LINKÖPINGS UNIVERSITET
Produktionsekonomi, IEI
TPPE32 Finansiell riskhantering
VT 2018

Assignment 3

MARKET RISK MEASURES AND BACK TESTING

AIM

The aim of this assignment is to provide knowledge about market risk measures (specifically Value-at-Risk and Expected Shortfall), risk factor mapping, and to learn how Extreme Value Theory can be applied in risk management.

ORGANIZATION

The assignment is carried out in groups of two students. Financial time series data is collected in the file *timeSeries.xlsx*. Recommended softwares are Excel and MATLAB.

A written report (pdf) containing results and analysis should be uploaded on Lisam. Submit data files (complete scripts) necessary to obtain your results. Each group will be assigned as either presenters or opponents before the seminar.

Grade: pass/fail

TASKS

The file *timeSeries.xlsx* contains data to the problems below. For problem 1 consider a portfolio with equal weights in all assets (implicitly assuming costless portfolio rebalancing). Base your time-series of VaR estimates in problem 1 b-d on a fixed portfolio value, $V_{p,t} = V_p = 10$ MSEK.

1. Value-at-Risk and Expected Shortfall

   a) Using the variance-covariance method (i.e. assuming a multivariate normal distribution for the assets in the portfolio), what is Value-at-Risk over one week at the 95, 97.5 and the 99 % confidence level on the last date in your time series?

   b) Assuming that the **portfolio returns** are normally distributed, determine a time series of $\text{VaR}_{0.95,1w}$ and $\text{VaR}_{0.99,1w}$ estimates (starting ten years after the first data point, i.e. approximately 500 data points) using EWMA, based on the portfolio returns, with $\lambda = 0.94$,

   $$\text{VaR}_{t,c,1w} = N^{-1}(c)\sigma_t V_{p,t}, \ \sigma_t^2 = 0.94\sigma_{t-1}^2 + (1-0.94)r_{t-1}^2,$$

   where the volatility is expressed on a weekly basis.

   c) Determine time series of $\text{VaR}_{0.95,1w}$ and $\text{VaR}_{0.99,1w}$ using historical simulation (synchronized with b). Also determine Expected Shortfall, $\text{RS}_{0.95,1w}$, for the last date in your time series, based on historical simulation.

   d) Calculate time series of $\text{VaR}_{0.95,1w}$ and $\text{VaR}_{0.99,1w}$ using historical simulation and the volatility updating scheme suggested by Hull and White (1998). Apply the method on your time series of portfolio returns and estimate volatility using EWMA with $\lambda = 0.94$.

   e) Perform the two-tailed failure rate test corresponding to the one-tailed test in the lecture material, (i.e. under the null hypothesis $p = 1 - c$, and alternative $p \neq 1 - c$) for the VaR estimates in problems 1 b-d.

   f) Test for serial dependence in VaR exceedences using Christoffersen (1998) for problem 1 b-d.

   Based on your results, which method seems to work best for the time period studied? Analyze your results!

2. RiskMetrics (Note: there is a hint on the next page.)

   Determine $\text{VaR}_{0.99,1d}$ for the Swedish Government bond SE1054 (see 0#SETSY=), at the last date in the time series, using the RiskMetrics cash flow mapping procedure. Use the covariance matrix for the vertices 1m, 3m, 6m, 1y, 2y, 3y, 4y and 5y in the sheet Problem 2. Use Eikon Excel (formula builder) to find coupon dates and cash flows.

3. Risk measurement using Taylor series expansion

   a) Determine $\text{VaR}_{0.99,1d}$ for the portfolio of options on S&P 500 (chain 0#SPX*.U) in the sheet Problem 3 using the methodology in the lecture material. Consider the linearized case with the three risk factors, S&P 500, σ_{VIX}, and r^f, under the assumption that the risk factors are multivariate normally distributed. **Hint:** Use Black-Scholes to estimate the greeks (Δ,ν,ρ) and the value of the options.

   b) Determine the marginal contribution to $\text{VaR}_{0.99,1d}$ from each asset and risk factor. **Hint:** See the lecture material.

4. Extreme Value Theory

   Use Extreme Value Theory to determine $\text{VaR}_{0.99,1w}$ for the portfolio in problem 1 on the last date in the time series (use all available data up to that date). Estimate parameters using Maximum Likelihood Estimation. Compare the VaR estimates using EVT with the normal-VaR and the historical simulation in 1 b-d. **Hint:** See the lecture material.

REFERENCES:

Christoffersen, P. F. (1998). Evaluating interval forecasts. *International Economic Review 39*, 841–862.

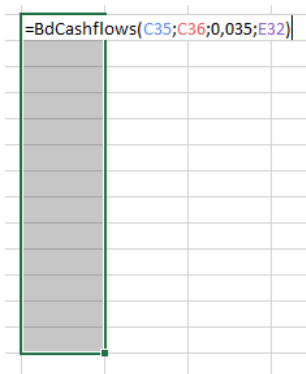
Hull, J. C. and A. White (1998). Incorporating volatility updating into the historical simulation method for value at risk. *Journal of Risk 1*, 5–19.

RiskMetrics (1996). Riskmetrics - technical document. Technical report, J.P.Morgan/Reuters.

Bondstructure

Choose Build Formula in Eikon Excel, enter the bonds RIC, choose Real-Time & Fundamental, search for ”bond structure” and choose one[1] of the ”Bond Structure” and a text string will be received, e.g. `ACC:E0 CCM:BBE0 CFADJ:NO CLDR:SWE_FI DATED:01JUN2010 ...` This text string contains information about the bond. Then use the function `BdCashflows` use [shift]+[F3] in Excel to find help for the function. The function will return all the coupon dates later then the ”CalcDate” (first argument of BdCashflows)[2].

Two Excel reminders. Dates are stored as integers in Excel and that you might need to change the Number Format. The bond you are asked to use have more than one coupon left more than one date should be return. First select e.g. 13 rows in a column and write the function call in the top cell and then evaluate the function be [ctrl]+[shift]+[enter].[3]



Figur 1: Example of the use of `BdCashflows`. Cell C35 contains the calculation day, C36 contains the bonds maturity day, 0,035 is the coupon rate and E32 is the contains the bondstructure.

[1]The reason that there are two identical is because the item can be found in two different folders in Thomson Reuters.

[2]Note that the CalcDate can be past date!

[3]If only a single cell is selected the function will only returnd the upcoming coupon.