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The results shown in the reports are indicative only and depend on the adopted methodology, data selection, parameters, assumptions, and the way risk and return measures are calculated. Actual results may differ materially from historical or simulated results.

The author may hold positions in the instruments discussed or may apply a similar approach in practice. The information contained in the reports may change without prior notice.

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.

ATR Ignition v.2

Investment Strategy Testing Summary

The ATR Ignition strategy is a **trend following trading technique** developed by Larry Connors that is based on **price breakouts above historical volatility as measured by the ATR** (Average True Range) indicator. The strategy aims to capture strong market moves that occur after key volatility levels are broken – situations where **the market emerges from a low volatility phase and initiates a new directional impulse.**

Compared to the ATR Ignition v.1 version of this strategy **added trend filter** to eliminate trades opened in the opposite direction to the dominant trend.

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

- **Item size:** the position corresponds to a risk of 0.5% of the capital value;
- **CAGR:** 12.2%;
- **MAR:** 0.36;
- **Maximum drawdown:** 33.9%.

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, which indicates that the strategy can be **considered as one of the trend following strategies in an investment portfolio.** 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 significant increase in drawdown in Monte Carlo tests,** which may result in an actual drawdown significantly higher than that achieved in the tests.
- **Walk-Forward Values Efficiency, oscillate around 50%-70% for CAR% and MAR,** which is a decent result at best.

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 at different times. **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."

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 ATR Ignition strategy is a trend following trading technique developed by Larry Connors that is based on **price breakouts above historical volatility as measured by the ATR** (Average True Range) indicator. The strategy aims to capture strong market moves that occur after key volatility levels are broken – situations where **the market emerges from a low volatility phase and initiates a new directional impulse.**

For the purpose of the test, the daily volatility of financial instruments was used, analyzing moments when **the price breaks above or below the last close by a value equal to a multiple of the ATR (e.g. 150%). However, this** breakout must occur in **the direction of the long-term trend** (measured by the moving average).

The strategy uses:

- **Average volatility (ATR)** to determine the level of order activation (breakout);
- **Buy stop and sell stop orders** activated above/below the previous day's close;
- **loss order** set one tick below (for a long position) or above (for a short position) the last candle;
- **Following the dominant trend** defined by the long-term moving average;
- **Mechanism of closing positions** when the trend changes.

Why can a volatility breakout be effective? A breakout above a certain volatility level means that the market is breaking through a barrier of "natural price noise." In situations where prices move too quickly by historical standards, a strong trend is often initiated—investors and algorithms respond to increased activity, volume, and breaks of psychological support and resistance levels. Relative volatility strategies like ATR Ignition don't try to predict market direction, but rather respond to market dynamics— making them immune to forecasting bias and works well in a momentum environment.

Characteristics of the strategy and its strengths and weaknesses:

- **Directional neutrality** – allows you to react to movements in both directions without predetermining the direction of the breakout.
- **Volatility-based** – adapts better to current market conditions than strategies with fixed price thresholds.
- **Defined risk level** – strict stop loss limits potential losses.
- **Lack of directional prediction** – strategy is based on reaction to movement, not prediction.
- **Potential false breakouts** – losses may occur in the case of short-term movements without continuation (so-called false breakouts).
- **Playing with the trend** – transactions are opened only in the direction of the dominant trend.
- **Sensitivity to the ATR parameter** – the threshold value (e.g. 150%) should be adjusted to the instrument and the market environment.

ATR Ignition is a strategy that, despite its simplicity, provides access to an effective breakout trading mechanism. **Its strength lies in its reactivity to market behavior and its ability to adapt to current volatility conditions.** However, it requires careful calibration and conscious risk management, especially in the environment of false price signals.

Step 2: Define investment principles

Below is **the pseudocode** for the **ATR Ignition v.2 strategy** on daily data:

1. **Calculating Indicators:**
   a. **ATR-N-day –** used to determine order activation levels.
   b. **The previous day's closing price** – reference base for setting stop orders.
   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. **Each day, designate:**
      i. Buy stop = Previous day's closing price + K * ATR
      ii. Sell stop = Previous day's closing price - K * ATR
      Where K is the ATR multiplier (e.g. 1.5, i.e. 150% ATR).
   b. **Trend direction condition:**
      i. a buy stop only if the previous day's low > SMA-X (uptrend).
      ii. a sell stop only if the previous day's high < SMA-X (downtrend).
   c. **Set an appropriate pending order (buy stop or sell stop).**
3. **Position Opening Rules:**
   a. **Long position:**
      i. If the market price rises to the buy stop level, a long position will be opened.
      ii. Set your stop loss one tick below the low of the previous day's candle.
   b. **Short position:**
      i. If the market price falls to the sell stop level, a short position will be opened.
      ii. Set your stop loss one tick above the high of the previous day's candle.
4. **Generating Exit Signals –** the position is closed when any of the following conditions is met:
   - Activation of stop loss order (original),
   - Price violates SMA-X:
      i. for long position: if low < SMA-X;
      ii. for short position: if high > SMA-X.
5. **Daily Monitoring –** every day:
   - Calculate ATR and update order activation levels based on last close.
   - Calculate SMA and update defense order.
   - Verify if a breakout up or down has occurred.
   - Set new orders, cancel outdated ones.

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 performed assuming that **the risk of one position corresponds to 0.5% 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 Nasdaq 100 futures contract. At the end of August 2023 (first candle in the left-hand rectangle), **the ATR(20) volatility was 274.9 points, the closing price that day was 15275.25, and we set the ATR multiplier to 150%.** Since the quotes are in a downtrend (below the 200-day moving average), the next day we set a **sell stop order at 14862.75** (15275.25 - 150% x 274.9; rounded). **The order was filled** (second candle in the left-hand rectangle) and a short position was opened (taking into account slippage, the execution price was 14848.75).

Stop loss (red steps) **was set tick above the high candle from the day preceding the opening of the position.** However, it should be noted that after a dozen or so days, our **stop loss begins to follow the market,** because **its level is set at the lower of the two values:** 1) the high candle from the day preceding the opening of the position; 2) the level of the moving average. At the end of January 2023, the moving stop loss was activated (candle in the rectangle on the right) and **the position was closed. The system worked correctly.**

The second transaction was carried out on a DAX futures contract. At the end of September 2024 (first candle in the rectangle on the left), **the ATR(20) volatility was 226.59 points, the closing price that day was**

19526.00, and we set the ATR multiplier to 150%. Since the quotes are in an uptrend (above the 200-day moving average), the next day we set a **buy stop order at 19866.00** (19526.00 + 150% x 226.59; rounded). **The order was filled** (second candle in the rectangle on the left) and a long position was opened (taking into account slippage, the execution price was 19869.00).

Stop loss (red steps) **was set tick below the low of the candle from the day before the position was opened.** In mid-November 2024, our original stop loss order was activated (candle in the rectangle on the right) and **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 conducted on **the basic 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:

- **Distance of buy/sell order from last closing price:** 150% ATR;
- **ATR lengths:** 20 days;
- **Moving average:** 200 days;
- **Stop loss:** for long position, tick below the minimum of the candle preceding the day the position was opened; for a short position, tick above the maximum of the candle preceding the day the position was opened;
- **Trailing stop loss:** moving average;
- **How to open a position:** buy stop/ sell stop order;
- **Position size:** corresponding to a risk of 0.5% of total capital;
- **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.

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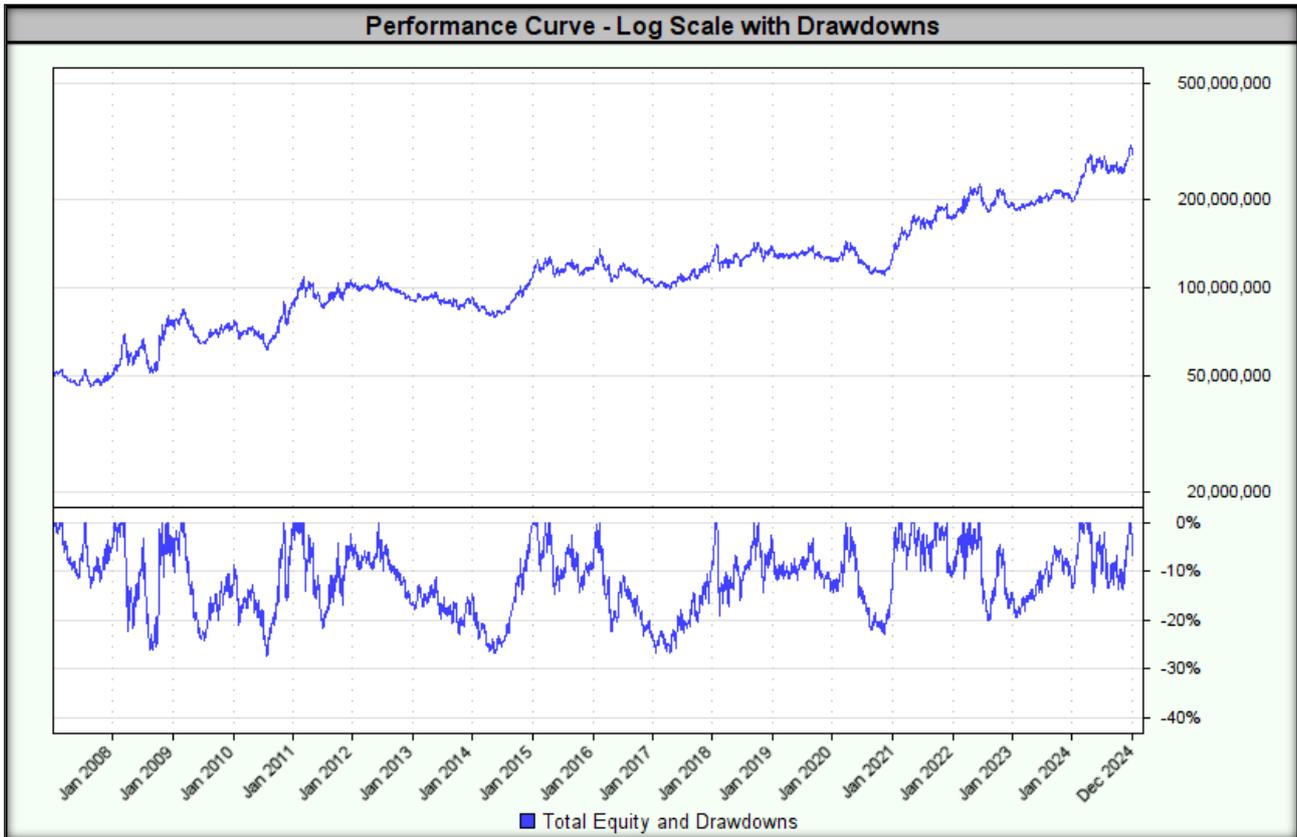
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Indicators/Measures	Concluding a transaction at the opening price
CAGR%	10.4%
MAR Ratio	0.38
RAR%	7.9%
R-Cubed	0.17
Robust Sharpe Ratio	0.39
Max Drawdown	27.4%
Wins	22.6%
Losses	77.4%
Average Win%	2.62%
Average Loss %	0.50%
Win/ Loss Ratio	5.28
Average Trade Duration (days)	89
Percent Profit Factor	1.54
SQN	0.69
Number of transactions	1119

In summary, the system works properly and generates signals as expected. Additionally, tests on basic parameters yielded good results. We can now 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 considerations 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**

Ignition v.2 Strategy in this version it assumes **optimizing the parameters proposed by the creator of the strategy, Larry Connors, and adding and optimizing the parameters for the moving average** filtering out transactions that are not in line with the dominant trend. We will optimize using **The Grid** method **Search,** 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 the parameters on **the in-sample data.** For this purpose, we determine the ranges of parameter **values** so that **the quotient of the highest and lowest values of the range was at least 150%.**

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

- **Distance of buy/sell order from last closing price:** range **120%-200% ATR (step: 5 pp.);**
- **ATR lengths:** range **15-25 days (step: 1);**
- **Moving average:** range **150-250 days (step: 5).**

The lowest MAR value of 0.19 was achieved for the following parameters:

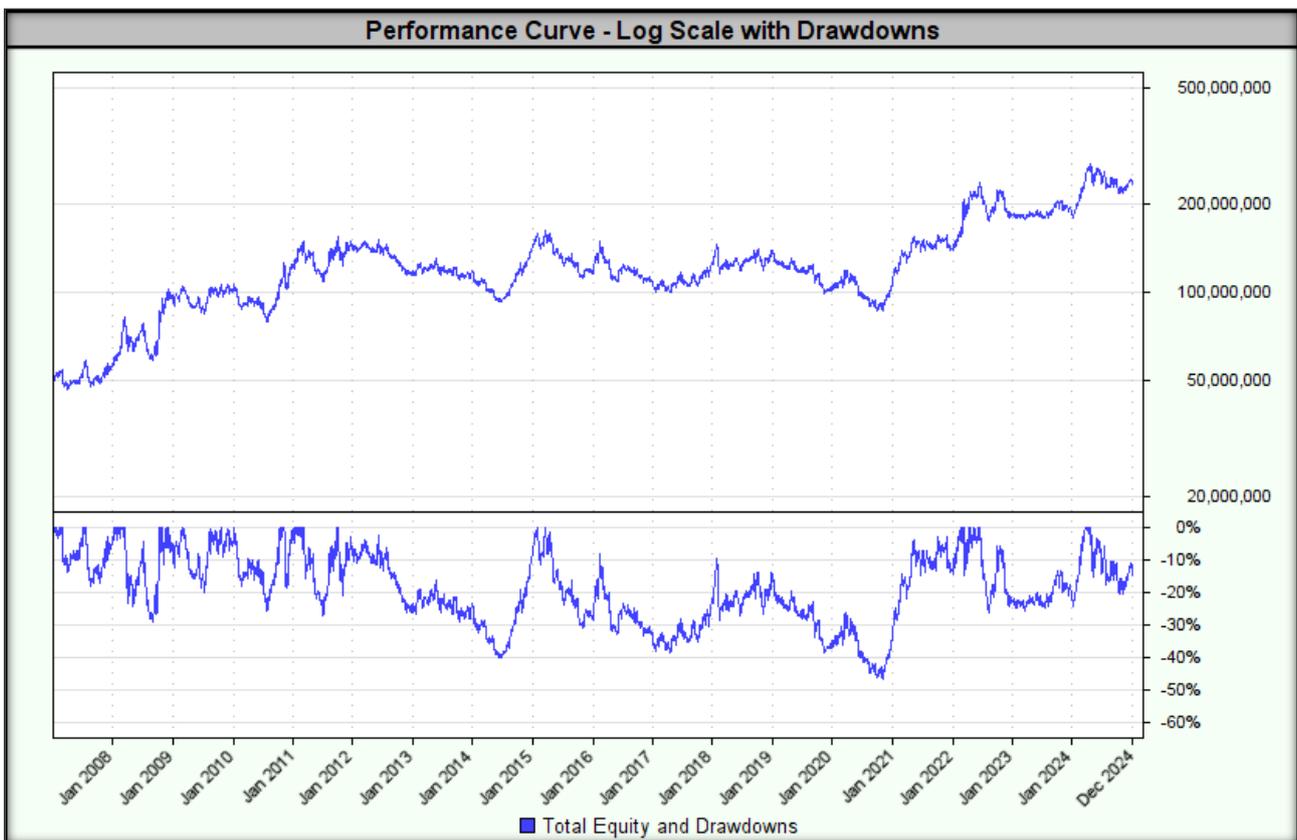- **Distance of buy/sell order from last closing price:** 120% ATR;

- **ATR lengths:** 15 days;
- **Moving average:** 150 days.

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

Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
1	15	120%	150	$234,087,236.30	8.96%	0.19	0.47	0.42	46.7%	83.2	1813	0.06	5.28
358	16	120%	150	$235,835,731.26	9.00%	0.19	0.47	0.42	46.4%	83.2	1805	0.06	5.30
2499	21	200%	250	$124,981,185.73	5.22%	0.19	0.46	0.42	26.9%	59.3	526	0.07	3.01
3927	25	200%	250	$120,366,147.01	5.00%	0.19	0.45	0.41	25.7%	62.3	529	0.06	2.74
2856	22	200%	250	$123,792,972.27	5.17%	0.19	0.46	0.41	26.5%	59.3	526	0.07	2.91
3570	24	200%	250	$120,540,659.53	5.01%	0.20	0.45	0.40	25.7%	62.3	530	0.06	2.72
3213	23	200%	250	$121,787,896.16	5.07%	0.20	0.45	0.41	25.8%	48.8	529	0.06	2.81
715	17	120%	150	$238,353,043.54	9.06%	0.20	0.47	0.43	45.5%	82.8	1803	0.07	5.45
2142	20	200%	250	$131,291,734.78	5.51%	0.20	0.49	0.45	27.5%	59.3	524	0.09	3.30
1785	19	200%	250	$137,859,781.05	5.80%	0.20	0.51	0.46	28.5%	108.1	522	0.09	3.43
1072	18	120%	150	$240,415,137.63	9.12%	0.20	0.47	0.43	44.5%	73.6	1802	0.07	5.60

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 0.46 was achieved for the following parameters:

- **Distance of buy/sell order from last closing price:** 165% ATR;
- **ATR lengths:** 17 days;
- **Moving average:** 215 days.

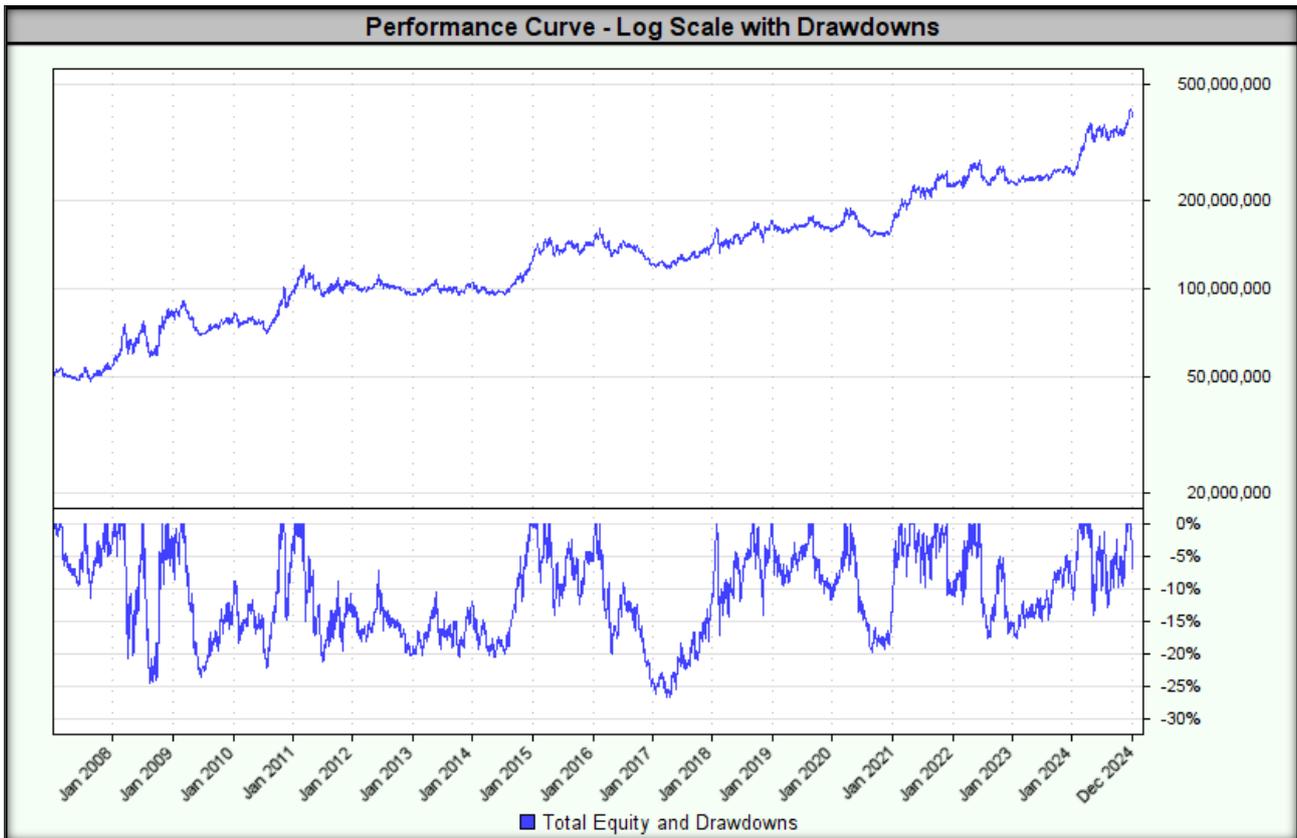The highest MAR value was accompanied by **a drawdown of 26.7%.**

