Algorithmic Trading, COMP0051, 2024/25

Coursework. Cohort 2024/25. This assignment is worth 60% of the overall mark.

All reports will be checked for plagiarism; do not include non-original material (text, images, tables) without clearly stating the source.

Standard and non-standard calculators are permitted

1. **Time Series Prep [30 Points]**

   (a) Download SPTL ETF ([1]) at end-of-day prices for the period of time between 1 Jan 2023 to 31 December 2023. Download the Effective Fed Funds Rate (EFFR Index) [2] as the risk-free rate. Adjust annual risk-free rate to make it a daily rate, i.e., $r_t^f = EFFR(t) \cdot dc$, where dc is a day-count. You can use $dc \approx (1/252)$.

   A unit of SPTL will cost p_t at time t, which we have to finance at the risk-free rate. The daily excess return per unit of SPTL reads,

   $$r_t^e = \frac{\Delta p_t}{p_t} - r_t^f.$$

   (b) Plot the SPTL return time series, the EFFR, and the excess return per unit of SPTL, starting from $t = 0$ corresponding to 1 Jan 2023.

2. **Trading Strategies [45 Points]**

   Definition. In a leveraged strategy, the (leveraged) *book size* is the available capital times the leverage amount. By a leveraged strategy we mean a sequence $\{\theta_t\}_{t=1}^T$ of dollar values of SPTL which can be long or short such that

   $$|\theta_t| \leq V_t^{total} \cdot L$$

   where the initial condition is given by

   $$|\theta_0| \leq V_0 \cdot L$$

   V_0 is the initial capital, and L is the leverage.

   (a) Define two leveraged trading strategies of your own choice for the SPTL with initial capital $V_0 = \$100,000$. For both strategies, set the leverage $L = 10$. Each strategy

[1] https://finance.yahoo.com/quote/SPTL/

[2] https://www.newyorkfed.org/markets/reference-rates/effr

is defined by the values of $\{\theta_t\}_{t=1}^{T}$, where θ_t is the dollar value of SPTL held at time t (i.e., $\theta_t = \text{units}(t) \times p_t$), compatible with the leverage constraints.

(b) Create a total PnL series for the strategies, where we assume that unused capital will be put in a money-market and grow at the same risk-free rate, i.e., the value of your account changes by the trading PnL (ΔV) and the change in the growth of the money-market capital account (ΔV^{cap}).

$$V_{t+1}^{total} - V_t^{total} = \Delta V_t^{total} = \Delta V_t + \Delta V_t^{cap}$$

with

$$\Delta V_t = \big(\frac{\Delta p_t}{p_t} - r_t^f\big)\theta_t$$

and

$$\Delta V_t^{cap} = (V_t^{total} - M_t) r_t^f$$

where $M_t = \frac{|\theta_t|}{L}$ is the total margin used. Plot ΔV_t, ΔV_t^{cap}, and ΔV_t^{total} and plot their cumulated values.

3. **Performance Indicators [25 Points]**

(a) Use the total return for the two strategies, $r_t = \Delta V_t^{total}/V_t^{total}$, to compute the Sharpe Ratio (SR) and the Calmar Ratio (CR) and present the results in a comparative table discussing the statistical significance of the results.

Written report A single written report in pdf (5 pages maximum) structured into the three questions and sub-questions and will need to be submitted to Moodle before the deadline of 26 March 2025.

Coding and Editing Students are allowed to use any programming language and any editing software for the report. For transparency, the code will need to be uploaded as well (preferably as one zip file).

Marking The marking will be based on the following criteria:

- Clarity of presentation and explanations;
- Consistency of language and mathematical notation;

- Justification of the methodology and originality, i.e. the trading strategies;
- Validity and critical interpretation of results.