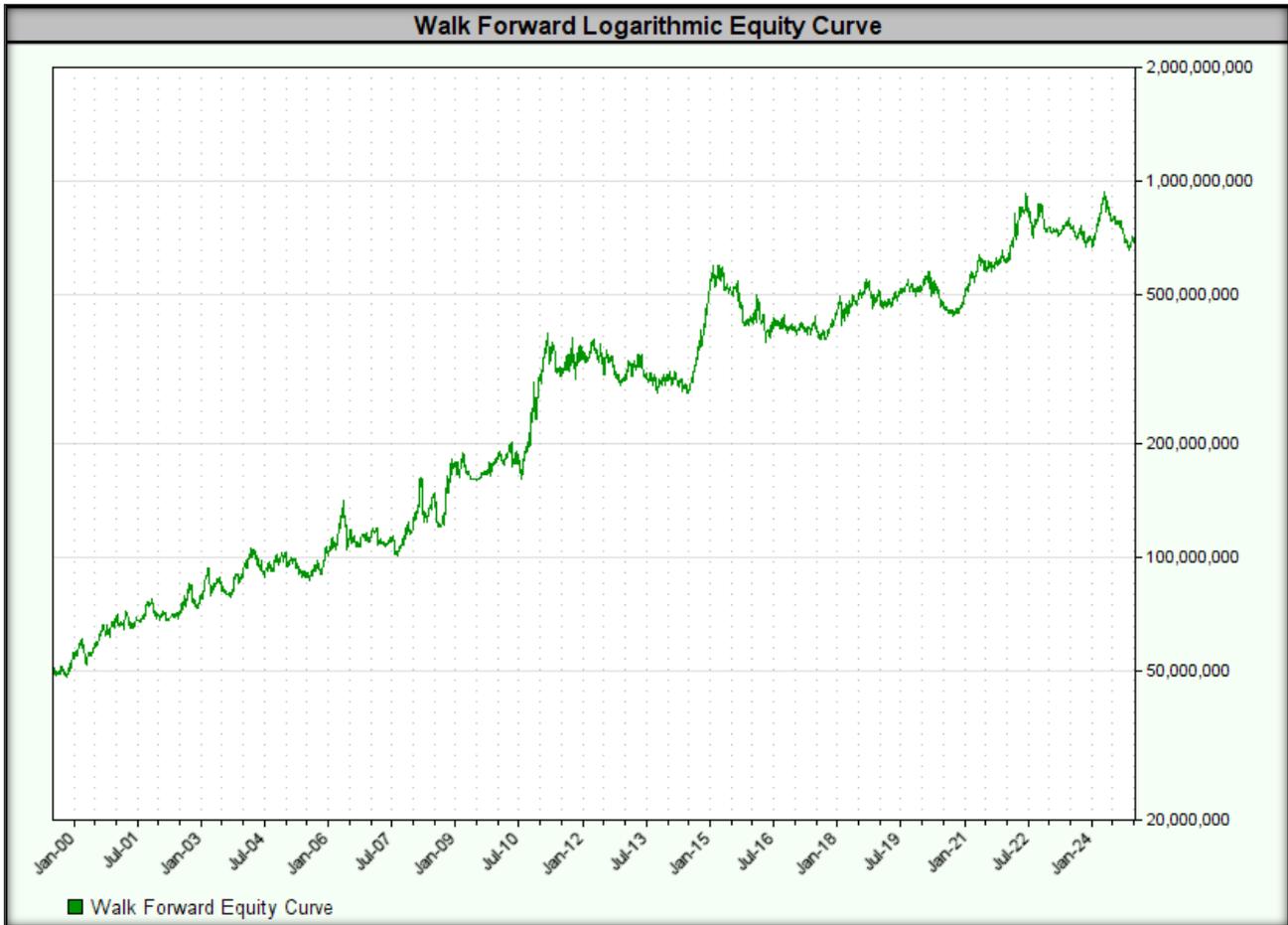
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1644	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
19990705	20001229	28.2%	23.3%	9.9%	14.8%	2.84	1.57

