**Tips for HW #4** Yellow Items are really important ☺

The purpose of this HW is to compute the mean and variance (and standard deviation) of individual stocks as well as a portfolio of those stocks. The data for the HW is different from the data in the videos, as you should be able to apply the metrics to any data series.

The purpose of the HW is to also cover matrix multiplication in Excel using the array functionality.

**Price\_Returns\_Data Worksheet:**

This worksheet has raw price data for 6 stocks. That raw price data is in rows 3 – 39.

In Rows 43 – 78, you can compute returns using the price data above. Use the natural log function in Excel as follows LN(Current price / Prior price)

In row 80, you should compute the mean of each return series.

In rows 84 – 119, you should compute each individual stock’s excess return, for each observation.

That is, take each month’s return (for a particular stock) and subtracts the mean (row 80).

In rows 123 – 158 you should square your excess returns from the section above.

In rows 161, 162, and 164, you should compute some metrics: variance and standard deviation of returns and the count of excess returns.

**Variance\_Covariance Worksheet**

In this worksheet, you are computing the variance-covariance matrix for the 6 stocks in your portfolio, using matrix multiplication.

Please watch the videos for the “idea” behind this.

Rows 8-13: You will be using the excess returns from Price\_returns\_Data worksheet.

Use the matrix multiplication array function in excel.

Each excess return is (X-Mean) or (X – Xbar)

So for the same firm, you are obtaining (X-Xbar) x (X-Xbar). It's the excess return squared. For one firm and another firm, you are obtaining (X-Xbar) x (Y-Ybar), where X is the return vector for one firm and Y is the return vector for another). That's why it is a variance-covariance matrix.   
  
Each multiplication will result in either the variance or the covariance. For the same firm, X transpose X results in what I need to compute the variance; for two different firms, it's the covariance. I still need to divide by N, but that's what is happening.

**Please watch the video for more explanation.**

Variance formula =Σ(Xi-Mean)2/N =Σ[(Xi-Meanx)(Xi-Meanx)]/N

Covariance formula = Σ[(Xi-Meanx)(Yi-Meany)]/N

Effectively, rows 8-13 are the numerator of the variance and/or covariance formula. In rows 21-26, we are dividing that “numerator” by N. That gives us variance-covariance.

Now, we also want the correlation matrix. How do we compute correlation?

Correlation between stock x and y = Covariancex,y / σxσy

Correlation = Covariance between any 2 stocks divided by the product of their standard deviations.

In rows 32-37, you have the standard deviation, called “d.” In rows 43-48, using matrix multiplication, you are getting d multiplied by the transpose of d. That’s effectively the product of the standard deviations (denominator of correlation).

Correlation matrix begins in row 56.

Portfolio Optimization Worksheet:

In Columns A – C, pull in the individual means and standard deviations.

In Columns E – H, you are computing three portfolio means and standard deviations.

First (Column F): assume the portfolio is equally weighted. What is the portfolio mean, portfolio variance, and portfolio standard deviation?

Second (Column G) Using solver, solve for the weights that will:

Maximize the portfolio mean (μ) subject to the portfolio standard deviation being less than or equal to the minimum individual stock standard deviation.

Third (Column H) Using solver, solve for the weights that will:

Minimize the portfolio standard deviation (σ) subject to the portfolio mean being GREATER THAN OR EQUAL TO the highest individual stock mean. **Note: Cell H3 in your spreadsheet should read as follows:**

**μ >=**

**NOTE: There need NOT be a unique solution for the weights for which you solve.**