Backtest Analysis:
2-Day RSI

Carnegie Mellon University
Quantitative Financial Analytics and Algorithmic Trading
Course ID: 36-680

Pei-An (Perry) LIn

Table Of Contents

Strategies Overview

The 2-Day RSI trading strategy being reproduced is presented by Oddmund Groette on the Quantified Strategies website. In the following section, the background of the RSI indicator will be discussed, including its founder and what it measures.

Background on RSI (Relative Strength Index)

The Relative Strength Index (RSI) was developed by J. Welles Wilder Jr., a mechanical engineer turned technical analyst. He introduced the RSI in his seminal 1978 book, "New Concepts in Technical Trading Systems." Wilder's work created the foundation for many modern technical indicators, including the RSI. The RSI is a momentum oscillator that measures the speed and change of price movements, oscillating between 0 and 100. It is commonly used to identify overbought or oversold conditions. Overbought conditions are typically indicated when the RSI is above 70, suggesting that a price correction or reversal may occur. Oversold conditions are indicated when the RSI is below 30, signaling a potential upward reversal.

2-Day RSI Strategy

The 2-Day RSI strategy, a shorter-term variant of the standard RSI strategy, focuses on quick reversals. The buy signal is triggered when the RSI crosses below a low threshold (often below 10 or 15), and the sell signal is triggered when the RSI crosses above a high threshold (often above 80 or 85). This shorter RSI period is designed to capture rapid market movements, making it particularly useful for swing traders looking to capitalize on short-term price movements. In **Appendix A**, a screenshot of the equity line and key backtest metrics for this strategy has been included.

Strategy Description

The 2-Day RSI Strategy, introduced by Oddmund Groette on the Quantified Strategies website, is a short-term mean-reversion trading approach that uses the Relative Strength Index (RSI) as its indicator. The strategy exploits extreme overbought and oversold conditions in the market, aiming to capture short-term reversals.

Indicators

- Relative Strength Index (RSI): The 2-day RSI is a momentum oscillator that measures the speed and change of price movements.
- It is used to identify overbought (RSI above 85) and oversold (RSI below 15) conditions.

Opening a Position (Buy Signal)

- A buy is triggered when the 2-day RSI crosses below 15, indicating that the asset is oversold and a potential price rebound could occur.
- This signal suggests that the price has dropped significantly and may be set for a reversal.

Closing a Position (Sell Signal & Stop-Loss)

- A sell signal occurs when the 2-day RSI crosses above 80, indicating the asset is overbought and a price correction is likely.
- This signal suggests it's time to exit the position as the price may be reaching a peak.
- **While the original article did not mention using a stop-loss, including one helped align the reproduction of the strategy more closely with the behavior of the original approach.**

Position Sizing

- **The article did not discuss position sizing.**
- By adding 2% risk-based position sizing for both buying and selling, the reproduction of the strategy was significantly improved.
- This adjustment helped align the results more closely with the performance of the original strategy.

Backtesting

Original Strategy Performance

Based on **Appendix A**, the performance metrics indicate strong long-term growth, with an initial equity of $100,000 growing to $861,655, resulting in a total return of 761.66% and a CAGR of 8.3%. However, the maximum drawdown of -33% highlights the strategy's significant volatility during certain periods. The strategy was in the market 42% of the time, suggesting a selective and tactical approach. The equity curve shows steady growth, with significant dips during crises like 2008 and 2020, though it consistently rebounded.

Reproduced Strategy Performance

Performance Metrics Comparison

Please refer to **Appendix D** for the performance metrics table.

The comparison between the original and reproduced 2-Day RSI strategies shows a high degree of similarity in terms of key performance metrics. Both strategies, which are tested on SPY, begin with an initial equity of $100,000, and the final equity values are nearly identical, with the original strategy achieving $861,655 and the reproduced strategy yielding $861,433.64. The total returns and CAGR are also closely aligned, with 761.66% and 8.3% for the original, compared to 761.43% and 8.05% for the reproduced strategy, respectively. While the original strategy did not provide a Sharpe Ratio, the reproduced strategy has a moderate Sharpe Ratio of 0.58, reflecting the risk-adjusted return. The max drawdown is slightly higher in the reproduced strategy at -36.31% compared to -33%, and the reproduced strategy executed 658 trades, a detail not available for the original. Lastly, the reproduced strategy was in the market for 39.01% of the time, slightly less than the original strategy's 42%, but overall, the performance results are consistent, demonstrating a successful replication.