20010101	20020702	22.9%	3.2%	15.5%	12.3%	1.47	0.26
20020703	20040101	20.1%	18.4%	18.5%	16.9%	1.08	1.09
20040102	20050701	15.7%	-2.2%	15.9%	16.1%	0.99	- 0.13
20050704	20070101	8.7%	17.2%	14.8%	26.0%	0.59	0.66
20070102	20080702	16.9%	19.8%	21.3%	24.3%	0.79	0.81
20080703	20100101	23.1%	14.9%	26.2%	19.1%	0.88	0.78
20100104	20110701	40.8%	41.3%	32.4%	22.8%	1.26	1.81
20110704	20130101	37.5%	-1.9%	30.2%	25.6%	1.24	- 0.07
20130102	20140703	24.4%	-4.7%	24.3%	21.3%	1.00	- 0.22
20140704	20160101	12.4%	32.3%	25.1%	30.8%	0.50	1.05
20160104	20170703	18.0%	-3.1%	17.2%	25.1%	1.05	- 0.12
20170704	20190102	14.7%	16.6%	19.5%	16.5%	0.75	1.00
20190103	20200703	17.2%	-5.7%	16.3%	19.8%	1.05	- 0.29
20200706	20211231	9.1%	20.6%	19.3%	9.9%	0.47	2.09
20220103	20230704	15.6%	16.6%	23.1%	23.7%	0.68	0.70
20230705	20250102	12.9%	-6.1%	22.6%	29.8%	0.57	- 0.21
Mean		**19.9%**	**11.8%**	**20.7%**	**20.9%**	**0.61**	**0.38**
		WFE:	**59.2%**	**WFE:**	**100.7%**	**WFE:**	**62.3%**

