Algorithmic Pairs Trading

Kent Quanrud

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Background

- Development
  - Gerard Bamberger
  - Morgan Stanley
  - Late 1980's

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Background

- Strategy
  - Some day-to-day stock prices are strongly correlated
  - Examples
    - Coke (KO) and Pepsi (PEP)
    - Wal-Mart (WMT) and Target (TGT)
    - Dell (DELL) and HP (HPQ)
  - When spread is large, trader buys the underperforming STOCK and sells the overachiever.

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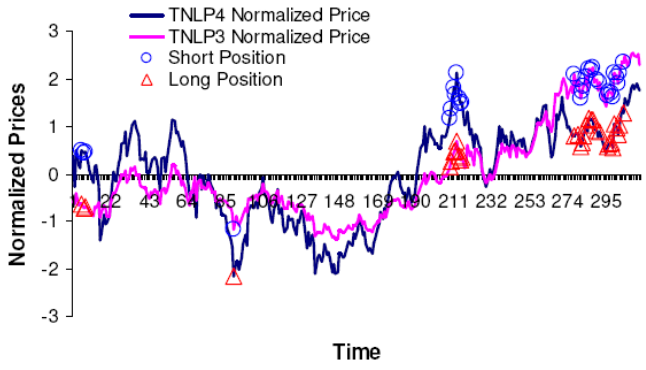
Background

Figure 1 – Example of Pairs Trading with TNLP4 and TNLP3 with *d=1*



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Background

- Market Neutrality
  - The bet is that the spread between the prices will converge.
  - If both stocks plummet, you would gain on the short position to negate the loss on the long.
  - Trade activity is more a function of volatility

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The code

- Files:
  - pairstrading.m – The engine that does most of the work
  - trades.m – Calculates number of trades.
  - pairs.m – find pairs for each stock in the matrix
  - normdata.m – Normalizes a matrix of stock prices

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Parameters

- x – Matrix of all stock prices in the framework. We run Get_Data.m to get prices for S&P500.
- d – Date of first trade
- window – the size of the rolling window of historical data to find pairs for each day.
- t – Threshold parameter to test the spread against.
- ut – Periodicity to find pairs
- c – Transaction cost (for returns calculation)

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The code

- "Training"
  - Before trading each day, it runs through the previous "window" days of prices to identify pairs.

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Step 1: Normalize the data:

- Formula:
  - Normalized Price = (Price – Mean)/(Standard Deviation)
- pairstrading.m:
  - x2=x(d-window+k-1:d+k-2,:);
    x3=normdata(x2);
- normdata.m:
  - for i=1:n2
    mean_x=mean(x(:,i));
    std_x=std(x(:,i));
    New_x(:,i)=(x(:,i)-mean_x)/std_x;

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Step 2: Identify Pairs:

- For each stock, identify its best pair by the minimum squared distance between the normalized price.
- pairstrading.m:
  - [p]=pairs(x3);
- normdata.m

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Step 3: Trading

- Using today's data, for each stock, find spread (with normalized data) between it and its paired counterpart.
- If the spread is greater than the threshold parameter t, short the overachiever and buy the underachiever.
- pairstrading.m

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Evaluation of Returns

- The code keeps track of returns to calculate raw returns.
- Excess returns is calculated as how the tested strategy exceeded the naïve rule of "buy&hold" and "sell&unhold".

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Observations

- Increasing t, the spread's threshold for trading, decreases the number of trades => less transaction costs and more efficient long and short positions.
- In this algorithm, all pairs are equal – that is, pairs of stronger correlation are not preferred to those of lower correlation given equal spread.
- Each stock is guaranteed at least one pair even if all square sum values are large.

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Trial:

- Data: S&P 500 prices for the last five years
- Parameters: t = 3, ut = 25, d = 501, window = 500.
- Total (Long&Short) Positions Results:
  Excessive Return: 2.8861
  Number of Days in the Market: 555
  Number of required Trades: 250

  elapsed_time =3.6411e+003

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