

# Backtesting Report: Pairs Trading Algorithm

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## Abstract

This report presents the backtesting results of a pairs trading algorithm using intraday data from Yahoo Finance. The strategy's methodology, performance metrics, and analysis are detailed for both long-term and short-term pairs with 15-minute intervals. Machine learning (Logistic Regression) was utilized for backtesting the short-term strategy.

## Introduction

### Objective

The objective of this report is to evaluate the performance of a pairs trading algorithm using intraday data from Yahoo Finance for both long-term and short-term pairs.

### Methodology

- **Data Collection:** Intraday adjusted closing prices for selected stocks were obtained from Yahoo Finance.
  - **Long-term Pairs:** Historical intraday data for ADBE and AMZN from 2013 to 2023 with 15-minute intervals.
  - **Short-term Pairs:** Recent intraday data for GOOG and AMD over the past month with 15-minute intervals.
- **Pair Selection:**
  - Cointegration tests were performed on the intraday data to identify pairs with statistically significant relationships.
  - Pairs were selected based on a significance level (p-value  $\leq 0.05$ ).
- **Trading Strategy Implementation:**
  - Calculate the Ratio of Adjusted Prices (RV) for each selected pair.
  - Use z-score thresholds to determine buy and sell signals for the pairs.
  - Implement trade execution rules based on z-score signals to capture mean reversion opportunities.
- **Backtesting Approach:**

- Backtest the trading signals for both long-term and short-term pairs to evaluate their effectiveness.
- Calculate performance metrics such as cumulative return, accuracy of trade signals, and risk-adjusted returns (Sharpe ratio).
- **Machine Learning Application:**
  - Utilized Logistic Regression for backtesting the short-term pairs trading strategy.
  - Mean accuracy of the logistic regression model: 0.9139.

## Pairs Trading Strategy Overview

### Description

The pairs trading strategy involved the following steps:

- **Long-term Pairs:**
  - Pair Selection: Cointegration test to identify pairs (ADBE and AMZN) with statistically significant relationships based on intraday data.
  - Ratio Calculation: Calculate the Ratio of Adjusted Prices (RV) for ADBE and AMZN.
  - Profit from backtesting (2013-2023 data): \$2665.81. On Unseen Data from 2023-2024
- **Short-term Pairs:**
  - Pair Selection: Cointegration test to identify pairs (GOOG and AMD) with statistically significant relationships based on intraday data.
  - Ratio Calculation: Calculate the Ratio of Adjusted Prices (RV) for GOOG and AMD.
  - Mean Accuracy of Logistic Regression Model: 0.9139.
  - Profit from backtesting (last month): \$44.40.
- **Mean Reversion Strategy:** Use z-score thresholds to determine buy and sell signals for both long-term and short-term pairs.
- **Trade Execution:** Execute trades based on z-score signals, buying one stock and selling the other to profit from mean reversion.

### Data Used

### Data Source

Yahoo Finance for intraday adjusted closing prices of selected stocks.

## Time Periods

- **Long-term Pairs:** Historical intraday data from 2013 to 2023 with 15-minute intervals (ADBE and AMZN).
- **Short-term Pairs:** Recent intraday data over the past month with 15-minute intervals (GOOG and AMD).

## Performance Metrics

### Key Metrics

The following key metrics were used to evaluate the performance of the pairs trading strategy:

- **Mean Accuracy:** Accuracy of predicted buy/sell signals compared to actual market movements.
- **Cumulative Return:** Total return generated by the strategy over the respective timeframe.
- **Sharpe Ratio:** Measure of risk-adjusted returns.
- **Signal Effectiveness:** Accuracy in identifying profitable trading opportunities based on z-score thresholds.

## Results Analysis

### Cointegration Test Results

- Cointegration test results for selected pairs (brief summary of findings for both long-term and short-term pairs).