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.**

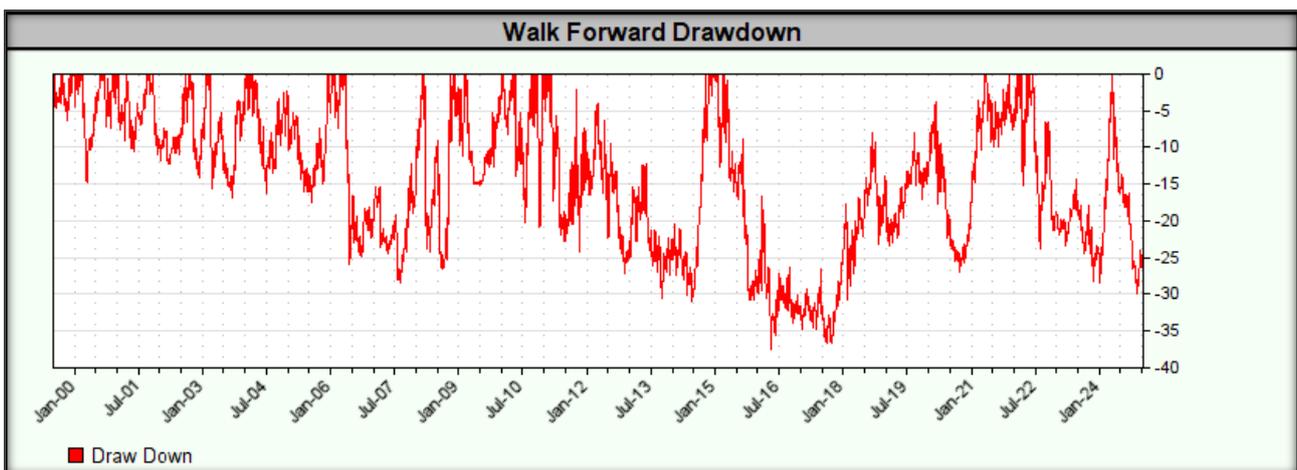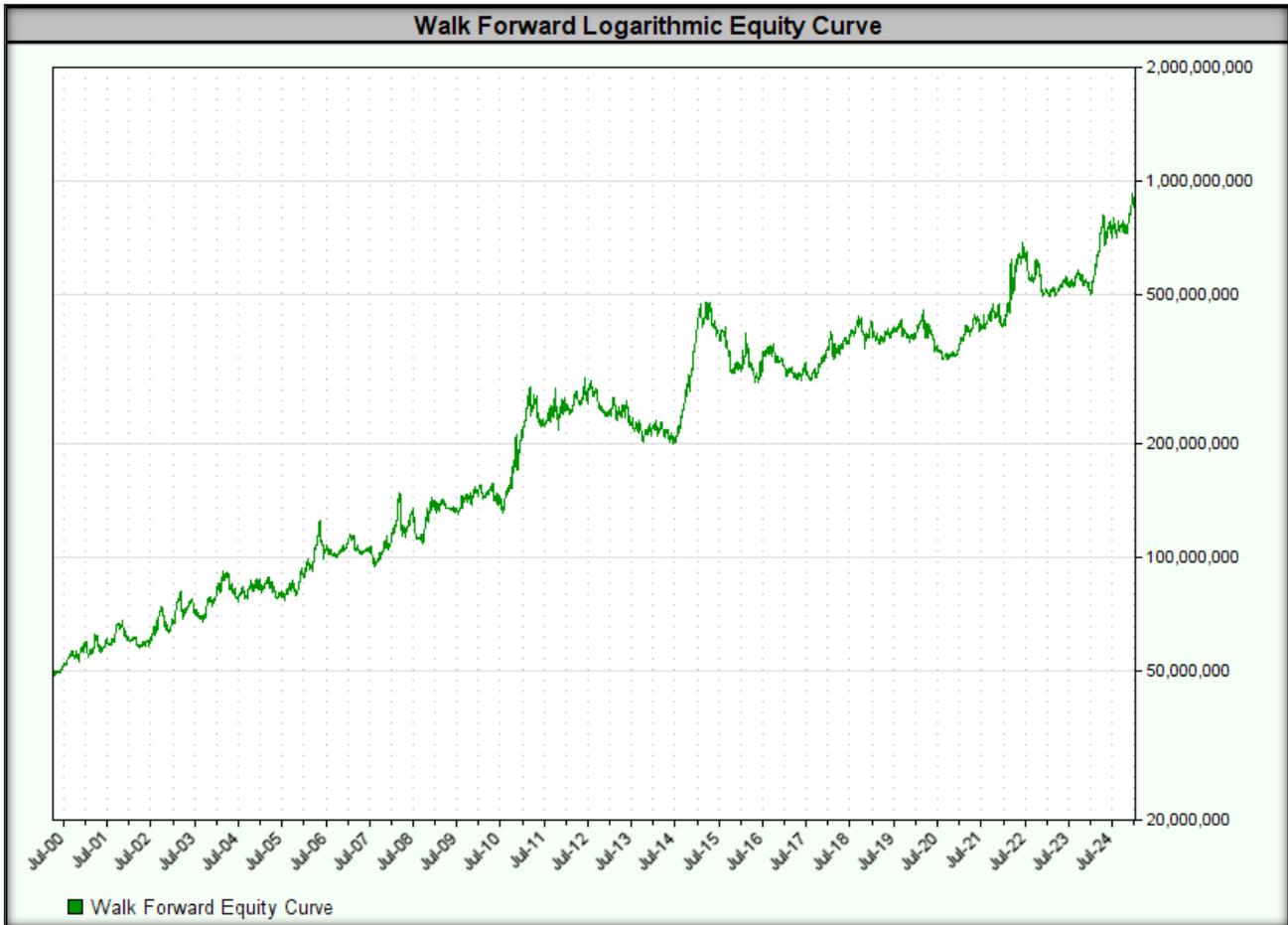*Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.*

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
858,937,065	12.16%	0.31	0.47	39.14%	82.37	1,141

