# Momentum Pinball v.2

## Investment Strategy Testing Summary

**The Momentum Pinball (MP) v.2** strategy is a modification of version **v.1,** consistent with **Linda Bradford Raschke's approach,** expanded with **a directional filter based on a moving average** and **new exit logic.** The entry signal still generates **the LBR/RSI** (short RSI calculated on the short-term price change - ROC), but **a position is opened after the signal** only if **the direction is in line with the trend.** Entry is executed **with a stop order** set for **the breakout of the signal candle's extreme,** and **exit** occurs **at the opening of the next session after the LBR/RSI crosses to the opposite extreme** – **we do not use a stop loss order.** In practice, v.2 is **more selective** (trend filter), and **the exit signal** is unambiguous, based on **an oscillator reversal.**

**It's worth noting that while the strategy's results on in-sample data are decent, it failed stability testing across a wide range of optimized parameters.** This means the strategy loses its profitability and generates significantly larger drawdowns when tested with suboptimal parameters. Therefore, **it is not recommended for use in real-world trading.**

Our goal is to have a strategy that remains **profitable and effective across a wide range of parameters,** because the market is a volatile organism, and optimal parameters can change over time. **I can't** 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

**Momentum Pinball (MP) v.2** retains the classic **"LBR/RSI extreme day & price confirmation entry"** sequence, adding **a trend filter** and **oscillator exit. The strategy is single-directional—long only** —and designed for markets that **naturally tend to rebound quickly:** major stock indices, Treasury futures, gold, and the US dollar index.

A signal day occurs when **the LBR/RSI falls below a pre-defined oversold threshold;** additionally, **the close of** the day **falls above the moving average,** confirming compliance with **an uptrend. For the following session, a buy stop** tick order is placed **above the signal candle's high, without a stop loss order.** This allows the market **to confirm** the direction before opening a position.

Once activated, the position is held **until the LBR/RSI enters the overbought zone,** at which point **it closes at the opening of the next session.** The absence of a stop loss, time-exit, and short version simplifies the decision-making process and focuses the strategy on **short, dynamic bounces** within the prevailing trend.

**The strategy uses:**

- **Extremes Oscillator (LBR/RSI)** – identifies a day of momentum overshoot;
- **Simple price trigger – T+1** entry on breakout of today's extreme;
- **Trend filter (MA)** – plays only with the market direction;
- **Exit on oscillator reversal** – closing at the session opening after LBR/RSI enters the overbought zone.
- **Short horizon** – the **LBR/RSI indicator** is very price sensitive, so it reaches extremes in periods of several days.

**Characteristics of the strategy and its strengths and weaknesses:**

- **Mechanical and transparent** – easy to code and test;
- **Selective** – the MA filter allows you to always play with the trend;
- **Snap-back oriented** – tailored to asset classes known for their quick rebounds;
- **Sensitive to gaps/slips** (stop entries) – realistic costs required;
- **No short side** – less diversification, but greater alignment with target market profile;
- **No stop loss orders** – requires appropriate scaling of position sizes and diversification within the strategies used.

**Momentum Pinball (MP) v.2,** despite its simplicity, provides **a solid foundation for building algorithmic portfolios.** However, it requires **discipline and strict adherence to risk management methods.**

## Step 2: Determine investment principles

Below is **the pseudocode** for the **Momentum Pinball (MP) v.2 strategy** on daily data:

1. **Calculating Indicators:**
    a. **LBR/RSI(X/Y)** – X-period RSI calculated on **the Y-period price change (ROC).**
    b. **MA(MABars)** – moving average used as **a direction filter** (uptrend when the price closes above the average).
2. **Generating Entry Signals – Long Position:**
    a. **Extreme Condition:** A signal day occurs when the LBR/RSI(X/Y) reading falls **below the established** oversold threshold (**RSIThreshold)**.
    b. **Trend filter:** Same day **close is above the MA(MABars).**
    c. **Setting an entry order (after the signal):** for the next session, set **a buy stop order** placed **one tick above the high** of the candle on the signal day.
    d. **Starting Stop:** lack.
3. **Generating Output Signals:**
    a. **Oscillator exit: when LBR/RSI(X/Y) enters the overbought zone** during the position, **close the position at the opening of the next session.**
4. **Daily Monitoring:**
    a. **The LBR/RSI(X/Y)** reading and identify a potential **day of extremes.**
    b. The system verifies entry/exit conditions and sets appropriate buy stop orders for the next day.
    c. For active positions, monitor **LBR/RSI(X/Y)** and execute **an oscillator exit** at the next day's open.
5. **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.**
    c. **Stop Loss Management:**
        i. The strategy does not use Stop Loss orders, which means that potential losses are not limited by automatic position closure.
        ii. This is an important consideration for risk management and requires discipline from the trader and the possible introduction of their own capital protection mechanisms.

**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 **2.0% 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.**

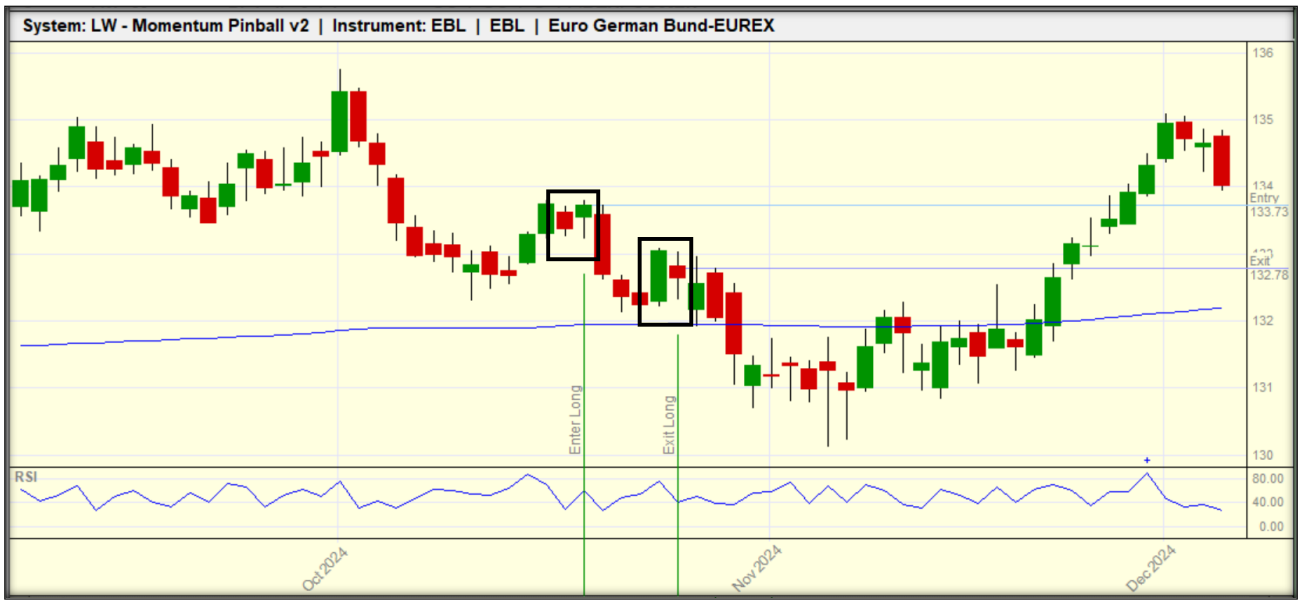
At this stage, **it doesn't matter** whether the trades are **profitable,** what **instrument was used,** or whether they occurred **recently** or **in the distant past.** The key is **to verify that the trades are generated correctly** and in line with the assumptions described in the previous step.

**The first transaction was executed on a gold futures contract.** In mid-September 2024, a long MP position signal appeared (first candle in the left-hand rectangle): the 3-day RSI calculated on a 1-period price change (ROC) fell below 30 points, and the closing price of this candle fell above the 150-day moving average. This indicates the formation of a signal candle. According to the strategy's rules, **a buy stop order was set for the next session, one tick above the high of the signal candle. The position was opened the next day** (second candle in the left-hand rectangle). **The system worked correctly.**

The strategy assumes **closing the position when the 3-day RSI, calculated on a 1-period price change (ROC), rises above 70 points (symmetrically relative to the opening level of 30 points).** This occurred on the third day after the position was opened (the first candle in the right-hand rectangle). Therefore, we close the position the following day at the opening (the second candle in the right-hand rectangle). **The system worked correctly.**

**The second transaction was executed on a German bond futures contract.** In mid-October 2024, a long MP position signal appeared (first candle in the left-hand rectangle): the 3-day RSI calculated on a 1-period price change (ROC) fell below 30 points, and the closing price of this candle fell above the 150-day moving average. This indicates the formation of a signal candle. In accordance with the strategy's rules, **a buy stop order was set for the next session, one tick above the high of the signal candle. The position was opened the next day** (second candle in the left-hand rectangle). **The system worked correctly.**

The strategy assumes **closing the position when the 3-day RSI, calculated on a 1-period price change (ROC), rises above 70 points (symmetrically relative to the opening level of 30 points).** This occurred on the fifth day after the position was opened (the first candle in the right-hand rectangle). Therefore, we close the position the following day at the opening (the second candle in the right-hand rectangle). **The system worked correctly.**




Once we are sure that the transactions are generated correctly, we can proceed to the first test of the strategy on the full **in-sample data set.** These tests are conducted on **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.

