2-RSI v.3

Investment Strategy Testing Summary

The 2-RSI strategy is a swing trading investment technique that uses **the short-term RSI (Relative Strength Index)** and a downward correction of an instrument in **an upward trend** (quotes above **the long-term moving average)**. The key assumption of the strategy is **to open long positions during a correction** and then **close them after the price increases.**

Compared to version 2-RSI v.1 in this strategy, **the two RSI levels** (Entry Threshold and Exit Threshold) **are replaced by one, symmetrical one.**

It should be noted that while the strategy's results on in-sample data are decent, the strategy failed the stability test in a wide range of optimized parameters. This means that the strategy loses its profitability and generates a significantly larger drawdown when tests are conducted on suboptimal parameters. Therefore, **it is not recommended to use it in real transactions.**

Our goal is to have a strategy that remains **profitable and effective over a wide range of parameters,** because the market is a changing organism and the optimal parameters can change over different periods. **I cannot** emphasize enough that for **a strategy to work** in real conditions, it must also work on **suboptimal parameters** and in **suboptimal conditions.** In a word - **it must be stable** to changing market conditions.

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

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

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

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Step 1: Formulate an investment strategy

2-RSI v.3 Strategy was developed by Larry Connors and Cesar Alvarez as a **short-term mean-reversion system** that uses **extreme readings of the 2-period RSI indicator.** In this approach, the strategy takes **only long positions** in markets that have a **historical tendency to quick rebounds,** i.e. major stock indices, Treasury bond futures, gold, US dollar index.

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

Compared to version 2-RSI v.1 in this strategy, **the two RSI levels** (Entry Threshold and Exit Threshold) **are replaced by one, symmetrical one.**

The strategy uses:

- **Extreme RSI oversold** – the indicator value below the established threshold signals a potential rebound;
- **SMA Direction Filter** – positions are only taken when the price closes above the long-term moving average;
- **Pre-defined exit point** – the trade lasts until the RSI returns to the neutral zone.

Characteristics of the strategy and its strengths and weaknesses:

- **Simple, quantitative logic** – two main conditions (RSI & SMA) simplify testing and automation;
- **Natural mean-reversion environment** – the indicated asset classes historically rebound after short corrections;
- **Small number of transactions** – clear filters reduce commission costs;
- **Risk during violent bear markets** – during heavy sell-offs, the price may fall significantly before recovering (2020);
- **Less activity during periods of low volatility** – extreme RSI values are rare then.

The 2-RSI strategy, while simple to implement, requires caution due to its susceptibility to false signals and **lack of stop losses.** Its application requires careful optimization and risk management, especially in volatile market conditions.

Step 2: Define investment principles

Below is **the pseudocode** for the **2-RSI v.3 strategy** on daily data:

1. **Calculating Indicators:**
    a. **X-Day RSI:** Used to identify short-term oversold market conditions.
    b. **YY-day SMA:** Determines the long-term trend of the market. If the price is above the SMA, it is considered to be in an uptrend.
2. **Generating Entry Signals – Long Position:**
    a. It is opened only when the market is in an uptrend (Price > SMA) and the RSI falls below ZZ, which indicates an oversold condition.
    b. A position is opened at the opening of the next day on which the conditions are met.
3. **Generating Output Signals:**
    a. The position is closed when the RSI rises above 100-ZZ (symmetry).
    b. The close 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 closing of positions.
    b. This is an important consideration for risk management and requires discipline from the trader and the possible introduction of his own capital protection mechanisms.
5. **Daily Monitoring:**
    a. RSI and SMA values are calculated every day.
    b. The system checks whether the entry or exit conditions are met and takes appropriate action the next day upon opening.
6. **Additional Notes:**
    a. **No Short Positions:** The strategy focuses only 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 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 **a hypothetical stop loss order located 2 x ATR (40 days)** away from the position opening point.

Step 3: Conduct a preliminary test of the investment strategy

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

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

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

The first transaction was made on the Nasdaq100 index futures contract. At the end of June 2018, the quotes were above **the 150-day moving average,** and the **2-day indicator value RSI fell below the 20 level,** which generated a signal to open a long position (**the first candle in the rectangle on the left)**. The position was opened the next day at the opening price (**the second candle in the rectangle on the left)**.

After several days of sideways movement, in early July 2018 the market rose, raising the **RSI value to 80** (symmetry: 100 - 20), which signaled the closing of the position (**the first candle in the rectangle on the right)**. The position was closed the next day at the opening price (**the second candle in the rectangle on the right)**. **The system worked correctly.**

