



Double 7s v.1

Investment Strategy Testing Summary

The **Double 7s strategy** is a **swing trading** technique that capitalizes on **short-term** downward corrections (multi-day lows) in an instrument that is in **an uptrend** (quotes above **its long-term moving average**). The key idea of the strategy is **to open long positions during a correction** and then **close them out after the price rises**.

The **optimal optimization window** for WFA tests is **730/183 days**, and the results are for the period **01/01/1995 – 31/12/2024** haughty:

- **Item size:** corresponding to a risk of 1.0% of the total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- **CAGR:** 8.2%
- **MAR:** 0.32;
- **Maximum drawdown:** 25.7%.

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

- **Length of the moving average (SMA):** 85 days;
- **Highest/lowest close (Donchian channel):** 19 days.

It is worth noting that **with a position size of 1.0% of equity, the drawdown in 99% of Monte Carlo simulations was 50% or less**, which compares **favorably to the in-sample and out-of-sample data**, where the drawdown was 24.2%. Ultimately, **position sizing should be adjusted to an acceptable drawdown level consistent with the individual risk profile**.

The strategy passed both **stability tests and Walk-Forward Analysis (WFA) tests**, indicating that the strategy can be **considered as a swing trading strategy in an investment portfolio**. However, **it has some significant limitations** that should be considered:

- **Relatively low MAR** compared to a trend-following strategy. However, the goal of this strategy is different than that of a trend-following strategy.
- **Large drawdown during a period of strong stock market declines (COVID)**, which means vulnerability to sudden market changes.
- **Significant decrease in CAGR% in Monte Carlo simulation**, from 7.5% to 2.5% calculated for 99% confidence interval.

Despite these limitations, the Double 7s v.1 strategy **can be an effective tool for investors who prefer swing trading strategies**, as it remains stable across a variety of market conditions and a wide range of parameters. **I cannot emphasize enough that for a strategy to work in real-world conditions, it must also perform under suboptimal parameters and conditions.** In short, **it must be stable** to changing market conditions.



I don't know who said these words, but they perfectly capture 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.



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Step 1: Formulate an investment strategy

The Double 7s strategy was introduced by Larry Connors and Cesar Alvarez as an ultra-simple, systematic **mean-reversion concept** in the **major stock indices market**. Its idea is **to buy short-term, seven-day lows in a strong uptrend** and exit the position when the market **reaches a seven-day high**.

The aim of the strategy is **to join the retracement after a short-term, sharp price drop** within a dominant uptrend.

The strategy uses:

- **SMA Direction Filter** – trades only when the closing price is above the long-term moving average;
- **Price extreme** – a buy signal appears after closing at the lowest level of the last few sessions;
- **Predetermined exit** – the position is closed at the highest level of the last few sessions;
- **No additional indicators** – the entire logic is contained in three rules (trend, entry, exit).

Characteristics of the strategy and its strengths and weaknesses:

- **Minimalistic, easy to program** – three simple rules ensure transparency and low computational costs;
- **Strong statistical advantage** – historically high percentage of accurate signals with low exposure time;
- **Natural mean-reversion environment** – large indices often rebound after a sharp decline within a trend;
- **Risk in strong bear markets** – when the price falls below the SMA, the filter completely turns off the system, so the strategy does not make money on bear market rebounds;
- **No stop losses** – open risk during sudden crashes requires additional capital management solutions;
- **Fewer transactions in sideways trends** – in the absence of clear multi-day extremes, the system remains out of position for a long time.

The Double 7s strategy, despite its extreme simplicity, provides a **solid foundation for building algorithmic portfolios**. However, it requires **discipline and the potential addition of independent risk limiters** (e.g., ATR stops or maximum allocation).



Step 2: Determine investment principles

Below is the pseudocode for the **Double 7s v.1 strategy** on daily data:

1. Calculating Indicators:

- a. **XXX-SMA** – XXX-day moving average of the closing price.
- b. **Y-DayLowestClose** – the lowest closing price from the last Y sessions (including the current one).
- c. **Y-DayHighestClose** – the highest closing price from the last Y sessions (including the current one).

2. Generating Entry Signals – Long Position:

- a. It is opened only when the market is in an uptrend ($\text{Price} > \text{XXX-SMA}$) and the closing price of the instrument is the lowest in Y days (**Y-DayLowestClose**), which indicates an oversold condition.
- b. The position is opened for the opening of the next day on which the conditions are met.

3. Generating Output Signals:

- a. The position is closed when the instrument's closing price is the highest in Y days (**Y-DayHighestClose**).
- b. The closing occurs at the opening price of the next day, after the signal is generated.

4. Loss Management:

- a. Loss orders, which means that potential losses are not limited by automatic position closure.
- b. This is an important consideration for risk management and requires discipline from the trader and the possible introduction of their own capital protection mechanisms.

5. Daily Monitoring:

- a. Every day the XXX-SMA, Y-DayLowestClose and Y-DayHighestClose values are calculated.
- b. The system checks whether entry or exit conditions are met and takes appropriate action the following day upon opening.

6. Additional Notes:

- a. **No Short Positions:** The strategy focuses solely on long positions in an uptrend.
- b. **Financial Instruments:** For the purposes of this test, **long positions on stock indices, bonds, gold and the dollar index were used.**

The above rules are 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 a **hypothetical stop loss order located 2 x ATR (40 days)** away from the position opening point.



Step 3: Pre-test your investment strategy

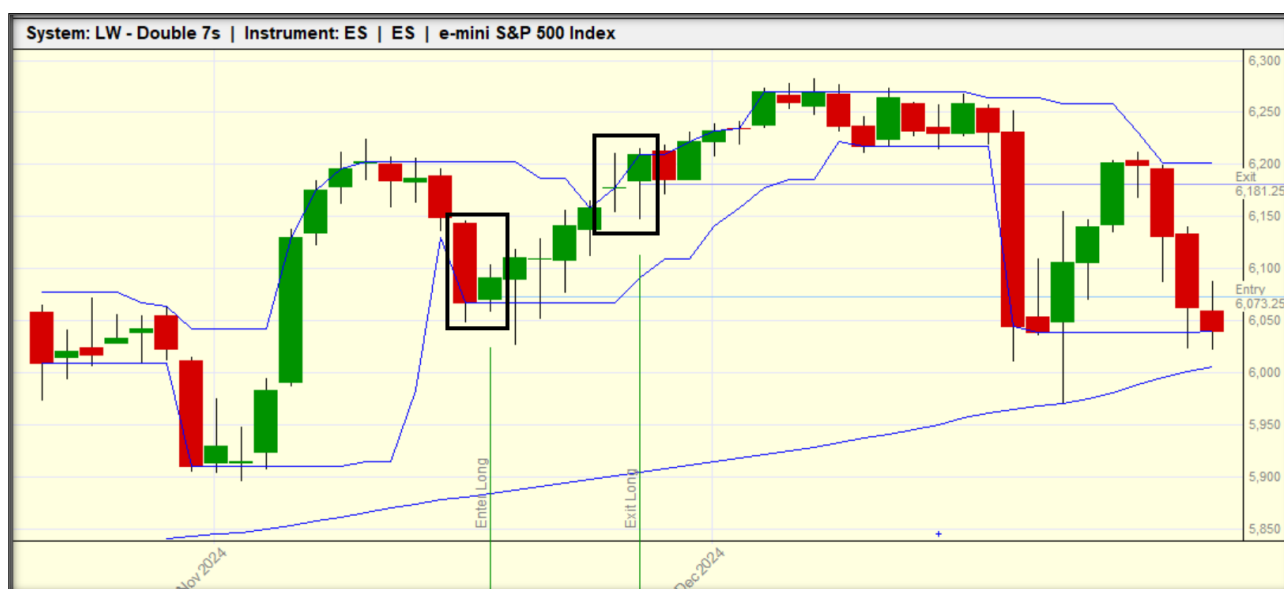
Below are some purchase and sale transactions that allow you to verify the following aspects:

- **Correctness of generated signals;**
- **Direction of opening a position;**
- **Moment of opening the position;**
- **The opening price of the position;**
- **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 doesn't matter** whether the trades are **profitable**, what **instrument was used**, or whether they occurred **recently** or **in the distant past**. The key is **to verify that the trades are generated correctly** and in line with the assumptions described in the previous step.

The first transaction was executed on an S&P 500 index futures contract (e-mini). The lowest/highest closing price over the last 7 days is shown on the chart as a channel. In mid-November 2024, the price was above **the 100-day moving average**, and the contract closed at a 7-day low (**the first candle in the left-hand rectangle**), which triggered a signal to open a long position. The position was opened the following day at the opening price (**the second candle in the left-hand rectangle**).

The quotes immediately entered an upward trend, and after a few days, the contract's closing price reached a seven-day high (**the first candle in the right-hand rectangle**), which generated a signal to close the long position. The position was closed the following day at the opening price (**the second candle in the right-hand rectangle**). **The system worked correctly.**





Once we've verified that trades are being generated correctly, we can proceed to our first test of the strategy on the full **in-sample** dataset. These tests are conducted on **baseline parameters** that, in my opinion, should align with the strategy's stated goals.

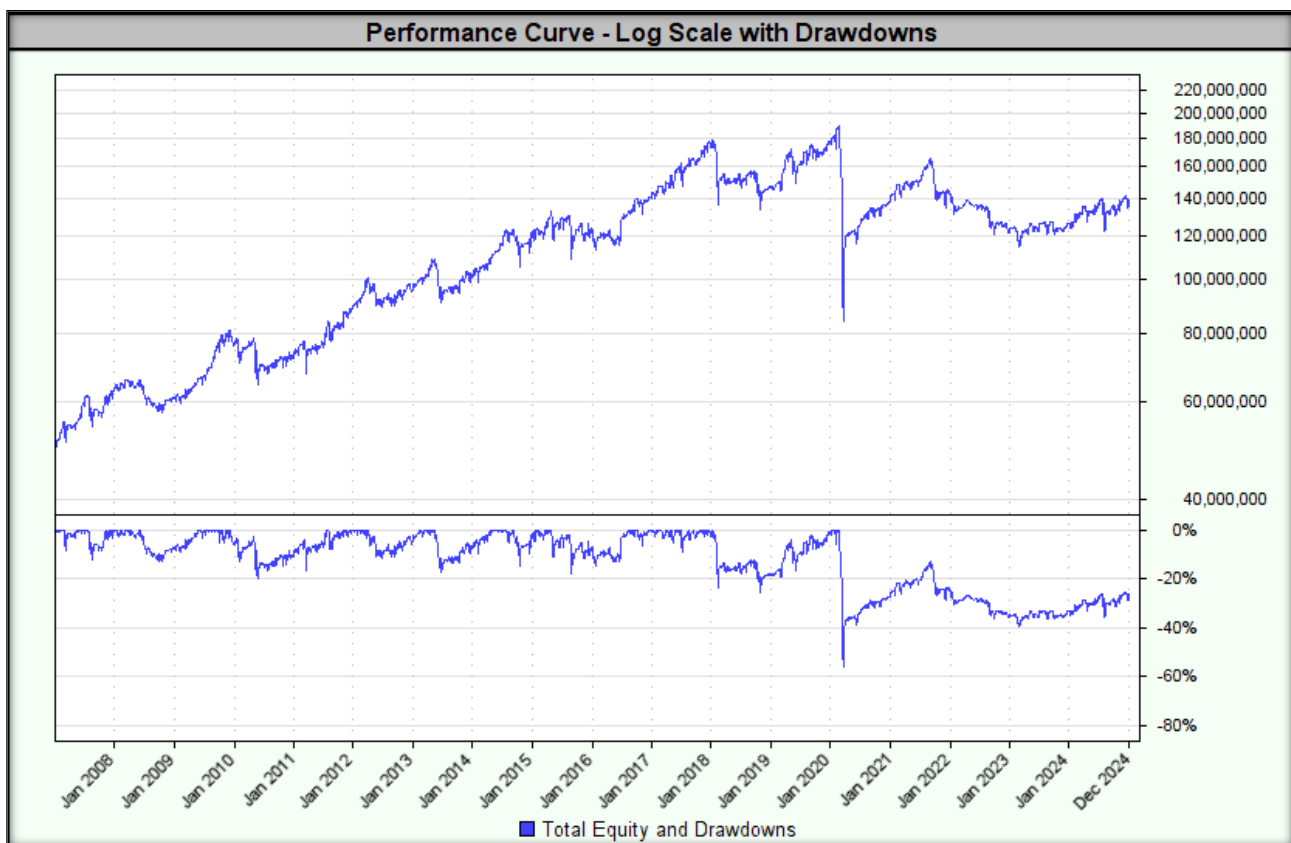
First, **we reject strategies that linearly lose capital**. If a strategy exhibits this pattern, it's a clear signal that any parameter optimization is pointless.

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

Tested base parameters:

- **Length of the moving average (SMA):** 100 days;
- **Highest/lowest close (Donchian channel):** 7 days;
- **Stop loss:** none;
- **Position opening method:** at the opening price of the next day;
- **Position size:** corresponding to a risk of 1.0% of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- **Position direction:** long positions (buy) only.

The test result is shown below.



Indicators/Measures	Concluding a transaction at the opening price
CAGR%	5.7%
MAR Ratio	0.10



RAR%	5.6%
R-Cubed	0.10
Robust Sharpe Ratio	0.41
Max Drawdown	55.6%
Wins	69.4%
Losses	30.6%
Average Win%	0.61%
Average Loss%	1.05%
Win/Loss Ratio	0.58
Average Trade Duration (days)	14
Percent Profit Factor	1.31
SQN	-
Number of transactions	1227

In summary, the system is working properly and generating signals as expected. Furthermore, tests on the baseline parameters yielded satisfactory results. We can now move on to the most interesting stage of creating an investment strategy – **optimization**.



Step 4: Optimizing and assessing the stability of the investment strategy

This stage of strategy development and testing is crucial because it determines how **effective** the strategy will be in **real-world conditions**. I cannot emphasize enough that for a strategy to work in real-world conditions, it must also perform under suboptimal parameters and conditions. In short, **it must be stable** to changing market conditions.

I don't know who said these words, but they perfectly capture 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 topic of consideration in **Step 5, "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

Double 7s Strategy v.1 in this version it assumes **optimization of parameters using The Grid method Search**. It involves **fully optimizing all specified parameters by creating a wide range of possible combinations**. Our goal is to find **parameter ranges** that will ensure **the strategy remains stable (robust)**, allowing us to assess its suitability in real market conditions.

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

In the first step, we test the stability of the parameters on **the in-sample data**. To do this, we determine the ranges of parameter **values** so that **the ratio of the highest and lowest values of the range was at least 150%**.

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

- **Moving average lengths (SMA): range 80-140 days (step: 5);**
- **Highest/lowest close (Donchian channel): range 13-20 days (step: 1);**

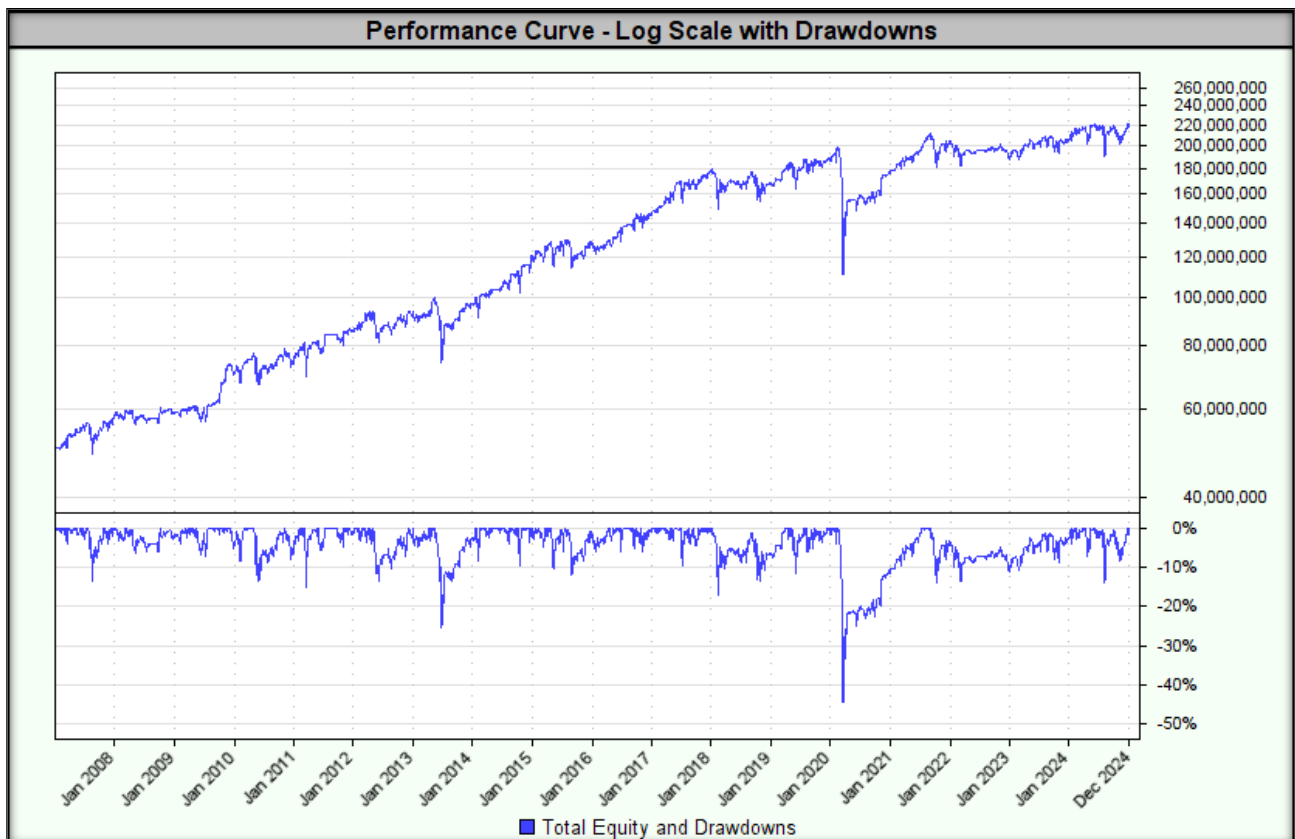
The lowest MAR value of 0.19 was achieved for the following parameters:

- **Length of the moving average (SMA): 125 days;**
- **Highest/lowest close (Donchian channel): 15 days.**



Test	Moving Average (bars)	Top & Bottom Donchian	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR (%)
75	125	15	\$217,889,776.96	8.52%	0.19	0.72	0.96	44.3%	28.4	589	0.30	8.95
99	140	15	\$220,247,984.75	8.59%	0.19	0.73	1.00	44.3%	29.0	592	0.33	9.17
91	135	15	\$222,703,737.80	8.65%	0.20	0.74	0.99	44.3%	29.0	589	0.34	9.23
83	130	15	\$223,928,979.15	8.69%	0.20	0.74	1.00	44.3%	29.0	588	0.33	9.17
58	115	14	\$255,038,524.65	9.48%	0.20	0.79	0.86	48.3%	29.3	628	0.32	10.10
74	125	14	\$256,586,815.39	9.51%	0.20	0.77	0.93	48.3%	31.5	637	0.32	10.33
82	130	14	\$262,929,916.66	9.66%	0.20	0.78	0.96	48.3%	32.5	634	0.32	10.56
66	120	14	\$270,522,810.41	9.83%	0.20	0.80	0.94	48.3%	29.2	632	0.36	10.74
90	135	14	\$271,522,991.87	9.86%	0.20	0.79	0.96	48.3%	32.5	639	0.34	10.89