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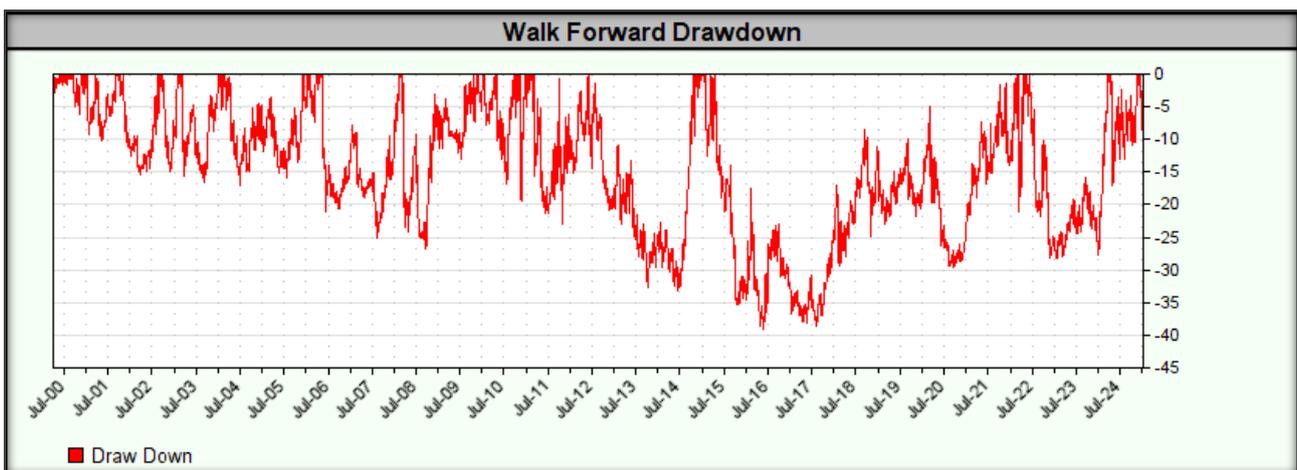
Walk Forward Logarithmic Equity Curve

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	28.0%	21.1%	9.9%	10.1%	2.83	2.08

|							
20011002	20030402	25.4%	4.5%	18.4%	15.7%	1.38	0.29
20030403	20041001	20.5%	10.7%	18.5%	17.0%	1.10	0.63
20041004	20060331	13.7%	15.6%	14.9%	12.8%	0.92	1.22
20060403	20071002	13.3%	-1.4%	14.3%	25.0%	0.93	- 0.05
20071003	20090402	13.1%	22.4%	22.7%	26.7%	0.58	0.84
20090403	20101001	23.1%	8.1%	25.0%	16.7%	0.92	0.48
20101004	20120402	36.2%	48.3%	32.4%	23.1%	1.12	2.09
20120403	20131002	35.4%	-17.7%	28.3%	31.8%	1.25	- 0.56
20131003	20150403	19.5%	66.1%	24.3%	13.5%	0.80	4.90
20150406	20160930	27.3%	-13.0%	24.3%	39.1%	1.12	- 0.33
20161003	20180403	14.3%	-1.4%	18.9%	18.1%	0.75	- 0.07
20180404	20191003	14.6%	8.4%	18.9%	17.7%	0.77	0.48
20191004	20210402	14.9%	0.4%	16.9%	25.9%	0.88	0.02
20210405	20221003	14.5%	29.9%	24.6%	21.7%	0.59	1.37
20221004	20240403	19.9%	16.6%	23.5%	20.1%	0.85	0.83
20240404	20250110	11.9%	21.4%	14.9%	17.0%	0.80	1.26
Mean		**20.3%**	**14.1%**	**20.6%**	**20.7%**	**0.63**	**0.36**
		WFE:	**69.4%**	**WFE:**	**100.3%**	**WFE:**	**57.5%**

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
610,111,650	10.97%	0.29	0.44	37.58%	59.66	1,069