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

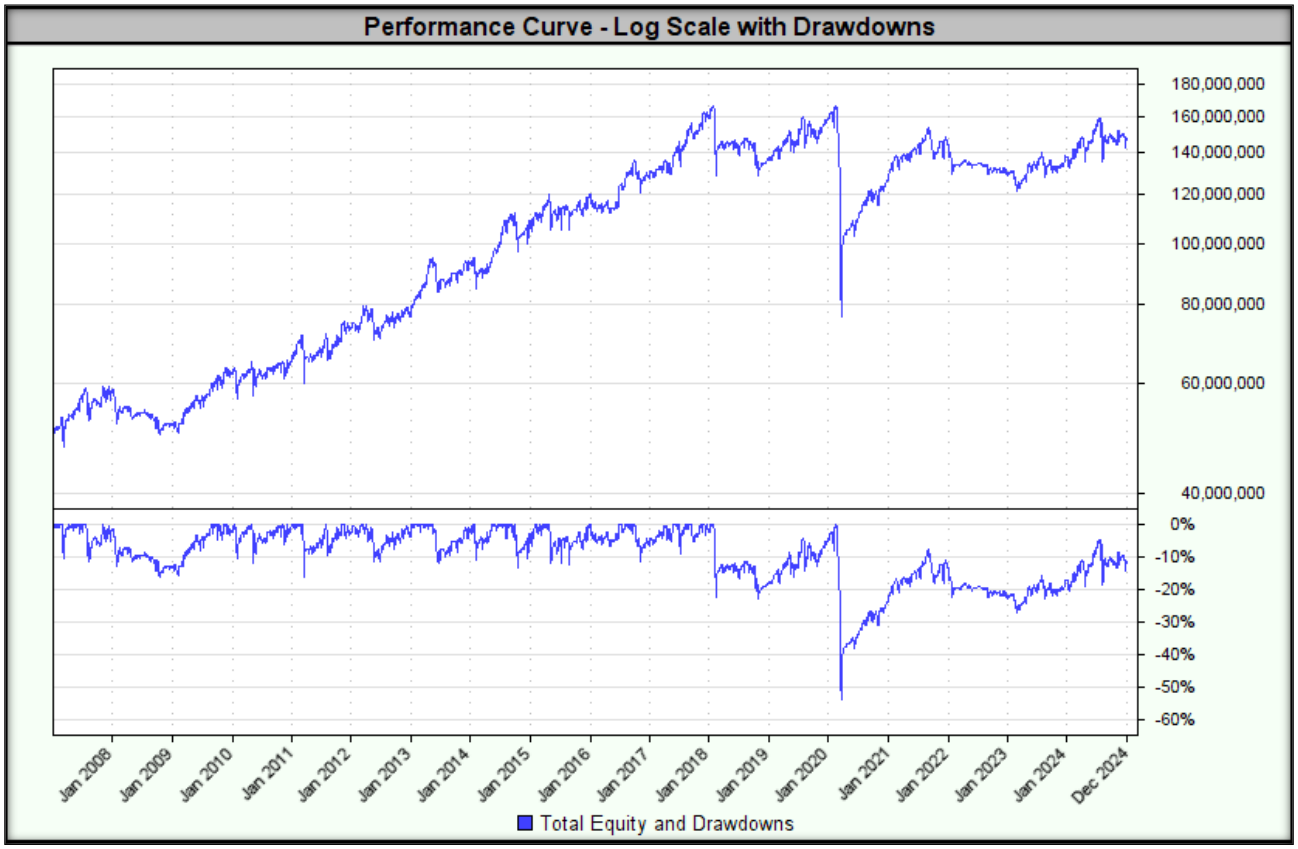
First of all, **we reject strategies that linearly lose capital.** If a strategy exhibits such a pattern, it is a clear signal that any parameter optimization does not make sense.

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

Tested base parameters:

- **Length of the moving average (SMA):** 150 days;
- **RSI Lengths:** 2 days;
- **RSI Entry Threshold:** 20;
- **RSI Exit Threshold (take profit):** 80 (symmetric; 100 - RSI Entry Threshold);
- **Stop loss:** none;
- **Method of opening a position:** at the opening price of the next day;
- **Position size:** corresponding to the 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 position;
- **Position direction:** long positions (buy) only.

The test result is shown below.



Indicators/Measures	Concluding a transaction at the opening price

CAGR%	6.2%
MAR Ratio	0.11
RAR%	6.8%
R-Cubed	0.18
Robust Sharpe Ratio	0.50
Max Drawdown	54.0%
Wins	67.1%
Losses	32.9%
Average Win%	0.53%
Average Loss %	0.85%
Win/Loss Ratio	0.62
Average Trade Duration (days)	11
Percent Profit Factor	1.27
SQN	-
Number of transactions	1682

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.**

Step 4: Optimization and assessment of investment strategy stability

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

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

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

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

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

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

2-RSI v.3 Strategy in this version it assumes **optimization of parameters using The Grid** method **Search.** It consists of **full optimization of all indicated parameters by creating a wide range of possible combinations.** Our goal is to find such **parameter ranges** that **the strategy remains stable (robust),** which will allow us to assess its usefulness in real market conditions.

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

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

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

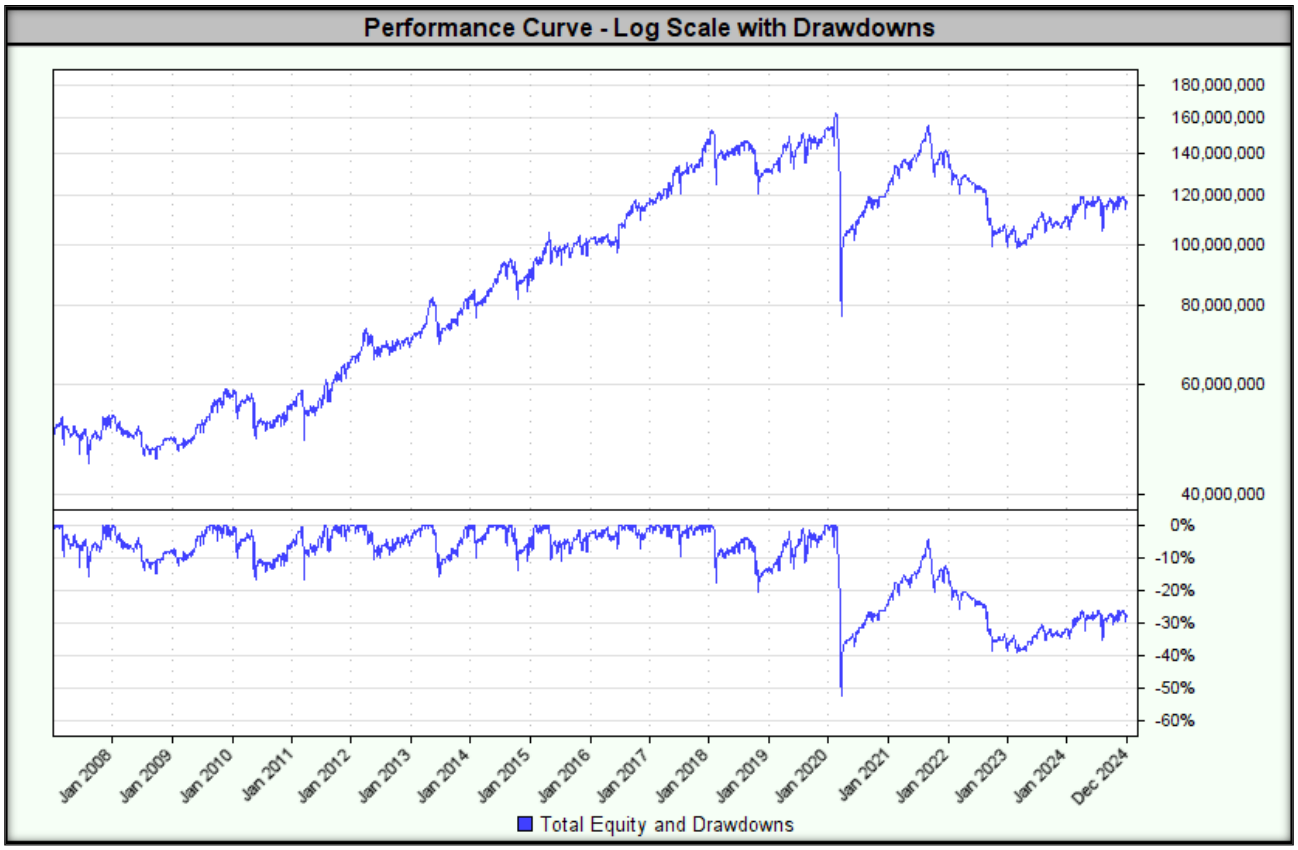
- **Moving average lengths (SMA):** range **80-150 days (step: 2);**
- **RSI Lengths: 2-3 day** range **(step: 1);**
- **RSI Entry & Exit Threshold:** range **13-20 (step: 0.5);**

