STA457 Time Series Analysis Assignment 1 (Winter 2019)

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Please check in Quercus regularly for the update of the assignment.

Background reading:

1. Assignment and solution (Fall 2018)
2. Moskowitz et al. (2012), "*Time series momentum*", Journal of Financial Economics

General instruction

- Download daily and monthly data of 30 constituents in the Dow Jones (DJ) index from 1999 December to 2018 December. Please see https://money.cnn.com/data/dow30/ for the list of DJ constituents.
- Calculate the performance based on a 60-month rolling window and rebalance the portfolio annually at the end of each year.

Questions:

A. Technical trading rule

1) Find the optimal double moving average (MA) trading rules for all 30 DJ constituents (stocks) using monthly data.

   Hint: see Assignment (Fall 2018) for more details.

2) Construct the equally weighted (EW) and risk-parity (RP) weighted portfolio using all 30 DJ constituents. Summarize the performances of EW and RP portfolios (trading strategies).

   Hint: For simplicity, assume the correlations among stocks are zero when constructing the risk-parity portfolio.

B. Time Series Momentum

1) Calculate the ex-ante volatility estimate σ_t for all 30 DJ constituents using the following formula:

$$\sigma_t^2 = 261 \sum_{i=0}^{\infty} (1-\delta)\delta^i (r_{t-1-i} - \bar{r}_t)^2, \quad (1)$$

and

$$\sigma_t = \sqrt{\sigma_t^2}, \quad (2)$$

where the weights $\delta^i(1-\delta)$ add up to one, and $\bar{r}_t$ is the exponentially weighted average return computed similarly.

2) Consider the predictive regression that regresses the (excess) return in month t on its return lagged h months, i.e.

$$\frac{r_{s,t}}{\sigma_{s,t-1}} = \alpha + \beta_h \cdot \frac{r_{s,t-h}}{\sigma_{s,t-h}} + \varepsilon_{s,t}, \quad (3)$$

and

$$\frac{r_{s,t}}{\sigma_{s,t-1}} = a + b_h \cdot sign\left(r_{s,t-h}\right) + \xi_{s,t}. \quad (4)$$

where $r_{s,t}$ denotes the s-th stock in the DJ constituents and in the prediction regression, returns are scaled by their ex-ante volatilities $\sigma_{s,t-1}$. Determine the optimal h for both predictive regressions for all 30 DJ constituents.

3) Consider a time series momentum trading strategy by constructing the following portfolios:

$$r_{t,t+1}^{TSMOM} = \frac{1}{30} \sum_{s=1}^{30} sign\left(r_{s,t-h_s:t}\right) \cdot \frac{40\%}{\sigma_{s,t}} r_{s,t:t+1}, \quad (5)$$

where $sign\left(r_{s,t-h_s:t}\right) \cdot \left(40\%/\sigma_{s,t}\right)$ is our position for the s-th constituent at time t and $r_{h_s:t-h_s:t}$ denote the h_s-month lagged returns observed at time t. Summarize the performance of the portfolio.

Hint: For simplicity, assume $h_s = 12$ for all 30 DJ constituents.

C. Dynamic position sizing for technical trading rules

1) Consider a technical indicator F_t, where the technical indicator may be given by

$$F_t = \sum_{h=0}^{m-2} d_i r_{t-j}. \quad (6).$$

Suppose that our position to the trading rule is determined by the strength (or magnitude) of the signal. The h-period holding period return is then given by

$$R_{t:t+h} = \sum_{i=0}^{h-1} F_{t+i-1} \cdot r_{t+i} = \sum_{i=0}^{h-1} \left(\sum_{j=0}^{m-2} d_i r_{t-j+i-1} \right) \cdot r_{t+i}. \quad (7)$$

Calculate the expected h-period holding period return, i.e., $E(R_{t:t+h})$.

Remark: In this question, we assume that our position changes linearly with the strength of the signal. We can generalize it by replacing F_{t+i-1} with $g(F_{t+i-1})$ in Equation (7).

2) Find the optimal double MA trading rule for all 30 DJ constituents that maximize the 12-period holding period return.