Report Instructions - SF2980 Risk Management

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Oct, 2016

Instructions

Objectives

The projects are intended as open ended exercises suitable for deeper investigation of some selected topics. Students will

- practice by applying the theory and methods on real examples
- develop their own statistical software functions in programs such as "R" or "MatLab" to solve the problems
- make qualitative and quantitative statements and conclusions about the risk management problems studied in the projects
- present the problems, relevant theory, results and conclusions in written reports
- present the problems, relevant theory, results and conclusions in oral presentations and organized discussions.

Format

- Students will work on the projects in groups of at most four people.
- The projects will be presented and evaluated in written form by handing in two written reports.
- The projects will be presented orally at two presentation seminars.

Grading

On each report you will be given a score in the range 0-25; the total score for the two reports is at most 50. A combined score of at least **25 pts is needed to pass** the assignments part of the course. Grades will be based on the following criteria.

- **Objectives.** A clear description of the project and its objectives.
- **Mathematical background.** A clear and concise presentation of the relevant mathematical background.
- **Results.** A clear and concise presentation of your solution and results. You may also add your own explorations/extensions that you find relevant.
- **Summary.** A clear and complete summary of your results.

Report Template

To get started with the report there is a report template in LaTeX available for download on the course webpage. Please use the sections outlined in the report template. If you are not able to use LaTeX to typeset your report you may use other software (e.g. Word, Pages, etc.)

KTH FinanceLab

Some parts of the projects will be done with the help of KTH FinanceLab. We will mainly use FinanceLab to incorporate real data into the assignments, but all coding can be done in "R" or "Matlab". You can log in to KTH FinanceLab at

`http://www.math.kth.se/matstat/finance/financelab/index.html`.

If you experience problems using FinanceLab you may get support by Alexander Aurell `aaurell@kth.se`.

Report I

In the first report (Report I), due on **November 18 at 10 a.m.**, you will present your analysis and results on the following two projects. The report must be handed in on **paper** (no emails), be **typeset on a computer** (no handwriting), and be **stapled** in the top left corner.

Total Returns

This is similar but not identical to Project 7 pp. 228-229 in the book.

Consider a five year investment in a portfolio of dividend paying stocks. The yearly portfolio returns S_{t+1}/S_t and dividends D_{t+1} paid at time $t+1$ are modeled as

$$\frac{S_{t+1}}{S_t} = e^{\mu+\sigma_S X_{t+1}} \quad \text{and} \quad \frac{D_{t+1}}{S_t} = \delta e^{-\sigma_D^2/2+\sigma_D Y_{t+1}},$$

where $X_1, \ldots, X_5, Y_1, \ldots, Y_5$ are independent and standard Normally distributed.

(a) Consider the value in five years of investing one million dollars in the portfolio of stocks and reinvesting the dividends in the portfolio of stocks. Determine the function f such that the value V_5 in five years of the investment strategy can be expressed as $V_5 = f(X_1, \ldots, X_5, Y_1, \ldots, Y_5, \mu, \sigma_S, \delta, \sigma_D)$.

(b) Use the following parameter values, $\sigma_S = 0.2, \delta = 0.01$ and $\sigma_D = 0.05$. Simulate a sample of suitable size from the distribution of $(X_1, \ldots, X_5, Y_1, \ldots, Y_5)$ and use this sample to determine the empirical distribution of V_5 for a range of values of the parameter μ. Estimate the smallest value of μ for which the probability that V_5 exceeds the value in five years of an investment of one million dollars in a five-year zero-coupon bond with zero rate 5% per year is 0.75. Motivate your choice of sample size.

(c) [This part of the project is done in FinanceLab. Separate instructions for FinanceLab will be posted on the course webpage]. Use the FinanceLab workspace `Project7.qlw` to select a portfolio of stocks and estimate the parameters σ_S, δ, and σ_D. You must not estimate μ. Open the workspace `Project7.qlw` in FinanceLab. In the left panel, select the stocks that you want to include in your portfolio and select the relative portfolio weights (positive weights that sum up to 1). Select the length of the historical data used to estimate the parameters. Run the program to compute the estimates of the parameters σ_S, δ, and σ_D. Repeat assignment (b) with the estimated parameter values.

Pension savings

Assignments (a) and (b) are almost identical to Project 8 p. 229 in the book, assignment (c) is new.

Consider a yearly investment of $1,000$ dollars in long positions in a portfolio of stocks and a risk-free one-year zero coupon bond over a 30-year period. The yearly returns on the portfolio of stocks year k is modeled as $R_k = e^{\mu + \sigma Z_k}$, where Z_k is standard Normally distributed. The yearly returns are assumed to be independent. The yearly return on the risk-free bond is assumed to be $e^{0.01}$. Each year, after the investment of $1,000$ dollars has been added, the portfolio is rebalanced such that the fraction of the total portfolio value invested in the stocks at the beginning of year k is $p(1 - c(k-1)/30)$, where $p, c \in [0, 1]$.

(a) Determine a function f such that the value of the pension savings in 30 years can be expressed as $V_{30} = f(\mu, \sigma, p, c, Z_1, \ldots, Z_{30})$.

Simulate a sample of suitable size n from the distribution of $(Z_1, \ldots, Z_{30})$ and use this sample to determine the empirical distribution F_n of V_{30} for a range of values of the parameters μ, σ, p, c.

(b) Set $\mu = 0.04$ and $\sigma = 0.2$ and investigate the effects on the empirical distribution $F_n(p, c)$ of V_{30} of varying p and c. Suggest a suitable criterion for selecting the optimal empirical distribution $F_n(p, c)$ and determine the optimizer (p, c).

(c) In assignments (a) and (b) you have used a log-normal distribution for the annual returns of the portfolio of stocks. In this exercise you should replace the log-normal distri-

bution by an empirical distribution based on monthly historical data and use the historical simulation approach. You may assume that monthly returns are independent, or use historical simulation based on, say, annual returns with overlapping segments of monthly returns. You must clearly specify your historical simulation approach. You may select a portfolio consisting of one or several funds from the Swedish Pension System (PPM). You can find historical data from the PPM system at:

- http://www.pensionsmyndigheten.se/HistoriskaFondkurser.html
- http://www.pensionsmyndigheten.se/AldreHistoriskaFondkurser.html

You may also select your own portfolio of stocks or other funds. You may find historical data at

- http://www.nasdaqomxnordic.com/shares
- http://www.nasdaqomxnordic.com/Funds

You can also find historical data on a large number of financial products at KTH Finance Lab:

- http://www.math.kth.se/matstat/finance/financelab/index.html