Donchian Breakout v.1

Investment Strategy Testing Summary

Donchian Breakout Strategy is a classic **trend-following technique** that is based on identifying a price breakout outside the range defined by the Donchian Channel. This breakout can signal **the beginning of a new trend or a continuation of an existing price movement.** The strategy involves opening **a long position** when the price exceeds **the upper boundary of the channel,** and **a short position** when the price falls **below the lower boundary of the channel.**

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

- **Item size:** the position corresponds to a risk of 0.5% of the capital value;
- **CAGR:** 17.7%;
- **MAR:** 0.55;
- **Maximum drawdown:** 32.1%.

[WFA analysis]**showed** that in the next period (2025) **the optimal parameters** for the strategy are:

- **Donchian Canal:** 150 days;
- **Stop loss order:** located 2.15 x ATR(40) from the position opening point;
- **Item size:** the position corresponds to a risk of 0.5% of the capital value.

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:

- **Large drawdown during the period of strong declines on the stock market (COVID) and during the 2008-2009 crisis,** which means susceptibility to sudden market changes.
- **The drawdown may last up to several dozen months,** which may cause great discomfort in using this strategy and growing concerns about its effectiveness.

Despite these limitations, the Donchian Breakout v.1 strategy **can be an effective tool for investors who prefer trend following strategies,** as it remains 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 Donchian Breakout strategy is based on the premise that key price moves occur when an asset's price **breaks through specific support or resistance levels** that are marked by **the Donchian Channel.**

The idea for the strategy comes from the observation that:

- **A breakout above the upper boundary of the Donchian channel** may signal **the beginning of a new uptrend.**
- **A breakout below the lower boundary of the Donchian channel** may suggest **a continuation or initiation of a downtrend.**

The strategy has **a positive expected value (Edge)** because **historically documented price action** indicates that **strong moves often follow channel breakouts.** Using this strategy allows you **to take advantage of large market moves,** which can give you an edge over the market.

Characteristics of the strategy and its strengths and weaknesses:

- **Trend Following** – the strategy works best in strong trends, allowing you to make significant profits from large price movements.
- **Simplicity** – the rules are clear and easy to implement, which minimizes the risk of errors in execution.
- **Capturing Big Trends** – Following the market systematically allows you to participate in long-term trends.
- **Poor performance in consolidations** – the strategy may generate losses in sideways markets where prices oscillate within a limited range and breakouts are false.
- **Potential Delays** – Because the strategy relies on price closing above or below the channel, market entries may be delayed, meaning you miss part of the price movement.
- **Sensitivity to false breakouts** – not all breakouts lead to strong trend movements, which may result in entering losing positions.

Donchian 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 **Donchian Breakout strategy** on daily data:

1. **Donchian Channel:**
    *   **Specify the time period** for the Donchian channel (e.g. **20 days)**.
    *   **Calculate the upper boundary of** the Donchian channel as **the highest price in the last 20 days.**
    *   **Calculate the lower boundary of** the Donchian channel as **the lowest price of the last 20 days.**
2. **Check buy signal (long):**
    *   **Entry Conditions:** Set **a buy stop order one tick above the upper boundary of** the Donchian Channel.
    *   **Stop Loss Order:** Set a **stop loss order X ATR(40) values away from the position opening position.**
    *   **Hold Conditions:** Stay in a long position until the price **triggers a stop loss order** or **falls one tick below the lower border of** the Donchian Channel.
3. **Check sell signal (short):**
    *   **Entry Conditions:** Set **a sell stop order one tick below the lower border** of the Donchian Channel.
    *   **Stop Loss Order:** Set a **stop loss order X ATR(40) values away from the position opening position.**
    *   **Hold Conditions:** Stay in the short position until the price **triggers a stop loss order** or **rises one tick above the upper border of** the Donchian Channel.
4. **Close previous position** – before opening a new position (long or short), **close the previous opposite position.**
5. **Monitor signals every day**
    *   **Each day,** calculate **the upper and lower boundaries of the Donchian Channel.**
    *   Check **entry and exit conditions** to decide whether to open or close 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 tests are carried out assuming that the risk of one position is **1.0% of the total capital,** with **the stop loss order** located at **X ATR value (40 days) from the position opening point.**

Step 3: Conduct a preliminary test of the investment strategy

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

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

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

The first transaction was made on a **wheat futures contract.** In mid-**2018,** the system generated **a buy signal** – the price rose above **the upper boundary of the Donchian channel,** designated as **the highest price in the last 100 days. The rectangle on the left side of the chart** indicates the day **of opening a long position.**

On the chart:

- **The green solid line** represents **the lower and upper boundaries of the Donchian channel.**
- **Red dots** mark **the stop loss order level, located 2 x ATR(40) away from the position opening point.**

The system operated as intended and correctly generated the input signal.
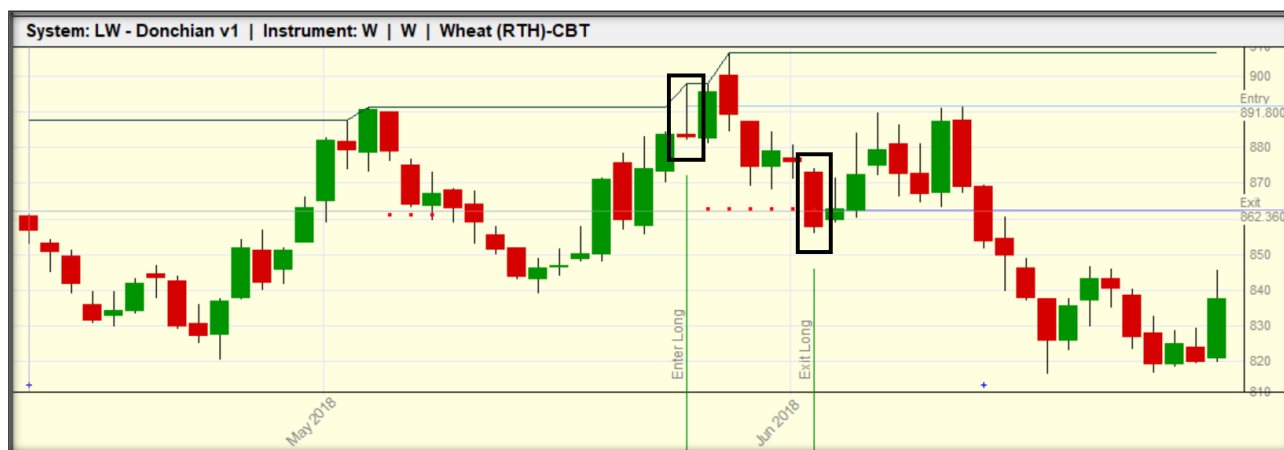
In early **June 2018,** the price fell to the **stop loss level,** which activated the closing of the long position. **The rectangle on the right side of the chart** indicates **the day the position was closed.**

The second transaction was made on a **gold futures contract.** In mid-**2018,** the system generated **a sell signal** - the price fell below **the lower the Donchian channel boundary,** defined as **the lowest price in the last 100 days. The rectangle on the left side of the chart** indicates the day **the short position was opened,** while **the red dots** indicate **the stop loss order level.**

In early **December 2018,** the price of gold rose to the **upper level the Donchian channel boundary,** which activated the close of the short position. **The rectangle on the right side of the chart** indicates **the day the position was closed.** Unlike the previous example, **the above position was closed at the upper boundary of the Donchian channel,** and not at the **stop loss order.** This is because **the stop loss does not follow the position,** unlike **the Donchian channel.**

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:

- **Upper/Lower Donchian Channel: 100 Days** – This means that the breakout levels are determined based on the highest and lowest price over the last **100 days.**
- **Stop loss order:** located 2 x ATR(40) away from the position opening point.
- **Way of Opening a Position: Enter-On-Stop:**
    - **Buy stop order** placed **1 tick above** the upper border of the Donchian channel (for a long position).
    - **Sell stop order** placed **1 tick below** the lower border of the Donchian channel (for a short position).
- **Position size:** each position represents **a risk of 1% of the capital value.**

The test result is shown below.

Performance Curve - Log Scale with Drawdowns
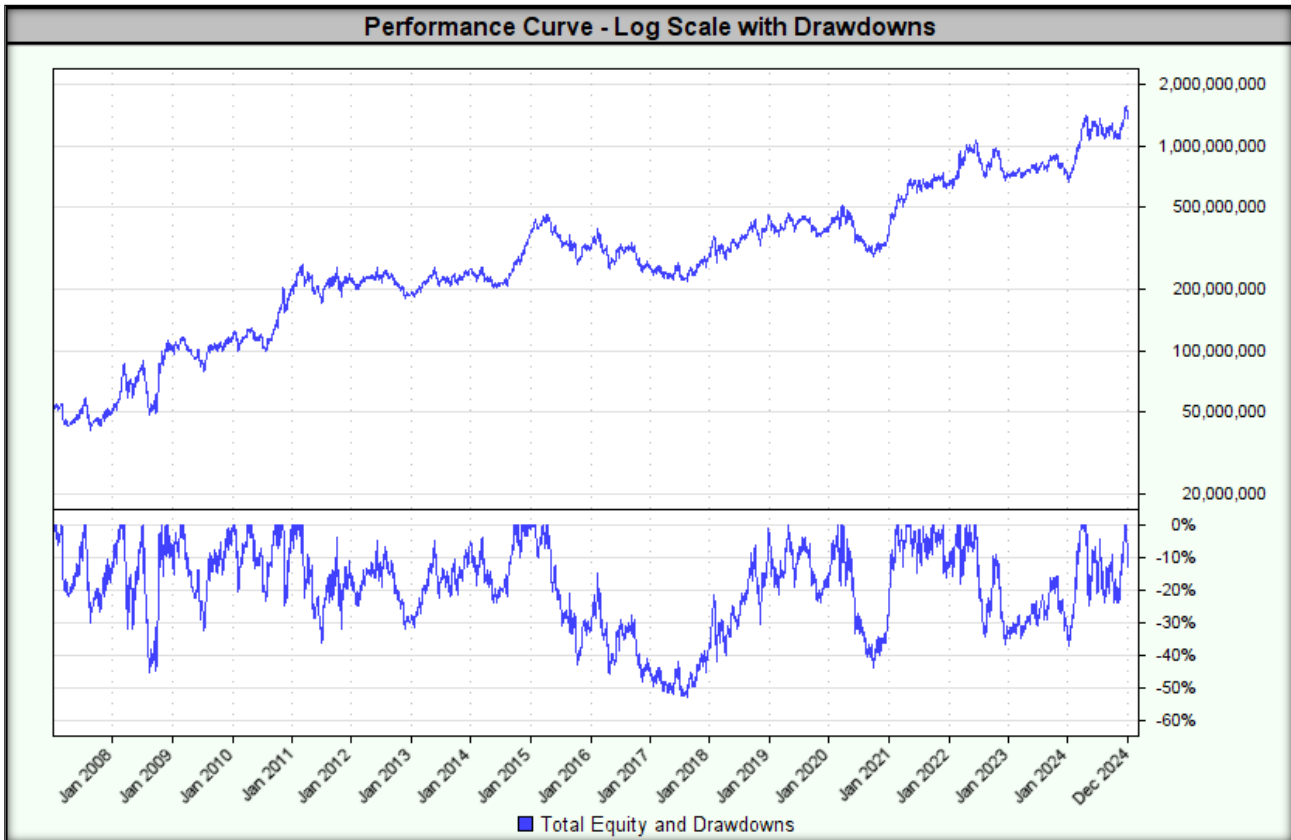
Indicators/Measures	Donchian Breakout
CAGR%	20.5%
MAR Ratio	0.39
RAR%	16.0%
R-Cubed	0.16
Robust Sharpe Ratio	0.42
Max Drawdown	52.9%
Wins	21.1%
Losses	78.9%
Average Win%	6.25%
Average Loss%	1.04%
Win/Loss Ratio	6.00
Average Trade Duration (days)	110
Percent Profit Factor	1.61
SQN	0.74
Number of transactions	1099

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. I cannot** emphasize enough that for **a strategy to work** in real conditions, it must also work on **suboptimal parameters** and in **suboptimal conditions.** In a word – **it must be stable** to changing market conditions.

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

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

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

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

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

The Donchian 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:

- **Donchian Channel:** range **100-150 days (step: 2);**
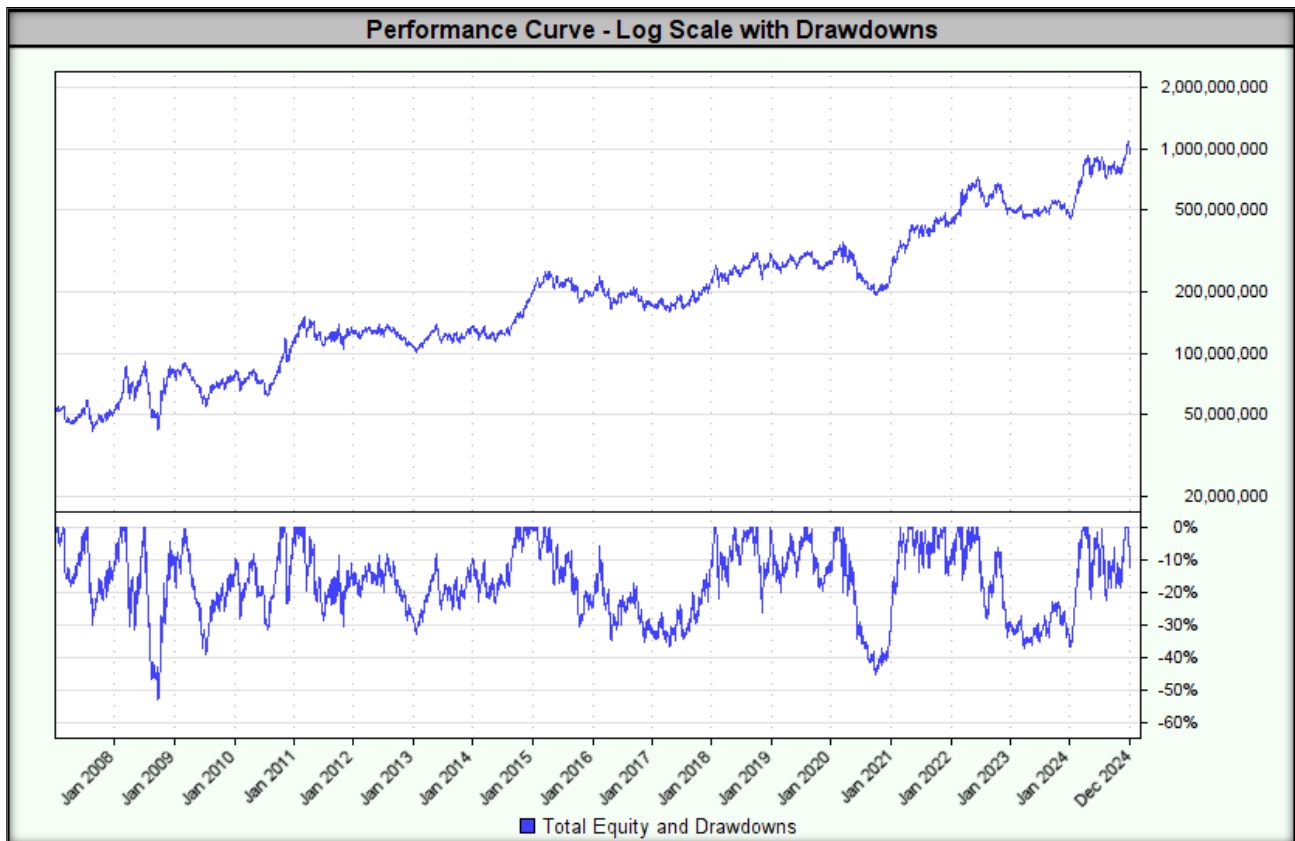- **Stop loss order:** range **1.50-2.30 x ATR (step: 0.05).**

The lowest MAR value of 0.34 was achieved for the following parameters:

- **Donchian Canal:** 128;
- **Stop loss order:** 2.25 x ATR(40).

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF
254	128	2.25	$989,809,319.15	18.04%	0.34	0.66	0.54	53.0%	42.5	875	0.17	15.14	1.64
253	128	2.20	$1,032,694,337.97	18.32%	0.34	0.66	0.54	53.5%	42.5	887	0.17	15.44	1.64
375	144	1.50	$1,703,853,308.03	21.66%	0.35	0.67	0.56	62.3%	44.1	1000	0.18	19.88	1.71
288	132	2.25	$1,077,824,338.47	18.60%	0.35	0.68	0.54	52.9%	42.0	850	0.19	15.97	1.68
271	130	2.25	$1,071,484,644.82	18.56%	0.35	0.67	0.55	52.8%	41.8	860	0.20	15.94	1.66
342	140	1.55	$1,853,930,595.80	22.23%	0.35	0.68	0.57	63.1%	41.4	1001	0.19	19.95	1.72
255	128	2.30	$997,929,126.53	18.10%	0.35	0.67	0.57	51.3%	42.7	863	0.17	15.07	1.65
392	146	1.50	$1,851,499,516.14	22.22%	0.35	0.68	0.57	62.9%	42.5	981	0.20	20.68	1.73
341	140	1.50	$1,956,592,316.74	22.60%	0.35	0.68	0.56	63.9%	42.7	1016	0.19	20.53	1.72
270	130	2.20	$1,107,424,982.15	18.78%	0.35	0.67	0.54	53.1%	41.6	874	0.18	16.02	1.66
409	148	1.50	$1,905,125,196.09	22.42%	0.35	0.68	0.57	63.3%	42.5	970	0.20	20.97	1.74
251	128	2.10	$1,200,003,146.91	19.31%	0.35	0.67	0.54	54.5%	42.5	910	0.17	16.08	1.66

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

Performance Curve - Log Scale with Drawdowns

■ Total Equity and Drawdowns

The highest MAR value of 0.65 was achieved for the following parameters:

- **Donchian Canal:** 112;
- **Stop loss order:** 1.75 x ATR(40).