Equity Plot Comparison

Please refer to **Appendix E** (bottom plot) for the Equity Plot (blue line) for the reproduced strategy.

The comparison between the equity curves in **Appendix A** (original strategy) and **Appendix E** (reproduced strategy) reveals strong similarities in performance. Both strategies show a consistent upward trajectory over time, with comparable growth and dips during market corrections. The final equity for both strategies is approximately $861,655, indicating that the reproduced strategy closely replicates the results of the original. While minor differences in drawdown periods are observed, the overall behavior and final outcomes of both strategies align well, confirming that the reproduction effectively mirrors the performance of the original strategy.

In **Appendix E**, the top graph illustrates the price chart of SPY from 1993 to 2020, where buy and sell signals are marked. A total of 658 trades were triggered, demonstrating the frequency of trading based on the strategy. The signals are a result of the rules shown in the middle graph, which shows the 2-day RSI values. The RSI is plotted against two key thresholds, 15 and 85, indicated by red lines. A buy signal is triggered when the RSI crosses below 15, and a sell signal occurs when it crosses above 85. Additionally, stop-loss and 2% risk-based position sizing are employed to manage each trade.

Hyperparameters

Risk-Based Position Sizing

The risk-based position sizing defines the portion of your current equity that you are willing to risk on a single trade. It directly influences the number of shares to buy when a trade signal is generated. For instance, with $100,000 in equity and a risk percentage of 2%, the trade will risk $2,000. The size of the position is adjusted accordingly to ensure that no more than this amount is at risk if the trade moves unfavorably.

Stop-Loss Order

The stop-loss percent from the stop-loss order represents the percentage below the entry price at which the trade will be exited. For example, if the asset is purchased at $100, a 2% stop-loss would trigger an exit if the price falls to $98. This predefined threshold ensures that losses are limited to a set percentage of the entry price.

Take-Profit Order

The take-profit percent can be defined as the percentage increase above the entry price at which the position will be closed to capture profits. For example, with an entry price of $100 and a 20% take-profit, the position would automatically close when the price reaches $120. This allows profits to be locked in once a predetermined gain has been achieved. The purpose of a take-profit order is to ensure that profits are realized at a predefined level, reducing the risk of the market reversing before profits are secured. This helps maintain consistency in profit-taking and reduces the likelihood of missing favorable exit opportunities.

RSI Period

The RSI period defines the number of time periods used to calculate the Relative Strength Index (RSI). It determines the sensitivity of the RSI to price movements, influencing the frequency of signals generated. A shorter RSI period can lead to more signals but may increase noise, while a longer period provides smoother readings, potentially capturing more sustained trends. Selecting an appropriate RSI period is essential for aligning the indicator with the trader's strategy and market conditions.

RSI Buy Threshold

The RSI buy threshold is set at 15, signaling a buy when the RSI drops below this level. This indicates that the asset may be oversold and could be due for a price rebound. By identifying this entry point, traders can capitalize on potential reversals in price, enhancing their chances of profitable trades.

RSI Sell Threshold

The RSI sell threshold is set at 85, generating a sell signal when the RSI exceeds this level. This suggests that the asset may be overbought, signaling a potential decline in price. By adhering to this exit point, traders can lock in profits and minimize losses, allowing for more disciplined trading strategies.

Optimization

Optimization Universe

The optimization universe (**Appendix F**) for the RSI-based trading strategy includes several key hyperparameters:

- **RSI Period**:
  - Values: 2, 3, 5
- **Buy Thresholds**:
  - Values: 10, 15, 20
- **Sell Thresholds**:
  - Values: 80, 85, 90
- **Stop Loss Percentages**:
  - Values: 2%, 3%
- **Take Profit Percentages**:
  - Values: 5%, 10%
- **Risk Percentage Allocated per Trade**:
  - Values: 1%, 2%

Optimized Strategy For Maximum Final Equity

The process involves looping through all possible combinations of parameters, including RSI length, buy and sell thresholds, stop-loss, take-profit, and risk. For each combination, a backtest is conducted to assess the strategy's performance. The objective is to identify the parameter set that yields the highest final equity. Please refer to **Appendix G** for the performance metrics of the optimized strategy based on final equity maximization. The optimzied hyperparameters are as follow:

- **RSI Period**:
  - Values: 2
- **Buy Thresholds**:
  - Values: 20
- **Sell Thresholds**:
  - Values: 90
- **Stop Loss Percentages**:
  - Values: 2%
- **Take Profit Percentages**:
  - Values: 10%
- **Risk Percentage Allocated per Trade**:
  - Values: 2%

The optimized strategy not only outperforms the reproduced version in terms of final equity, growing to $1,335,480.11 compared to $861,433.64, but it also achieves a higher total return of 1235.48% and a better compound annual growth rate (CAGR) of 9.76%. Additionally, the optimized strategy shows an improved Sharpe ratio (0.65 vs. 0.58), indicating better risk-adjusted performance. However, it comes

with a slightly higher maximum drawdown (-38.27% vs. -36.31%) and fewer total trades (626 vs. 658). Despite these trade-offs, the optimized strategy spends less time in the market at 36.64%, compared to 39.01% for the reproduced strategy.

In the equity curve (**Appendix H**), there is a brief period at the beginning where the buy-and-hold SPY strategy outperforms the RSI strategy. However, for a substantial portion of the timeline, the RSI strategy outperforms SPY, showing higher equity growth. Later on, the gap between the two strategies closes, with both showing similar performance towards the end. It's also worth noting that the RSI strategy is only in the market 36.64% of the time, which is significantly less than the SPY buy-and-hold strategy, meaning the RSI strategy achieved comparable returns with much less exposure to the market.

Data Visualization: Impact of Hyperparameters on Final Equity

The heatmaps in **Appendix I, J,** and **K** offer insights into the performance of the trading strategy based on different parameter combinations and their impact on final equity.

Appendix I: RSI Length vs RSI Buy Threshold

The heatmap illustrates that an RSI length of 2 paired with a buy threshold of 20 produces the highest final equity. This indicates that a shorter RSI period combined with a higher buy threshold might capture more profitable short-term oversold conditions. Lower RSI lengths, especially paired with higher thresholds, tend to outperform longer RSI lengths (3 and 5) in this particular strategy.

Appendix J: RSI Sell Threshold vs Risk (%)

This heatmap shows that the optimal combination for final equity occurs at a sell threshold of 90 and a risk allocation of 2%. A higher sell threshold with a higher risk allocation produces the best results, suggesting that aggressive strategies (holding positions longer until overbought conditions and taking higher risk per trade) yield better equity growth compared to lower sell thresholds or lower risk allocation.

Appendix K: Stop Loss (%) vs Take Profit (%)

The heatmap highlights that a stop loss of 2% paired with a take profit of 10% generates the highest final equity. The combination of a tighter stop loss and a larger take profit enables capturing significant upward movements while protecting against downside risk effectively. The contrast between 2% and 3% stop losses is noticeable, with 3% generally resulting in lower final equity.

