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Practice Exam Quantitative Financial Risk Management QF 4.5

1. You have 2 mln Euros invested into AEX and DJ indices in equal proportion. Using this as the collateral, you borrow another 2 mln Euros against the current 1-year German government bond interest rate. You want to exploit the ongoing European debt crisis: you saw that (because of obvious reasons) Portugese bonds pay in excess of 6% at the moment, so you invest your borrowed 2 mln Euros into 1-year Portugese government bonds (assume no coupons).

   a) Identity your risk factors. Write down the loss operator, which maps the risk factor changes into losses.

   b) Calculate a first-order approximation of the loss operator (i.e. write down the *linearized loss operator*), and express the portfolio loss as a linear function of the risk factor changes.

   c) Calculate the portfolio weights in b) if AEX today was at 310, DJ at 10065, Eurodollar exchange rate is at 1.25, German bond yield at 0.5% and Portugese bond yield at 6%.

   d) Discuss how your investment strategy can go completely pear-shaped, i.e., explain possible scenarios leading to excessive loss.

2. A 1-mln Euros portfolio consists of stock index, commodity index and a bond, in equal proportions (1/3). The yearly average return is 12% for the stock index, 20% for commodity index and 5% for a bond. The following table gives an estimated historical Variance-Covariance matrix of the returns (all numbers expressed as yearly):

$$\begin{pmatrix} 0.1 & 0.04 & 0.03 \\ 0.04 & 0.2 & -0.04 \\ 0.03 & -0.04 & 0.6 \end{pmatrix}$$

   a) Compute the yearly and daily volatility of your portfolio and the average yearly portfolio return.

   b) Give the estimates of Value-at-Risk(0.95, 1 day) and VaR(0.99, 1 day), assuming normality of the returns and also assuming the returns have Student-t distribution with 4 degrees of freedom (the corresponding quantilies are 1.645 and 2.326 for Normal (0,1) and 2.132 and 3.747 for Student-t(4)).

   c) Under the assumption of Normal distribution, compute also the Expected Shortfalls corresponding to VaRs in b) and compute VaR(0.95, 5 days), VaR(0.95, 10 days) and VaR(0.95, 1 year).

3. The most recent volatility estimate for an index is 43% p/a. The today's return on the index is -0.5%. Using EWMA with the usual parameter 0.94, how does this latest return updates your volatility estimate? *Hint: do not forget to express everything either in daily vols or in yearly vols, assuming 251 trading days per year!*

4. **The last question: you can choose to answer ONE of the following three questions**:

   • What is conditional risk management? What is the main distinction of such risk management approach from unconditional risk management? What is EWMA method for estimating the volatilities and correlations? Describe it. What are ARCH and GARCH models? Argue whether the conditional risk management should be preferred over the unconditional risk management and why.

   • Give definition of a copula. Formulate Sklar's theorem. Describe the steps necessary for fitting a copula to the data. What are the main advantages of using copulas for describing dependence? Mention at least three known copulas and their characteristic features.

   • Give the definition of operational risk. Give examples of operational losses. Describe three approaches allowed by Basel II/III for operational risk measurement. What are the main challenges in modeling operational risk losses and what are possible quantitative solutions?