

Instructions:

Be verbose. Explain clearly your reasoning, methods, and results in your written work.

No code is necessary, but including it in your answer could result in partial credit.

Written answers are worth 10 points per question. 10 questions total – 100 possible points.

2 extra credit problems at the end are worth 10 points each.

Total available points on this exam is 120.

1. Answers should be formatted as a PDF.
2. Restate the question along with the question number before each answer
3. When finished, email your PDF directly to me.

All work needs to be in my inbox by 8pm on 12/17.

Data for problems can be found in CSV files with this document in the class repository.

You may use your notes and the internet. You may not work with other students – all work must be your own. You may not copy an answer directly from an internet source. Any reference to a source outside the notes must be attributed.

All students will be held to the Duke Community Standard

Duke's Community Standard:

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

1. I will not lie, cheat, or steal in my academic endeavors,
2. I will conduct myself honorably in all my endeavors; and
3. I will act if the Standard is compromised.

1. Discuss the difference between Market, Credit, and Liquidity risks?
2. Assume, Risk Free = 4%, Implied Volatility=20%, Stock Price = 100, Strike Price=\$90, No dividends are paid.
 - a. What are the value and greeks (Delta, Gamma, Vega, and Theta) of a short put with 30 days (365 total yearly days) until maturity?
 - b. After 5 days, assuming the price and implied volatility has not changed, what are the greeks for the same short put position?
3. Use data in question3.csv. This is a simulation of prices 5 days forward for the underlying from Question 2.
 - a. Graph the dollar Profit and Loss from the short put position after these 5 days.
 - b. What is VaR and ES?
 - c. Discuss the risk versus return for this position.

4. Assume you own 3 stocks, GE, IBM, AMZN. Describe how you would attribute each stock's contribution to ex-Ante risk.

5. Use data in question5.csv.
 - a. Plot the Autocorrelation and Partial Autocorrelation Functions.
 - b. Is this data a Moving Average Process, Autoregressive Process, or neither. Why?
 - c. If it is a MA or AR process, what is the order?

6. Use data in question6.csv. You own 100 shares of AAPL and 100 shares of AMZN.

You assume a structural model:

$$AAPL = \alpha_1 + \beta_1 SPY + \epsilon_1$$

$$AMZN = \alpha_2 + \beta_2 SPY + \epsilon_2$$

You assume the stock returns and SPY returns are normally distributed. ϵ_1 & ϵ_2 are iid and normally distributed (but not necessarily independent from each other).

Using this model, calculate the VaR of your portfolio.

7. Assume the have the same three variables and structural model as in Question #6. However, now we assume that ϵ_1 & ϵ_2 are iid and distributed by a generalized Student T distribution.

Describe how you would calculate VaR.

8. Compare and contrast Standard Deviation, Value at Risk, and Expected Shortfall as competing risk measures. Discuss different assumptions such as underlying distributions as well as applications affect where one might be preferred over another.
9. Given 3 Assets, A, B, and C. The risk free rate is 4%. The correlation matrix is:

```
3x3 Matrix{Float64}:  
 1.0  0.7  0.4  
 0.7  1.0  0.6  
 0.4  0.6  1.0
```

Volatilities are

```
3-element Vector{Float64}:  
 0.1  
 0.2  
 0.3
```

Expected Returns are

```
3-element Vector{Float64}:  
 0.05  
 0.07  
 0.09
```

What is the maximum sharpe ratio portfolio with no constraints on negative weights?

10. Given the covariance structure in #9,
- What are the risk parity portfolio weights?
 - Discuss the differences between the portfolios found in #9 and #10.

Extra Credit. Each of these questions are worth an additional 10 points. They are completely optional.

EC1. The file ec1_history.csv contains monthly returns for 3 stocks (S1, S2, and S3) and returns for 2 factors (F1 and F2). The risk free rate is 0.3% per month. Factors returns are in excess of the risk free rate however stock returns are not.

- Calculate the factor Betas for each Stock.
- The file ec1_fwd.csv contains a series of returns for both stocks and factors. Assume the Alpha from the fitting above is 0. Assume you start the period holding with the stock weights as [0.3, 0.45, 0.25]. Attribute the realized excess return and standard deviation of the portfolio over the series to each factor. Report the residual as Portfolio Alpha.

EC2. Using the data in ec2.csv.

- a. $X \sim N(\mu, \sigma)$
- b. $Y_i = \alpha_i + \beta_i X + \epsilon_i \text{ for } i \in [1, 2]$
- c. $\epsilon_i \sim T(0, \sigma_i, \nu_i) \text{ for } i \in [1, 2]$
- d. Initial price of Y1 = \$10.
- e. Initial price of Y2 = \$50.
- f. You hold a portfolio of 100 shares of both Y1 and Y2

What is the VaR and ES of the portfolio, given the information above, expressed as a \$ profit and loss?