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

Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
917	17	165%	215	$399,679,734.58	12.24%	0.46	0.71	0.66	26.7%	45.3	871	0.23	9.29
560	16	165%	215	$392,663,175.48	12.13%	0.45	0.70	0.66	26.8%	45.4	877	0.23	9.13
921	17	165%	235	$388,830,314.48	12.07%	0.45	0.70	0.60	26.8%	45.7	849	0.21	8.92
2009	20	170%	215	$356,883,207.79	11.54%	0.45	0.70	0.61	25.7%	45.7	814	0.21	8.43
919	17	165%	225	$419,115,474.88	12.54%	0.45	0.72	0.62	27.9%	45.4	860	0.22	9.25
564	16	165%	235	$383,359,637.63	11.98%	0.45	0.69	0.60	26.8%	45.8	854	0.20	8.78
918	17	165%	220	$396,101,447.24	12.19%	0.45	0.71	0.65	27.3%	45.3	866	0.23	9.12
562	16	165%	225	$412,986,718.60	12.45%	0.45	0.71	0.62	28.0%	45.4	865	0.22	9.09
920	17	165%	230	$394,700,999.38	12.16%	0.44	0.70	0.60	27.5%	45.5	862	0.21	8.92
165	15	155%	235	$400,860,011.01	12.26%	0.44	0.66	0.58	27.8%	30.8	1008	0.20	9.08
561	16	165%	220	$388,159,438.31	12.06%	0.44	0.70	0.65	27.3%	45.4	872	0.22	8.95

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 46.7%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
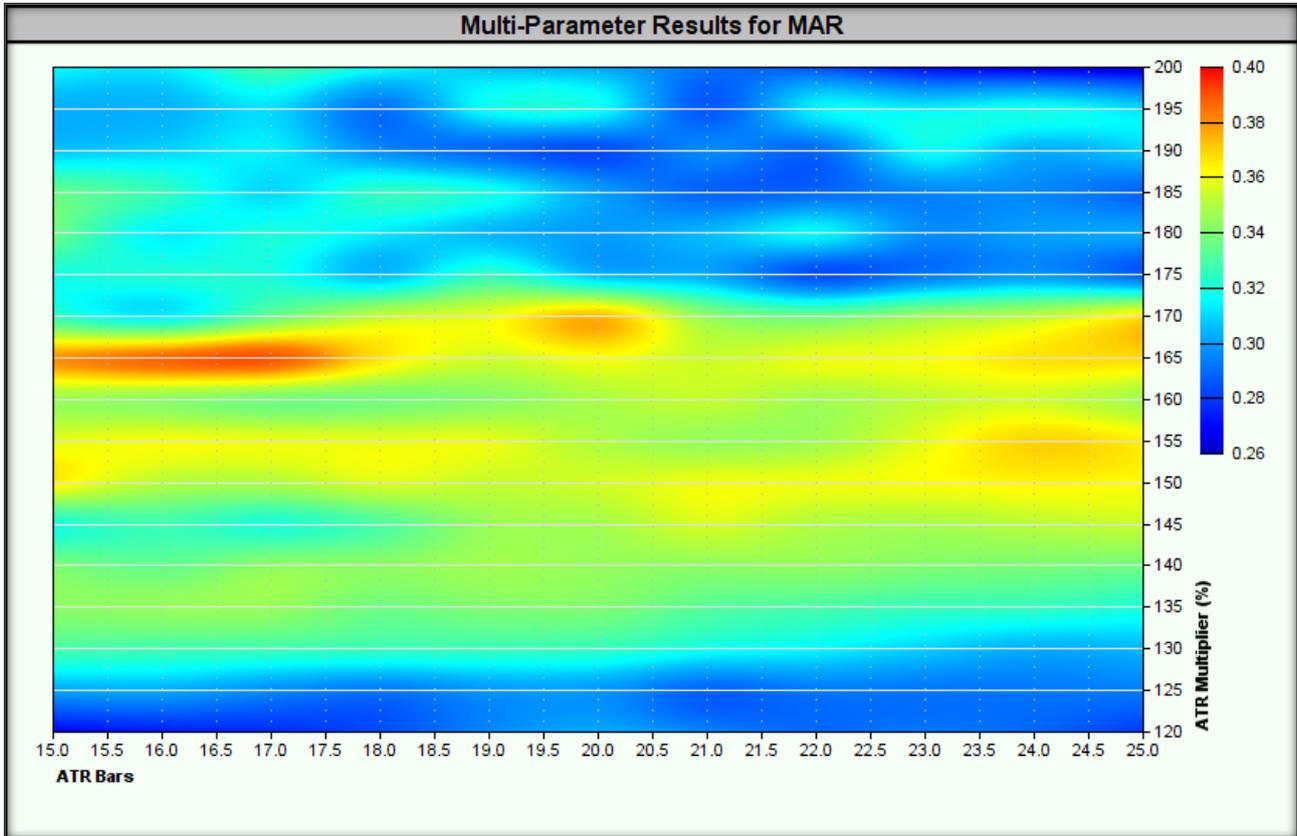
Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD ▽	Longest DD	Trades	R3	RAR [%]
1	15	120%	150	$234,087,236.30	8.96%	0.19	0.47	0.42	46.7%	83.2	1813	0.06	5.28
358	16	120%	150	$235,835,731.26	9.00%	0.19	0.47	0.42	46.4%	83.2	1805	0.06	5.30
715	17	120%	150	$238,353,043.54	9.06%	0.20	0.47	0.43	45.5%	82.8	1803	0.07	5.45
16	15	120%	225	$413,173,432.90	12.45%	0.27	0.58	0.51	45.3%	60.3	1539	0.11	8.84
1072	18	120%	150	$240,415,137.63	9.12%	0.20	0.47	0.43	44.5%	73.6	1802	0.07	5.60
373	16	120%	225	$415,826,371.94	12.49%	0.28	0.59	0.52	44.4%	60.3	1535	0.12	9.01
15	15	120%	220	$399,156,386.61	12.23%	0.28	0.58	0.52	44.3%	60.4	1546	0.12	8.76
730	17	120%	225	$422,152,495.09	12.58%	0.29	0.59	0.53	44.1%	60.2	1532	0.12	9.08
3229	24	120%	225	$448,512,186.17	12.96%	0.30	0.61	0.55	43.8%	60.2	1494	0.13	9.38
17	15	120%	230	$417,702,232.86	12.52%	0.29	0.59	0.52	43.8%	60.2	1532	0.12	9.12
1087	18	120%	225	$434,352,846.71	12.76%	0.29	0.60	0.54	43.6%	60.2	1526	0.12	9.27

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

- **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 (**46.7% vs. 26.7 %**) – 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 ATR Bars Varies

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

MAR as ATR Multiplier (%) Varies

Legend: ■ Maximum ■ Average + SD ■ Average ■ Average - SD ■ Minimum

MAR as Moving Average (bars) Varies

Legend: ■ Maximum ■ Average + SD ■ Average ■ Average - SD ■ Minimum
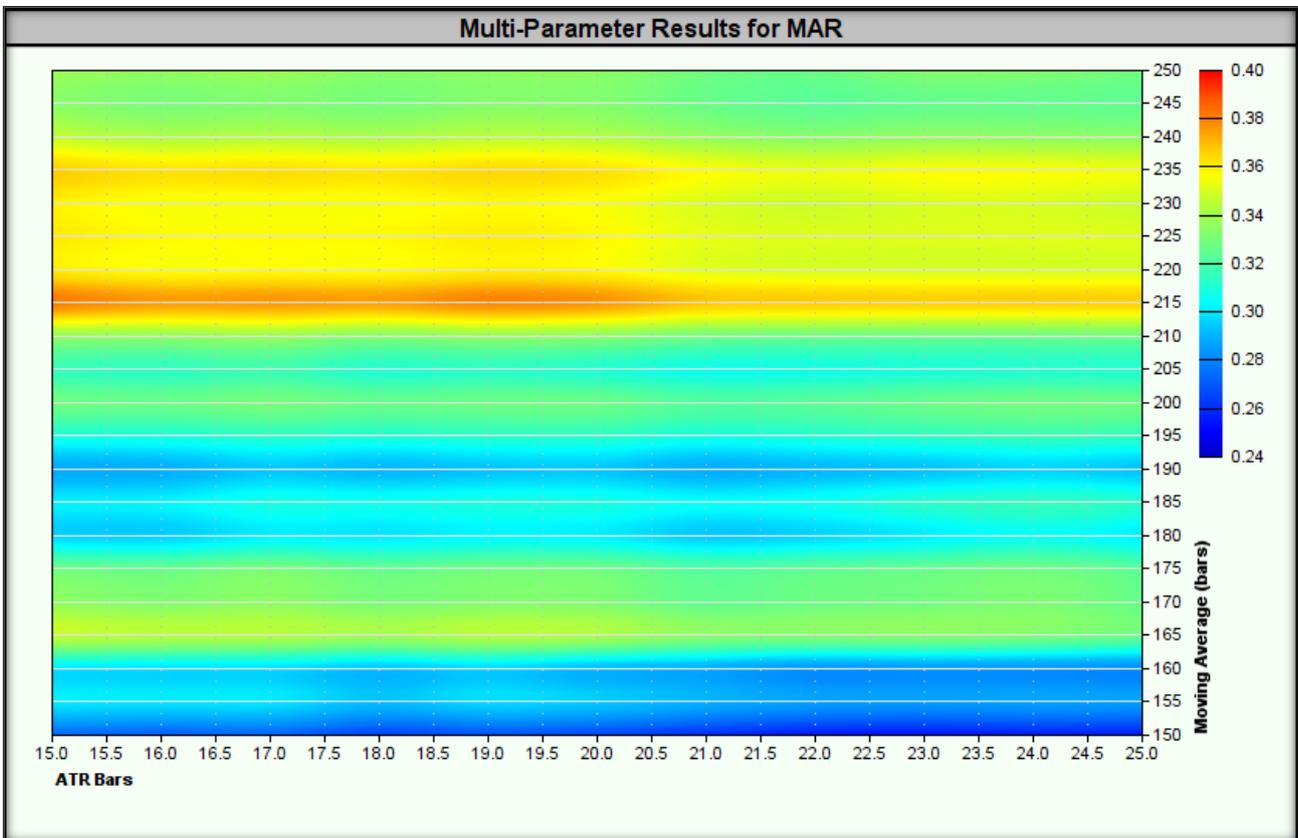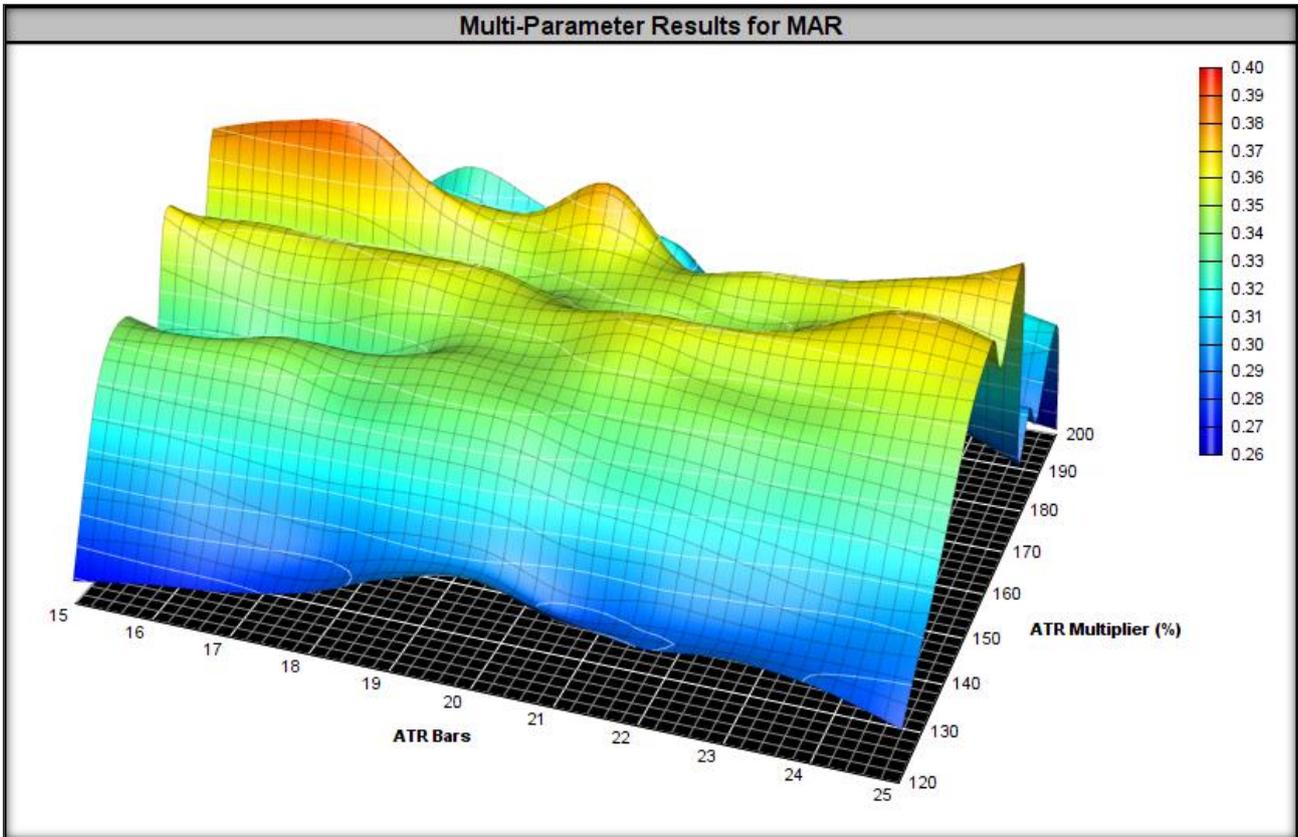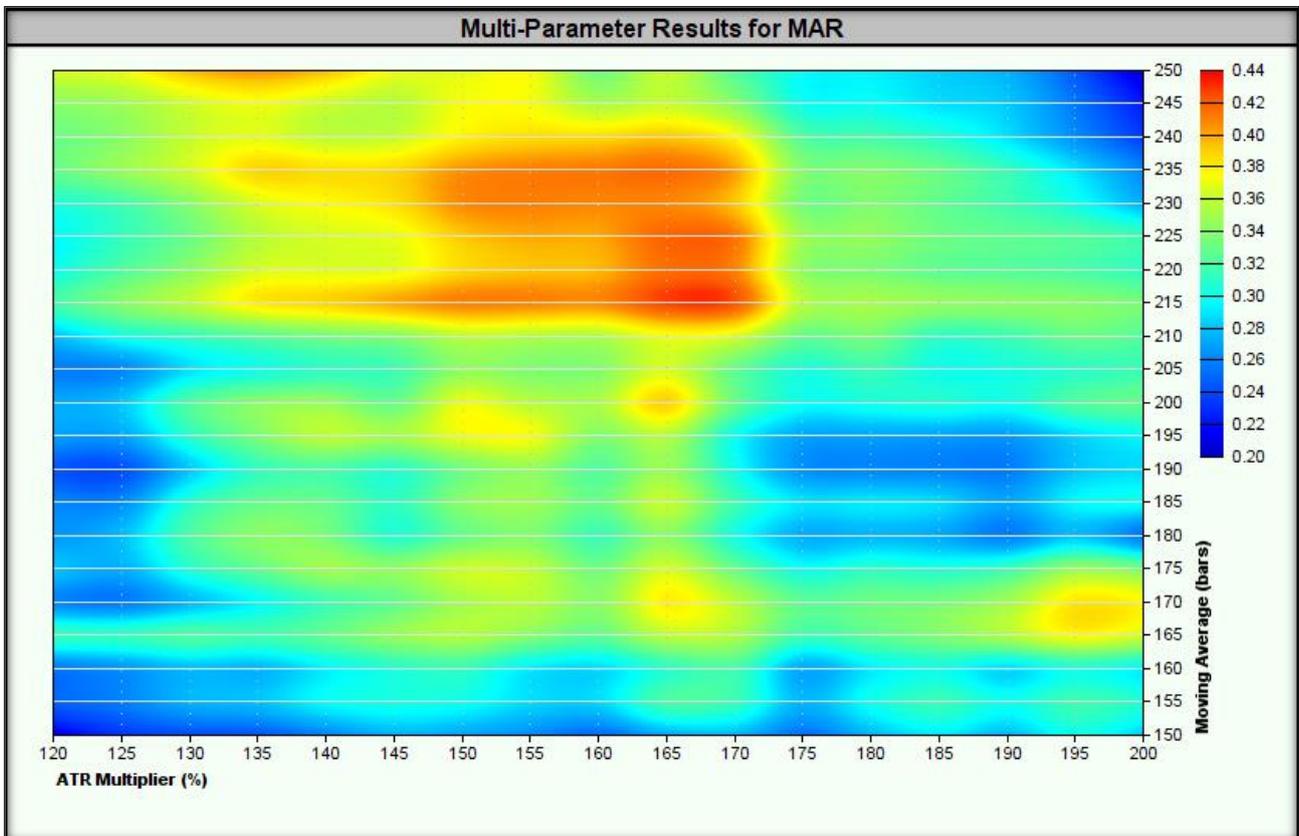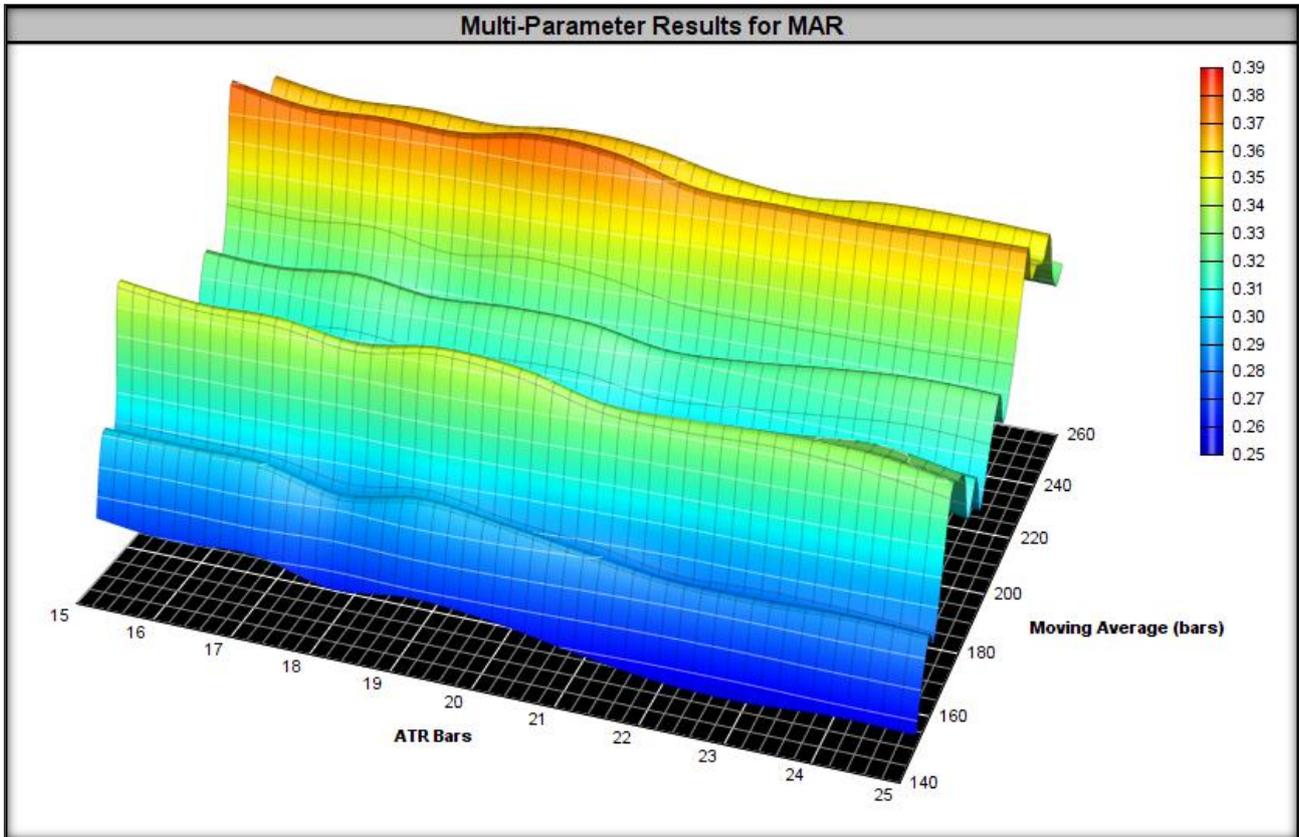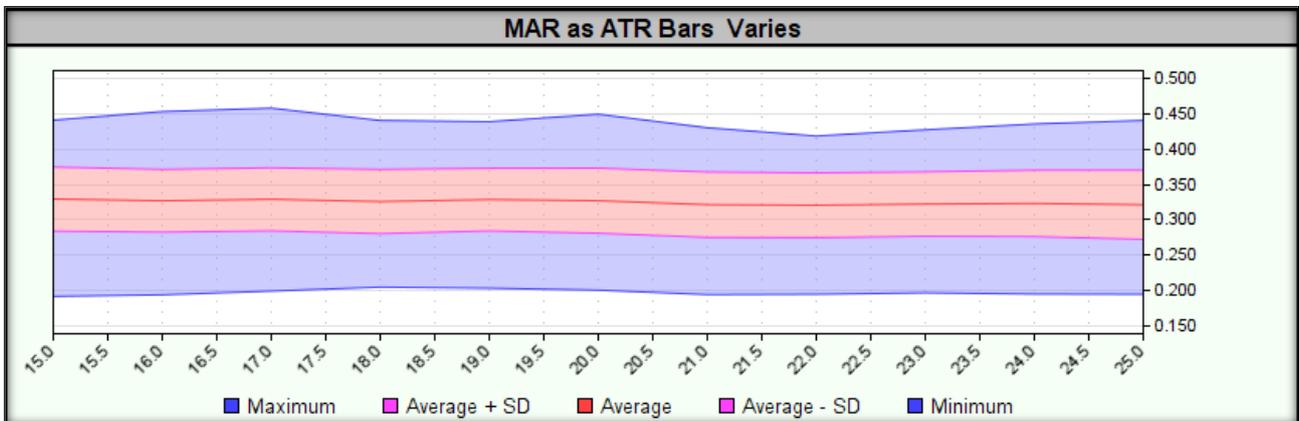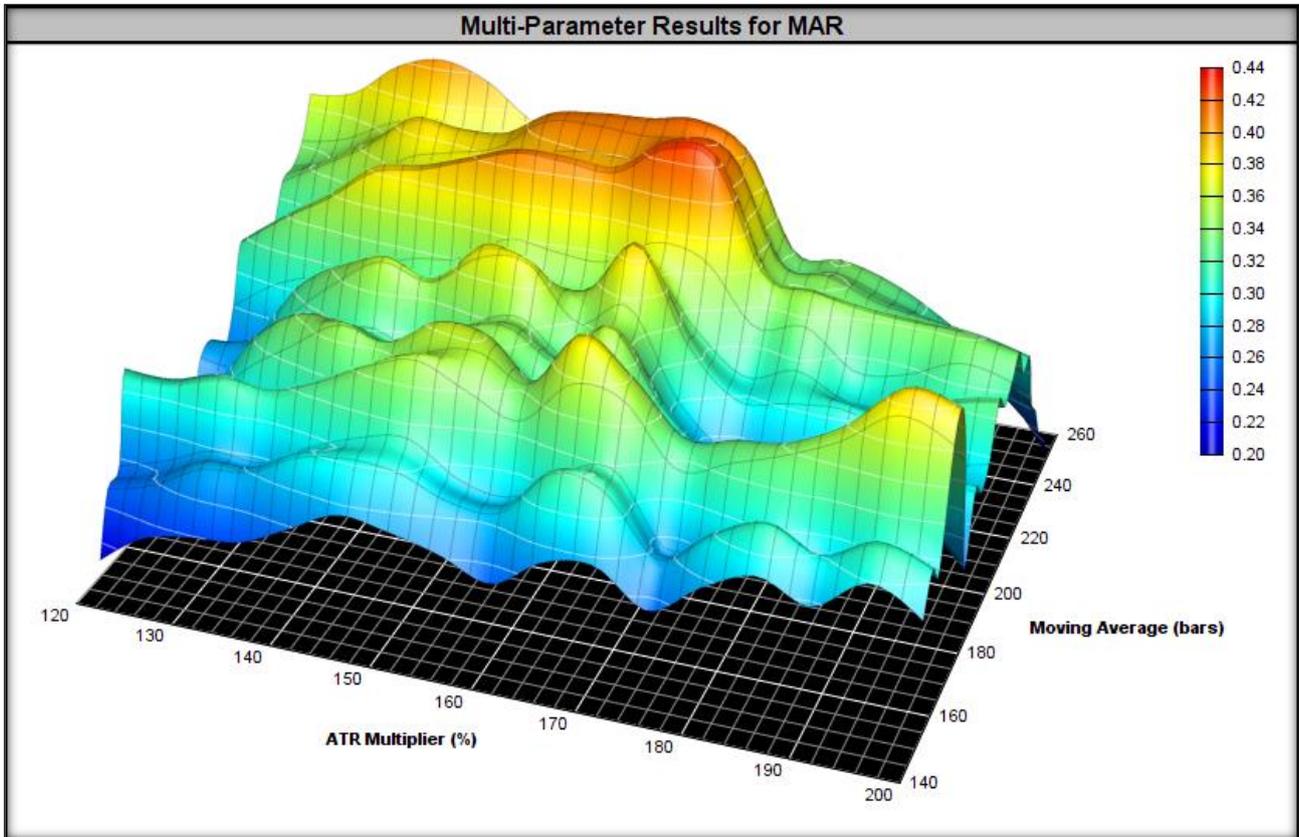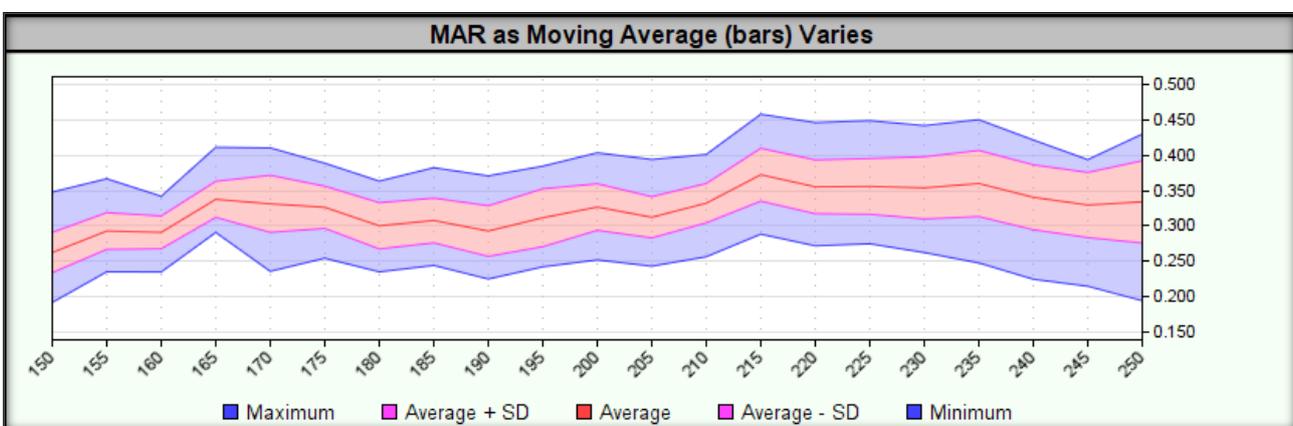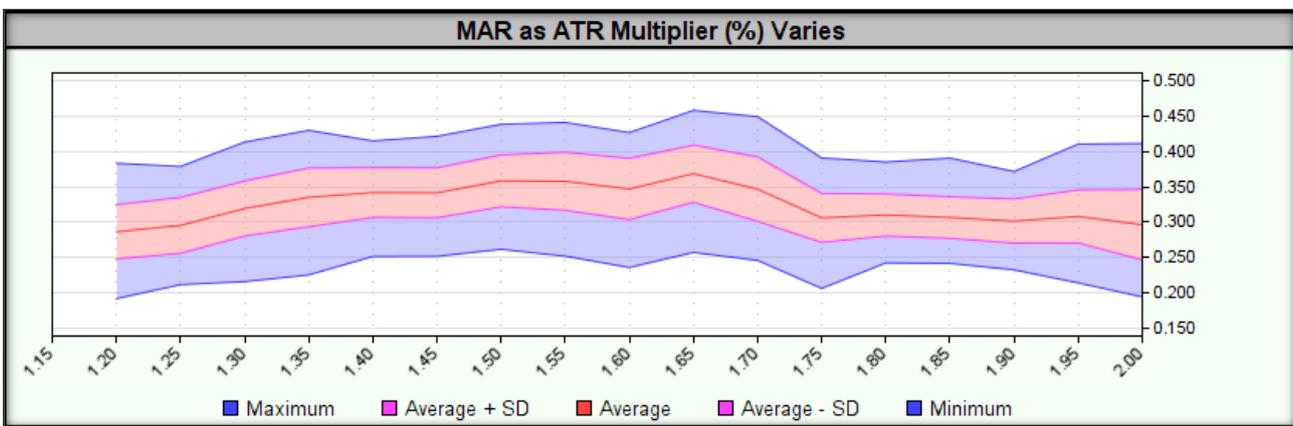
After passing the stability tests on **the in-sample data,** it is time perform the same on **the out-of-sample data.** For this purpose, we use **the same range of parameters** as on the in-sample data:

