STAT8020 Quantitative Strategies and Algorithmic Trading
T1: *Examples of simple trading strategies*

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January 22, 2021

About STAT8020 Tutorial

Welcome to Tutorials of STAT8020 Quantitative Strategies and Algorithmic Trading.
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EWMA: Exponentially Weighted Moving Average

Roughly speaking, MA(moving averages) are expected to show us the trend of the stock price(if there is any), or at least the average cost of the recent buyers buying the stock.
As shown in the lecturer's slides Lec1.pdf P24, we have the simple moving average

$$\text{SMA}(\mathrm{N},\mathrm{t}) = \left(\mathrm{P}_\mathrm{t} + \mathrm{P}_{\mathrm{t}-1} + \ldots + \mathrm{P}_{\mathrm{t}-\mathrm{N}+1}\right)/\mathrm{N}.$$

However, we may expect that the latter the prices are, the more important they are. So we may want the MA to have adjusted weight.
weighted moving average

$$\mathrm{WMA}(\mathrm{N},\mathrm{t}) = \left(\mathrm{N} * \mathrm{P}_\mathrm{t} + (\mathrm{N}-1) * \mathrm{P}_{\mathrm{t}-1} + \ldots + 1 * \mathrm{P}_{\mathrm{t}-\mathrm{N}+1}\right)/\mathrm{S},$$

where $\mathrm{S} = \frac{N(N+1)}{2}$.

Also, we can make the past effects decay even faster: (Exponentially weighted moving average) EMA (λ, t) defined recursively as follows:

$$\begin{aligned}\text{EMA}(\lambda,1) &= \mathrm{P}_1,\\ \text{EMA}(\lambda,t) &= (1-\lambda) * \text{EMA}(\lambda,t-1) + \lambda * \mathrm{P}_t\\ &= \lambda * \mathrm{P}_\mathrm{t} + \lambda * (1-\lambda)\mathrm{P}_{\mathrm{t}-1} + \ldots.\end{aligned}$$

To illustrate,

$$\begin{aligned}\text{EMA}(\lambda,1) &= \mathrm{P}_1,\\ \text{EMA}(\lambda,2) &= (1-\lambda)\mathrm{P}_1 + \lambda\mathrm{P}_2,\\ \text{EMA}(\lambda,3) &= (1-\lambda)^2\mathrm{P}_1 + \lambda(1-\lambda)\mathrm{P}_2 + \lambda\mathrm{P}_3.\\ \text{EMA}(\lambda,4) &= (1-\lambda)^3\mathrm{P}_1 + \lambda(1-\lambda)^2\mathrm{P}_2 + \lambda(1-\lambda)\mathrm{P}_3 + \lambda\mathrm{P}_4.\\ &\ldots\end{aligned}$$

Q1: Use EWMA for a trend following (momentum) trading rule

Q1. Given the following time series for HSBC stock price over a 12-month period:

$$83, 85, 89, 85, 80, 78, 79, 75, 74, 71, 72, 73.$$

a Calculate the EWMA for this time series using $\lambda = 0.8$.

b Indicate the trading signals, if any, for HSBC over the 12-month period, based on the following rules:

1. go long if HSBC>EWMA until at a later date when HSBC<EWMA then go short,
2. go short if HSBC<EWMA until at a later date when HSBC>EWMA then go long.

Solution: See Excel

Bollinger Bands

Bollinger Bands are a type of statistical chart characterizing the prices and volatility over time of a financial instrument or commodity(John Bollinger, 1980s).

Two input parameters (N, α) chosen independently by the user govern how a given chart summarizes the known historical price data, allowing the user to vary the response of the chart to the magnitude and frequency of price changes, similar to parametric equations in signal processing or control systems. Bollinger Bands consist of an N-period moving average $SMA(N, t)$, an upper band at α times an N-period standard deviation above the moving average $SMA(N, t) + \alpha\sigma(N, t)$, and a lower band at α times an N-period standard deviation below the moving average $SMA(N, t) - \alpha\sigma(N, t)$.

Roughly speaking, Bollinger Bands yields a "confidence interval" via past N-data.

Q2: Use Bollinger Bands for a *contrarian*? trading rule

Q2. The following data are the closing stock prices of the Hong Kong Stock Exchange (HK.0388) in January 2016.