The lowest MAR value of 0.09 was achieved for the following parameters:

- **Length of the moving average (SMA):** 80;
- **RSI lengths:** 2;
- **RSI Entry & Exit Threshold:** 16.

Test	Moving Average Long (bars)	RSI (bars)	RSI Threshold Entry & Exit	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3
7	80	2	16.0	$116,840,950.97	4.83%	0.09	0.42	0.35	52.6%	58.7	1307	0.16
37	82	2	16.0	$118,718,360.55	4.92%	0.09	0.43	0.37	52.6%	58.7	1305	0.16
283	98	2	19.0	$126,268,736.43	5.28%	0.10	0.44	0.37	54.0%	58.7	1565	0.17
163	90	2	19.0	$130,246,474.86	5.46%	0.10	0.46	0.38	55.4%	83.4	1549	0.17
1057	150	2	16.0	$137,667,290.38	5.79%	0.10	0.47	0.46	58.7%	58.7	1371	0.16
907	140	2	16.0	$139,339,856.35	5.86%	0.10	0.47	0.46	58.7%	58.7	1370	0.15
10	80	2	17.5	$125,825,684.78	5.26%	0.10	0.46	0.39	52.6%	58.7	1416	0.19
313	100	2	19.0	$129,031,463.74	5.41%	0.10	0.45	0.37	54.0%	83.2	1564	0.18
67	84	2	16.0	$126,121,031.46	5.27%	0.10	0.45	0.40	52.6%	58.7	1312	0.17

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



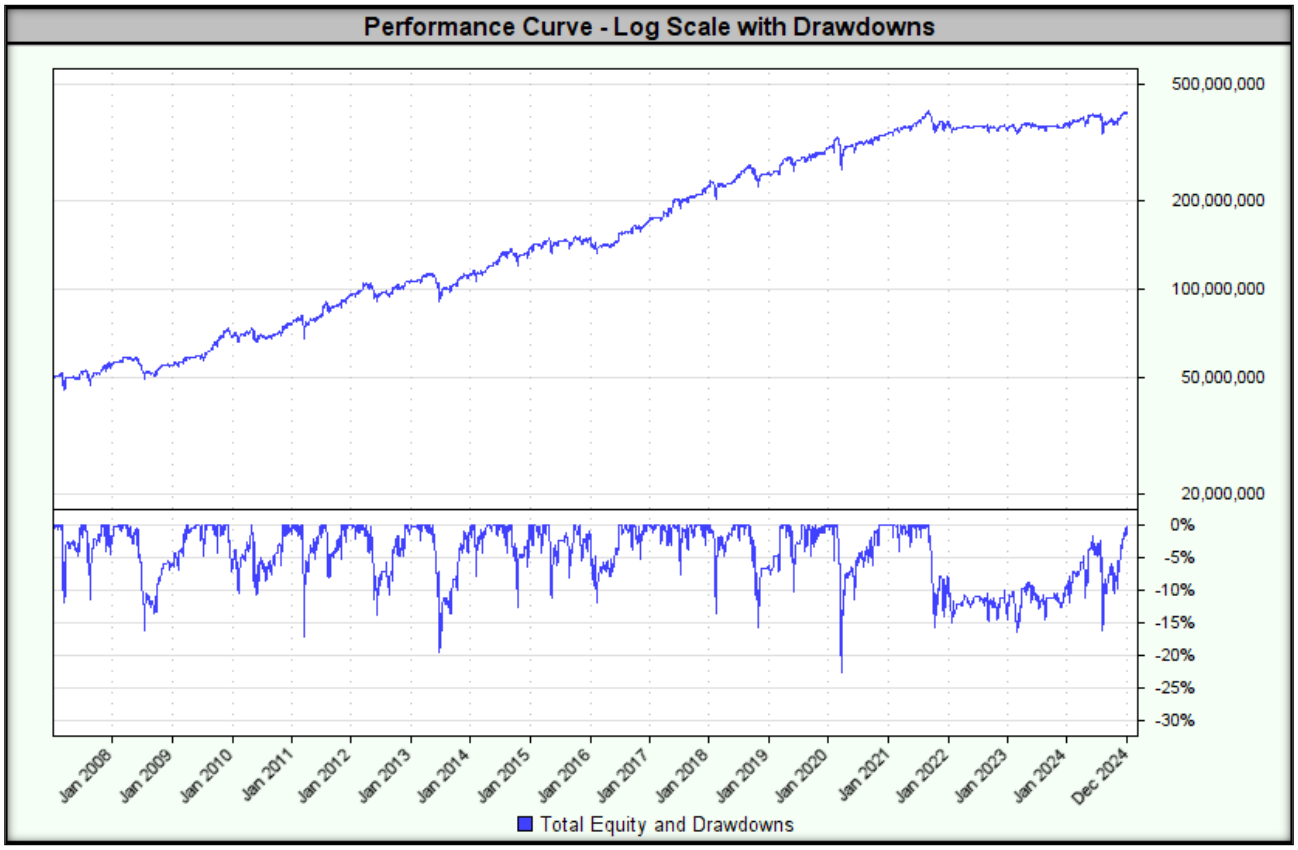
The highest MAR value of 0.54 was achieved for the following parameters:

- **Length of the moving average (SMA):** 88;
- **RSI lengths:** 3;
- **RSI Entry & Exit Threshold:** 19.

