Assignment

One of the difficult questions in linear regression is the size of the window W. In this assignment, we will build a linear regression model for stock prices and decide whether we want to hold a (long or short) position overnight. Specifically, we take a window of W days and given the (adj_close) prices $P_1, P_2, \ldots, P_W$ for days $t = 1, 2, \ldots, W$ we estimate the closing price P^*_{W+1} for day $W + 1$ using ordinary linear regression. We will choose W based on the profitability of our strategy.

We need to decide our investment at the end of day W and decide how to invest for day $W + 1$. Our trading strategy at the end of day W is the following:

1. if $P^*_{W+1} > P_W$ then we decide that tomorrow the price will rise (daily return for day $W + 1$ will be positive). In this case we do the following:

   (a) if we do not have a position, we buy \$100 of stock at the closing price P_W. We establish a long position with $100/P_W$ (fractional) number of shares.

   (b) if we already have a long position (i.e. we bought yesterday or day(s) before), we keep the position. Since

we expect the price to rise the next day, we expect to increase our profit

(c) if we have a short position from yesterday, we close this position by buying the approporiate number of shares. If we established such a short position with x (possibly fractional) number of shares with price P_x, the profit/loss per share will be $P_x - P_W$.

2. if $P^*_{W+1} < P_W$ then we decide that tomorrow the price will fall (daily return for day $W + 1$ will be negative). In this case we do the following:

(a) if we do not have a position, we sell short \$100 of stock at the closing price P_W. We establish a short position with $100/P_W$ (fractional) number of shares

(b) if we already have a short position (i.e. we sold short yesterday or day(s) before), we keep the position. Since we expect the price to fall the next day, we expect to increase our profit

(c) if we have a long position, we close the position. If we established such a long position with x (possibly fractional) number of shares with price P_x, then the profit/loss per share is $P_W - P_x$.

(d) if $P^*_{W+1} = P_W$, then we do nothing (this is a highly unlikely event) and we ignore trading costs

Questions:

1. take $W = 5, 6, \ldots, 30$ and consider your data for year 1. For each W in the specified range, compute your average P/L per trade and plot it: on x-axis you plot the values of W and on the y axis you plot profit and loss per trade. What is the optimal value W^* of W?

2. use the value of W^* from year 1 and consider year 2. For every day in year 2, take the previous W^* days, compute linear regression and compute the value of r^2 for that day. Plot the graph of r^2 for year 2. What is the average r^2. How well does it explain price movements?

3. take the optimal value of W^* from year 1 and use it to implement the above trading strategy for year 2. How many "long position" and 'short position" transactions did you have in year 2?

4. what is the average profit/loss per "long position" trade and per "short position" trades in year 2?

5. what is the average number of days for long position and short position transactions in year 2?

6. are these results very different from those in year 1 for this value of W^*?