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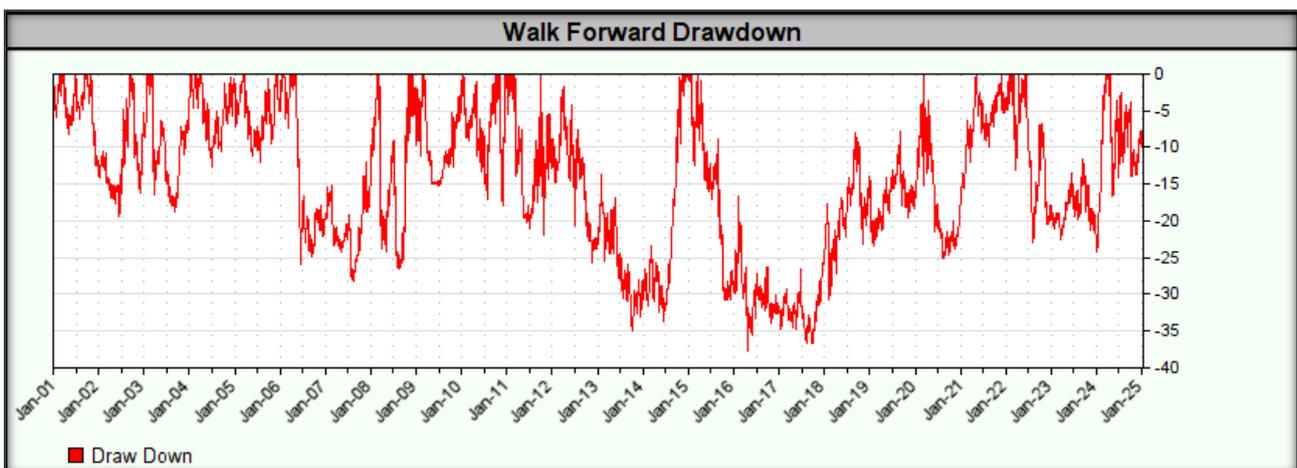
Walk Forward Logarithmic Equity Curve

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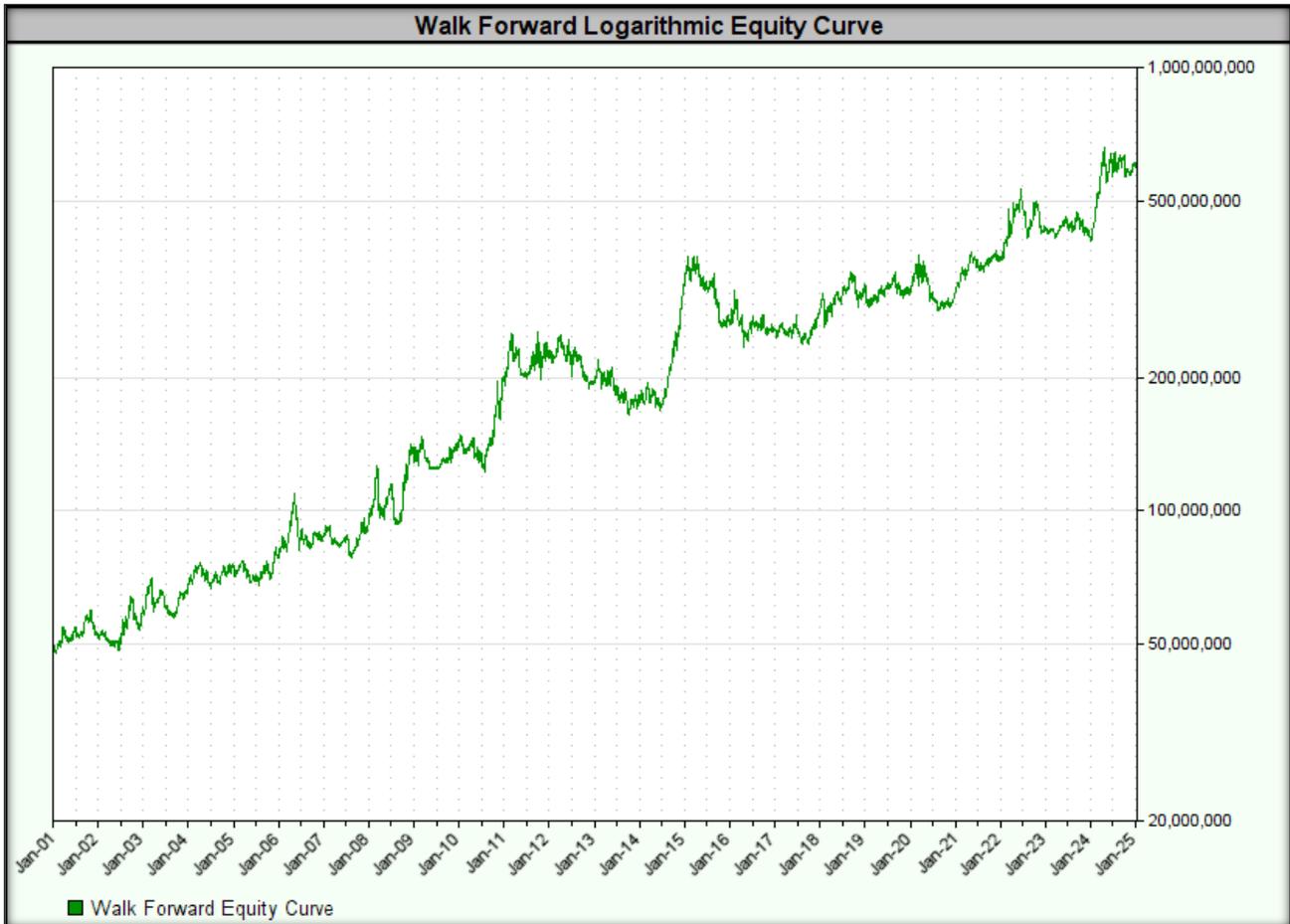
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	2192	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20010101	20020702	35.3%	1.9%	21.9%	19.4%	1.61	0.10