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



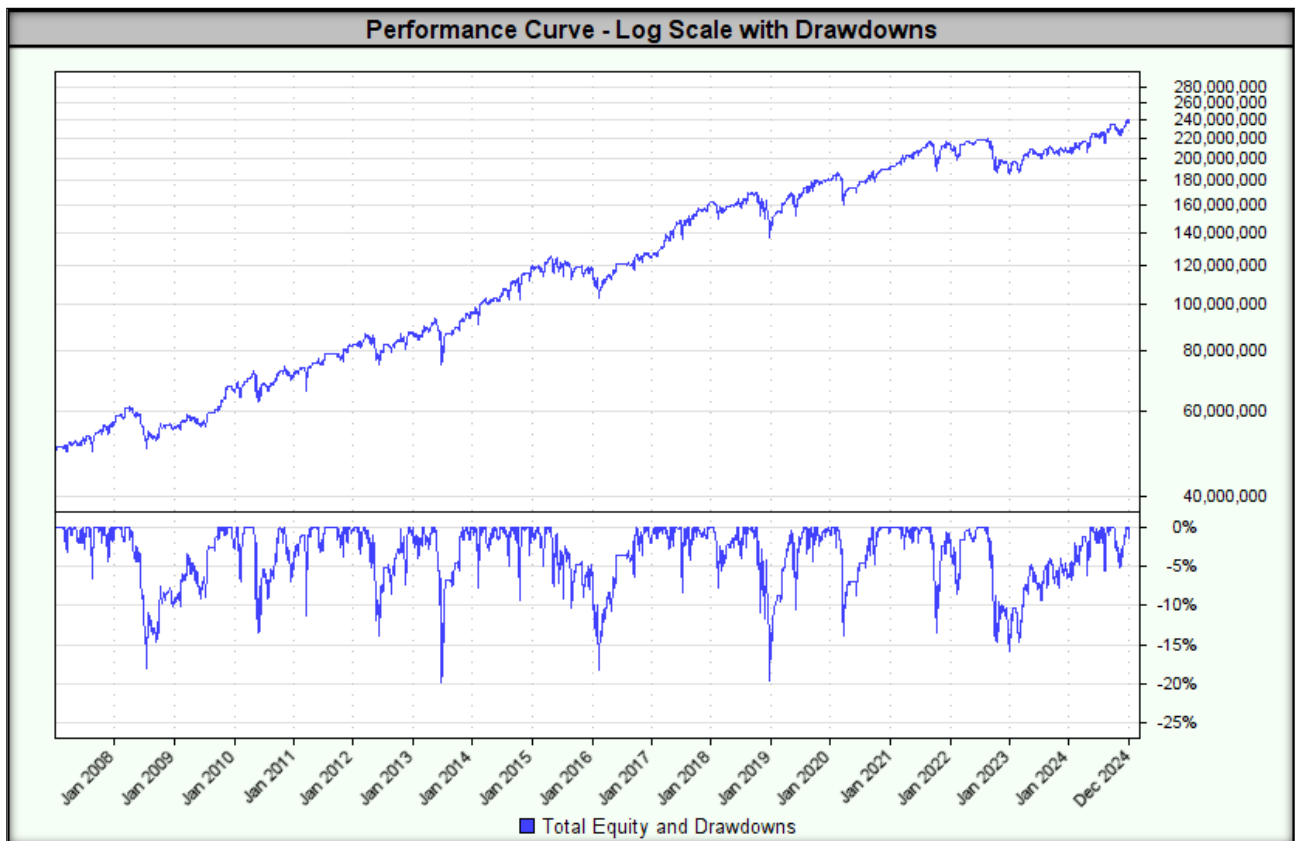
The highest MAR value of **0.46** was achieved for the following parameters:

- Length of the moving average (SMA): 85 days;
- Highest/lowest close (Donchian channel): 18 days.

The highest MAR value was accompanied by a **drawdown of 19.8%**.

Test	Moving Average (bars)	Top & Bottom Donchian	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR (%)
14	85	18	\$236,982,797.27	9.03%	0.46	0.82	0.82	19.8%	20.6	438	0.42	9.54
69	120	17	\$274,500,394.14	9.92%	0.43	0.88	1.00	23.0%	18.3	518	0.50	10.39
61	115	17	\$264,886,520.80	9.71%	0.42	0.87	0.91	23.0%	18.7	510	0.42	9.90
15	85	19	\$205,014,984.35	8.16%	0.41	0.76	0.71	19.8%	19.0	397	0.39	8.52
68	120	16	\$254,598,738.59	9.46%	0.41	0.84	1.02	23.0%	15.3	546	0.52	9.94
37	100	17	\$247,214,996.84	9.29%	0.40	0.82	0.84	23.0%	29.0	506	0.36	10.11
53	110	17	\$246,639,419.10	9.27%	0.40	0.84	0.82	23.0%	19.3	509	0.41	9.71
5	80	17	\$217,098,786.28	8.50%	0.39	0.76	0.68	21.5%	40.0	464	0.29	9.31
13	85	17	\$220,080,997.35	8.58%	0.39	0.76	0.71	21.8%	40.0	476	0.32	9.59

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



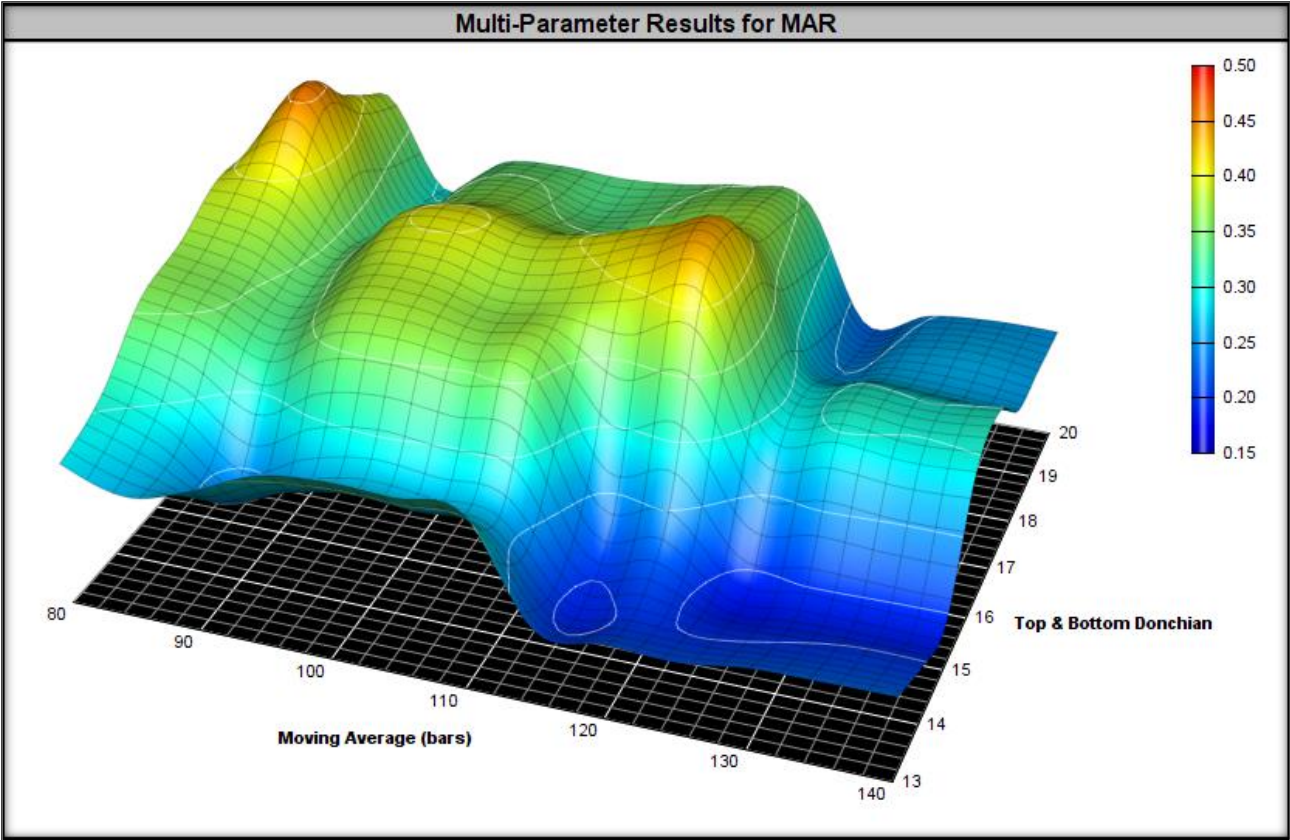
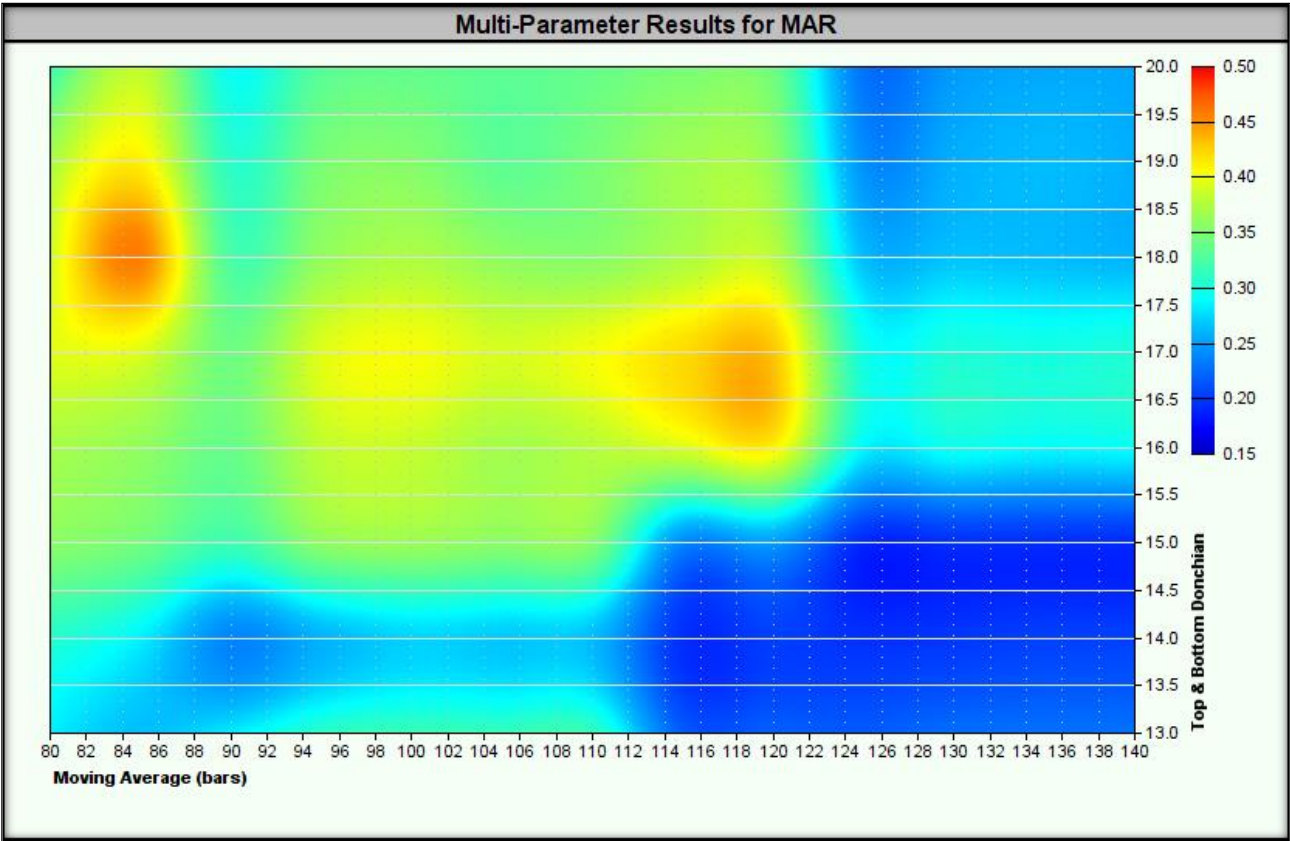
For all combinations of tested parameter ranges, **the highest drawdown was 48.3%.**

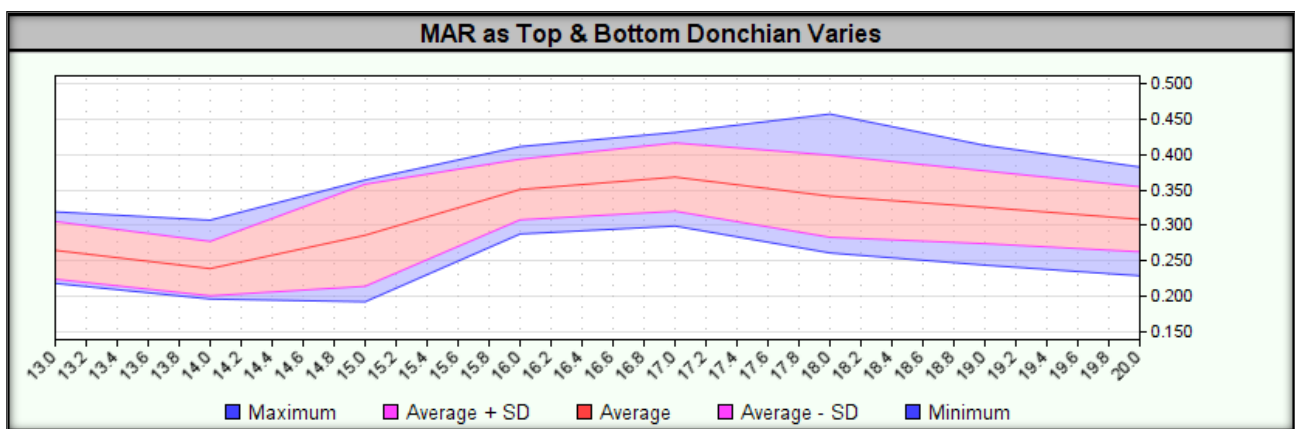
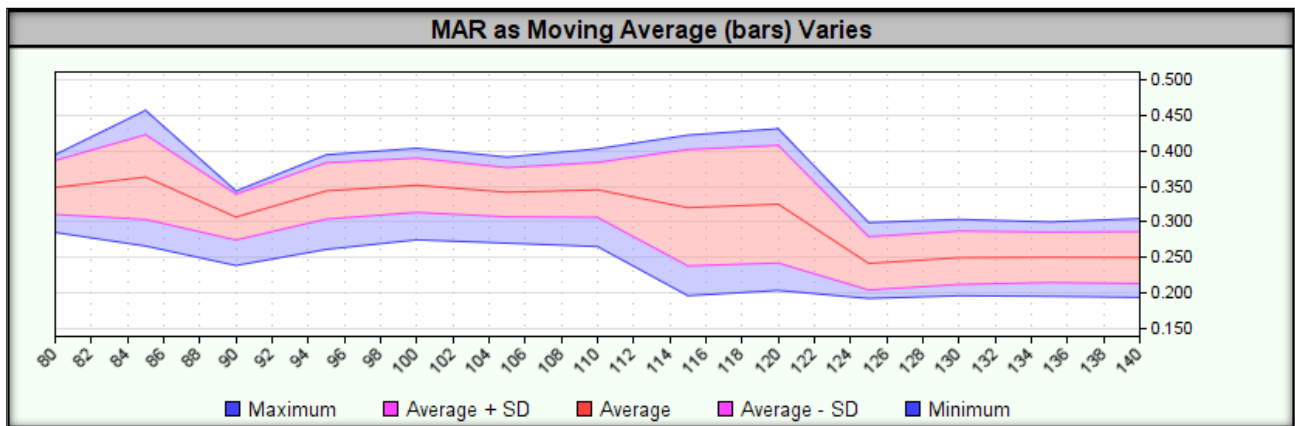
Test	Moving Average (bars)	Top & Bottom Donchian	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
82	130	14	\$282,929,916.66	9.66%	0.20	0.78	0.96	48.3%	32.5	634	0.32	10.56
98	140	14	\$272,474,873.86	9.88%	0.20	0.80	0.98	48.3%	32.5	644	0.34	10.90
74	125	14	\$256,586,815.39	9.51%	0.20	0.77	0.93	48.3%	31.5	637	0.32	10.33
66	120	14	\$270,522,810.41	9.83%	0.20	0.80	0.94	48.3%	29.2	632	0.36	10.74
58	115	14	\$255,038,524.65	9.48%	0.20	0.79	0.86	48.3%	29.3	628	0.32	10.10
90	135	14	\$271,522,991.87	9.86%	0.20	0.79	0.96	48.3%	32.5	639	0.34	10.89
91	135	15	\$222,703,737.80	8.65%	0.20	0.74	0.99	44.3%	29.0	589	0.34	9.23
75	125	15	\$217,889,776.96	8.52%	0.19	0.72	0.96	44.3%	28.4	589	0.30	8.95
99	140	15	\$220,247,994.75	8.59%	0.19	0.73	1.00	44.3%	29.0	592	0.33	9.17

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

- **MAR value** – indicating 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 (**48.3% vs. 19.8%**) – which means an acceptable risk of deep capital drawdowns.

Heatmaps for the tested ranges are shown below.





After passing the stability tests on **the in-sample data**, it is time perform the same procedure on **the out-of-sample data**. For this purpose, we use **the same range of parameters** as on the in-sample data:

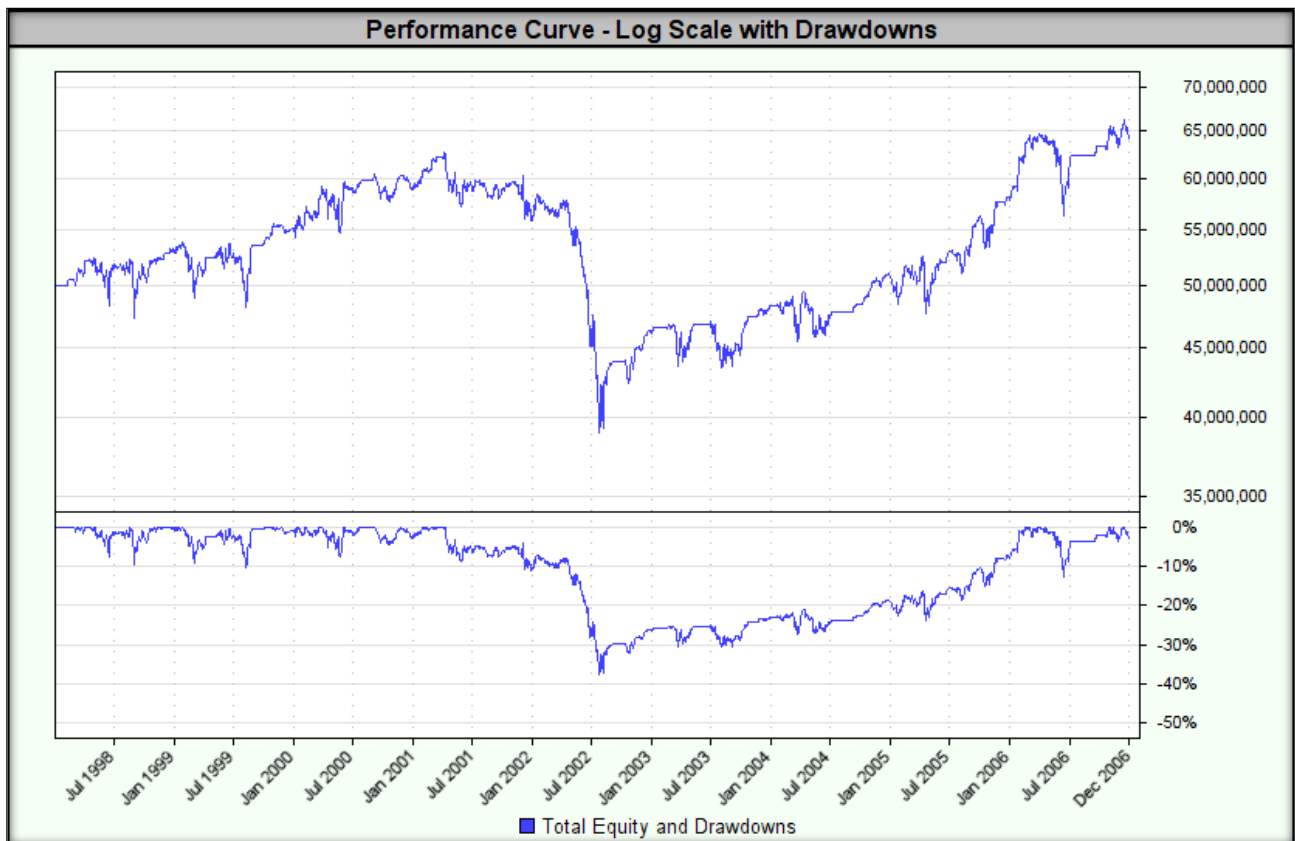
- **Moving average lengths (SMA): range 80-140 days (step: 5);**
- **Highest/lowest close (Donchian channel): range 13-20 days (step: 1);**

