ECP3004: Spring 2023

-Final Project-

For this project, everyone will be using the same data.

1. S&P 500 index: vfinx
2. European stock index: veurx
3. Emerging markets fund: veiex
4. Short-term bond fund: vbisx
5. Pacific stock index: vpacx

Information on these funds is available on Yahoo! finance site. After typing in the ticker symbol and retrieving the quote data, check the profile/description to get a summary of the fund. Please review each fund before doing any of the analysis below.

Downloading Data

For the project you will analyze 5 years of monthly closing price data from the end of June 2014 through the end of June 2019.

The following R script file "3004project2022" (available on the course website) guides you through the creation of the necessary R objects for the analysis of the data in R.

Formal Write-up

I want you to give a formal write-up, separate from the R statistical analysis. Treat this write-up as a term-paper project. Typically, the write-up is between 10 and 20 pages (double spaced with graphs and tables). Your write up should consist of:

1. An executive summary, which gives a brief summary of the main results using bullet points.
2. A one-pager with a brief description of each fund.
3. Sections that summarize the results of your statistical analysis by topic (see below).

You may find it helpful to include parts of your spreadsheet and computer output as part of your write-up.

You only need to turn in the formal write-up. Turning in print-outs of your R output is optional.

Analysis

Return calculations and Sample Statistics

- Compute time plots of monthly prices and continuously compounded returns and comment. Are there any unusually large or small returns? Can you identify any news events that may explain these unusual values? Give a plot showing the growth of $1 in each of the funds over the five year period (this is called an "equity curve"). Which fund gives the highest future value? Are you surprised?
- Create 3 panel diagnostic plots containing histograms, and boxplots for each return series and comment. Do the returns look normally distributed? Are there any outliers in the data?
- Compute univariate descriptive statistics (mean, variance, standard deviation, skewness, kurtosis, quantiles) for each return series and comment. Which funds have the highest and lowest average return? Which funds have the highest and lowest standard deviation? Which funds look most and least normally distributed?
- Using a monthly risk free rate equal to 0.0004167 per month (which corresponds to a continuously compounded annual rate of 0.5%), compute Sharpe's slope/ratio for each asset ((R-rf)/std dev.) Which asset has the highest slope?
- 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. Using these values, compute annualized Sharpe ratios. Are the asset rankings the same as with the monthly Sharpe ratios? Assuming you get the average annual return every year for 5 years, how much would $1 grow to after 5 years? (Remember, the annual return you compute is a cc annual return).
- Compute and plot all pair-wise scatterplots between your 6 assets. Briefly comment on any relationships you see.
    - Compute the sample covariance matrix of the returns on your six assets and comment on the direction of linear association between the asset returns.
- Compute the sample correlation matrix of the returns on your six assets and plot this correlation matrix using the R corrplot package function corrplot(). 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?

Value-at-Risk Calculations

- Assume that you have $100,000 to invest starting at June 30, 2015. For each asset, determine the 1% and 5% value-at-risk of the $100,000 investment over a one month investment horizon based on the normal distribution using the estimated means and variances of your assets. Which assets have the highest and lowest VaR?
- Using the monthly mean and standard deviation estimates, compute the annualized mean (12 time monthly mean) and standard deviation (square root of 12 time monthly std dev) and determine the 1% and 5% value-at-risk of the $100,000 investment over a one year investment horizon. Arrange these results nicely in a table.

Portfolio Theory

Use all 6 assets and the estimates computed above (from the continuously compounded returns) for the following computations.

- Compute the global minimum variance portfolio and calculate the expected return and SD of this portfolio. Are there any negative weights in the global minimum variance portfolio?
    - Graph the weights of the 6 assets in this portfolio using a bar chart.
- Annualize the monthly mean and SD by multiplying the mean by 12 and the SD by the square root of 12. Compute the annual Sharpe ratio from these values. Briefly comment on these values relative to those for each asset.
- Assume that you have $100,000 to invest starting at June 30, 2015. For the global minimum variance portfolio, determine the 1% and 5% value-at-risk of the $100,000 investment over a one month investment horizon. Remember that returns are continuously compounded, so you have to convert the 1% and 5% quantiles to simple returns (see the example in the lecture notes). Compare this value to the VaR values for the individual assets.
- Compute the global minimum variance portfolio with the added restriction that short-sales are not allowed, and calculate the expected return and SD of this portfolio. This is the relevant portfolio for you because you cannot short mutual funds in your 401K account.
    - Graph the weights of the 6 assets in this portfolio.
    - Annualize the the monthly estimates by multiplying the ER by 12 and the SD by the square root of 12. Compute the annual Sharpe ratio from these values. Compare this portfolio with the global minimum variance portfolio that allows short-sales.
- Assume that you have $100,000 to invest for a year starting at June 30. For the global minimum variance portfolio with short-sales not allowed, determine the 1% and 5% value-at-risk of the $100,000 investment over a one month investment horizon. Compare your results with those for the global minimum variance that allows short sales.
- Using the estimated means, variances and covariances computed earlier, compute and plot the efficient portfolio frontier, allowing for short sales, for the 6 risky assets using the Markowitz algorithm. That is, compute the Markowitz bullet. Indicate the location of the global minimum variance portfolio (with short sales allowed) as well as the locations of your six assets.

- Compute the tangency portfolio using a monthly risk free rate equal to 0.0004167 per month (which corresponds to an annual rate of 0.5%). We need the risk free rate to be smaller than the average return on the global minimum variance portfolio in order to get a nice graph.
    - Graph the weights of the 6 assets in this portfolio. In the tangency portfolio, are any of the weights on the 6 funds negative?
    - Compute the expected return, variance and standard deviation of the tangency portfolio.
    - Compare the Sharpe ratio of the tangency portfolio with those of the individual assets.

    - Show the tangency portfolio as well as combinations of T-bills and the tangency portfolio on a plot with the Markowitz bullet. That is, compute the efficient portfolios consisting of T-bills and risky assets.

- Using a monthly risk free rate equal to 0.0004167 per month and the estimated means, variances and covariances compute the tangency portfolio imposing the additional restriction that short-sales are not allowed.
    - Compute the expected return, variance and standard deviation of the tangency portfolio.
    - Give the value of Sharpe's slope for the no-short sales tangency portfolio.
    - Compare this tangency portfolio with the tangency portfolio where short-sales are allowed.