

# Pairs Trading And Cointegration Strategy



BY HEDGERS

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# Objective

This project focuses on implementing pairs trading and cointegration strategies using a carefully selected set of **Nifty 100** stocks of the last 3 years. Pairs trading is a market-neutral trading strategy that capitalizes on the relative price movements of two correlated assets, while cointegration identifies long-term relationships between financial instruments. We aim to develop and test trading strategies that leverage statistical analysis to identify profitable opportunities in the stock universe.

# Pair Identification and Selection

## Pearson Correlation Pretest

Once we have stock prices for all Nifty 100 stocks, we conduct a Pearson correlation pretest on all the pairs of stocks selected to assess the pairwise correlations between these stocks. We predefined a correlation threshold (0.9) to identify potential pairs. Stocks that meet this criterion are included in our list of potential pairs for further analysis.

$$\text{Correlation}(X, Y) = \rho = \text{COV}(X, Y) / \text{SD}(X).\text{SD}(Y)$$

Where

- $\text{COV}(X, Y)$  = covariance of two selected stock X and Y.
- $\text{SD}(X)$  = standard deviation of stock X.
- $\text{SD}(Y)$  = standard deviation of stock Y.

**AFTER THE PRETEST, WE ARE LEFT WITH 50 PAIRS OF STOCKS.**



# Cointegration Test

Following the correlation test for each pair of assets, we applied cointegration test to the selected pairs. Pairs with cointegration p-values less than 0.05 were identified as statistically significant and were opted out of the previously selected pairs. This approach allowed us to focus on pairs that exhibited a strong and reliable long-term relationship, which is a fundamental criterion for our pair trading strategy.

After the cointegration test , we are left with **24** pairs of stocks

# Hedge Ratio

The hedge ratio is determined through a linear regression analysis of the cointegrated pair. Specifically, it is the coefficient of the cointegrated asset X in a linear regression model:

$$Y_t = \alpha + \beta X_t + \varepsilon_t$$

Where:

- $Y_t$  represents the value of the first asset at time t.
- $X_t$  represents the value of the second asset at time t.
- $\alpha$  is the regression intercept.
- $\beta$  is the hedge ratio.
- $\varepsilon_t$  is the residual, representing the difference between the actual value of Y and the value predicted by the regression.

To calculate  $\beta$ , we use the following formula:

$$\beta = \text{Cov}(Y, X) / \text{Var}(X)$$

Where:

- $\text{Cov}(Y, X)$  is the covariance between the two assets.
- $\text{Var}(X)$  is the variance of the second asset,  $X$ .

We got the closest HEDGE RATIO of 0.99 so we chose  
these stocks.

After all the before said tests, we  
finally select our pair as:

**HEROMOTOCORP LTD. (HEROMOTOCO.NS)**  
**EICHERMOTORS LTD. (EICHERMOT.NS)**

# • TRADING STRATEGY

With our carefully selected trading pair in place, our next step was to calculate the spread between the two assets. The spread is a fundamental component of pair trading and is typically defined as the difference between the prices or returns of the two assets within the pair.

For instance, if our pair consists of Asset A and Asset B, the spread at time 't' can be calculated as follows:

$$\text{Spread}_t = \text{Price}_{A_t} - \text{Hedge\_Ratio} * \text{Price}_{B_t}$$

Where:

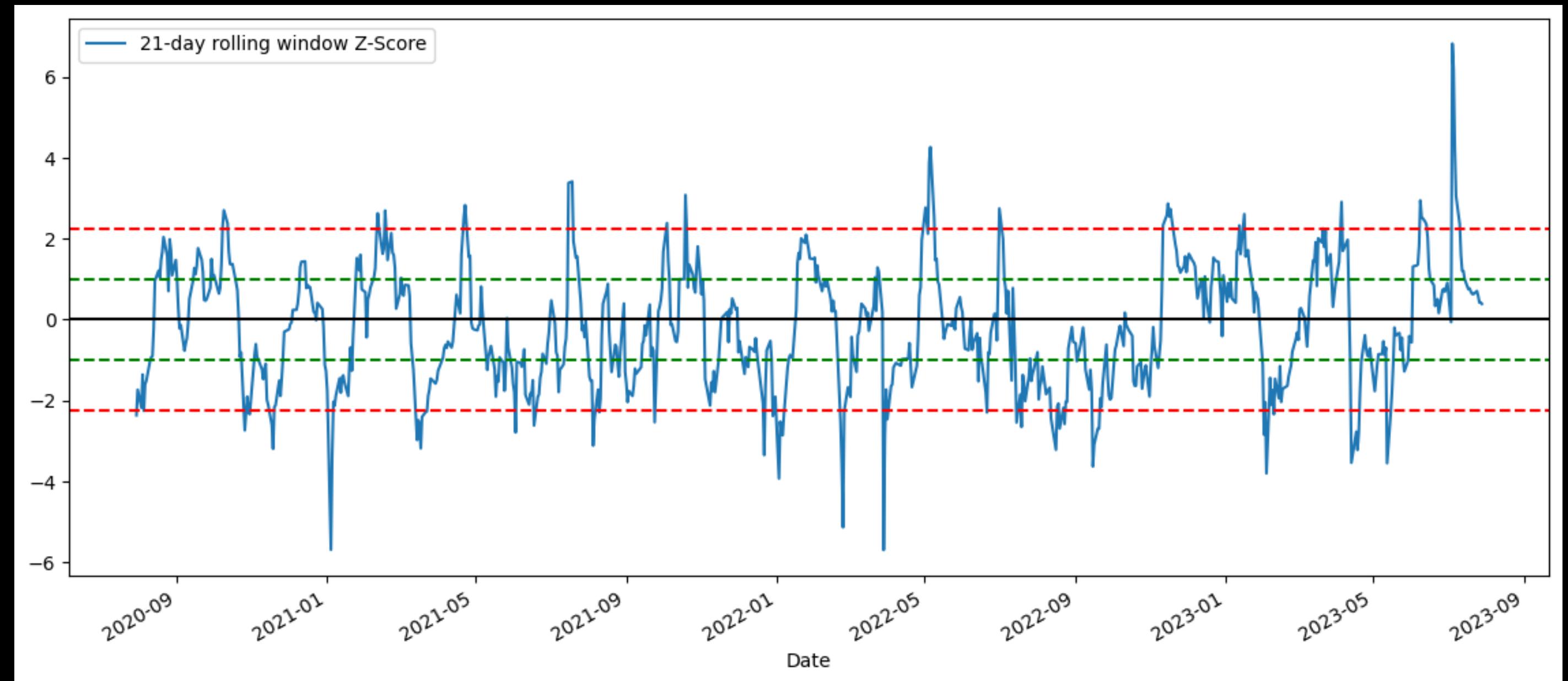
- $\text{Price}_{A_t}$  is the price of Asset A at time 't'.
- $\text{Price}_{B_t}$  is the price of Asset B at time 't'.
- Hedge\_Ratio is the determined coefficient that balances the positions of Asset A and Asset B in the pair.

Having computed the spread, we then proceeded to calculate the Z-score for the spread. This calculation aids in identifying potential entry and exit points for our pair trading strategy.

The Z-score at time 't' can be calculated as follows:

$$Z_t = (\text{Spread}_t - \text{Mean\_of\_Spread}) / \text{Standard\_Deviation\_of\_Spread}$$

Positive or negative Z-scores signal potential opportunities to enter or exit positions within our pair trading strategy, taking advantage of mean-reversion tendencies within the spread. In the pursuit of refining our pair trading strategy, we implemented a criterion for selecting specific trading periods. We focused on periods where the Z-score of the spread fell within a predefined range. This Z-score range, carefully chosen to guide our trading decisions, was set between **1 and 2.25 for positive Z-scores and between -1 and -2.25 for negative Z-scores.** When the Z-score of the spread was within the designated range, it indicated a degree of statistical significance, making it an attractive window for executing pair trading strategies.