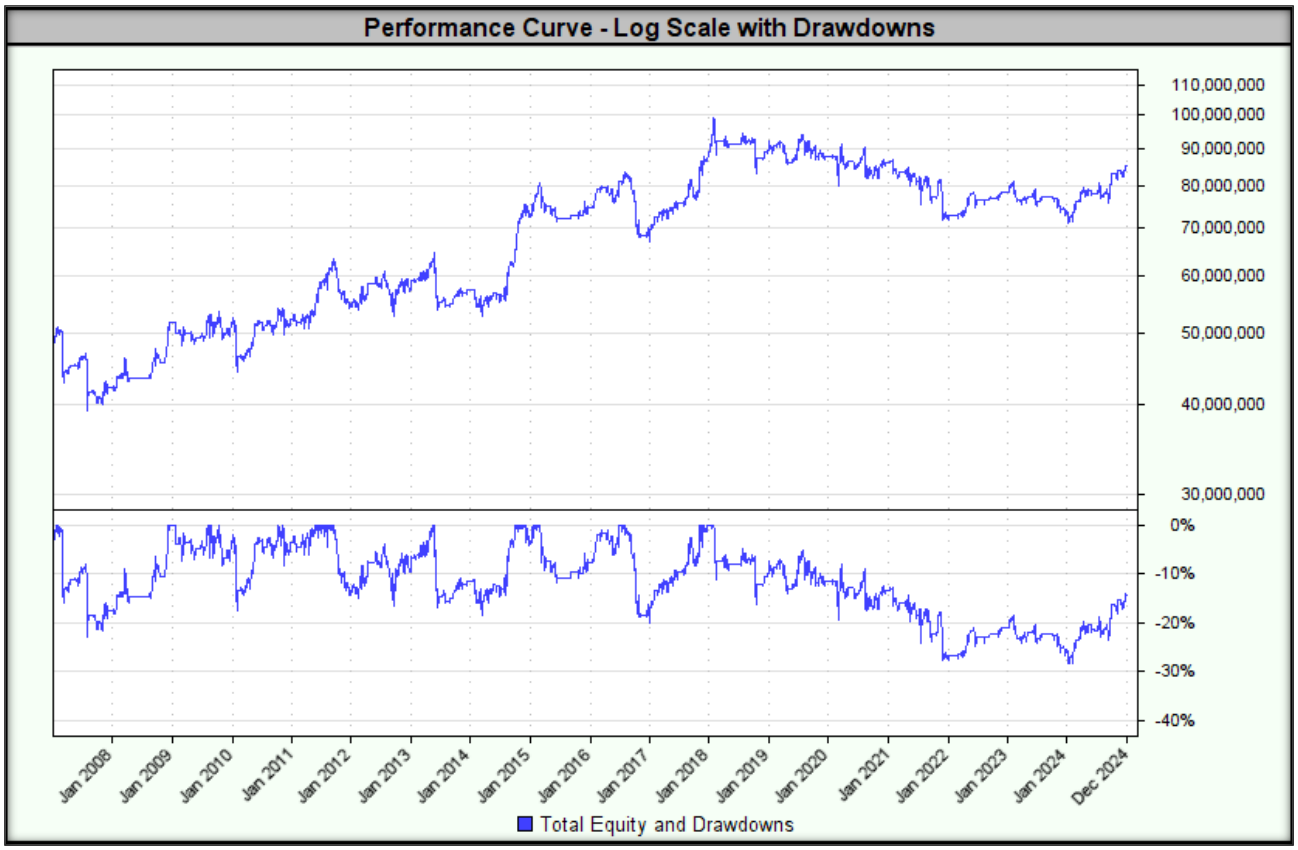
Our basic expectation is that the strategy generates **positive results,** even if they are at a low level.

Tested base parameters:

- **LBR/RSI(3/1):** 3-period RSI calculated on a 1-period price change (ROC);
- **LBR/RSI Threshold (open/close):** 30/70;
- **MA(150):** 150-period moving average;
- **Method of opening a position (long/short):** buy stop one tick above the high of the signal candle;
- **Order validity:** the order remains active only in the next session;
- **Stop loss:** none;

- **Closing the position:** LBR/RSI at 70 points;
- **Position direction:** long positions;
- **Financial Instruments:** for the purposes of this test, **long positions** on **stock indices, bonds, gold** and **the dollar index were used.**
- **Position sizes:** corresponding to a risk of **2.0% of total capital,** with **a hypothetical stop loss order located 2 x ATR (40 days)** away from the position opening point.

The test result is shown below.




| Indicators/Measures | Concluding a transaction at the opening price |
|---|---|
| CAGR% | 2.99% |
| MAR Ratio | 0.11 |
| RAR% | 4.03% |
| R-Cubed | 0.07 |
| Robust Sharpe Ratio | 0.32 |
| Max Drawdown | 28.4% |
| Wins | 60.0% |
| Losses | 40.0% |
| Average Win% | 1.24% |
| Average Loss% | 1.57% |
| Win/Loss Ratio | 0.79 |
| Average Trade Duration (days) | 13 |
| Percent Profit Factor | 1.19 |

| | |
|---|---|
| SQN | - |
| Number of transactions | 563 |

In summary, the system works properly and generates signals as expected. Furthermore, tests on the baseline parameters yielded acceptable results, although the drawdown length may be concerning. Nevertheless, we can 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 even **stable.**

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

This version **of the Momentum Pinball (MP) v.2 strategy utilizes the Grid Search** method **to optimize parameters.** This approach **fully optimizes all specified parameters by creating a wide range of possible combinations.** Our goal is to find **parameter ranges** that **will keep the strategy stable (robust),** allowing us to assess its suitability in real-world 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 parameters on **in-sample data.** To do this, we define **ranges of** parameter values so that **the ratio of the highest to lowest value in the range is at least 150%.**

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

- **LBR/RSI:**
  - **ROC:** range **2-3 (step: 1);**
  - **RSI:** range **3-4 (step: 1);**
- **LBR/RSI Threshold:** range **20-30 (step: 1);**
- **MA:** range **100-170 (step: 5).**

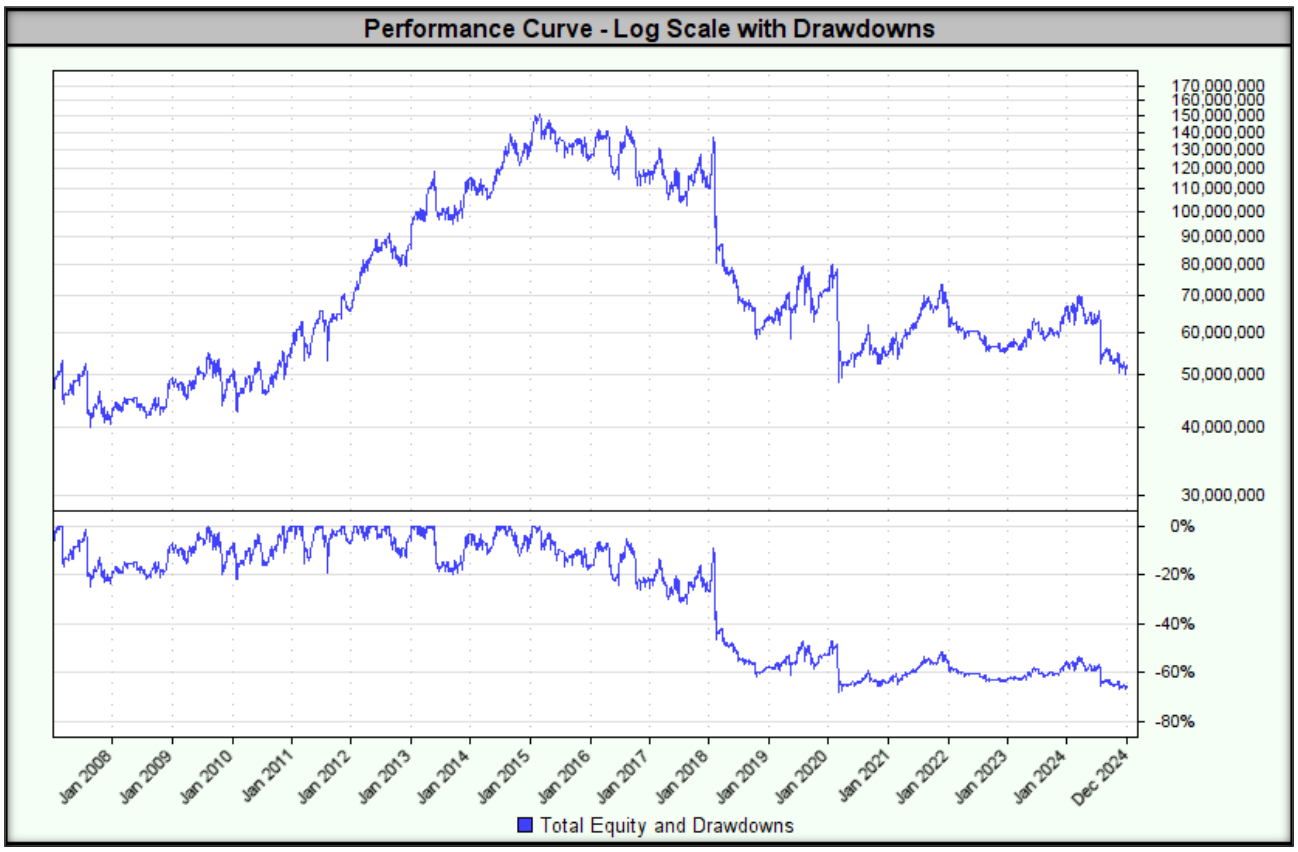
**The lowest MAR value of 0.00** was achieved for the following parameters:

- **LBR/RSI:**
  - **ROC:** 3;

- **RSI:** 3;
- **LBR/RSI Threshold:** 30;
- **MA:** 105.

| Test | Rate of Change (# bars) | RSI (# bars) | RSI Threshold | MA (bars) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD | Trades | R3 | RAR [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 482 | 3 | 3 | 30 | 105 | $52,042,115.90 | 0.22% | 0.00 | 0.13 | 0.01 | 67.8% | 118.1 | 1618 | 0.01 | 1.04 |
| 483 | 3 | 3 | 30 | 110 | $53,775,462.71 | 0.41% | 0.01 | 0.14 | 0.02 | 66.8% | 118.1 | 1628 | 0.01 | 0.91 |
| 481 | 3 | 3 | 30 | 100 | $54,023,052.06 | 0.43% | 0.01 | 0.14 | 0.02 | 68.0% | 118.1 | 1614 | 0.01 | 1.22 |
| 495 | 3 | 3 | 30 | 170 | $57,147,143.17 | 0.75% | 0.01 | 0.15 | 0.04 | 66.9% | 118.1 | 1651 | 0.01 | 1.20 |
| 466 | 3 | 3 | 29 | 100 | $59,307,658.14 | 0.95% | 0.02 | 0.16 | 0.05 | 62.7% | 116.2 | 1513 | 0.02 | 1.48 |
| 164 | 2 | 3 | 30 | 165 | $60,174,484.48 | 1.03% | 0.02 | 0.16 | 0.06 | 67.9% | 118.1 | 1364 | -0.01 | -0.73 |
| 165 | 2 | 3 | 30 | 170 | $60,200,299.34 | 1.04% | 0.02 | 0.16 | 0.06 | 68.0% | 118.1 | 1373 | -0.01 | -0.81 |
| 493 | 3 | 3 | 30 | 160 | $60,400,050.65 | 1.06% | 0.02 | 0.17 | 0.05 | 67.3% | 118.1 | 1639 | 0.02 | 1.37 |
| 487 | 3 | 3 | 30 | 130 | $60,679,916.25 | 1.08% | 0.02 | 0.17 | 0.05 | 67.2% | 118.1 | 1635 | 0.02 | 1.57 |
| 494 | 3 | 3 | 30 | 165 | $61,141,884.74 | 1.12% | 0.02 | 0.17 | 0.06 | 67.3% | 118.1 | 1642 | 0.02 | 1.36 |
| 484 | 3 | 3 | 30 | 115 | $60,855,584.81 | 1.10% | 0.02 | 0.17 | 0.06 | 65.7% | 118.1 | 1634 | 0.02 | 1.70 |
| 467 | 3 | 3 | 29 | 105 | $60,362,003.20 | 1.05% | 0.02 | 0.17 | 0.06 | 62.5% | 116.2 | 1517 | 0.02 | 1.54 |