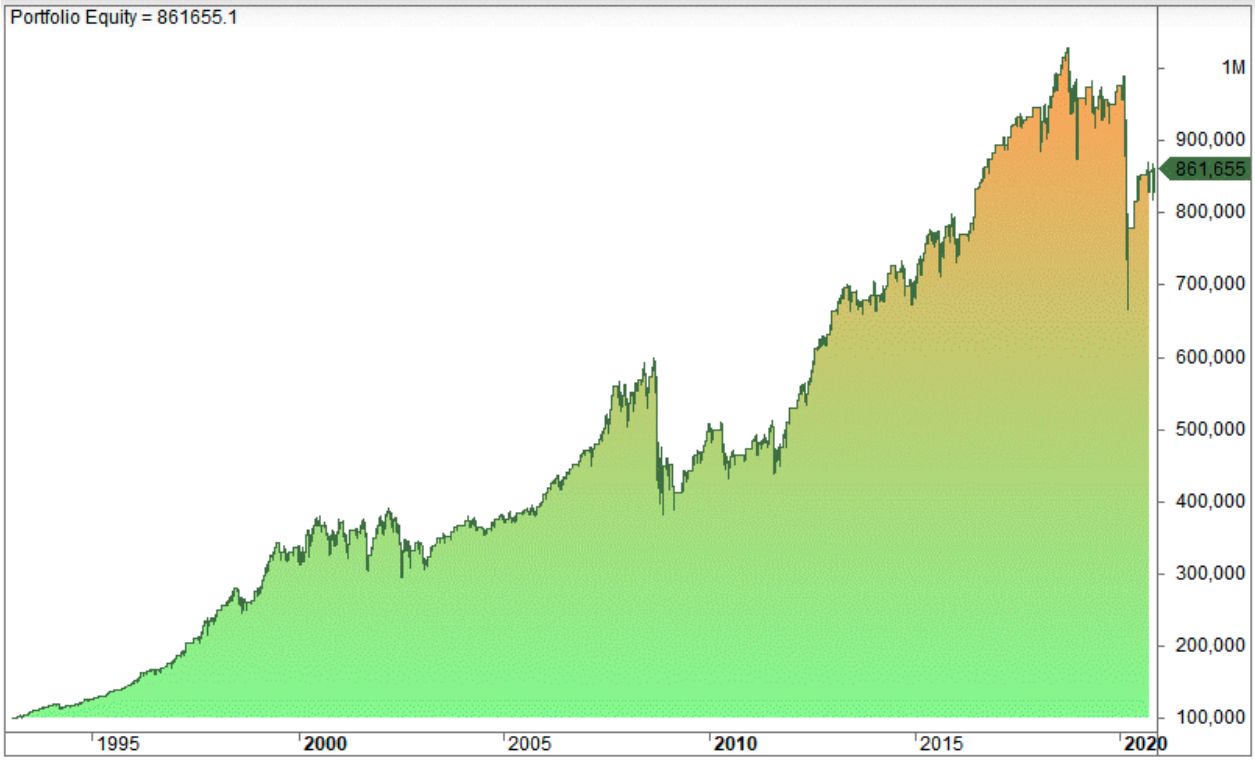
References

Groette, O. (2020). RSI trading strategy. Quantified Strategies. https://www.quantifiedstrategies.com/rsi-trading-strategy/

Appendices

Appendix A: Equity Plot & Performance Metrics (Original Strategy)

Metric	Original
Initial Equity	100,000
Final Equity	861,655
Sharpe Ratio	N/A
Max Drawdown	-33%
Total Trades	N/A
Total Returns	761.66%
CAGR	8.3%
Time in Market	42%



Appendix B: Data Used in Strategy Reproduction

Date	Open	High	Low	Close	Adj Close	Volume
1993-01-29	43.96875	43.96875	43.75000	43.93750	24.608616	1003200
1993-02-01	43.96875	44.25000	43.96875	44.25000	24.783655	480500
1993-02-02	44.21875	44.37500	44.12500	44.34375	24.836151	201300
1993-02-03	44.40625	44.84375	44.37500	44.81250	25.098680	529400
1993-02-04	44.96875	45.09375	44.46875	45.00000	25.203718	531500