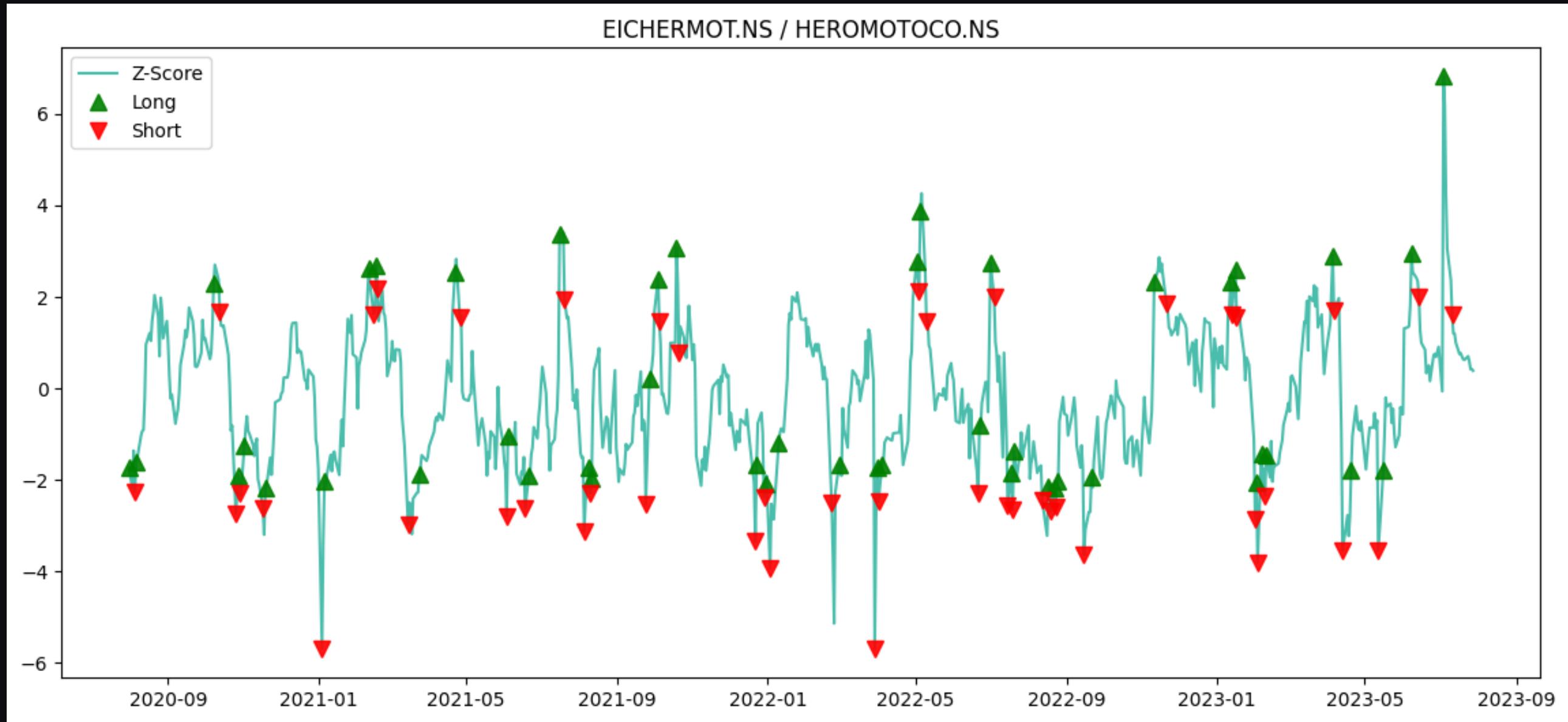
Illustrating entry (green) and exit (red) conditions

# Risk Management Measures

The introduction of a **stop-loss** threshold is a proactive measure to protect our capital and minimize potential drawdowns. It forms an integral part of our trading strategy by setting predefined exit points to prevent substantial losses.