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



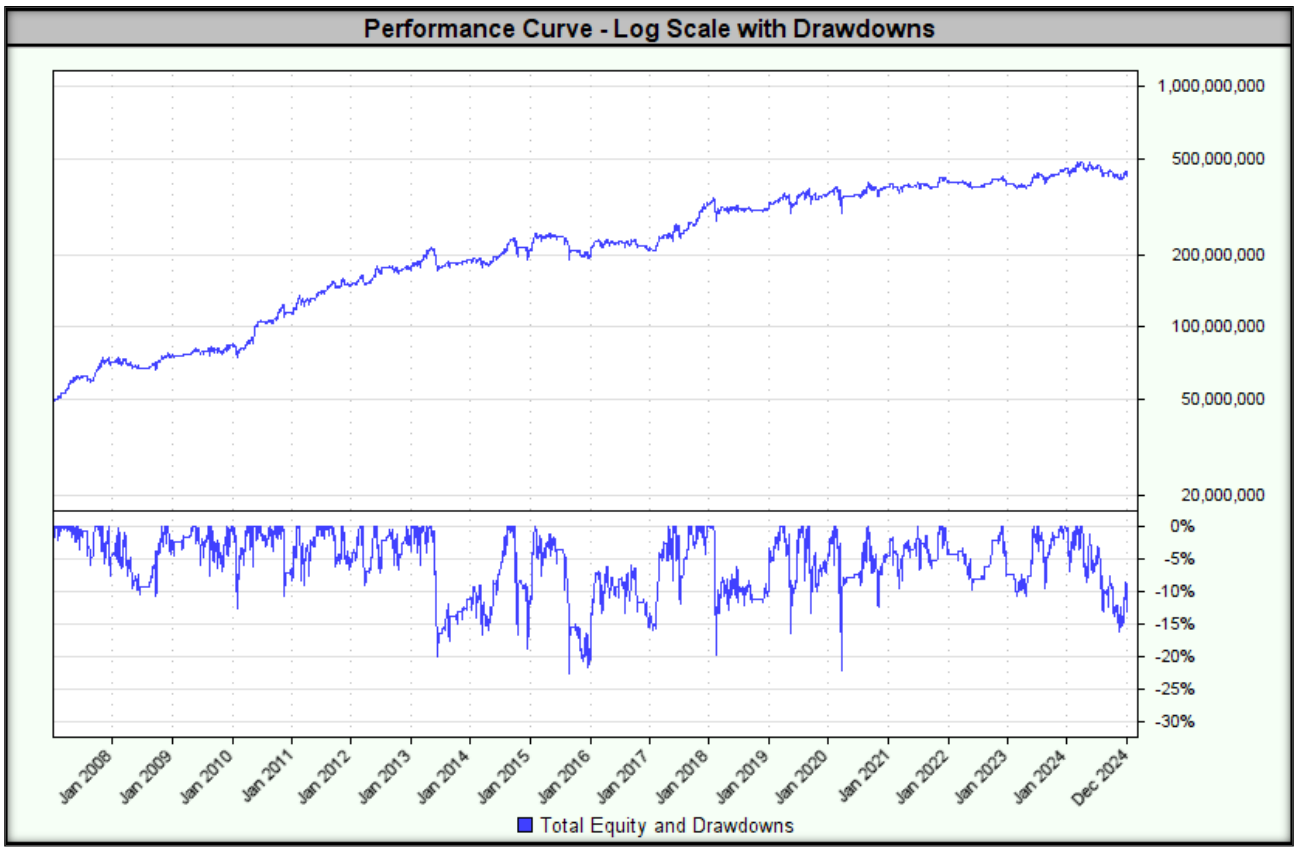

**The highest MAR value of 0.56** was achieved for the following parameters:

- **LBR/RSI:**
  - **ROC:** 2;
  - **RSI:** 4;
- **LBR/RSI Threshold:** 29;
- **MA:** 150.

**The highest MAR value** was accompanied by **a drawdown of 22.6%.**

| Test | Rate of Change (# bars) | RSI (# bars) | RSI Threshold | MA (bars) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD | Trades | R3 | RAR [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 311 | 2 | 4 | 29 | 150 | $423,516,710.60 | 12.60% | 0.56 | 0.86 | 0.73 | 22.6% | 27.7 | 564 | 0.46 | 12.38 |
| 312 | 2 | 4 | 29 | 155 | $409,103,713.87 | 12.39% | 0.55 | 0.85 | 0.72 | 22.4% | 26.6 | 560 | 0.45 | 12.23 |
| 310 | 2 | 4 | 29 | 145 | $407,596,098.18 | 12.36% | 0.55 | 0.85 | 0.77 | 22.6% | 26.6 | 563 | 0.45 | 12.60 |
| 309 | 2 | 4 | 29 | 140 | $390,010,365.97 | 12.09% | 0.54 | 0.83 | 0.77 | 22.6% | 27.7 | 561 | 0.43 | 12.26 |
| 304 | 2 | 4 | 29 | 115 | $380,924,712.01 | 11.94% | 0.53 | 0.84 | 0.80 | 22.6% | 25.3 | 557 | 0.43 | 12.00 |
| 313 | 2 | 4 | 29 | 160 | $364,168,421.20 | 11.66% | 0.52 | 0.79 | 0.68 | 22.5% | 27.7 | 562 | 0.40 | 11.11 |
| 315 | 2 | 4 | 29 | 170 | $356,976,443.72 | 11.54% | 0.51 | 0.79 | 0.67 | 22.5% | 27.7 | 568 | 0.39 | 10.93 |
| 303 | 2 | 4 | 29 | 110 | $355,818,800.27 | 11.52% | 0.51 | 0.82 | 0.82 | 22.6% | 24.6 | 556 | 0.43 | 11.74 |
| 49 | 2 | 3 | 23 | 115 | $340,046,892.25 | 11.24% | 0.51 | 0.75 | 0.80 | 22.1% | 25.8 | 616 | 0.36 | 11.83 |
| 314 | 2 | 4 | 29 | 165 | $346,054,557.49 | 11.35% | 0.51 | 0.78 | 0.66 | 22.4% | 27.7 | 566 | 0.39 | 10.83 |
| 308 | 2 | 4 | 29 | 135 | $381,589,598.18 | 11.95% | 0.49 | 0.82 | 0.79 | 24.3% | 27.7 | 561 | 0.41 | 11.93 |
| 48 | 2 | 3 | 23 | 110 | $318,678,527.50 | 10.84% | 0.48 | 0.73 | 0.83 | 22.6% | 25.7 | 614 | 0.36 | 11.55 |