### Trading Signals and Backtesting Results

- Visual representation of intraday price movements for selected pairs.
- Charts showing RV, z-score, and trade signals for both long-term and short-term pairs.
- Backtested results including cumulative return, Sharpe ratio, and trade effectiveness.
- Profit generated from backtesting:
  - Long-term pairs (ADBE and AMZN): \$2665.81.
  - Short-term pairs (GOOG and AMD): \$44.40.

# Conclusion

## Summary

Overall the Algorithmic Implementation of this was fun and challenging and turned out to be fruitful the main challenge was figuring out the Short Term Trading as it was hard to get data for very small intervals.

## Appendix

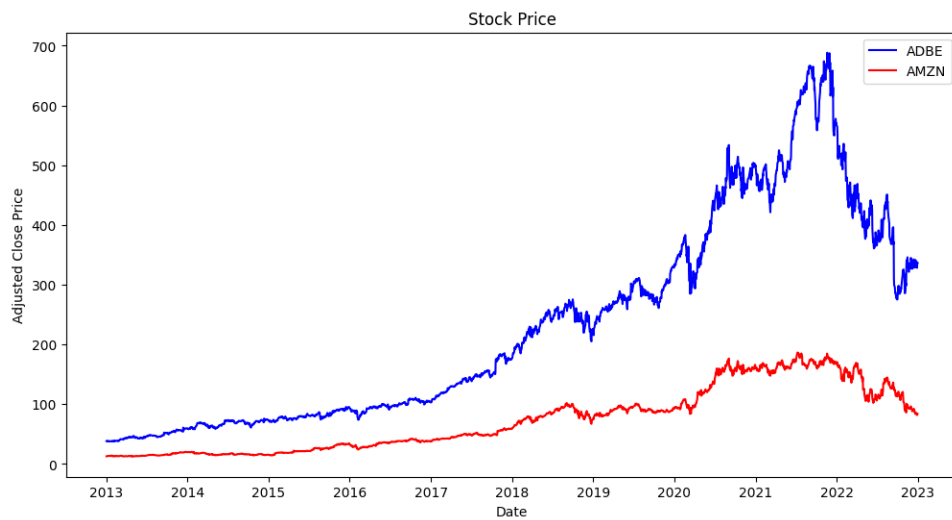


Figure 1: Amazon and Adobe Co-integration

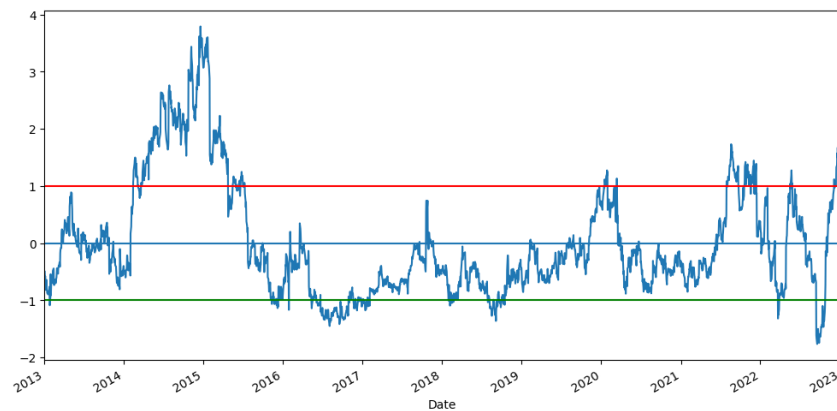


Figure 2: Mean Reversion

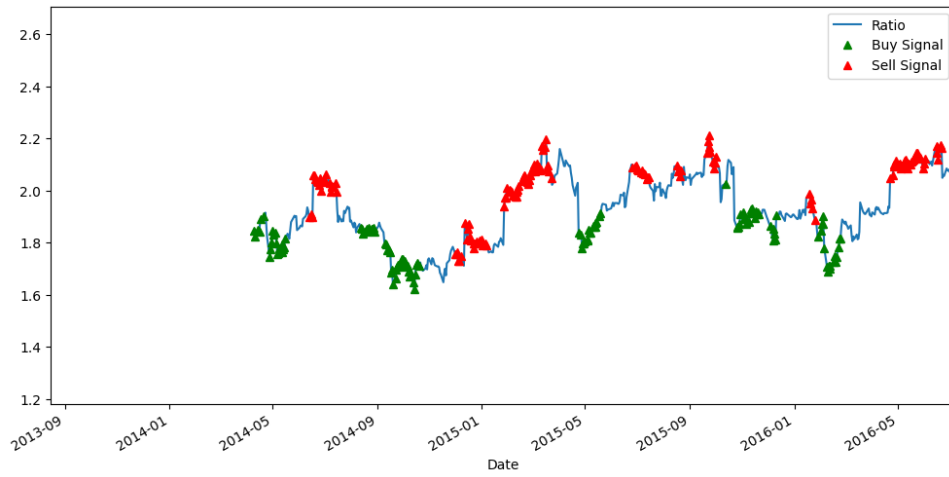


Figure 3: Buy and Sell Signals Generated

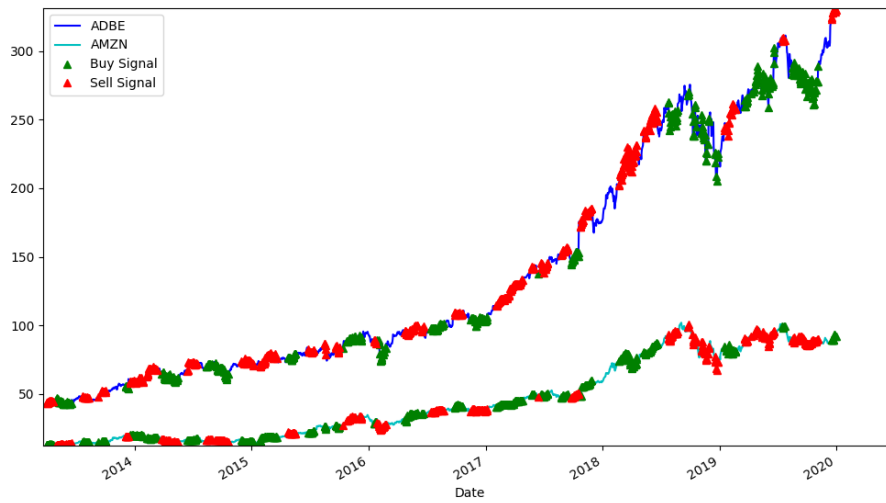


Figure 4: Long and Short for Individual Stocks

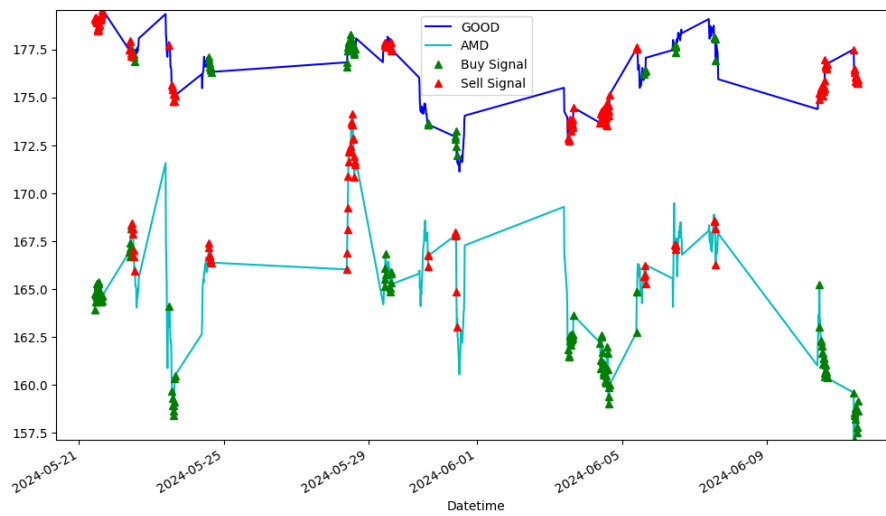


Figure 5: For Short Term Identified Stocks