- **Distance of buy/sell order from last closing price:** range **120%-200% ATR (step: 5 pp.);**
- **ATR lengths:** range **15-25 days (step: 1);**
- **Moving average:** range **150-250 days (step: 5).**

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

- **Distance of buy/sell order from last closing price:** 200% ATR;
- **ATR lengths:** 25 days;
- **Moving average:** 170 days.

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

Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
3911	25	200%	170	$70,461,205.00	3.89%	0.23	0.40	0.54	16.7%	37.6	288	0.13	1.78
676	16	195%	165	$73,998,747.97	4.46%	0.23	0.41	0.64	19.1%	33.2	331	0.18	3.07
677	16	195%	170	$72,231,892.19	4.18%	0.24	0.39	0.53	17.5%	29.3	325	0.15	2.48
319	15	195%	165	$74,674,145.50	4.56%	0.24	0.42	0.68	19.0%	33.2	330	0.18	3.21
320	15	195%	170	$72,726,461.24	4.26%	0.24	0.40	0.56	17.5%	29.3	324	0.15	2.59
1033	17	195%	165	$74,640,653.48	4.56%	0.24	0.42	0.65	18.7%	33.2	329	0.19	3.10
1034	17	195%	170	$72,915,111.12	4.29%	0.24	0.40	0.54	17.5%	29.3	323	0.16	2.52
3914	25	200%	185	$75,119,482.79	4.63%	0.24	0.45	0.61	18.9%	59.9	281	0.16	2.20
3915	25	200%	190	$75,521,727.66	4.69%	0.25	0.45	0.65	18.8%	59.6	276	0.18	2.43
3912	25	200%	175	$73,389,399.88	4.36%	0.25	0.43	0.60	17.4%	37.6	286	0.14	2.03
1038	17	195%	190	$78,014,561.68	5.07%	0.25	0.45	0.62	20.2%	51.6	308	0.20	3.17
327	15	195%	205	$76,138,498.93	4.79%	0.25	0.43	0.56	19.0%	28.5	304	0.25	3.84

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 0.86 was achieved for the following parameters:

- **Distance of buy/sell order from last closing price:** 125% ATR;
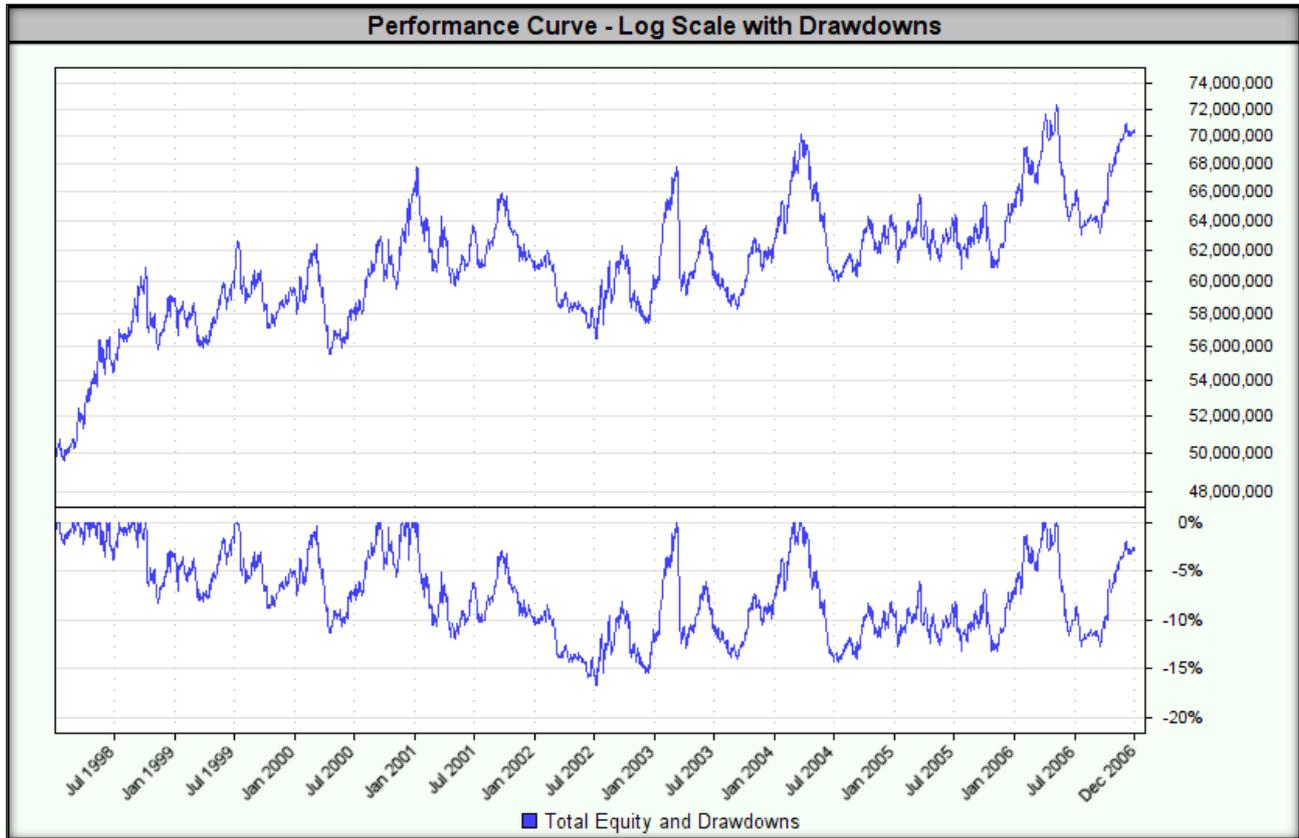- **ATR lengths:** 25 days;
- **Moving average:** 230 days.

The highest MAR value was accompanied by **a drawdown of 27.1%.**

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

Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
3608	25	125%	230	$327,494,414.90	23.25%	0.86	1.05	1.37	27.1%	11.8	607	1.56	21.20
2894	23	125%	230	$319,666,386.97	22.92%	0.85	1.03	1.37	27.1%	11.9	614	1.54	20.95
2537	22	125%	230	$318,956,777.29	22.89%	0.84	1.03	1.38	27.1%	11.9	615	1.55	20.89
2180	21	125%	230	$314,793,866.04	22.71%	0.84	1.02	1.37	27.1%	11.8	619	1.53	20.72
3251	24	125%	230	$312,741,769.69	22.62%	0.83	1.02	1.37	27.1%	11.9	615	1.49	20.59
3607	25	125%	225	$307,549,424.01	22.39%	0.82	1.02	1.33	27.5%	11.8	619	1.52	20.04
2892	23	125%	220	$299,430,129.87	22.03%	0.81	0.99	1.28	27.2%	11.9	638	1.35	19.89
2535	22	125%	220	$299,501,539.41	22.03%	0.81	0.99	1.29	27.2%	11.9	639	1.35	19.85
3609	25	125%	235	$297,813,935.06	21.95%	0.81	1.01	1.50	27.1%	12.0	598	1.52	19.48
1110	18	125%	235	$293,528,109.24	21.76%	0.80	1.00	1.67	27.0%	12.0	606	1.66	19.73
3249	24	125%	220	$294,287,828.38	21.79%	0.80	0.98	1.28	27.1%	11.9	638	1.32	19.55
3606	25	125%	220	$293,844,022.77	21.77%	0.80	0.99	1.27	27.2%	11.9	635	1.40	19.52

