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 20^{th} 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 α=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 20^{th} 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 (α=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,..,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 16^{th} of January 2017 consider a portfolio formed by stocks of *BMW* for 1,186,680 Euro and short the same <u>number</u> of call options with expiry on the 18^{th} 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 <u>exotic</u> derivative that cannot be priced via a closed formula?

3. Case Study: **Pricing in presence of counterparty risk**
On the 15^{th} of ~~January~~ 2008 at 10:45 C.E.T. bank XX buys form 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

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