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 almost 86%.**

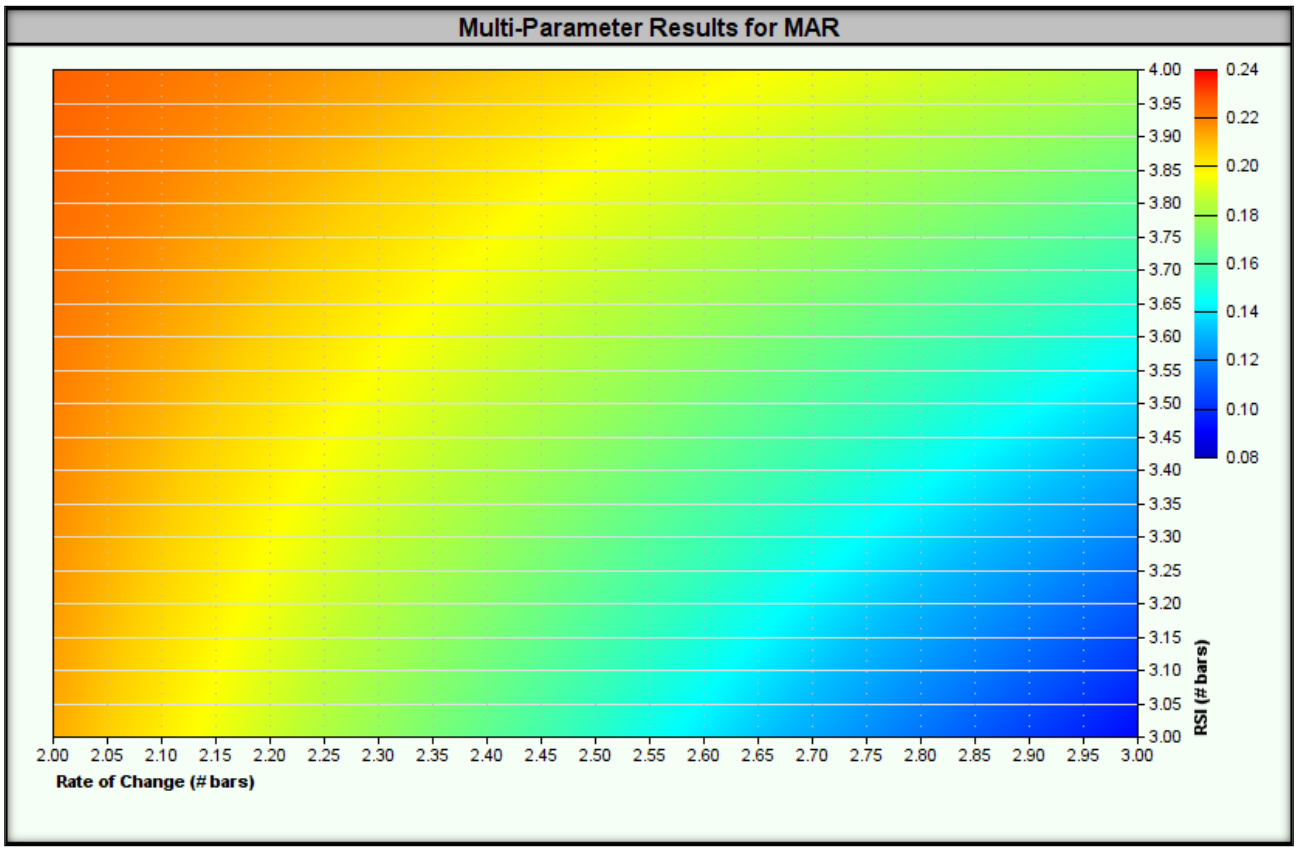
| Test | Rate of Change (# bars) | RSI (# bars) | RSI Threshold | MA (bars) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD | Trades | R3 | RAR [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184 | 2 | 4 | 21 | 115 | $112,929,474.23 | 4.63% | 0.05 | 0.31 | 0.29 | 86.0% | 102.3 | 116 | 0.06 | 7.06 |
| 189 | 2 | 4 | 21 | 140 | $136,472,526.44 | 5.74% | 0.07 | 0.35 | 0.33 | 86.0% | 90.6 | 115 | 0.08 | 8.51 |
| 186 | 2 | 4 | 21 | 125 | $131,106,409.51 | 5.50% | 0.06 | 0.34 | 0.32 | 86.0% | 90.5 | 113 | 0.07 | 8.18 |
| 187 | 2 | 4 | 21 | 130 | $131,106,409.51 | 5.50% | 0.06 | 0.34 | 0.32 | 86.0% | 90.5 | 113 | 0.07 | 8.18 |
| 183 | 2 | 4 | 21 | 110 | $115,618,334.72 | 4.77% | 0.06 | 0.31 | 0.30 | 85.9% | 102.3 | 115 | 0.07 | 7.25 |
| 188 | 2 | 4 | 21 | 135 | $134,601,542.25 | 5.66% | 0.07 | 0.34 | 0.32 | 85.9% | 90.6 | 114 | 0.08 | 8.41 |
| 185 | 2 | 4 | 21 | 120 | $125,460,869.00 | 5.24% | 0.06 | 0.33 | 0.31 | 85.9% | 90.5 | 114 | 0.07 | 7.80 |
| 182 | 2 | 4 | 21 | 105 | $91,439,830.66 | 3.41% | 0.04 | 0.27 | 0.21 | 85.9% | 105.4 | 116 | 0.05 | 5.93 |
| 181 | 2 | 4 | 21 | 100 | $90,728,845.40 | 3.37% | 0.04 | 0.27 | 0.21 | 85.9% | 105.4 | 116 | 0.05 | 5.79 |
| 195 | 2 | 4 | 21 | 170 | $152,225,759.05 | 6.38% | 0.08 | 0.37 | 0.35 | 84.9% | 98.9 | 118 | 0.08 | 9.46 |
| 194 | 2 | 4 | 21 | 165 | $152,225,759.05 | 6.38% | 0.08 | 0.37 | 0.35 | 84.9% | 98.9 | 118 | 0.08 | 9.46 |
| 192 | 2 | 4 | 21 | 155 | $137,532,162.73 | 5.78% | 0.07 | 0.35 | 0.32 | 84.9% | 99.2 | 117 | 0.07 | 8.72 |

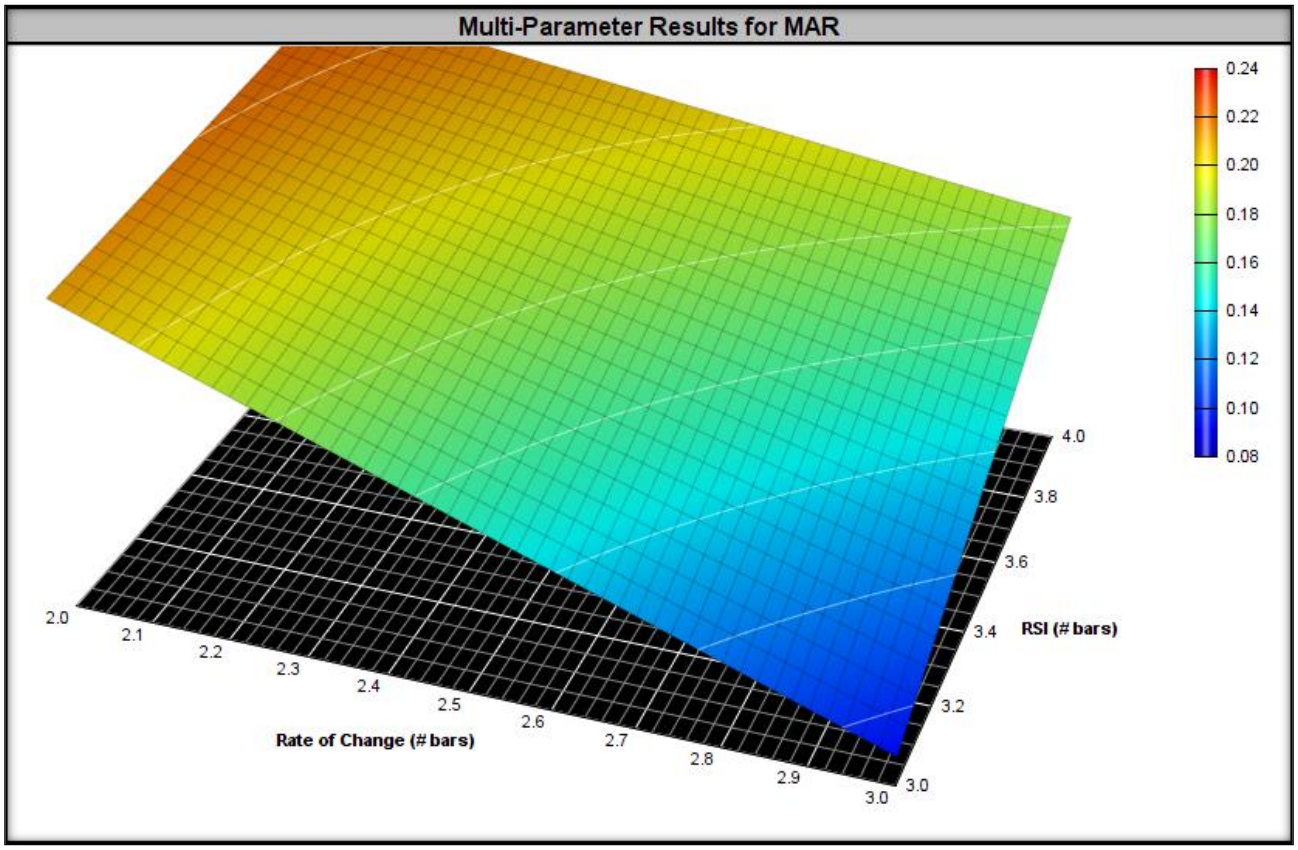
**In summary,** the strategy **failed the stability test** over a wide range of optimized parameters because:

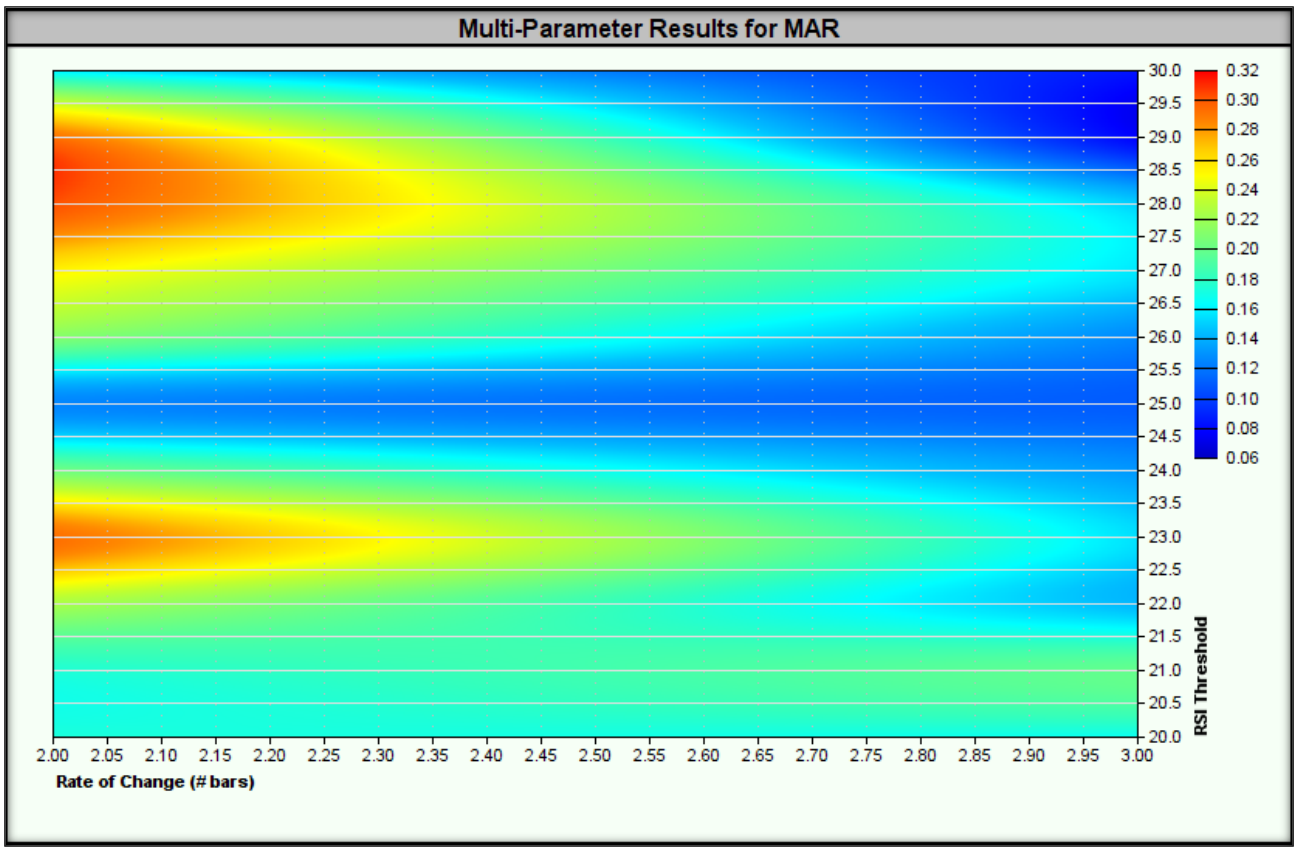
- **The maximum drawdown exceeded 250% of the drawdown value** for the result with the highest MAR (**86.9% vs. 22.6%)** – which means a high risk of deep capital drawdowns.