The highest MAR value was accompanied by **a drawdown of 43.6%.**

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF
108	112	1.75	$4,510,205,564.76	28.42%	0.65	0.83	0.68	43.6%	33.4	1038	0.35	24.30	1.84
107	112	1.70	$5,225,387,120.51	29.47%	0.65	0.84	0.69	45.3%	38.9	1051	0.40	25.14	1.86
109	112	1.80	$4,030,351,197.83	27.62%	0.64	0.82	0.67	43.3%	39.6	1026	0.37	23.29	1.83
124	114	1.70	$5,007,298,774.33	29.17%	0.64	0.83	0.71	45.8%	38.0	1037	0.36	24.84	1.85
140	116	1.65	$4,840,613,403.43	28.93%	0.63	0.82	0.68	45.9%	38.9	1040	0.38	25.29	1.85
110	112	1.85	$3,677,936,297.25	26.97%	0.63	0.81	0.67	43.1%	40.2	1013	0.36	22.72	1.82
141	116	1.70	$5,225,052,158.47	29.47%	0.62	0.84	0.73	47.3%	34.1	1019	0.37	25.24	1.88
125	114	1.75	$4,300,393,992.98	28.08%	0.62	0.82	0.69	45.0%	34.2	1024	0.35	23.98	1.84
123	114	1.65	$4,789,243,945.01	28.85%	0.62	0.82	0.65	46.3%	40.0	1056	0.37	25.07	1.84
90	110	1.70	$4,441,164,257.69	28.31%	0.62	0.81	0.68	46.0%	40.3	1078	0.37	24.20	1.82
106	112	1.65	$4,900,666,098.53	29.01%	0.61	0.82	0.64	47.3%	40.3	1072	0.37	25.29	1.84
73	108	1.70	$4,680,579,738.80	28.68%	0.61	0.82	0.70	46.9%	40.3	1086	0.37	24.64	1.83

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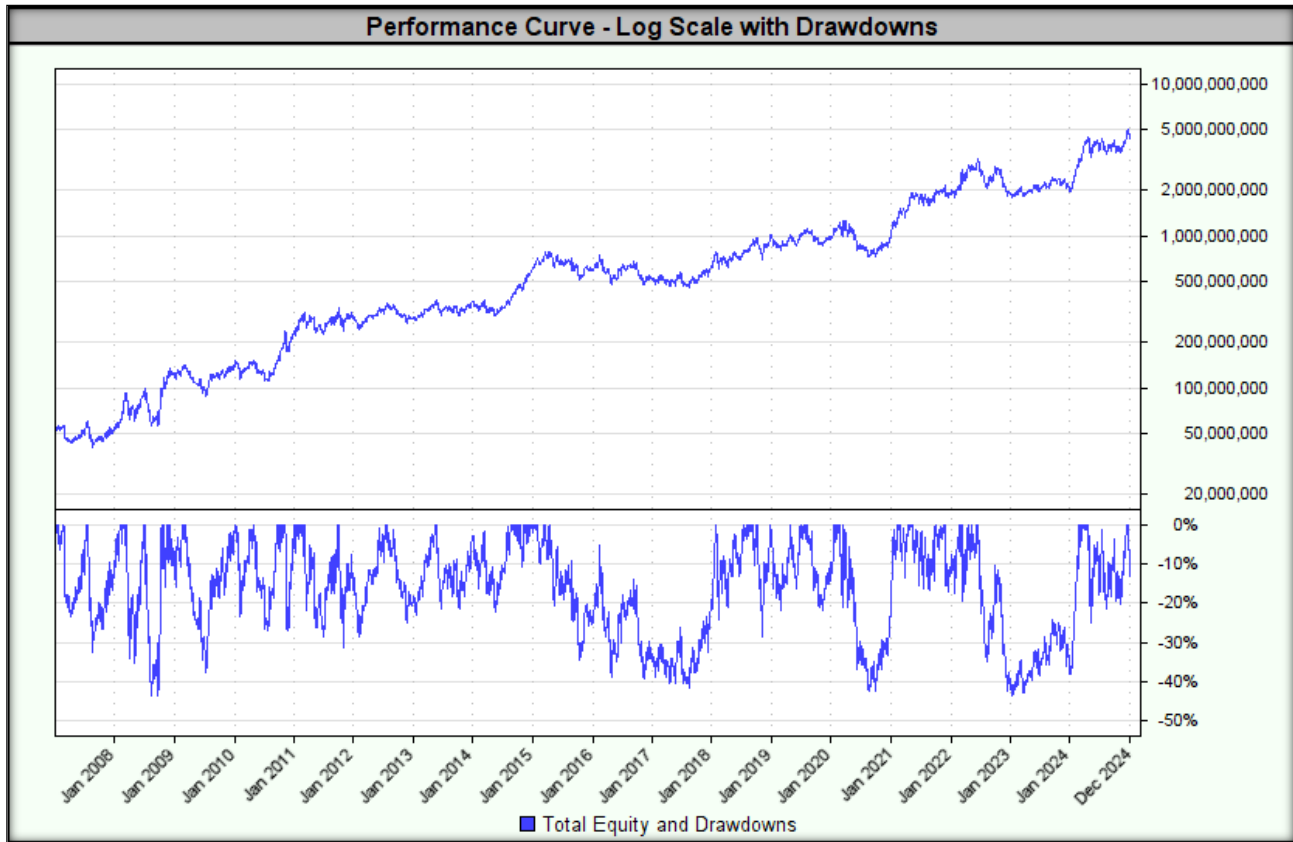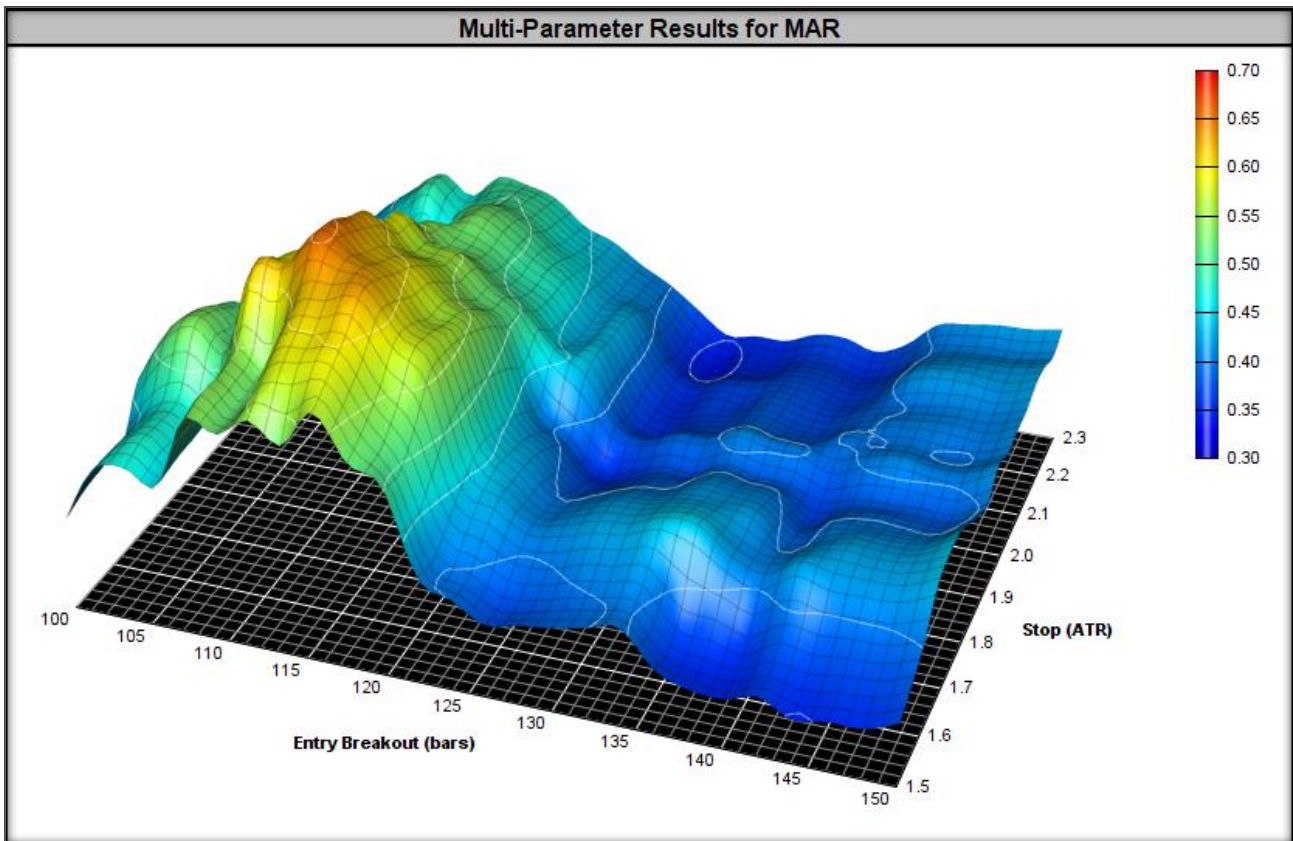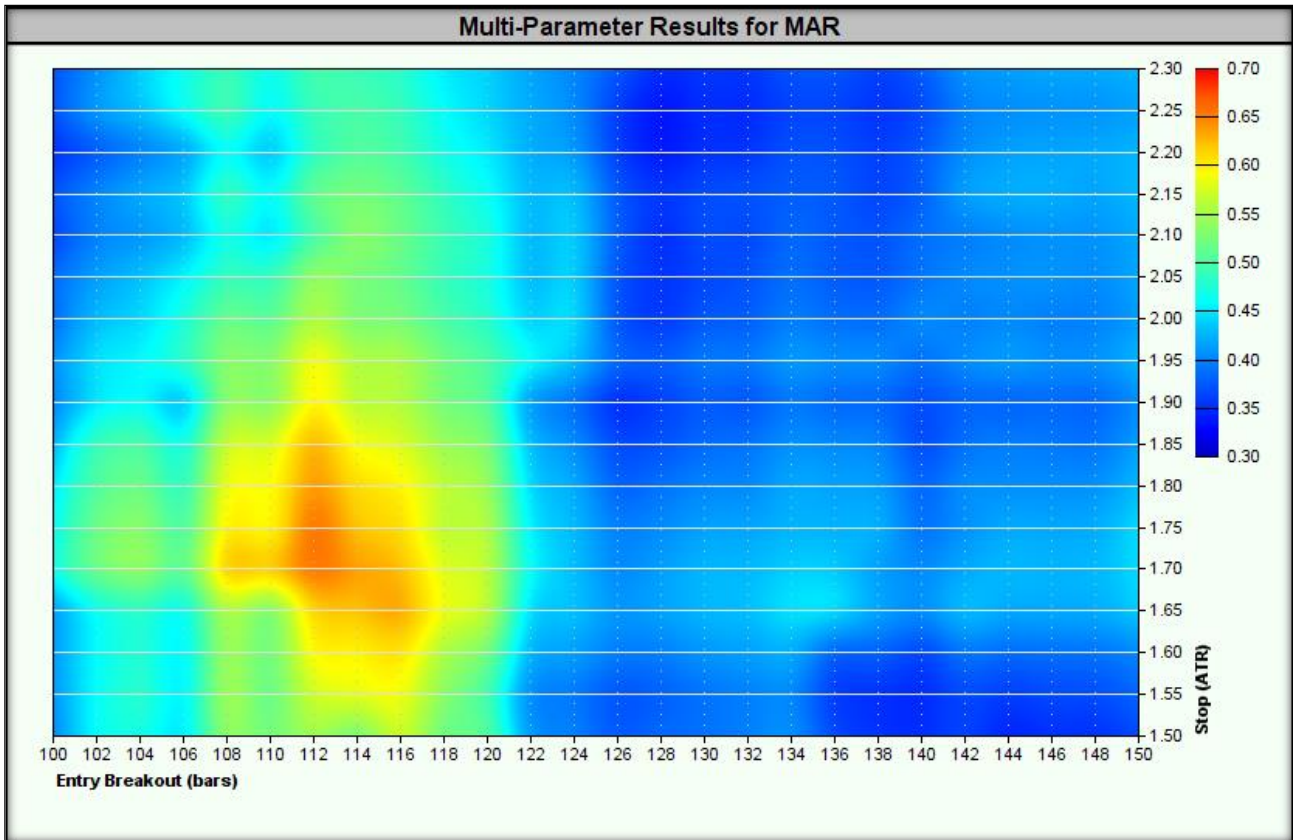

For all combinations of tested parameter ranges, **the highest drawdown was 65.5%.**

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD ▽	Longest DD	Trades	R3	RAR [%]	%PF	^
324	138	1.50	$2,173,261,005.01	23.31%	0.36	0.70	0.58	65.5%	42.5	1018	0.20	21.18	1.74	
307	136	1.50	$2,432,678,519.70	24.09%	0.37	0.71	0.64	65.2%	32.7	1026	0.25	22.71	1.75	
325	138	1.55	$2,115,396,974.59	23.13%	0.36	0.70	0.59	65.1%	41.3	1003	0.20	20.84	1.75	
290	134	1.50	$3,382,983,401.60	26.38%	0.41	0.76	0.66	64.9%	32.7	1017	0.31	25.53	1.79	
308	136	1.55	$2,240,368,563.46	23.52%	0.36	0.71	0.63	64.9%	32.9	1012	0.26	21.95	1.75	
273	132	1.50	$3,135,863,206.57	25.85%	0.40	0.75	0.64	64.8%	32.7	1033	0.31	25.12	1.77	
291	134	1.55	$3,189,524,264.92	25.97%	0.40	0.75	0.66	64.6%	32.9	1000	0.29	24.85	1.80	
274	132	1.55	$3,074,643,450.02	25.71%	0.40	0.75	0.65	64.5%	32.9	1016	0.30	24.60	1.77	
256	130	1.50	$2,851,945,638.80	25.19%	0.39	0.73	0.61	64.4%	32.9	1047	0.29	24.56	1.76	
341	140	1.50	$1,956,592,316.74	22.60%	0.35	0.68	0.56	63.9%	42.7	1016	0.19	20.53	1.72	
257	130	1.55	$2,765,000,212.58	24.98%	0.39	0.74	0.63	63.8%	33.0	1030	0.28	23.79	1.76	
239	128	1.50	$2,629,859,429.04	24.63%	0.39	0.72	0.62	63.8%	32.8	1065	0.23	23.80	1.73	∨

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 (**65.5% vs. 43.6%**) – 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
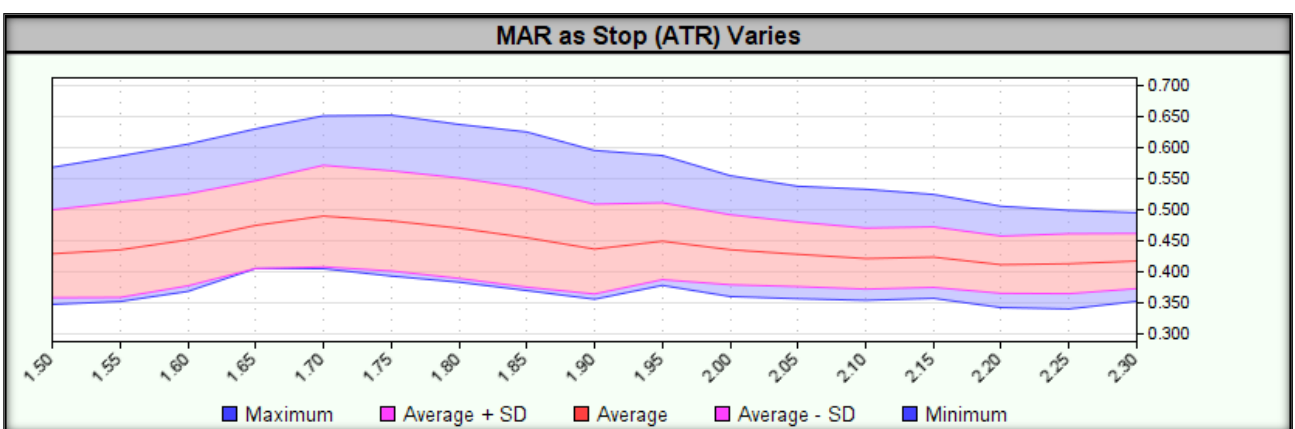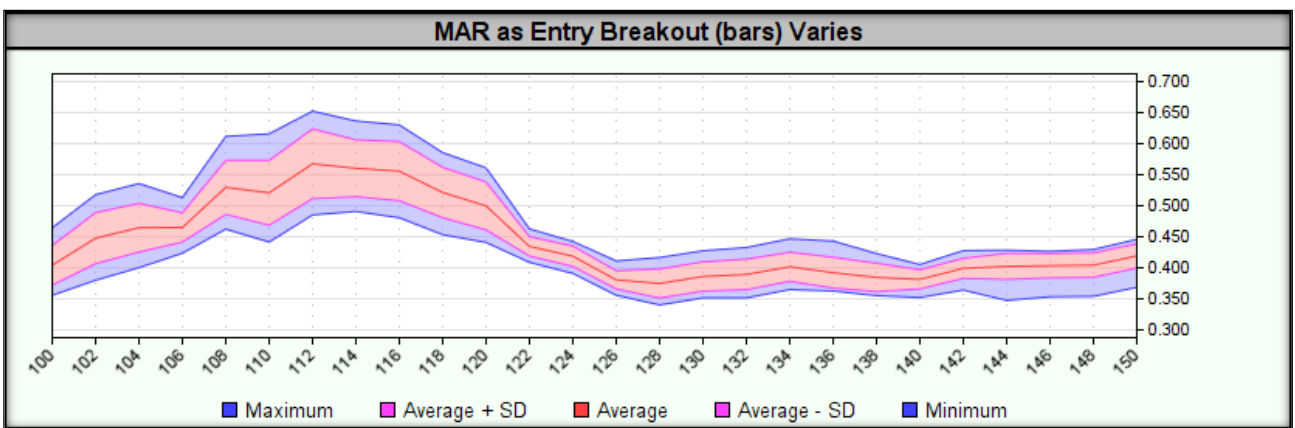
After passing the stability tests on **in-sample data,** it is time perform the same on **out-of-sample data.** For this purpose, we use **the same range of parameters** as on in-sample data:

- **Donchian Channel:** range **100-150 days (step: 2);**
- **Stop loss order:** range **1.50-2.30 x ATR (step: 0.05).**

The lowest MAR value of 0.59 was achieved for the following parameters:

- **Donchian Canal:** 124;
- **Stop loss order:** 1.50 x ATR(40).