The highest MAR value was accompanied by **a drawdown of 22.7%.**

Test	Moving Average Long (bars)	RSI (bars)	RSI Threshold Entry & Exit	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3
148	88	3	19.0	$399,023,069.43	12.23%	0.54	1.03	1.28	22.7%	40.0	712	0.81
178	90	3	19.0	$386,037,360.98	12.03%	0.53	1.00	1.24	22.7%	39.8	713	0.74
118	86	3	19.0	$385,002,435.76	12.01%	0.53	1.02	1.25	22.7%	40.0	707	0.78
28	80	3	19.0	$376,971,585.30	11.88%	0.52	1.01	1.21	22.7%	40.0	700	0.73
149	88	3	19.5	$381,986,487.96	11.96%	0.52	1.01	1.32	22.9%	33.1	744	0.88
150	88	3	20.0	$379,177,324.86	11.91%	0.52	0.99	1.28	22.8%	33.1	769	0.84
238	94	3	19.0	$372,148,164.03	11.80%	0.52	0.99	1.22	22.7%	32.7	717	0.79
180	90	3	20.0	$374,387,956.45	11.84%	0.52	0.98	1.28	22.8%	32.7	770	0.80
179	90	3	19.5	$371,960,592.18	11.79%	0.52	0.99	1.31	22.8%	32.7	744	0.80

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 58.7%.**

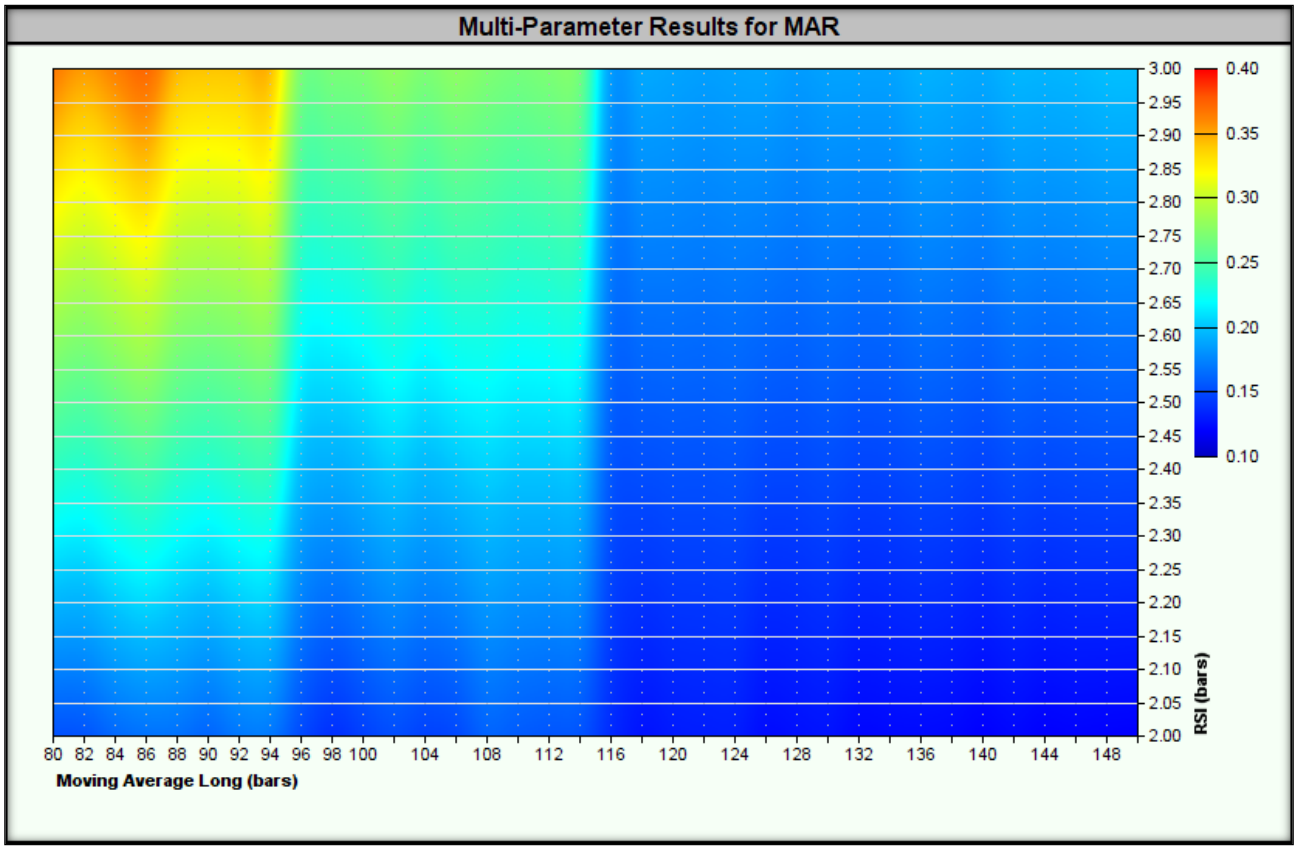
Test	Moving Average Long (bars)	RSI (bars)	RSI Threshold Entry & Exit	End Balance	CAGR%	MAR	Sharpe	Ann. Sharpe	Max TE DD	Longest DD	Trades	R3
1027	148	2	16.0	$140,241,298.82	5.90%	0.10	0.48	0.46	58.7%	58.7	1373	0.16
997	146	2	16.0	$141,986,175.19	5.97%	0.10	0.48	0.47	58.7%	58.7	1372	0.16
878	138	2	16.5	$146,144,934.72	6.14%	0.10	0.50	0.51	58.7%	58.7	1421	0.19
607	120	2	16.0	$151,458,877.43	6.35%	0.11	0.51	0.48	58.7%	58.7	1346	0.18
697	126	2	16.0	$145,130,581.73	6.10%	0.10	0.49	0.47	58.7%	58.7	1358	0.17
608	120	2	16.5	$156,806,456.87	6.56%	0.11	0.53	0.52	58.7%	58.7	1396	0.21
938	142	2	16.5	$147,019,506.50	6.18%	0.11	0.50	0.51	58.7%	58.7	1423	0.20
1057	150	2	16.0	$137,667,290.38	5.79%	0.10	0.47	0.46	58.7%	58.7	1371	0.16
1058	150	2	16.5	$144,334,389.05	6.07%	0.10	0.49	0.50	58.7%	58.7	1423	0.18