The lowest MAR value of **0.07** was achieved for the following parameters:

- **Length of the moving average (SMA): 130 days;**
- **Highest/lowest close (Donchian channel): 20 days.**

Test	Moving Average (bars)	Top & Bottom Donchian	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
88	130	20	\$64,224,490.56	2.82%	0.07	0.31	0.32	37.9%	58.3	162	0.01	0.29
80	125	20	\$64,927,142.94	2.95%	0.08	0.32	0.33	37.8%	57.7	162	0.02	0.42
96	135	20	\$68,415,719.63	3.55%	0.09	0.38	0.38	37.8%	57.7	161	0.03	0.52
104	140	20	\$68,603,960.49	3.58%	0.09	0.39	0.38	37.8%	58.2	162	0.03	0.53
87	130	19	\$72,293,306.53	4.19%	0.11	0.44	0.42	37.2%	57.2	173	0.05	1.14
79	125	19	\$72,707,622.18	4.25%	0.11	0.44	0.41	37.2%	57.0	172	0.06	1.18
103	140	19	\$75,837,317.61	4.74%	0.13	0.49	0.45	37.2%	57.7	173	0.05	1.08
95	135	19	\$77,040,642.34	4.93%	0.13	0.51	0.46	37.2%	57.0	172	0.07	1.31
46	105	18	\$71,353,152.26	4.03%	0.15	0.44	0.48	27.6%	60.0	182	0.07	1.48

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



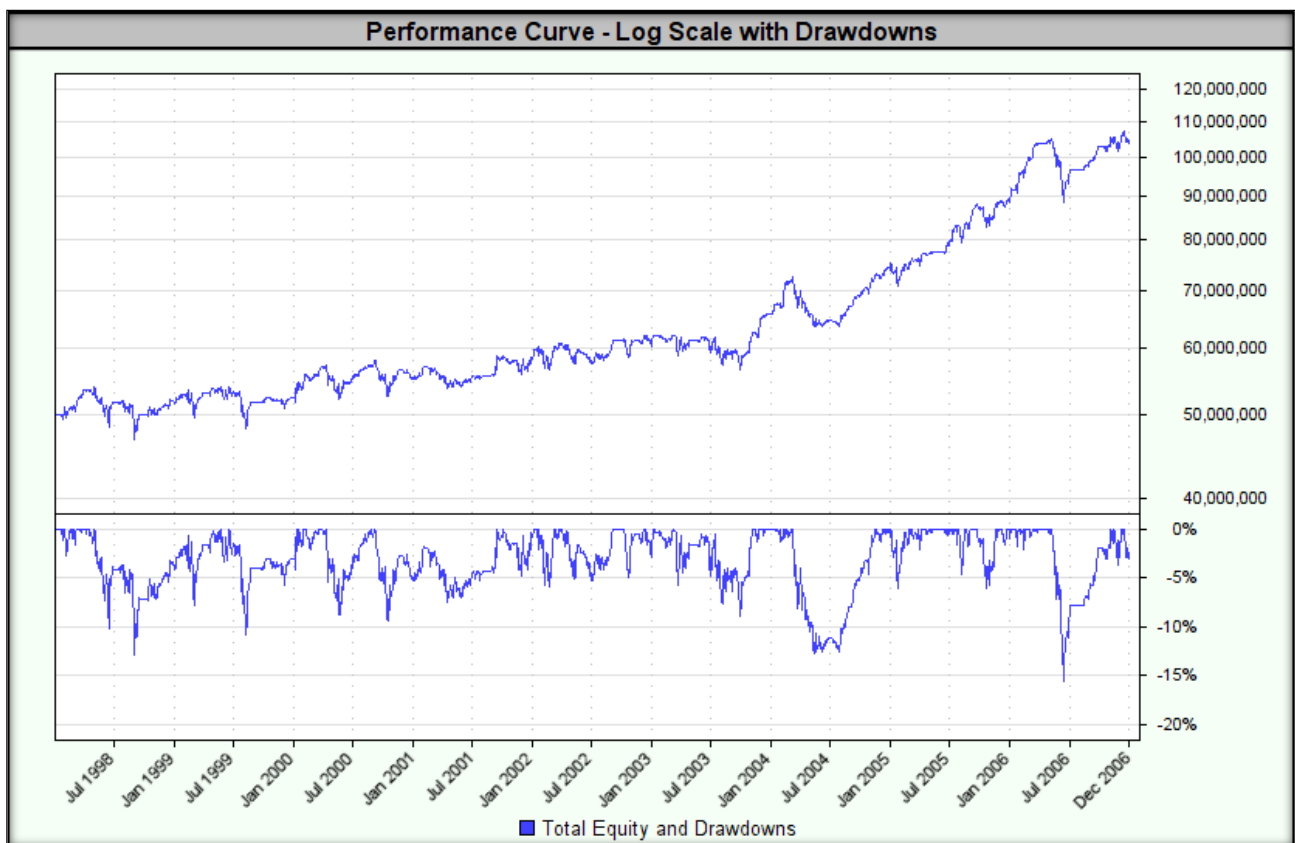
The highest MAR value of **0.54** was achieved for the following parameters:

- Length of the moving average (SMA): 85 days;
- Highest/lowest close (Donchian channel): 13 days.

The highest MAR value was accompanied by a **drawdown of 15.5%**.

Test	Moving Average (bars)	Top & Bottom Donchian	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3	RAR [%]
9	85	13	\$103,884,426.91	8.47%	0.54	0.85	1.41	15.5%	12.6	266	0.75	7.68
25	95	13	\$102,675,204.96	8.33%	0.54	0.84	1.52	15.5%	16.0	273	0.65	7.25
33	100	13	\$100,856,469.79	8.12%	0.52	0.81	1.48	15.5%	18.5	277	0.59	7.02
17	90	13	\$100,153,824.95	8.03%	0.52	0.81	1.44	15.5%	16.0	269	0.63	6.97
1	80	13	\$100,001,581.07	8.01%	0.52	0.82	1.37	15.5%	12.6	264	0.74	7.45
49	110	13	\$99,326,386.27	7.93%	0.51	0.78	1.47	15.5%	24.0	279	0.53	6.68
65	120	13	\$101,554,310.91	8.20%	0.50	0.79	1.73	16.4%	15.5	281	0.61	7.21
57	115	13	\$101,434,557.05	8.19%	0.50	0.79	1.83	16.4%	16.8	279	0.59	7.21
73	125	13	\$99,865,203.80	8.00%	0.49	0.78	1.59	16.4%	16.9	275	0.54	6.84

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



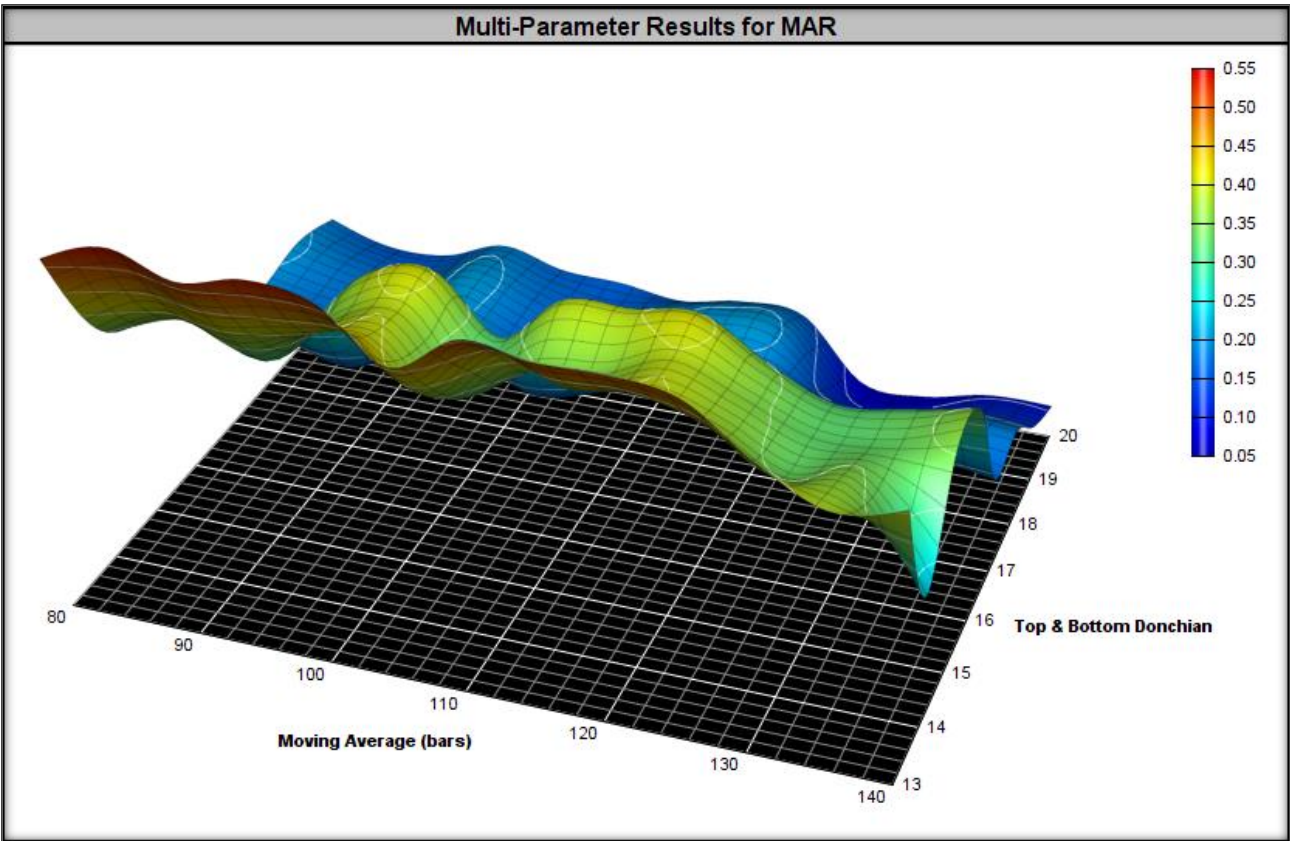
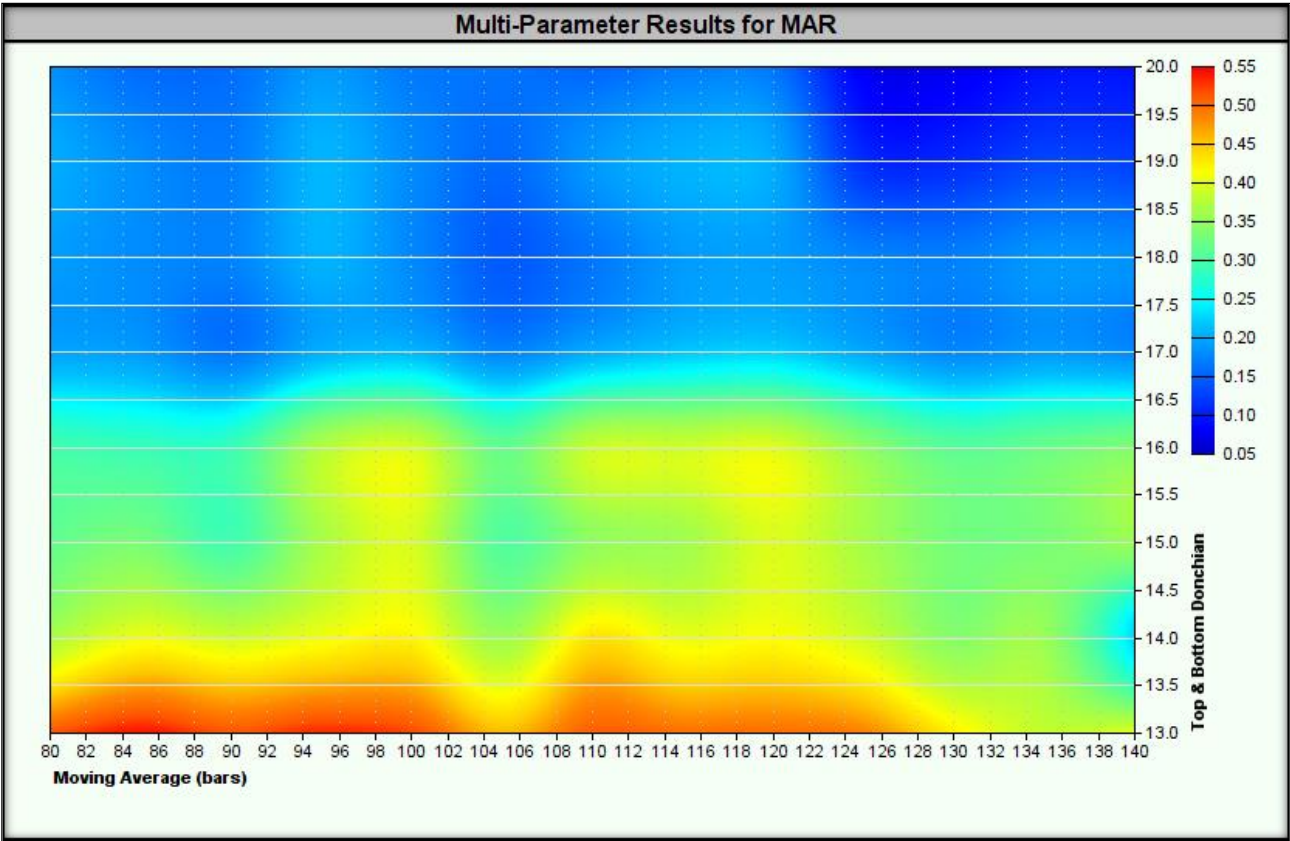
For all combinations of tested parameter ranges, **the highest drawdown was 37.9%.**

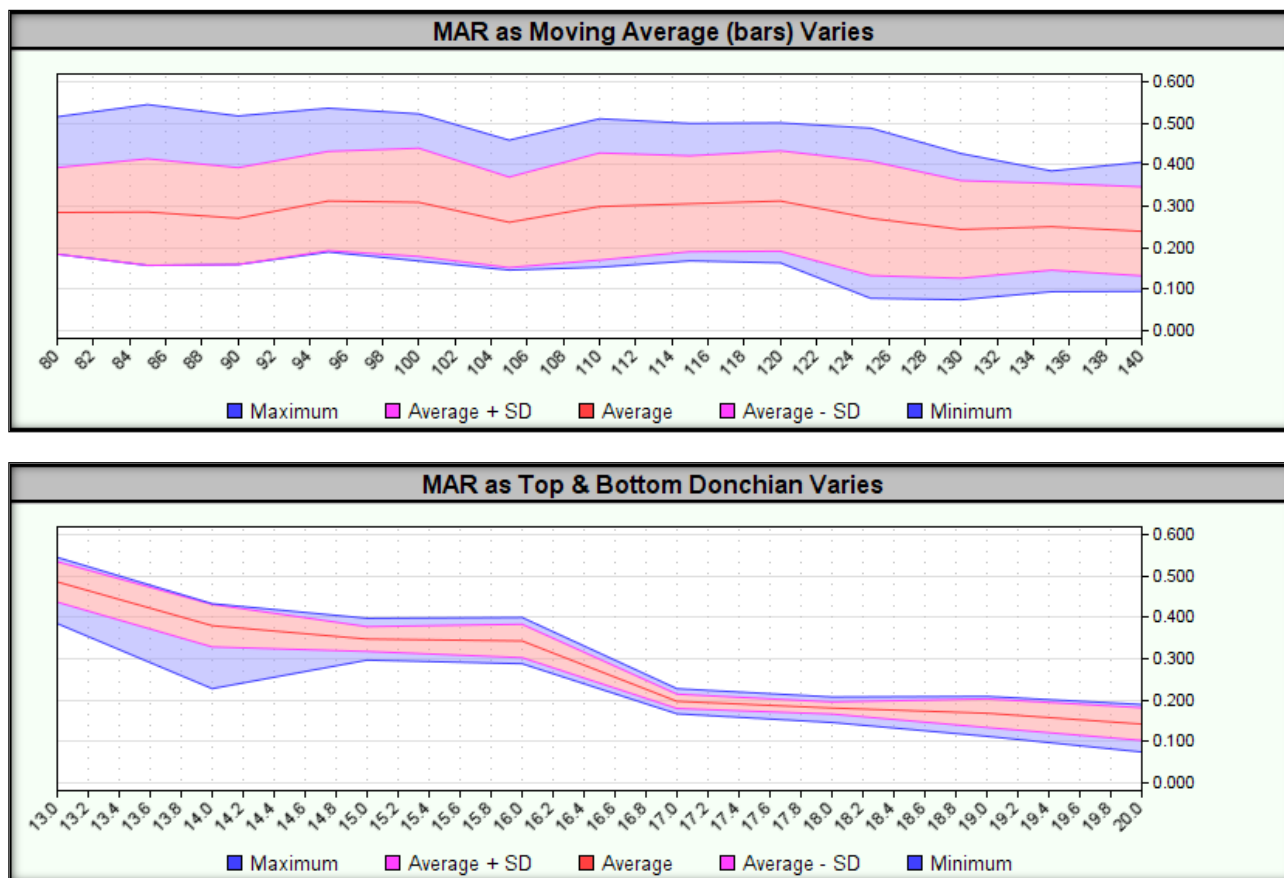
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88	130	20	\$64,224,490.56	2.82%	0.07	0.31	0.32	37.9%	58.3	162	0.01	0.29
104	140	20	\$68,803,960.49	3.58%	0.09	0.39	0.38	37.8%	58.2	162	0.03	0.53
80	125	20	\$64,927,142.94	2.95%	0.08	0.32	0.33	37.8%	57.7	162	0.02	0.42
96	135	20	\$68,415,719.63	3.55%	0.09	0.38	0.38	37.8%	57.7	161	0.03	0.52
95	135	19	\$77,040,642.34	4.93%	0.13	0.51	0.46	37.2%	57.0	172	0.07	1.31
103	140	19	\$75,837,317.61	4.74%	0.13	0.49	0.45	37.2%	57.7	173	0.05	1.08
87	130	19	\$72,293,306.53	4.19%	0.11	0.44	0.42	37.2%	57.2	173	0.05	1.14
79	125	19	\$72,707,622.18	4.25%	0.11	0.44	0.41	37.2%	57.0	172	0.06	1.18
47	105	19	\$74,452,344.46	4.53%	0.16	0.49	0.51	28.9%	60.0	169	0.10	1.94

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 (37.9% vs. 48.3%)** – 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% compared to the in-sample test results (0.54 vs. 0.46)** – indicating that the strategy can achieve good results in a variety of market conditions.

Heatmaps for the tested ranges are shown below.





Once the stability test has passed across 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 step above.