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR /	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF
205	124	1.50	$567,908,522.11	31.03%	0.59	0.85	0.88	52.7%	25.4	529	0.44	20.58	1.89
222	126	1.50	$563,207,717.14	30.91%	0.59	0.85	0.90	52.3%	25.4	523	0.47	21.16	1.89
190	122	1.60	$547,067,924.73	30.49%	0.59	0.86	0.92	51.4%	25.4	509	0.49	20.83	1.93
188	122	1.50	$571,438,588.74	31.12%	0.60	0.85	0.90	51.8%	24.9	533	0.48	21.15	1.89
224	126	1.60	$543,628,350.31	30.40%	0.61	0.86	0.93	50.1%	24.9	503	0.46	21.01	1.92
207	124	1.60	$562,977,984.49	30.90%	0.61	0.87	0.92	50.9%	24.9	506	0.46	20.69	1.93
171	120	1.50	$591,790,265.73	31.63%	0.61	0.86	0.90	51.9%	24.9	534	0.48	21.18	1.90
189	122	1.55	$568,943,336.30	31.06%	0.61	0.86	0.93	50.9%	24.9	519	0.50	21.34	1.91
241	128	1.60	$565,350,693.11	30.96%	0.61	0.87	0.96	50.8%	24.9	492	0.51	21.80	1.95
239	128	1.50	$607,796,426.85	32.02%	0.62	0.87	0.95	51.9%	24.8	510	0.52	22.63	1.93

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

Performance Curve - Log Scale with Drawdowns
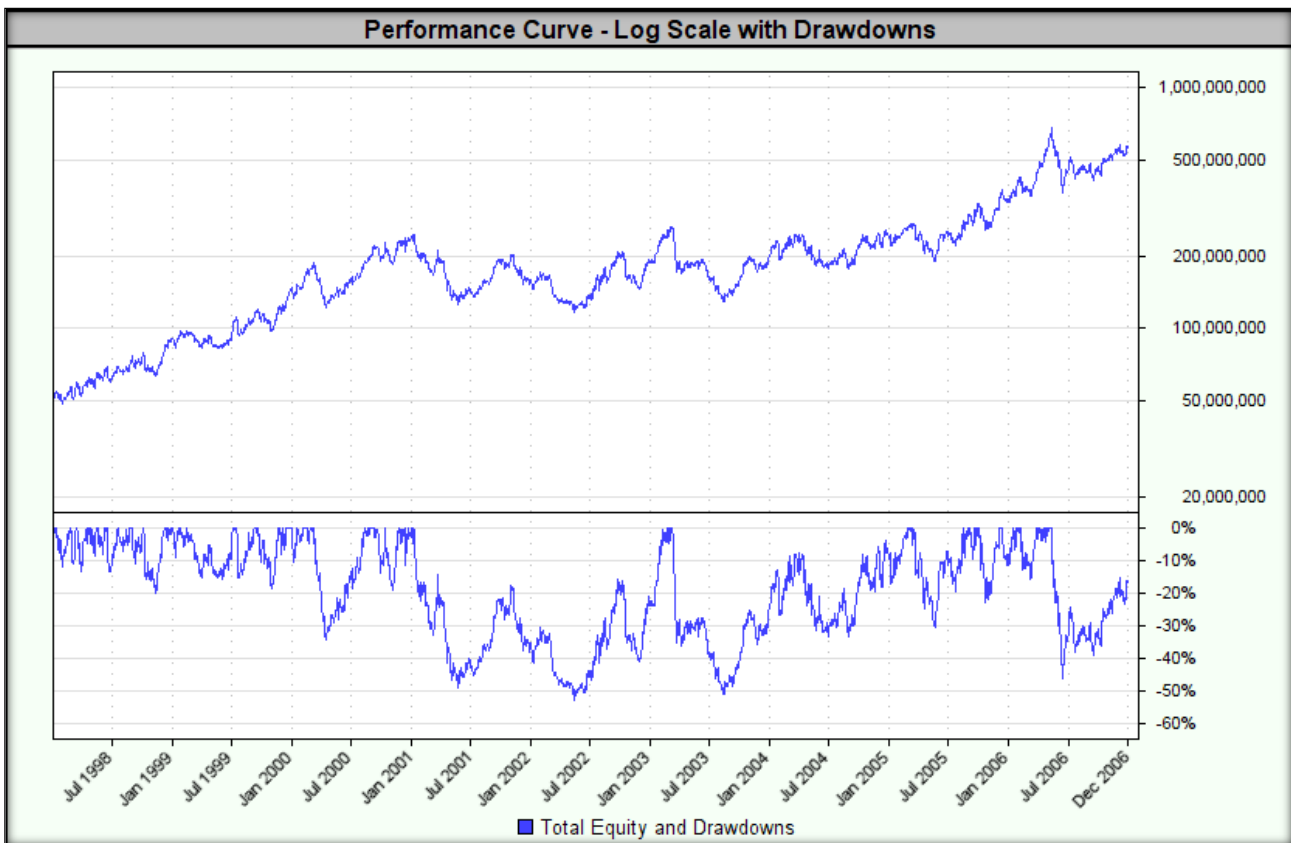
The **highest MAR value of 0.95** was achieved for the following parameters:

- **Donchian Canal:** 102;
- **Stop loss order:** 2.10 x ATR(40).

The highest MAR value was accompanied by **a drawdown of 37.6%.**

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR ▽	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF
30	102	2.10	$786,470,193.06	35.86%	0.95	1.13	1.85	37.6%	10.1	457	1.84	31.53	2.14
13	100	2.10	$785,711,657.92	35.85%	0.95	1.13	1.79	37.7%	10.1	465	1.64	31.32	2.13
4	100	1.65	$967,010,623.84	39.02%	0.94	1.06	1.32	41.3%	10.8	535	1.01	29.82	2.06
31	102	2.15	$755,409,999.77	35.25%	0.94	1.12	1.79	37.3%	10.1	452	1.62	30.84	2.13
5	100	1.70	$943,364,809.06	38.64%	0.94	1.07	1.38	40.9%	10.5	524	1.10	30.05	2.08
29	102	2.05	$772,408,040.53	35.59%	0.94	1.09	1.69	37.8%	10.2	469	1.40	30.38	2.09
14	100	2.15	$755,549,283.53	35.26%	0.94	1.13	1.74	37.5%	10.1	460	1.62	30.67	2.12
1	100	1.50	$1,123,054,116.21	41.35%	0.94	1.06	1.24	44.0%	10.7	563	1.05	30.42	2.07
28	102	2.00	$814,465,037.80	36.39%	0.94	1.10	1.70	38.8%	10.1	475	1.41	31.15	2.09
129	114	1.95	$816,297,697.85	36.43%	0.94	1.10	1.64	38.9%	10.5	445	1.23	30.74	2.16

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

Performance Curve - Log Scale with Drawdowns
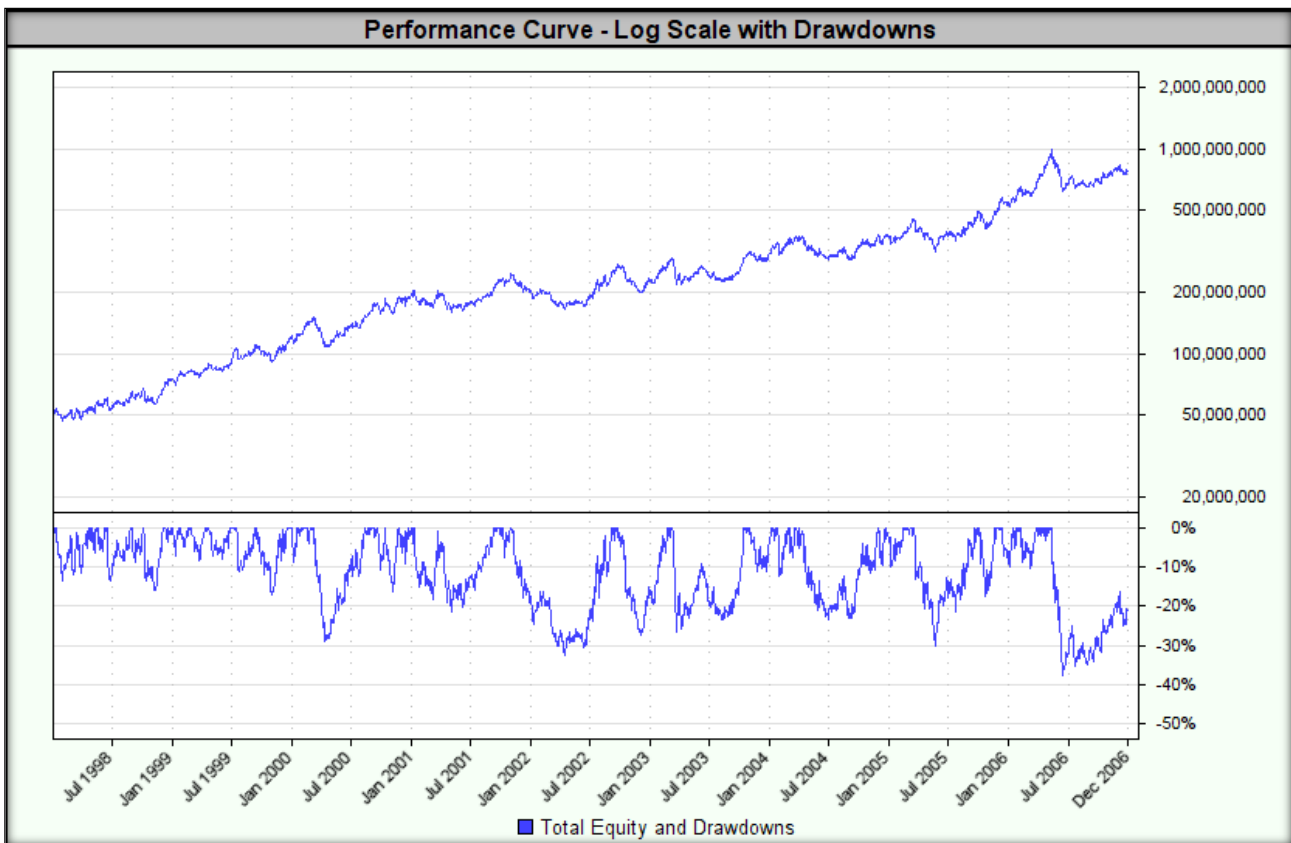
For all combinations of tested parameter ranges, **the highest drawdown was 52.7%.**

Test	Entry Breakout (bars)	Stop (ATR)	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD ▽	Longest DD	Trades	R3	RAR [%]	%PF
205	124	1.50	$567,908,522.11	31.03%	0.59	0.85	0.88	52.7%	25.4	529	0.44	20.58	1.89
222	126	1.50	$563,207,717.14	30.91%	0.59	0.85	0.90	52.3%	25.4	523	0.47	21.16	1.89
239	128	1.50	$607,796,426.85	32.02%	0.62	0.87	0.95	51.9%	24.8	510	0.52	22.63	1.93
171	120	1.50	$591,790,265.73	31.63%	0.61	0.86	0.90	51.9%	24.9	534	0.48	21.18	1.90
188	122	1.50	$571,438,588.74	31.12%	0.60	0.85	0.90	51.8%	24.9	533	0.48	21.15	1.89
273	132	1.50	$726,416,437.80	34.67%	0.67	0.91	1.08	51.6%	23.6	486	0.64	26.33	2.02
426	150	1.50	$843,585,544.02	36.93%	0.72	0.94	1.17	51.5%	20.7	450	0.74	28.03	2.14
290	134	1.50	$751,556,031.09	35.18%	0.68	0.92	1.09	51.5%	23.4	479	0.65	26.72	2.05
190	122	1.60	$547,067,924.73	30.49%	0.59	0.86	0.92	51.4%	25.4	509	0.49	20.83	1.93
240	128	1.55	$592,525,950.88	31.65%	0.62	0.87	0.96	51.1%	24.8	500	0.53	22.50	1.94

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 (52.7 % vs. 65.5 %)** – 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 (0.95 vs. 0.65)** – 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
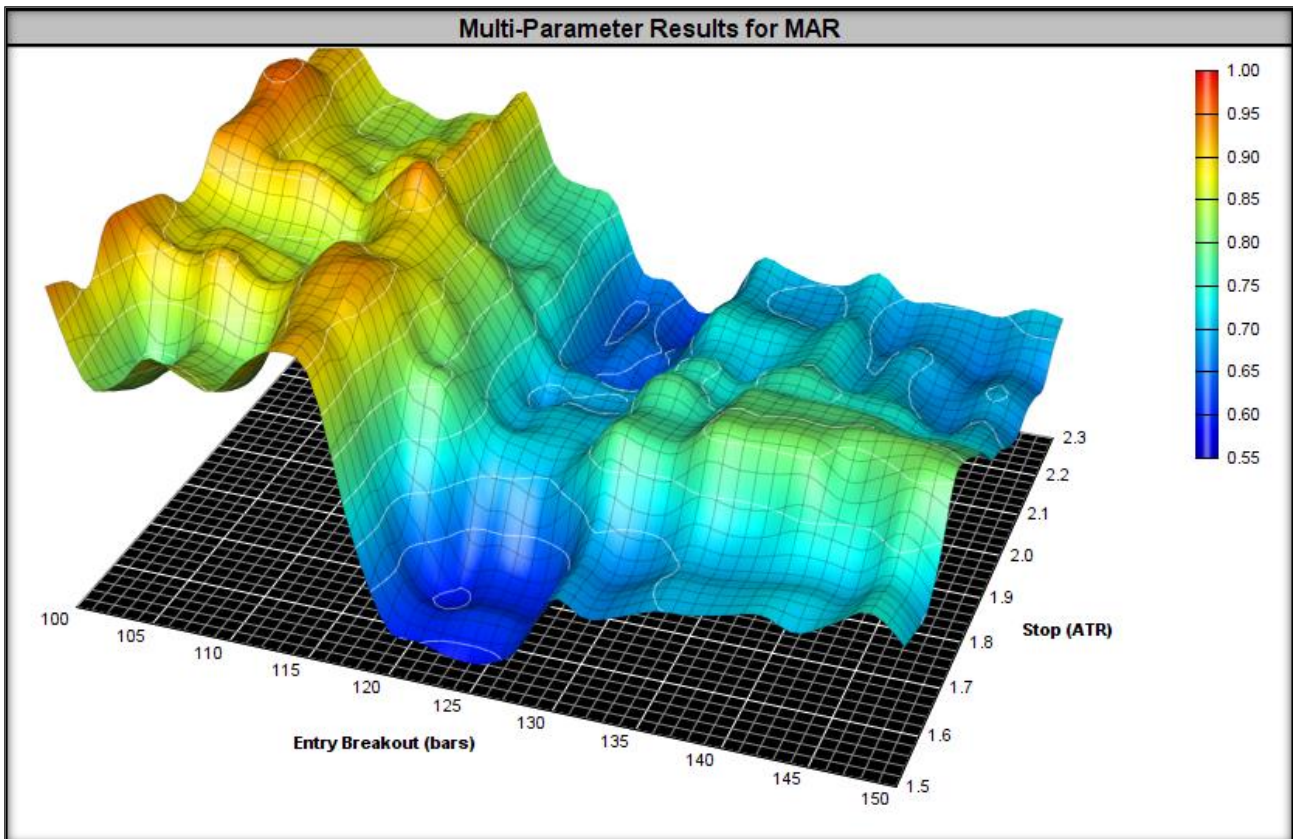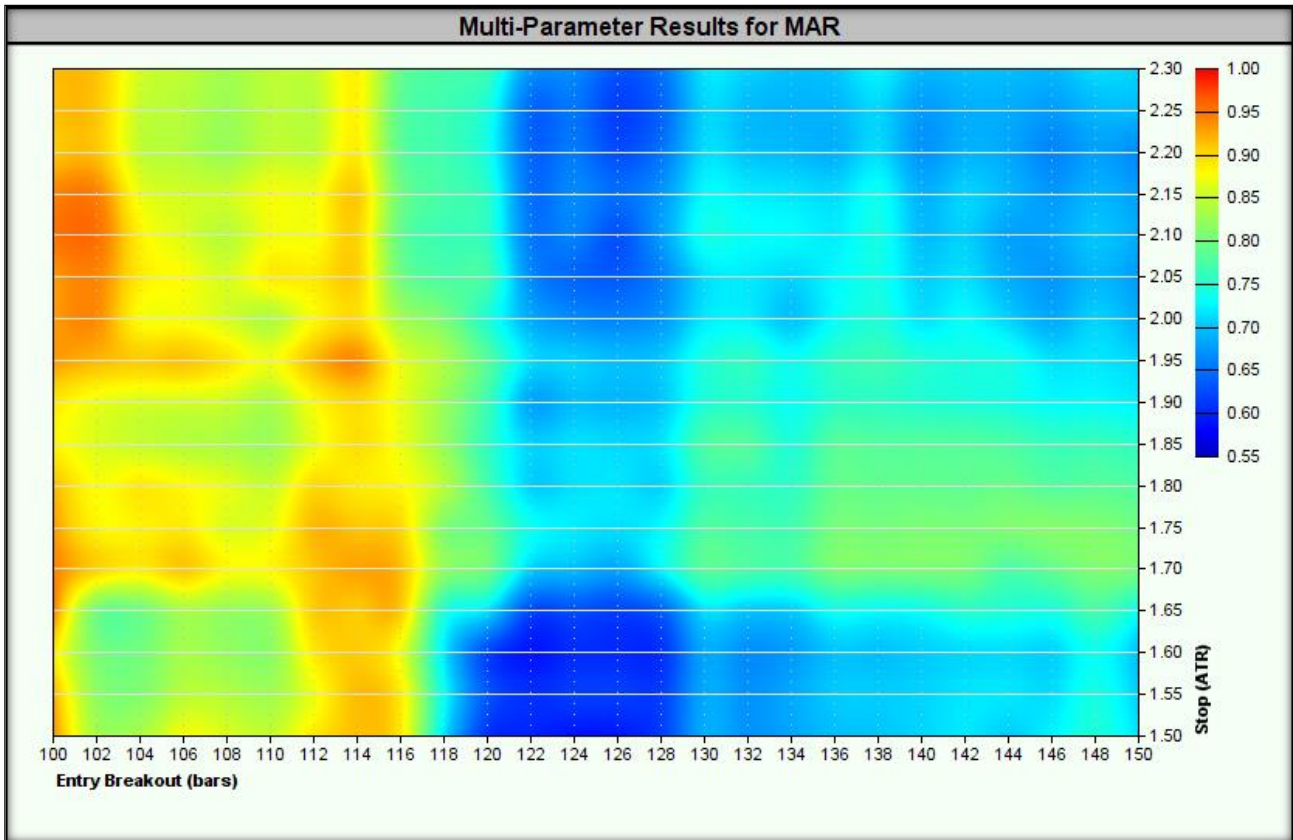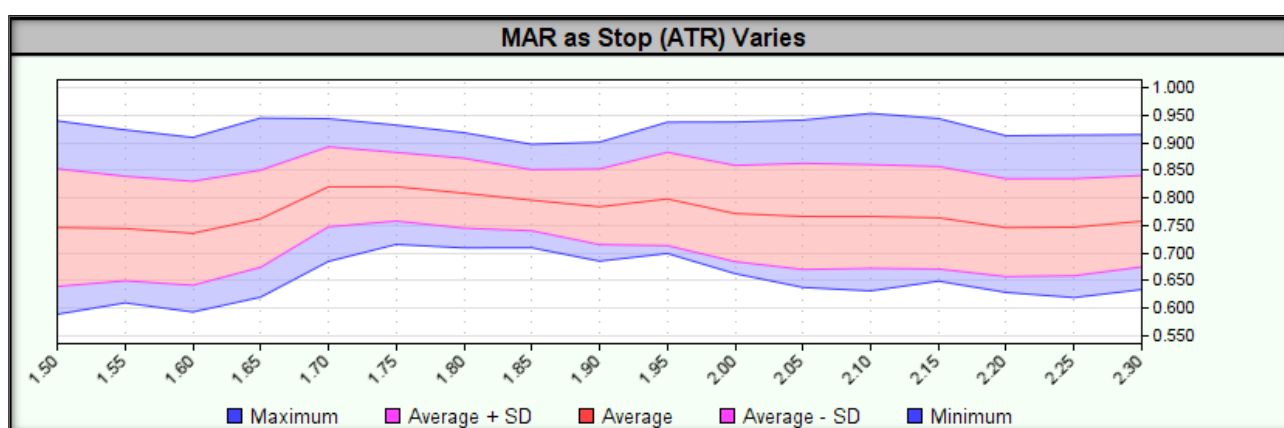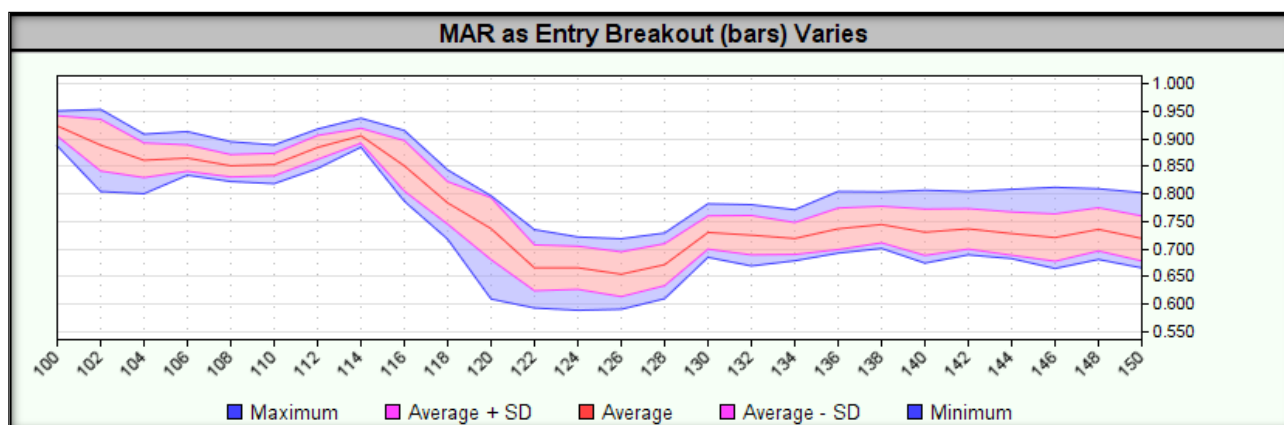
After passing **the stability test in a wide range of optimized parameters,** we can proceed to **stability testing using Monte Carlo simulation.** The conditions for passing this test are similar to those required in the above step.