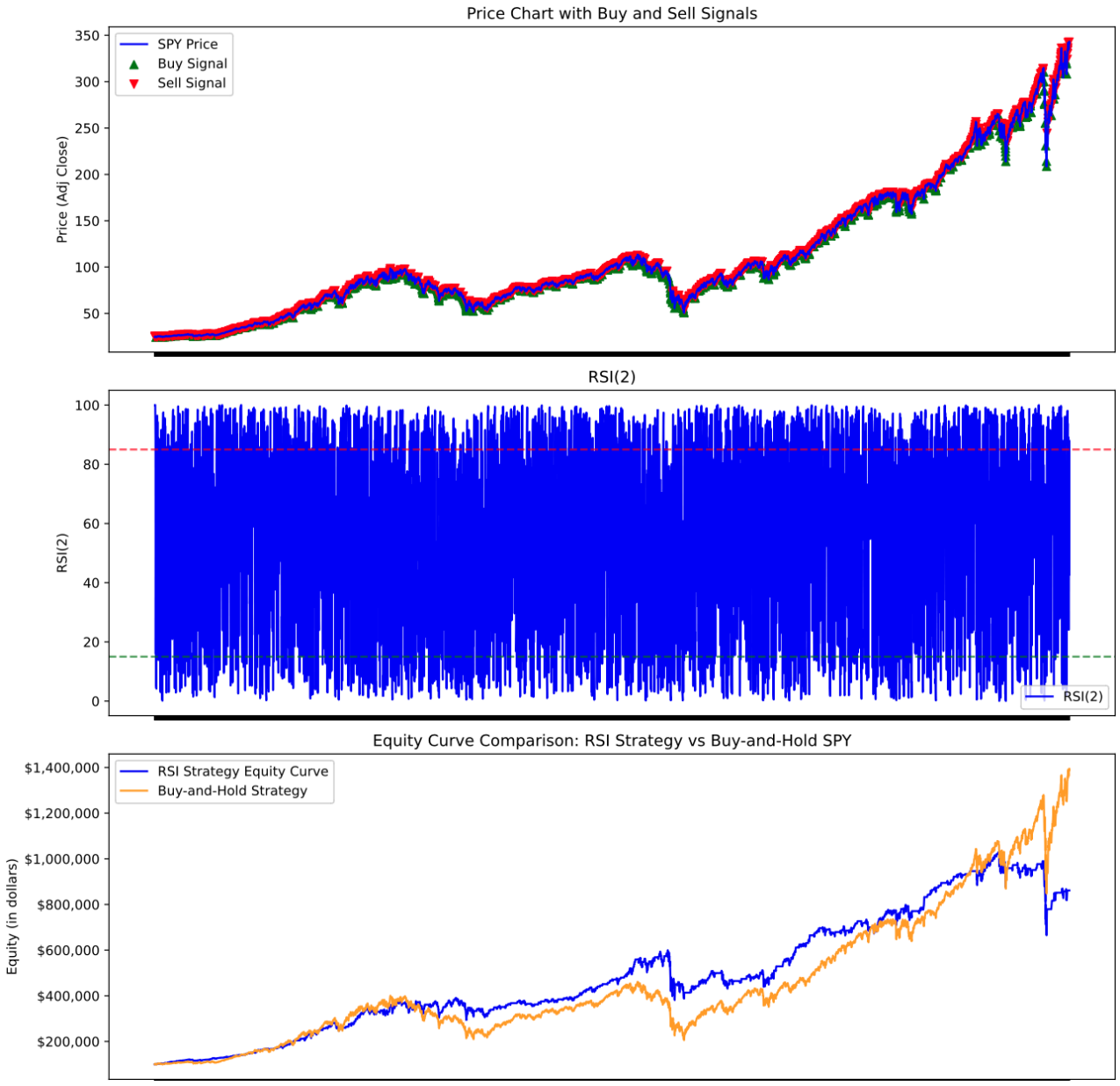
Appendix C: RSI Calculation (pandas_ta)

```
# Calculate the 2-day RSI using pandas_ta
cleaned_data['RSI_2'] = ta.rsi(cleaned_data['Adj Close'], length=2)
```

Appendix D: Performance Metrics Table (RSI)

Metric	Original Strategy	Reproduced Strategy
Initial Equity	$100,000	$100,000
Final Equity	$861,655	$861.433.64
Sharpe Ratio	NA	0.58
Max Drawdown (%)	-33%	-36.31%
Total Trades	NA	658
Total Returns	761.66%	761.43%
CAGR	8.3%	8.05%
Time in Market (%)	42%	39.01%