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

**Heatmaps for the tested ranges** are shown below.



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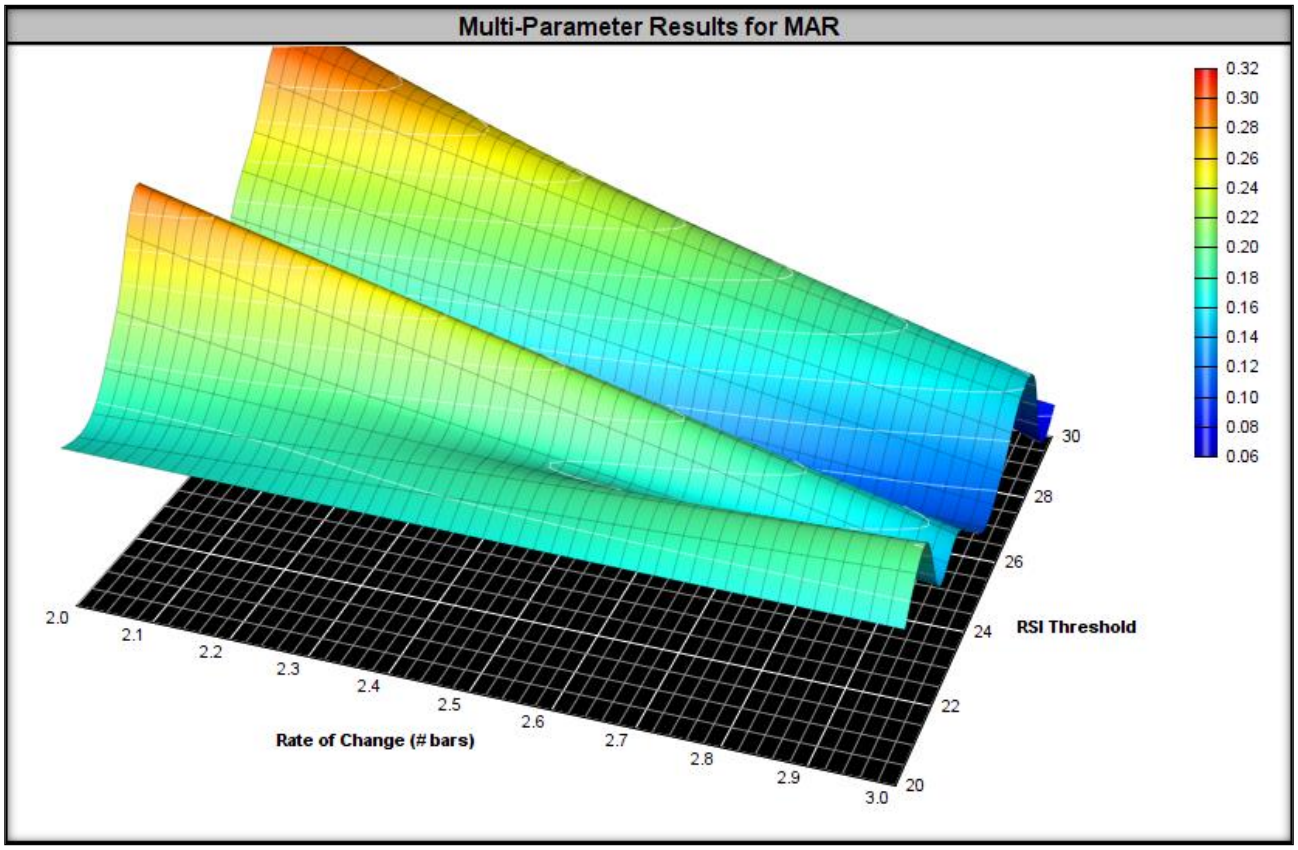