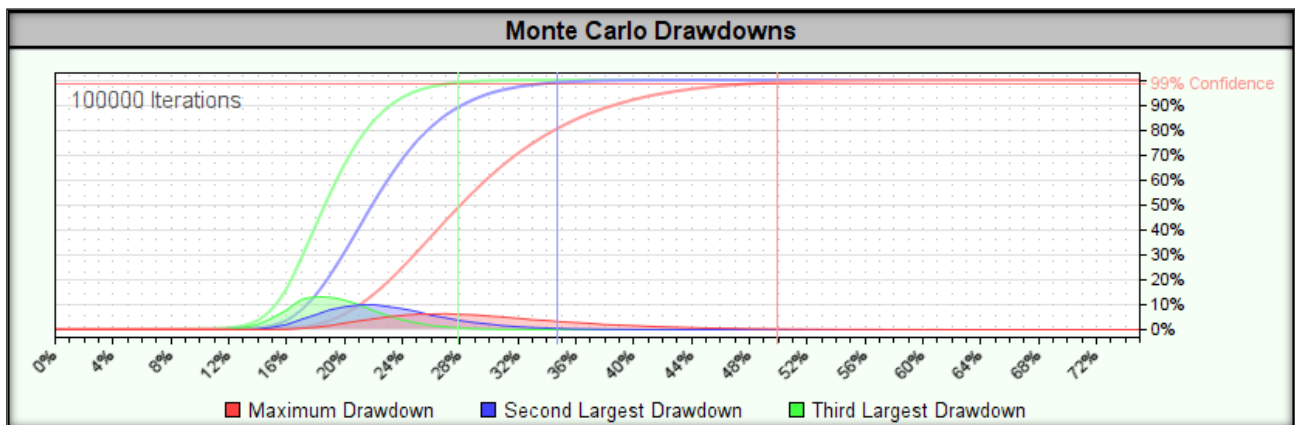
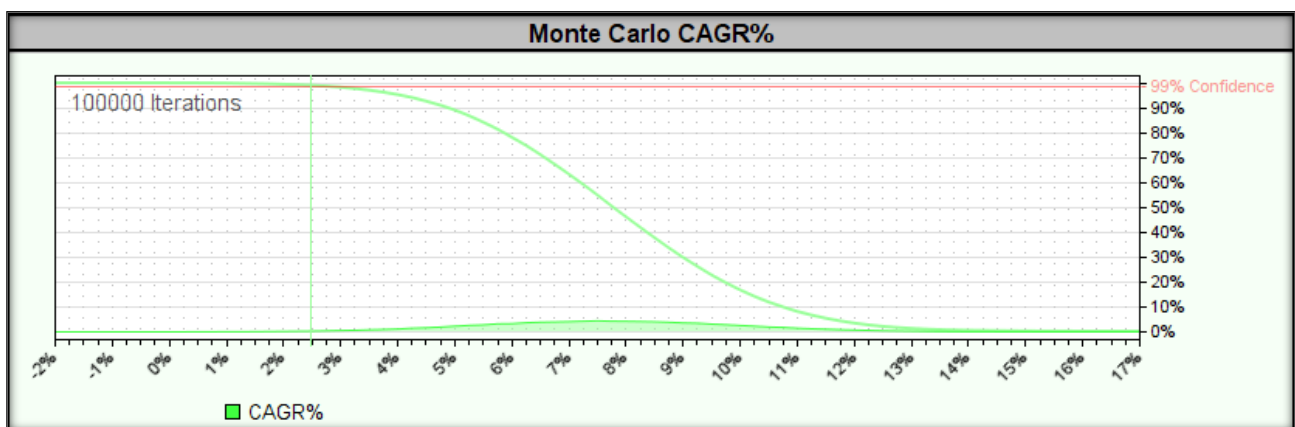
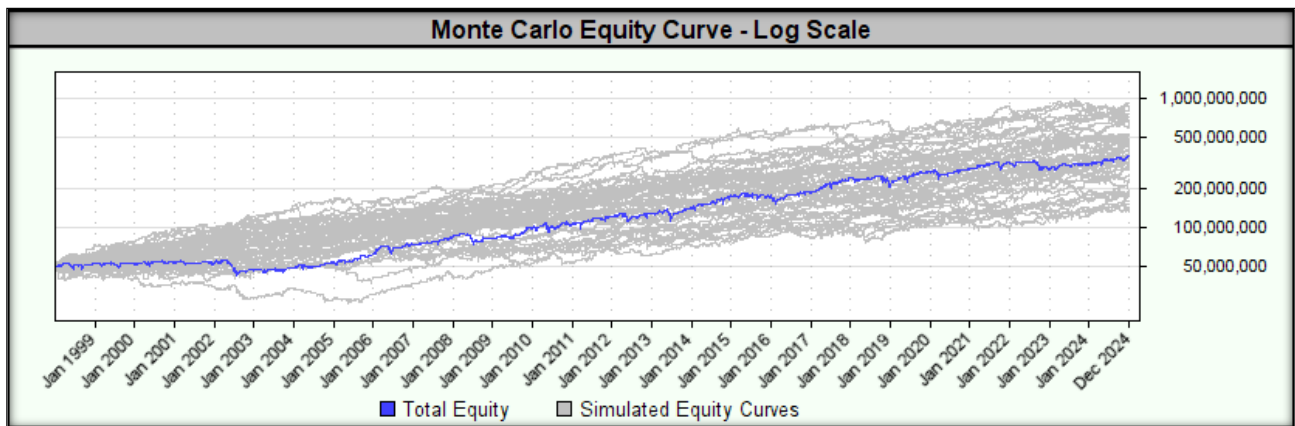
2. Monte Carlo simulation

Monte Carlo simulation involves running multiple simulations to examine how a strategy might perform under various market scenarios. A key goal of this method is to assess the potential **drawdown** of an optimized strategy. **Monte Carlo simulation** better reflects possible equity curve fluctuations and the depth of potential **drawdown**, allowing for a more realistic risk assessment. It also provides 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 **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%**.

The sample-replacement simulation are presented below.



- **CAGR%** – In 99% of simulations achieved a rate of return equal to or higher than 2.5%.
- **Drawdown** – in 99% of simulations, drawdown equal to or lower than 50% was achieved. For parameters optimized on in-sample data, drawdown was 24.2%.

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

Now that we know that the strategy is **stable** across **wide ranges of data** and a **changing environment**, it is 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 shifted one year apart** (for both in-sample and out-of-sample data). This process involves applying **strategy parameters optimized for the in-sample data**, setting a one-year or three-year trading window, and shifting it by one year.

We then analyze what proportion of these one- and three-year periods showed positive returns. **A strategy considered 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 the three-year rate of return every year**.

A one-year (365/365) test 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	\$53,057,786.37	6.12%	0.56	0.50	2.00	10.9%	8.4	17	2.36	1.21	1.83	0.00
2	19990101	\$50,008,241.15	0.02%	0.00	0.04	NA	10.5%	7.4	16	-0.46	-0.35	1.02	0.00
3	20000101	\$50,767,741.54	1.55%	0.21	0.30	NA	7.4%	5.1	18	3.81	2.51	1.24	0.00
4	20010101	\$48,445,038.17	-3.11%	-0.41	-0.53	-2.01	7.7%	10.1	18	-3.71	-1.53	0.77	0.00
5	20020101	\$42,013,608.89	-15.98%	-0.66	-1.15	-2.00	24.2%	9.2	14	-18.23	-21.69	0.21	0.00
6	20030101	\$52,364,156.84	4.73%	0.67	0.53	2.00	7.0%	3.6	20	6.04	3.13	1.52	0.00
7	20040101	\$54,393,375.96	8.79%	1.00	1.39	NA	8.8%	7.3	17	21.14	8.23	2.85	0.00
8	20050101	\$57,983,616.72	16.17%	3.61	2.28	NA	4.5%	2.7	30	46.35	17.46	3.48	0.00
9	20060101	\$59,411,688.25	18.89%	1.42	1.64	2.01	13.3%	6.7	27	14.13	9.97	3.05	0.00
10	20070101	\$57,166,463.29	14.34%	2.16	3.57	2.00	6.6%	1.5	20	33.87	13.02	6.74	0.00
11	20080101	\$47,186,679.31	-5.63%	-0.31	-0.46	NA	18.1%	9.2	17	-12.78	-10.21	0.61	0.00
12	20090101	\$58,995,666.22	18.00%	3.02	1.77	2.00	6.0%	4.0	26	62.55	20.41	4.51	0.00
13	20100101	\$52,213,667.53	4.44%	0.33	0.37	NA	13.5%	5.1	29	6.93	6.72	1.35	0.00
14	20110101	\$57,377,339.98	14.94%	1.43	2.63	NA	10.5%	3.6	21	27.35	14.52	9.05	0.00
15	20120101	\$52,993,006.60	6.01%	0.43	0.54	NA	13.8%	8.5	29	3.85	2.79	1.52	0.00
16	20130101	\$55,575,746.29	11.16%	0.57	0.81	2.00	19.7%	5.9	29	9.24	8.30	1.91	0.00
17	20140101	\$60,830,510.59	21.68%	2.31	2.56	2.00	9.4%	1.7	30	44.95	21.54	5.91	0.00
18	20150101	\$49,327,714.08	-1.35%	-0.13	-0.13	-2.01	10.3%	8.2	27	-3.71	-2.15	0.94	0.00
19	20160101	\$56,258,985.85	12.56%	2.77	1.41	NA	4.5%	2.2	22	43.40	16.33	4.64	0.00
20	20170101	\$64,043,933.28	28.20%	3.41	2.58	2.01	8.3%	1.8	33	82.43	28.67	11.58	0.00
21	20180101	\$44,849,662.02	-10.31%	-0.53	-0.76	-2.00	19.6%	5.1	16	-0.27	-0.34	0.44	0.00
22	20190101	\$58,540,639.30	17.09%	1.68	1.16	2.00	10.2%	2.3	26	35.81	19.70	3.98	0.00
23	20200101	\$52,922,842.27	5.85%	0.42	0.84	NA	13.9%	6.7	19	9.25	7.65	1.76	0.00
24	20210101	\$55,514,862.73	11.07%	0.83	1.01	NA	13.4%	4.0	28	18.58	9.65	2.07	0.00
25	20220101	\$43,293,178.98	-13.56%	-0.86	-1.06	NA	15.7%	4.4	14	-23.19	-11.69	0.19	0.00
26	20230101	\$52,234,187.19	4.48%	0.89	0.45	2.01	5.0%	4.0	22	14.01	7.05	1.62	0.00
27	20240101	\$56,402,386.71	12.81%	2.32	1.31	NA	5.5%	2.3	29	23.29	12.94	3.67	0.00

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	L
1	19980101	\$53,326,601.23	2.18%	0.20	0.27	0.76	10.9%	9.8	50	0.48	1.96	1.32	0.00	
2	19990101	\$49,974,417.51	-0.02%	-0.00	0.03	-0.02	10.5%	15.9	52	0.23	0.91	1.01	0.00	
3	20000101	\$44,278,460.23	-3.98%	-0.16	-0.36	-0.70	24.3%	16.2	49	-0.79	-4.10	0.71	0.00	
4	20010101	\$45,542,199.23	-3.07%	-0.13	-0.23	-0.47	24.2%	21.2	50	-1.38	-6.14	0.80	0.00	
5	20020101	\$48,636,603.49	-0.92%	-0.04	-0.03	-0.08	24.2%	33.1	50	0.13	0.48	0.97	0.00	
6	20030101	\$65,731,014.23	9.56%	1.08	1.22	2.18	8.8%	7.3	67	4.72	9.64	2.38	0.00	
7	20040101	\$74,311,851.38	14.16%	1.07	1.67	3.53	13.3%	7.3	72	6.93	16.82	3.07	0.00	
8	20050101	\$79,167,785.02	16.60%	1.25	2.09	2.28	13.3%	6.7	75	9.82	16.58	3.80	0.00	
9	20060101	\$66,250,242.01	9.85%	0.54	1.03	1.02	18.1%	9.2	64	2.61	8.67	2.25	0.00	
10	20070101	\$65,685,208.91	9.53%	0.53	1.05	1.00	18.0%	18.0	63	2.36	6.39	2.49	0.00	
11	20080101	\$60,833,861.11	6.76%	0.37	0.61	0.68	18.1%	18.0	72	2.24	9.92	1.73	0.00	
12	20090101	\$73,737,919.26	13.86%	1.03	1.33	3.52	13.5%	5.3	76	4.96	13.41	3.33	0.00	
13	20100101	\$63,979,282.05	8.57%	0.62	0.77	1.85	13.9%	8.5	79	2.32	9.26	1.96	0.00	
14	20110101	\$67,134,653.98	10.35%	0.52	0.93	3.04	19.8%	8.5	79	2.09	7.85	2.13	0.00	
15	20120101	\$71,885,917.25	12.89%	0.65	1.08	1.72	19.7%	8.5	88	3.41	12.60	2.37	0.00	
16	20130101	\$68,167,110.31	10.89%	0.55	1.02	1.11	19.7%	8.2	86	4.56	15.02	2.04	0.00	
17	20140101	\$64,273,168.71	8.75%	0.48	0.91	0.94	18.1%	16.9	79	2.00	6.50	1.90	0.00	
18	20150101	\$68,056,081.60	10.85%	0.60	1.04	0.82	18.1%	16.9	82	3.44	10.37	2.22	0.00	
19	20160101	\$65,437,564.99	9.39%	0.48	0.86	0.57	19.6%	5.2	71	7.55	15.93	2.33	0.00	
20	20170101	\$70,620,696.67	12.22%	0.62	0.93	0.77	19.6%	9.4	75	3.01	8.80	2.70	0.00	
21	20180101	\$58,987,627.51	5.67%	0.29	0.51	0.42	19.6%	9.4	61	1.55	6.49	1.70	0.00	
22	20190101	\$69,597,186.49	11.66%	0.84	1.06	2.82	13.9%	6.7	73	3.97	10.41	2.53	0.00	
23	20200101	\$50,957,558.80	0.64%	0.04	0.11	0.06	15.8%	9.3	62	1.66	6.65	1.09	0.00	
24	20210101	\$53,528,657.86	2.30%	0.15	0.24	0.23	15.8%	16.5	65	-0.01	-0.03	1.25	0.00	
25	20220101	\$55,429,820.36	3.51%	0.22	0.34	0.28	15.7%	20.6	65	1.12	3.10	1.49	0.00	

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): 21 out of 27 periods** ended with a positive rate of return (**78%**).
- **For the three-year test window (1095/365): 21 out of 25 periods** ended with a positive rate of return (**84%**).

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

4. Long/short stability

For 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 an upside scenario, typically resulting from the data used for optimization, can lead to **problems** when markets enter a **long-term downward trend**. Under such conditions, the strategy can generate **significant losses**.

To check if **the strategy** shows a tendency to go **Long Bias** or (less often) **Short Bias** requires examining **the distribution of historical** buy and sell trades. Ideally, this distribution should be approximately **50%/50%**. However, if one side is significantly biased (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.

In the case of the Double 7s v.1 strategy testing **long/short stability** does not make sense because **the strategy** involves opening **only long positions**.

5. Stability in the portfolio of financial instruments

In this step, we want to examine **how the strategy's performance is distributed across the various 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.

Instrument Performance Summary													
Symbol	Wins	%	Losses	%	Trades	Win Months	%	Loss Months	%	Avg. Win %	Avg. Loss %	Avg. Trade %	% Profit Factor
DX	40	72.7%	15	27.3%	55	284	87.7%	40	12.3%	0.99%	1.48%	0.32%	1.78
EBL	48	68.6%	22	31.4%	70	264	81.5%	60	18.5%	0.97%	1.65%	0.14%	1.28
ES	57	81.4%	13	18.6%	70	282	87.0%	42	13.0%	1.02%	1.28%	0.60%	3.50
FDX	51	79.7%	13	20.3%	64	279	86.1%	45	13.9%	0.98%	1.55%	0.46%	2.47
FLG	46	74.2%	16	25.8%	62	281	86.7%	43	13.3%	0.84%	1.14%	0.33%	2.11
GC	27	55.1%	22	44.9%	49	277	85.5%	47	14.5%	0.88%	0.68%	0.18%	1.57
HSI	43	70.5%	18	29.5%	61	276	85.2%	48	14.8%	1.11%	1.77%	0.26%	1.50
NIY	31	67.4%	15	32.6%	46	294	90.7%	30	9.3%	1.08%	1.37%	0.28%	1.62
NQ	52	75.4%	17	24.6%	69	279	86.1%	45	13.9%	1.00%	1.16%	0.47%	2.65
TY	47	73.4%	17	26.6%	64	280	86.4%	44	13.6%	0.85%	1.30%	0.28%	1.82

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
DX	52	74.3%	18	25.7%	70	279	86.1%	45	13.9%	0.91%	1.46%	0.30%	1.80
EBL	56	70.9%	23	29.1%	79	262	80.9%	62	19.1%	0.83%	1.67%	0.10%	1.21
ES	77	80.2%	19	19.8%	96	276	85.2%	48	14.8%	0.96%	0.98%	0.58%	3.96
FDX	66	74.2%	23	25.8%	89	266	82.1%	58	17.9%	0.95%	1.50%	0.32%	1.82
FLG	56	66.7%	28	33.3%	84	265	81.8%	59	18.2%	0.81%	1.16%	0.15%	1.39
GC	52	66.7%	26	33.3%	78	259	79.9%	65	20.1%	0.78%	0.92%	0.21%	1.68
HSI	51	70.8%	21	29.2%	72	262	80.9%	62	19.1%	0.85%	1.79%	0.08%	1.16
NIY	42	66.7%	21	33.3%	63	279	86.1%	45	13.9%	0.99%	1.80%	0.06%	1.10
NQ	80	78.4%	22	21.6%	102	268	82.7%	56	17.3%	1.00%	1.06%	0.55%	3.41
TY	57	67.9%	27	32.1%	84	259	79.9%	65	20.1%	0.81%	1.37%	0.11%	1.24

For our tested strategy:

- **The portfolio with the highest MAR** (obtained on IS data) has a percentage of instruments with **profit factor > 1** at the level of **100%**.
- **The portfolio with the lowest MAR** (obtained on IS data) has a percentage of instruments with **profit factor > 1** at the level of **100%**.

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



6. Money Management (Position Sizing)

After completing the **stability tests**, we now know **what range of results we can expect from our strategy**, and even more importantly – **what amount of capital loss (drawdown)**.

Previous tests show that:

- **Drawdown in-sample** for optimized parameters was **19.8%**.
- **In-sample and out-of-sample drawdown** for the optimized parameters was **24.2%**.
- **The highest drawdown in the sample** for the tested range of parameters was **48.3%**.
- **sample drawdown** for the tested parameter range was **37.9%**.
- **Drawdown in 99% of Monte Carlo simulations** was equal to or lower than **50.0%**.

Our investment strategy was tested assuming that **the risk of a single position is 1.0% of the total capital, with a hypothetical stop loss order placed 2 x ATR (40 days) away from the position opening point**.

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 personally acceptable to me, but I will make the final decision after conducting Walk-Forward Analysis tests**.

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

- **Length of the moving average (SMA): 85 days;**
- **Highest/lowest close (Donchian channel): 18 days;**
- **Stop loss: none;**
- **Position opening method: at the opening price of the next day;**
- **Position size: corresponding to a risk of 1.0% of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;**
- **Position direction: long positions (buy) only.**

7. Strategy Risk Management

In addition to specifying **a maximum position size**, we can implement additional mechanisms to **improve risk management** within your 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.**

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



These aren't the "best" optimal values for all market conditions – just like position size, sometimes **it's worth reducing it and sometimes increasing it**. However, the key goal is **to avoid drawdowns** that could force you **to terminate your strategy for financial or emotional** reasons.