Appendix E: Strategy Reproduction Backtest Plot



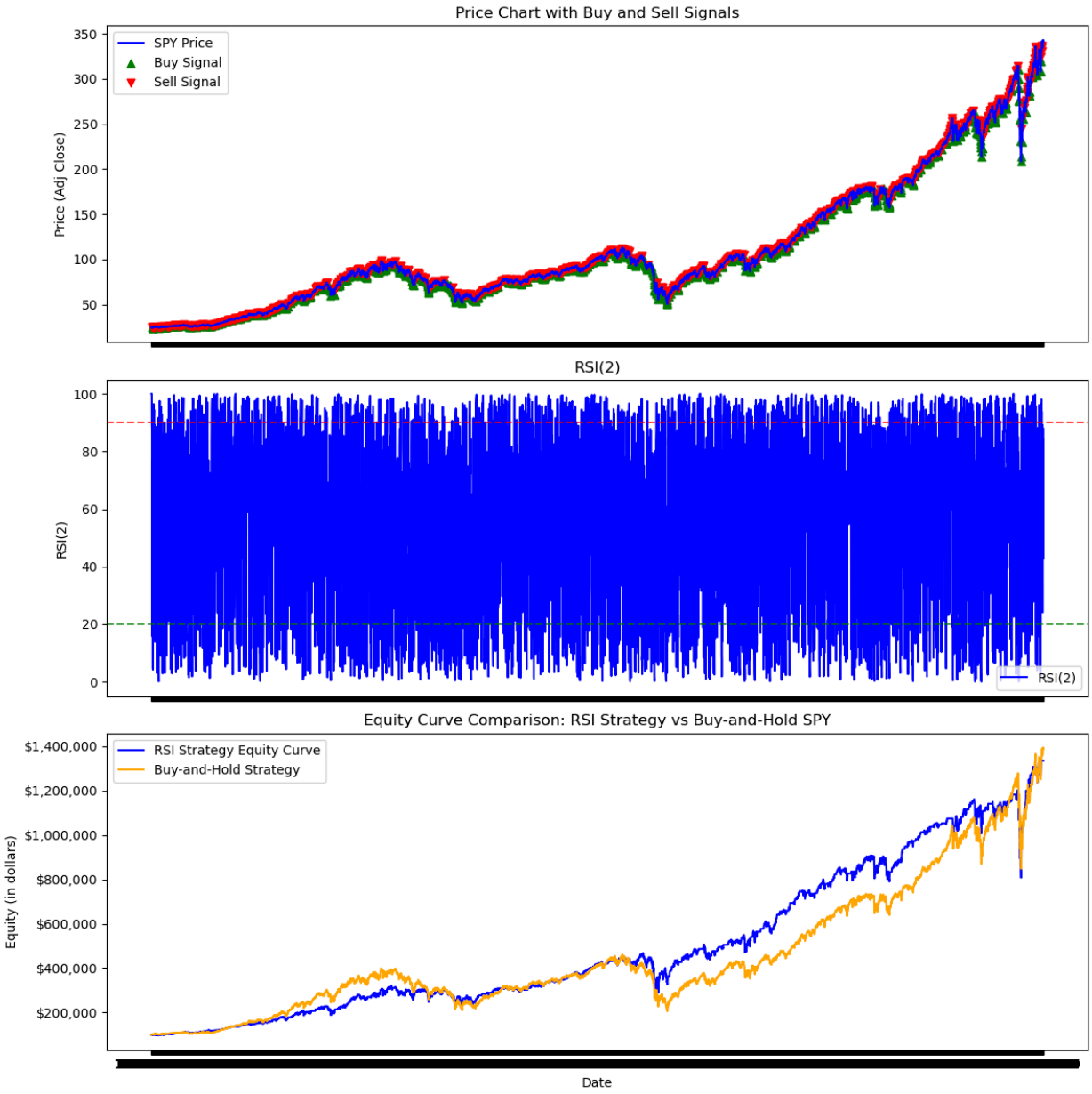
Appendix F: Hyperparameter Ranges For Optimization

```
# Define hyperparameter ranges for optimization
rsi_lengths = [2, 3, 5]
rsi_buy_thresholds = [10, 15, 20]
rsi_sell_thresholds = [80, 85, 90]
stop_loss_percents = [0.02, 0.03]
take_profit_percents = [0.05, 0.10]
risk_percents = [0.01, 0.02]
```

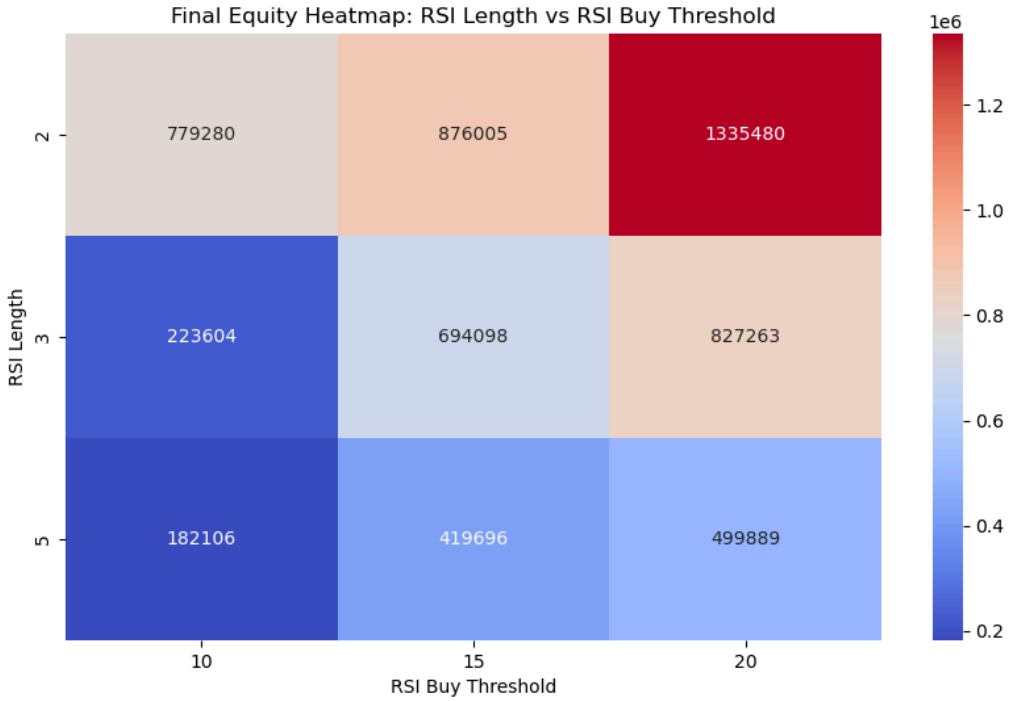
Appendix G: Performance Metrics Comparison Optimized Strategy