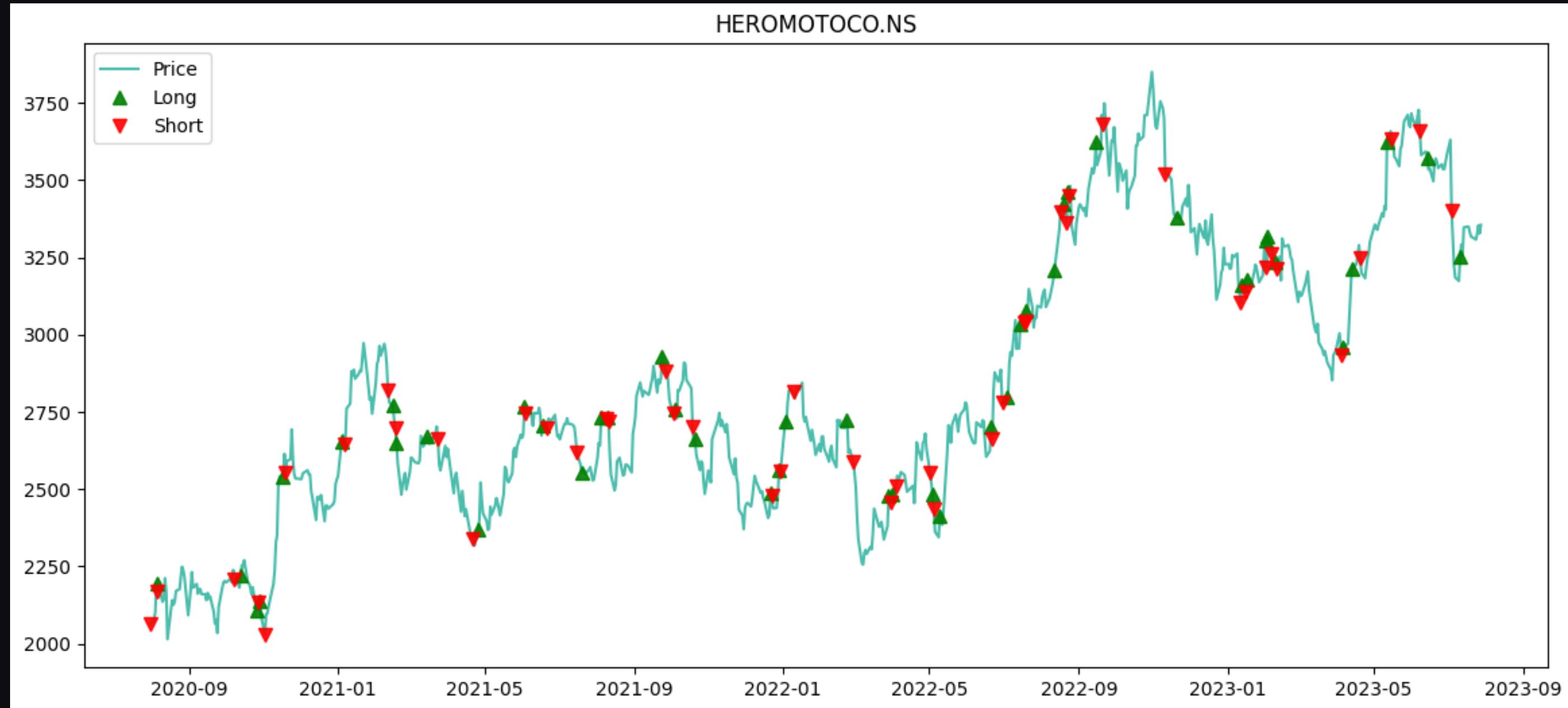
As part of our risk management strategy, we employed a specific **Z-score threshold of 2.25 and -2.25** to determine the stop-loss level for our pair trading positions. If the cointegration is broken while the pair is ON, the strategy warrants cutting the positions since the basic hypothesis is nullified.