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

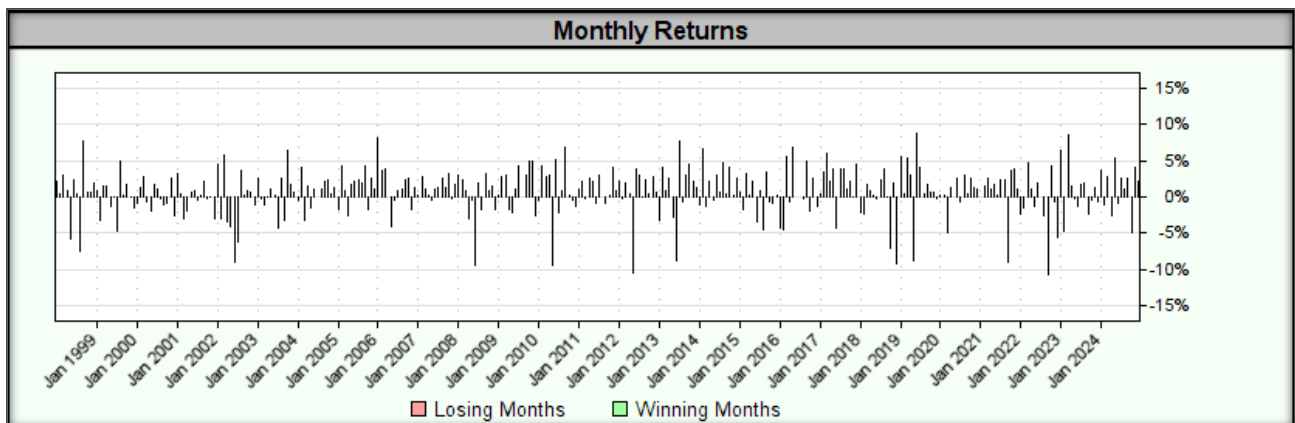
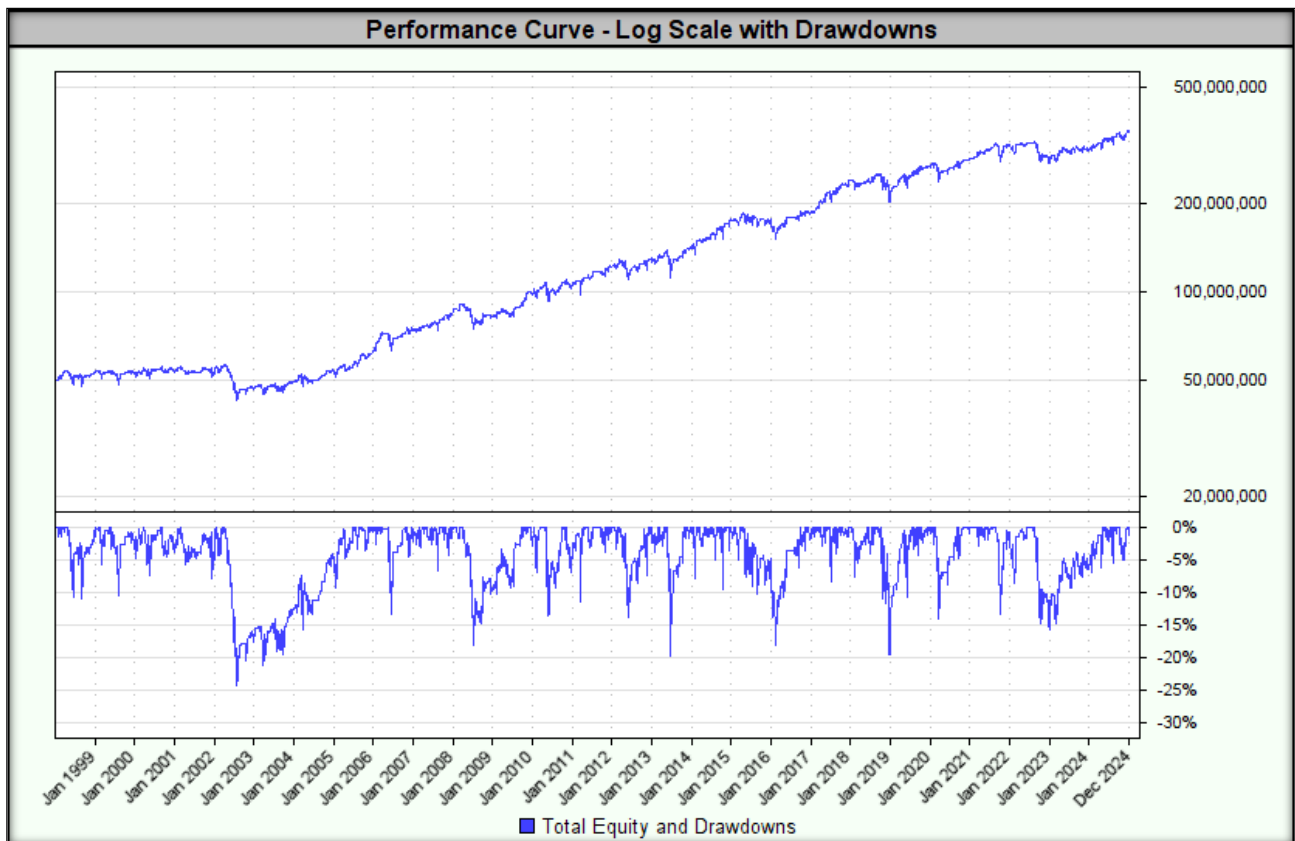
After this step, we've **optimized all the elements of our investment strategy**. We can finally **analyze the results the strategy generates in more detail**.

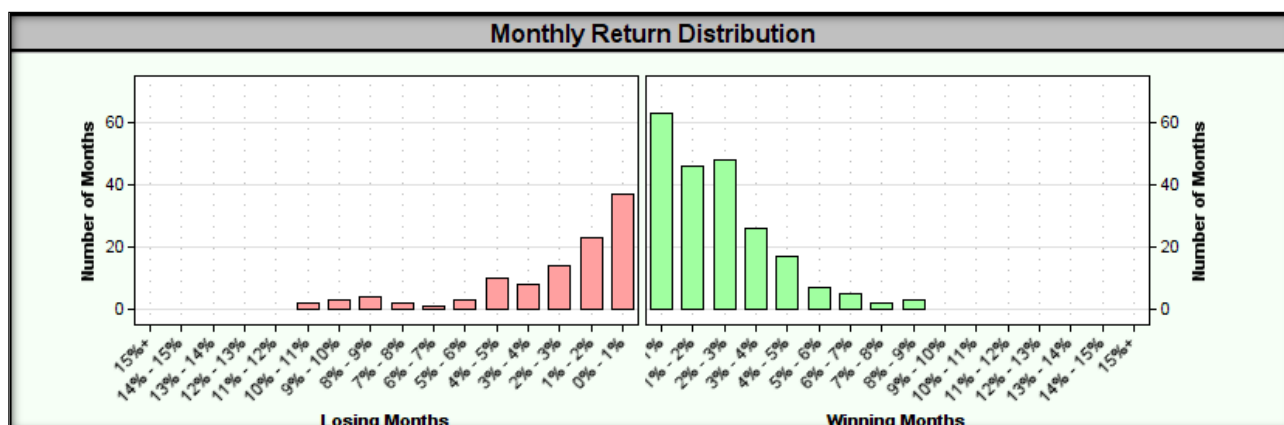
We haven't done this before because our goal **was not to optimize the parameters themselves and look for the "best" set, but to build a stable strategy**.

Importantly, **we will not ultimately use the parameters optimized in the backtests, as 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%	9.0%	7.5%
MAR Ratio	0.46	0.31
RAR%	9.5%	8.9%
R-Cubed	0.42	0.24
Robust Sharpe Ratio	0.84	0.82
Max Drawdown	19.8%	24.2%
Wins	74.4%	72.5%
Losses	25.6%	27.5%
Average Win%	0.95%	0.97%
Average Loss%	1.30%	1.33%
Win/Loss Ratio	0.67	0.73
Average Trade Duration (days)	31	32
Percent Profit Factor	2.12	1.93
SQN	-	-
Number of transactions	438	610





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

- Length of the moving average (SMA): 85 days;
- Highest/lowest close (Donchian channel): 18 days;
- Stop loss: none;
- Position opening method: at the opening price of the next day;
- Position size: corresponding to a risk of 1.0% of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- 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;
- Position direction: long positions (buy) only.



Step 5: Walk-Forward Analysis

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

1. **What rate of return can you expect from the strategy?**
 - The optimization result often overstates the expected rate of return, which can lead to unrealistic forecasts.
 - WFA provides more **reliable and realistic measures 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, minimizing 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)**.
 - This step adjusts the parameters 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 Performance Efficiency (WFE) is a key metric that assesses a strategy's potential to perform under real-world market conditions. WFE compares:

- **The rate of return achieved in the in-sample window** (where parameters were optimized)
- **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 to be **stable (robust)** should meet the following conditions:

- **WFE \geq 50% for the rate of return** – means that the strategy retains at least half of its effectiveness beyond the optimization period.
- **WFE \leq 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 evaluation of the strategy effectiveness according to the Walk-Forward measure are presented below. **Efficiency.**

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

- **Objective function:** MAR;



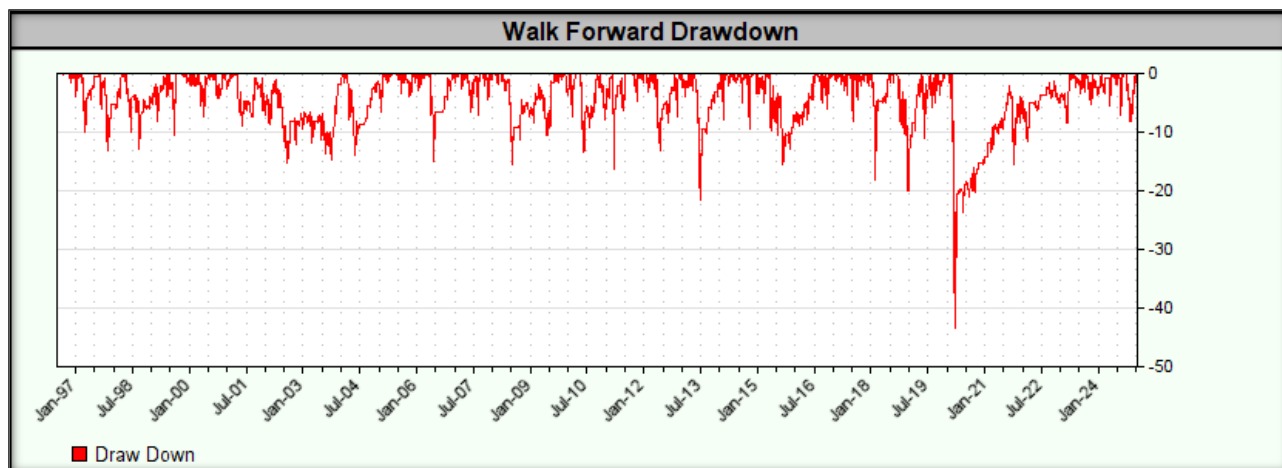
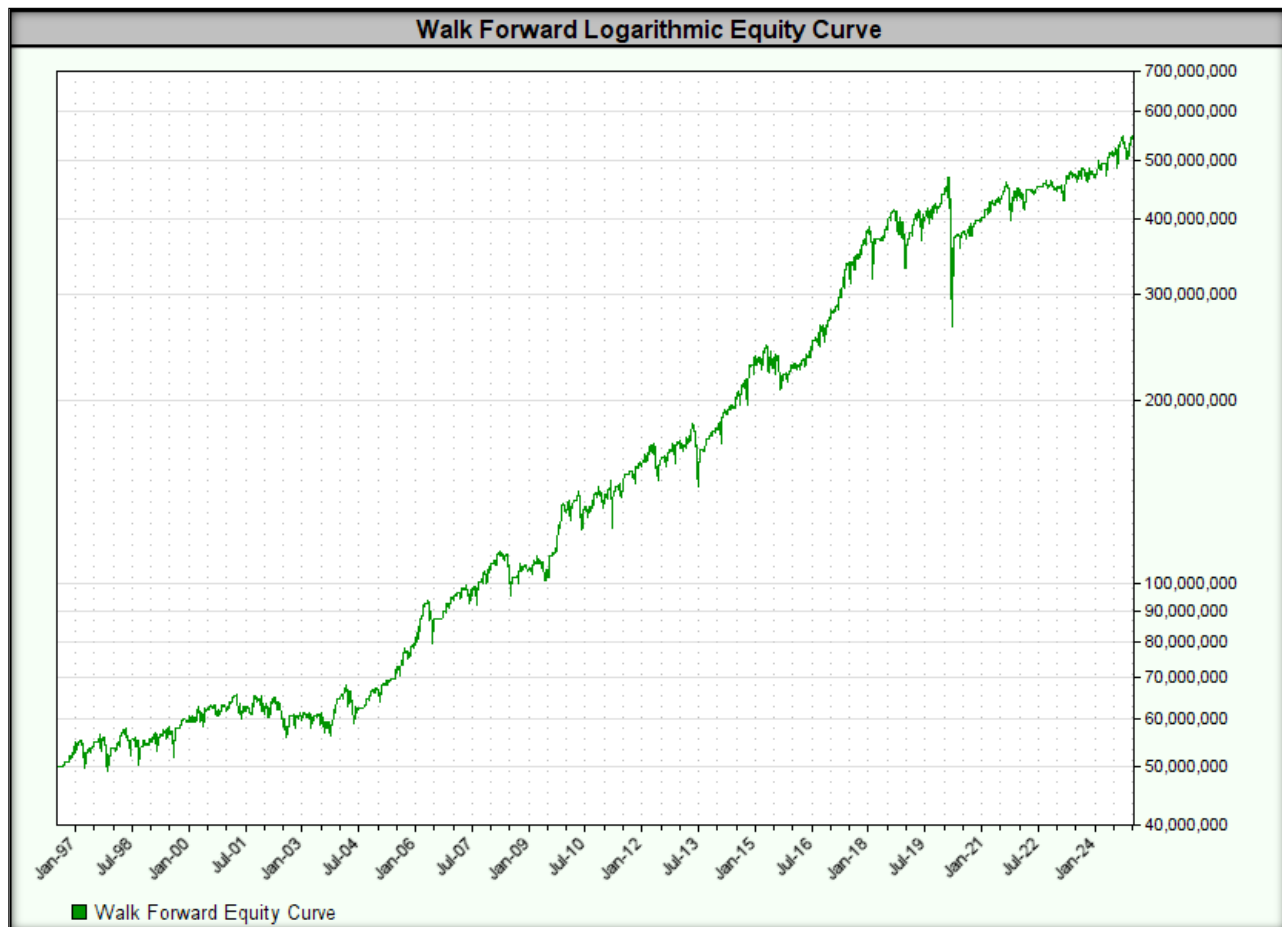
- **Position size:** corresponding to a risk of 1.0% of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- **Range of optimized parameters:**
 - **Moving average lengths (SMA):** range **80-140 days (step: 5)**;
 - **Highest/lowest close (Donchian channel):** range **13-20 days (step: 1)**;
- **Position opening method:** at the opening price of the next day;
- **Stop loss:** none;
- **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;
- **Position direction:** long positions only (buy);
- **Data period:** 01/01/1995 – 31/12/2024.

Below are the test results for various windows.

1. Walk Forward Optimization: 549 days; Walk Forward Out-of-sample: 183 days

The results of the Walk-Forward Analysis (WFA) for the 549/183 day combination are presented below.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
532,691,385	8.65%	0.20	0.49	43.38%	37.26	752



Optimization:	549	CAGR%		Max DD		MAR	
WFA:	183	Projections	Real	Projections	Real	Projections	Real
19960703	19970101	9.0%	15.7%	3.7%	1.8%	2.41	8.61
19970102	19970703	12.5%	4.1%	5.1%	10.0%	2.42	0.41
19970704	19980102	8.3%	-5.0%	6.9%	13.2%	1.21	-0.38
19980105	19980703	8.5%	7.4%	7.7%	10.1%	1.10	0.73



19980706	19990101	10.1%	-0.8%	10.4%	9.7%	0.97	- 0.09
19990104	19990705	9.3%	7.0%	9.7%	6.6%	0.96	1.07
19990706	20000104	11.0%	9.3%	8.2%	9.2%	1.35	1.01
20000105	20000705	9.1%	9.7%	8.2%	7.3%	1.11	1.33
20000706	20010104	11.7%	-1.5%	7.0%	4.3%	1.66	- 0.35
20010105	20010706	7.8%	1.3%	7.0%	8.9%	1.11	0.15
20010709	20020104	11.2%	-2.6%	10.7%	6.5%	1.05	- 0.41
20020107	20020705	4.1%	-5.4%	7.7%	10.5%	0.54	- 0.51
20020708	20030106	2.7%	4.4%	5.9%	6.9%	0.46	0.64
20030107	20030708	7.6%	-3.3%	5.9%	5.7%	1.29	- 0.57
20030709	20040107	4.4%	16.4%	5.9%	8.5%	0.74	1.92
20040108	20040708	10.5%	-7.8%	6.5%	13.9%	1.60	- 0.56
20040709	20050107	5.5%	10.4%	8.8%	2.8%	0.63	3.71
20050110	20050708	14.4%	21.9%	8.5%	3.8%	1.69	5.76
20050711	20060106	15.2%	28.1%	8.5%	4.0%	1.78	7.02
20060109	20060710	25.7%	15.3%	4.3%	15.0%	5.91	1.02
20060711	20070109	18.8%	16.5%	9.5%	2.1%	1.98	8.00
20070110	20070711	18.7%	6.8%	9.5%	6.5%	1.97	1.05
20070712	20080110	13.6%	23.0%	9.8%	6.7%	1.39	3.43
20080111	20080711	15.4%	-17.4%	4.5%	12.9%	3.40	- 1.35
20080714	20090109	9.5%	15.9%	13.6%	3.1%	0.70	5.13
20090112	20090710	5.4%	-5.8%	10.6%	9.0%	0.51	- 0.65
20090713	20100111	-0.6%	67.9%	9.0%	3.8%	- 0.07	17.85
20100112	20100713	19.2%	0.3%	4.7%	13.5%	4.11	0.02
20100714	20110112	18.7%	11.2%	13.5%	8.0%	1.38	1.40
20110113	20110714	22.8%	16.0%	13.7%	16.4%	1.67	0.98
20110715	20120113	13.0%	10.9%	15.4%	4.7%	0.85	2.30
20120116	20120713	17.3%	3.0%	7.3%	13.3%	2.36	0.22
20120716	20130111	12.3%	7.9%	13.2%	7.3%	0.93	1.09
20130114	20130715	8.2%	-2.7%	10.7%	21.5%	0.77	- 0.13
20130716	20140114	4.2%	23.3%	19.0%	1.3%	0.22	18.60
20140115	20140716	14.5%	27.5%	19.0%	7.9%	0.76	3.48
20140717	20150115	22.3%	22.4%	19.0%	9.4%	1.17	2.38
20150116	20150717	27.6%	8.0%	9.4%	10.5%	2.92	0.76
20150720	20160115	23.2%	-9.5%	9.5%	12.5%	2.45	- 0.76
20160118	20160715	15.6%	23.5%	12.3%	4.1%	1.27	5.76
20160718	20170116	12.1%	24.9%	10.5%	6.1%	1.14	4.07
20170117	20170718	20.8%	44.4%	5.0%	8.1%	4.12	5.47
20170719	20180117	33.7%	28.0%	8.1%	4.4%	4.16	6.32
20180118	20180719	33.5%	11.7%	8.1%	16.7%	4.13	0.70
20180720	20190118	22.4%	-16.3%	7.8%	20.0%	2.86	- 0.81
20190121	20190719	13.0%	25.1%	15.5%	10.7%	0.84	2.34