Metric	Original Strategy	Reproduced Strategy	Optimized Strategy
Initial Equity	$100,000	$100,000	$100,000
Final Equity	$861,655	$861.433.64	$1,335,480.11
Sharpe Ratio	NA	0.58	0.65
Max Drawdown (%)	-33%	-36.31%	-38.27%
Total Trades	NA	658	626
Total Returns	761.66%	761.43%	1235.48%
CAGR	8.3%	8.05%	9.76%
Time in Market (%)	42%	39.01%	36.64

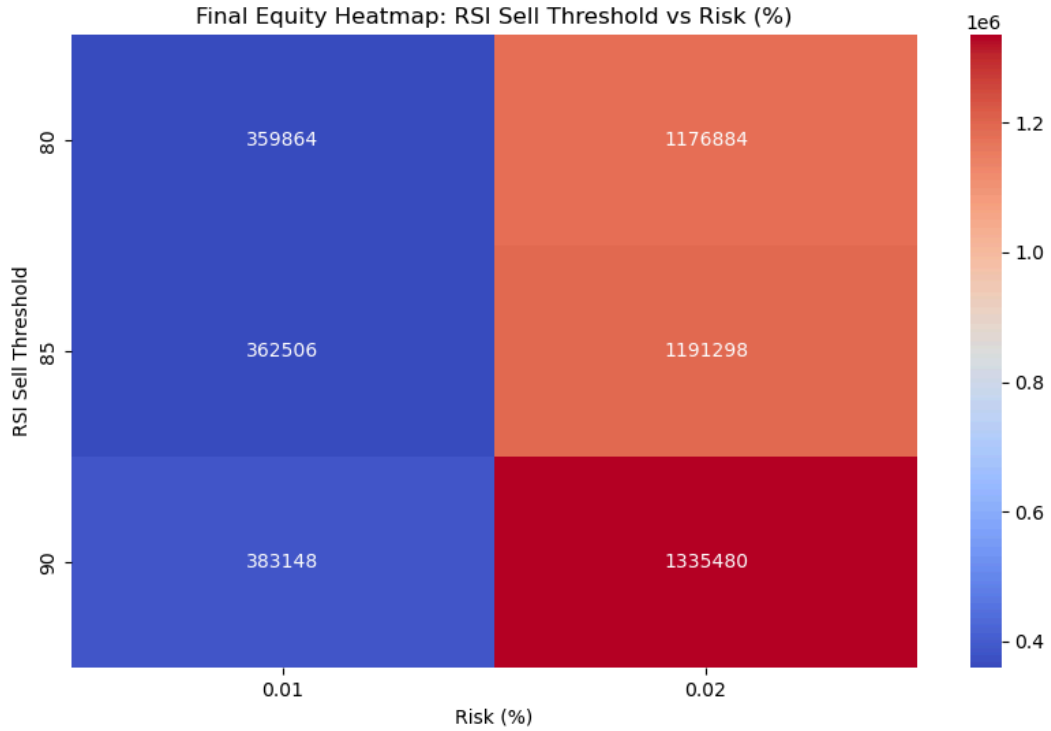
Appendix H: Backtest Plot



Appendix I: Heatmap RSI Length vs RSI Buy Threshold



Appendix J: Heatmap RSI Sell Threshold vs Risk (%)



Appendix K: Heatmap Stop Loss (%) vs Take Profit (%)