INTER IIT TECH CAMP QUANT P.S

Pairs Trading Strategy

Team Name :- Data Drivers

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Problem Statement :- To Design and implement a low-frequency pairs trading strategy that leverages the concept of cointegration to profit from the relative price movements of two assets. Your task is to create a trading algorithm that identifies, trades, and manages pairs of assets exhibiting cointegration.

Introduction and Basic Idea

Pairs trading is a market-neutral trading strategy that involves the simultaneous purchase of one asset and the sale of another asset that is highly cointegrated. We have designed and implemented a strategy based on Pairs Trading that leverages the concept of cointegration to profit from the relative price movements of two assets. We have also created an algorithm that picks a pair of stocks from a dataset that shows a high degree of cointegration.

Reason for choosing Automobile Sector :- It is influenced by common fundamental factors , experiences periods of volatility, high liquidity in the stocks of this sector, mean reversion often occurs in this sector - ideal for pairs trading.

We have evaluated the effectiveness of the strategy by analysing different metrices like sharpe ratio, drawdown ratio and annualized returns.
For Pair selection we applied the algorithm in the period June 2017 to June 2020. Backtesting of the strategy is conducted during the period July 2020 to July 2023.

Pair Identification and Selection

13 Stocks of Automobile Sector have been selected as dataset. We have implemented an algorithm that selects a pair of stocks from this dataset based on p value .The p-value is a statistical measure used to assess the likelihood of a cointegrating relationship between two assets . Lower the p value, higher the strength of cointegration. If the p-value is less than a chosen significance level (commonly 0.05), you can reject the null hypothesis. .This suggests that the data is stationary, and the time series does not possess a unit root or stochastic trend.

Two stocks Amaraja Batteries and Bharat Forge have been generated by that algorithm.
In the algorithm stat models library and different functions like coint and adfuller have been used. The above generated pair shows highest cointegration among this dataset with a minimum p value of 0.02098 which signifies that we can reject null hypothesis as 97.9 % times it falsify the null hypothesis.
Formulas that has been used are given below.

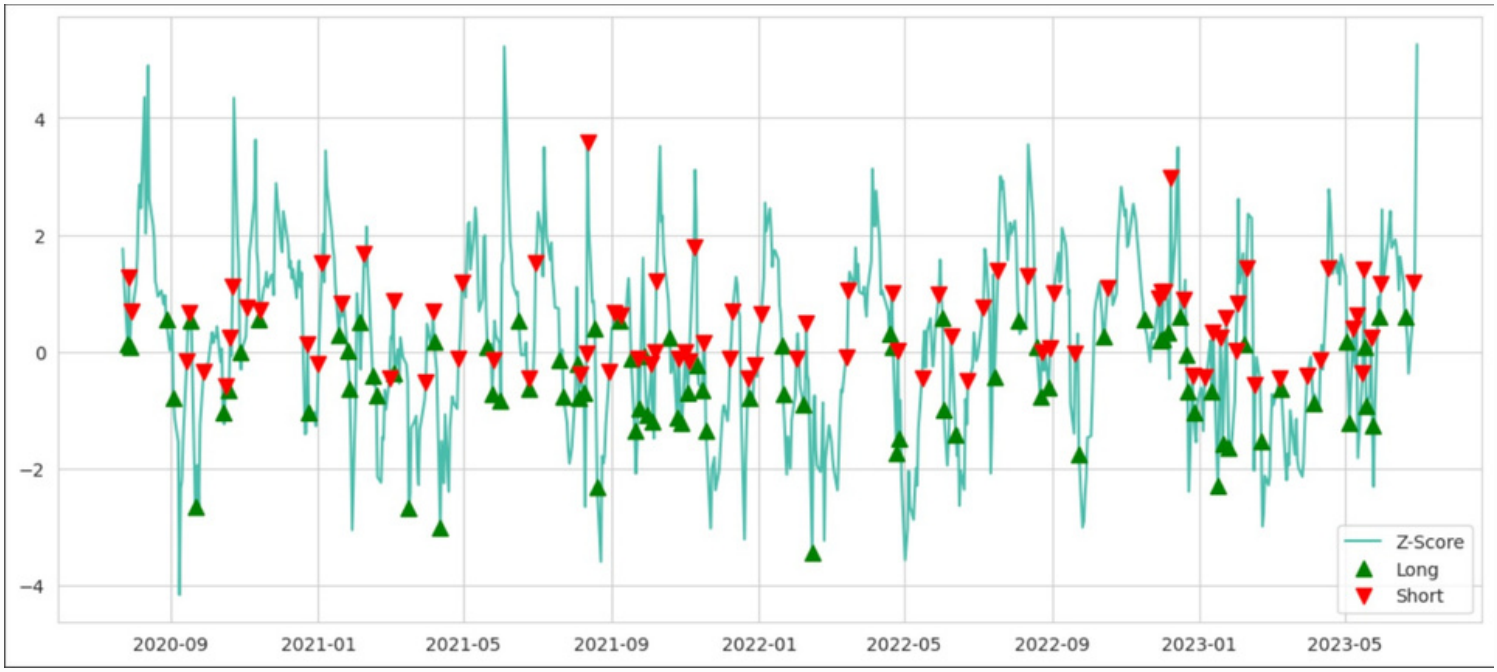
Spread = a - n*b

where, a = price of stock A , n = hedge ratio,
b = price of stock B

Trading Strategy and Signal Generation Method

Our trading strategy as described earlier Pairs trading strategy also called as mean reversion strategy in which we expect the price to return back to its normal historic trend whenever it outperforms or underperforms its normal value.
We calculated z score of the pair from its spread value using rolling mean and standard deviation for a time period of 't' intervals.
We have calculated the threshold values as 0.6 sigma and - 0.6 sigma using the norm.ppf function which takes p value as input and output the threshold values.