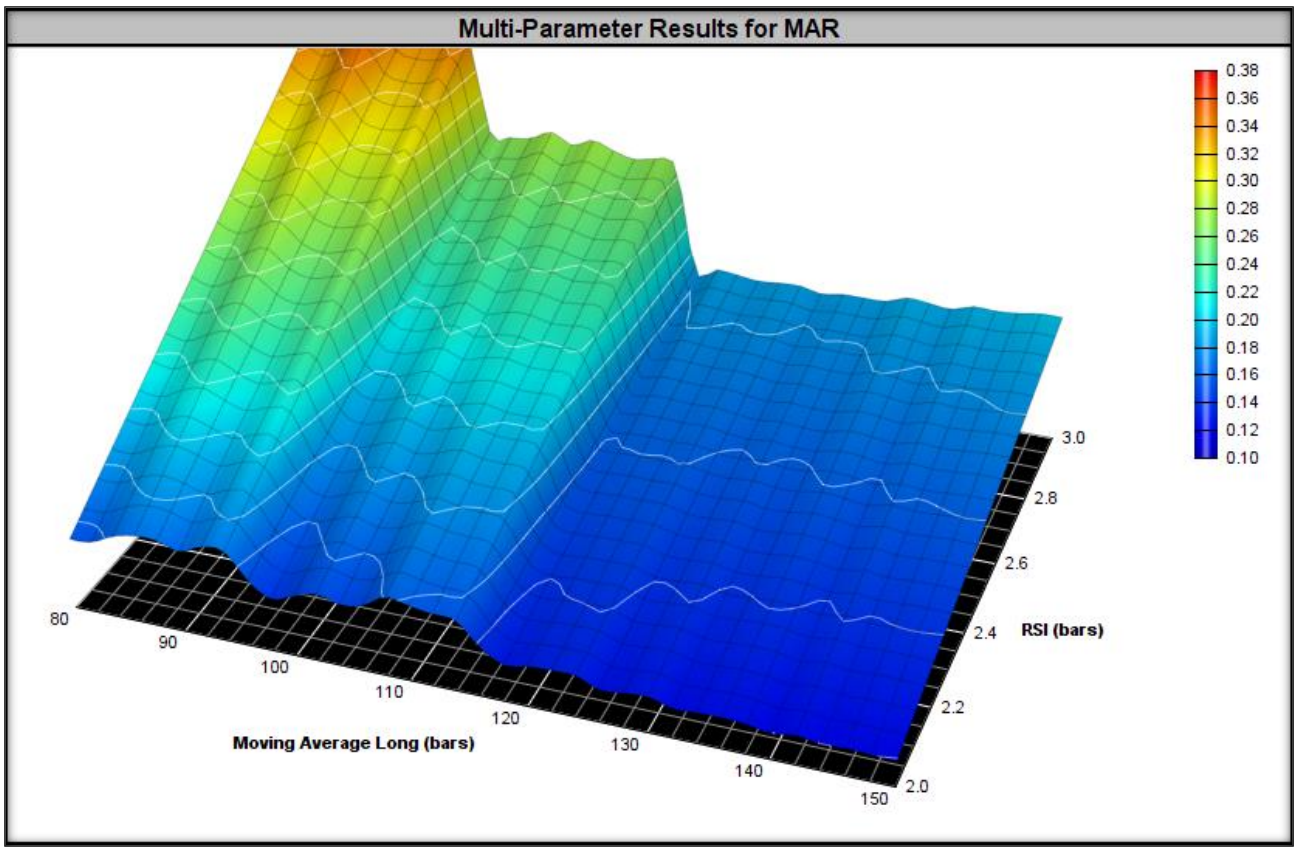
In summary, the strategy **failed the stability test** over a wide range of optimized parameters because:

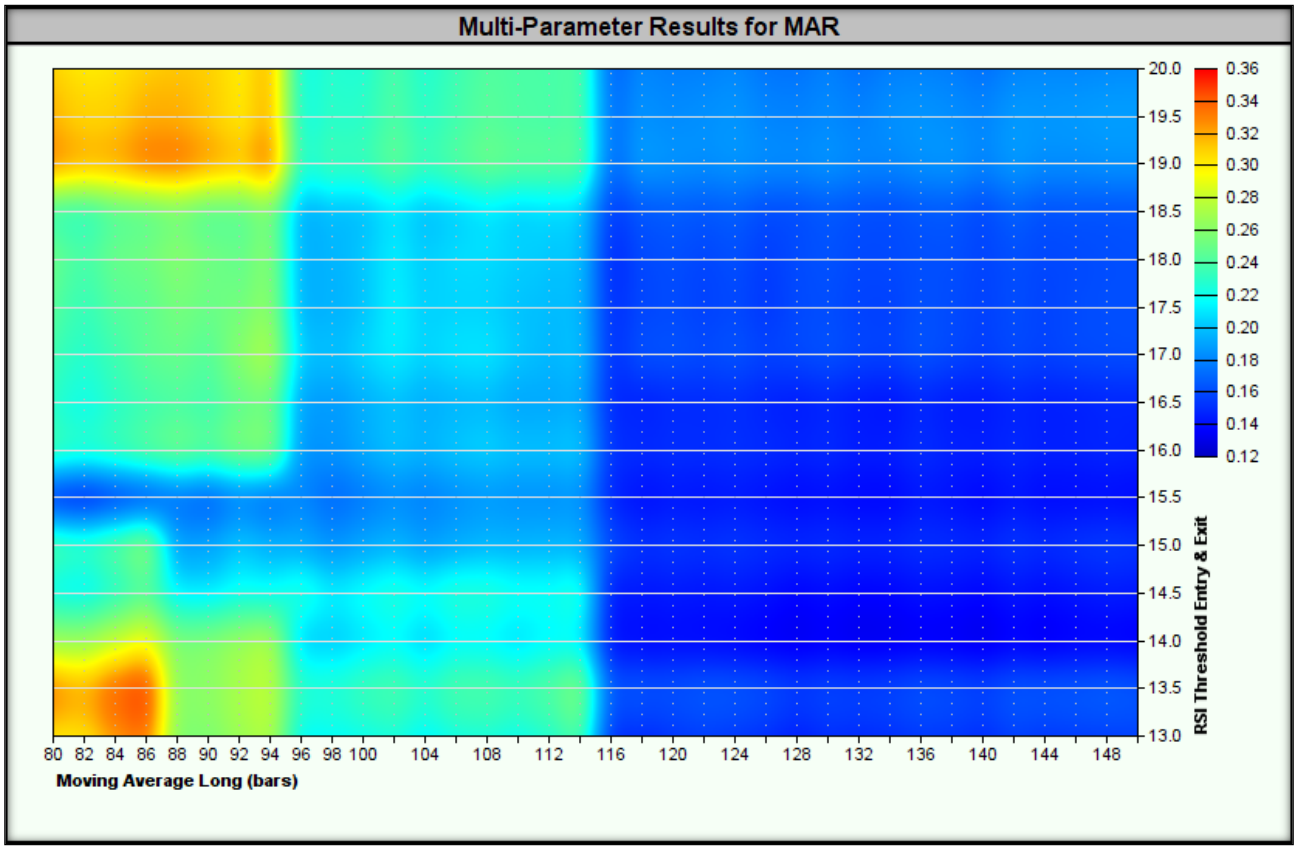
- **The maximum drawdown exceeded 250% of the drawdown value** for the result with the highest MAR (**58.7% vs. 22.7%)** – which means a high risk of deep capital drawdowns.

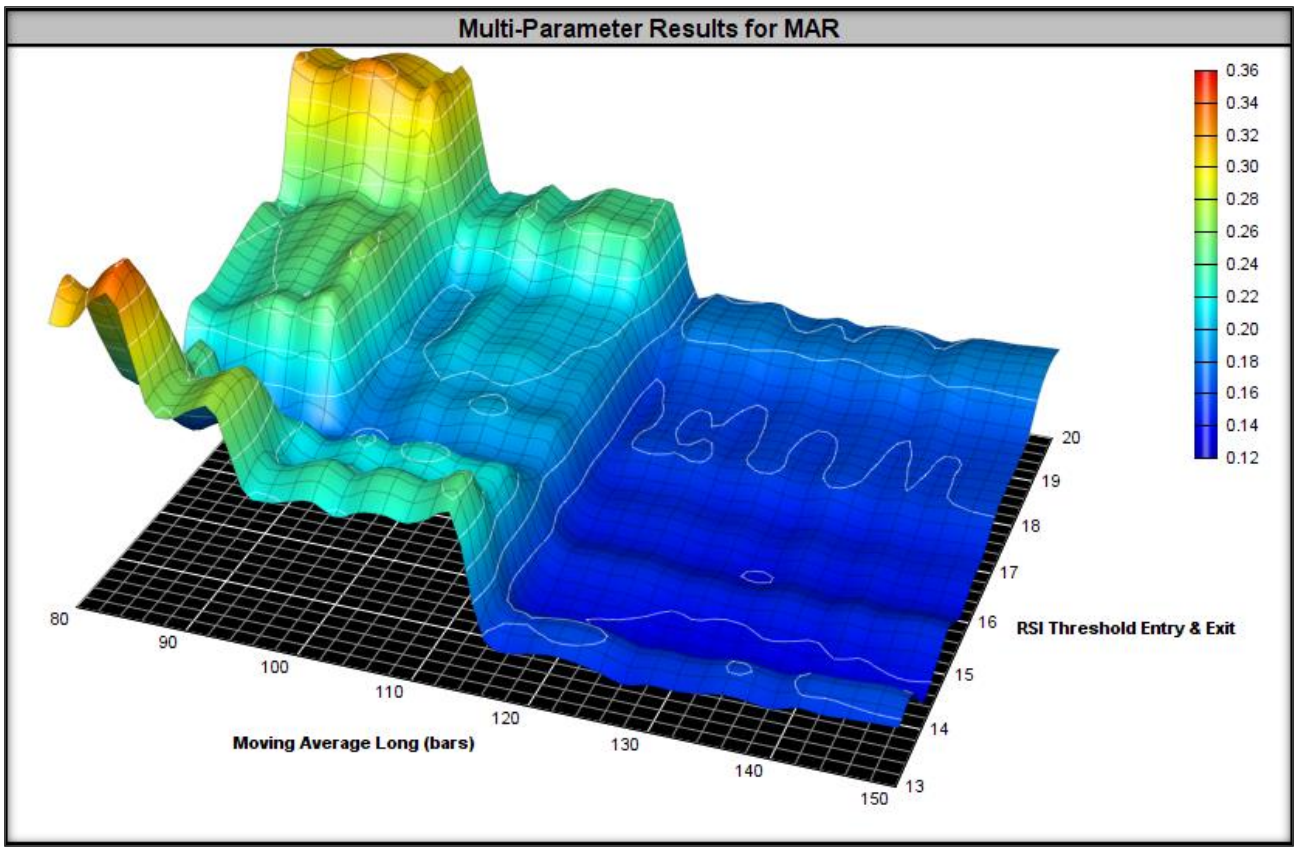
Therefore, **<u>further testing of the strategy is not justified,</u>** as its use in real transactions **is highly questionable.**

