Computer Exercise

1 Problem description

You are the head of market risk management of a bank. The bank has 100 mln USD available for investing on market tradable assets. The regulator requires that the risk of the invested portfolio is constrained by a capital requirement: with holding the invested portfolio for 100-days, the Value-at-Risk (VaR) at 99.9% level multiplied by a multiplier 3 has to be lower than the capital of the bank. From the bank's balance sheet, the capital level is exogenously given at 30 mln USD. Your Chief Investment Officer (CIO) has decided that the portfolio composition will remain the same as that in the past years. Hence, the only decision issue the bank faces is: what fraction of the available 100 mln can be invested on the risky portfolio? The rest will be invested in a risk-free asset with a risk-free return at zero.

Your Chief Risk Officer (CRO) thus requests a report addressing the following question.
1) To comply with the regulation rule, what is the maximum amount of asset (in mln USD) that can be invested in the risky portfolio?
Suppose the bank invests the maximum amount allowed. The CRO wants to get further insight on the market and systemic risk based on the following questions.
2) With holding the portfolio for 100-days, what is the expected shortfall (ES) once the regulatory VaR is surpassed (in mln USD)?
3) Conditional on the market is experiencing a tail event with probability 0.1%, what is expected loss of the invested portfolio?

2 Data

To analyze the three questions, you have collected the historical data on the performance of the risky portfolio in the last ten years. They consists of 2517 daily returns. Further, you have collected the daily return of the market index in the same period. See attached Excel file. You could assume that the data are i.i.d. over time.

3 Guideline for the report

Writing the report requires a mentality of serving your CRO. Here are some background information of her and the corresponding strategy for writing the report.

1) She is an extremely busy person, thus has no time to read any report longer than five pages. **Please make sure that your report, including all text, tables, graphs, references stays within five pages.** The main text (except footnotes, tables and graphs) is written on a A4 paper with at least a margin 2.5cm on each side, a font size 11 and a 1.5 line spacing.

2) She had the course "market and systemic risk management" 20 years ago. Hence, she has an idea on the basic concepts such as heavy tails, VaR and ES. Nevertheless, she remembers nothing about mathematical details and she would not like to read them either. **Please try to explain all the concepts by economic intuition rather than giving formulas. There should be no formula in your report unless it is unavoidable.** Some hints on how you may proceed without formula: instead of the formula on heavy tails, you may write "As the threshold increases, the probability above such a threshold decays in a power speed governed by a shape parameter α."

3) She has to take your report to the board discussion, thus the report must be formal. **Give justification for each statement you make.** For example, if you use the heavy-tailed approach, you must convince her and other readers that your data is heavy-tailed. This may be done by proper graphs. Furthermore, use references smartly. For example, for the Hill estimator, you may simply refer to Hill (1975) without giving the formula.

An example structure of the potential report (you do not have to follow this):

1) Introduction: Briefly review the decision problem. Give the answers to the three questions.

2) Data: Justify statistical properties of the data (such as heavy tails) which you use for your analysis.

3) Analysis: Describe your estimation and/or calculation procedure towards answering the three questions, which ultimately leads to the answers you presented in the introduction.

4) Reference

4 Hand in the report

The report is due at 23:59pm, 27 June 2021.

Good luck with the report!