Final Project
STA 4261/5261
Fall, 2024

1 Project Instructions

The project requires you to synthesize all the material from the course. This is not a regular homework assignment, and it should be treated accordingly. The goal is for you to solidify your understanding of the financial statistics methods that you have learned in this course. You will present your findings in a written report, explaining your methodology in simple terms. There is no need to explain the terminology in detail, and you should not use formulas or copying output directly from R. The final report should be clear, concise, and readable.

The maximum allowed length for the report is five 8x11 sheets of paper (both sides). All figures and tables should be relevant, readable, and well-labeled. Figures can be placed in an appendix (which is not included in the 5-sheet limit). Only include relevant plots.

1.1 Data Requirements:

Assets: You are required to analyze 8 to 12 assets and obtain at least 5 years of monthly returns.
Risk-Free Rate: Risk-free rates can be found at this link under "Treasury bills (secondary market)" (choose from 3-month, weekly, monthly, or annual rates).

Submission Deadline: Your report is due Tuesday, December 17, at 10 am. Additionally, you must email me your data and R programs by the same day.

2 Project Structure:

Your project should include at least the following sections:

2.1 Executive Summary:

A brief summary of your main results in bullet points.

2.2 Descriptive Statistics:

Report sample statistics for each asset (mean, standard deviation, skewness, kurtosis, beta). Include an equity curve for each asset superposed with that of the SP 500 (showing the growth of $1 invested in each asset over the period). Perform a stationarity test and discuss whether returns appear to be normally distributed. Check for outliers in the data and fit different distributions to assess which one fits best. Compute the Sharpe ratio for each asset

and determine which asset has the highest Sharpe ratio. Convert monthly sample means into annual estimates by multiplying by 12, and convert monthly standard deviations into annual estimates by multiplying by the square root of 12. Present results in a table (example below). Example Table:

Asset	Mean Return	Std Dev	Sharpe Ratio	VaR (0.05)	ES (0.05)	Distribution
XYZ	8%	15%	1.5	13,500	17,550	t_5

2.3 Portfolio Theory:

Construct the minimum variance portfolio (MVP) and estimate its mean return, standard deviation, value-at-risk (VaR), and expected shortfall (ES). Comment on the portfolio's weights and annualized return/risk. With \$100,000 to invest, calculate the 5% VaR for the MVP over a one-month horizon. Compare this VaR with individual assets' VaR. Repeat the analysis for a portfolio where short sales are allowed, and calculate the expected return and risk. Use Markowitz's approach to compute the efficient frontier with and without short sales. Compare the Sharpe ratios of each asset with that of the tangency portfolio. Do al this with and without short sales allowed. Show the weights and statistics of each portfolio in tables.

2.4 Asset Allocation:

Achieve a target expected return of 6% per year (0.5% per month, you can use different target expected return) using only risky assets, with no short sales. Determine the efficient portfolio to meet this target return and report the amount invested in each asset. Compute the monthly risk, VaR (5%), and ES for a \$100,000 investment. Now, achieve the same target return using a combination of T-Bills and the tangency portfolio (without short sales). Report the amount invested in each asset and the risk-free asset. Compare the VaR for this portfolio with the VaR computed from the allocation of risky assets.

2.5 Principal Component Analysis (PCA):

Compute the correlation matrix of the asset returns. Identify which assets are most and least correlated, and discuss the implications for diversification. Perform PCA and interpret the results. Run factor analysis, report the number of factors, and interpret the factor loadings.

2.6 Risk Management:

For each asset, estimate the 5% VaR and ES on a \$100,000 investment over a one-month horizon, using both normal and nonparametric methods. Identify which assets have the highest and lowest VaR and ES at a one-month horizon. Do the same for all portfolios and use bootstrapping to compute standard errors and 95% confidence intervals for VaR and ES.

2.7 Copulas:

Use copulas to model the joint distribution of the returns. Determine which copula fits the data best and discuss the implications.

2.8 Conclusion:

Provide a brief conclusion summarizing your findings and insights.

2.9 Formatting Guidelines:

Keep your report clear and concise. Avoid including unnecessary technical details—focus on the interpretation and application of the methods you used. Ensure that tables and figures are properly labeled and relevant to your analysis. Good luck with your project, and please let me know if you have any questions or need further clarification.