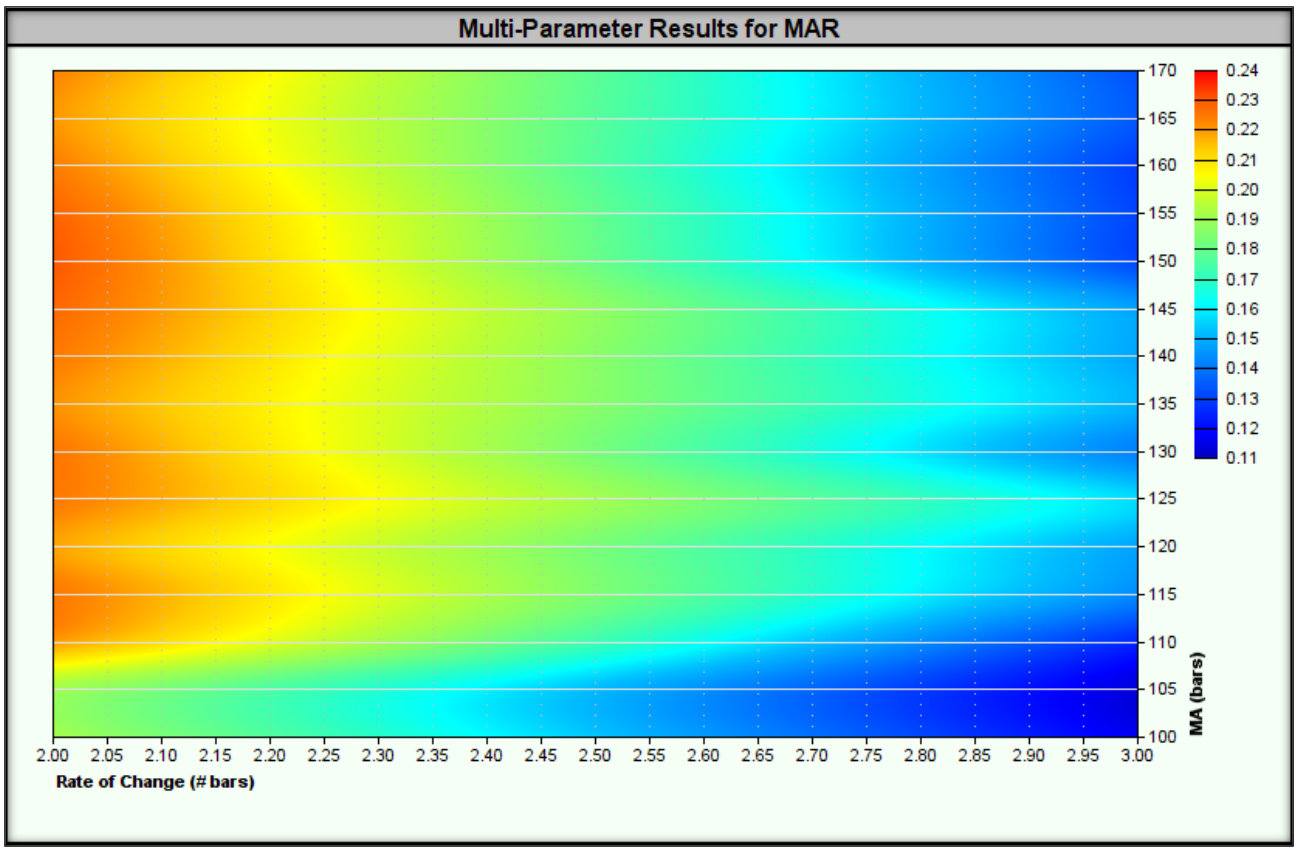
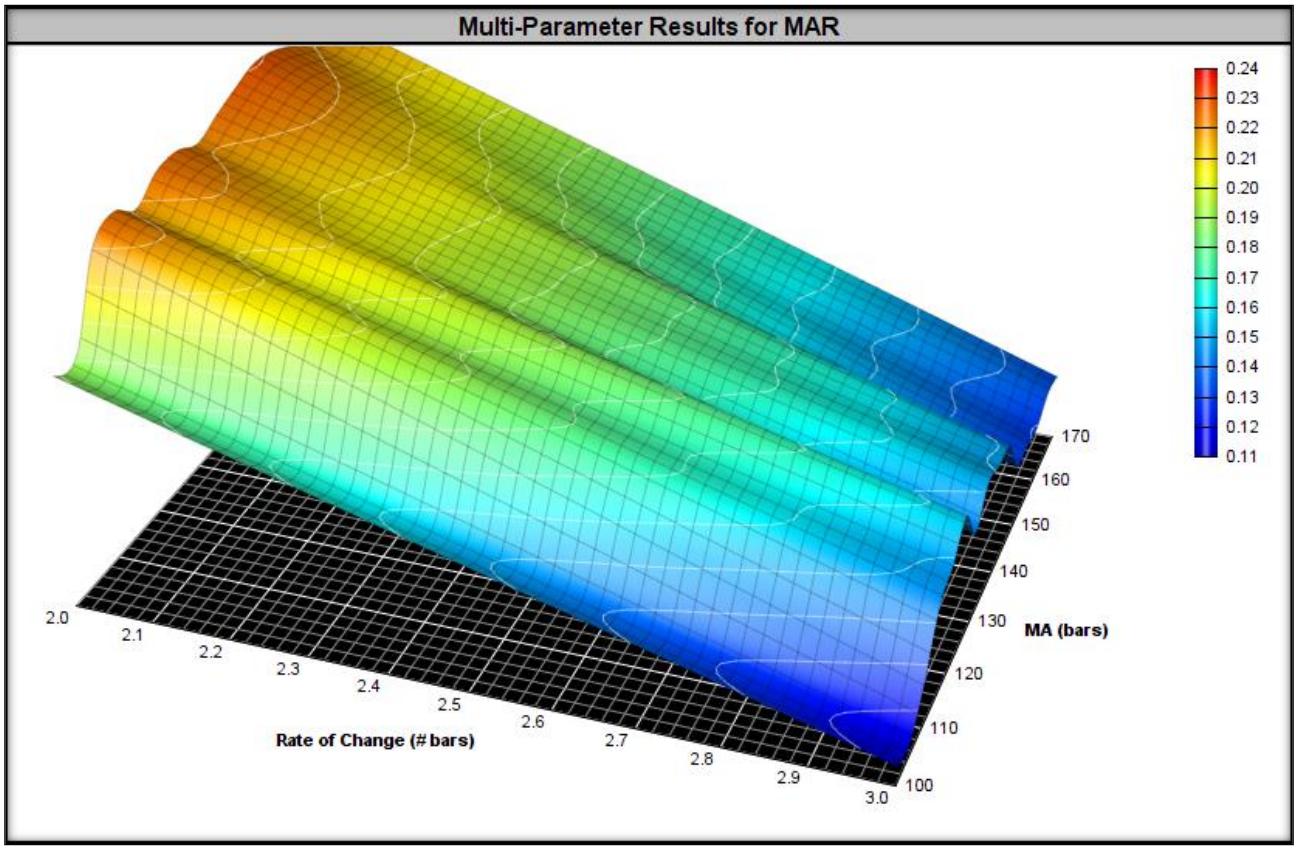
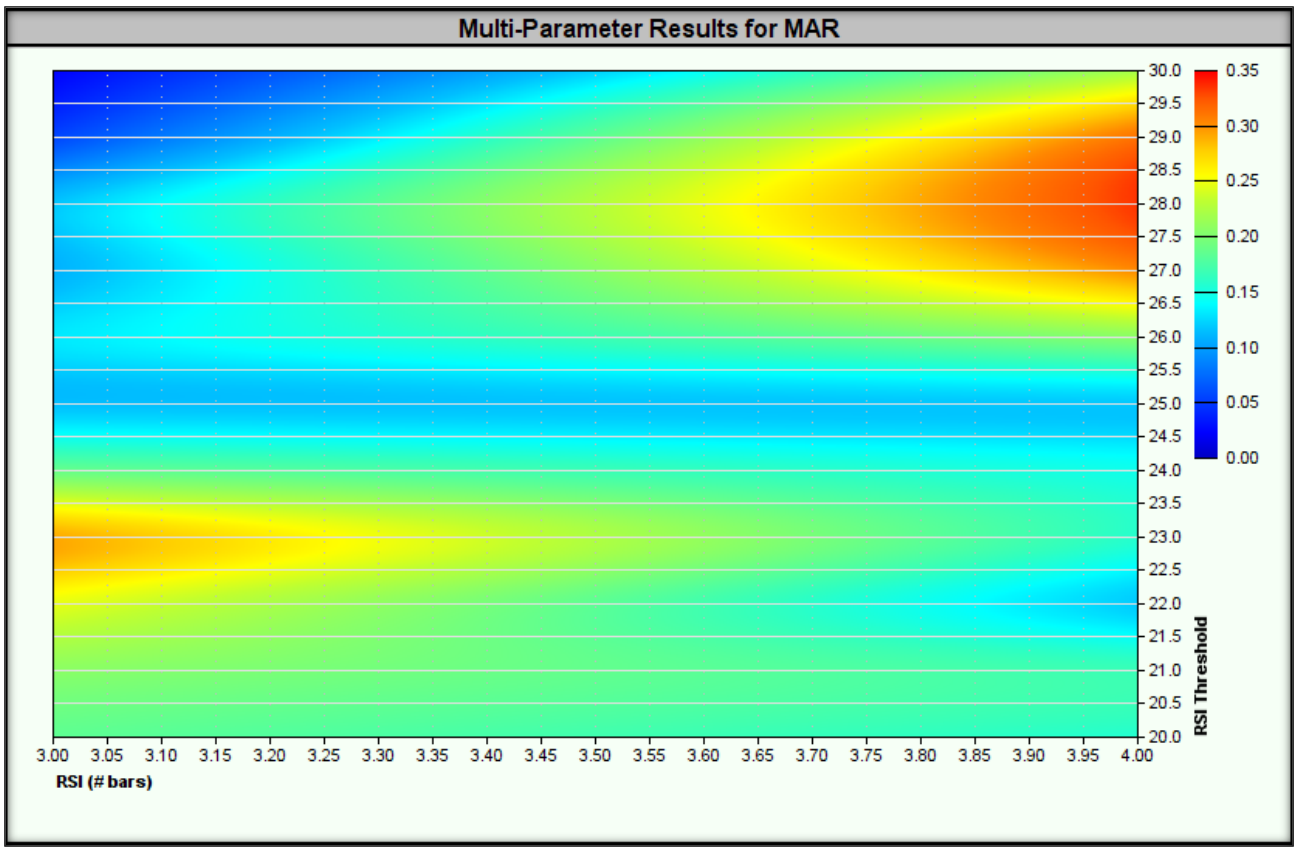
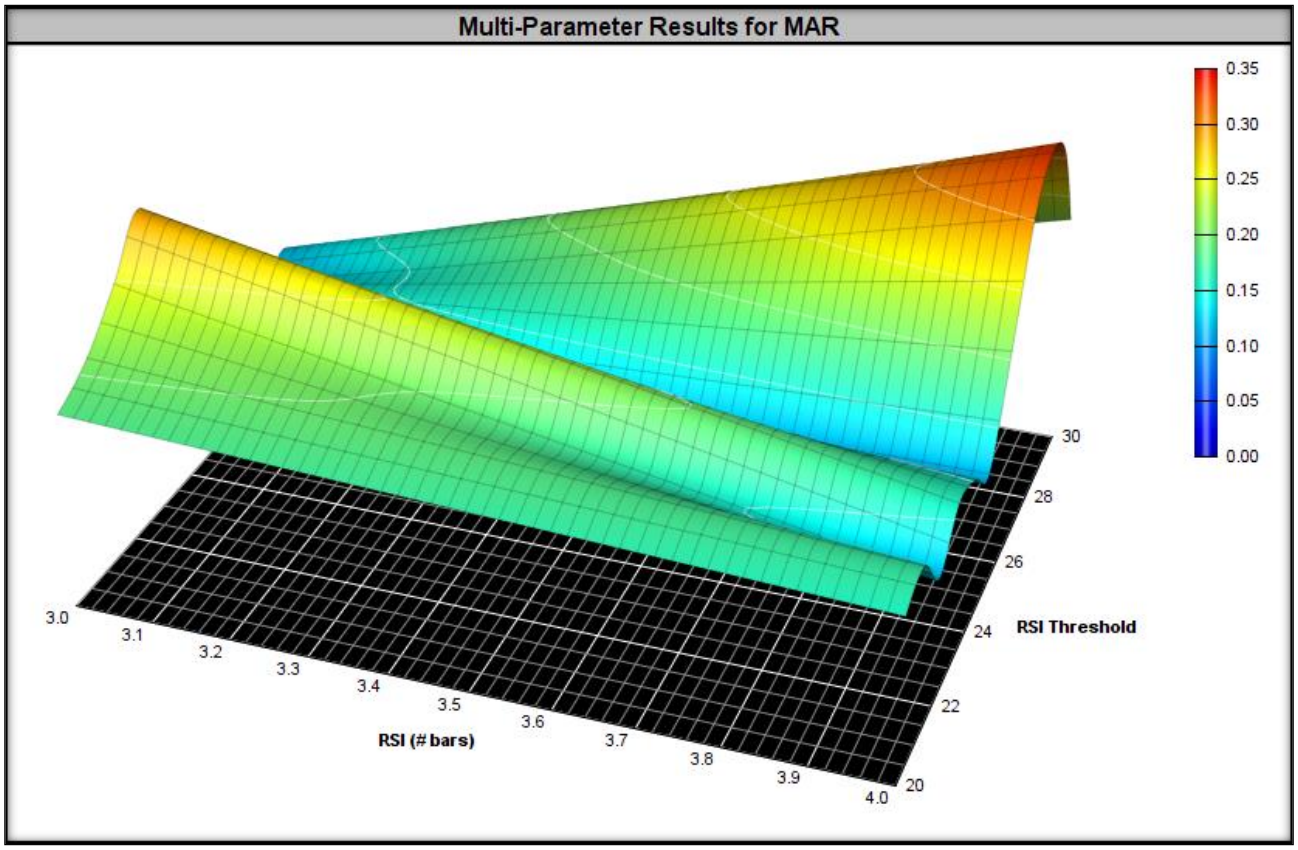
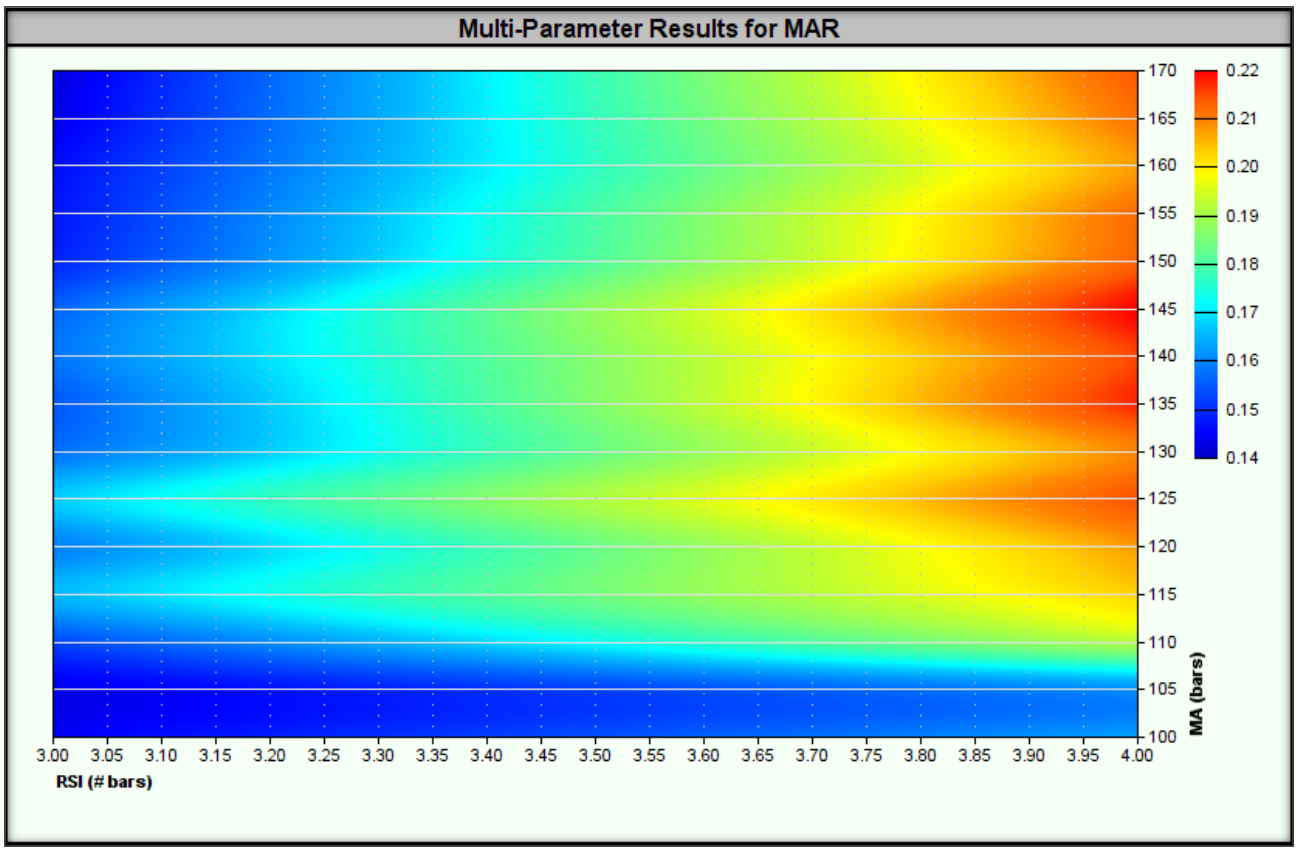

