**Finding the Efficient Frontier**

**Instructions for Students**

**General Instructions**

The objective of this assignment is to graph the efficient frontier for eight assets using both constrained and unconstrained portfolios.

There are two spreadsheet available for you to use. One makes the use of some Macros that will automatically run Solver and paste your results onto the “Efficient Frontier” tab. The other spreadsheet does not have any Macros installed. If you use it, you will need to manually run Solver 13 times and paste your results onto the “Efficient Frontier” tab each time to generate graph #1. You’ll need to do it again to generate graph #2.

I realize that running Solver yourself so many times is fairly time consuming, but if you have the time, I recommend using the “No Macros” spreadsheet as it will give you practice running Solver. I also realize that some PCs are configured to not allow macros to be used. For those PCs, you will need to use the “No Macros” spreadsheet. However, you are certainly free to use either spreadsheet for this assignment. If run correctly, they will each end up with the same results (though some asset weights may differ very slightly).

The spreadsheet that you use for this assignment will graph the efficient frontier for you after you have selected your eight assets, a risk-free rate, and a market risk premium. The “Returns” tab of the spreadsheet makes use of the StockHistory function in Excel 365. In order for the spreadsheet work for you, you must be using the Excel 365 version of Excel. StockHistory will list the most recent 61 monthly closing prices for each ticker symbol you enter, and the spreadsheet will then calculate the following: monthly returns, the annualized standard deviation of those returns, correlations and covariances with the other seven assets, a beta coefficient, and the expected return for each using the Capital Asset Pricing Model (CAPM).

The spreadsheet with Macros will then build a weighted variance/covariance matrix by using Solver to find the smallest possible standard deviation for the eight-asset portfolio with portfolio expected returns ranging from 2% to 13% (in increments of 1%). The macro in the program will then paste each of these 12 solutions into the last worksheet where they are automatically graphed in mean/variance space – building the familiar-looking hyperbola. Additionally, it will use Solver to calculate both the minimum variance portfolio (MVP) and the mean/variance efficient portfolio (MVE). The graph shows the location of each of the eight selected assets, the risk-free asset, the MVP, and the MVE.

The ”No Macros” spreadsheet will automatically calculate the everything on the “Returns” and “Correlation Matrix” tabs, as well as the “Var/Cov Matrix” at the top of the “Covar Matrix” tab. You will need to run Solver to find the smallest standard deviation for expected returns ranging from 2% to 13% and also to fine the MVP and MVE. For each of these, you’ll need to copy and paste the values into the appropriate cells in the “Efficient Frontier” tab. The graph will read those values and then show up. To see how to use Solver in this manner, please refer to the video(s) “The Efficient Frontier for 8 Stocks”.

This exercise also gives you the opportunity to place a no-shorting constraint on your portfolio which restricts the weights on each asset to be non-negative. Optionally, you can place additional constraints on your portfolio such as a maximum weight on one or more assets.

**Specific Instructions**

For this assignment, choose a risk-free rate that you believe reflects current market conditions. You should also choose a market risk-premium that you believe reflects current investor sentiment (how much extra expected return investors require to move from a risk-free asset to the riskiness of “the market”). Enter those values in celss G11 and G12 on the “Inputs” tab. Select any eight stocks and/or ETFs, and then do the following:

Please do the following:

1. Enter the values you have chosen for the risk-free rate and the market risk-premium in cells G11 and G12
2. Enter the ticker symbols for the stocks and/or ETFs you have chosen in cells C15 – C22.
3. Give me the full name (not just the ticker symbol) of each of your eight assets, and in a couple of sentences, explain why you selected these assets (it can be any reason).
4. Study the expected returns and standard deviations of each asset you selected as well as the correlation matrix
5. If you are using the spreadsheeet with Macros, Click on the “Execute Solver” button on the Inputs page and wait wile Solver finds the minimum standard deviations for expected returns ranging from 2% through 13%, as well as the MVP and MVE for your portfolio. When Solver is finished, you will see the hyperbola as well as all values on the “Efficient Frontier” page.
6. If you are using the spreadsheet with no Macros, go to the “Covar Matrix” page and use Solver to find the minimum standard deviation for expected returns ranging from 2% to 13%, as well as the Minimum Variance Portfolio (MVP), and the Mean/Variance Efficient Portfolio (MVE). Each time you run Solver, paste the values into the appropriate cells on the “Efficient Frontier” page.
7. Make a copy of the “Efficient Frontier” page.**This is Graph #1**
8. Go back to the “Inputs” page and, if you are using the spreadsheet with Macros, put a check-mark in the box for “Click here to exclude negative weights for all assets”. This will put a no-shorting constraint on your portfolios.
9. If you want, you can also check the box for “Click here for ALL weights to be less than x”, and then select what value you want all weights to be less than.
10. Click the “Execute Solver” button again and wait while the macro runs Solver and pastes the values in the “Efficient Frontier” page.
11. If you are using the “No Macros” spreadsheet, repeat step (6) above, but this time, each time you run Solver, add a constraint that the weights of the assets must be greater than or equal to zero. If you want to, you may also enter a constraint that their weights must be less than or equal to some value.
12. Whether you are using the “Macros” or “No Macros” spreadsheet, you will likely find that Solver cannot find a solution for some expected returns.
13. When you have finished filling in the “Efficient Frontier” page with all possible values using these constraints, make a copy of that page. **This is Graph #2**
14. Compare the two graphs that you copied. One had no constraints and the other had some constraints. Which graph appears to offer investors the least portfolio risk (as measured by standard deviation) for a given expected return? Which graph seems to offer the greatest choice among portfolio expected returns? Why do you think that one graph offers less risk and more possible expected returns than the other graph?
15. Choose a set of eight stocks and/or ETFs and their weights that you feel will give you the “best” portfolio if you are managing a hedge fund for a variety of individual and institutional investors. Feel free to define “best” however you want. Feel free to choose different assets from those you used above. There is no right or wrong set of choices for this step, but please explain **why** you decided to select this particular combination of assets and their weights for your hedge fund.
16. Please submit your two graphs along with your answers to the above questions.