A Pairs Trading strategy is a **market-neutral strategy**. The direction of the market does not affect the profit or loss of the strategy. In pairs trading, we take a long position and a short position each on a pair of highly-correlated securities. For this strategy, we use the JP Morgan Diversified Return Emerging Markets Equity ETF ("ETF1" in blue) and JP Morgan Diversified Return Global Equity ETF ("ETF2" in green).

The plot below shows the prices of the ETFs in relation to each other.


Calculating spread and normalizing to a z-score

The spread is the price difference between ETF1 and ETF2. When the spread is large, that is, the price of ETF1 is very much higher than the price of ETF2, we take a hedged position by shorting ETF1 and longing ETF2. Due to mean reversion, we expect ETF1 prices to decrease towards the mean and we expect ETF2 prices to increase towards the mean.

We **normalise** the spread signals be calculating a z-score based on moving averages.

$$Spread\ on\ day\ N = Price\ of\ ETF1\ on\ day\ N - Price\ of\ ETF2\ on\ day\ N = P_{1,N} - P_{2,N}$$

Assuming 2 days, $MA\ short\ = Mean\ of\ 2\ days\ of\ Spread = [(P_{1,1} - P_{2,1}) + (P_{1,2} - P_{2,2})]\ /\ 2$

Assuming 5 days, $MA\ long\ = Mean\ of\ 5\ days\ of\ Spread$

$$= [(P_{1,1} - P_{2,1}) + (P_{1,2} - P_{2,2}) + \cdots + (P_{1,5} - P_{2,5})]\ /\ 5$$

$$Standard\ Deviation = Standard\ deviation\ of\ 5\ days\ of\ Spread$$

The **z-score** shows how extreme the spread is and is calculated as follows:

$$Zscore = \frac{(MA\ short - MA\ long)}{Standard\ Deviation}$$

Executing the trades

We set the z-score entry threshold to be 0.5 and the z-score exit threshold to be 0.1. Part of the Quantopian code is extracted below.

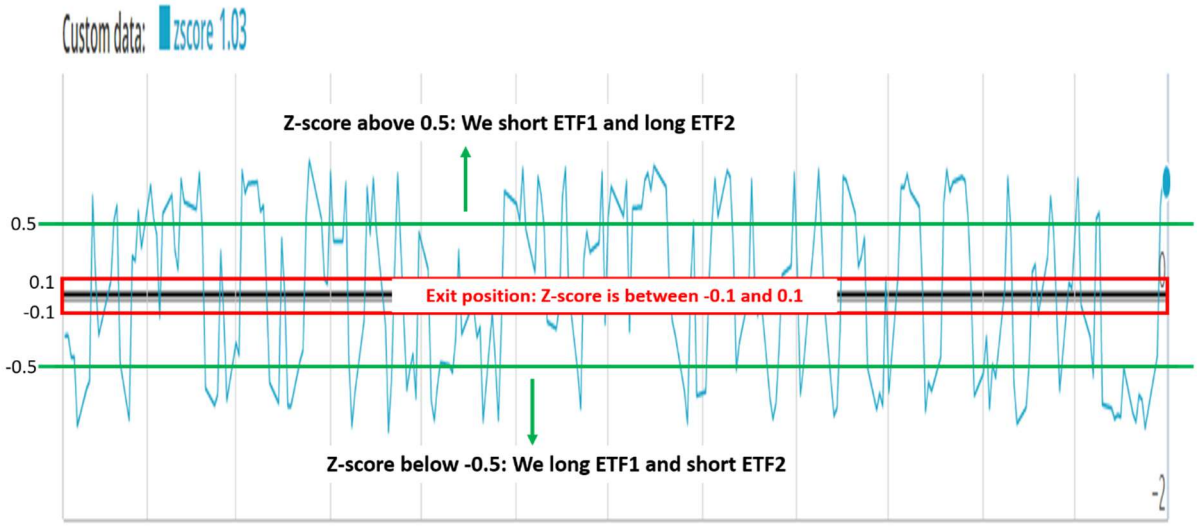
```
# There are two entry cases; one for taking a short position, the other a long position.
# The first case is when zscore is above the threshold and we are currently not in a SHORT trade.
if zscore > context.entry_threshold and (not context.currently_short_the_spread):
    order_target_percent(s1, -0.5) # short Emerging Market Equity ETF
    order_target_percent(s2, 0.5) # long Global Equity ETF
    context.currently_short_the_spread = True # Now that we have taken a short position on the spread, we assign the value of True to this variable.
```

context.currently_long_the_spread = False # Now that we have taken a short position on the spread, we assign the value of False to this variable.

# The second case is when zscore is below the threshold and we are currently not in a LONG trade.
elif zscore < -context.entry_threshold and (not context.currently_long_the_spread):
order_target_percent(s1, 0.5) # long Emerging Market Equity ETF
order_target_percent(s2, -0.5) # short Global Equity ETF
context.currently_short_the_spread = False
context.currently_long_the_spread = True

# This is the exit case. When the zscore is less than the exit threshold, that is, when the zscore approaches zero, we exit the position.
elif abs(zscore) < context.exit_threshold:
order_target_percent(s1, 0) # Do not long or short any ETF.
order_target_percent(s2, 0) # Do not long or short any ETF.
context.currently_short_the_spread = False # Now that we have exited the position, the values of these are assigned back to the initial value False.
context.currently_long_the_spread = False

Below is the graphical representation of the z-score and how trades are executed.




Results

Initial capital: $50,000 from 9 Jan 2015 to 2 Apr 2017