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
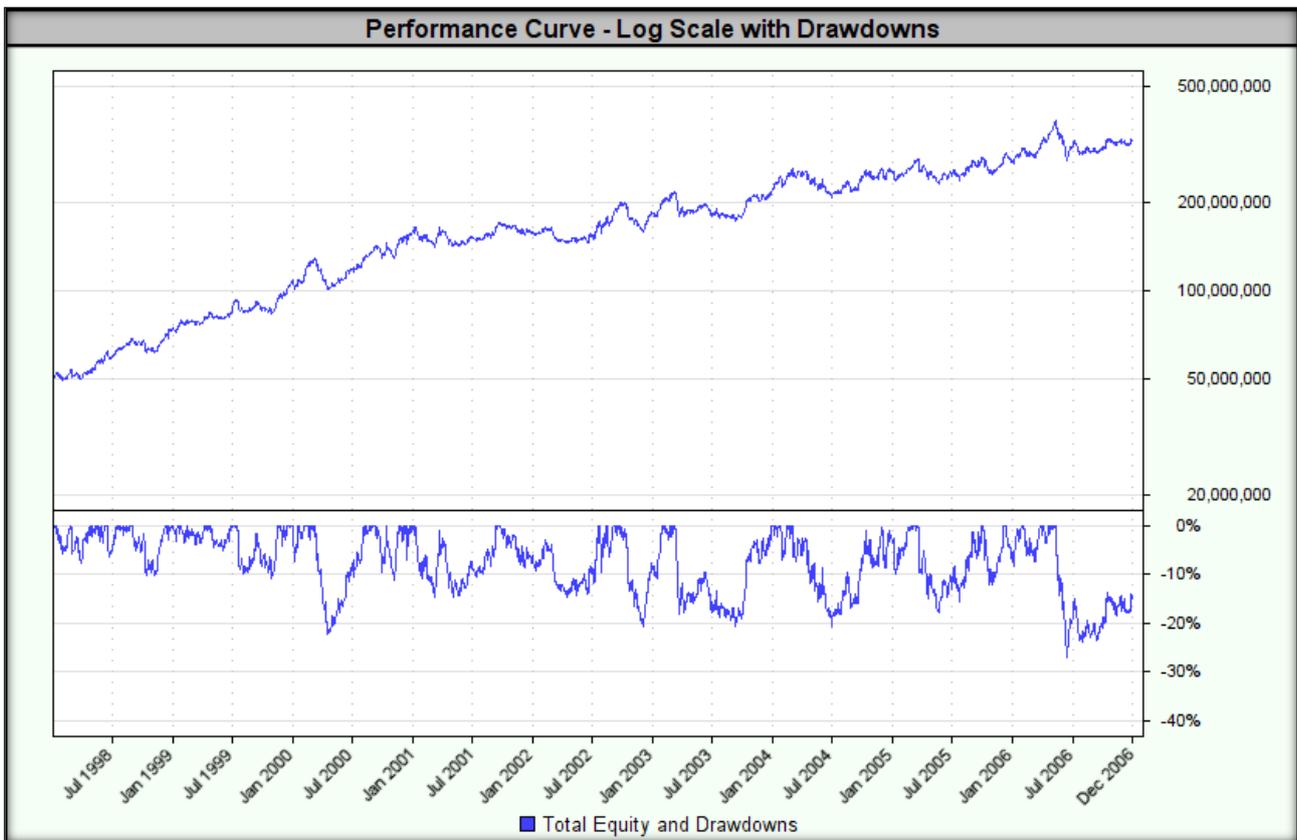
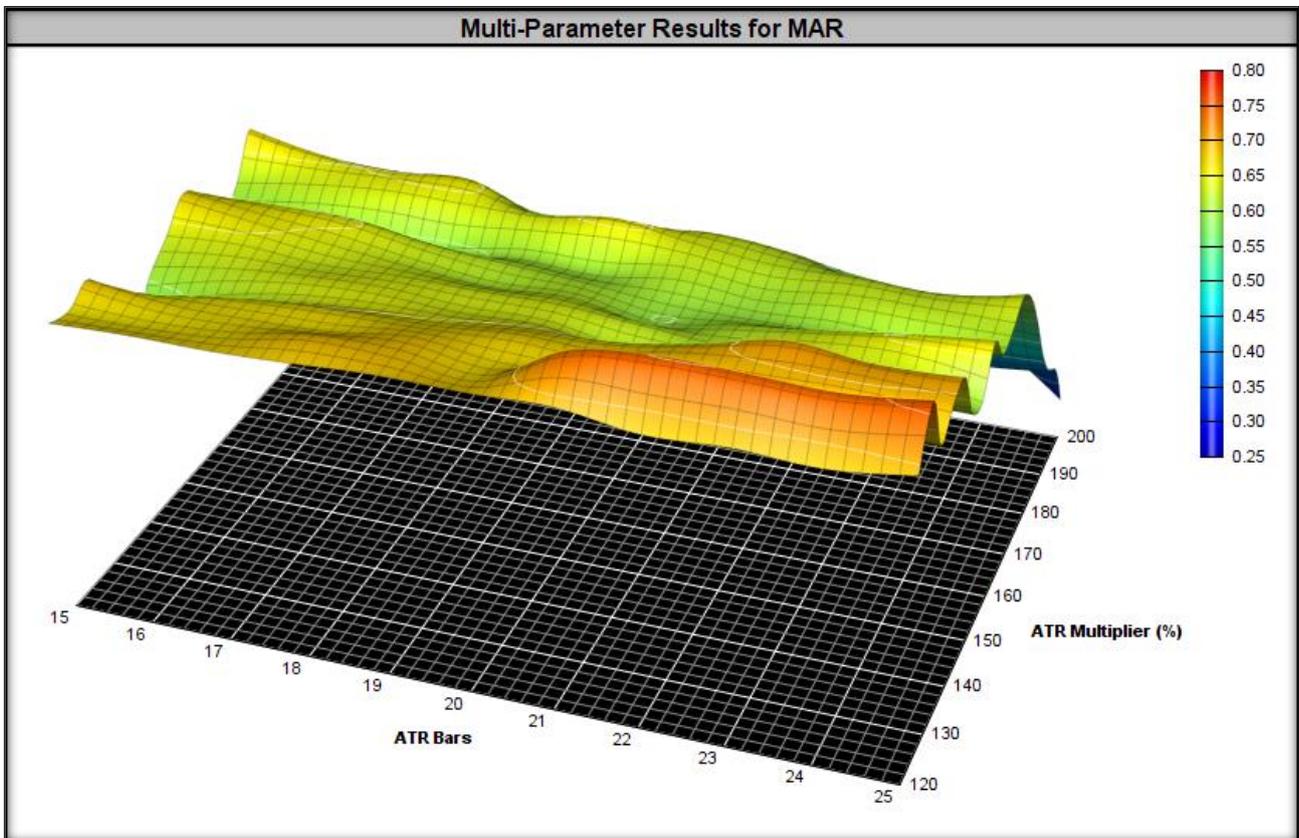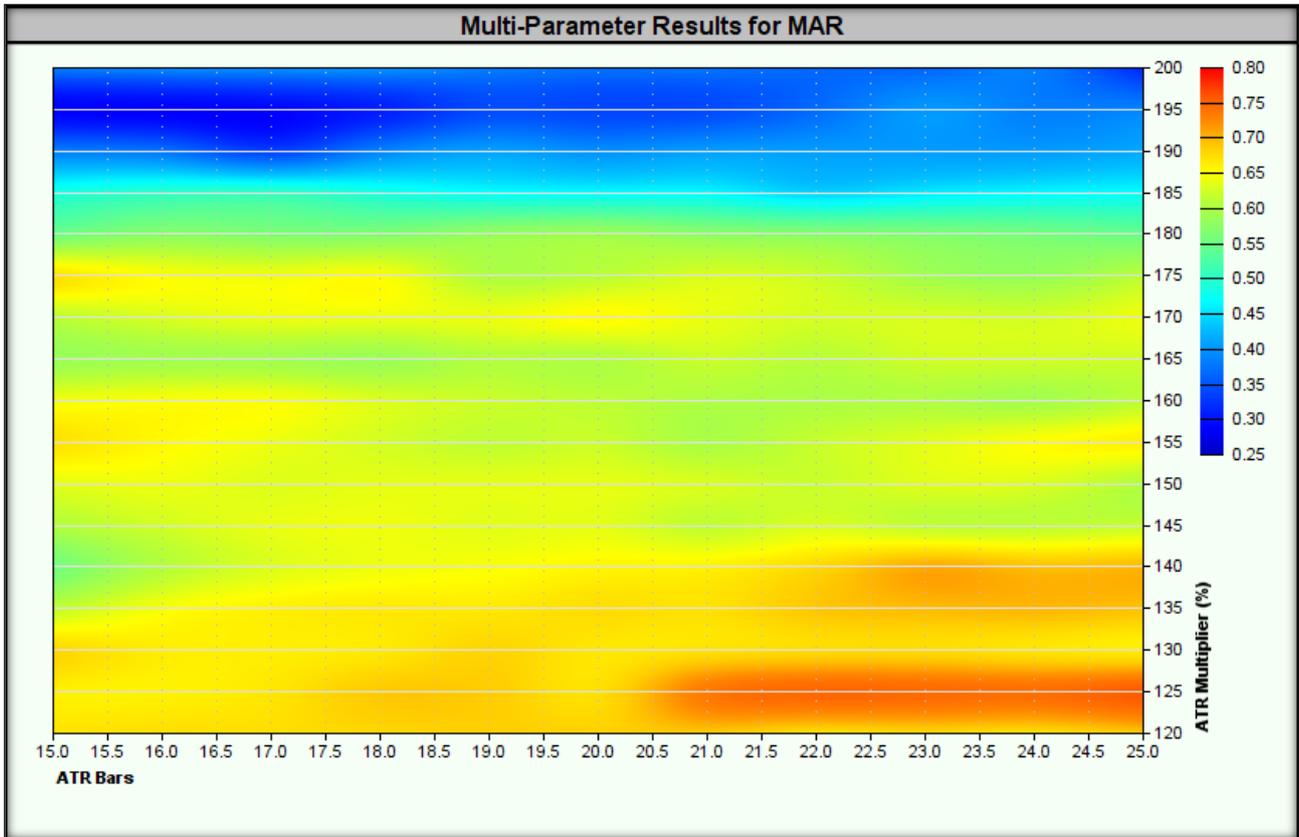For all combinations of tested parameter ranges, **the highest drawdown was 30.9%.**

Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.
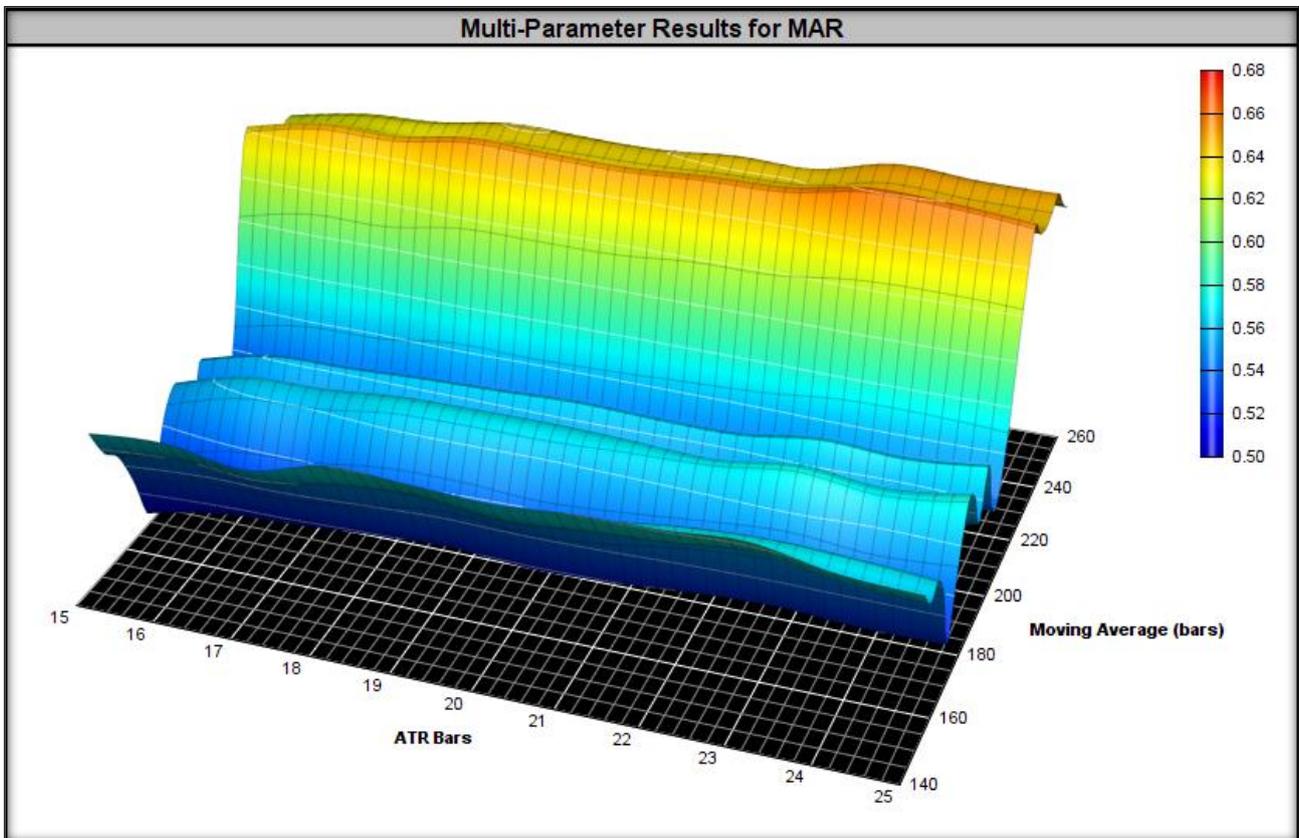
Test	ATR Bars	ATR Multiplier (%)	Moving Average (bars)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD ▽	Longest DD	Trades	R3	RAR [%]
3225	24	120%	205	$230,088,300.81	18.50%	0.60	0.85	0.96	30.9%	21.2	697	0.72	16.02
3220	24	120%	180	$238,496,608.13	18.98%	0.62	0.86	0.95	30.7%	20.5	742	0.65	15.33
3224	24	120%	200	$236,105,697.60	18.84%	0.62	0.86	0.98	30.5%	22.9	711	0.62	15.18
3226	24	120%	210	$242,316,349.00	19.19%	0.63	0.88	1.01	30.5%	21.2	692	0.75	16.29
3222	24	120%	190	$240,212,322.26	19.07%	0.63	0.86	1.00	30.5%	22.9	723	0.62	15.58
3582	25	120%	205	$233,063,165.32	18.67%	0.61	0.86	0.97	30.5%	21.3	693	0.73	16.08
3219	24	120%	175	$231,166,904.91	18.57%	0.61	0.84	0.93	30.5%	22.1	752	0.65	15.18
2505	22	120%	175	$229,809,014.49	18.49%	0.61	0.84	0.91	30.4%	22.1	757	0.64	15.00
3577	25	120%	180	$243,180,405.89	19.24%	0.63	0.87	0.97	30.4%	20.5	737	0.67	15.52
2511	22	120%	205	$225,900,160.31	18.26%	0.60	0.84	0.92	30.3%	21.3	701	0.74	15.64
2868	23	120%	205	$229,413,199.00	18.46%	0.61	0.85	0.95	30.2%	21.3	700	0.75	15.85
363	16	120%	175	$224,756,892.38	18.19%	0.60	0.82	0.91	30.2%	22.1	769	0.61	14.64

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

- **MAR value** – which indicates the stability of the strategy in various market conditions.
- **Maximum drawdown on out-of-sample data did not exceed 150% of the maximum drawdown value on in-sample data (30.9 % vs. 46.7 %)** – 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 (0.86 vs. 0.46)** – 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 ATR Bars Varies

