

Some Suggestions for the Project
STAT 4261/5261
Professor Hammou Elbarmi
Department of Statistics

The project requires you to synthesize all the material from the course. This is not a regular Homework and it should be treated differently. The goal here 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. You should explain what you did using simple words. You do not need to explain the terminology in details. **No formulas and no cut and paste from R.** The final report should be clear and readable. The maximum number of pages allowed for the report is five 8x11 sheets of paper (both sides). All figures and tables that are included should be readable, relevant and well labeled. Figures can be relegated to an Appendix (not part of the 5 sheets). Make sure to only include relevant plots. What follows are some suggestions for your final project. You need to find your own data and a good source for it is [yahooofinance.com](http://www.yahooofinance.com). You will need to use **exactly 15** assets and you should look for at least 5 years of monthly returns from 2015 to 2020. The risk free rates can be found at this link <http://www.federalreserve.gov/releases/h15/data.htm> under Treasury bills (secondary market) (3months, weekly, monthly or annually). You are required to hand in your report no later than **Monday, May 5th at 1pm**. You are required to email me your data and your R programs by the same day. Your project should consist of at least the following items:

1. **An executive summary, in which you give a brief summary of the main results using bullet points**
2. **Descriptive Statistics**
3. **Sections that summarize the results of your statistical analysis by topic (see below)**
4. **A conclusion**

1 Summary

This section should be a brief summary of your main results using bullet points

2 Descriptive Statistics

In this section you report sample statistics (Means, standard deviations, Skewness Coefficients, Kurtosis Coefficients and beta of each asset) and comment of your results. You should also provide an equity curve for each asset (that is, a curve that shows the growth of a \$1 in each of the asset over the time period you chose) and comment of your results. You

should do the same for S&P 500 and compare it with the assets. Run a test for stationarity. Do the returns look normally distributed ? Are there any outliers in the data? Fit different distributions to your data, which ones fits better? Compute Sharpe's slope for each asset. Which asset has the highest slope? Make sure to convert the monthly sample means into annual estimates by multiplying by 12 and convert the monthly sample SDs into annual estimates by multiplying by the square root of 12. Comment on the values of these annual numbers. Results should be displayed in the table like

asset.	mean return	stand. dev.	sharp ratio.	$\text{VaR}_{0.05}, S_0 = 100000$	$\text{ES}_{0.05}$	β	distribution
XYZ.	8%	15%	1.5	13500	17550	0.90	t_5

3 Portfolio Theory:

In this part of the project, you construct some of the portfolios that we covered in class. Compute the minimum variance portfolio (MVP) and estimate its mean return, its standard deviation, its value at risk and expected shortfall. Comment on the weights of this portfolio and annualize the monthly mean and risk by multiplying the mean and the risk by 12. Comment on these values relative to those of each asset. Assume that you have \$100,000 to invest. For the MVP, determine the 5% value-at-risk of the \$100,000 investment over a one month investment horizon. Compare this value to the VaR values for the individual assets. Repeat this with the added restriction that short-sales are allowed, and calculate the expected return and risk of this portfolio. Using the estimated means, variances and covariances computed earlier, compute the efficient portfolio frontier, with and without short sales allowed, for the risky assets using the Markowitz approach Compare the Sharpe ratios of each asset with that of the tangency portfolio. Compute the tangency portfolio when short-sales are not allowed and compute its expected return and standard deviation. Obtain the Sharpe ratios and comment on your results.

Show the weights and the statistics of each portfolio in tables.

4 Asset Allocation:

Suppose you wanted to achieve a target expected return of 6% per year (which corresponds to an expected return of 0.5% per month) using only the risky assets and no short sales allowed, what is the efficient portfolio that achieves this target return? How much is invested in each of the assets in this efficient portfolio? Compute the monthly risk on this efficient portfolio, as well as the monthly 5% value-at-risk and expected shortfall based on an initial \$100,000 investment. Now suppose you wanted to achieve a target expected return of 6% per year (which corresponds to an expected return of 0.5% per month) using a combination of T-Bills and the tangency portfolio (that does not allow for short sales). In this allocation, how much is invested in each of the assets and how much is invested in the risk free asset? Compute the monthly risk on this efficient portfolio, as well as the monthly and 5% value-at-risk and expected shortfall based on an initial \$100,000 investment. Compare this with

the VaR computed from the allocation of risky assets without short sales.

5 Principal Component Analysis:

Compute the sample correlation matrix of the returns on your assets. Which assets are most highly correlated? Which are least correlated? Based on the estimated correlation values do you think diversification will reduce risk with these assets? Run the PCA analysis and comment on your results. Run factor analysis and report the number and the loadings of each factors. Do they have any meaningful interpretation?

6 Risk Management:

Assume that you have \$100,000 to invest. For each asset, estimate the 5% value-at-risk of the and expected shortfall on \$100,000 investment over a one month investment horizon based on the normal distribution using the estimated means and variances of your assets. Do the same using the nonparametric method we discussed in class. Which assets have the highest and lowest VaR at a one month horizon? Which assets have the highest and lowest expected shortfall at a one month horizon? Do the same for all your portfolios. Use the bootstrap to compute estimated standard errors and 95% confidence intervals for your 5% VaR and expected short fall. .

7 Copulas:

Use copulas to to model the joint distribution of the returns. Which copula fits better the data? What are the implications?

8 Conclusion

In this section you give your conclusion