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.

Monte Carlo Equity Curve - Log Scale

Monte Carlo CAGR%

Monte Carlo Drawdowns
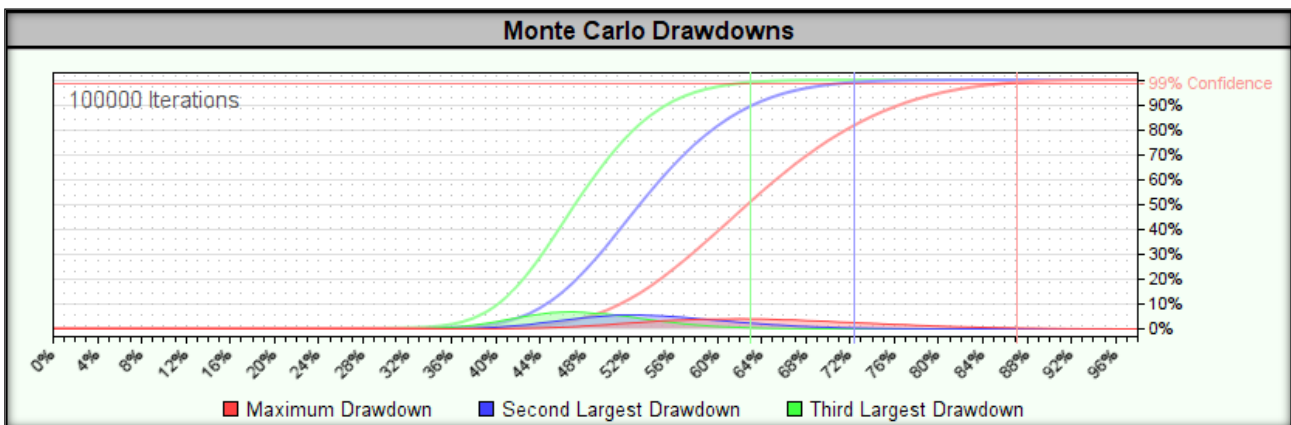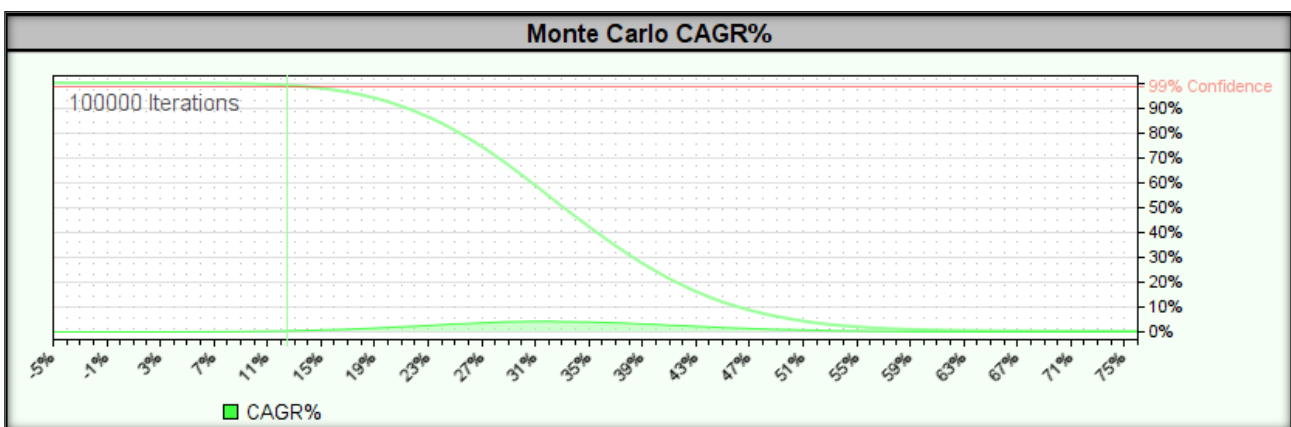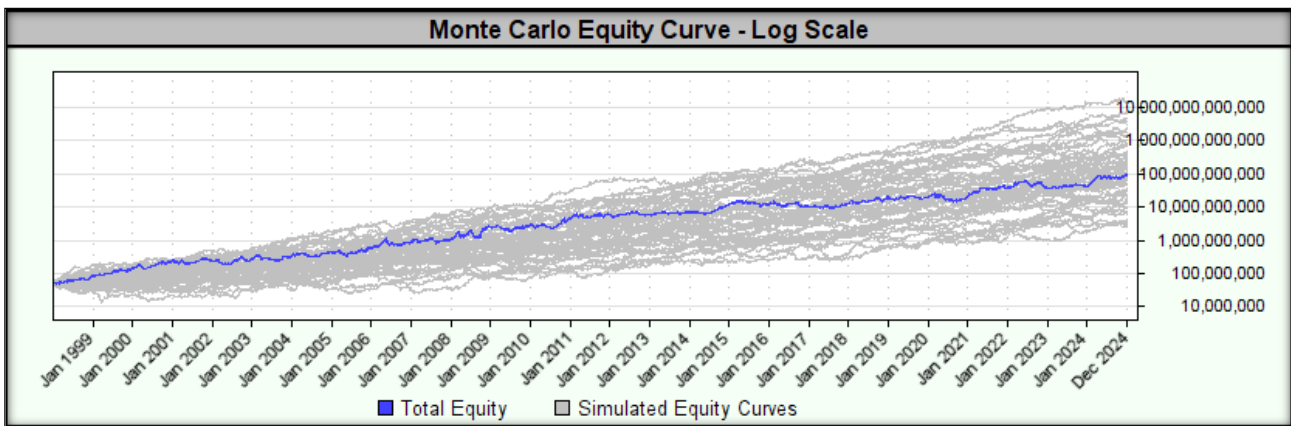
- **CAGR%** – In 99% of simulations achieved **a return equal to or higher than 12.5%.**
- **Drawdown** – in 99% of simulations, **drawdown equal to or lower than 87% was achieved.** For parameters optimized on in-sample data, drawdown was 43.6%.

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.

The problem with these tests, however, is the fact that **the drawdown on the optimized parameters is 43.6%,** which means that **even with a 100% loss of capital in the Monte Carlo tests we will not exceed the**

stability criterion (250% drawdown). Therefore, **it is necessary to reduce the position size so that the simulation results make sense.**

For the purpose of **the repeated Monte Carlo test we are reducing the position size to 0.5% of capital per position** (from 1%).

The results of repeated tests for the simulation with sample replacement are presented below.

- **CAGR%** – In 99% of simulations achieved **a rate of return equal to or higher than 7.5%.**

- **Drawdown** – in 99% of simulations, **drawdown equal to or lower than 69% was achieved.** For parameters optimized on in-sample data, drawdown was 29.8%.

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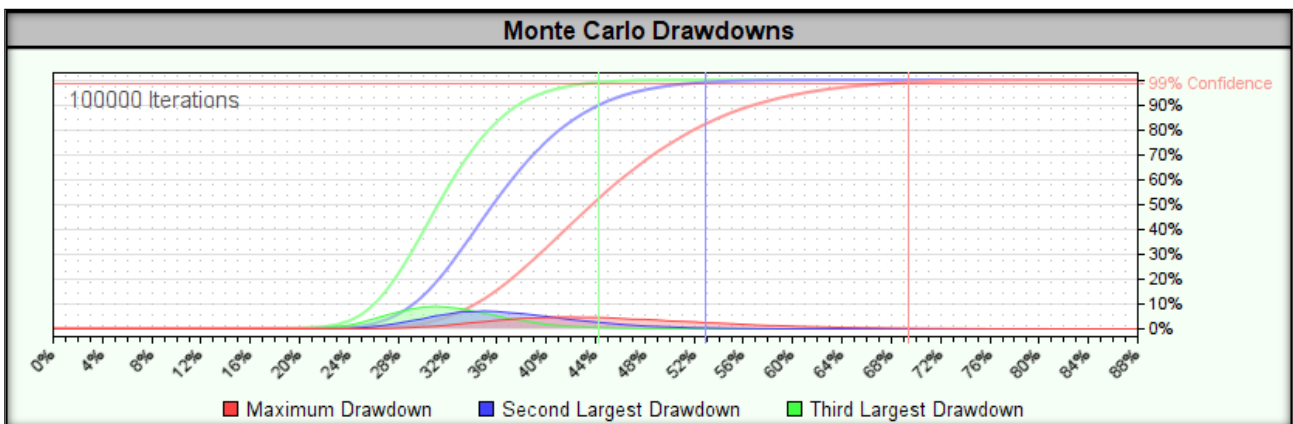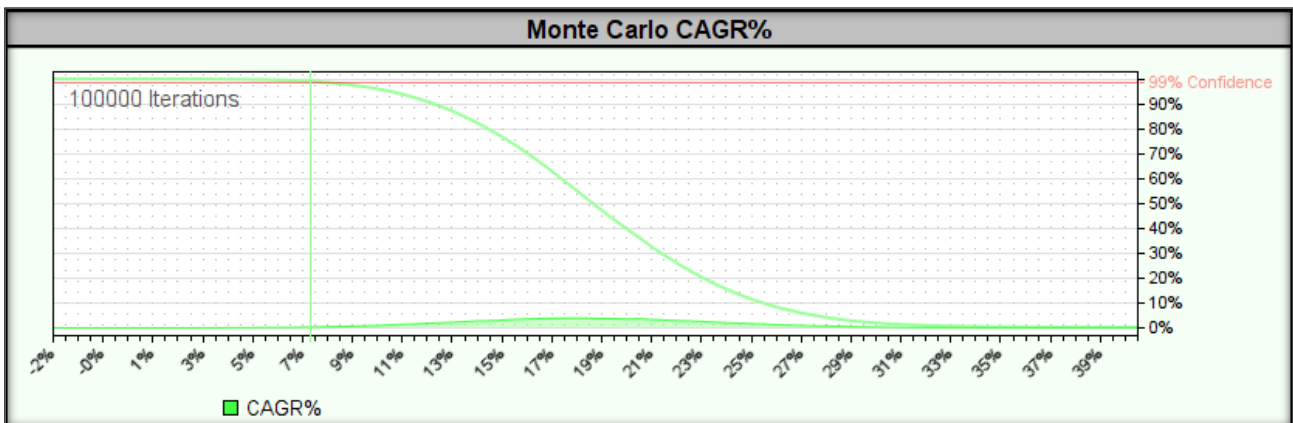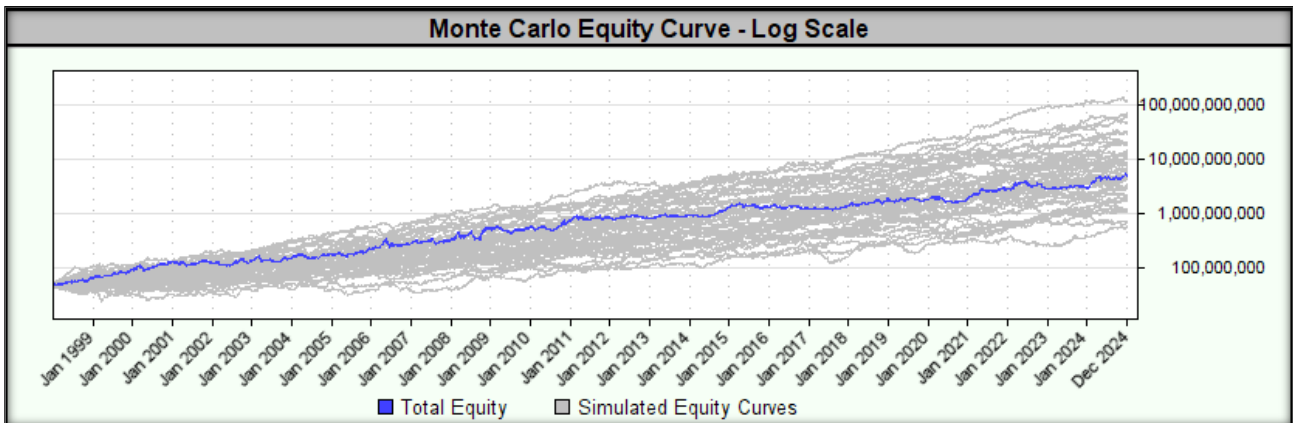
Now that we know the strategy is **stable** across **wide data ranges** and **a changing environment,** it's time to test its **stability** over **different time periods.**

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

Rolling window stability testing involves **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.

/	Test Start Date	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF	Expectancy	^
1	19980101	$87,406,202.16	74.88%	4.37	2.18	2.00	17.1%	2.0	67	43.90	43.08	2.34	1.08	
2	19990101	$88,393,898.99	77.13%	3.54	1.87	NA	21.8%	4.6	61	42.26	44.86	2.64	1.18	
3	20000101	$73,339,108.92	47.34%	1.49	1.34	NA	31.8%	4.9	76	22.23	43.37	1.89	0.70	
4	20010101	$64,827,906.11	29.68%	1.46	0.96	2.00	20.3%	4.5	64	24.38	39.56	1.54	0.41	
5	20020101	$60,574,588.79	21.17%	0.70	0.63	1.99	30.3%	6.4	73	9.92	14.58	1.48	0.37	
6	20030101	$52,484,767.45	4.97%	0.14	0.31	1.98	35.9%	9.9	77	-8.73	-15.10	1.12	0.11	
7	20040101	$64,553,393.10	29.13%	1.08	0.85	NA	27.0%	6.5	72	3.98	7.17	1.52	0.38	
8	20050101	$53,530,593.23	7.15%	0.23	0.36	NA	31.3%	8.5	80	-12.67	-16.96	1.25	0.21	
9	20060101	$65,029,558.57	30.18%	0.83	1.01	2.00	36.4%	7.7	81	6.87	9.72	1.49	0.37	
10	20070101	$53,608,053.87	7.22%	0.22	0.41	1.99	32.7%	5.7	87	-9.42	-11.02	1.15	0.13	
11	20080101	$106,056,493.89	112.22%	2.61	1.37	NA	43.0%	3.4	72	18.65	37.13	3.38	1.46	
12	20090101	$59,299,485.45	18.61%	0.78	0.79	2.00	24.0%	5.6	65	8.55	10.16	1.49	0.37	
13	20100101	$71,704,516.01	43.59%	1.46	1.01	NA	29.9%	9.0	83	12.22	21.64	2.01	0.74	
14	20110101	$54,091,286.57	8.28%	0.22	0.41	NA	36.8%	9.9	82	-5.36	-9.77	1.19	0.15	
15	20120101	$50,259,553.52	0.52%	0.02	0.13	NA	23.5%	5.4	65	2.87	4.57	0.99	-0.00	
16	20130101	$61,642,159.74	23.30%	1.21	1.20	2.00	19.2%	7.0	71	11.03	12.93	1.40	0.31	
17	20140101	$86,766,544.28	73.60%	3.82	1.98	2.00	19.3%	5.1	83	31.94	40.82	2.33	1.01	
18	20150101	$41,166,088.11	-17.68%	-0.43	-0.38	-2.01	41.3%	8.6	78	-15.04	-27.90	0.71	-0.23	
19	20160101	$50,975,889.77	1.96%	0.06	0.24	NA	31.5%	10.6	80	-0.31	-0.58	1.06	0.04	
20	20170101	$65,315,473.02	30.75%	1.52	1.36	2.00	20.3%	4.3	82	3.66	5.40	1.52	0.41	
21	20180101	$65,852,371.00	31.73%	1.16	0.84	2.00	27.4%	8.0	85	-7.82	-12.29	1.56	0.40	
22	20190101	$48,763,952.24	-2.47%	-0.09	0.03	-2.04	26.9%	8.3	77	-10.80	-15.17	0.92	-0.07	
23	20200101	$55,248,833.38	10.51%	0.28	0.44	NA	38.1%	9.0	101	-8.50	-16.50	1.19	0.16	
24	20210101	$86,848,606.05	74.03%	3.48	1.65	NA	21.3%	2.9	70	37.30	57.90	2.38	1.00	
25	20220101	$52,172,018.88	4.40%	0.10	0.32	NA	45.0%	6.6	84	4.34	8.94	1.14	0.11	
26	20230101	$50,245,670.89	0.49%	0.03	0.13	1.89	19.0%	3.6	81	6.56	11.75	1.05	0.04	
27	20240101	$86,301,737.07	72.67%	3.07	1.79	NA	23.7%	5.0	70	5.40	8.69	2.42	1.11	v