Multi-Parameter Results for MAR
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
Rate of Change (# bars)
30
28
26
24
22
20
RSI Threshold

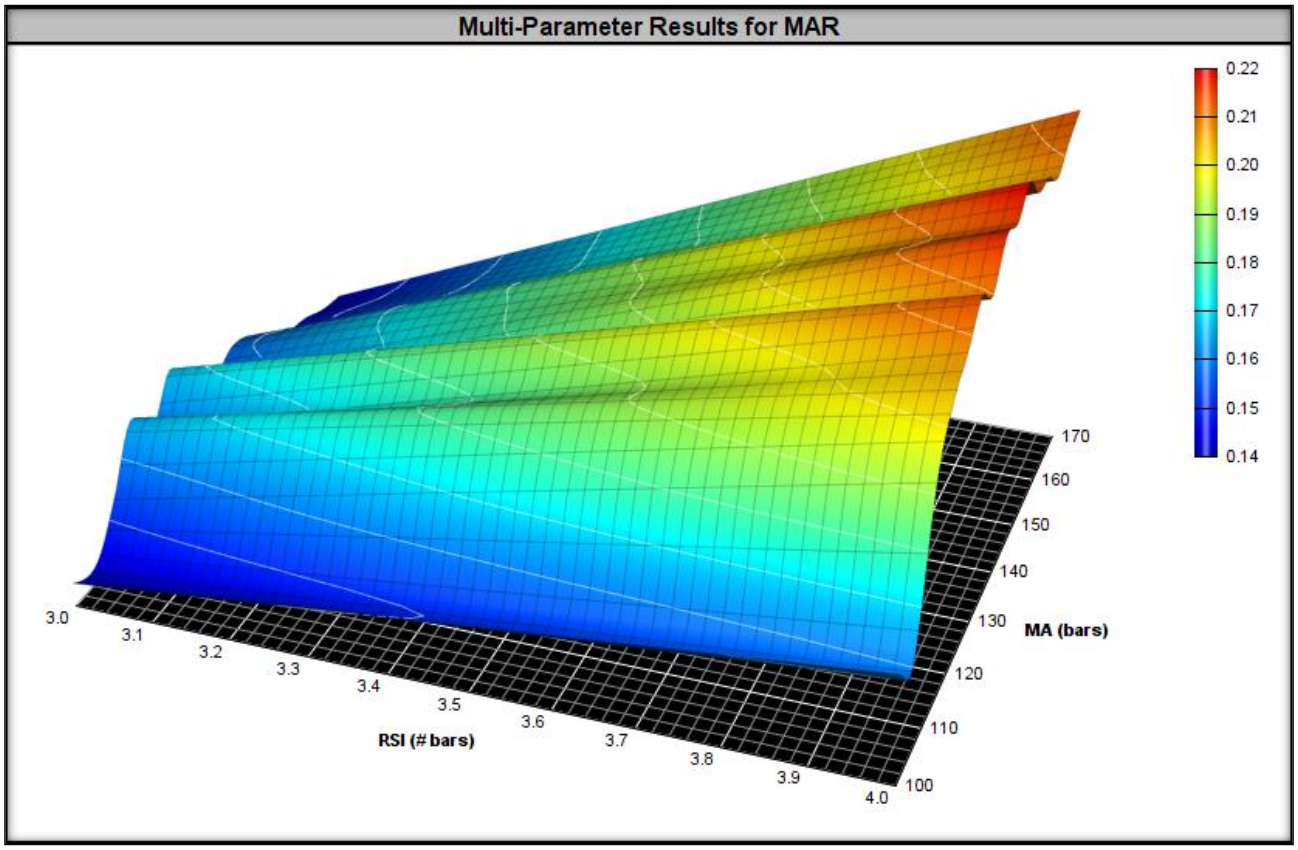

Multi-Parameter Results for MAR
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
MA (bars)
2.00 2.05 2.10 2.15 2.20 2.25 2.30 2.35 2.40 2.45 2.50 2.55 2.60 2.65 2.70 2.75 2.80 2.85 2.90 2.95 3.00
Rate of Change (# bars)

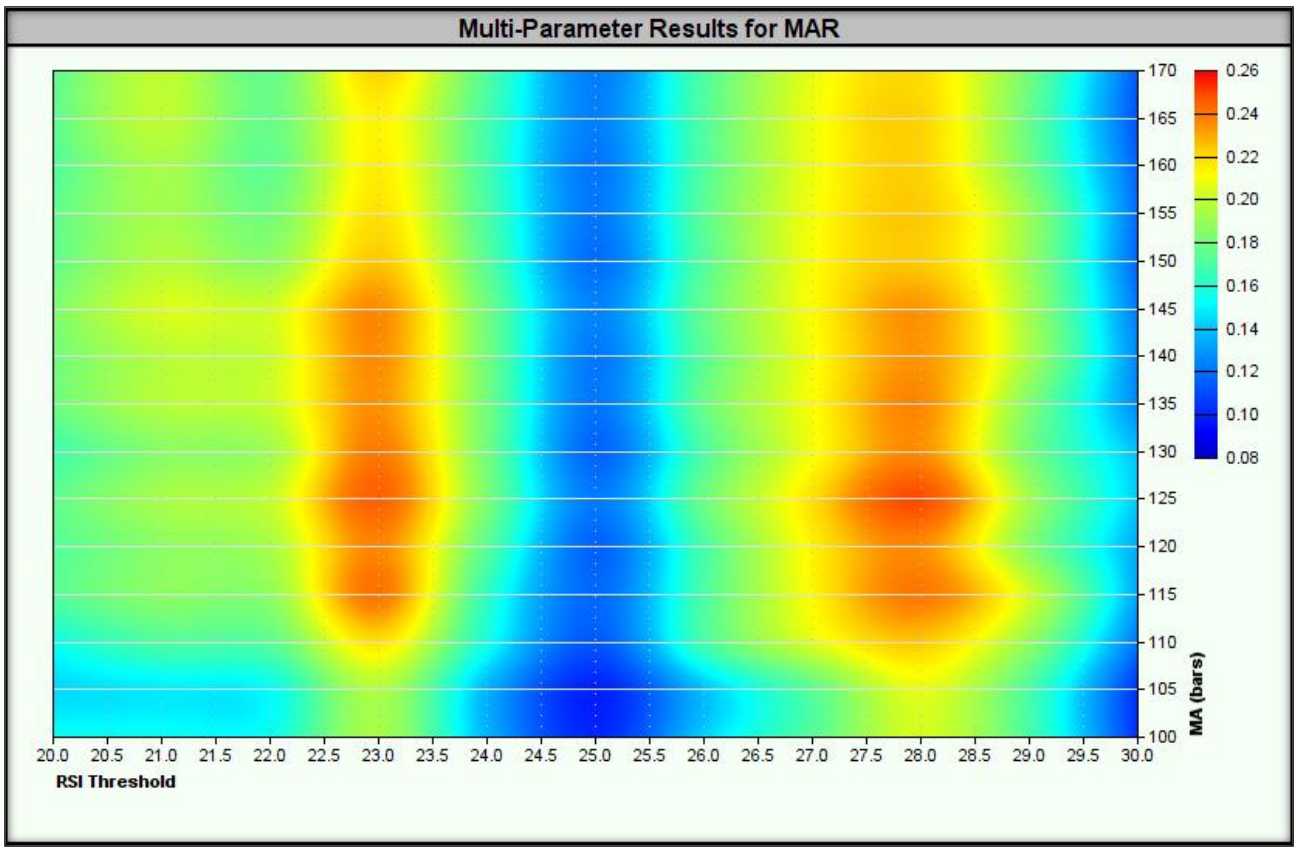

Multi-Parameter Results for MAR
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
Rate of Change (# bars)
170
160
150
140
130
120
110
100
MA (bars)

