**Project 01**

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##Problem 1:

1. A simple question using functions read\_csv and calculate returns with .shift(1).
2. Same using np.log function.

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Arithmetic Returns - Last 5 Rows:

SPY AAPL EQIX

Date

2024-12-27 -0.011492 -0.014678 -0.006966

2024-12-30 -0.012377 -0.014699 -0.008064

2024-12-31 -0.004603 -0.008493 0.006512

2025-01-02 -0.003422 -0.027671 0.000497

2025-01-03 0.011538 -0.003445 0.015745

Arithmetic Returns - Total Standard Deviation:

SPY 0.008077

AAPL 0.013483

EQIX 0.015361

dtype: float64

Log Returns - Last 5 Rows:

SPY AAPL EQIX

Date

2024-12-27 -0.011515 -0.014675 -0.006867

2024-12-30 -0.012410 -0.014696 -0.007972

2024-12-31 -0.004577 -0.008427 0.006602

2025-01-02 -0.003392 -0.027930 0.000613

2025-01-03 0.011494 -0.003356 0.015725

Log Returns - Total Standard Deviation:

SPY 0.008078

AAPL 0.013446

EQIX 0.015270

dtype: float64

##Problem 2:

1. Simple calculations where *shares.T @ portfolio.*
2. As below.
3. Exponentially weighted covariance sourced from Project01 (my own code). After get the EWM using the previous function, simply use the new EWM matrix as the origin of stock variance and portfolio sigma.

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SPY AAPL EQIX

SPY 0.000072 0.000054 0.000052

AAPL 0.000054 0.000140 0.000038

EQIX 0.000052 0.000038 0.000153

VaR $ Expected Shortfall $

Portfolio 3856.321669 4835.982950

SPY 827.848763 1038.155747

AAPL 946.076369 1186.417935

EQIX 2933.512216 3678.742668

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1. Given a vector of SPY AAPL and EQIX returns, steps are as follows:
2. Fit the stocks each into T-distribution
3. Map the vector through the T-distribution CDF to (0,1)
4. Map the (0,1) using the normal quantile function
5. Using spearman rank correlation to get the correlation matrix
6. Using the correlation matrix to simulate.

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VaR 5% $ Expected Shortfall 5% $

Portfolio 4370.396952 6015.125106

SPY 776.069970 1029.625609

AAPL 1060.162802 1508.531772

EQIX 3394.449844 4774.627478

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1. To simply take the historic data as an simulated result and get the lowest 5% percent from that result. Yet I was trying to make like 200 or 400 draws from the 500+ data as taught, but I don’t know whether it is “using the full history”, so answers may be slightly different.

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VaR 5% $ Expected Shortfall 5% $

Portfolio 4575.034060 6059.387076

SPY 872.403863 1080.104204

AAPL 1067.114956 1437.785272

EQIX 3635.077091 4714.893996

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1. Method 1, EWM: It generates the least loss, maybe because it assumes a more ideal normal distribution condition. It calculates the covariance matrix using the EWM method, which is more sensitive to the recent data.

Method 2, Copulas: It generates a result similar to historical simulation.

Method 3, Historic Simulation: It simply uses history data without any modeling & parametres to estimate the var and risk.

##Problem 3

1. An easy problem using Black Scholes Merton. First to define the call-price function, then use the brentq function in scipy.optimization to approach the answer.
2. Still implement the formulas. And compare between the results from a vega \* volatility\_change and the actual calculation using BSM.

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Implied volatility: 0.3351

Delta: 0.6659

Vega: 5.6407

Theta: -5.5446

Estimated price change: 0.0564

Actual price change: 0.0565

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1. Of course it would hold. BSM naturally conform to Put-Call Parity.

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Put-Call Parity Holds! (Diff: 0.000000)

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1. Questions towards this problem: why implied volatility is hugely different from assumed annual volatility.
2. I can’t find exact formula on course slides. I scenario one case where there is only one underlying price: the stock price that could affect 3 assets. As for the theta decay, I simple add the theta of call option and put option as the portfolio theta, and multiply it by holding\_days/trading\_days.

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For Delta Normal VaR and ES

VaR: 4.4441

ES: 5.4104

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1. I simulated a (2000, 20) array of (0, 20%/) normally-distributed data as the daily return. And then I calculate the portfolio value through the 20-day time, and conduct a 5% lowest among all these data to get the VaR and ES.

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For Historical Simulation VaR and ES

VaR: 2.6637

ES: 3.2563

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1. Comparison: Since there are time\_laps in this question, so I think an appropriate method is to see the portfolio holding for a specific period. While using delta normal would arrive at a linear result, the Monte Carlo Simulation would arrive at an irregular curve that is due to random sampling.

For these two methods, I think the simulation is more acceptable because it is a dynamic way to modeling the portfolio value.

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图表, 折线图

AI 生成的内容可能不正确。

Codes are in relative ipynb files. Thanks for your reading.

Have a gooooood day !