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

/	Test Start Date	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]	%PF	Expectancy	^
1	19980101	$242,929,533.07	69.59%	2.25	1.93	7.94	31.0%	5.1	156	13.06	71.30	3.05	1.66	
2	19990101	$134,977,096.32	39.27%	1.12	1.09	1.23	34.9%	5.7	160	5.72	42.21	1.88	0.71	
3	20000101	$84,465,993.60	19.15%	0.51	0.64	1.01	37.3%	10.5	181	1.14	13.46	1.44	0.37	
4	20010101	$85,947,061.12	19.80%	0.51	0.64	1.81	38.9%	10.6	175	1.21	14.25	1.51	0.42	
5	20020101	$95,492,811.18	24.09%	0.69	0.73	7.73	35.1%	10.3	178	2.07	25.15	1.61	0.50	
6	20030101	$84,073,323.85	18.95%	0.53	0.65	1.60	35.9%	11.4	191	1.11	14.74	1.46	0.39	
7	20040101	$130,267,783.28	37.71%	0.92	1.06	3.40	40.8%	7.6	183	4.27	39.05	1.93	0.73	
8	20050101	$105,710,987.15	28.43%	0.68	0.90	1.40	41.7%	13.1	191	3.60	34.83	1.78	0.66	
9	20060101	$182,465,014.05	54.06%	1.28	1.05	1.36	42.4%	9.4	189	4.96	39.24	2.17	0.92	
10	20070101	$138,855,693.91	40.59%	0.93	0.88	0.75	43.6%	10.0	189	5.16	56.58	1.90	0.70	
11	20080101	$203,344,920.22	59.67%	1.39	1.11	1.50	43.0%	10.0	168	4.11	35.94	2.78	1.17	
12	20090101	$127,487,047.12	36.72%	1.18	0.98	1.61	31.0%	6.6	163	5.28	46.05	1.97	0.73	
13	20100101	$89,663,951.87	21.51%	0.71	0.68	1.22	30.3%	9.0	181	3.44	36.60	1.51	0.40	
14	20110101	$69,103,053.58	11.42%	0.31	0.50	1.00	36.8%	14.9	182	0.91	9.39	1.26	0.22	
15	20120101	$105,848,307.75	28.45%	1.21	1.13	1.06	23.5%	14.2	184	1.17	9.73	1.72	0.58	
16	20130101	$97,993,834.08	25.16%	0.73	0.88	0.93	34.7%	8.6	185	5.13	41.30	1.76	0.63	
17	20140101	$72,468,484.62	13.19%	0.34	0.52	0.34	38.9%	20.6	203	2.02	17.42	1.52	0.41	
18	20150101	$41,188,512.57	-6.27%	-0.13	-0.03	-0.35	46.8%	32.6	211	-2.20	-16.54	0.97	-0.03	
19	20160101	$95,523,056.38	24.10%	0.77	0.82	1.08	31.5%	22.9	196	1.01	10.45	1.66	0.50	
20	20170101	$101,725,548.09	26.76%	0.90	0.89	1.20	29.6%	6.6	184	4.07	31.02	1.66	0.53	
21	20180101	$71,714,369.79	12.78%	0.30	0.52	0.95	42.0%	9.8	208	1.30	15.32	1.26	0.22	
22	20190101	$90,228,840.36	21.76%	0.46	0.76	0.60	47.1%	11.3	198	1.85	19.81	1.68	0.58	
23	20200101	$100,235,665.77	26.14%	0.62	0.78	0.78	42.4%	9.4	213	4.74	54.41	1.83	0.69	
24	20210101	$95,004,646.05	23.88%	0.52	0.74	0.78	46.0%	18.6	206	2.02	21.02	1.60	0.48	
25	20220101	$121,429,766.83	34.52%	0.75	0.94	0.58	46.2%	21.0	201	2.01	20.68	1.97	0.81	v

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): 25 out of 27 periods** ended with a positive rate of return (**93%**).
- **For the three-year test window (1095/365): 24 out of 25 periods** ended with a positive rate of return (**96%**).

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

4. **Long/short stability**

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

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

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

Results for Donchian Breakout Strategy (1998-2024):

- **Total number of transactions: 1483**
- **Long trades: 753 (50.8%)**
- **Short trades: 730 (49.2%)**

The trade distribution is 50.8%/49.2%, 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.

Instrument Performance Summary													
Symbol	Wins	%	Losses	%	Trades	Win Months	%	Loss Months	%	Avg. Win %	Avg. Loss %	Avg. Trade %	% Profit Factor
C	17	20.0%	68	80.0%	85	181	55.9%	143	44.1%	5.14%	1.06%	0.18%	1.22
CC	7	11.1%	56	88.9%	63	197	60.8%	127	39.2%	26.79%	1.09%	2.01%	3.08
CFI	8	28.6%	20	71.4%	28	247	76.2%	77	23.8%	15.09%	1.07%	3.55%	5.64
CL	10	16.1%	52	83.9%	62	199	61.4%	125	38.6%	10.41%	1.06%	0.79%	1.88
CT	13	19.7%	53	80.3%	66	192	59.3%	132	40.7%	8.37%	1.08%	0.78%	1.89
DX	16	27.6%	42	72.4%	58	200	61.7%	124	38.3%	6.67%	0.99%	1.12%	2.57
EBL	12	18.5%	53	81.5%	65	193	59.6%	131	40.4%	6.60%	1.07%	0.35%	1.40
ES	12	20.0%	48	80.0%	60	200	61.7%	124	38.3%	6.22%	1.03%	0.42%	1.50
FDX	17	30.9%	38	69.1%	55	192	59.3%	132	40.7%	4.07%	1.04%	0.54%	1.75
FLG	13	21.3%	48	78.7%	61	181	55.9%	143	44.1%	5.01%	1.08%	0.22%	1.26
GC	9	18.0%	41	82.0%	50	209	64.5%	115	35.5%	7.17%	1.07%	0.41%	1.47
HG	12	19.4%	50	80.6%	62	175	54.0%	149	46.0%	12.13%	1.03%	1.52%	2.83
HSI	13	24.1%	41	75.9%	54	197	60.8%	127	39.2%	4.96%	1.16%	0.31%	1.35
KC	11	17.5%	52	82.5%	63	199	61.4%	125	38.6%	7.34%	1.08%	0.39%	1.44
LCO	13	21.0%	49	79.0%	62	202	62.3%	122	37.7%	9.36%	1.06%	1.12%	2.34
LGO	13	23.2%	43	76.8%	56	192	59.3%	132	40.7%	12.72%	1.08%	2.12%	3.55
NG	9	14.5%	53	85.5%	62	182	56.2%	142	43.8%	7.62%	1.06%	0.20%	1.22
NIY	7	14.6%	41	85.4%	48	233	71.9%	91	28.1%	10.99%	1.10%	0.66%	1.70
NQ	11	18.0%	50	82.0%	61	204	63.0%	120	37.0%	8.70%	1.06%	0.70%	1.80
OJ	8	11.4%	62	88.6%	70	193	59.6%	131	40.4%	13.87%	1.17%	0.55%	1.53
PA	10	18.9%	43	81.1%	53	199	61.4%	125	38.6%	15.54%	1.09%	2.05%	3.31
S	15	30.6%	34	69.4%	49	197	60.8%	127	39.2%	6.67%	1.03%	1.33%	2.86
SB	14	22.6%	48	77.4%	62	194	59.9%	130	40.1%	6.44%	1.12%	0.59%	1.68
TY	13	22.4%	45	77.6%	58	193	59.6%	131	40.4%	7.60%	1.06%	0.88%	2.08
W	12	17.1%	58	82.9%	70	180	55.6%	144	44.4%	4.78%	1.03%	-0.03%	0.96

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

Instrument Performance Summary

Symbol	Wins	%	Losses	%	Trades	Win Months	%	Loss Months	%	Avg. Win %	Avg. Loss %	Avg. Trade %	Profit Factor
C	15	20.5%	58	79.5%	73	177	54.6%	147	45.4%	4.17%	1.01%	0.05%	1.07
CC	7	11.9%	52	88.1%	59	197	60.8%	127	39.2%	20.04%	1.07%	1.44%	2.53
CFI	9	33.3%	18	66.7%	27	242	74.7%	82	25.3%	8.85%	1.06%	2.24%	4.17
CL	10	19.6%	41	80.4%	51	199	61.4%	125	38.6%	8.06%	1.08%	0.71%	1.82
CT	12	21.4%	44	78.6%	56	189	58.3%	135	41.7%	5.96%	1.06%	0.44%	1.53
DX	11	22.9%	37	77.1%	48	199	61.4%	125	38.6%	7.27%	1.02%	0.88%	2.12
EBL	11	20.4%	43	79.6%	54	201	62.0%	123	38.0%	5.49%	1.03%	0.30%	1.36
ES	12	23.5%	39	76.5%	51	194	59.9%	130	40.1%	4.71%	1.03%	0.32%	1.40
FDX	15	34.1%	29	65.9%	44	198	61.1%	126	38.9%	3.51%	1.03%	0.52%	1.77
FLG	12	27.3%	32	72.7%	44	183	56.5%	141	43.5%	5.03%	1.04%	0.62%	1.82
GC	7	15.9%	37	84.1%	44	204	63.0%	120	37.0%	6.13%	0.97%	0.16%	1.19
HG	11	20.0%	44	80.0%	55	168	51.9%	156	48.1%	9.85%	1.00%	1.17%	2.45
HSI	12	25.5%	35	74.5%	47	196	60.5%	128	39.5%	4.36%	1.09%	0.30%	1.37
KC	9	17.0%	44	83.0%	53	207	63.9%	117	36.1%	5.85%	1.04%	0.13%	1.15
LCO	11	21.2%	41	78.8%	52	200	61.7%	124	38.3%	8.18%	1.10%	0.86%	1.99
LGO	11	20.0%	44	80.0%	55	194	59.9%	130	40.1%	11.08%	1.06%	1.37%	2.62
NG	8	15.4%	44	84.6%	52	181	55.9%	143	44.1%	5.12%	1.06%	-0.11%	0.88
NIY	6	14.6%	35	85.4%	41	230	71.0%	94	29.0%	9.58%	1.06%	0.50%	1.55
NQ	11	22.0%	39	78.0%	50	199	61.4%	125	38.6%	6.51%	1.05%	0.61%	1.75
OJ	7	11.7%	53	88.3%	60	189	58.3%	135	41.7%	9.90%	1.13%	0.16%	1.16
PA	9	23.1%	30	76.9%	39	196	60.5%	128	39.5%	12.79%	0.99%	2.19%	3.87
S	11	27.5%	29	72.5%	40	191	59.0%	133	41.0%	6.42%	0.99%	1.05%	2.47
SB	13	22.0%	46	78.0%	59	182	56.2%	142	43.8%	4.61%	1.08%	0.17%	1.20
TY	11	26.2%	31	73.8%	42	195	60.2%	129	39.8%	6.81%	0.99%	1.05%	2.44
W	11	19.6%	45	80.4%	56	183	56.5%	141	43.5%	3.55%	1.00%	-0.11%	0.87

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 92%.**

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:

- **In-sample drawdown** for optimized parameters was **43.6%.**
- **In-sample and out-of-sample drawdown** for the optimized parameters was **43.6% (29.8% at 0.5% position).**
- **The highest in-sample drawdown** for the tested parameter range was **65.5%.**
- **The largest out-of-sample drawdown** for the tested parameter range was **52.7 %.**
- **Drawdown in 99% of the Monte Carlo simulations** was equal to or lower than **87.0% (69% at 0.5% position).**

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 too large for me personally and I decide to reduce it to 0.5% of total capital.**

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

- **Donchian Canal:** 112 days;
- **Stop loss order:** located 1.75 x ATR(40) away from the position opening point;
- **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 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.**
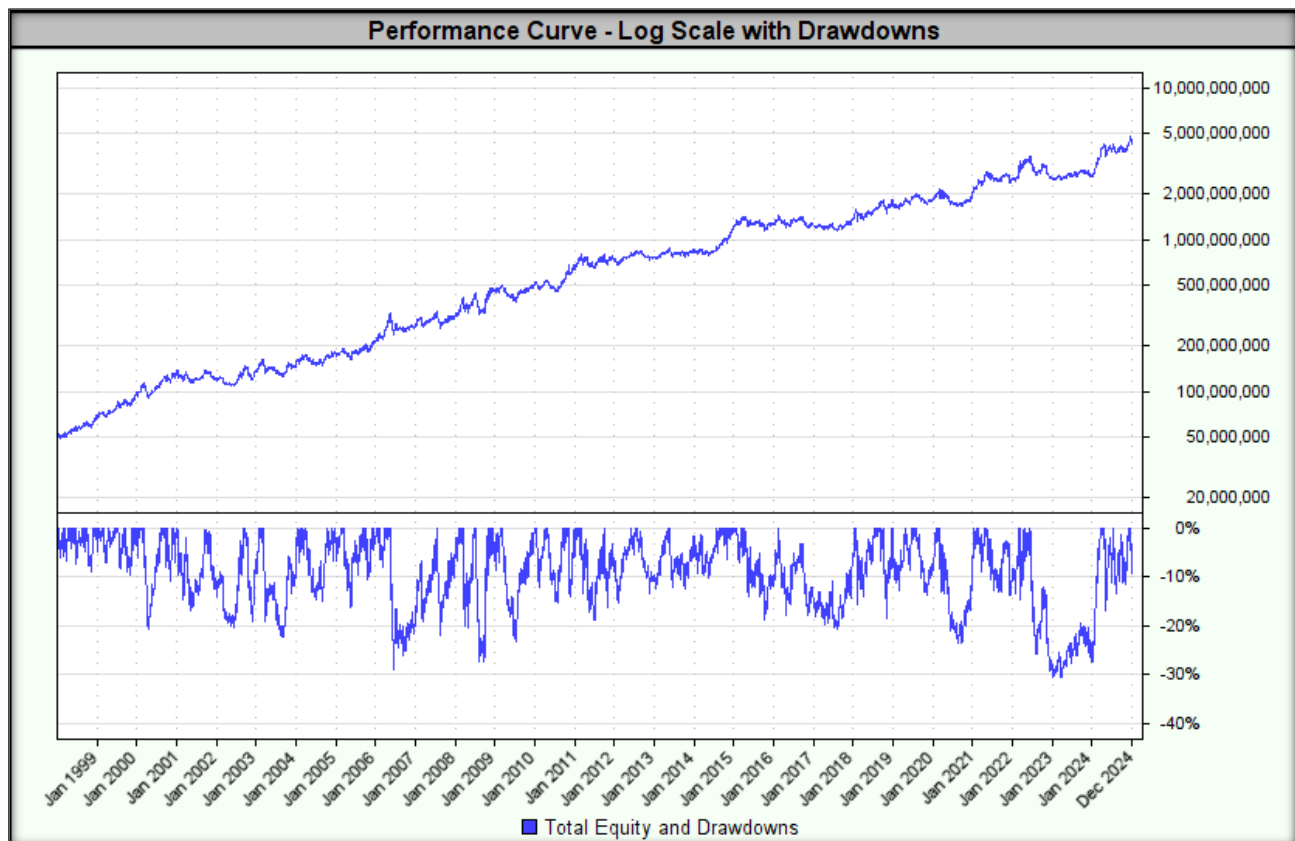
We haven't done this before because our goal **was not to optimize the parameters themselves and look for the "best" set,** but **to build a stable strategy.**
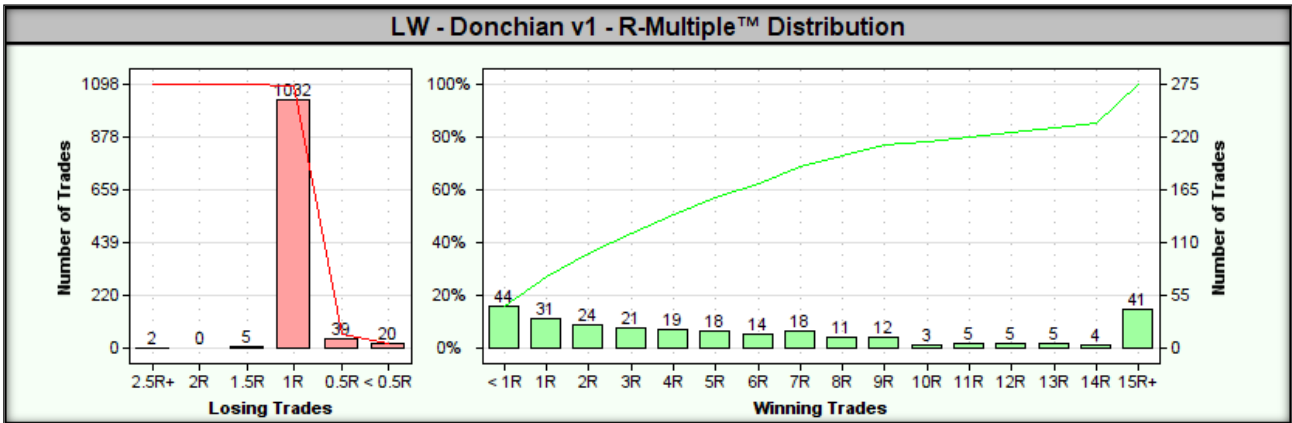
Importantly, **we will not use the parameters optimized in back-tests in the end,** because **they serve only as a reference point. The parameters used in real transactions will be determined during the Walk Forward Analysis.**

