

Assignment 4.

NB: The code for the assignment has to be developed in Python, using the IDE PyCharm by JetBrains.

0. Exercise. Variance-covariance method for VaR & ES in linear portfolio: a simple example of data mining

At the end of the 20th of February 2020 for an equally weighted equity portfolio with *Adidas*, *Allianz*, *Munich Re* and *L'Oréal*. Compute daily VaR and ES with a 5y estimation using the dataset provided via t-student (nu=4) parametric approach. The notional of the portfolio is €15 MIO and the significance level is $\alpha=0.99\%$.

[Hint: Pay attention that the trading days of the different stocks are not the same. Add previous day value in case of missing share price.]

1. Case study: Historical (HS & WHS) Simulation, Bootstrap and PCA for VaR & ES in a linear portfolio

At the end of the 20th of March 2019 an asset manager due to different rules on three company units (portfolios) has to compute risk measures according to the following rules ($\alpha=0.95\%$):

- A. Portfolio 1 with: *Total* (25K shares), *AXA* (20K Shares), *Sanofi* (20K Shares), *Volkswagen* (10K Shares). Compute daily VaR and ES with a 5y estimation using the dataset provided via a Historical Simulation approach and a Bootstrap method with 200 simulations.
- B. Portfolio 2 with equally weighted equity: *Adidas*, *Airbus*, *BBVA*, *BMW* and *Deutsche Telekom*. Compute daily VaR and ES with a 5y estimation using the dataset provided via a Weighted Historical Simulation approach with $\lambda = 0.95$.
- C. Portfolio 3. An equally weighted equity portfolio with shares of the first 18 companies in the provided csv file “_indexes.csv”. Compute 10 days VaR and ES with a 5y estimation using the dataset provided via a Gaussian parametric PCA approach using the first n principal components, with the parameter $n = 1, \dots, 5$. Comment the results.

For the three portfolios check results' order of magnitude via a Plausibility check.

2. Exercise: Full Monte-Carlo and Delta normal VaR

At the end of the 16th of January 2017 consider a portfolio formed by stocks of *BMW* for 1,186,680 Euro and short the same number of call options with expiry on the 18th of April 2017, with strike 25 Euro and volatility equal to 15.4% (dividend yield of 3.1% and fixed interest rate of 0.5% for the period). Compute a 10dd/95% VaR via a Full Monte-Carlo and a Delta normal approaches (only delta term). Use a 2y Weighted Historical Simulation approach for the underlying with $\lambda = 0.95$.

Can you improve the Delta normal VaR? How?

Why the Full Monte-Carlo can be numerical intensive for an exotic derivative that cannot be priced via a closed formula?

3. Case Study: Pricing in presence of counterparty risk

On the 15th of January 2008 at 10:45 C.E.T. bank XX buys from ISP a 7y Cliquet option for a 30 MIO € notional. Option yearly payoff (annual bond) at payment date is

$$[L * S(t_i) - S(t_{i-1})]^+.$$

The option is on an equity stock (with no dividends) and constant volatility 20%. L is a participation coefficient with value 0.99.

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What should be the correct price and does a closed formula for this product exists? At what price ISP would try to sell it?

[Hint: consider the dynamics of the underlying not of the corresponding forward]

Function signatures

[ES, Var] = AnalyticalNormalMeasures(alpha, weights, portfolioValue, riskMeasureTimeIntervalInDay, returns)

[ES, VaR] = HSMeasurements(returns, alpha, weights, portfolioValue, riskMeasureTimeIntervalInDay)

samples = bootstrapStatistical(numberOfSamplesToBootstrap, returns)

[ES, VaR] = WHSMeasurements(returns, alpha, lambda, weights, portfolioValue, riskMeasureTimeIntervalInDay)

[ES, VaR] = PrincCompAnalysis(yearlyCovariance, yearlyMeanReturns, weights, H, alpha, numberOfPrincipalComponents, portfolioValue)

VaR = plausibilityCheck(returns, portfolioWeights, alpha, portfolioValue, riskMeasureTimeIntervalInDay)

VaR = FullMonteCarloVaR(logReturns, numberOfShares, numberOfPuts, stockPrice, strike, rate, dividend, volatility, timeToMaturityInYears, riskMeasureTimeIntervalInYears, alpha, NumberOfDaysPerYears)

VaR = DeltaNormalVaR(logReturns, numberOfShares, numberOfPuts, stockPrice, strike, rate, dividend, volatility, timeToMaturityInYears, riskMeasureTimeIntervalInYears, alpha, NumberOfDaysPerYears)

Delivery date: Tuesday 26th of March at 14:00.

Delivery date for correctors: Friday 29th of April at 23:00.

Corrector groups: **1,4,11,16**.

Useful Python packages:

numpy	for vector and matrix management
pandas	for working with dataframes
scipy (and scipy.stats)	for PDFs, CDFs and quantile functions
datetime	for dates management