MAR as ATR Multiplier (%) Varies

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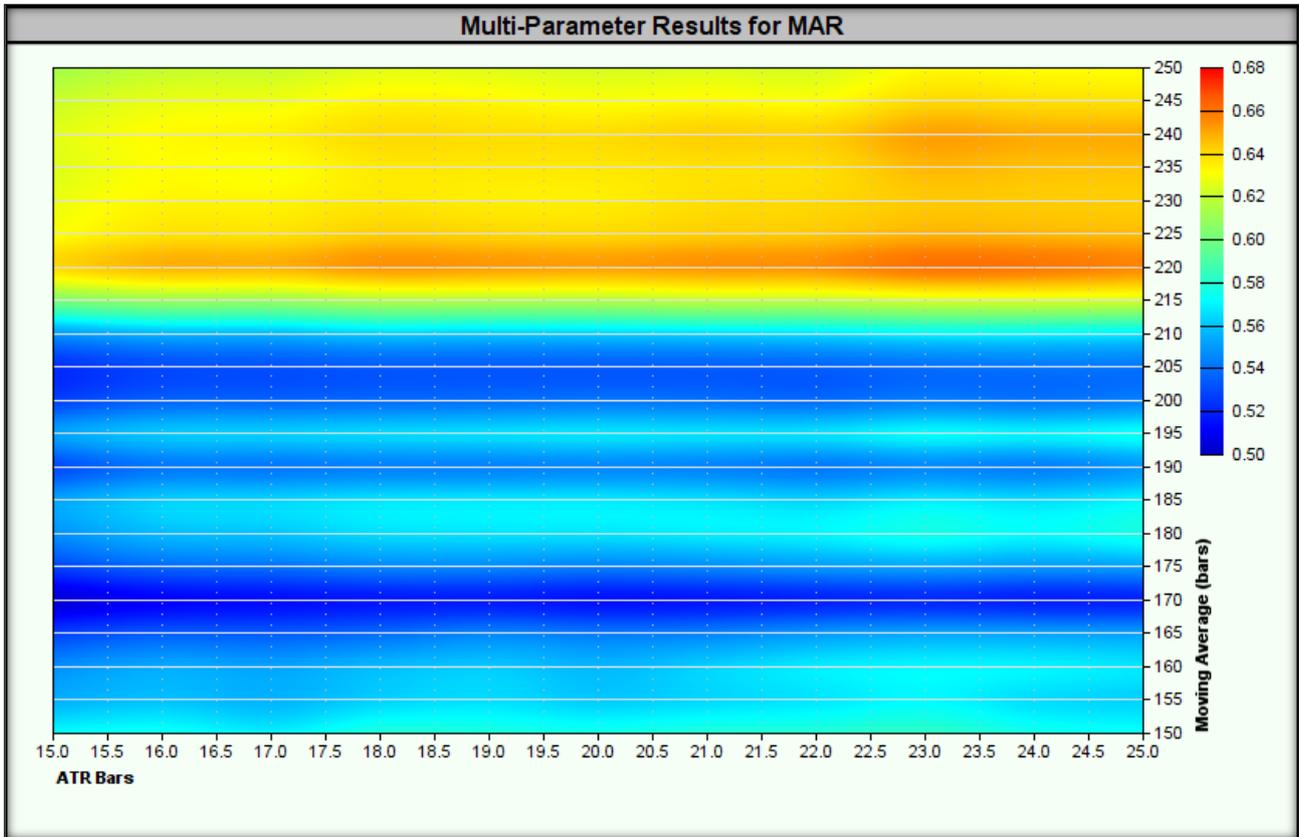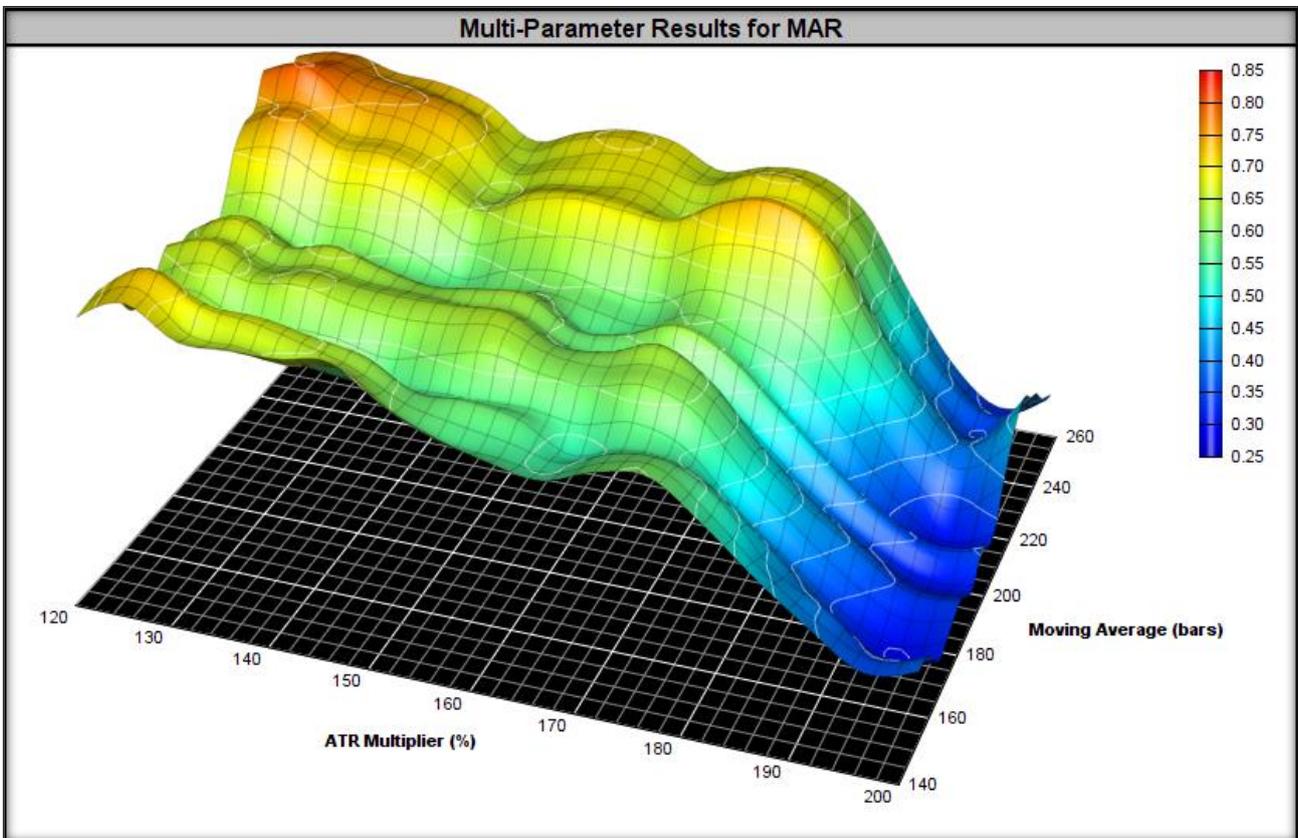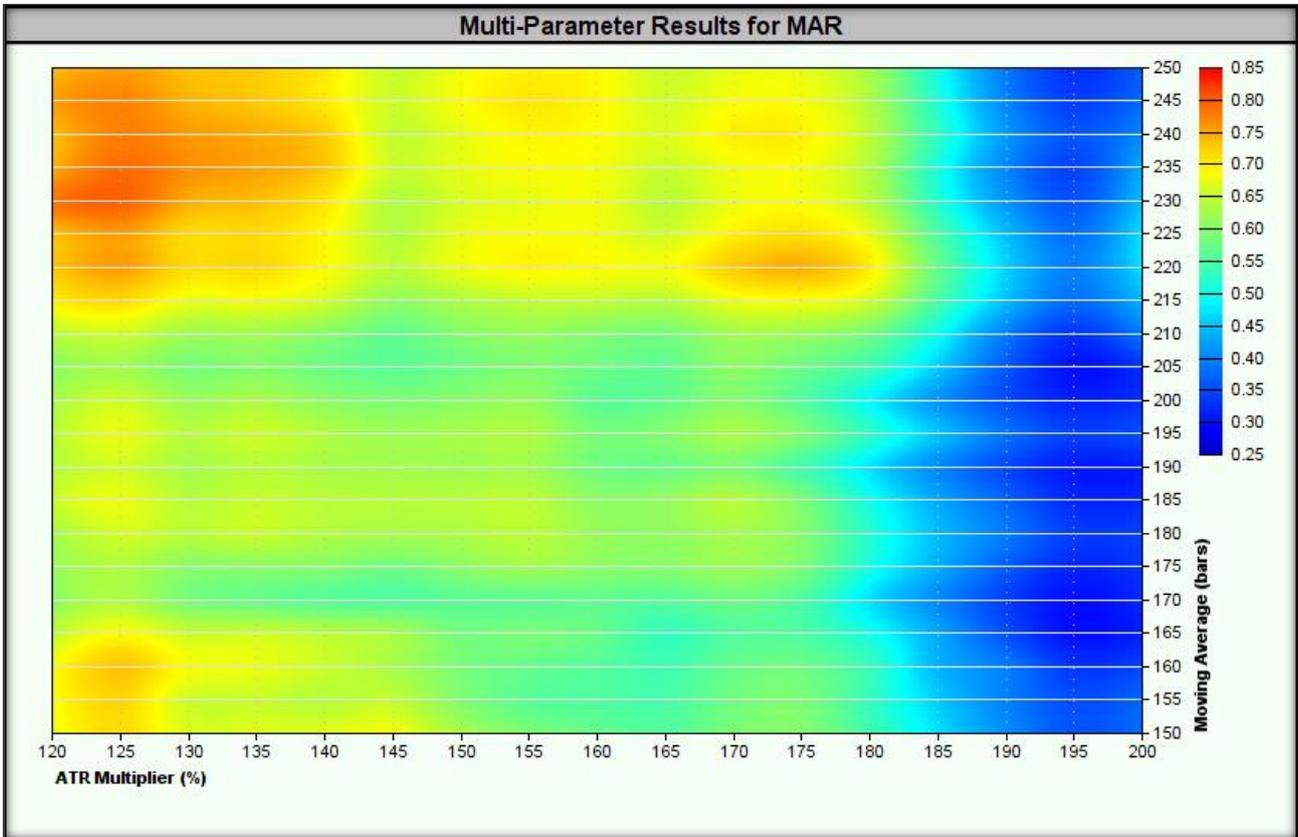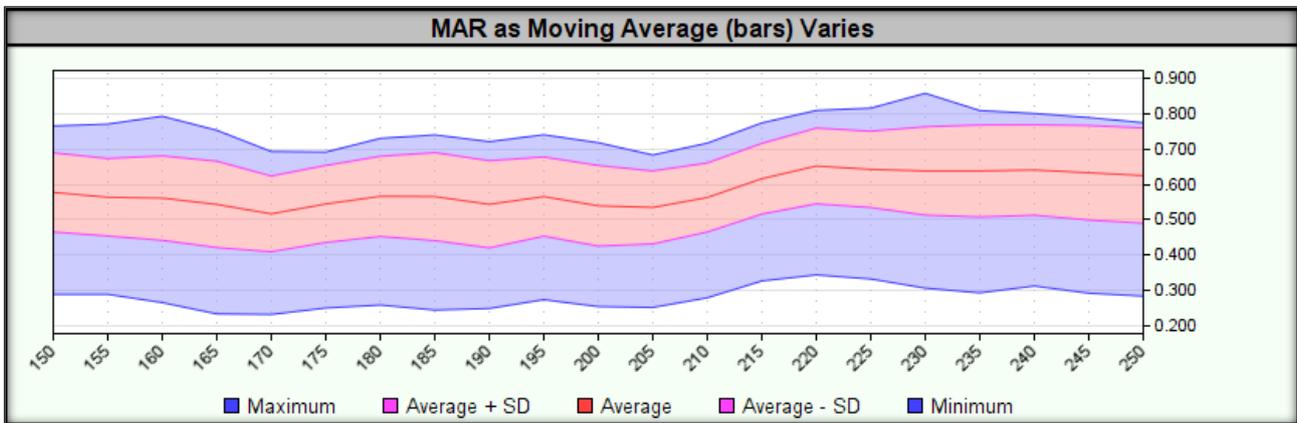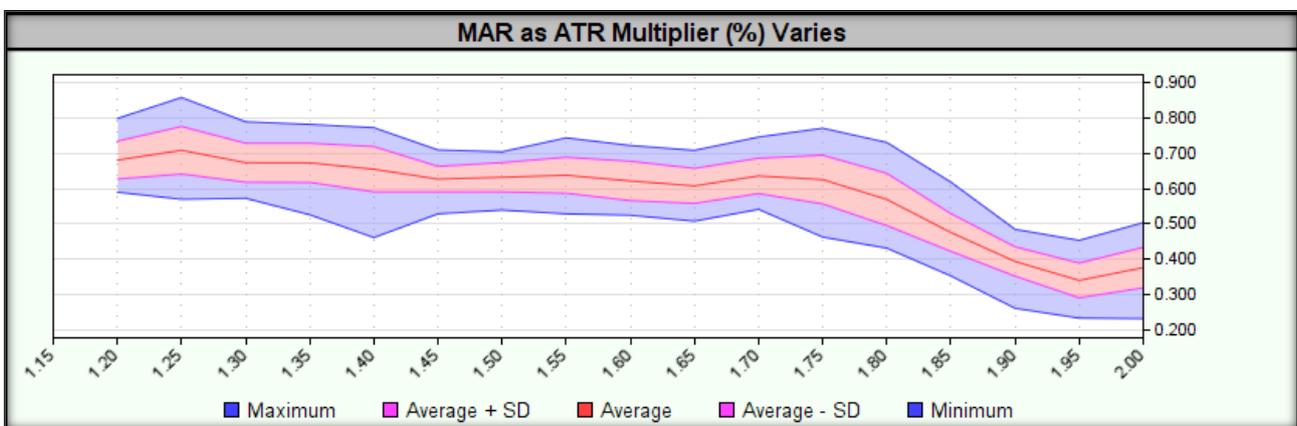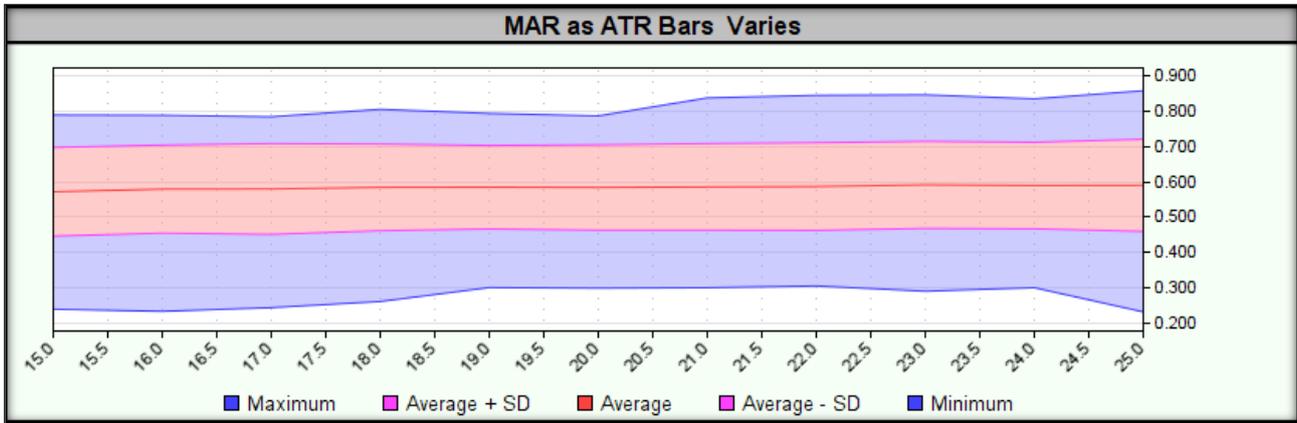
After passing **the stability test in a wide range of optimized parameters,** we can proceed to **stability testing using Monte Carlo simulation.** The conditions for passing this test are similar to those required in the above step.

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** was carried out **Monte Carlo simulation** 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.
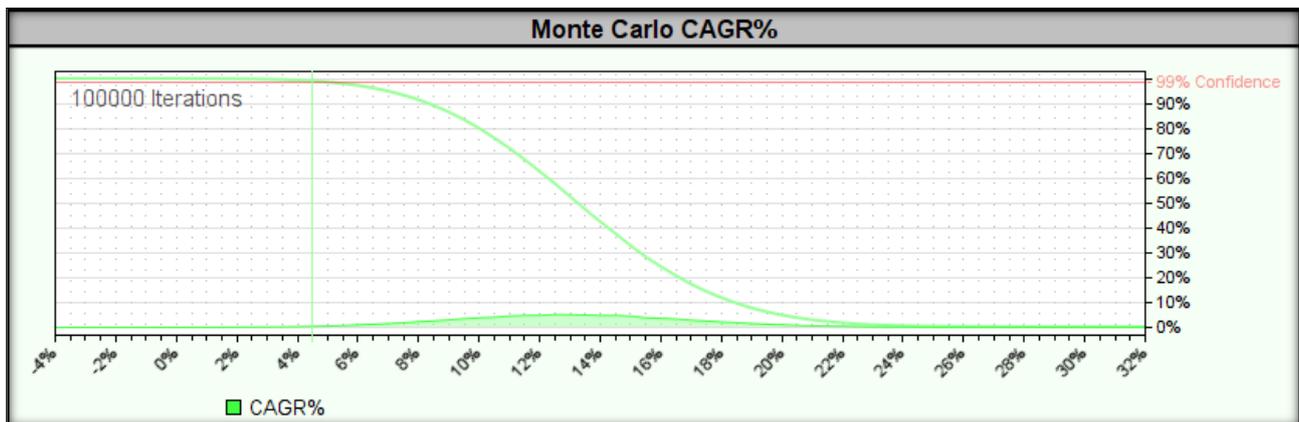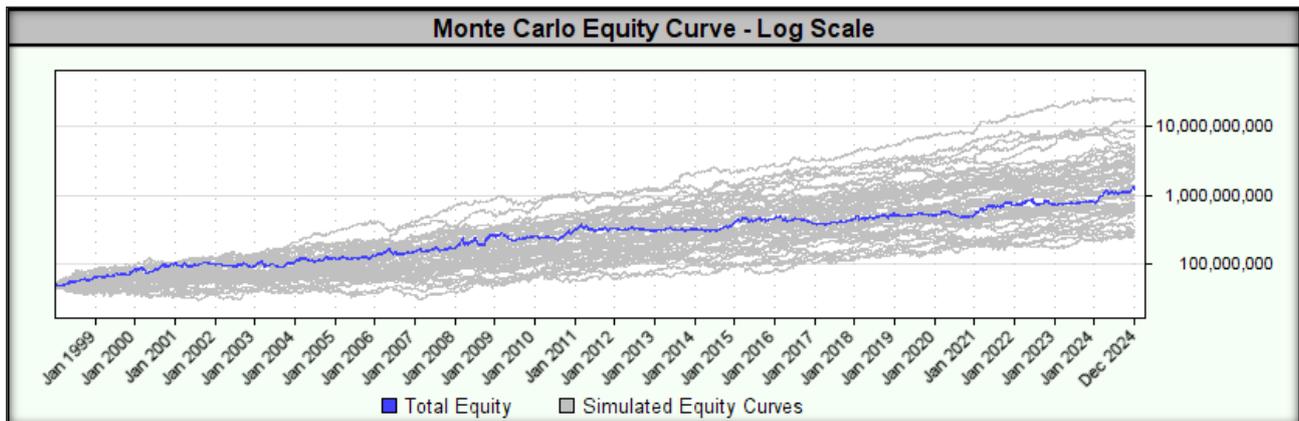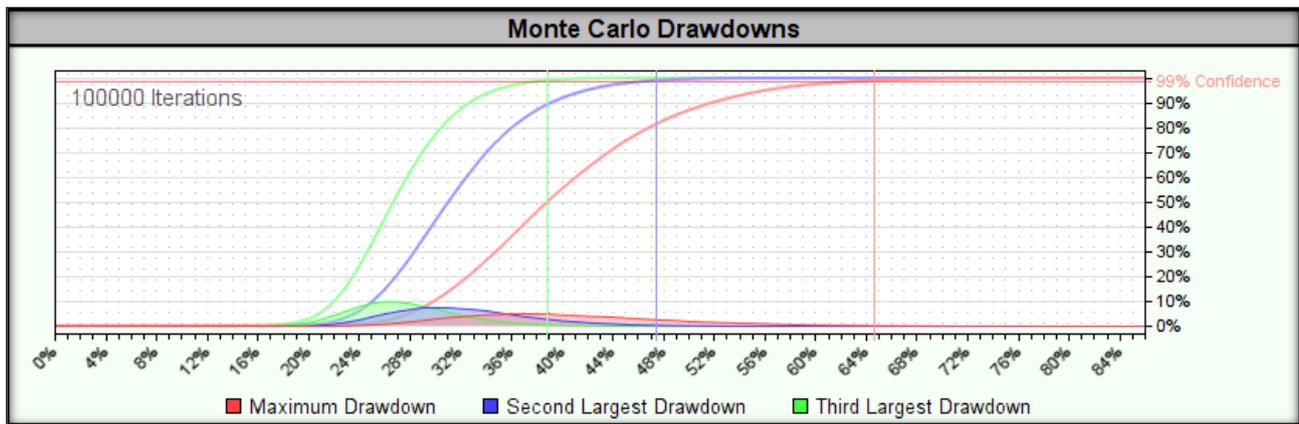
- **CAGR%** – In 99% of simulations achieved **a rate of return equal to or higher than 4.5%.**
- **Drawdown** – in 99% of simulations, **drawdown equal to or lower than 65% was achieved.** For parameters optimized on in-sample data, drawdown was 26.8%.

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 **estimating one- 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- 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** was carried out **testing optimized parameters** 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) test window are shown below.

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

T	Test Start Date	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF	Expectancy
1	19980101	$66,290,729.33	32.61%	4.39	2.19	2.00	7.4%	2.1	49	69.61	26.96	2.82	1.29
2	19990101	$62,694,239.14	25.49%	3.05	1.67	NA	8.4%	4.1	61	23.59	11.98	2.19	0.81
3	20000101	$60,017,117.45	20.29%	1.97	1.27	NA	10.3%	4.2	62	23.04	16.78	1.92	0.69
4	20010101	$56,486,189.96	12.98%	1.29	0.79	2.00	10.0%	5.3	56	19.05	13.17	1.66	0.45
5	20020101	$49,540,783.57	-0.92%	-0.06	0.00	-2.06	14.5%	5.3	64	-18.04	-8.94	0.97	-0.02
6	20030101	$53,096,615.46	6.20%	0.41	0.42	1.99	15.2%	9.9	61	-12.62	-8.95	1.31	0.23
7	20040101	$52,725,375.19	5.45%	0.61	0.52	NA	9.0%	5.9	54	1.08	0.77	1.29	0.21
8	20050101	$51,282,916.72	2.60%	0.22	0.29	NA	11.7%	8.8	56	-10.80	-4.76	1.15	0.12
9	20060101	$56,495,704.60	13.04%	0.84	1.28	2.00	15.5%	7.7	49	6.53	2.83	1.81	0.52
10	20070101	$54,841,525.33	9.69%	0.85	1.21	2.00	11.4%	4.6	61	-2.12	-1.01	1.43	0.33
11	20080101	$69,664,844.42	39.36%	1.81	1.16	NA	21.7%	3.6	69	22.76	16.72	2.83	1.10
12	20090101	$49,849,037.05	-0.30%	-0.02	0.03	-2.09	18.1%	10.0	59	-10.62	-6.69	1.05	0.04
13	20100101	$60,760,383.07	21.60%	1.43	1.09	NA	15.1%	5.6	56	9.18	6.36	2.13	0.82
14	20110101	$51,799,336.54	3.64%	0.31	0.31	NA	11.6%	6.6	53	-4.98	-2.83	1.24	0.17
15	20120101	$46,848,124.85	-6.32%	-0.46	-0.63	NA	13.8%	7.0	63	-6.10	-3.98	0.70	-0.20
16	20130101	$51,811,482.49	3.63%	0.37	0.42	1.99	9.8%	8.3	68	-6.74	-3.49	1.13	0.10
17	20140101	$63,341,285.47	26.70%	3.13	1.75	2.00	8.5%	6.3	69	16.65	8.76	2.15	0.81
18	20150101	$54,463,166.38	8.93%	0.89	0.78	2.00	10.0%	4.3	52	12.92	8.24	1.51	0.34
19	20160101	$45,211,438.00	-9.61%	-0.52	-0.64	NA	18.3%	10.6	70	-15.45	-8.61	0.61	-0.27
20	20170101	$55,729,379.48	11.50%	1.72	1.18	2.00	6.7%	3.5	63	2.40	1.11	1.52	0.37
21	20180101	$50,304,935.36	0.61%	0.04	0.11	1.94	13.9%	11.2	67	-9.38	-5.69	1.07	0.05
22	20190101	$54,278,272.39	8.56%	0.68	0.81	2.00	12.6%	3.9	51	19.24	14.95	1.48	0.34
23	20200101	$51,602,534.98	3.21%	0.16	0.26	NA	19.5%	8.3	72	-7.82	-7.80	1.16	0.11
24	20210101	$58,396,980.46	16.86%	1.47	0.97	NA	11.5%	4.4	54	26.66	21.59	2.03	0.64
25	20220101	$47,341,550.24	-5.38%	-0.30	-0.23	NA	17.7%	6.6	61	-4.75	-5.04	0.79	-0.16
26	20230101	$55,127,975.64	10.29%	1.24	0.85	2.01	8.3%	1.8	52	25.27	15.84	1.51	0.41
27	20240101	$68,591,296.08	37.21%	3.31	2.28	NA	11.3%	4.6	49	29.19	15.19	3.50	1.54

A three-year test 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	$102,772,861.99	27.22%	1.34	1.48	5.84	20.3%	5.4	139	9.70	25.80	2.58	1.21
2	19990101	$76,829,169.45	15.41%	0.85	0.87	1.27	18.2%	7.9	151	5.04	18.77	1.83	0.62
3	20000101	$56,172,511.24	3.97%	0.23	0.32	0.36	17.5%	15.3	162	0.81	4.16	1.21	0.16
4	20010101	$61,651,061.37	7.24%	0.37	0.47	0.86	19.3%	16.7	159	0.11	0.61	1.39	0.28
5	20020101	$63,015,763.69	8.02%	0.41	0.52	1.20	19.4%	9.8	151	1.67	9.21	1.46	0.34
6	20030101	$63,717,514.63	8.43%	0.55	0.60	4.18	15.3%	9.9	145	1.92	9.63	1.49	0.39
7	20040101	$64,543,368.44	8.91%	0.42	0.73	2.03	21.2%	8.6	140	2.44	8.55	1.50	0.39
8	20050101	$66,937,856.33	10.24%	0.48	0.85	1.56	21.2%	13.8	143	2.47	10.63	1.59	0.46
9	20060101	$96,112,305.22	24.38%	1.04	1.02	1.41	23.5%	8.2	150	5.49	18.67	2.43	1.01
10	20070101	$79,203,093.51	16.58%	0.68	0.72	0.75	24.5%	9.8	154	4.31	22.08	1.98	0.68
11	20080101	$84,329,236.76	19.05%	0.81	0.83	1.08	23.5%	19.2	150	2.23	9.64	2.24	0.81
12	20090101	$66,583,839.54	10.05%	0.47	0.61	0.85	21.5%	18.8	145	3.35	15.06	1.69	0.49
13	20100101	$59,654,814.45	6.07%	0.29	0.42	0.51	21.3%	21.9	148	2.39	9.61	1.41	0.29
14	20110101	$52,021,325.48	1.33%	0.09	0.17	0.20	14.1%	19.0	159	-0.24	-0.76	1.08	0.06
15	20120101	$61,976,313.61	7.43%	0.54	0.65	0.66	13.8%	28.0	181	-0.33	-0.87	1.37	0.28
16	20130101	$69,867,549.75	11.81%	0.84	0.78	1.44	14.1%	17.0	165	4.38	15.20	1.66	0.51
17	20140101	$60,721,094.43	6.70%	0.27	0.46	0.40	24.8%	10.6	167	3.28	14.70	1.45	0.33
18	20150101	$55,239,146.75	3.39%	0.13	0.32	0.27	27.1%	22.6	165	-0.88	-3.84	1.19	0.14
19	20160101	$62,136,371.80	7.52%	0.37	0.56	0.59	20.3%	22.8	170	0.27	1.06	1.47	0.33
20	20170101	$62,380,230.76	7.67%	0.40	0.57	0.87	19.0%	7.4	145	2.71	10.97	1.50	0.36
21	20180101	$52,867,155.95	1.88%	0.10	0.21	0.90	19.7%	18.2	161	0.72	3.56	1.14	0.10
22	20190101	$76,168,707.80	15.07%	0.76	1.01	1.25	19.7%	9.8	149	3.92	13.48	2.02	0.71
23	20200101	$71,250,604.14	12.55%	0.64	0.72	0.92	19.5%	9.8	156	3.31	18.47	1.81	0.59
24	20210101	$65,347,621.66	9.34%	0.55	0.63	1.53	17.0%	18.6	149	1.82	8.09	1.55	0.41
25	20220101	$82,511,640.89	18.22%	0.98	1.03	0.64	18.6%	19.8	149	2.99	13.50	2.20	0.92

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): 25 out of 25 periods** ended with a positive rate of return (**100%**).