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.**

Indicators/Measures	In-sample	In-sample & Out-of-sample
CAGR%	16.3%	18.1%
MAR Ratio	0.53	0.59
RAR%	14.5%	16.6%
R-Cubed	0.46	0.41
Robust Sharpe Ratio	0.68	0.79
Max Drawdown	30.5%	30.5%
Wins	19.8%	20.0%
Losses	80.2%	80.0%
Average Win%	4.01%	4.28%
Average Loss%	0.53%	0.52%
Win/Loss Ratio	7.61	7.98
Average Trade Duration (days)	113	117
Percent Profit Factor	1.88	2.00
SQN	0.81	0.86
Number of transactions	950	1373
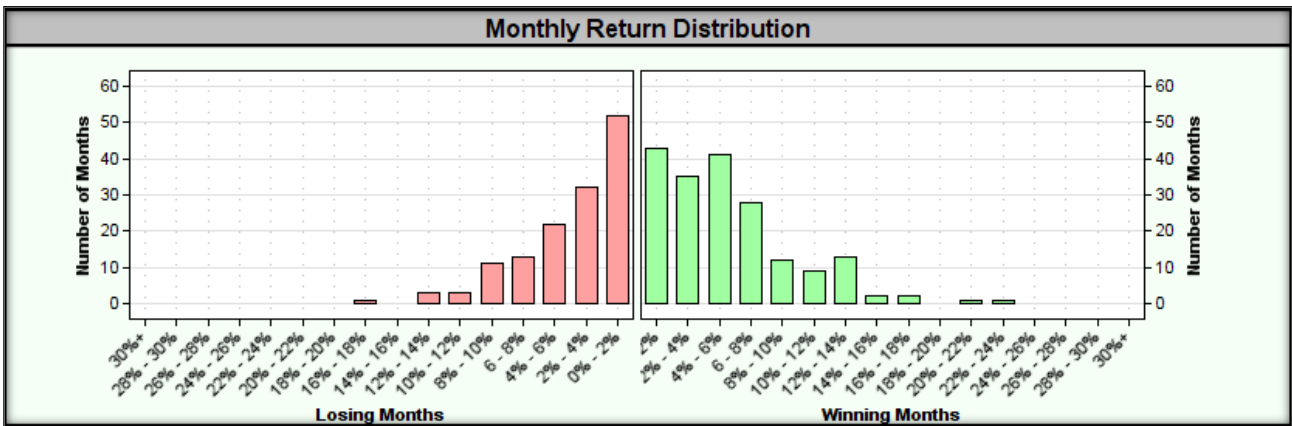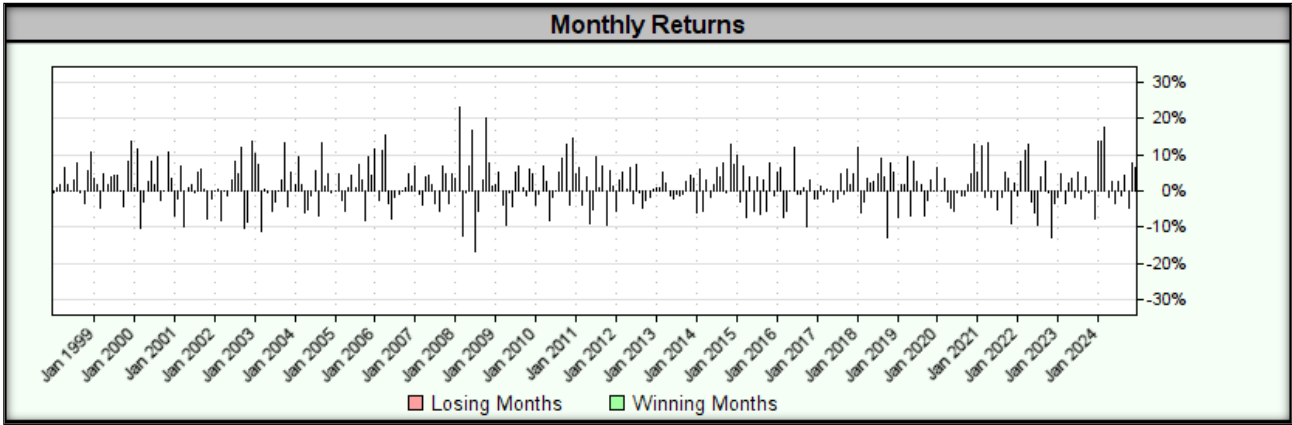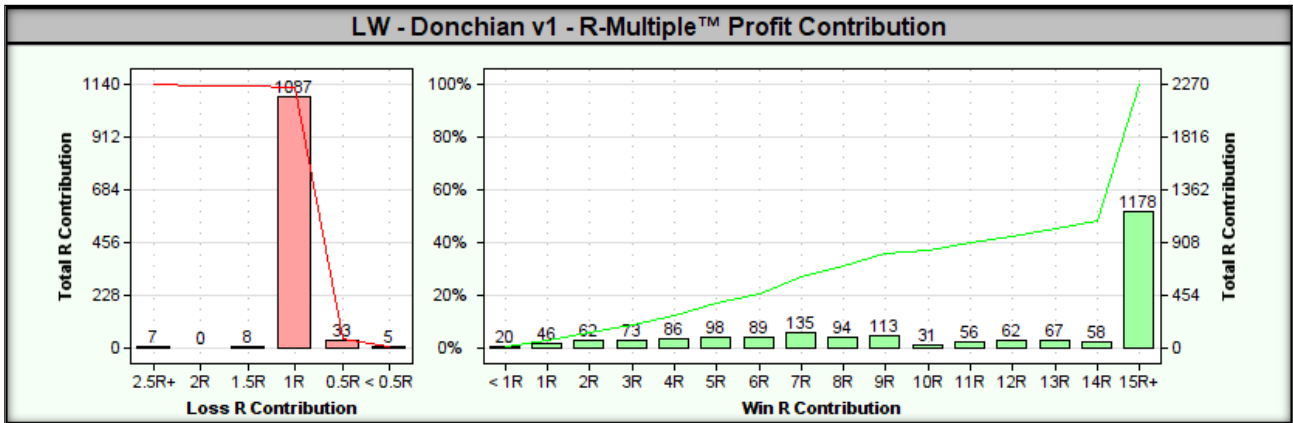
Performance Curve - Log Scale with Drawdowns

Monthly Returns

Losing Months Winning Months

Monthly Return Distribution

Losing Months   Winning Months

LW - Donchian v1 - R-Multiple™ Distribution

Losing Trades   Winning Trades

LW - Donchian v1 - R-Multiple™ Profit Contribution

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

- **Donchian Canal:** 112 days;
- **Stop loss order:** located 1.75 x ATR(40) away from the opening position;
- **Position size:** each position corresponds to a risk of 0.5% of the capital value;
- **Way of Opening a Position: Enter-On-Stop:**
    - **Buy stop order** placed **1 tick above** the upper border of the Donchian channel (for a long position);
    - **Sell stop order** placed **1 tick below** the lower border of the Donchian channel (for a short position);
- **Maximum number of open positions in different categories:**
    - **Highly correlated instruments:** 3 items;
    - **Moderately correlated instruments:** 6 items;
    - **Maximum number of positions in one direction:** 12 positions.

Step 5: Walk Forward Analysis

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

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

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

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

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

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

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

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

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

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

Walk Forward Optimization (WFO) parameters:

- **Objective function:** MAR;
- **Position size:** 0.5% of total capital;
- **Range of optimized parameters:**
  - **Donchian Channel:** 100-150 days (step: 2);
  - **Stop loss order:** 1.50-2.30 x ATR (step: 0.05);
- **How to open a position:**
  - **Buy stop order** placed **1 tick above** the upper border of the Donchian channel (for a long position);
  - **Sell stop order** placed **1 tick below** the lower border of the Donchian channel (for a short position);
- **Maximum number of open positions in different categories:**
  - **Highly correlated instruments:** 3 items;
  - **Moderately correlated instruments:** 6 items;
  - **Maximum number of positions in one direction:** 12 positions;
- **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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
4,113,177,550	17.74%	0.55	0.71	32.09%	23.00	1,368

Walk Forward Logarithmic Equity Curve

Walk Forward Equity Curve

Walk Forward Drawdown

Draw Down
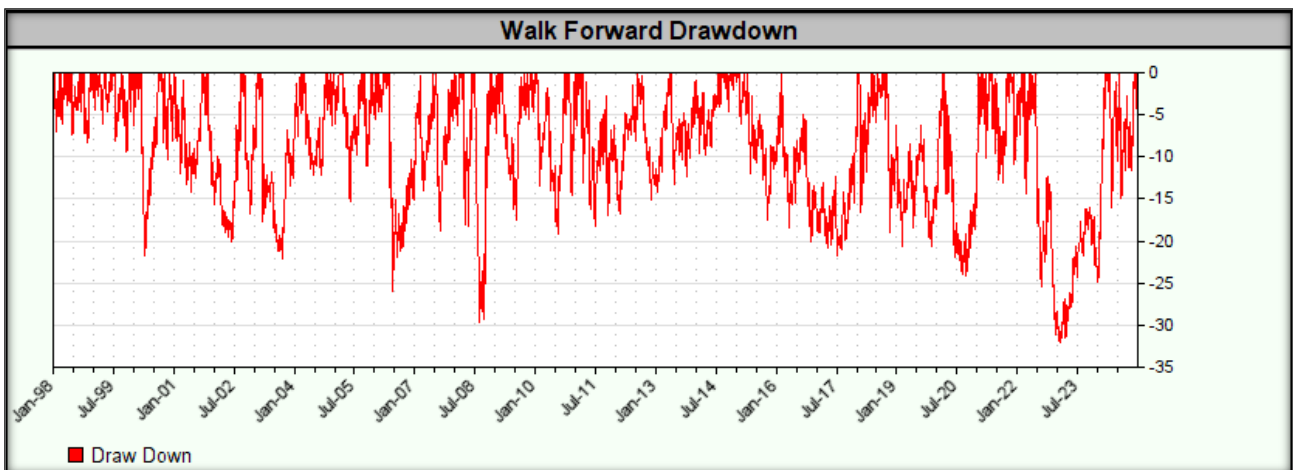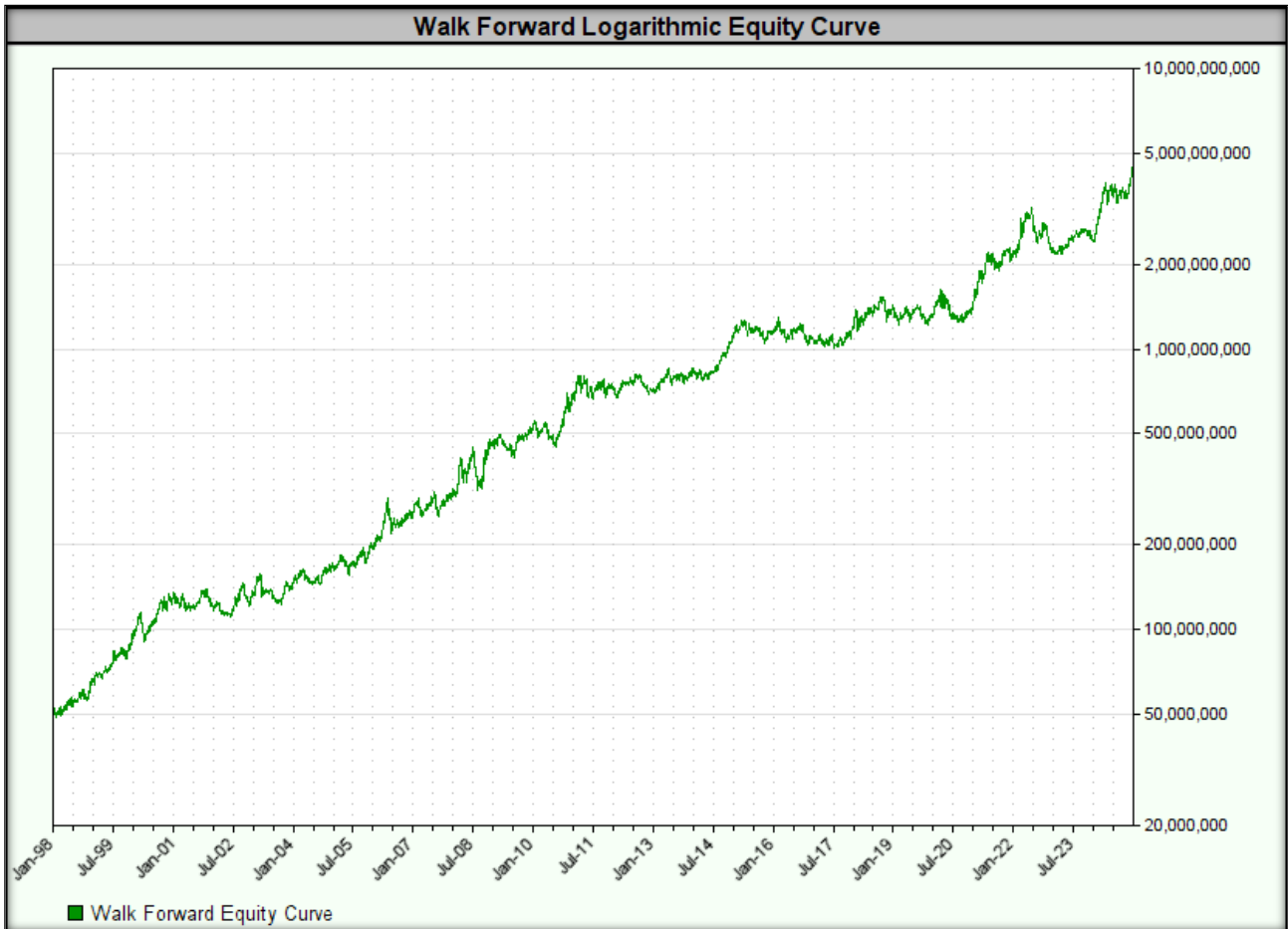
Optimization:	1095	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19971231	19981230	28.9%	33.1%	13.4%	8.3%	2.15	3.98
19981231	19991230	37.7%	47.3%	13.8%	9.4%	2.74	5.02
19991231	20001229	36.8%	34.6%	9.7%	21.7%	3.80	1.59
20010101	20011228	43.8%	-8.9%	22.0%	14.1%	1.99	- 0.63

20011231	20021227	21.9%	14.2%	20.2%	16.8%	1.09	0.85
20021230	20031229	13.3%	5.5%	16.6%	22.1%	0.80	0.25
20031230	20041228	12.7%	17.7%	16.0%	12.1%	0.80	1.46
20041229	20051228	16.8%	16.8%	15.7%	15.3%	1.07	1.10
20051229	20061228	13.5%	30.3%	19.1%	25.9%	0.71	1.17
20061229	20071228	23.5%	19.1%	28.5%	18.8%	0.82	1.02
20071231	20081226	18.3%	52.7%	28.3%	29.7%	0.65	1.77
20081229	20091225	29.8%	13.0%	29.9%	17.6%	1.00	0.74
20091228	20101227	21.8%	31.2%	29.7%	19.2%	0.73	1.63
20101228	20111227	27.5%	4.4%	23.2%	18.2%	1.19	0.24
20111228	20121226	21.9%	-2.0%	20.2%	15.1%	1.08	- 0.13
20121227	20131226	16.9%	20.4%	19.7%	13.3%	0.86	1.53
20131227	20141226	7.7%	30.8%	13.4%	8.9%	0.58	3.47
20141229	20151225	15.1%	2.5%	10.2%	17.4%	1.48	0.14
20151228	20161223	21.2%	-4.8%	17.3%	20.1%	1.23	- 0.24
20161226	20171225	12.4%	10.7%	15.3%	10.7%	0.81	1.00
20171226	20181225	6.0%	20.6%	21.6%	19.0%	0.28	1.08
20181226	20191225	19.5%	-9.2%	18.8%	15.4%	1.04	- 0.59
20191226	20201224	20.4%	7.4%	20.7%	24.1%	0.99	0.31
20201225	20211224	9.8%	52.2%	23.5%	13.1%	0.42	3.97
20211227	20221223	18.1%	6.7%	25.4%	31.1%	0.71	0.21
20221226	20231222	19.8%	7.9%	20.6%	8.4%	0.96	0.94
20231225	20241223	20.2%	72.2%	23.1%	16.0%	0.88	4.50
Mean		**20.6%**	**19.5%**	**19.8%**	**17.1%**	**0.69**	**0.63**
		WFE:	94.7%	WFE:	86.2%	WFE:	91.1%

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
3,235,577,180	17.39%	0.51	0.67	33.82%	33.97	1,411

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Walk Forward Drawdown

■ Draw Down
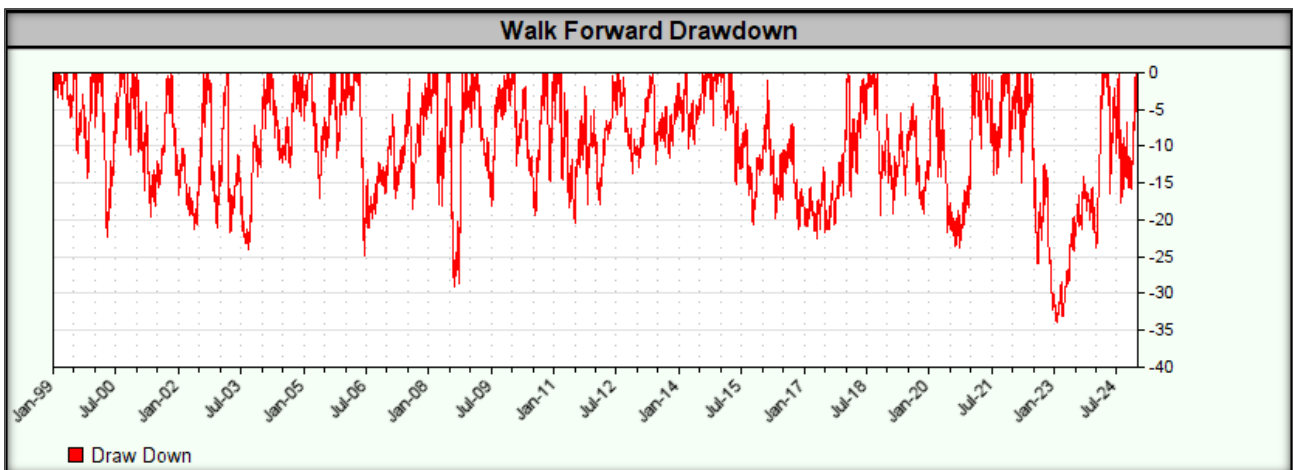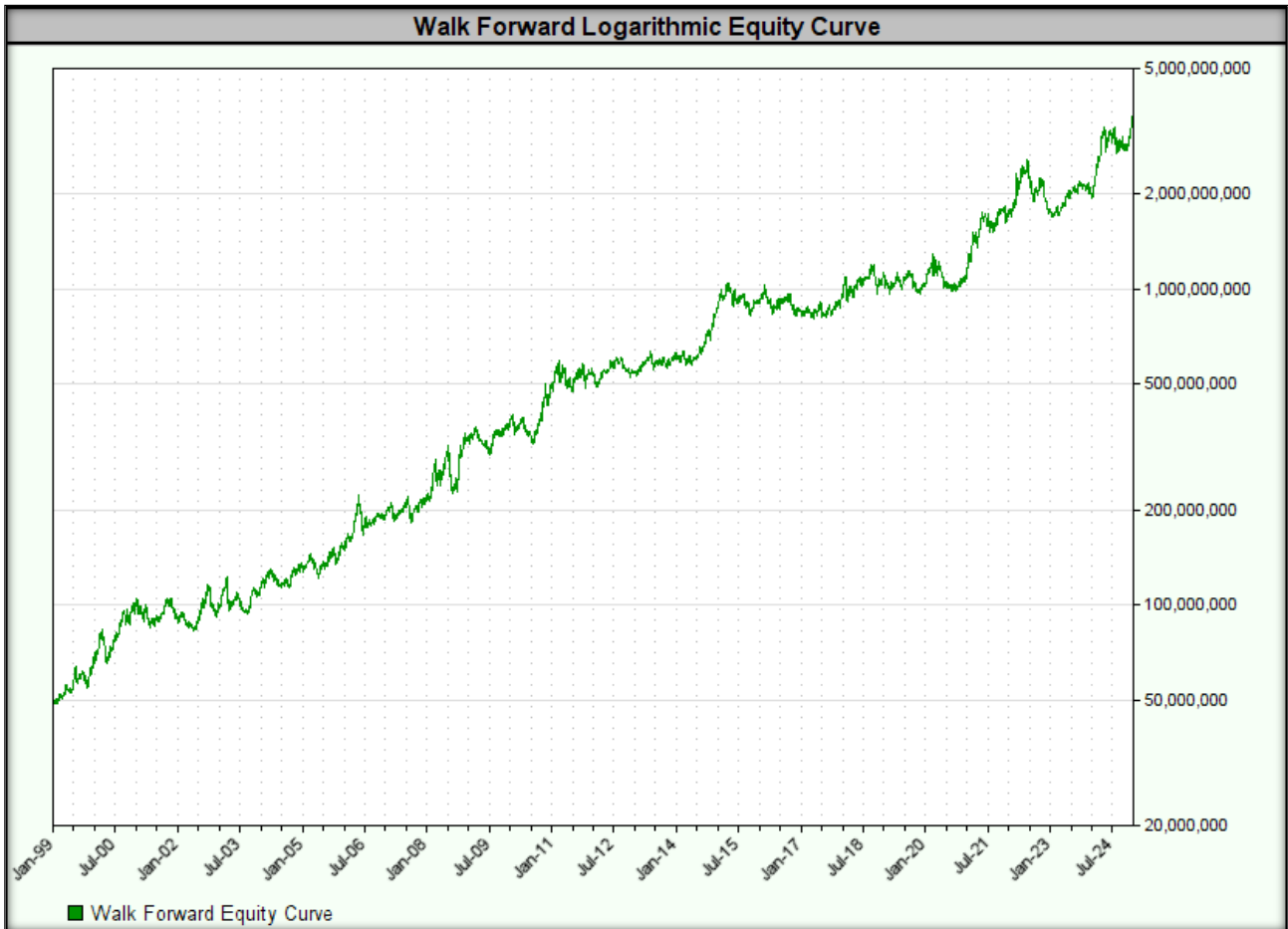
Optimization:	1460	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19981231	19991230	41.0%	40.3%	15.3%	14.3%	2.69	2.82
19991231	20001229	43.0%	46.2%	13.8%	22.4%	3.12	2.06
20010101	20011228	50.5%	-11.9%	22.1%	19.5%	2.29	- 0.61
20011231	20021227	28.0%	12.8%	22.0%	21.0%	1.27	0.61