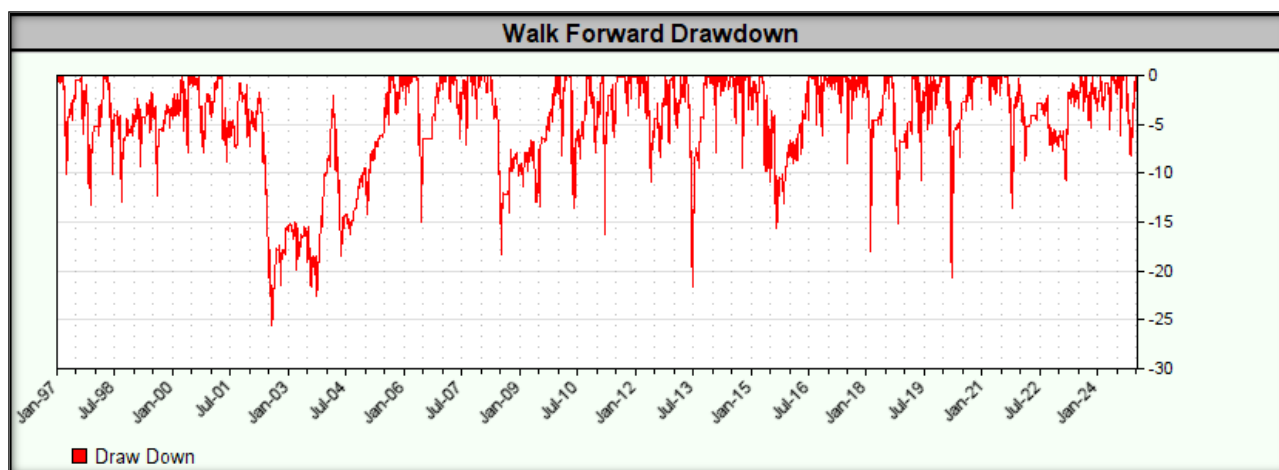
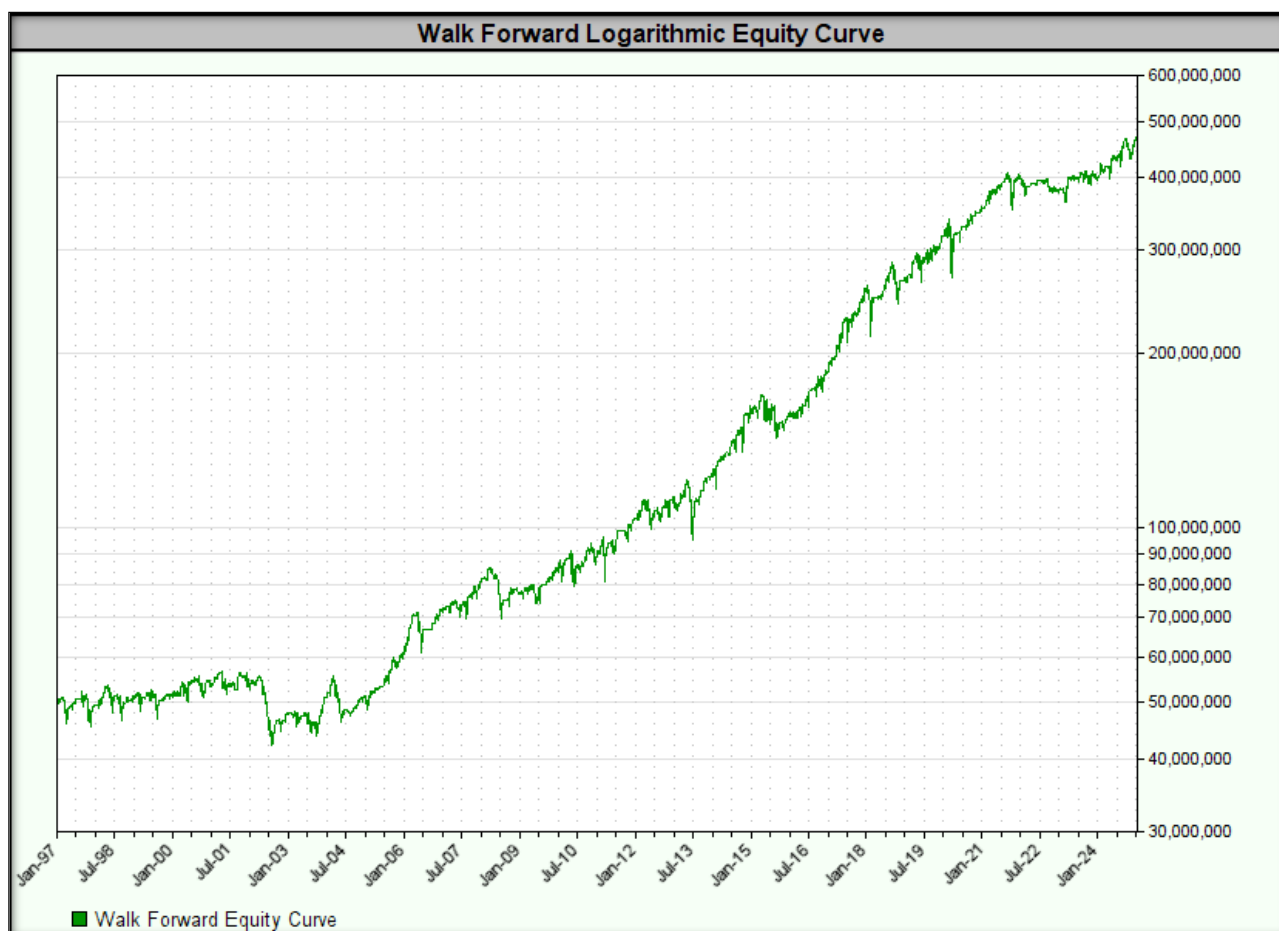


20190722	20200117	13.9%	19.9%	14.9%	5.8%	0.94	3.45
20200120	20200720	15.4%	-29.1%	15.5%	43.4%	0.99	- 0.67
20200721	20210119	11.7%	12.5%	11.6%	4.8%	1.00	2.60
20210120	20210721	11.5%	20.5%	14.1%	3.0%	0.82	6.81
20210722	20220120	13.5%	-3.3%	10.5%	13.6%	1.29	- 0.25
20220121	20220722	18.9%	8.6%	11.3%	5.9%	1.67	1.45
20220725	20230120	11.1%	-1.1%	11.3%	3.8%	0.99	- 0.28
20230123	20230721	4.2%	11.1%	13.0%	5.4%	0.32	2.06
20230724	20240122	6.4%	3.8%	7.3%	5.3%	0.87	0.71
20240123	20240723	6.3%	16.6%	5.4%	5.5%	1.17	3.02
20240724	20250110	11.5%	5.1%	5.5%	8.2%	2.10	0.62
Mean		13.3%	9.7%	9.7%	8.8%	0.70	0.22
WFE:		73.3%	WFE:	90.6%	WFE:	32.2%	

2. Walk Forward Optimization: 730 days; Walk Forward Out-of-sample: 183 days

Forward Analysis (WFA) results for the 730/183 day combination are presented below.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
456,521,089	8.21%	0.32	0.53	25.65%	52.37	743



Optimization:	730	CAGR%		Max DD		MAR	
WFA:	183	Projections	Real	Projections	Real	Projections	Real
19961231	19970701	10.6%	3.4%	5.1%	10.0%	2.05	0.34
19970702	19971231	9.8%	-5.1%	6.9%	13.2%	1.42	- 0.38
19980101	19980702	4.6%	7.2%	8.3%	10.1%	0.56	0.72
19980703	19990101	9.2%	-0.9%	10.4%	9.7%	0.88	- 0.09



19990104	19990702	7.5%	2.3%	10.4%	7.1%	0.72	0.32
19990705	19991231	8.7%	0.4%	9.7%	9.4%	0.89	0.04
20000103	20000703	10.6%	9.8%	11.4%	7.9%	0.93	1.25
20000704	20010102	9.4%	-2.8%	8.2%	7.9%	1.15	- 0.36
20010103	20010704	8.9%	-0.6%	7.0%	8.9%	1.27	- 0.07
20010705	20020103	8.1%	0.3%	10.7%	6.5%	0.76	0.05
20020104	20020705	7.7%	-23.6%	10.7%	19.4%	0.72	- 1.22
20020708	20030103	2.7%	5.6%	7.7%	9.6%	0.35	0.58
20030106	20030704	5.4%	-5.6%	5.9%	5.6%	0.92	- 0.99
20030707	20040105	4.1%	20.5%	5.9%	8.5%	0.69	2.41
20040106	20040706	7.3%	-10.1%	8.4%	16.7%	0.87	- 0.60
20040707	20050105	6.0%	8.2%	8.3%	2.2%	0.72	3.77
20050106	20050707	10.0%	16.0%	8.5%	3.8%	1.17	4.25
20050708	20060106	15.6%	31.4%	8.5%	4.0%	1.83	7.85
20060109	20060707	18.2%	15.6%	8.5%	15.0%	2.13	1.04
20060710	20070105	17.1%	15.1%	9.5%	2.1%	1.80	7.34
20070108	20070709	17.9%	7.2%	9.5%	6.5%	1.89	1.11
20070710	20080108	16.3%	22.0%	9.8%	6.7%	1.67	3.29
20080109	20080709	15.9%	-20.5%	9.8%	15.2%	1.63	- 1.35
20080710	20090108	9.9%	11.9%	13.6%	4.5%	0.73	2.64
20090109	20090710	9.3%	-8.3%	13.6%	7.3%	0.68	- 1.13
20090713	20100108	2.5%	35.8%	10.6%	1.9%	0.24	18.97
20100111	20100709	12.8%	0.5%	6.3%	13.5%	2.02	0.04
20100712	20110110	16.1%	9.3%	13.5%	8.0%	1.19	1.16
20110111	20110712	18.9%	19.2%	13.7%	16.3%	1.38	1.18
20110713	20120111	20.2%	11.9%	13.5%	4.2%	1.49	2.84
20120112	20120712	13.9%	5.7%	16.3%	10.9%	0.85	0.53
20120713	20130111	16.8%	3.5%	16.3%	6.9%	1.03	0.50
20130114	20130712	11.2%	0.9%	13.2%	21.6%	0.84	0.04
20130715	20140110	6.4%	32.3%	19.0%	2.1%	0.34	15.60
20140113	20140714	10.4%	27.7%	19.0%	7.9%	0.55	3.52
20140715	20150113	17.4%	25.3%	19.0%	9.4%	0.91	2.69
20150114	20150715	22.9%	3.7%	19.0%	10.8%	1.20	0.34
20150716	20160114	24.5%	-5.8%	9.5%	12.5%	2.58	- 0.46
20160115	20160715	15.8%	21.2%	12.3%	4.1%	1.28	5.19
20160718	20170113	18.1%	24.8%	12.3%	6.1%	1.47	4.05
20170116	20170714	16.4%	37.5%	10.5%	9.0%	1.56	4.15
20170717	20180115	25.9%	29.6%	8.1%	4.5%	3.19	6.62
20180116	20180717	31.7%	12.9%	8.1%	16.7%	3.91	0.78
20180718	20190116	26.3%	-4.1%	11.3%	15.1%	2.33	- 0.27
20190117	20190718	20.3%	24.2%	15.5%	10.7%	1.31	2.26
20190719	20200117	15.9%	21.5%	15.5%	5.6%	1.02	3.84

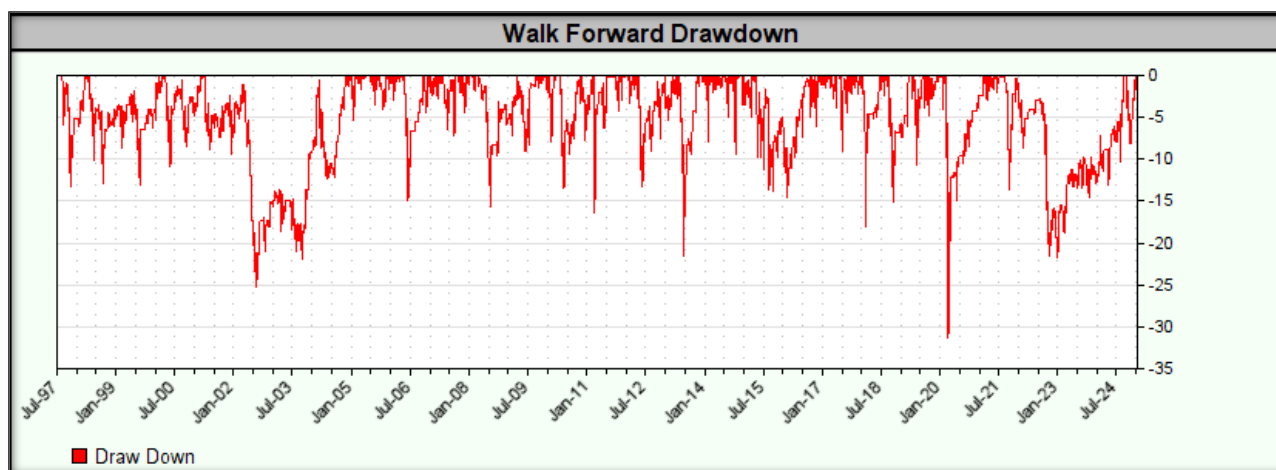
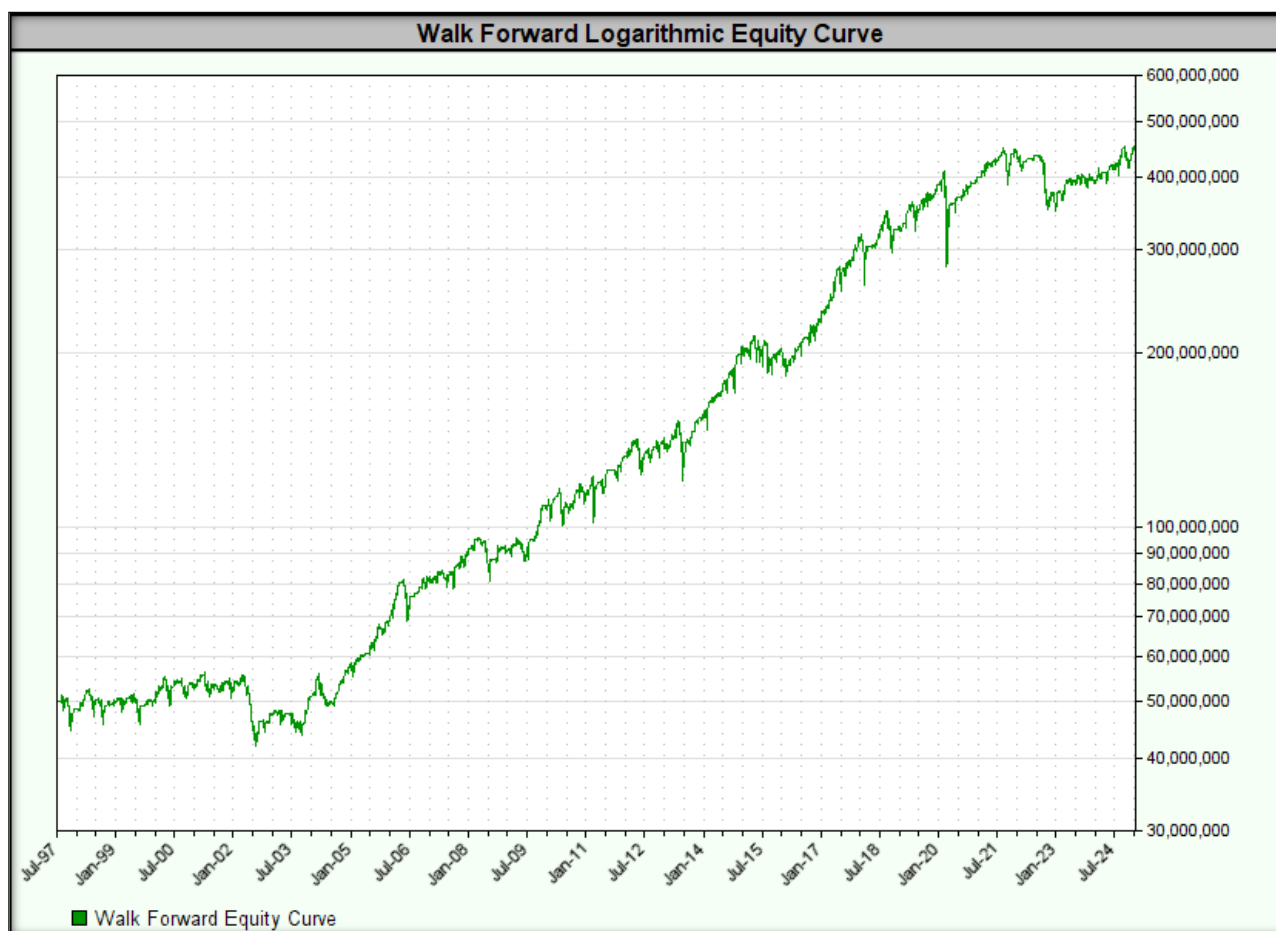


20200120	20200717	15.3%	2.4%	14.9%	20.7%	1.03	0.12
20200720	20210115	8.3%	16.8%	14.0%	3.5%	0.59	4.82
20210118	20210719	12.7%	23.1%	11.6%	2.9%	1.09	7.86
20210720	20220118	11.9%	-2.3%	10.5%	13.6%	1.13	- 0.17
20220119	20220720	9.2%	3.3%	12.2%	6.0%	0.75	0.56
20220721	20230119	15.2%	-7.2%	11.3%	5.7%	1.35	- 1.26
20230120	20230721	8.0%	13.6%	11.3%	5.3%	0.71	2.58
20230724	20240119	6.9%	-1.1%	11.3%	5.4%	0.61	- 0.20
20240122	20240719	4.6%	18.5%	5.4%	5.5%	0.85	3.37
20240722	20250110	8.7%	8.1%	5.5%	8.2%	1.60	0.99
Mean		12.8%	9.1%	11.0%	8.8%	0.67	0.42
		WFE:	71.6%	WFE:	79.8%	WFE:	63.2%

3. Walk Forward Optimization: 913 days; Walk Forward Out-of-sample: 183 days

The results of the Walk-Forward Analysis (WFA) for the 913/183 day combination are presented below.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
440,217,335	8.22%	0.26	0.49	31.32%	43.20	750



Optimization:	913	CAGR%		Max DD		MAR	
WFA:	183	Projections	Real	Projections	Real	Projections	Real
19970702	19971231	7.1%	-5.1%	6.9%	13.2%	1.03	- 0.39
19980101	19980702	6.1%	7.2%	8.3%	10.1%	0.73	0.72
19980703	19990101	6.9%	-0.8%	10.4%	9.7%	0.67	- 0.09
19990104	19990702	10.5%	0.4%	12.9%	5.5%	0.82	0.08



19990705	19991231	7.1%	0.3%	10.8%	9.5%	0.65	0.03
20000103	20000703	6.9%	14.8%	11.1%	10.8%	0.62	1.37
20000704	20010102	9.4%	-4.2%	10.1%	7.9%	0.93	- 0.53
20010103	20010704	7.0%	-0.6%	8.2%	8.9%	0.86	- 0.07
20010705	20020103	6.3%	1.1%	8.1%	7.3%	0.79	0.15
20020104	20020705	6.1%	-23.4%	10.7%	19.4%	0.58	- 1.20
20020708	20030103	4.6%	5.5%	10.4%	9.6%	0.45	0.58
20030106	20030704	5.8%	-5.0%	7.7%	5.6%	0.75	- 0.89
20030707	20040105	3.2%	20.5%	5.9%	8.5%	0.54	2.41
20040106	20040706	7.6%	-3.9%	8.8%	11.9%	0.86	- 0.33
20040707	20050105	4.1%	31.0%	11.9%	2.2%	0.34	14.32
20050106	20050707	9.6%	16.5%	8.5%	4.1%	1.12	4.04
20050708	20060106	11.4%	31.4%	8.5%	4.0%	1.34	7.85
20060109	20060707	18.6%	15.6%	8.5%	15.0%	2.18	1.04
20060710	20070105	15.3%	12.7%	9.8%	4.5%	1.56	2.83
20070108	20070709	16.6%	7.3%	9.5%	6.5%	1.75	1.13
20070710	20080108	16.6%	22.0%	9.8%	6.7%	1.70	3.28
20080109	20080709	17.1%	-15.4%	9.5%	11.9%	1.80	- 1.30
20080710	20090108	10.9%	15.6%	13.2%	4.4%	0.83	3.51
20090109	20090710	8.5%	-6.4%	12.0%	8.9%	0.71	- 0.71
20090713	20100108	6.2%	55.1%	12.0%	2.0%	0.51	26.91
20100111	20100709	12.8%	0.1%	12.1%	13.5%	1.05	0.01
20100712	20110110	10.3%	9.3%	13.5%	7.8%	0.76	1.19
20110111	20110712	15.4%	19.2%	13.7%	16.3%	1.12	1.18
20110713	20120111	18.1%	13.6%	13.5%	4.2%	1.34	3.25
20120112	20120712	18.5%	2.9%	13.5%	13.3%	1.37	0.22
20120713	20130111	12.2%	3.5%	16.3%	6.9%	0.75	0.50
20130114	20130712	12.4%	0.9%	13.2%	21.6%	0.93	0.04
20130715	20140110	8.2%	32.3%	19.0%	2.1%	0.43	15.62
20140113	20140714	11.3%	27.7%	19.0%	7.9%	0.60	3.51
20140715	20150113	13.7%	25.3%	19.0%	9.4%	0.72	2.69
20150114	20150715	18.9%	6.5%	19.0%	11.2%	0.99	0.58
20150716	20160114	18.8%	-11.4%	19.0%	12.4%	0.99	- 0.92
20160115	20160715	14.1%	18.1%	9.5%	6.5%	1.49	2.79
20160718	20170113	17.5%	24.8%	12.3%	6.1%	1.41	4.06
20170116	20170714	18.1%	37.5%	10.5%	9.0%	1.72	4.15
20170717	20180115	20.5%	29.6%	10.5%	4.5%	1.95	6.63
20180116	20180717	26.1%	12.9%	8.1%	16.7%	3.23	0.78
20180718	20190116	26.3%	-4.1%	11.3%	15.1%	2.33	- 0.27
20190117	20190718	21.4%	24.2%	15.5%	10.7%	1.38	2.26
20190719	20200117	20.2%	18.1%	14.5%	4.9%	1.40	3.72
20200120	20200717	16.7%	-11.4%	15.5%	31.3%	1.08	- 0.37