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

4. Stability long/short

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 bullish scenarios often easier than betting on bearish scenarios. **Optimizing a strategy** for a bullish scenario, which is usually implied by the data used for optimization, can

lead to **problems** when markets enter **long-term bearish trends.** In such conditions, the strategy can generate **significant losses.**

To check if **the strategy** shows a tendency to **Long Bias** or (less often) **Short Bias, the distribution of historical buy and sell transactions** should be verified. 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.

ATR Ignition (1998-2024):

- **Total number of transactions: 1267**
- **Long trades: 677 (53.4%)**
- **Short trades: 590 (46.6%)**

The trade distribution is 53.4%/46.6%, 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 **the in-sample and out-of-sample data combined,** 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	14	26.4%	39	73.6%	53	195	60.2%	129	39.8%	2.01%	0.52%	0.15%	1.40
CC	10	16.1%	52	83.9%	62	205	63.3%	119	36.7%	7.87%	0.52%	0.83%	2.90
CFI	10	33.3%	20	66.7%	30	256	79.0%	68	21.0%	4.16%	0.47%	1.07%	4.41
CL	11	22.0%	39	78.0%	50	214	66.0%	110	34.0%	2.97%	0.50%	0.26%	1.68
CT	14	25.0%	42	75.0%	56	198	61.1%	126	38.9%	3.47%	0.52%	0.47%	2.21
DX	11	18.6%	48	81.4%	59	211	65.1%	113	34.9%	3.91%	0.51%	0.31%	1.76
EBL	8	14.3%	48	85.7%	56	220	67.9%	104	32.1%	3.59%	0.50%	0.09%	1.20
ES	11	28.9%	27	71.1%	38	237	73.1%	87	26.9%	2.77%	0.51%	0.44%	2.20
FDX	14	34.1%	27	65.9%	41	220	67.9%	104	32.1%	2.00%	0.49%	0.36%	2.11
FLG	13	24.5%	40	75.5%	53	204	63.0%	120	37.0%	1.48%	0.51%	-0.02%	0.95
GC	11	15.7%	59	84.3%	70	192	59.3%	132	40.7%	2.85%	0.50%	0.02%	1.06
HG	10	17.2%	48	82.8%	58	203	62.7%	121	37.3%	3.10%	0.49%	0.13%	1.31
HSI	17	30.4%	39	69.6%	56	201	62.0%	123	38.0%	1.94%	0.49%	0.25%	1.73
KC	12	24.0%	38	76.0%	50	213	65.7%	111	34.3%	2.39%	0.51%	0.19%	1.48
LCO	10	19.2%	42	80.8%	52	211	65.1%	113	34.9%	4.60%	0.51%	0.47%	2.16
LGO	12	22.2%	42	77.8%	54	205	63.3%	119	36.7%	4.91%	0.51%	0.70%	2.77
NG	13	25.0%	39	75.0%	52	208	64.2%	116	35.8%	2.11%	0.52%	0.14%	1.36
NIY	10	27.0%	27	73.0%	37	247	76.2%	77	23.8%	2.89%	0.50%	0.41%	2.12
NQ	11	29.7%	26	70.3%	37	254	78.4%	70	21.6%	2.58%	0.52%	0.40%	2.11
OJ	16	23.9%	51	76.1%	67	187	57.7%	137	42.3%	2.23%	0.53%	0.13%	1.31
PA	9	23.7%	29	76.3%	38	223	68.8%	101	31.2%	4.04%	0.43%	0.63%	2.94
S	12	20.0%	48	80.0%	60	206	63.6%	118	36.4%	2.57%	0.50%	0.12%	1.29
SB	15	33.3%	30	66.7%	45	207	63.9%	117	36.1%	2.42%	0.49%	0.48%	2.47
TY	14	29.2%	34	70.8%	48	209	64.5%	115	35.5%	2.50%	0.45%	0.41%	2.28
W	10	22.2%	35	77.8%	45	225	69.4%	99	30.6%	1.74%	0.45%	0.03%	1.10

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	23	20.2%	91	79.8%	114	173	53.4%	151	46.6%	2.50%	0.50%	0.11%	1.27
CC	17	15.2%	95	84.8%	112	167	51.5%	157	48.5%	4.66%	0.47%	0.31%	1.76
CFI	17	24.6%	52	75.4%	69	223	68.8%	101	31.2%	3.51%	0.52%	0.47%	2.21
CL	18	14.8%	104	85.2%	122	158	48.8%	166	51.2%	3.60%	0.50%	0.11%	1.25
CT	22	23.4%	72	76.6%	94	173	53.4%	151	46.6%	3.11%	0.50%	0.34%	1.90
DX	28	25.2%	83	74.8%	111	177	54.6%	147	45.4%	2.96%	0.49%	0.38%	2.02
EBL	19	17.9%	87	82.1%	106	175	54.0%	149	46.0%	3.29%	0.51%	0.17%	1.41
ES	24	26.7%	66	73.3%	90	190	58.6%	134	41.4%	2.00%	0.50%	0.16%	1.44
FDX	19	18.4%	84	81.6%	103	183	56.5%	141	43.5%	3.19%	0.50%	0.18%	1.45
FLG	23	20.0%	92	80.0%	115	157	48.5%	167	51.5%	2.32%	0.49%	0.07%	1.18
GC	25	20.5%	97	79.5%	122	152	46.9%	172	53.1%	1.67%	0.50%	-0.06%	0.86
HG	19	16.7%	95	83.3%	114	167	51.5%	157	48.5%	2.62%	0.48%	0.04%	1.09
HSI	27	23.1%	90	76.9%	117	163	50.3%	161	49.7%	2.11%	0.52%	0.08%	1.20
KC	17	16.3%	87	83.7%	104	180	55.6%	144	44.4%	2.48%	0.49%	-0.00%	1.00
LCO	22	20.4%	86	79.6%	108	176	54.3%	148	45.7%	2.98%	0.49%	0.22%	1.55
LGO	22	19.8%	89	80.2%	111	172	53.1%	152	46.9%	4.02%	0.51%	0.39%	1.95
NG	27	25.2%	80	74.8%	107	177	54.6%	147	45.4%	1.74%	0.49%	0.07%	1.20
NIY	17	17.5%	80	82.5%	97	205	63.3%	119	36.7%	2.48%	0.54%	-0.01%	0.98
NQ	19	17.9%	87	82.1%	106	173	53.4%	151	46.6%	2.86%	0.50%	0.10%	1.25
OJ	24	21.2%	89	78.8%	113	170	52.5%	154	47.5%	2.79%	0.52%	0.18%	1.44
PA	21	29.2%	51	70.8%	72	200	61.7%	124	38.3%	3.26%	0.49%	0.60%	2.72
S	23	22.3%	80	77.7%	103	166	51.2%	158	48.8%	2.47%	0.49%	0.17%	1.46
SB	21	23.3%	69	76.7%	90	177	54.6%	147	45.4%	3.15%	0.50%	0.35%	1.91
TY	21	19.4%	87	80.6%	108	171	52.8%	153	47.2%	2.53%	0.49%	0.09%	1.24
W	29	27.4%	77	72.6%	106	171	52.8%	153	47.2%	1.00%	0.50%	-0.09%	0.75

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 88%.**

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:

- **Drawdown in-sample** for optimized parameters was **26.7 %.**
- **In-sample and out-of-sample drawdown** for the optimized parameters was **26.8%.**
- **The highest in-sample drawdown** for the tested parameter range was **46.7%.**
- **The largest out-of-sample drawdown** for the tested parameter range was **30.9%.**
- **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:**

- **Distance of buy/sell order from last closing price:** 165% ATR;
- **ATR lengths:** 17 days;
- **Moving average:** 215 days;
- **Position size:** each position represents a risk of 0.5% of the capital value.

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 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.**
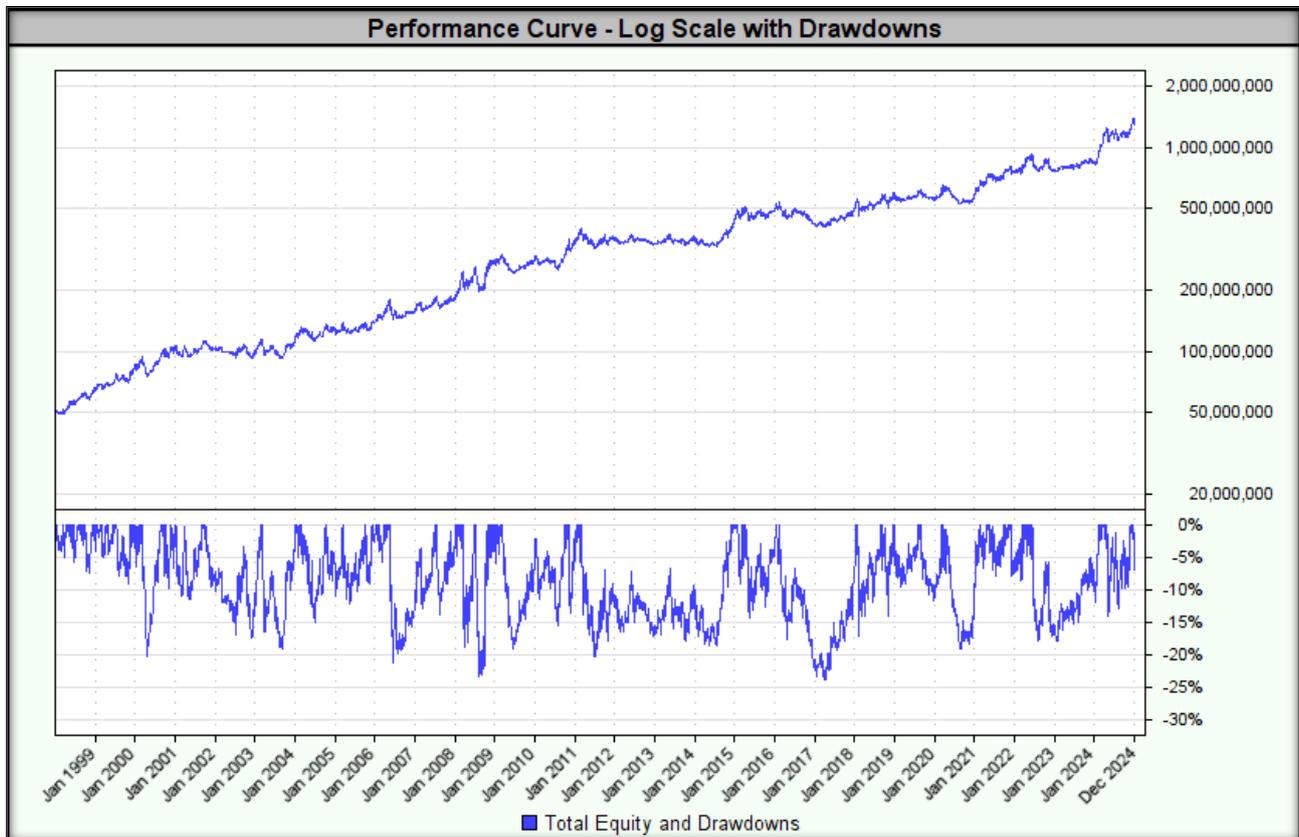
Before we move on to this step, **let us summarize the results on the in-sample data and on the combined in-sample and out-of-sample data.**

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%	12.3%	13.0%
MAR Ratio	0.51	0.55
RAR%	9.2%	10.9%
R-Cubed	0.25	0.26
Robust Sharpe Ratio	0.52	0.62
Max Drawdown	24.2%	23.7%
Wins	24.2%	23.8%
Losses	75.8%	76.2%
Average Win%	2.87%	3.00%
Average Loss %	0.50%	0.50%
Win/ Loss Ratio	5.80	5.98
Average Trade Duration (days)	106	108
Percent Profit Factor	1.85	1.87
SQN	0.78	0.85
Number of transactions	824	1211

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.

Monthly Return Distribution

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

LW - ATR Ignition v2 - R-Multiple™ Distribution

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

LW - ATR Ignition v2 - R-Multiple™ Profit Contribution

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

- **Distance of buy/sell order from last closing price:** 165% ATR;
- **ATR lengths:** 17 days;
- **Moving average:** 215 days;
- **Position size:** each position corresponds to a risk of 0.5% of the capital value;
- **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 profit and risk** after the optimization process and allows for answering 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 measure 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 the assessment of the strategy effectiveness according to the Walk-Forward measure are presented below. **Efficiency.**

Parameters **Walk-Forward Optimization (WFO):**

- **Objective function:** MAR;
- **Position size:** 0.5% of total capital;
- **Range of optimized parameters:**
  - **Distance of buy/sell order from last closing price:** range **120%-200% ATR (step: 5 pp.);**
  - **ATR lengths:** range **15-25 days (step: 1);**
  - **Moving average:** range **150-250 days (step: 10);**
- **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
1,117,562,464	12.18%	0.36	0.58	33.87%	62.36	1,373

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	33.5%	34.5%	10.8%	7.5%	3.10	4.62

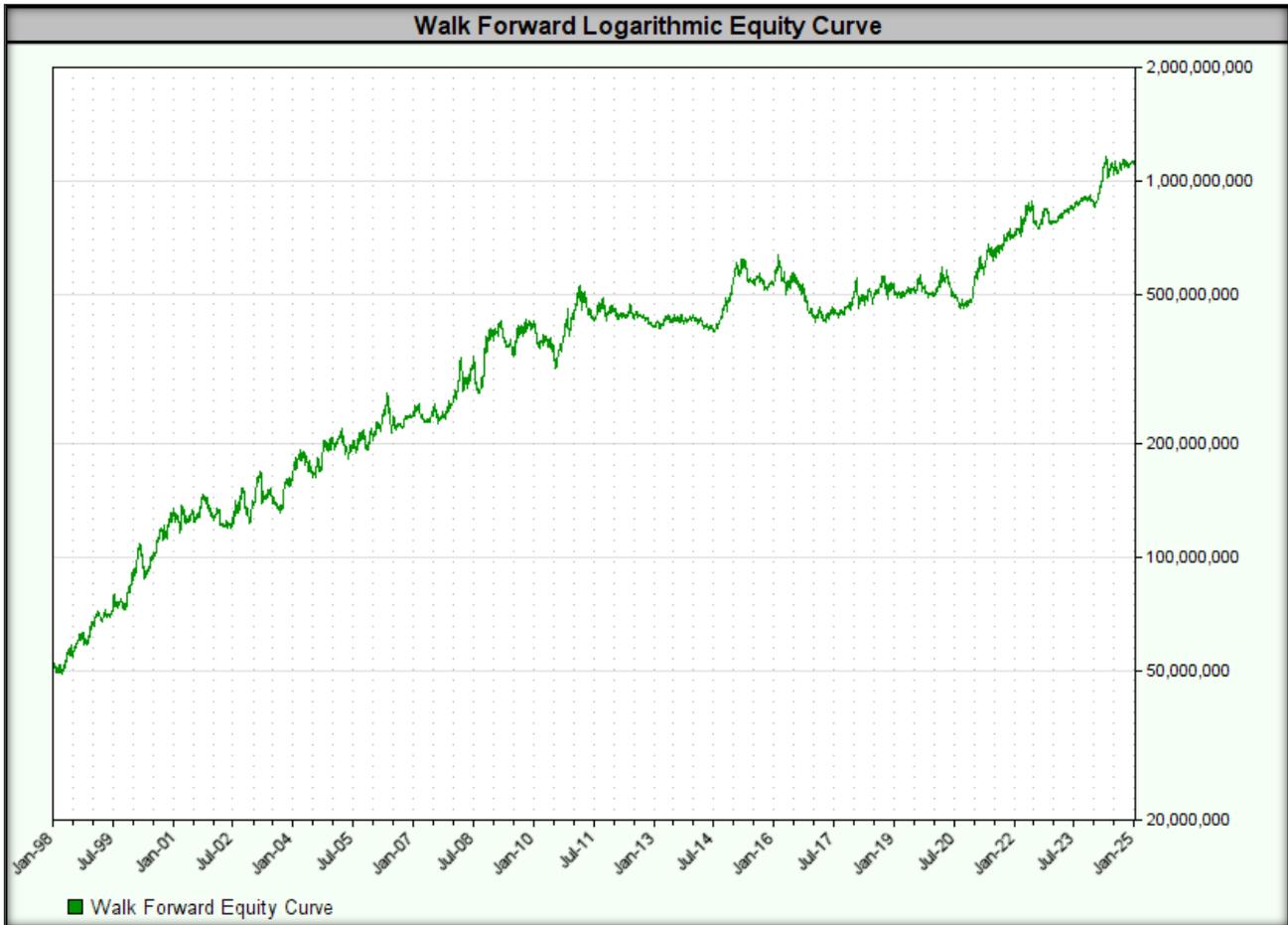|							
19981231	19991230	37.2%	36.8%	8.3%	8.6%	4.48	4.28
19991231	20001229	37.7%	42.7%	6.4%	19.2%	5.85	2.23
20010101	20011228	48.7%	-2.8%	19.7%	13.7%	2.47	- 0.20
20011231	20021227	27.8%	10.9%	18.9%	19.7%	1.47	0.55
20021230	20031229	18.1%	18.4%	16.9%	22.2%	1.07	0.83
20031230	20041228	19.0%	22.5%	17.8%	16.0%	1.07	1.40
20041229	20051228	22.4%	2.4%	17.8%	16.9%	1.26	0.14
20051229	20061228	13.1%	14.0%	11.6%	21.9%	1.13	0.64
20061229	20071228	13.9%	8.7%	19.3%	11.7%	0.72	0.74
20071231	20081226	15.6%	55.0%	18.9%	20.2%	0.82	2.72
20081229	20091225	38.1%	3.4%	22.3%	19.3%	1.71	0.18
20091228	20101227	29.6%	7.0%	22.3%	25.4%	1.32	0.28
20101228	20111227	19.7%	2.2%	15.8%	20.0%	1.25	0.11
20111228	20121226	11.7%	-9.2%	17.5%	12.6%	0.67	- 0.73
20121227	20131226	5.3%	6.8%	12.9%	5.0%	0.41	1.37
20131227	20141226	2.5%	22.9%	16.5%	9.4%	0.15	2.45
20141229	20151225	5.9%	-1.0%	11.7%	17.3%	0.50	- 0.06
20151228	20161223	20.3%	-17.8%	19.3%	31.0%	1.05	- 0.58
20161226	20171225	7.2%	11.0%	14.9%	9.1%	0.48	1.21
20171226	20181225	7.0%	9.5%	22.9%	17.2%	0.30	0.55
20181226	20191225	11.7%	-6.4%	23.2%	13.6%	0.50	- 0.47
20191226	20201224	13.5%	1.9%	16.0%	22.4%	0.84	0.08
20201225	20211224	3.4%	40.0%	11.7%	10.1%	0.29	3.97
20211227	20221223	18.8%	9.4%	17.0%	16.0%	1.10	0.59
20221226	20231222	12.7%	12.4%	10.7%	4.7%	1.18	2.62
20231225	20241223	12.5%	28.4%	8.0%	12.1%	1.56	2.35
Mean		**18.8%**	**13.5%**	**15.9%**	**15.7%**	**0.81**	**0.43**
		WFE:	**71.8%**	**WFE:**	**98.5%**	**WFE:**	**53.8%**