HK.0388			
Date	Price	Date	Price
1/1/2016	129.3	1/17/2016	128.2
1/2/2016	129.9	1/20/2016	127.2
1/3/2016	127.5	1/21/2016	126.9
1/6/2016	126.7	1/22/2016	127.2
1/7/2016	126.2	1/23/2016	125.9
1/8/2016	128.7	1/24/2016	125.1
1/9/2016	127.4	1/27/2016	122.6
1/10/2016	127	1/28/2016	121.8
1/13/2016	126.9	1/29/2016	122.2
1/14/2016	126.4	1/30/2016	121.9
1/15/2016	127.8	1/31/2016	121.9
1/16/2016	127.7		

a Create an Excel worksheet to calculate the Bollinger Band for the above data with $N = 5$ and $\alpha = 0.5$.

b Illustrate 2 different trading rules of the Bollinger Band, indicate the long/short or no positions in part a.

Solution: See Excel

Hint: The area covered between the lower Bollinger Bands and the upper Bollinger Bands serves as "area of value".

This means when the market pullback towards the N-SMA, it could an opportunity for you to get long (or short).

Alexander's Filter Trading Rule

Lecturer's slides Lec1.pdf P31 yields the most intuitive explanation. While the exact trading signals are introduced in P32. Copy and Paste here

$\mathrm{PCS} =$ Positive CUSUM

$\mathrm{NCS} =$ Negative CUSUM, defined recursively

- $\mathrm{PCS}_0 = 0, \mathrm{PCS}_t = \max(0, \mathrm{PCS}_{t-1} + \mathrm{Y}_t) >= 0$
  $\mathrm{NCS}_0 = 0, \mathrm{NCS}_t = \min(0, \mathrm{NCS}_{t-1} + \mathrm{Y}_t) <= 0$
  $\mathrm{Y}_t =$ return
- signal $_t = 1$ if $\mathrm{PCS}_t > \delta; = -1$ if $\mathrm{NCS}_t < -\delta$
  whichever comes first
- Once signal $= 1($ or -1), reset PCS, NCS=0 and compute future PCS, NCS as usual, then change signal to $-1(+1)$ if $NCS < -\delta(\mathrm{PCS} > \delta)$.

Q3: Example for calculating the PCS & NCS: Filter Trading Rule

Q3. The following data are the daily returns of a trading product in 14 consecutive trading days.

$$1\%, -2\%, 3\%, 4\%, 1\%, -3\%, 2\%, -2\%, -4\%, -3\%, 3\%, 2\%, -1\%, 3\%.$$

Create an Excel worksheet to calculate the filter trading signals for the above data with $\delta = 6\%$.

Solution: See Excel

Trick: If we are currently going long(short), then I only need to calculate the NCS(PCS), for the other index will not affect the signal for the time being.

Q4: Comparing the BAH with the filter rule(Commission fee considered)

Q4. The following data are the daily closing prices of a trading product in 10 consecutive trading days.

100, 102, 104, 99, 100, 96, 97, 100, 103, 105

Create an Excel worksheet to calculate

a the daily returns from day 2 onwards, and

b the cumulative wealth after these 10 consecutive trading days with 0.16% transaction costs based on the filter trading rule with $\delta = 1\%$.

Solution: See Excel

Attension: Each time I switch from "long" to " short", I need to close long(selling what I had) then open short (selling what I don't have yet). While Each time I switch from "short" to " long", I need to close short(buying and returning what I had borrowed) then open long (buying what I don't have yet). Thus **changing of signals would yield twice the transaction fee, to be calculated the next day**.

Q5: The better one may be be statistically better. Hypothesis testing for comparing BAH with Filter TR

Q5. Based on the same methodology as in Q4, calculate the cumulative wealth of the Hong Kong Stock Exchange (HK.0388) in January 2016 (Data as given in Q2) based on the closing prices (Filter trading rule: $\delta = 1\%$ with 0.16% transaction cost). Test whether this technical trading rule (TTR) is significantly better than BAH at the 5% level of statistical significance.

Good strategies or not?–"Five Barriers" in "Finding truth in math" in HKEJ

1. A strategy must pass a out-sample test. How the strategy would behave outside the training data is the most important.
2. Commission fees / gaps between selling prices and buying prices/ Slippage.
3. Can it outrun BAH?
4. If the risk is also higher than BAH? Need to reevaluate gains accordingly as risk running higher.
5. If it's statistically significantly better than BAH?

End

That's all. Thank you very much!