If z-score crosses the upper threshold value of 0.6 sigma , a trading signal will be generated ,expecting the z-score to revert towards mean, taking a Short position in asset A and a long position in asset B and we will exit the trade as the z-score approaches 0. Similarly , we can take entry when z-score crosses the lower threshold value and exit the trade when it approaches zero.



Risk Management Measures

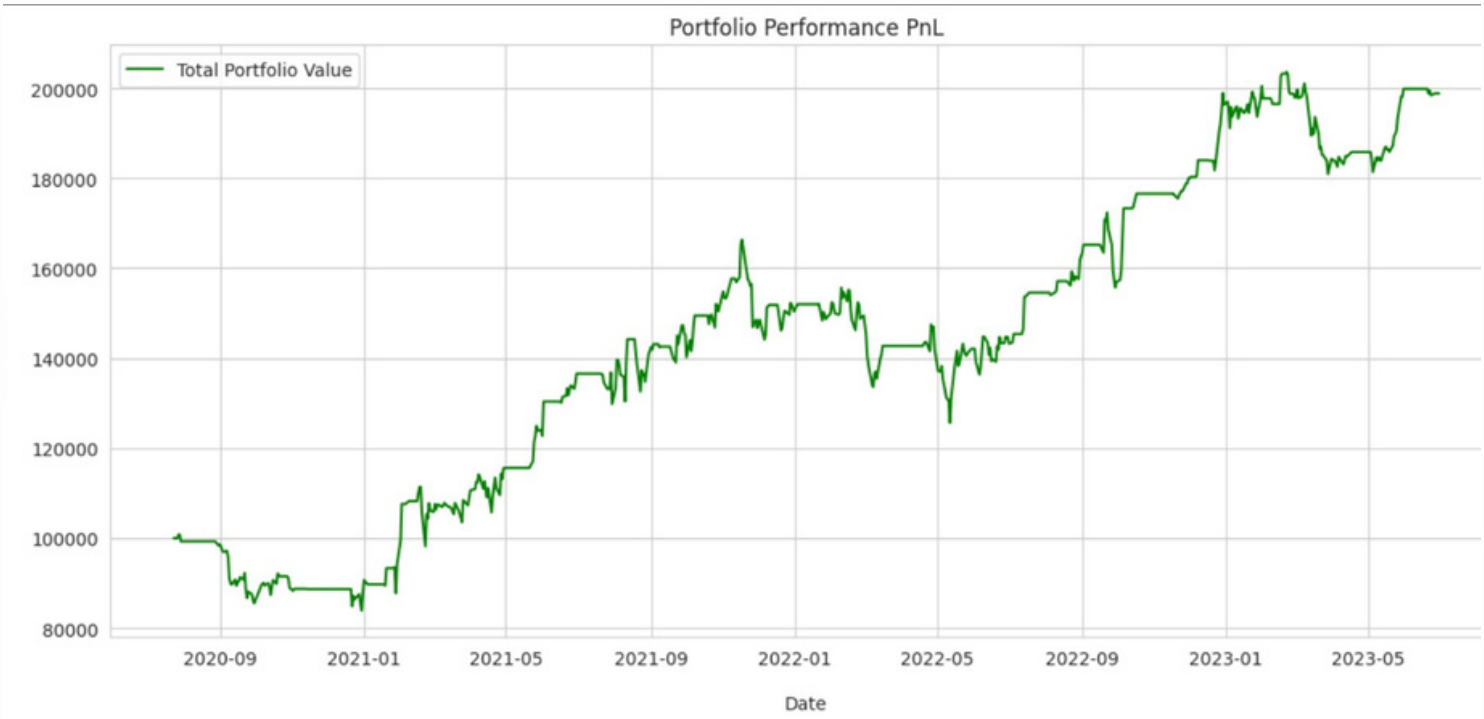
For risk management , stoploss implementation is an important component to limit the losses and reduce the risk .Utilizing a stop loss set at a threshold of 3.5 standard deviations (3.5σ) from the mean spread between the paired assets provides a prudent mechanism for limiting potential losses. This means that if the spread widens to a level three and a half times its historical standard deviation, the trade will automatically be exited, mitigating the risk of substantial and unexpected losses. By incorporating this 3.5σ stop loss, traders can establish a predefined level of acceptable risk while participating in the pairs trading strategy, helping to protect their capital in the face of unforeseen market fluctuations.

The division of capital between the two stocks also plays a significant role in risk management and profit optimization. In our strategy, we allocate 50% of the capital to asset A and the remaining 50% to asset B. This equal allocation approach is straightforward to implement and comprehend while effectively balancing the exposure to risk.It doesn't require complex calculations or continuous adjustments based on changing market conditions.

Portfolio PnL

During the three-year backtesting period, our trading strategy, executed with an initial capital allocation of ₹100,000, demonstrated impressive results. The final capital reached ₹198,446.089172, with a Compounded Annual Growth Rate (CAGR) of 26.728%. Our total profit from the strategy amounted to ₹98,446.089172, representing the cumulative financial gain realized during the backtesting period. These metrics reflect a strong and commendable performance of our trading approach, underlining its potential to generate significant returns.

$$\text{CAGR Formula} = \left[\left(\frac{\text{Ending Value}}{\text{Beginning Value}}\right)^{\frac{1}{\text{No. of years}}} - 1\right] \times 100\%$$



Portfolio Performance PnL

Key Performance Metrics

Below are the different key performance metrices based on which trading opportunities has been generated.

Sharpe ratio : 1.056956495287732

Cumulated Returns - 0.988548

Maximum Drawdown Value: -24.475033143937786 %

CAGR :- 26.728%

Z-score