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

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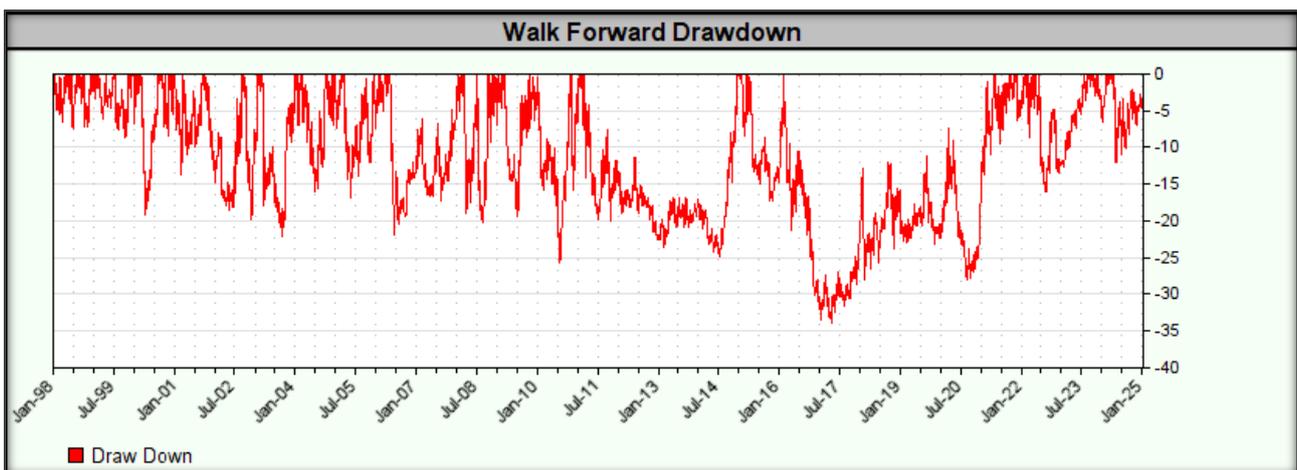
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
581,507,012	9.89%	0.38	0.47	26.10%	34.23	1,383

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	36.8%	32.8%	10.0%	8.4%	3.70	3.92

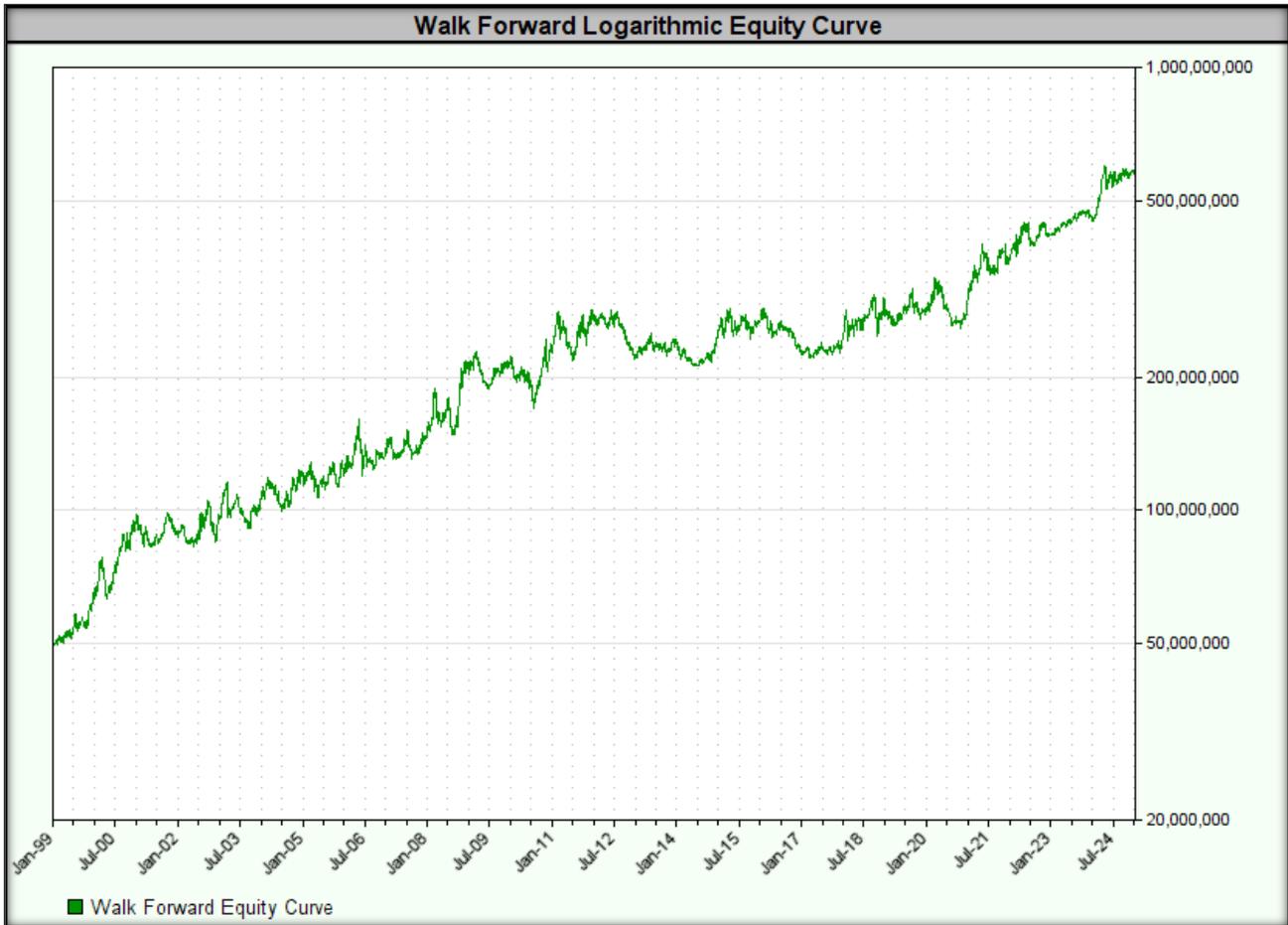|							
19991231	20001229	36.5%	43.5%	8.4%	19.1%	4.33	2.27
20010101	20011228	31.5%	-7.2%	12.8%	15.8%	2.47	- 0.46
20011231	20021227	32.4%	10.7%	19.7%	19.0%	1.64	0.56
20021230	20031229	23.6%	6.9%	18.7%	21.3%	1.26	0.33
20031230	20041228	20.4%	16.8%	19.0%	16.4%	1.07	1.02
20041229	20051228	19.9%	0.6%	17.8%	16.7%	1.12	0.03
20051229	20061228	17.0%	10.7%	17.9%	25.9%	0.95	0.41
20061229	20071228	12.5%	10.0%	19.3%	14.1%	0.65	0.71
20071231	20081226	13.8%	45.2%	18.6%	21.1%	0.74	2.14
20081229	20091225	24.0%	-0.1%	19.8%	17.6%	1.21	- 0.01
20091228	20101227	29.4%	9.5%	22.6%	24.0%	1.30	0.40
20101228	20111227	22.2%	15.0%	21.3%	22.3%	1.04	0.67
20111228	20121226	24.7%	-18.1%	23.3%	21.9%	1.06	- 0.83
20121227	20131226	6.8%	9.4%	17.4%	11.3%	0.39	0.84
20131227	20141226	5.9%	2.3%	14.8%	12.7%	0.40	0.18
20141229	20151225	8.5%	7.0%	19.2%	14.5%	0.44	0.48
20151228	20161223	7.8%	-14.4%	14.2%	20.5%	0.55	- 0.70
20161226	20171225	9.6%	6.3%	22.8%	6.0%	0.42	1.05
20171226	20181225	15.0%	24.6%	27.1%	19.3%	0.55	1.28
20181226	20191225	10.4%	-6.8%	24.7%	14.7%	0.42	- 0.46
20191226	20201224	5.9%	2.7%	21.3%	22.8%	0.28	0.12
20201225	20211224	12.2%	26.9%	21.6%	14.5%	0.57	1.85
20211227	20221223	8.1%	14.7%	11.7%	11.6%	0.69	1.26
20221226	20231222	12.0%	9.3%	11.8%	4.0%	1.02	2.34
20231225	20241223	12.1%	27.3%	10.7%	11.5%	1.13	2.36
Mean		**17.6%**	**11.0%**	**17.9%**	**16.4%**	**0.65**	**0.42**
		WFE:	**62.2%**	**WFE:**	**91.6%**	**WFE:**	**65.1%**

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

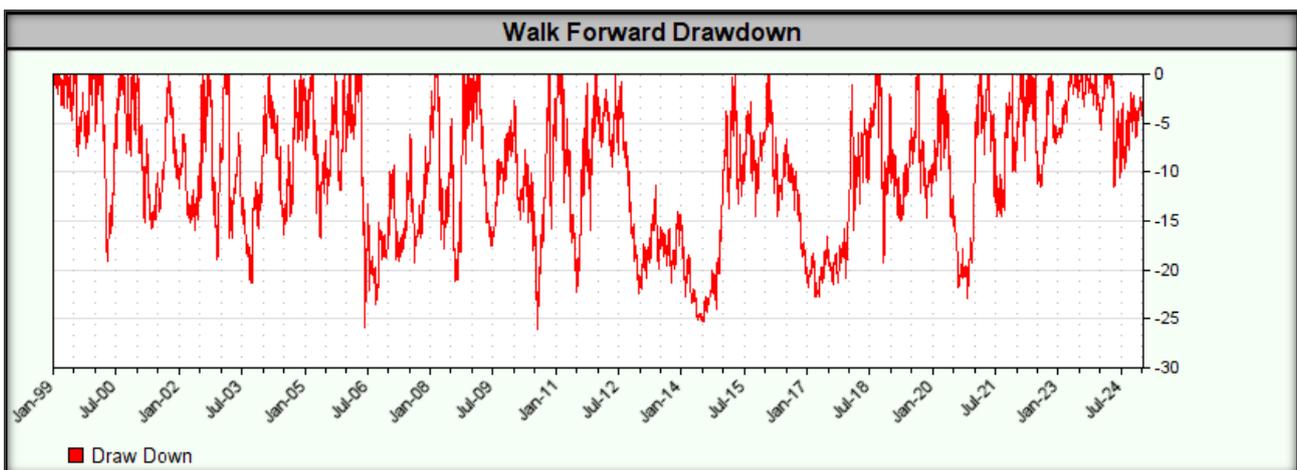Below are **the results of Walk-Forward Analysis (WFA) for 1825/365 day combinations.**

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
592,853,813	10.38%	0.34	0.47	30.57%	31.18	1,475

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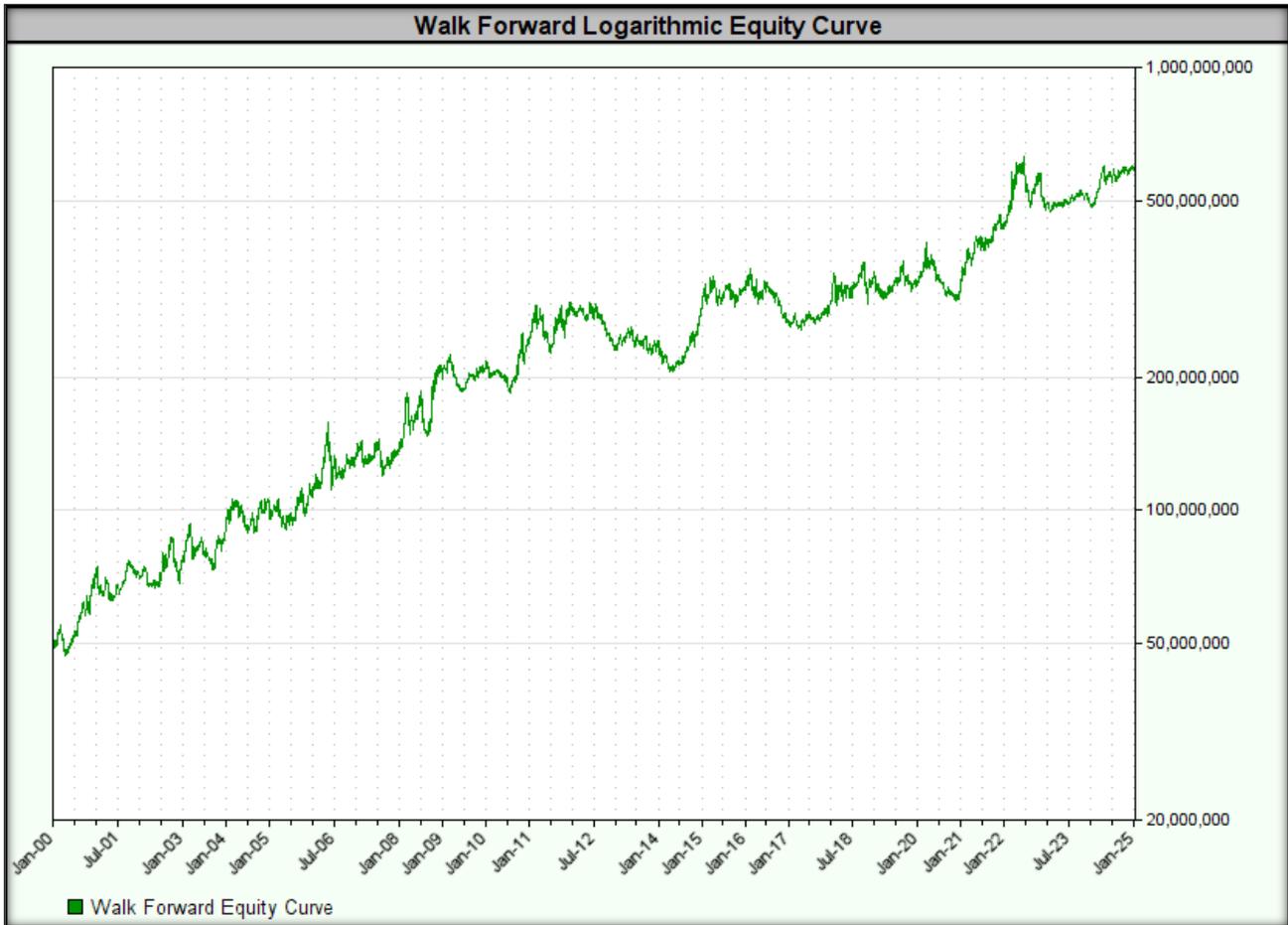
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

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

Optimization:	1825	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19991231	20001229	38.0%	44.5%	10.2%	14.7%	3.73	3.03

20010101	20011228	29.2%	-2.2%	13.1%	16.1%	2.23	- 0.13
20011231	20021227	38.1%	12.0%	21.0%	21.4%	1.81	0.56
20021230	20031229	27.6%	14.8%	19.7%	21.2%	1.40	0.70
20031230	20041228	24.3%	16.0%	21.0%	16.4%	1.15	0.98
20041229	20051228	20.6%	4.1%	19.0%	14.6%	1.09	0.28
20051229	20061228	17.7%	19.5%	19.1%	29.2%	0.92	0.67
20061229	20071228	17.1%	5.1%	24.9%	17.7%	0.69	0.29
20071231	20081226	13.0%	54.7%	19.3%	20.4%	0.67	2.68
20081229	20091225	20.4%	-0.8%	19.6%	17.5%	1.04	- 0.05
20091228	20101227	18.7%	16.0%	19.8%	15.0%	0.94	1.06
20101228	20111227	23.6%	16.4%	21.2%	21.5%	1.11	0.77
20111228	20121226	22.1%	-17.7%	21.6%	21.5%	1.02	- 0.82
20121227	20131226	14.3%	3.6%	21.7%	12.7%	0.66	0.28
20131227	20141226	6.1%	16.1%	17.4%	14.8%	0.35	1.09
20141229	20151225	11.6%	12.4%	19.0%	14.4%	0.61	0.86
20151228	20161223	9.2%	-15.3%	19.2%	24.3%	0.48	- 0.63
20161226	20171225	2.6%	10.7%	15.0%	7.8%	0.18	1.37
20171226	20181225	15.2%	16.4%	27.3%	19.0%	0.56	0.87
20181226	20191225	14.5%	-5.5%	24.1%	14.7%	0.60	- 0.38
20191226	20201224	6.3%	-2.3%	24.7%	26.0%	0.25	- 0.09
20201225	20211224	4.9%	37.1%	16.8%	8.4%	0.29	4.41
20211227	20221223	16.4%	13.3%	21.6%	24.5%	0.76	0.54
20221226	20231222	8.5%	0.0%	11.7%	6.9%	0.73	- 0.01
20231225	20241223	11.7%	21.0%	11.8%	9.1%	0.99	2.31
Mean		**17.3%**	**11.6%**	**19.2%**	**17.2%**	**0.63**	**0.40**
		WFE:	**67.2%**	**WFE:**	**89.6%**	**WFE:**	**62.9%**

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

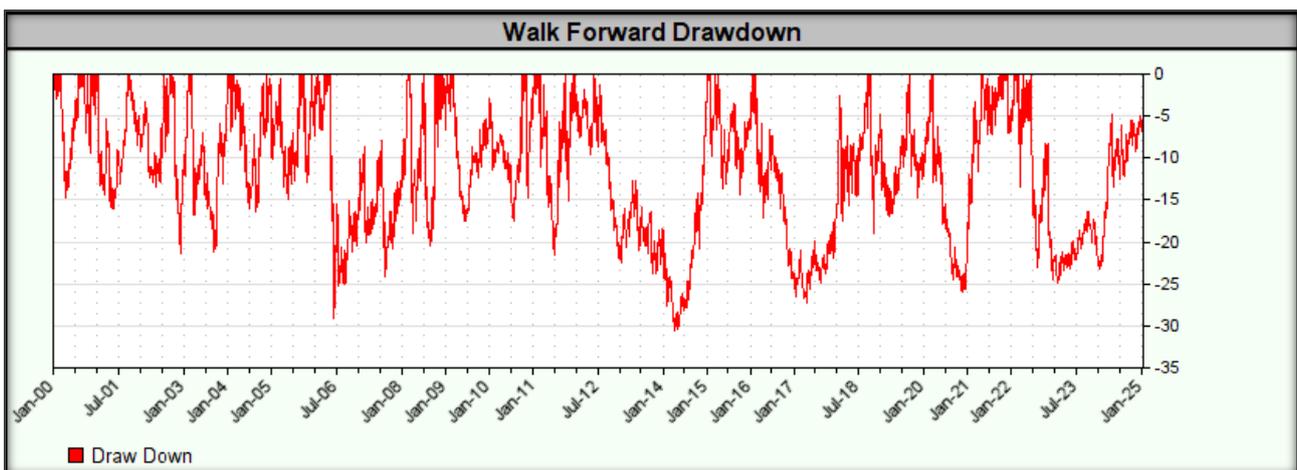Below are **the results of Walk-Forward Analysis (WFA) for the 1644/548 day combination.**

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
650,943,047	10.58%	0.34	0.46	30.84%	33.94	1,519

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

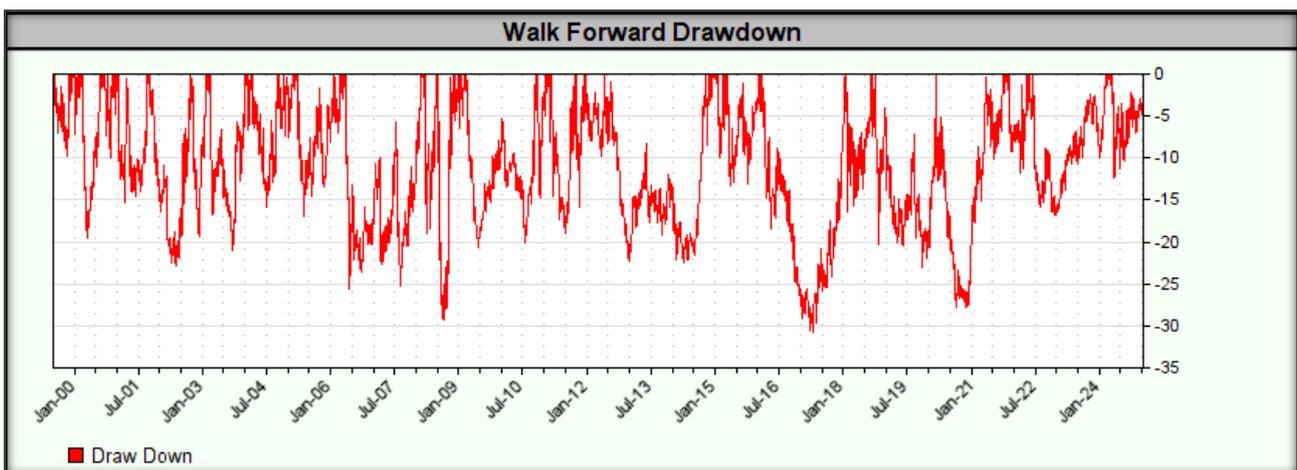*Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.*