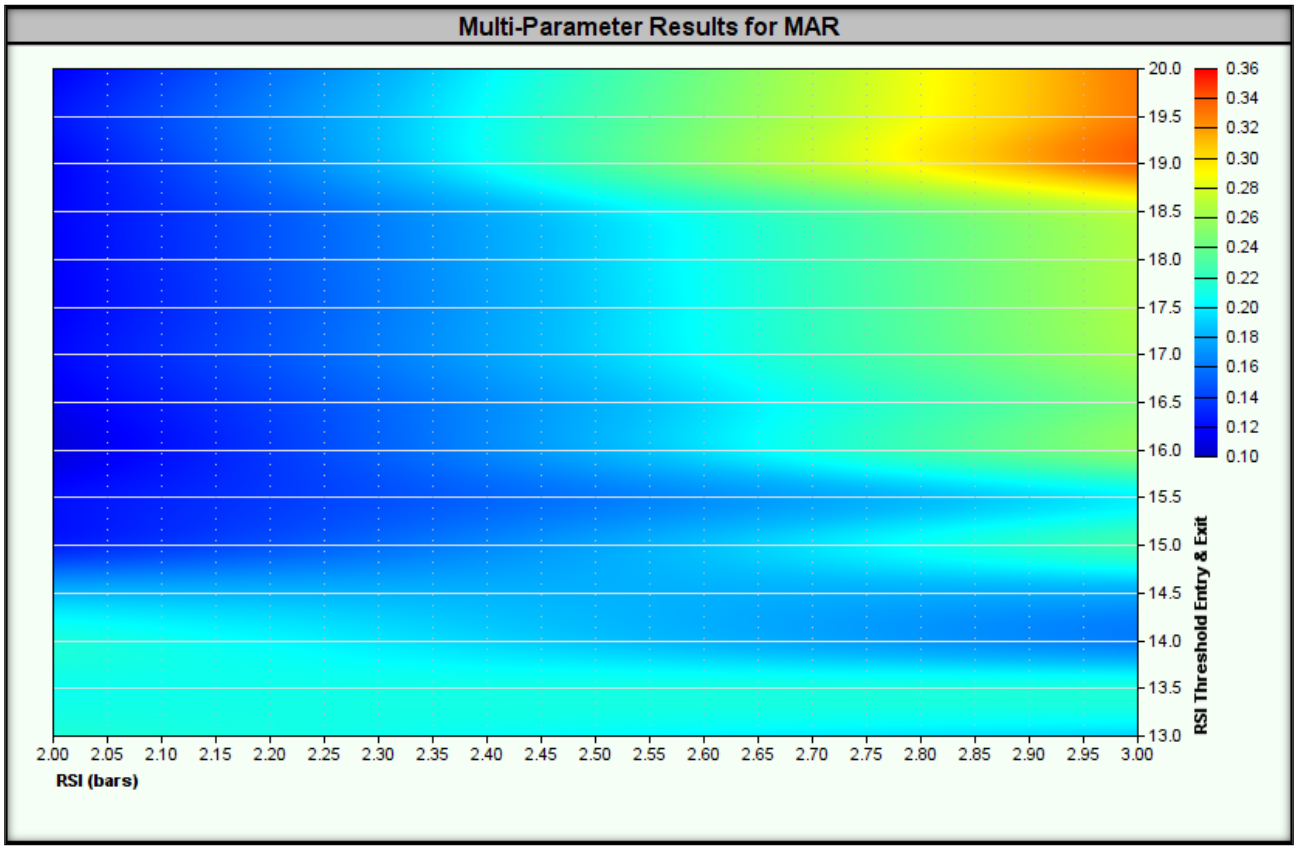
Heatmaps for the tested ranges are presented below.

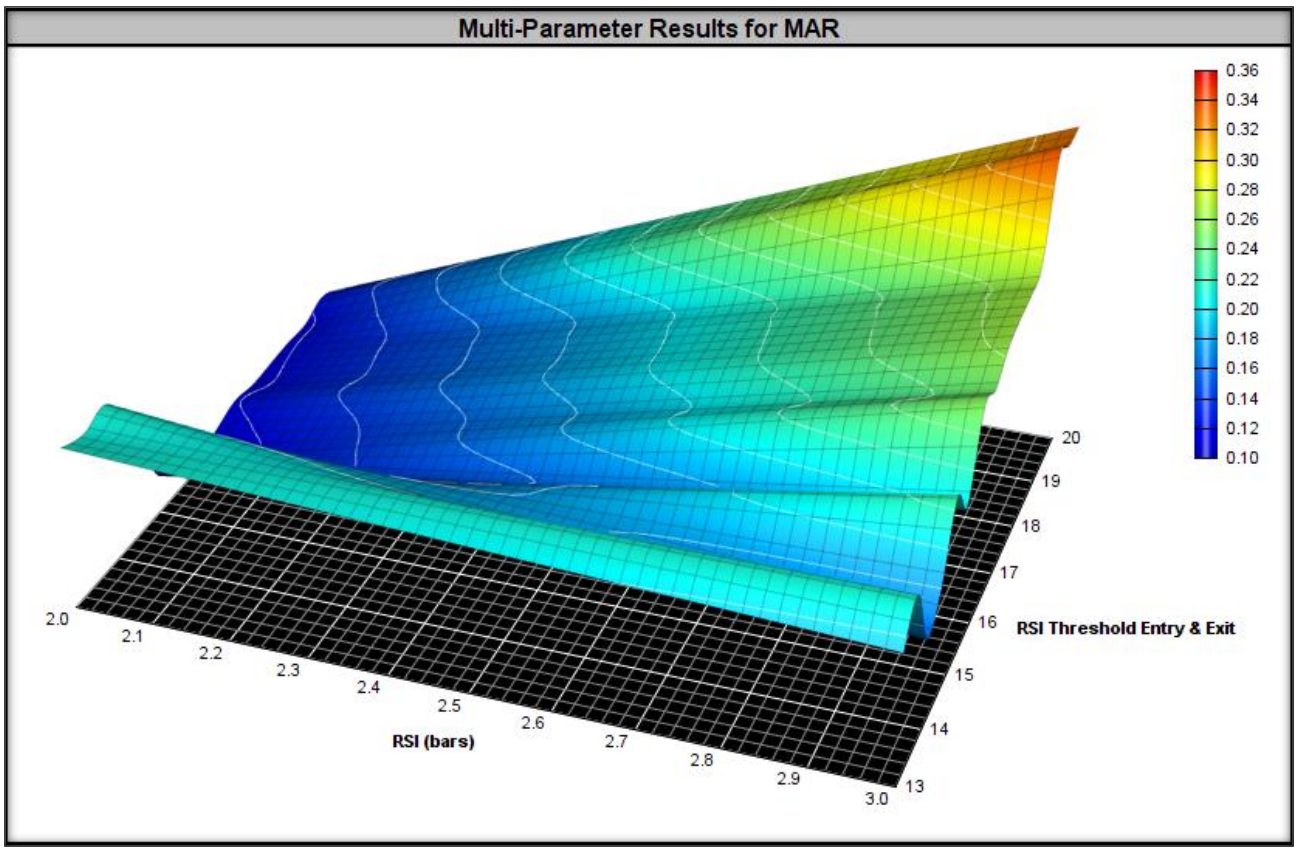

Multi-Parameter Results for MAR
Moving Average Long (bars)
RSI (bars)