# Trading Signals Generated and Position Sizing

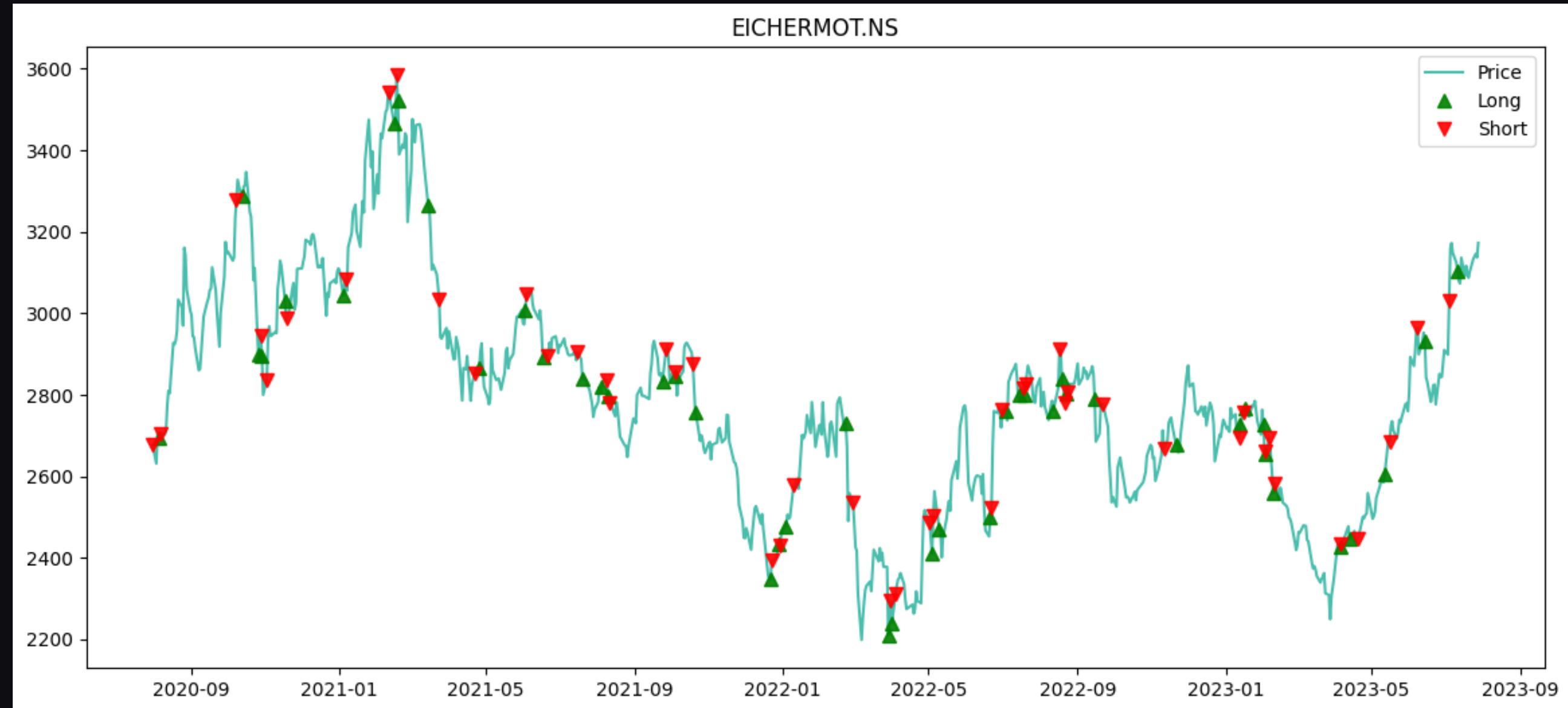


- Long position => buy Eicher Motor and sell Hero Motor
- Short position => sell Eicher Motor and buy Hero Motor

