**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 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 monthly but calibrate/estimate parameters () at the end of each year.
* **Performance:** Annualized expected return, annualized volatility (standard deviation), and Annualized Sharpe ratio. Annualization is done using the squared root of time. Use Sharpe ratio as example

where assume that annual risk free rate and   is the sample mean of monthly strategy returns and  is the monthly volatility.

**Questions:**

1. **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.

* 1. Construct the equally weighted (EW) and [risk-parity](https://quant.stackexchange.com/questions/3114/how-to-construct-a-risk-parity-portfolio) (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.

1. is defined in Equation (1) (see question B)
2. **Time Series Momentum**
   1. Calculate the ex-ante volatility estimate for all 30 DJ constituents using the following formula:

and

where the weights add up to one, and   is the exponentially weighted average return computed similarly.

**Hint:** Solve using

and

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

where denotes the -th stock in the DJ constituents and in the prediction regression, returns are scaled by their ex-ante volatilities . Determine the optimal for both predictive regressions for all 30 DJ constituents.

**Remark:** For simplicity, students only need to consider Equation (4) in this question and use R-squared to evaluate the predictive regression.

* 1. Consider a time series momentum trading strategy by constructing the following portfolios:

where is our position for the -th constituent at time and denote the -month lagged returns observed at time . Summarize the performance of the portfolio.

**Hint:** For simplicity, assume for all 30 DJ constituents.

1. **Dynamic position sizing for technical trading rules**
   1. Consider a technical indicator , where the technical indicator may be given by

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

Calculate the expected -period holding period return, i.e., .

**Remark**: In this question, we assume that our position changes linearly with the strength of the signal. We can generalize it by replacing with in Equation (7).

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