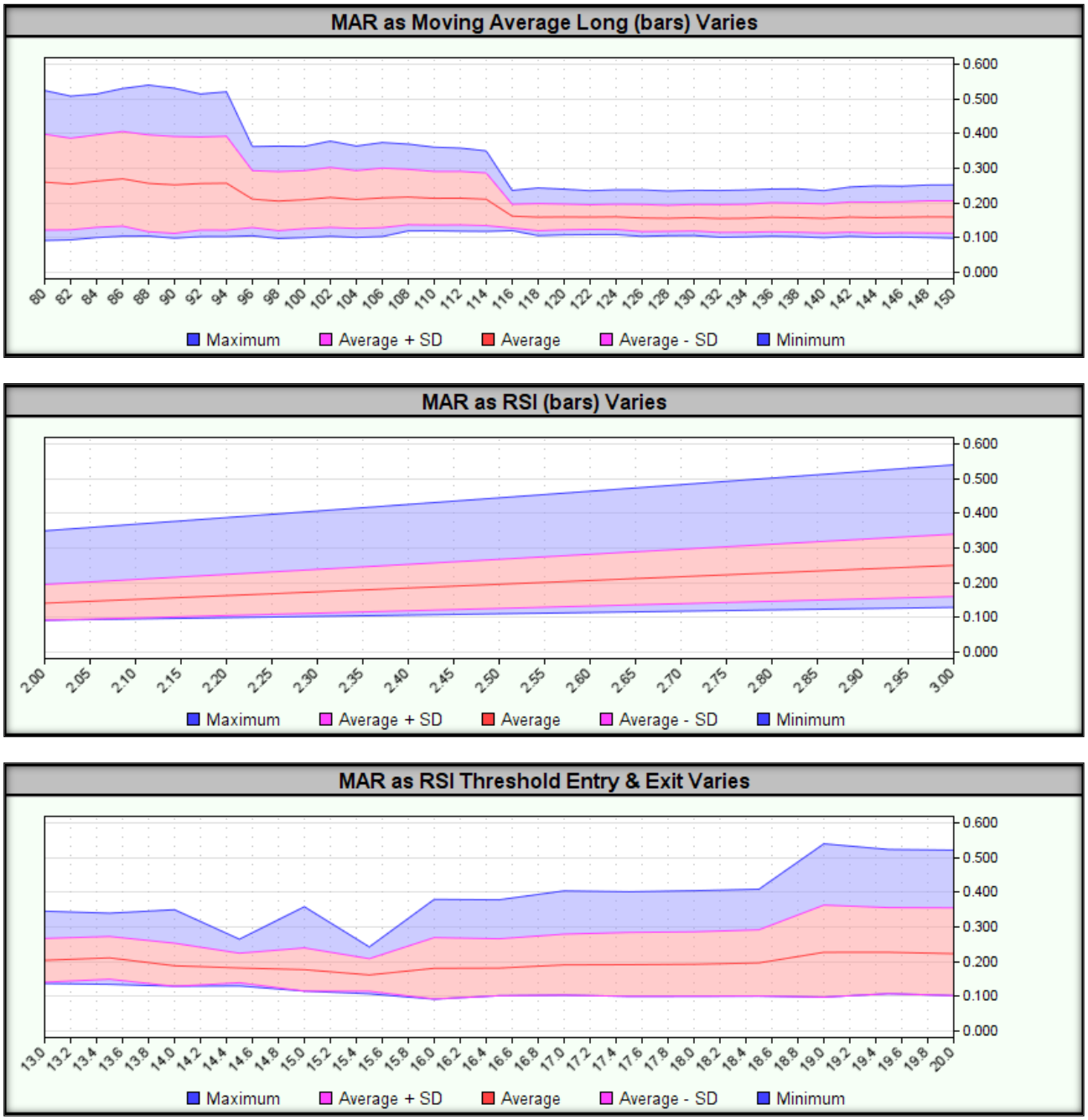

Multi-Parameter Results for MAR
Moving Average Long (bars)
RSI (bars)


Multi-Parameter Results for MAR
Moving Average Long (bars)
RSI Threshold Entry & Exit


Multi-Parameter Results for MAR
Moving Average Long (bars)
RSI Threshold Entry & Exit


Multi-Parameter Results for MAR
RSI (bars)
RSI Threshold Entry & Exit


Multi-Parameter Results for MAR
RSI (bars)
RSI Threshold Entry & Exit



2. **Monte Carlo simulation**

This step was skipped due to **failure of previous stability tests.**

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

This step was skipped due to **failure of previous stability tests.**

4. **Stability long/short**

This step was skipped due to **failure of previous stability tests.**

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

This step was skipped due to **failure of previous stability tests.**

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

This step was skipped due to **failure of previous stability tests.**

7. **Strategy Risk Management**

This step was skipped due to **failure of previous stability tests.**

Step 5: Walk-Forward Analysis

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

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

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

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

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

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

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

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

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

This step was skipped due to **failure of previous stability tests.**

Step 6: Using the strategy in real time

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

The most important element of **strategy implementation** is **consistent enforcement of all signals, without exceptions. How Larry Williams noted:** *"Trading strategies work. Traders do not."*

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

Key criteria for evaluating the strategy before implementation:

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

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

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

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

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

In our case, **the incubation period** lasts from the moment **the strategy is launched in the 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.