20021230	20031229	19.4%	9.9%	20.2%	23.9%	0.96	0.41
20031230	20041228	12.4%	19.4%	15.2%	12.9%	0.81	1.51
20041229	20051228	13.9%	14.9%	16.0%	17.0%	0.86	0.87
20051229	20061228	16.8%	24.4%	15.7%	24.9%	1.07	0.98
20061229	20071228	18.7%	14.5%	28.5%	17.7%	0.66	0.82
20071231	20081226	22.5%	57.4%	28.5%	29.1%	0.79	1.97
20081229	20091225	24.9%	10.7%	29.0%	18.2%	0.86	0.59
20091228	20101227	25.2%	31.8%	29.9%	19.3%	0.84	1.65
20101228	20111227	23.9%	7.2%	29.0%	20.4%	0.82	0.35
20111228	20121226	24.3%	2.3%	25.7%	13.6%	0.95	0.17
20121227	20131226	16.6%	15.1%	20.5%	12.5%	0.81	1.21
20131227	20141226	16.4%	40.2%	19.7%	10.4%	0.83	3.88
20141229	20151225	13.2%	3.3%	13.8%	20.5%	0.96	0.16
20151228	20161223	14.5%	-5.8%	16.8%	20.4%	0.87	- 0.29
20161226	20171225	12.7%	11.7%	15.4%	10.0%	0.82	1.17
20171226	20181225	15.5%	18.2%	16.3%	19.5%	0.95	0.93
20181226	20191225	10.8%	-8.1%	20.0%	15.5%	0.54	- 0.52
20191226	20201224	15.1%	7.5%	19.8%	23.8%	0.77	0.31
20201225	20211224	16.7%	53.3%	24.4%	13.8%	0.68	3.86
20211227	20221223	18.8%	4.7%	23.5%	32.2%	0.80	0.14
20221226	20231222	18.6%	13.0%	28.1%	8.7%	0.66	1.49
20231225	20241223	19.0%	65.8%	31.3%	17.8%	0.61	3.70
Mean		**21.2%**	**19.2%**	**21.6%**	**18.4%**	**0.68**	**0.60**
		WFE:	**90.3%**	**WFE:**	**85.5%**	**WFE:**	**87.8%**

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
1,506,884,800	14.59%	0.42	0.56	34.69%	23.20	1,398

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Walk Forward Drawdown

■ Draw Down
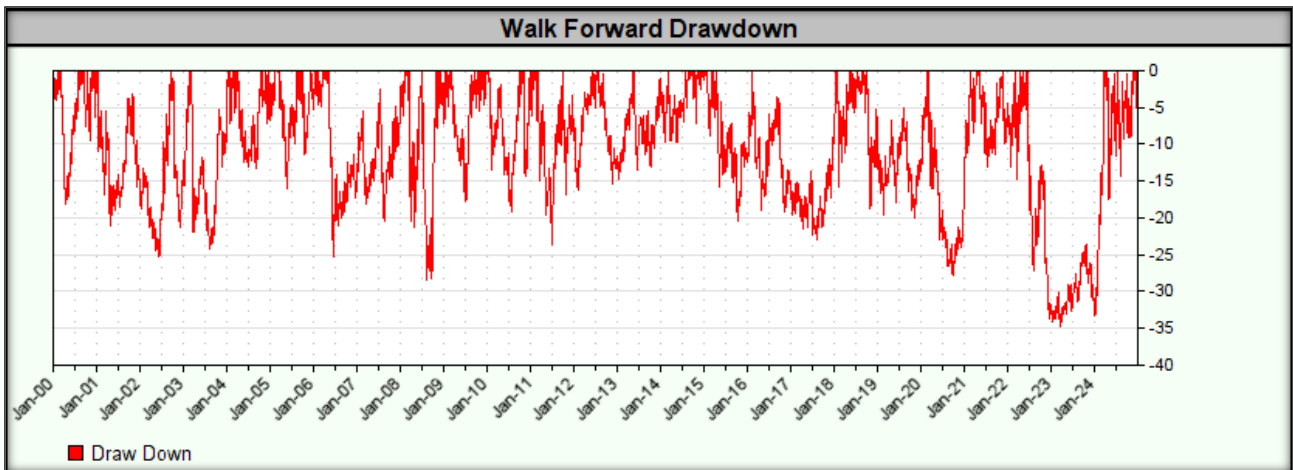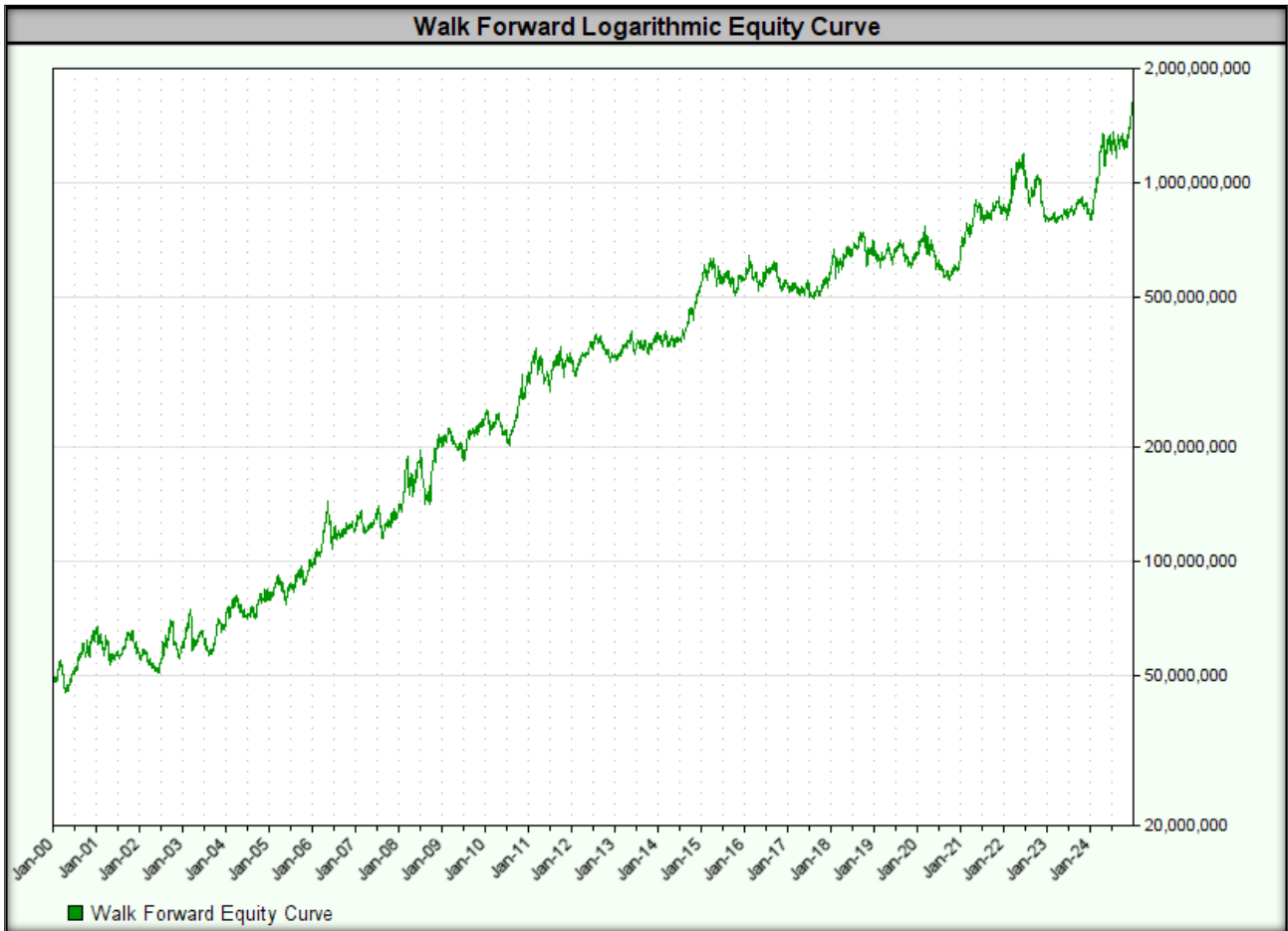
Optimization:	1825	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19991231	20001229	43.6%	32.6%	15.1%	18.2%	2.90	1.79
20010101	20011228	44.1%	-14.7%	22.2%	21.0%	1.99	- 0.70
20011231	20021227	35.3%	8.7%	22.1%	21.4%	1.60	0.41
20021230	20031229	24.3%	12.9%	21.0%	24.2%	1.15	0.53

20031230	20041228	17.4%	19.8%	19.3%	13.2%	0.90	1.49
20041229	20051228	13.2%	18.3%	15.2%	15.9%	0.87	1.15
20051229	20061228	14.4%	24.4%	16.0%	25.2%	0.90	0.97
20061229	20071228	21.4%	10.4%	28.3%	18.5%	0.76	0.56
20071231	20081226	18.6%	57.0%	28.5%	28.5%	0.65	2.00
20081229	20091225	28.4%	12.8%	30.0%	17.7%	0.95	0.72
20091228	20101227	22.0%	30.2%	29.0%	19.2%	0.76	1.57
20101228	20111227	26.4%	8.7%	29.9%	23.5%	0.88	0.37
20111228	20121226	21.8%	3.0%	30.4%	15.4%	0.72	0.19
20121227	20131226	19.8%	16.4%	25.7%	13.4%	0.77	1.22
20131227	20141226	16.5%	33.8%	20.2%	9.7%	0.82	3.50
20141229	20151225	20.7%	3.2%	19.7%	20.5%	1.05	0.16
20151228	20161223	12.7%	-2.1%	18.3%	19.2%	0.70	- 0.11
20161226	20171225	10.7%	6.8%	15.3%	10.8%	0.70	0.63
20171226	20181225	15.3%	21.6%	16.5%	18.7%	0.92	1.16
20181226	20191225	19.1%	-8.6%	19.8%	15.8%	0.96	- 0.55
20191226	20201224	12.0%	-2.8%	29.1%	27.8%	0.41	- 0.10
20201225	20211224	12.5%	35.6%	23.7%	13.1%	0.53	2.71
20211227	20221223	22.5%	-3.8%	24.4%	33.7%	0.92	- 0.11
20221226	20231222	11.5%	1.2%	21.1%	9.9%	0.54	0.12
20231225	20241223	14.5%	88.1%	29.9%	17.5%	0.48	5.02
Mean		**20.7%**	**16.5%**	**22.8%**	**18.9%**	**0.68**	**0.49**
	WFE:	**79.7%**	**WFE:**	**82.7%**	**WFE:**	**71.8%**	

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
2,849,498,477	17.17%	0.51	0.64	33.97%	22.80	1,415

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Walk Forward Drawdown

■ Draw Down
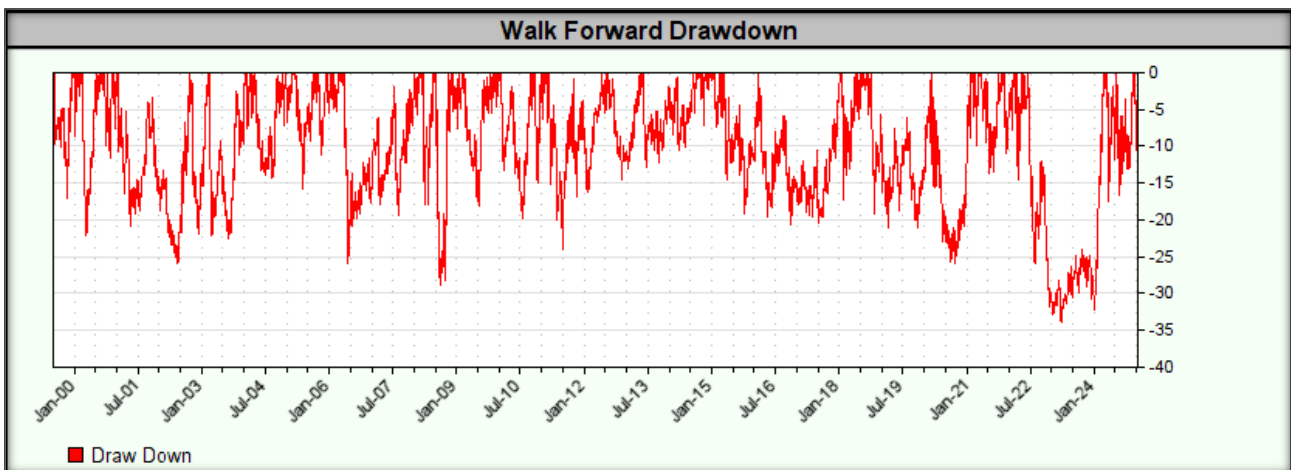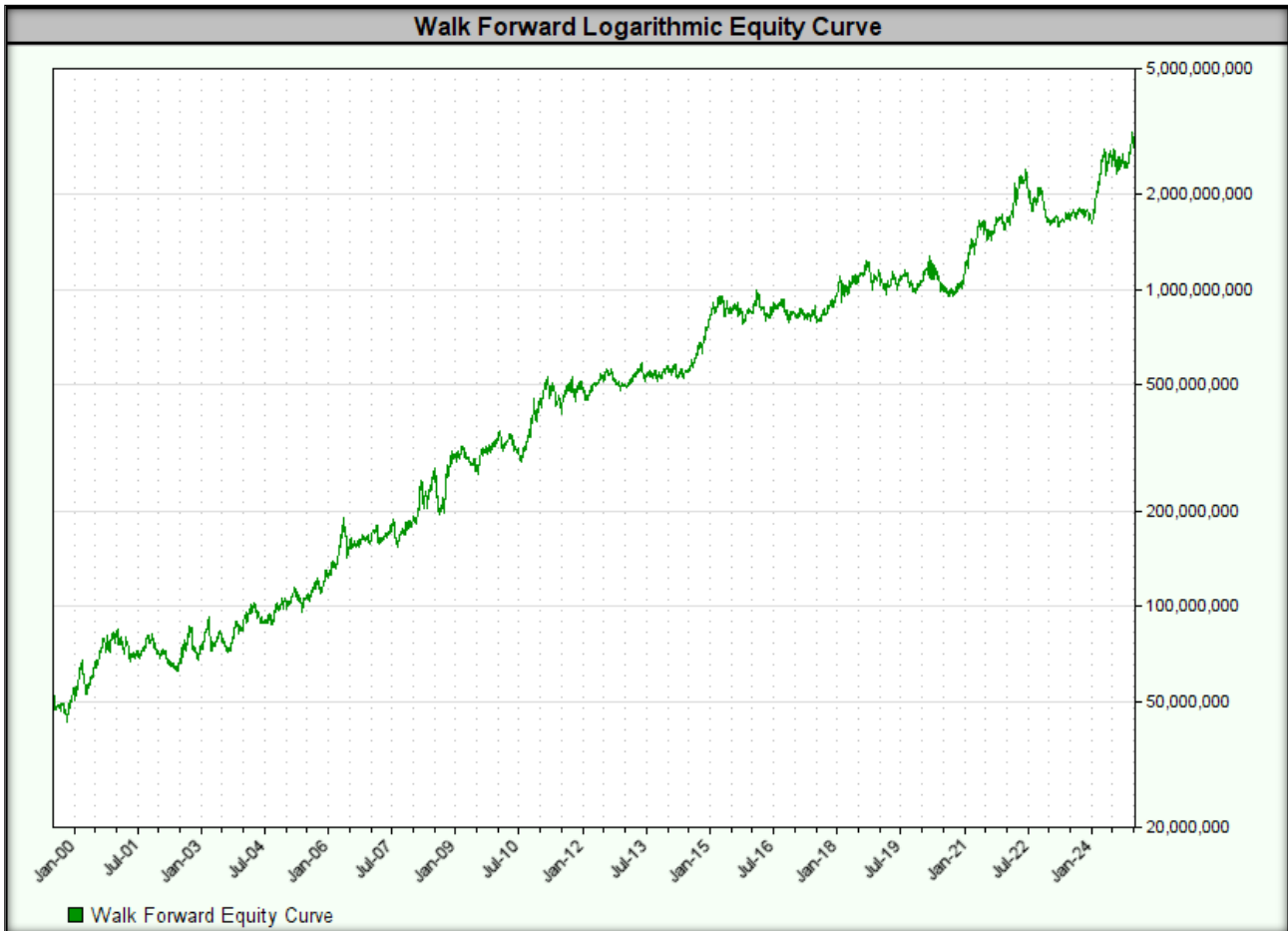
Optimization:	1644	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
19990705	20001229	41.3%	40.3%	15.1%	22.0%	2.74	1.83
20010101	20020702	52.0%	-12.4%	22.2%	25.9%	2.34	- 0.48
20020703	20040101	25.0%	19.9%	22.0%	22.6%	1.13	0.88
20040102	20050701	15.7%	13.4%	19.2%	15.8%	0.82	0.85

