**Learning Objective: Understand portfolio optimization. Put several assets in a portfolio and find the weights that will a) minimize variance and b) maximize mean**

This homework will be completed in Excel. This homework has finance and excel learning objectives.

**Instructions for completion:**

Please use the Excel File named “Portfolio\_HW\_4.xlsx.” This is similar to the files posted in week 12. This assignment involves completing the “work” that is done in the videos for Week 12. Following along the videos to understand how it is done.

Note this assignment is SLIGHLY different from the videos. So please read these instructions carefully!

Work is required in the following worksheets:

-Data\_Prices\_Returns

-Variance Covariance Matrix

-Portfolio Optimization

**All work must be done individually. Do not share your files with other students.**

**Instructions for Writing Formulas: Any cell which is “filled” with a GRAY color must have a formula.**

**Please write the formulas as shown in the videos!**

**That is, use matrix algebra when indicated in the instructions above!**

**The following instructions indicate what work you should do in each of the worksheets:**

1. **Data\_Prices\_Returns**

In this worksheet, you will find adjusted closing prices for 6 companies from December 2016 through December 2019 (monthly).

LOW, Lowes Companies Inc

KO, Coca-Cola Co

WEN, Wendy’s Co

BAC, Bank of America Corp

AAPL, Apple Inc.

AGCO, AGCO Corporation

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Using the LN function, compute returns for these 6 firms for January 2017 through December 2019. This should be placed in Rows 43 – 78.

In Row 80, compute the monthly average of the returns. Use the average function.

In Rows 84 – 119, compute the excess return (monthly observation less the mean from Row 80). Square those excess returns in Rows 123 – 158.

Compute the variance and standard deviation in rows 161 and 162 using Excel’s function for populations (not samples).

In Row 164 count the number of observations of your excess returns using the COUNT function.

1. **Variance Covariance Matrix**

Here, you will mostly use matrix multiplication to compute various measures.

*XTX*

In Rows 8 – 13, use matrix multiplication to square the excess returns from the Data\_Prices\_Return worksheet.

*XTX / N (this is your variance-covariance matrix)*

In Rows 21 – 26, divide your excess return matrix by the number of observations. Use the number of observations you computed in Data\_Prices\_Returns

*Matrix D*

In Rows 32 through 48, you need to compute Matrix D which is d x dT where d is a vector of individual standard deviations of the stock returns (pull these from Data\_Prices\_Returns). In order to compute D, you need to use matrix multiplication.

*Correlation Matrix*

In Rows 56 – 61, compute the correlation matrix by dividing your variance-covariance matrix by D. Diagonals should be 1.

1. **Portfolio Optimization**

Following along the videos, compute the portfolio mean, variance and standard deviation under three scenarios:

1. Equally weight the stocks (weights should go in Cells F6 – F11).
2. Using the weights which result in the minimum variance portfolio
3. Using the weights which result in the maximum return portfolio

For 2) and 3) above, you must use SOLVER to find the weights!

In Cells F12 – H12, sum the weights. For the mean and variance in rows 13 and 14, use matrix multiplication.

**Tips for #2 and #3: Read carefully:**

**Allow for short sales (therefore you can remove the constraint on weights having to be greater than or equal to 0). Obviously, sometimes short restrictions occur, but for this exercise, we want to see what happens to the mean/standard deviation.**

**Analysis Write-up**

Write one to two paragraphs explaining your results. What do you learn from the analysis? Do you believe if there were more data (a longer time series of returns), the weights would change? What is the point of portfolio optimization strategy? Focus on whether you can improve (higher return/lower variance) an equally weighted portfolio.

Specifically, when you find the portfolio for the minimum variance, does the portfolio earn a greater return than the asset whose variance is that minimum?

When you find the portfolio for the maximum return, does the portfolio have a lower variance than the asset with that return?

Even if you can improve, what are the pitfalls if any?

When you complete your assignment, please save your excel file as follows:

HW\_4\_YOURLASTNAME

So, for me, it would be: HW\_4\_Garner.xlsx

Complete the Information sheet in the Excel file with your last name and your GTID!

Write your analysis a Word document and Save your word document as:

HW\_4\_Yourlastname.docx

Complete the Information sheet with your last name and your GT ID!

**END OF INSTRUCTIONS**