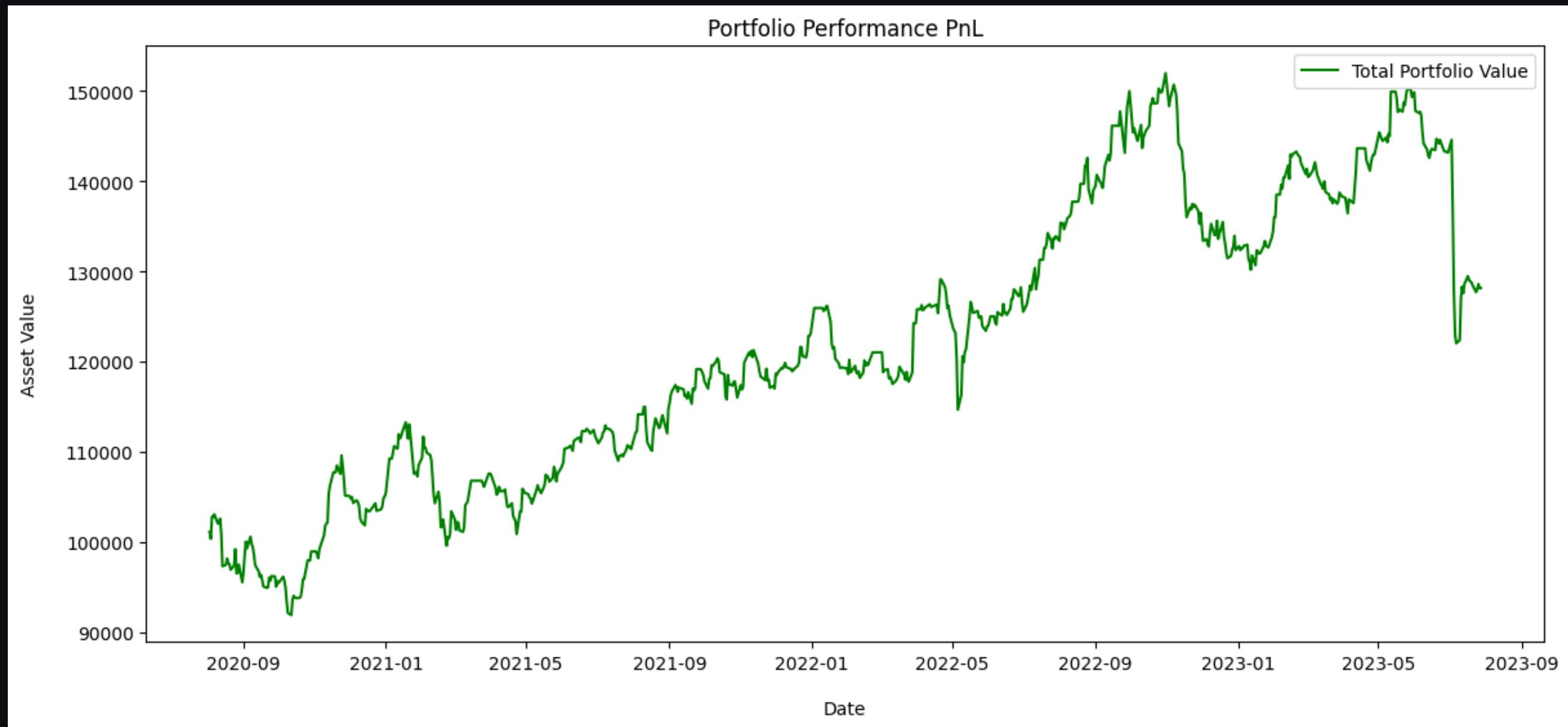
# Trading Signal of Heromotocorp LTSD.



# Trading signal of EICHER MOTORS Ltd.



# Portfolio PnL



This graph shows the estimated profits and loss

# Performance Metrics

Cumulative Returns = 26.685%

Compounded Annual Growth Rate(CAGR) = 8.341%

Sharpe Ratio = 0.59

Maximum Drawdown = -19.695%

Frequency of Trades = 31.161per year

# CONCLUSION

In conclusion, our pairs trading strategy, rooted in cointegration analysis, exhibited promising results with notable risk-adjusted returns. However, challenges arose, emphasizing the critical need for high-quality data and robust risk management techniques. To enhance our strategy, we recommend rigorous parameter optimization, real-time implementation, and continuous monitoring. Additionally, exploring advanced modeling techniques and considering regime-switching models in different market conditions could offer avenues for future research. Portfolio expansion and due consideration of the risk-free rate, particularly in Sharpe calculations, is an additional way to augment the strategy's robustness. While the project has delivered insights and promising outcomes, further refinements and adaptability to dynamic market conditions remain essential for long-term success.

Thank  
you!