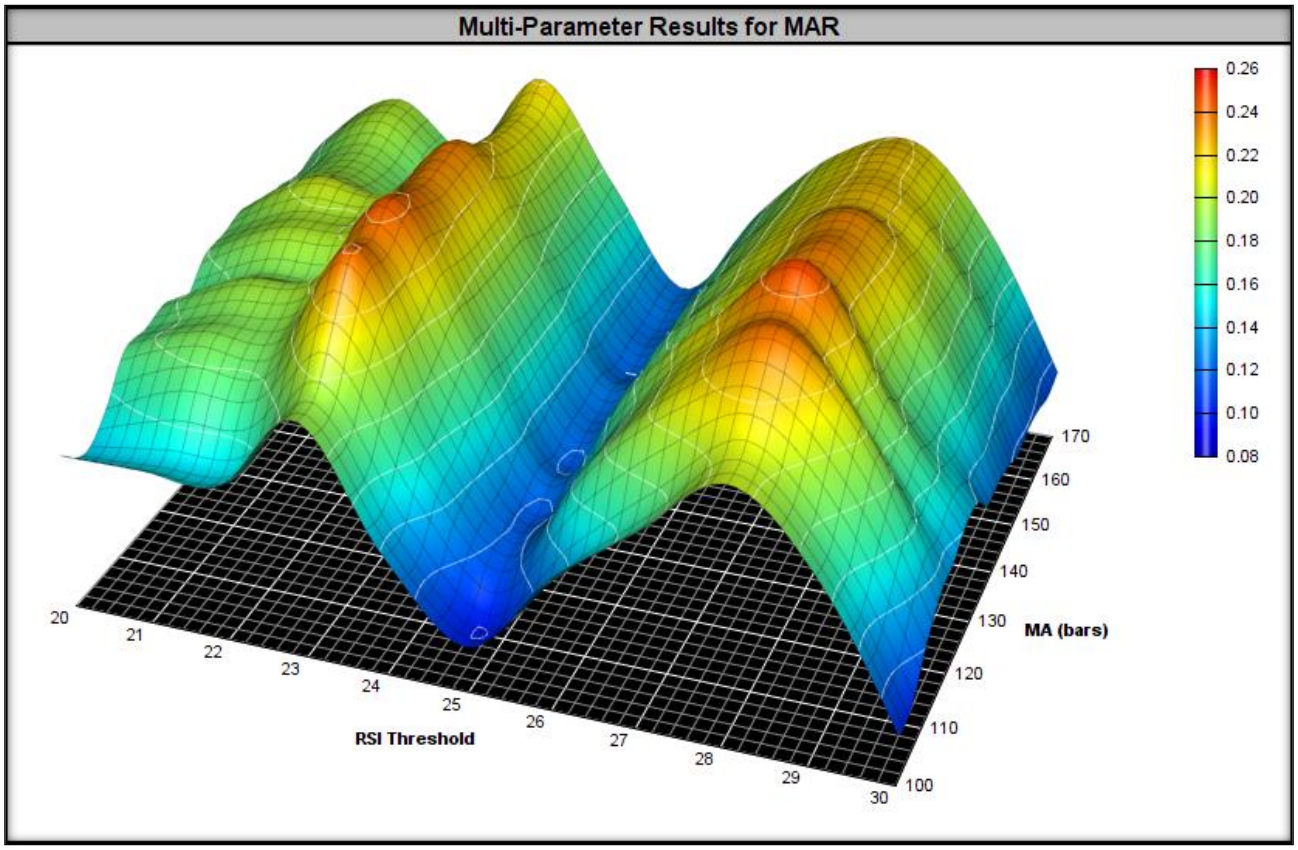

Multi-Parameter Results for MAR
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
30.0
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
RSI Threshold
3.00
3.05
3.10
3.15
3.20
3.25
3.30
3.35
3.40
3.45
3.50
3.55
3.60
3.65
3.70
3.75
3.80
3.85
3.90
3.95
4.00
RSI (# bars)

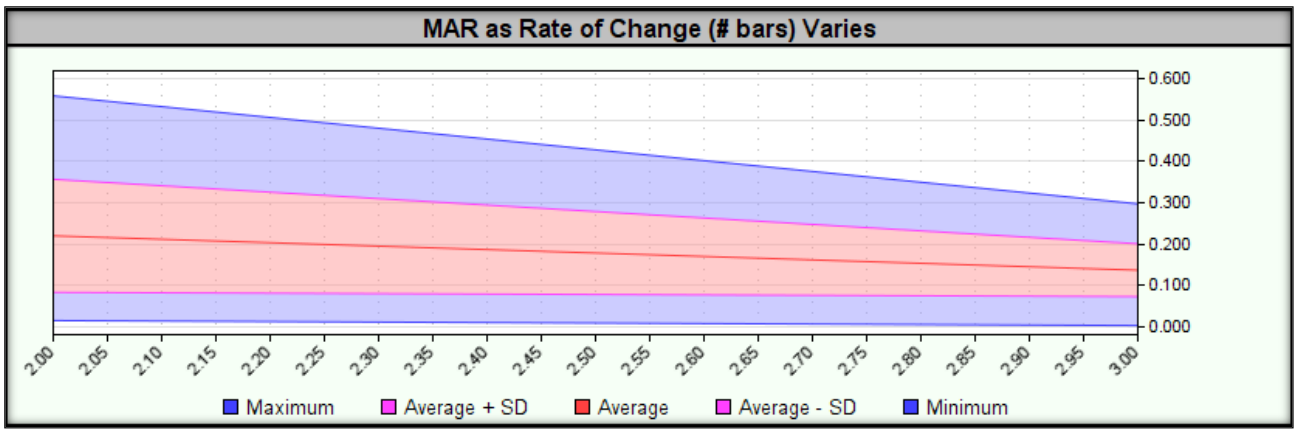

Multi-Parameter Results for MAR
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
30
28
26
24
22
20
RSI Threshold
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
RSI (# bars)

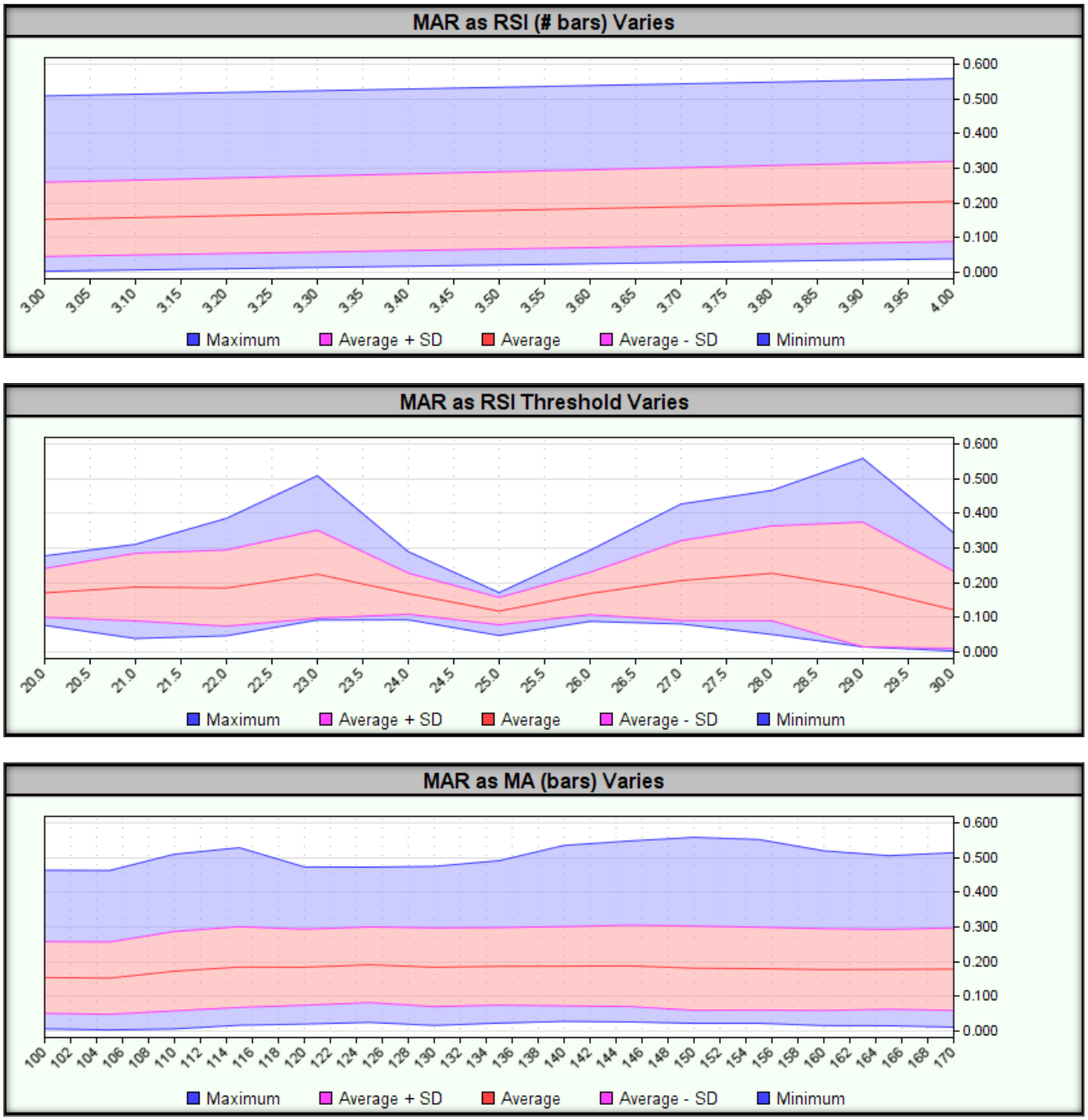

Multi-Parameter Results for MAR
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
MA (bars)
3.00
3.05
3.10
3.15
3.20
3.25
3.30
3.35
3.40
3.45
3.50
3.55
3.60
3.65
3.70
3.75
3.80
3.85
3.90
3.95
4.00
RSI (# bars)


Multi-Parameter Results for MAR
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
170
160
150
140
130
120
110
100
MA (bars)
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
RSI (# bars)


Multi-Parameter Results for MAR
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
MA (bars)
20.0
20.5
21.0
21.5
22.0
22.5
23.0
23.5
24.0
24.5
25.0
25.5
26.0
26.5
27.0
27.5
28.0
28.5
29.0
29.5
30.0
RSI Threshold


Multi-Parameter Results for MAR
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
20
21
22
23
24
25
26
27
28
29
30
RSI Threshold
170
160
150
140
130
120
110
100
MA (bars)


MAR as Rate of Change (# bars) Varies
0.600
0.500
0.400
0.300
0.200
0.100
0.000
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
Maximum
Average + SD
Average
Average - SD
Minimum










2. **Monte Carlo simulation**

**The step was omitted** due to **failure of previous stability tests.**

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

**The step was omitted** due to **failure of previous stability tests.**

4. **Long/short stability**

**The step was omitted** due to **failure of previous stability tests.**

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

**The step was omitted** due to **failure of previous stability tests.**

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

**The step was omitted** due to **failure of previous stability tests.**

7. **Strategy Risk Management**

**The step was omitted** 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 in real-world market conditions.** It provides **reliable measures of reward 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 overestimates 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 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 running 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 beyond the optimization period.
- **WFE ≤ 150% for drawdown** – means that the drawdown outside the optimization period is not significantly higher than during the optimization period.

**The step was omitted** due to **failure of previous stability tests.**

# Step 6: Using the strategy in real time

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

The most important element **of strategy execution** is **consistent execution of all signals, without exception. As Larry Williams noted:** *"Trading strategies work. Traders do not."*

Before making **a final decision to implement a strategy,** it'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.