**Pairs Trading Strategy Report**

**Introduction**

Pairs Trading Strategy is a market-neutral trading strategy that identifies two correlated assets and aims to profit from the relative movement between them. The strategy assumes that the two assets maintain a stable long-term relationship. When a significant deviation from this relationship occurs, it provides trading opportunities. Below, I present the details of my strategy implementation using cryptocurrency trading pairs from Binance.

**Objectives**

* Identify Cointegrated Pairs: Find pairs of assets that show a consistent statistical relationship over time (cointegration).
* Analyze Mean-Reversion Properties: Determine the likelihood of the price spread returning to the mean using metrics like the half-life and Hurst exponent.
* Develop a Trading Strategy: Create a systematic approach to trading identified pairs based on the results of statistical tests.

**Methodology**

**Data Collection**

* Symbol Selection: Retrieve all USDT-quoted cryptocurrency pairs from Binance using their API.
  + Function used: get\_all\_binance\_symbols
  + Filtering Criteria: The trading pairs should have data available from at least January 1, 2020, to May 3, 2024.
* Historical Data Retrieval: Fetch historical daily closing prices for each symbol using Binance's API.
  + Function used: get\_historical\_klines
  + Parameters:
    - symbol: The trading pair symbol (e.g., BTCUSDT)
    - interval: The time interval (1d for daily data)
    - startTime: The starting timestamp (January 1, 2020)
    - endTime: The ending timestamp (May 3, 2024)

**Statistical Testing**

* Cointegration Test: Verify whether two time series are cointegrated using the Engle-Granger two-step method.
  + Function used: cointegration\_test
  + Parameters:
    - series1, series2: Time series data for two symbols
    - Pass Criteria:
    - p\_value < 0.3 indicates a cointegrated pair
* Hurst Exponent Test: Assess the level of mean-reversion of the series.
  + Function used: hurst\_exponent\_test
  + Parameters:
  + series1, series2: Time series data for two symbols
  + Pass Criteria:
    - Hurst < 0.7 indicates strong mean-reversion tendencies
* Half-Life Calculation: Determine the mean-reversion speed of the spread using half-life calculations.
  + Function used: compute\_half\_life
  + Parameters:
    - series: The time series of the spread between two cointegrated symbols
  + Pass Criteria:
    - Half-life between 3 and 400 indicates a reasonable time for mean-reversion

**Strategy Implementation**

* Generate Signals: Implement trading signals based on the z-score of the spread.
  + If z-score > 2: Short the spread (Sell symbol1 and Buy symbol2)
  + If z-score < -2: Long the spread (Buy symbol1 and Sell symbol2)
* Position Sizing: Calculate position sizes to ensure market neutrality.
* Backtest: Simulate historical trades to evaluate profitability.

**Implementation Code**

**Step 1: Fetch Binance Symbols and Dates**

**A computer screen shot of a black screen

Description automatically generated**

Binance has 500 symbols quoted in USDT, of which 69 symbols have data between 2020-01-01 to 2024-05-03

**Step 2: Perform Cointegration Tests**

**A screen shot of a computer code

Description automatically generated**

**Step 3: Analyze Results**

**A screen shot of a computer

Description automatically generated**

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol1** | ZECUSDT | ZECUSDT | XTZUSDT |
| **Symbol2** | XTZUSDT | KAVAUSDT | KAVAUSDT |
| **Cointegration P Value** | 0.104526659 | 0.122706202 | 0.034036413 |
| **Hurst1** | 0.668873904 | 0.668873904 | 0.690041193 |
| **Hurst2** | 0.690041193 | 0.672012069 | 0.672012069 |
| **HalfLife1** | 40.91657079 | 40.91657079 | 45.72652463 |
| **HalfLife2** | 45.72652463 | 47.70218779 | 47.70218779 |

These 3 pairs managed acceptable cointegration p value and half lifes. But their Hurst Exponent are higher than 0.50, which may suggest that they exhibit more of a trending characteristic as opposed to a mean reverting characteristic.

For instance, by plotting the normalised prices of LTCUSDT and ETHUSDT, it become clear that this pair is trending together.

A graph showing the price comparison

Description automatically generated

**Step 4: Implement Trading Signals**

For completion of this project, I have written a pairs trading code, and the intention is to further explore the suitability of a statistical arbitrage pairs trading strategy on a trending pair. We use LTCUSDT and ETHUSDT in this case. As expected, the performance is not good.

**A computer screen shot of a program code

Description automatically generated**

**A graph showing the growth of a stock market

Description automatically generated**

**Conclusion**

Crypto pairs tend to exhibit trending instead of mean reverting characteristics, hence statistical arbitrage pairs trading strategy is not suitable.

**Attachments:**

* Identify\_Pairs.py
  + Code to identify cointegrated pairs
* Trading\_Strategy.ipynb
  + Code to construct the trading strategy
* binance\_earliest\_and\_latest\_dates.csv
  + Binance symbols and their earliest and latest dates available
* binance\_filtered\_symbols\_2020\_2024.csv
  + Binance symbols with data between 2020-01-01 to 2024-05-03
* cointegration\_results.csv
  + Results of running the cointegration tests on each pairs
* (Reference) Statistical Arbitrage in Pairs Trading
  + This paper laid out a process to identify cointegrated pairs for NASDAQ Indices and to subsequently perform a pairs trading strategy. The intention of my project is to explore whether this set of methods is workable for Crypto