20050704	20070101	12.4%	31.3%	16.0%	25.8%	0.77	1.21
20070102	20080702	21.6%	42.5%	28.8%	17.9%	0.75	2.37
20080703	20100101	30.8%	15.4%	28.5%	28.9%	1.08	0.53
20100104	20110701	28.8%	12.6%	30.0%	23.9%	0.96	0.53
20110704	20130101	19.5%	15.2%	29.0%	16.2%	0.67	0.94
20130102	20140703	24.5%	7.7%	21.4%	12.8%	1.14	0.60
20140704	20160101	11.3%	31.8%	18.2%	19.1%	0.62	1.66
20160104	20170703	16.0%	-2.9%	18.2%	20.7%	0.88	- 0.14
20170704	20190102	11.4%	24.6%	16.2%	19.2%	0.71	1.28
20190103	20200703	23.6%	-7.9%	19.8%	23.0%	1.19	- 0.34
20200706	20211231	12.0%	39.8%	21.8%	13.6%	0.55	2.93
20220103	20230704	24.7%	3.7%	23.6%	34.0%	1.05	0.11
20230705	20241231	17.1%	40.6%	31.8%	17.4%	0.54	2.33
Mean		**22.8%**	**18.6%**	**22.5%**	**21.1%**	**0.72**	**0.55**
		WFE:	**81.4%**	**WFE:**	**93.9%**	**WFE:**	**76.3%**

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.**

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
1,648,433,955	15.15%	0.49	0.57	31.01%	23.20	1,408

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Walk Forward Drawdown

■ Draw Down
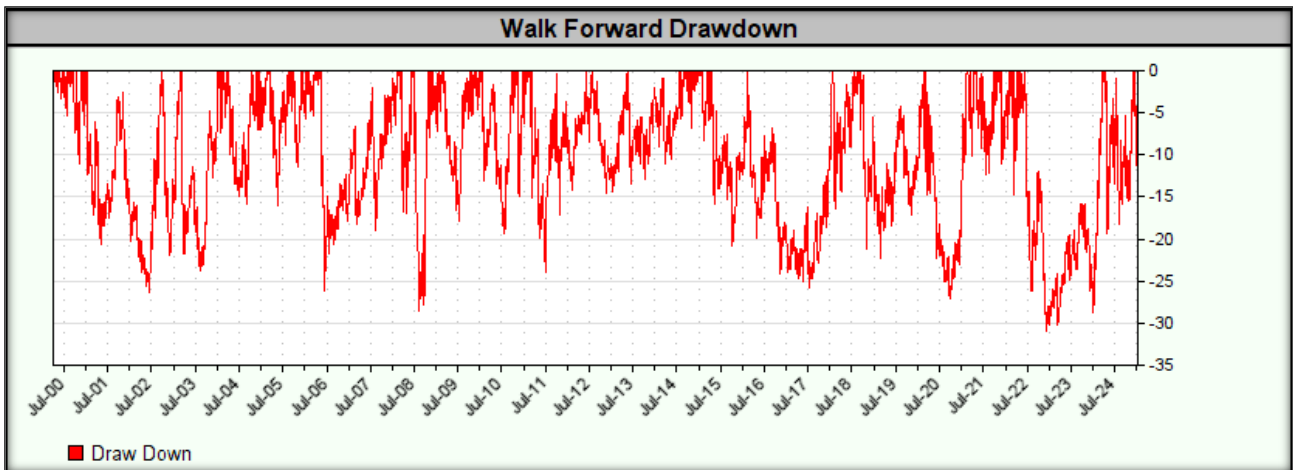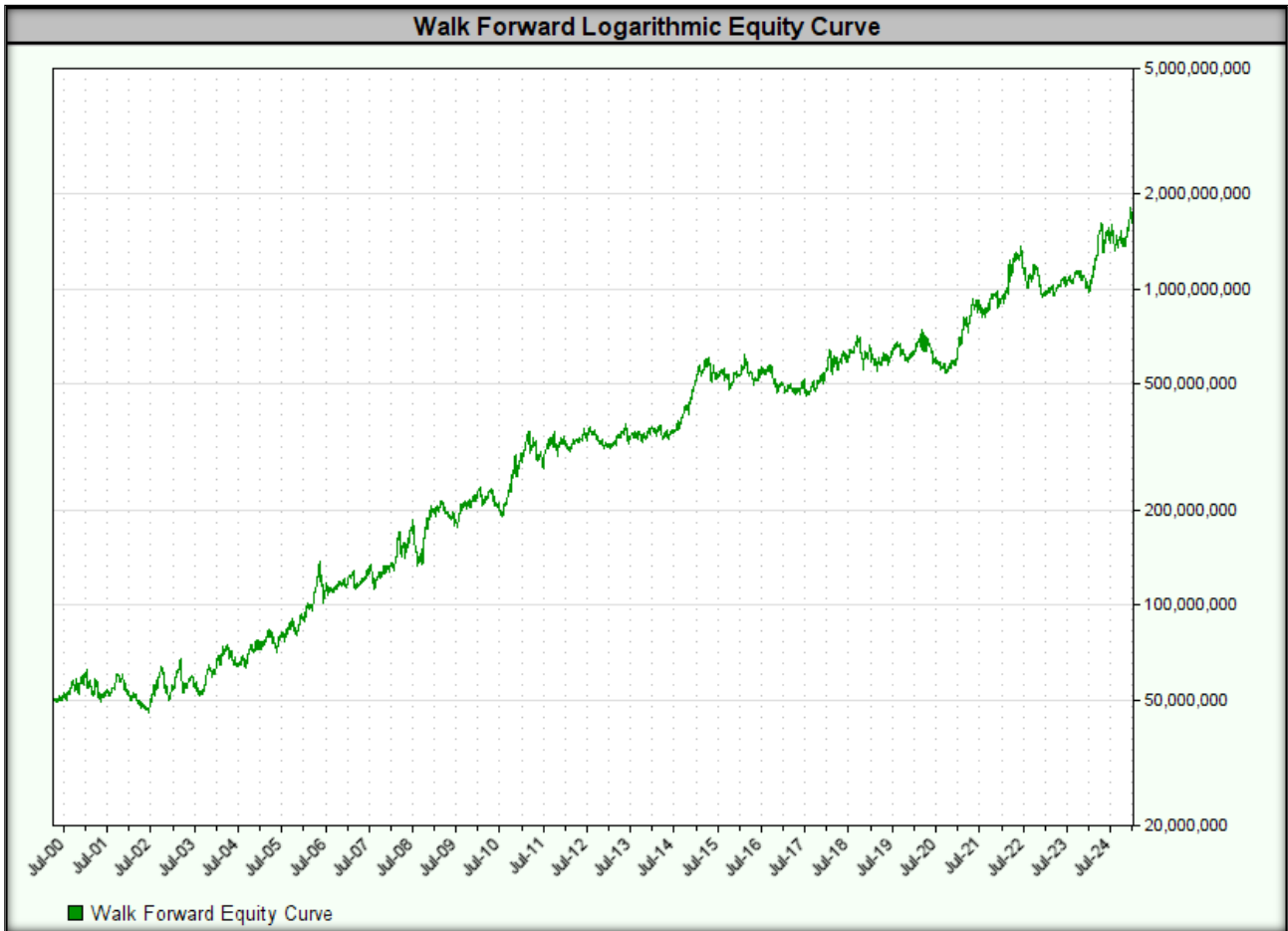
Optimization:	1918	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20000403	20011001	42.2%	13.3%	15.1%	20.6%	2.80	0.64
20011002	20030402	43.2%	-6.1%	22.1%	24.5%	1.96	- 0.25
20030403	20041001	22.6%	19.4%	21.0%	15.9%	1.07	1.22
20041004	20060331	15.0%	31.1%	19.2%	16.1%	0.78	1.94

20060403	20071002	17.0%	10.7%	16.0%	26.2%	1.06	0.41
20071003	20090402	20.4%	35.8%	28.8%	28.5%	0.71	1.26
20090403	20101001	26.6%	11.2%	30.0%	19.4%	0.89	0.58
20101004	20120402	24.6%	28.4%	30.0%	23.9%	0.82	1.19
20120403	20131002	21.6%	-0.6%	30.5%	14.6%	0.71	- 0.04
20131003	20150403	21.4%	44.1%	21.4%	10.3%	1.00	4.26
20150406	20160930	20.2%	-3.8%	18.3%	20.8%	1.10	- 0.18
20161003	20180403	15.9%	2.1%	18.2%	16.4%	0.88	0.12
20180404	20191003	14.4%	7.6%	16.2%	22.2%	0.89	0.34
20191004	20210402	19.5%	15.1%	19.8%	27.0%	0.99	0.56
20210405	20221003	17.5%	30.6%	24.0%	26.2%	0.73	1.17
20221004	20240403	25.9%	20.4%	25.4%	21.7%	1.02	0.94
20240404	20241231	23.6%	11.4%	31.4%	19.4%	0.75	0.59
Mean		**23.0%**	**15.9%**	**22.8%**	**20.8%**	**0.73**	**0.56**
		WFE:	69.1%	WFE:	91.4%	WFE:	76.1%

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
2,024,213,631	16.65%	0.48	0.62	35.05%	22.97	1,380

Walk Forward Logarithmic Equity Curve

■ Walk Forward Equity Curve

Walk Forward Drawdown

■ Draw Down
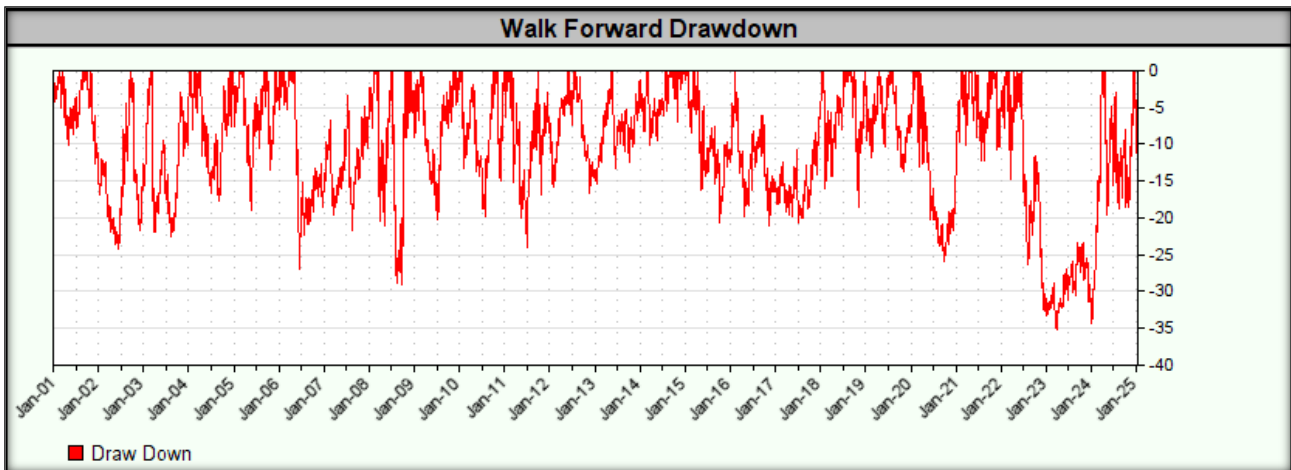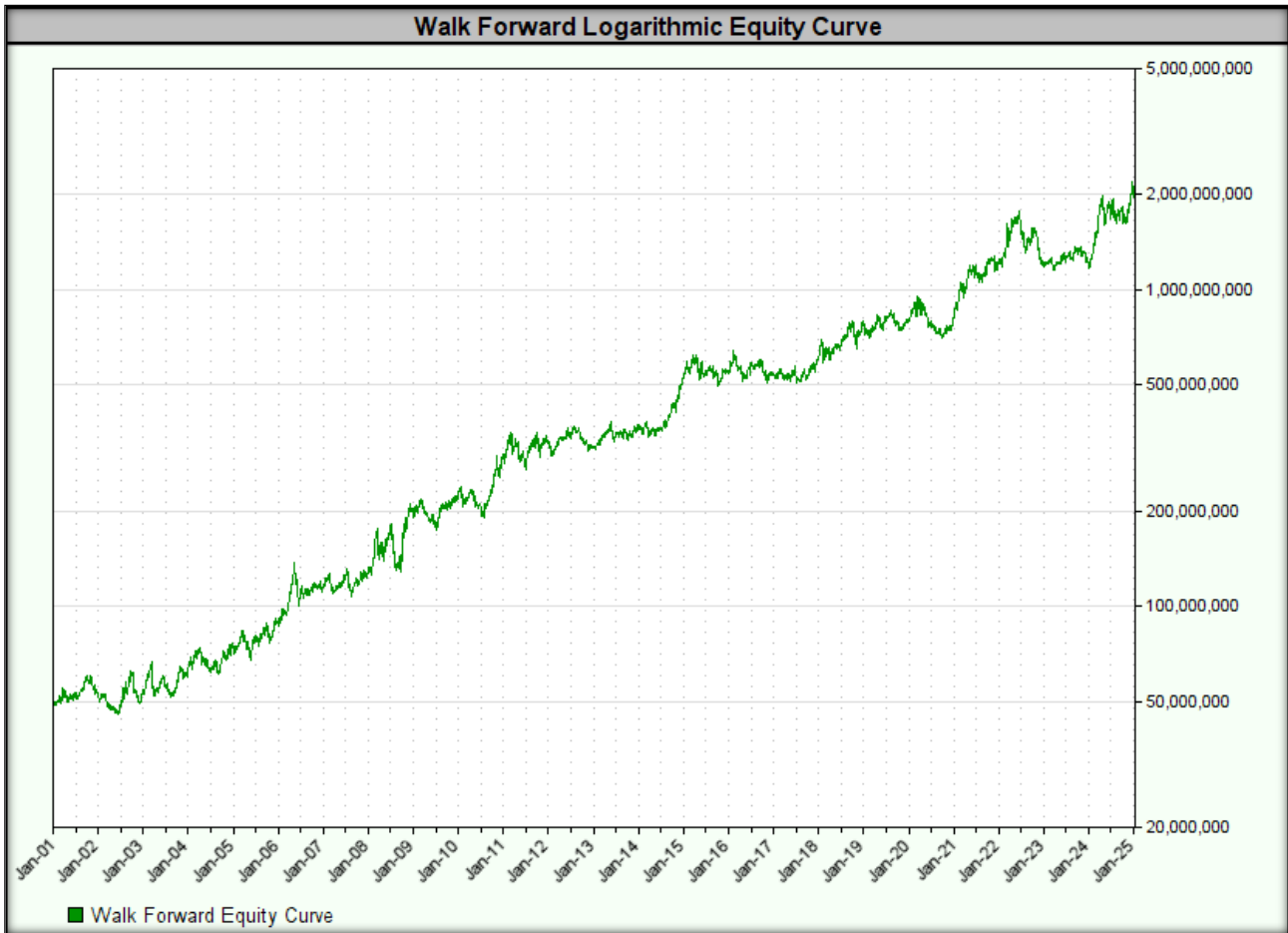
Optimization:	2192	CAGR%		Max DD		MAR	
WFA:	**548**	**Projections**	**Real**	**Projections**	**Real**	**Projections**	**Real**
20010101	20020702	44.3%	-0.6%	21.6%	24.3%	2.05	- 0.03
20020703	20040101	34.1%	18.4%	22.1%	22.6%	1.54	0.82
20040102	20050701	23.5%	14.8%	22.2%	19.0%	1.06	0.78
20050704	20070101	14.5%	28.4%	19.2%	27.0%	0.75	1.05

20070102	20080702	19.2%	36.4%	28.4%	21.1%	0.68	1.73
20080703	20100101	27.2%	15.9%	28.8%	29.0%	0.94	0.55
20100104	20110701	26.0%	12.6%	30.0%	23.9%	0.87	0.53
20110704	20130101	25.2%	11.9%	30.7%	16.8%	0.82	0.71
20130102	20140703	18.4%	9.1%	30.5%	13.2%	0.60	0.69
20140704	20160101	19.9%	31.2%	21.4%	20.6%	0.93	1.51
20160104	20170703	15.7%	-3.1%	18.7%	21.0%	0.84	- 0.15
20170704	20190102	11.5%	31.2%	16.6%	18.4%	0.69	1.69
20190103	20200703	18.2%	-1.6%	19.8%	20.1%	0.92	- 0.08
20200706	20211231	16.3%	36.4%	22.2%	12.2%	0.73	2.97
20220103	20230704	18.6%	3.5%	24.0%	35.1%	0.78	0.10
20230705	20250102	20.1%	35.8%	28.4%	19.7%	0.71	1.82
Mean		**22.0%**	**17.5%**	**24.0%**	**21.5%**	**0.72**	**0.50**
		WFE:	**79.5%**	**WFE:**	**89.5%**	**WFE:**	**69.7%**

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 80%-90%,** which indicates high performance of the strategy in real conditions. **One of the six tests had WFE below 80%.**
- **The WFE for drawdown remains around 80%-100%,** which means that the strategy does not lose significant stability outside of the optimization period.

Apart from the tests **for the 1825/365 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:

- **Donchian Canal:** 150 days;
- **Stop loss order:** 2.15 x ATR(40).

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:**

	WFA	Optimized
CAGR%	17.7%	18.1%
MAR Ratio	0.55	0.59
Max Drawdown	32.1%	30.5%

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

To sum up, after all the tests, **the strategy for 2025 has been optimized to the following parameters:**

- **Donchian Channel:** 150 days;
- **Stop loss order:** located 2.15 x ATR(40) away from the position opening point;
- **Position size:** each position corresponds to a risk of 0.5% of the capital value;
- **Way of Opening a Position: Enter-On-Stop:**
  - **Buy stop order** placed **1 tick above** the upper border of the Donchian channel (for a long position);
  - **Sell stop order** placed **1 tick below** the lower border of the Donchian channel (for a short position);
- **Maximum number of open positions in different categories:**
  - **Highly correlated instruments:** 3 items;
  - **Moderately correlated instruments:** 6 items;
  - **Maximum number of positions in one direction:** 12 positions.

Step 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.