Walk Forward Drawdown

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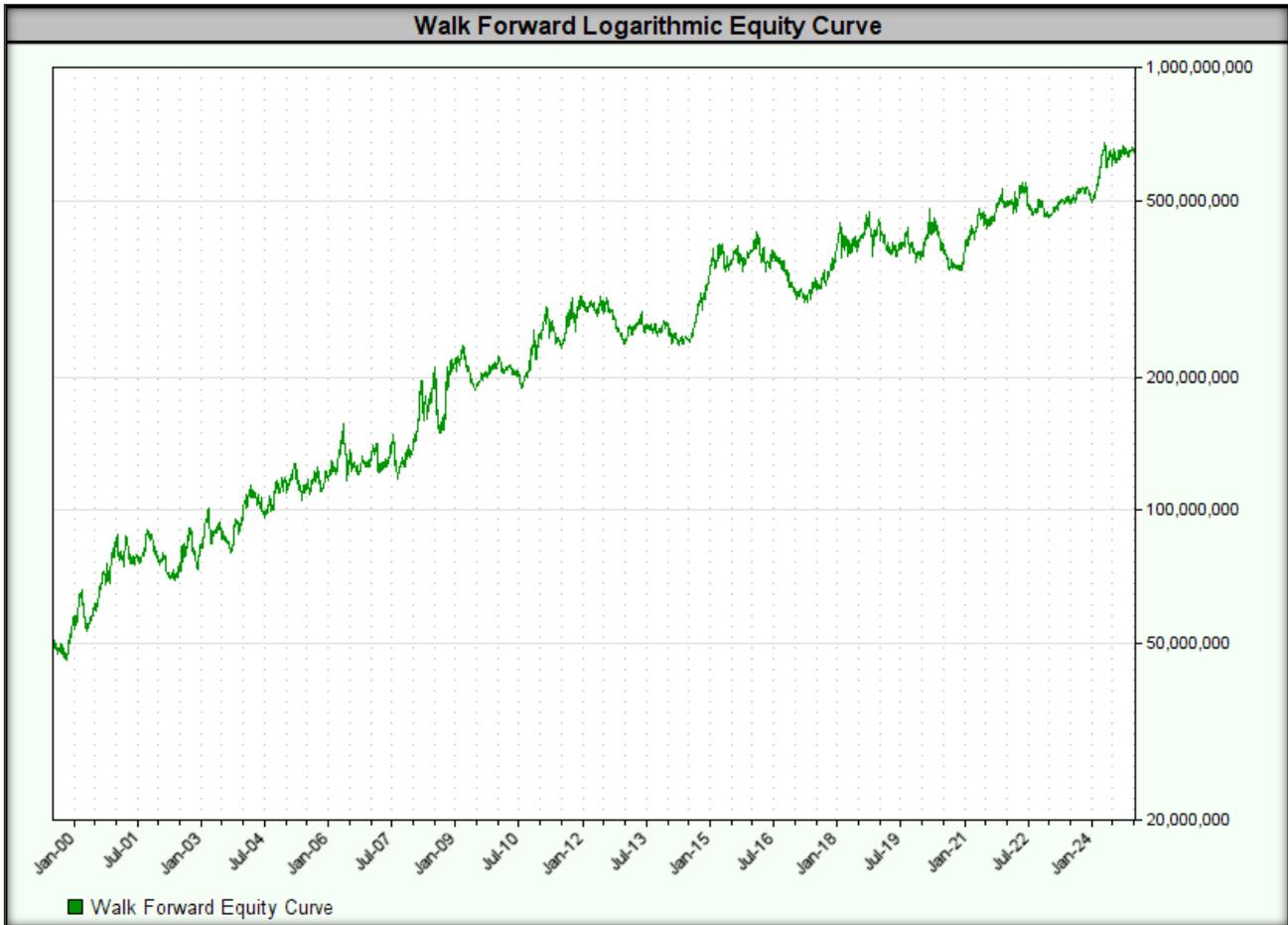
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1644	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
19990705	20001229	34.6%	42.6%	9.4%	19.6%	3.69	2.17

20010101	20020702	47.3%	-7.8%	20.6%	22.9%	2.30	- 0.34
20020703	20040101	28.4%	21.7%	19.7%	21.0%	1.44	1.03
20040102	20050701	23.6%	9.3%	21.7%	17.0%	1.09	0.54
20050704	20070101	17.2%	8.6%	18.4%	25.6%	0.93	0.33
20070102	20080702	17.7%	38.1%	26.3%	20.9%	0.67	1.83
20080703	20100101	20.5%	1.3%	20.0%	29.3%	1.03	0.05
20100104	20110701	22.0%	5.7%	19.2%	18.7%	1.14	0.30
20110704	20130101	18.5%	1.5%	22.1%	22.3%	0.84	0.07
20130102	20140703	13.3%	0.8%	19.0%	15.6%	0.70	0.05
20140704	20160101	5.2%	36.3%	19.1%	13.2%	0.27	2.74
20160104	20170703	13.8%	-11.7%	19.4%	30.8%	0.71	- 0.38
20170704	20190102	10.1%	25.3%	27.3%	20.3%	0.37	1.25
20190103	20200703	21.2%	-9.5%	27.2%	20.2%	0.78	- 0.47
20200706	20211231	4.5%	17.6%	18.6%	10.2%	0.24	1.73
20220103	20230704	12.6%	1.9%	15.3%	16.9%	0.82	0.11
20230705	20250102	11.8%	18.5%	11.9%	12.3%	0.99	1.51
Mean		**19.0%**	**11.8%**	**19.7%**	**19.8%**	**0.69**	**0.38**
		WFE:	**62.1%**	**WFE:**	**100.4%**	**WFE:**	**54.9%**

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
470,899,831	9.48%	0.29	0.42	32.24%	47.05	1,486

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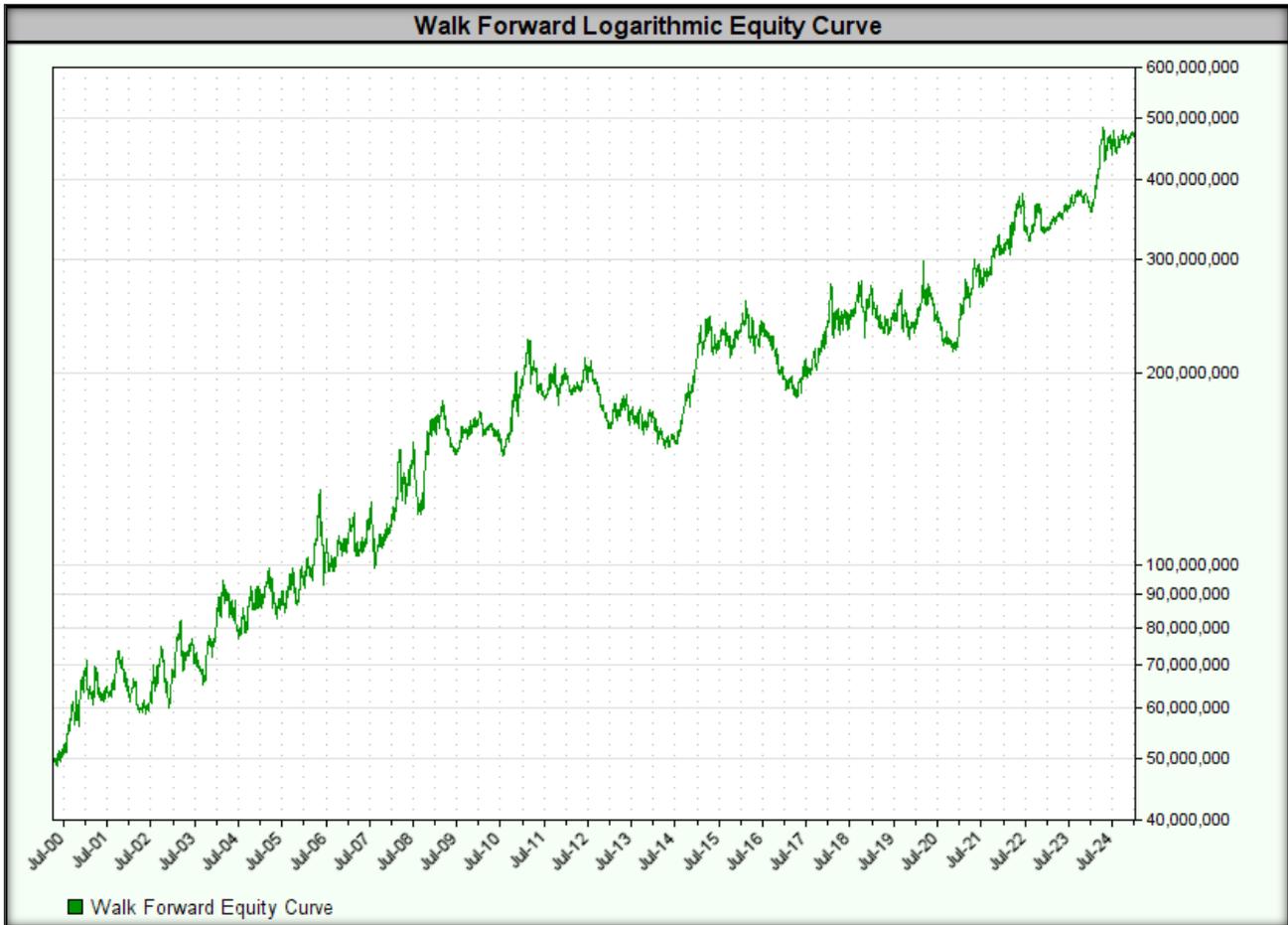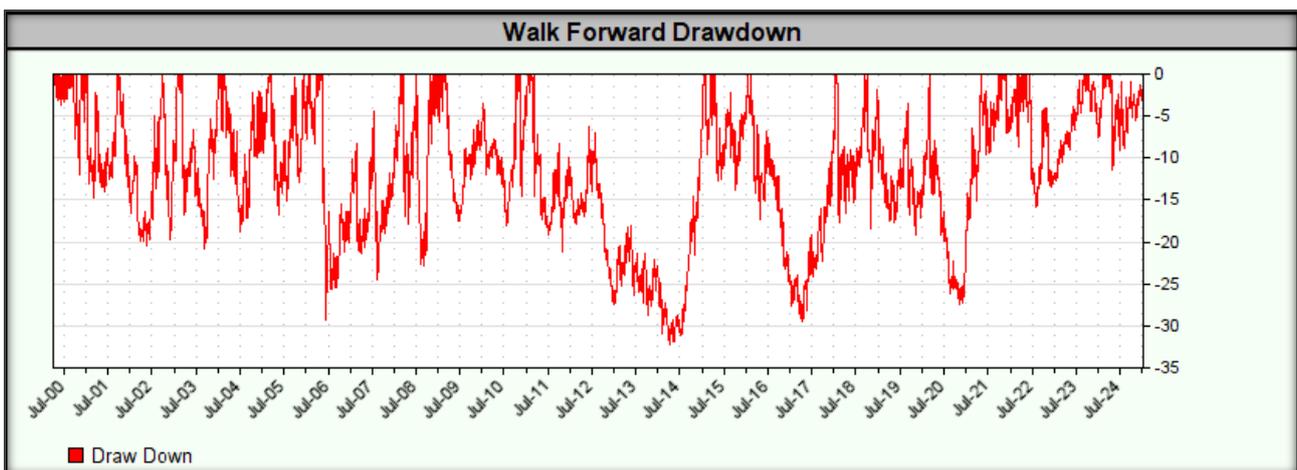
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	1918	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20000403	20011001	39.4%	29.5%	12.4%	14.8%	3.18	1.99

20011002	20030402	39.7%	-2.5%	19.8%	20.5%	2.01	- 0.12
20030403	20041001	26.8%	15.5%	19.7%	18.8%	1.36	0.83
20041004	20060331	22.3%	12.2%	20.8%	16.7%	1.07	0.73
20060403	20071002	19.7%	2.3%	19.1%	29.2%	1.03	0.08
20071003	20090402	13.0%	32.8%	20.4%	22.8%	0.64	1.44
20090403	20101001	18.7%	-1.0%	19.6%	15.0%	0.95	- 0.07
20101004	20120402	17.8%	12.3%	19.2%	21.1%	0.93	0.58
20120403	20131002	21.1%	-10.4%	22.1%	22.7%	0.96	- 0.46
20131003	20150403	10.5%	26.5%	19.0%	13.0%	0.55	2.04
20150406	20160930	13.9%	-2.9%	19.1%	17.3%	0.73	- 0.17
20161003	20180403	10.9%	3.5%	19.4%	18.0%	0.56	0.20
20180404	20191003	12.8%	3.7%	27.3%	18.5%	0.47	0.20
20191004	20210402	14.8%	3.4%	24.3%	27.5%	0.61	0.12
20210405	20221003	7.5%	23.3%	16.8%	15.9%	0.45	1.47
20221004	20240403	12.4%	18.1%	13.9%	9.8%	0.89	1.83
20240404	20250110	14.2%	3.7%	11.2%	11.5%	1.27	0.32
Mean		**18.6%**	**10.0%**	**19.1%**	**18.4%**	**0.68**	**0.34**
		WFE:	**53.9%**	**WFE:**	**96.7%**	**WFE:**	**50.3%**

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
276,535,586	7.38%	0.18	0.33	40.38%	59.76	1,427

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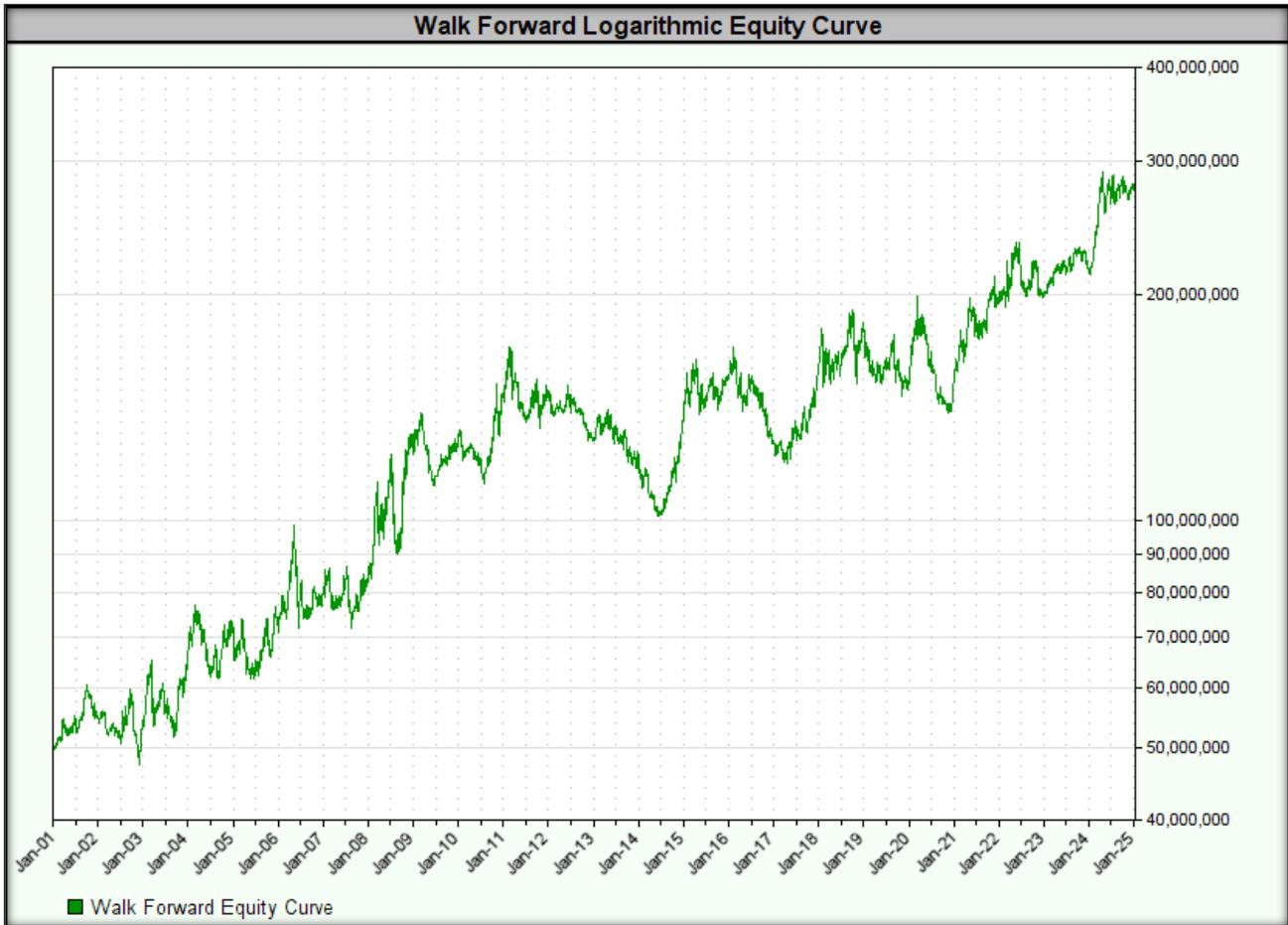
Historical or simulated results do not guarantee that similar outcomes will be achieved in the future.

Optimization:	2192	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20010101	20020702	28.2%	1.9%	12.8%	15.1%	2.21	0.13

20020703	20040101	33.1%	19.5%	21.0%	20.8%	1.58	0.94
20040102	20050701	28.9%	-3.4%	21.6%	20.4%	1.34	- 0.17
20050704	20070101	19.8%	16.2%	20.8%	27.1%	0.95	0.60
20070102	20080702	16.4%	33.1%	25.1%	17.6%	0.65	1.88
20080703	20100101	19.0%	2.8%	19.9%	26.2%	0.96	0.11
20100104	20110701	16.6%	4.3%	19.6%	20.0%	0.85	0.22
20110704	20130101	17.7%	-4.0%	19.2%	17.2%	0.92	- 0.23
20130102	20140703	14.3%	-13.7%	22.1%	27.7%	0.65	- 0.49
20140704	20160101	8.1%	31.5%	18.4%	15.4%	0.44	2.04
20160104	20170703	12.0%	-11.3%	19.1%	30.1%	0.63	- 0.38
20170704	20190102	8.6%	25.3%	27.3%	20.3%	0.32	1.25
20190103	20200703	13.9%	-8.1%	27.3%	20.0%	0.51	- 0.41
20200706	20211231	12.5%	14.7%	24.3%	13.4%	0.52	1.10
20220103	20230704	9.2%	7.2%	16.8%	15.5%	0.55	0.46
20230705	20250102	11.4%	17.4%	13.9%	12.1%	0.82	1.44
Mean		**16.9%**	**8.3%**	**20.6%**	**19.9%**	**0.62**	**0.28**
		WFE:	**49.4%**	**WFE:**	**96.8%**	**WFE:**	**44.9%**

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 60%-70%,** which indicates decent performance of the strategy in real-world conditions. **One of the six tests had WFE below 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.

Apart from the tests **for the 2192/548 day combination,** the results are very close to each other, which is good news.

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). Therefore, in the next period we use the following parameters:

- **Distance of buy/sell order from last closing price:** 190% ATR;
- **ATR lengths:** 16 days;
- **Moving average:** 210 days.

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%	12.2%	13.0%
MAR Ratio	0.36	0.55

| Max Drawdown | 33.9% | 23.7% |

WFA results are similar to the optimized ones, although weaker, mainly at the maximum drawdown level, which with a similar rate of return also means a decrease in MAR. This should be a signal for us that in real conditions the strategy results may differ from the optimized results.

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 previously established rules and formulas.

The most important element of **strategy implementation** is **the consistent enforcement of all signals, without exceptions. How 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.