

Coursework 2. Cohort 2021/22. This assignment is worth 60% of the overall mark.

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

Standard and non-standard calculators are permitted

## Time Series Generation [20 Points]

1. Generate a price time series using the equation

$$\Delta p_t - d = \phi(\Delta p_{t-1} - d) + \varepsilon_t + \theta \varepsilon_{t-1}$$

where  $\Delta p_t = p_t - p_{t-1}$ ,  $t$  ranges 0 to 3000,  $p_0 = p_1 = 1000$ ,  $\phi = 0.5$ ,  $d = 0.02$ ,  $\theta = -0.3$ .

$\varepsilon(t)$  is a sequence of i.i.d Gaussian random variables with zero mean and unit variance. Divide the time series into a training set and a test set, representing 70% and 30% of the data, respectively.

## Trading Strategies [40 Points]

2. Define 3 self-financing long (or flat)-only trading strategies with initial cash  $C_0 = 10000$ .

The self-financing condition for the update of cash and volume at each time step is given by

$$TV(t) = C(t) + p(t)V(t) = C(t+1) + p(t)V(t+1),$$

for all time steps  $t$ , where  $TV(t)$  is the total value of the portfolio,  $C(t)$  is cash -most liquid asset with zero excess return- at time  $t$ , and  $V(t)$  is the volume of the position at time  $t$ .

The long-only condition is given by  $V(t) \geq 0$  for all time steps. No borrowing is also considered,  $C(t) \geq 0$  for all time steps.

The strategies will need to update the values of  $C(t)$  and  $V(t)$  consistently with the self-financing condition. If your strategy has coefficients, only use the training set to choose them.

3. Define the return of a trading strategy  $a$  at time  $t$  as,

$$r_a(t) = \left( \frac{TV_a(t)}{TV_a(t-1)} - 1 \right)$$

## Performance Indicators [20 Points]

4. Compute the Sharpe ratio, the Sortino Ratio and the Maximum Drawdown of your strategies, to evaluate them. If appropriate, for each of them provide two independent measurements: one within the training set and one within the test set.

## Statistical Tests [20 Points]

5. For the hypotheses that the strategies have a non-zero Sharpe ratio, use a statistical test covered in the lectures to control for Family Wise Error Rate (FWER) at a confidence level of 5%. Separately, compute the adjusted Sharpe Ratios for your three strategies using the same FWER adjustment.

Explain why this is a useful thing to do; you can use a simple example to illustrate your answer. Explain the importance of this as you increase the number of strategies.

**Written report** A single written report in pdf (maximum 10 pages) structured into:

- Introduction
- Methodology
- Results
- Discussion
- Bibliography

will need to be submitted to Moodle before the deadline of 04/04/2022.

**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 (you can choose your preferred format).

**Marking** The marking will be based on the following criteria:

- Clarity of presentation and explanations;
- Justification of the methodology;
- Validity of results;
- Consistency of language and mathematical notation;
- Critical interpretation of results.