20020703	20040101	17.4%	20.8%	15.5%	18.7%	1.12	1.12
20040102	20050701	18.8%	1.8%	17.1%	12.7%	1.10	0.14
20050704	20070101	11.0%	16.3%	14.9%	25.8%	0.74	0.63
20070102	20080702	13.1%	19.7%	21.3%	24.3%	0.61	0.81
20080703	20100101	21.8%	14.9%	26.2%	19.1%	0.83	0.78
20100104	20110701	21.9%	25.7%	25.0%	20.8%	0.88	1.23
20110704	20130101	40.9%	-1.2%	32.4%	25.6%	1.26	- 0.05
20130102	20140703	27.5%	-7.8%	28.3%	24.8%	0.97	- 0.32
20140704	20160101	17.6%	32.7%	25.1%	30.8%	0.70	1.06
20160104	20170703	15.3%	-3.1%	18.5%	25.1%	0.83	- 0.12
20170704	20190102	11.8%	16.6%	19.5%	16.5%	0.60	1.00
20190103	20200703	16.1%	-3.7%	18.9%	21.5%	0.85	- 0.17
20200706	20211231	11.3%	15.0%	18.3%	10.0%	0.61	1.51
20220103	20230704	12.3%	13.2%	23.1%	22.9%	0.53	0.58
20230705	20250102	15.7%	22.1%	23.5%	16.7%	0.67	1.33
Mean		**19.2%**	**11.6%**	**21.9%**	**20.9%**	**0.59**	**0.38**
		WFE:	**60.1%**	WFE:	**95.7%**	WFE:	**63.3%**

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 very good:**

- **WFE for CAGR% remains around 60%-75%,** which indicates the correct performance of the strategy in real conditions.
- **The WFE for drawdown remains around 90%-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):

- **Moving average:** 250;
- **Upper/Lower Bollinger Bands:** 1.70;
- **Middle Bollinger Band:** 0.00;

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%	13.1%	16.1%
MAR Ratio	0.27	0.49
Max Drawdown	47.7%	32.7%

The results are significantly weaker, which is a warning sign - it means that the strategy is **not very effective, stable** and **may exhibit 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 identify **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 to fully implement it 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.