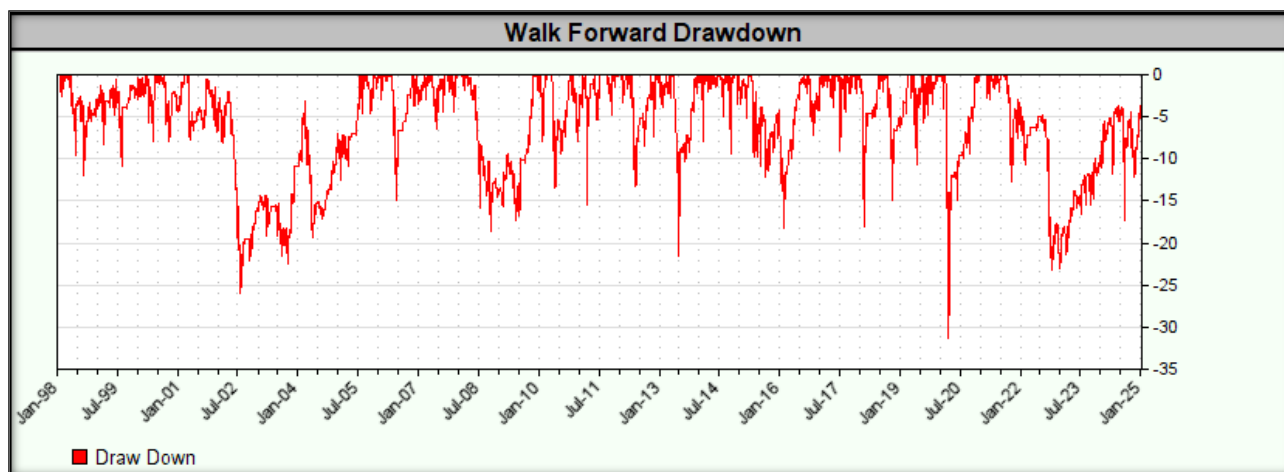
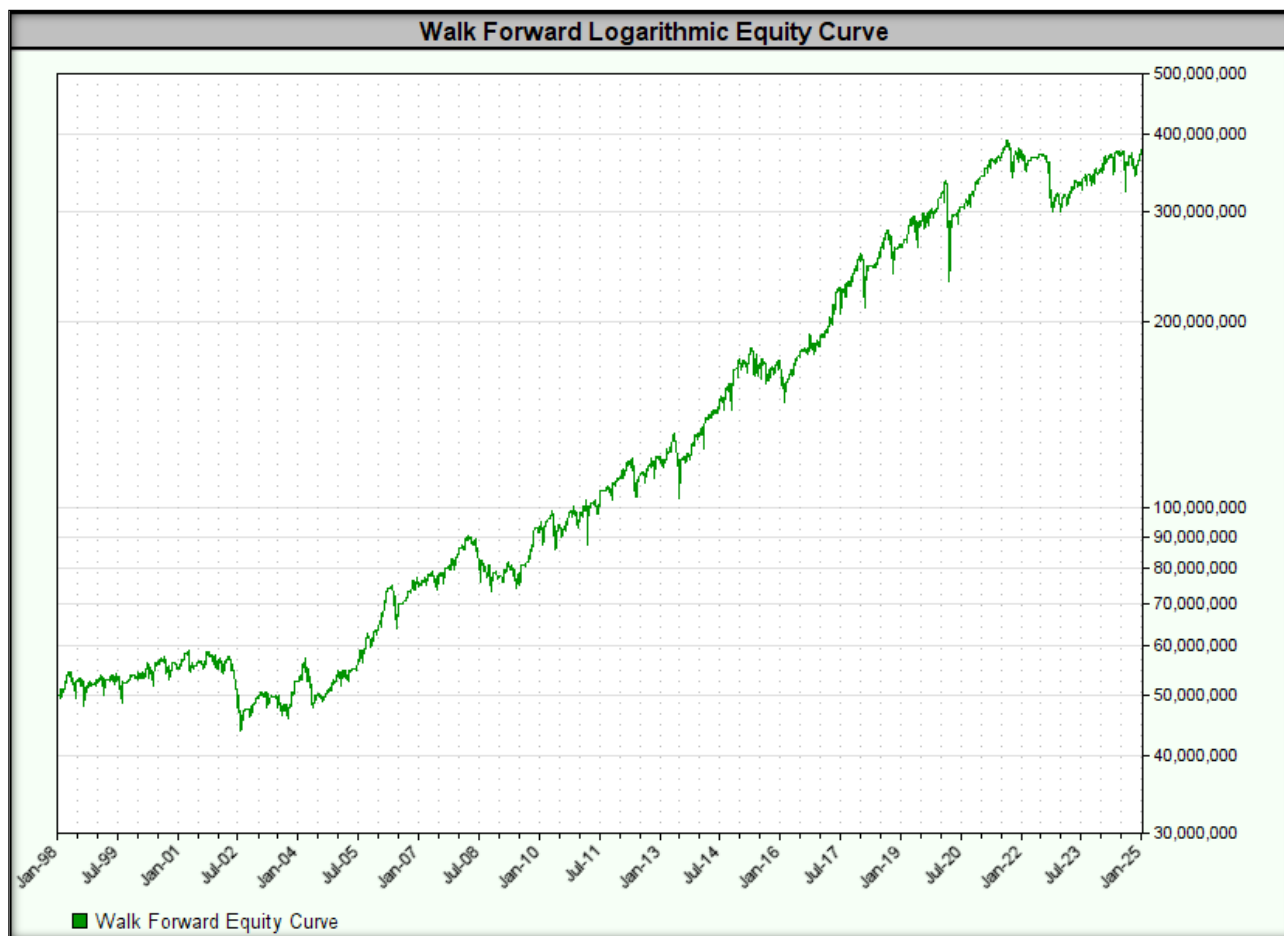


20200720	20210115	8.7%	16.8%	14.0%	3.5%	0.62	4.83
20210118	20210719	9.9%	18.3%	14.0%	3.0%	0.70	6.07
20210720	20220118	14.6%	-2.3%	11.6%	13.6%	1.25	- 0.17
20220119	20220720	8.9%	3.3%	12.2%	6.0%	0.73	0.56
20220721	20230119	8.0%	-25.7%	12.2%	19.5%	0.66	- 1.32
20230120	20230721	11.7%	13.8%	11.3%	3.8%	1.04	3.61
20230724	20240119	9.1%	-1.1%	11.3%	5.4%	0.80	- 0.20
20240122	20240719	5.3%	13.1%	11.3%	6.4%	0.47	2.05
20240722	20250110	7.2%	8.1%	5.5%	8.2%	1.31	0.99
Mean		10.9%	8.1%	11.3%	8.2%	0.93	0.99
WFE:		74.3%	WFE:	72.7%	WFE:	107.2%	

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

The results of the Walk-Forward Analysis (WFA) for the 1095/365 day combination are presented below.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
365,327,630	7.64%	0.24	0.45	31.32%	52.21	772



Optimization:	1095	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19971231	19981230	6.2%	5.7%	10.4%	12.0%	0.60	0.47
19981231	19991230	5.8%	1.6%	10.4%	10.3%	0.55	0.16
19991231	20001229	7.6%	2.9%	12.9%	7.9%	0.59	0.37
20010101	20011228	8.7%	-0.3%	11.1%	7.7%	0.78	-0.04

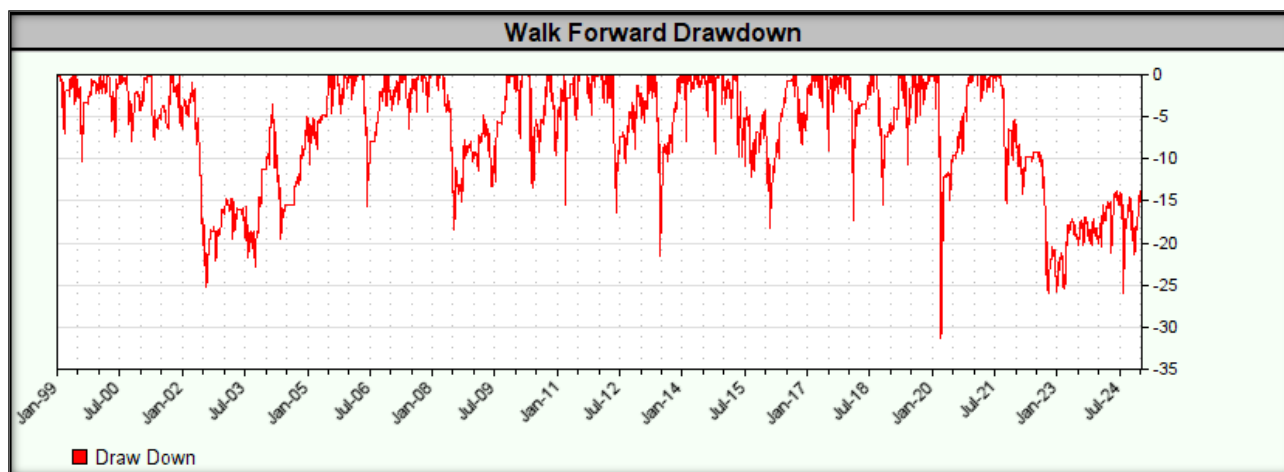
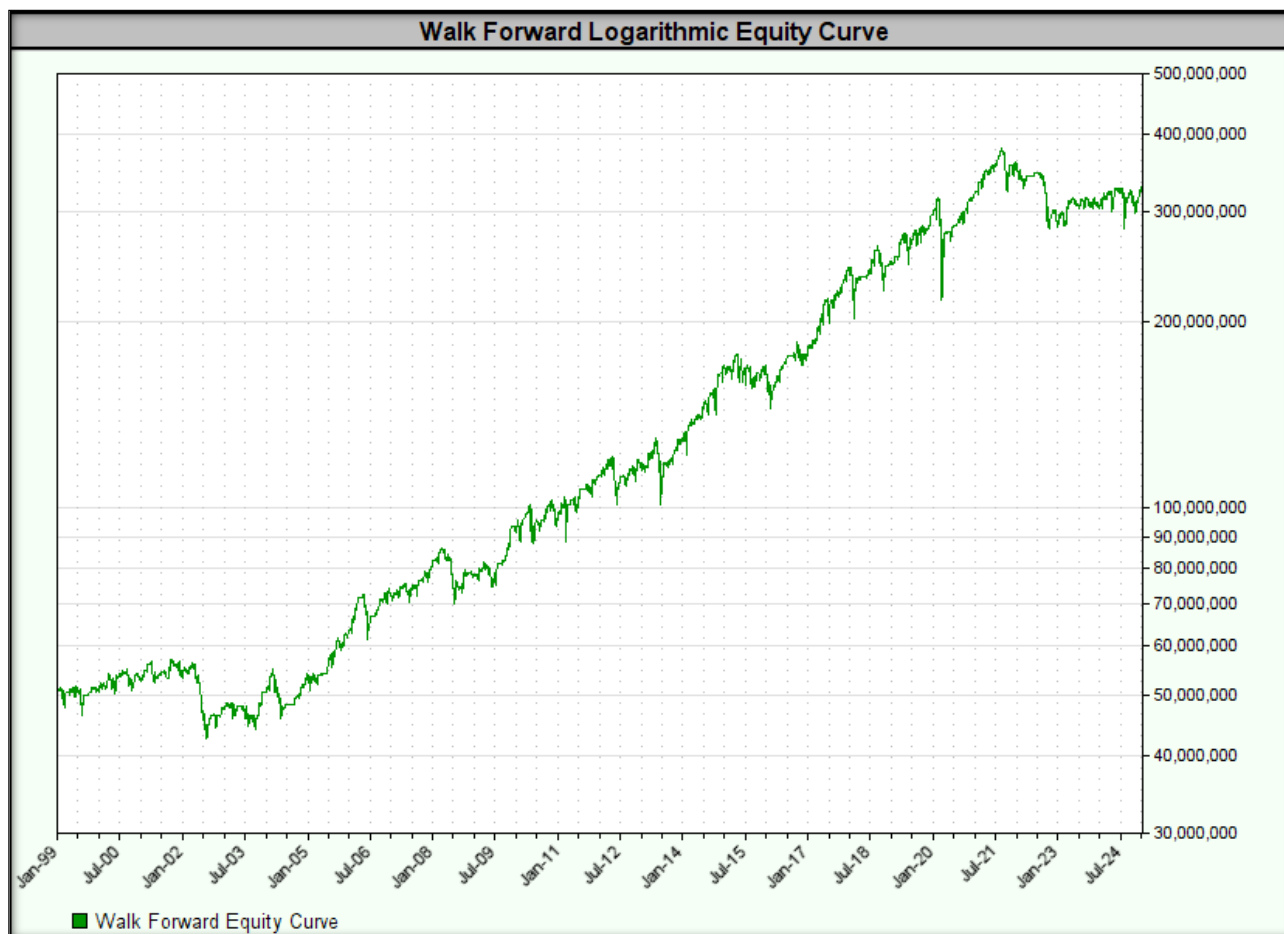


20011231	20021227	4.4%	-10.1%	8.1%	24.4%	0.54	- 0.41
20021230	20031229	7.1%	6.3%	10.4%	9.5%	0.69	0.66
20031230	20041228	5.9%	2.5%	8.4%	16.7%	0.71	0.15
20041229	20051228	8.6%	19.1%	11.9%	5.9%	0.72	3.21
20051229	20061228	14.2%	17.4%	8.5%	15.0%	1.66	1.16
20061229	20071228	15.0%	13.0%	9.5%	6.5%	1.58	2.02
20071231	20081226	16.5%	-9.2%	9.5%	18.6%	1.74	- 0.50
20081229	20091225	11.8%	18.9%	13.2%	8.9%	0.89	2.12
20091228	20101227	13.9%	3.1%	12.1%	13.5%	1.14	0.23
20101228	20111227	10.5%	18.3%	13.7%	15.4%	0.76	1.19
20111228	20121226	17.1%	7.8%	13.5%	13.3%	1.27	0.59
20121227	20131226	9.9%	9.4%	13.5%	21.6%	0.74	0.44
20131227	20141226	11.8%	31.7%	19.0%	9.4%	0.62	3.37
20141229	20151225	16.5%	-1.6%	19.0%	12.1%	0.87	- 0.14
20151228	20161223	15.0%	6.8%	19.0%	14.6%	0.79	0.47
20161226	20171225	17.1%	38.6%	10.5%	9.0%	1.62	4.28
20171226	20181225	21.9%	4.8%	10.5%	18.1%	2.08	0.26
20181226	20191225	22.2%	19.3%	15.5%	10.7%	1.43	1.80
20191226	20201224	20.6%	7.5%	15.5%	31.3%	1.32	0.24
20201225	20211224	9.1%	10.6%	14.1%	12.7%	0.65	0.83
20211227	20221223	12.8%	-18.9%	12.2%	20.6%	1.05	- 0.92
20221226	20231222	5.8%	14.5%	23.0%	4.2%	0.25	3.48
20231225	20241223	8.5%	7.5%	13.5%	14.1%	0.63	0.53
Mean		12.0%	8.4%	12.9%	13.5%	0.52	0.27
WFE:		70.1%	WFE:	104.3%	WFE:	51.5%	

5. 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
318,499,367	7.37%	0.24	0.43	31.33%	45.77	760



Optimization:	1460	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19981231	19991230	6.5%	2.4%	10.4%	10.3%	0.63	0.24
19991231	20001229	7.0%	3.1%	12.9%	7.9%	0.54	0.39
20010101	20011228	7.4%	0.9%	10.7%	7.7%	0.69	0.12
20011231	20021227	6.4%	-10.7%	10.7%	24.5%	0.60	-0.44



20021230	20031229	6.5%	6.2%	11.1%	9.5%	0.58	0.65
20031230	20041228	6.9%	5.1%	10.4%	16.7%	0.66	0.31
20041229	20051228	8.3%	19.1%	11.9%	5.9%	0.70	3.21
20051229	20061228	10.8%	14.5%	11.9%	15.7%	0.91	0.92
20061229	20071228	12.7%	12.3%	9.5%	6.5%	1.33	1.91
20071231	20081226	15.4%	-4.6%	9.8%	18.4%	1.57	- 0.25
20081229	20091225	13.6%	18.9%	13.2%	8.9%	1.03	2.11
20091228	20101227	14.4%	3.6%	13.2%	13.5%	1.09	0.27
20101228	20111227	12.6%	18.4%	13.7%	15.4%	0.92	1.19
20111228	20121226	11.7%	4.1%	13.5%	16.4%	0.87	0.25
20121227	20131226	14.7%	10.2%	13.5%	21.6%	1.09	0.47
20131227	20141226	9.7%	31.7%	19.0%	9.4%	0.51	3.37
20141229	20151225	16.4%	-1.6%	19.0%	12.1%	0.86	- 0.13
20151228	20161223	11.9%	4.9%	19.0%	14.6%	0.62	0.34
20161226	20171225	13.5%	38.5%	19.5%	9.0%	0.69	4.27
20171226	20181225	21.6%	2.1%	10.5%	17.1%	2.05	0.12
20181226	20191225	17.6%	19.3%	15.5%	10.7%	1.13	1.80
20191226	20201224	21.4%	7.5%	15.5%	31.3%	1.38	0.24
20201225	20211224	18.1%	12.4%	20.7%	15.2%	0.88	0.82
20211227	20221223	9.5%	-20.1%	14.1%	21.8%	0.67	- 0.92
20221226	20231222	5.4%	6.8%	13.5%	5.3%	0.40	1.28
20231225	20241223	7.5%	6.9%	23.0%	14.1%	0.33	0.49
Mean		11.8%	8.2%	14.1%	13.8%	0.51	0.26
WFE:		68.9%	WFE:	98.3%	WFE:	50.6%	

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

The results of the Walk-Forward Analysis (WFA) for the 1825/365 day combination are presented below.

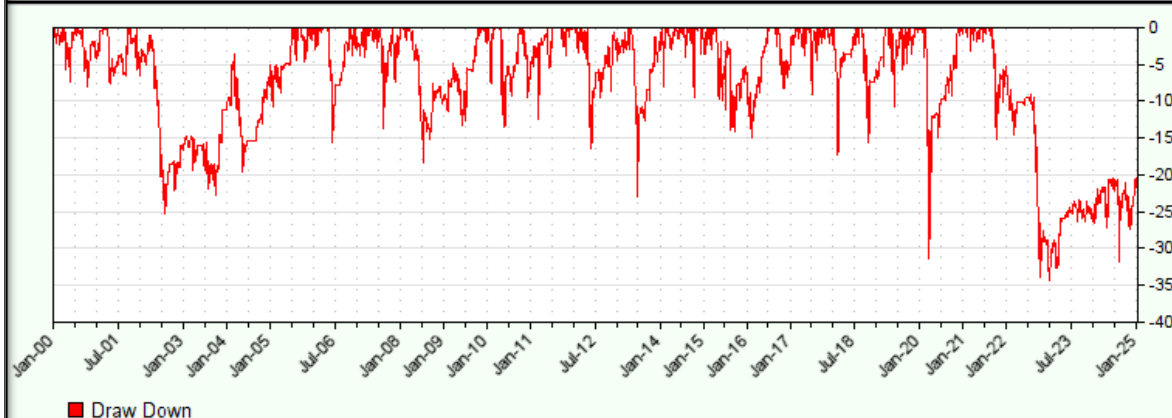
Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
268,100,572	6.94%	0.20	0.40	34.24%	45.77	743



Walk Forward Logarithmic Equity Curve



Walk Forward Drawdown



Optimization:	1825	CAGR%		Max DD		MAR	
WFA:	365	Projections	Real	Projections	Real	Projections	Real
19991231	20001229	7.8%	3.1%	13.0%	7.9%	0.60	0.39
20010101	20011228	6.4%	0.9%	10.7%	7.7%	0.60	0.12
20011231	20021227	6.1%	-10.7%	10.7%	24.5%	0.57	- 0.44
20021230	20031229	6.2%	6.2%	12.2%	9.5%	0.51	0.65



20031230	20041228	6.4%	5.1%	11.1%	16.7%	0.58	0.31
20041229	20051228	7.6%	19.1%	11.9%	5.9%	0.64	3.21
20051229	20061228	10.1%	14.5%	11.9%	15.7%	0.85	0.92
20061229	20071228	12.1%	11.4%	15.7%	13.7%	0.77	0.84
20071231	20081226	13.2%	-3.0%	9.8%	18.4%	1.35	- 0.16
20081229	20091225	11.6%	18.9%	13.2%	8.9%	0.88	2.12
20091228	20101227	15.1%	3.6%	13.2%	13.5%	1.14	0.27
20101228	20111227	12.2%	16.6%	13.5%	10.5%	0.90	1.58
20111228	20121226	12.6%	3.3%	13.5%	16.4%	0.93	0.20
20121227	20131226	10.7%	6.0%	15.4%	23.0%	0.69	0.26
20131227	20141226	13.2%	24.8%	20.2%	9.4%	0.66	2.63
20141229	20151225	13.8%	-0.8%	19.0%	14.1%	0.72	- 0.05
20151228	20161223	12.8%	7.1%	19.0%	10.1%	0.67	0.71
20161226	20171225	12.0%	38.5%	20.7%	9.0%	0.58	4.27
20171226	20181225	18.5%	2.1%	20.7%	17.1%	0.89	0.12
20181226	20191225	18.3%	19.3%	15.5%	10.7%	1.18	1.80
20191226	20201224	17.9%	7.5%	15.5%	31.3%	1.16	0.24
20201225	20211224	19.7%	12.4%	20.7%	15.2%	0.95	0.82
20211227	20221223	17.4%	-29.0%	20.6%	30.2%	0.84	- 0.96
20221226	20231222	5.4%	10.8%	24.1%	5.3%	0.23	2.04
20231225	20241223	9.1%	6.9%	23.1%	14.1%	0.40	0.49
Mean		11.8%	7.8%	15.8%	14.4%	0.49	0.25
WFE:		65.8%	WFE:	90.9%	WFE:	50.7%	

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

The results of the Walk-Forward Analysis (WFA) for the 1644/548 day combination are presented below.

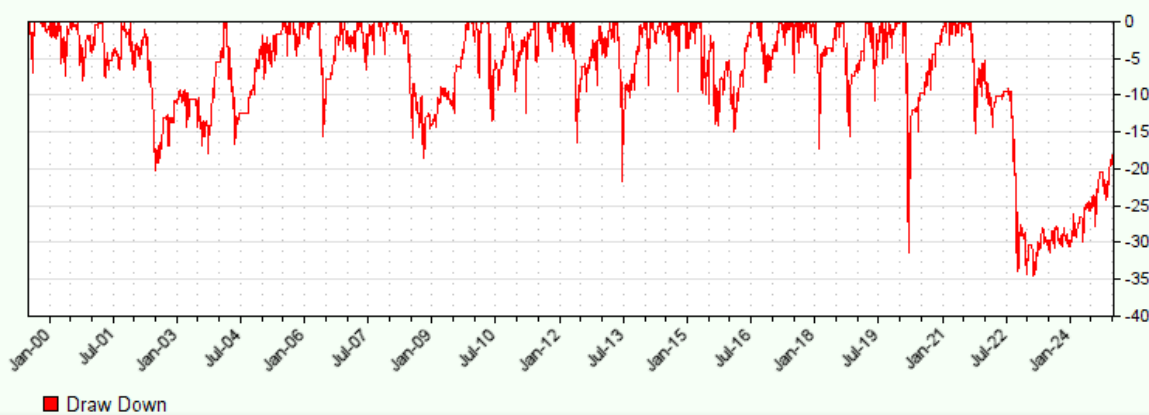
Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
271,078,136	6.85%	0.20	0.41	34.57%	40.61	714



Walk Forward Logarithmic Equity Curve



Walk Forward Drawdown



Optimization:	1644	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
19990705	20001229	7.6%	5.1%	13.0%	7.9%	0.59	0.64
20010101	20020702	7.3%	-9.3%	10.7%	20.2%	0.68	- 0.46
20020703	20040101	4.8%	11.7%	12.2%	9.5%	0.40	1.23
20040102	20050701	6.0%	6.7%	10.4%	16.7%	0.58	0.40

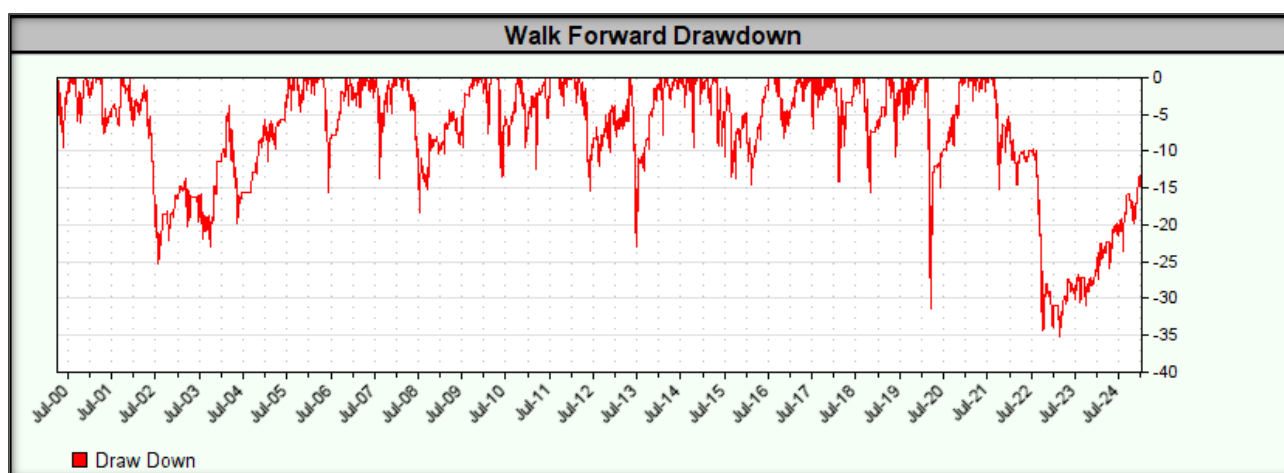
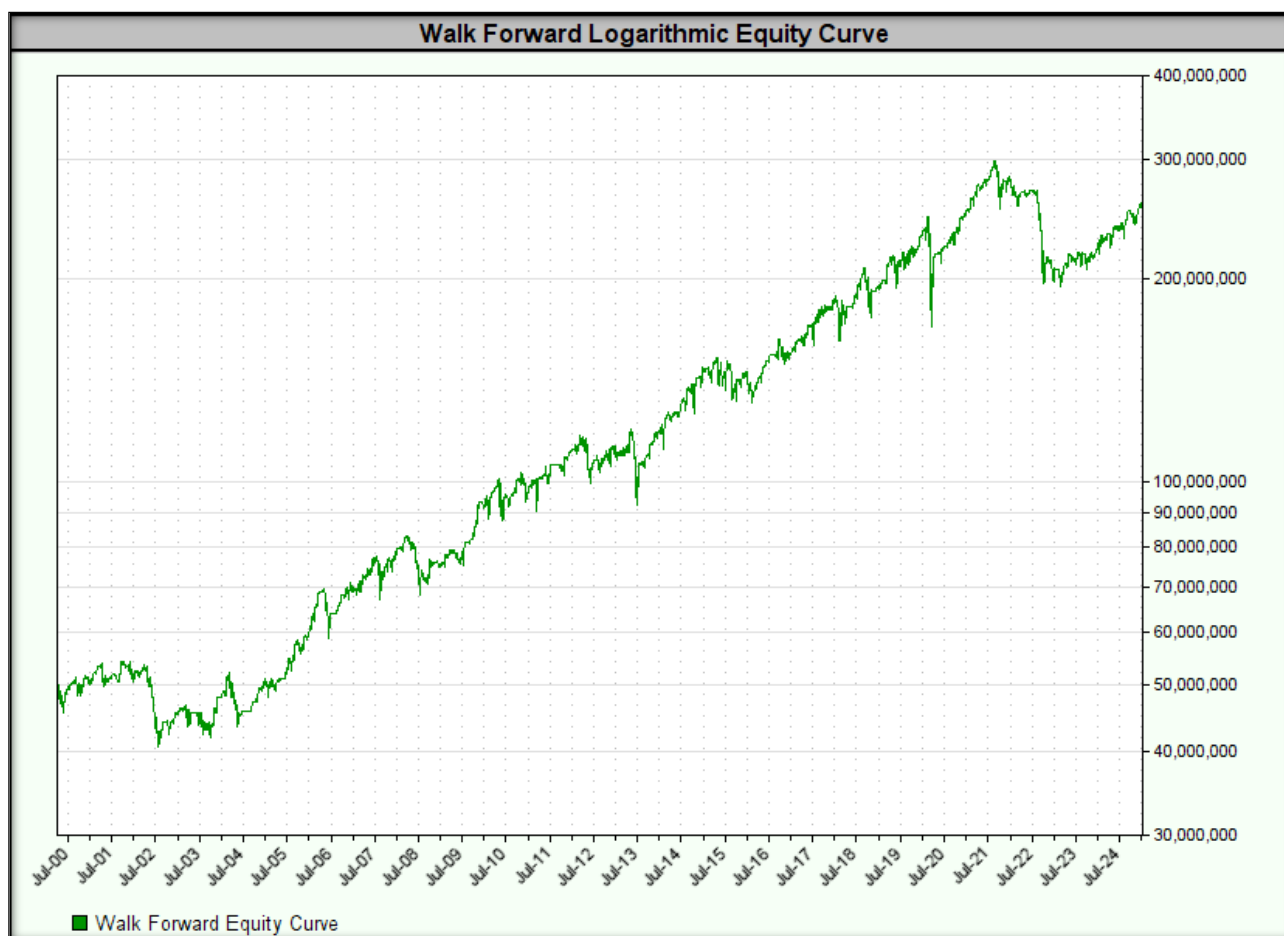


20050704	20070101	8.2%	19.6%	11.9%	15.7%	0.69	1.25
20070102	20080702	11.9%	3.3%	9.5%	11.7%	1.25	0.28
20080703	20100101	11.1%	11.0%	11.7%	11.1%	0.95	0.99
20100104	20110701	14.7%	7.5%	13.3%	13.5%	1.11	0.55
20110704	20130101	11.5%	8.4%	13.5%	16.4%	0.85	0.51
20130102	20140703	13.6%	12.9%	13.5%	21.6%	1.00	0.60
20140704	20160101	11.3%	9.1%	19.0%	14.1%	0.59	0.64
20160104	20170703	13.1%	8.3%	19.0%	9.4%	0.69	0.88
20170704	20190102	15.8%	14.9%	20.7%	17.3%	0.76	0.86
20190103	20200703	18.3%	9.3%	15.5%	31.3%	1.18	0.30
20200706	20211231	20.0%	13.7%	20.7%	15.2%	0.97	0.90
20220103	20230704	14.8%	-17.6%	20.6%	30.3%	0.72	- 0.58
20230705	20250102	5.9%	9.8%	13.5%	5.6%	0.44	1.76
Mean		11.5%	7.3%	14.6%	15.7%	0.56	0.23
WFE:		63.4%	WFE:	107.6%	WFE:	41.9%	

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

The results of the Walk-Forward Analysis (WFA) for the 1918/548 day combination are presented below.

Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
254,143,590	6.78%	0.19	0.39	35.10%	45.77	738



Optimization:	1918	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20000403	20011001	7.8%	5.0%	10.4%	9.5%	0.75	0.52
20011002	20030402	7.6%	-11.4%	10.7%	25.2%	0.71	-0.45
20030403	20041001	5.8%	3.5%	12.2%	16.7%	0.48	0.21
20041004	20060331	5.6%	28.6%	11.9%	6.1%	0.47	4.71



20060403	20071002	12.6%	6.7%	11.9%	15.7%	1.06	0.43
20071003	20090402	12.1%	2.7%	9.8%	18.3%	1.23	0.15
20090403	20101001	11.9%	17.7%	13.2%	13.5%	0.89	1.31
20101004	20120402	14.5%	9.6%	13.5%	12.3%	1.07	0.78
20120403	20131002	14.6%	-3.2%	15.4%	23.0%	0.95	- 0.14
20131003	20150403	11.2%	23.0%	20.2%	9.4%	0.56	2.43
20150406	20160930	13.6%	5.4%	19.0%	14.5%	0.71	0.37
20161003	20180403	13.5%	5.9%	19.0%	14.1%	0.71	0.42
20180404	20191003	16.9%	16.1%	20.7%	15.5%	0.82	1.04
20191004	20210402	18.2%	15.2%	15.5%	31.3%	1.17	0.49
20210405	20221003	20.7%	-15.0%	20.7%	31.8%	1.00	- 0.47
20221004	20240403	10.3%	5.9%	31.2%	11.8%	0.33	0.50
20240404	20250110	6.0%	12.0%	13.5%	5.6%	0.44	2.14
Mean		11.9%	7.5%	15.8%	16.1%	0.38	0.24
		WFE:	62.9%	WFE:	102.1%	WFE:	61.9%

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

The results of the Walk-Forward Analysis (WFA) for the 2192/548 day combination are presented below.

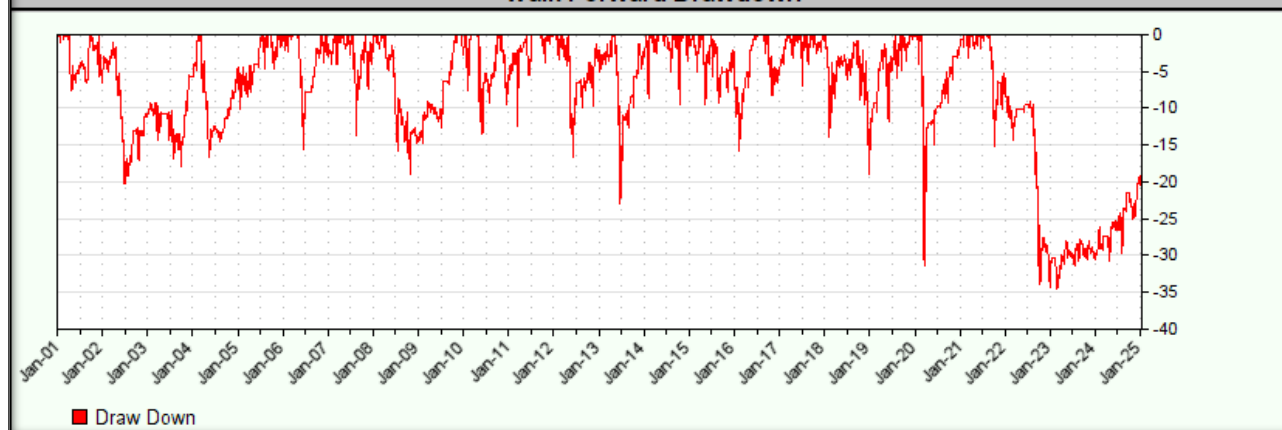
Walk Forward Summary Performance						
Ending Balance	CAGR%	MAR	Annual Sharpe	Max Total Equity DD	Longest Drawdown	# Trades
184,109,292	5.58%	0.16	0.32	34.57%	40.61	684



Walk Forward Logarithmic Equity Curve



Walk Forward Drawdown



Optimization:	2192	CAGR%		Max DD		MAR	
WFA:	548	Projections	Real	Projections	Real	Projections	Real
20010101	20020702	6.8%	-10.1%	10.7%	20.2%	0.63	- 0.50
20020703	20040101	5.0%	11.7%	12.2%	9.5%	0.41	1.23
20040102	20050701	6.3%	5.3%	12.1%	16.7%	0.52	0.32
20050704	20070101	6.7%	17.8%	11.9%	15.7%	0.56	1.14



20070102	20080702	11.2%	1.7%	15.7%	13.7%	0.71	0.13
20080703	20100101	9.8%	10.9%	11.7%	11.2%	0.84	0.97
20100104	20110701	13.1%	7.5%	13.2%	13.5%	0.99	0.55
20110704	20130101	12.9%	8.0%	13.5%	16.6%	0.96	0.48
20130102	20140703	12.3%	10.3%	15.4%	23.0%	0.80	0.45
20140704	20160101	13.4%	8.3%	20.2%	9.5%	0.66	0.87
20160104	20170703	11.0%	7.6%	19.0%	12.8%	0.58	0.59
20170704	20190102	12.1%	1.5%	19.0%	19.0%	0.64	0.08
20190103	20200703	16.4%	10.8%	20.7%	31.3%	0.79	0.35
20200706	20211231	17.4%	13.7%	20.7%	15.2%	0.84	0.90
20220103	20230704	18.6%	-17.6%	20.6%	30.2%	0.90	- 0.58
20230705	20250102	7.6%	8.9%	24.1%	7.0%	0.32	1.27
Mean		11.3%	6.0%	16.3%	16.6%	0.47	0.19
		WFE:	53.2%	WFE:	101.6%	WFE:	41.0%

10. 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**:

- **The WFE for CAGR% remains around 60%-70%**, indicating good performance of the strategy in real-world conditions. **One of the nine tests had a WFE around 50%.**
- **The WFE for drawdown remains around 70%-100%**, which means that the strategy does not lose significant stability outside the optimization period.

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

Considering both **MAR** and **WFE**, the best results were achieved for **the 730/183 days combination** (730 days of optimization, 183 days of testing). Therefore, in the next period we use the following parameters:

- **Length of the moving average (SMA): 85 days;**
- **Highest/lowest close (Donchian channel): 19 days.**

Below is a comparison of the WFA test results for the 730/183 combination with the results of the strategy using the optimized parameters from step 4:

	WFA	Optimized
CAGR%	8.2%	7.5%
MAR Ratio	0.32	0.31
Max Drawdown	25.7%	24.2%

The results are similar at the **CAGR%**, **MAR**, and **Max Drawdown** levels – that's good news. The strategy remains **stable** and **unaffected by overfitting**.

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



- Length of the moving average (SMA): 85 days;
- Highest/lowest close (Donchian channel): 19 days;
- Stop loss: none;
- Position opening method: at the opening price of the next day;
- Position size: corresponding to a risk of 1.0% of total capital, with a hypothetical stop loss order located 2 x ATR (40 days) away from the position opening point;
- 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;
- Position direction: long positions (buy) only.



Step 6: Using the strategy in real time

After **extensive testing**, implementing a **real-time trading strategy** becomes **relatively simple**. 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 implementation** is the **consistent execution of all signals, without exception**. **Larry Williams noted:** *"Trading strategies work. Traders do not."*

Before making a **final decision to implement a strategy**, it's important to verify **whether it actually adds value** to the overall portfolio performance. It doesn't make sense to implement a strategy that **generates similar signals or has a similar equity curve**.

Key criteria for evaluating strategies 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 or none of them are met**.

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

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

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

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

Thanks to this:

- **We avoid investing real money in an untested environment.**



- **We wait for a drawdown to occur** before launching the strategy, which **reduces the risk of starting at an unfavorable moment.**

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