BMD 5301
Project 1: Asset Allocation
DUE DATE: September 18 2023

Instructions:

- This assignment is to be done in your groups of **4-5 students**.
- Each group member will receive identical grade for the write-up components (deliverables #1 and #2 below).
- Please present your analysis in a short, self-contained, professional report (Word format), being sure to address each issue or question identified below. Discussions need to be clearly articulated so that the reader can follow the analysis without undue burden.
- The write-up should not exceed **4 double-spaced** pages of text (not including exhibits).
    - **All figures and exhibits, including analysis performed using Excel (or other analytical tools), should be carefully labeled and included in the Word document. They do not count towards the page limit, but each must be referred to in the text.**
- Deliverables:
    (1) The Word report (docx/pdf);
    (2) Excel spreadsheet (**or** codes/outputs of other analytical tools); and
    (3) Presentation slides (pptx/pdf), to facilitate a 10-minute presentation of the results.
    - Please submit (1) and (2) via **Canvas** by **4pm** on **the due date.**
    - Please submit (3) via **Canvas** by **6pm on the due date**.
    - Each file should include all group members' names and NUS matriculation numbers.

General Information:

- The previous three decades have exhibited many interesting patterns – the high inflation of 1980's, the equity market bull-run of 1990's, and the financial crisis of late 2000's. **Begin by choosing one of the three decades.**
- The Excel sheet posted on Canvas provides historical monthly return data for an entire decade for the following indexes:

1.	S&P 500	domestic U.S. large equity
2.	Russell 2000	domestic U.S. small equity
3.	LB Long Term Gvt./Corp. Bonds	fixed income
4.	MSCI EAFE	international equity
5.	T-bills	risk free

- **Please state clearly which decade you choose in the project report and the presentation slides.**

Questions:

1. Calculating inputs (3 points)

Using the monthly time series of data, calculate the following for each asset class:

a) Monthly and annual average return
b) Month and annual standard deviation of return
c) Correlation between indexes of risky asset classes

Use the above as Input List for the asset allocation problem below. You may assume that the T-bill has zero standard deviation and zero correlation with other asset classes.

- Which is an unbiased estimate of future return – Arithmetic or Geometric mean?
- Annual return parameters can be obtained using two approaches:
    1. Calculate the relevant statistic (mean, standard deviation, correlation) using monthly return (120 observations). Next, obtain annual statistic.
        - Annual return = 12 * monthly return
        - Annual Std. Dev = √12 * monthly Std. Dev
    2. First calculate annual return (10 observations). Next, calculate the relevant statistic.

Do the two approaches yield the same result? If not, which approach is better? Why?

Note: Please follow approach 1 for the rest of the assignment.

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2. Optimal Asset Allocation (8 points)

IMPORTANT NOTE: The following steps describe the process you would perform in Excel. **You can choose other more advanced analytical tools (Python, R, …) to perform these steps if you so choose.**

a) For each portfolio return highlighted in yellow in the spreadsheet 'Efficient Frontier', calculate the minimum unconstrained portfolio standard deviation.
   - **Plot and attach the "Efficient Frontier Graph" with your project submission.**

b) For the Global Minimum Variance portfolio, report the expected return, standard deviation, and portfolio weights.

c) Report the expected return, standard deviation, and portfolio weights for the unconstrained tangency (optimal) portfolio. Describe the process to identify the tangency portfolio.

Use ***Solver*** (or *Goal Seek*) in ***Excel*** to solve the Asset Allocation problem

To check whether Solver is installed in your Excel application, click on Data. Solver should appear in the "Analysis" set.

- If Solver does not appear, click on File > Options. Choose Add-Ins. In the Manage box at the bottom, select Excel Add-ins and then click "Go". In the Add-Ins available box, select the Solver Add-in check box, and then click OK.
- If the Solver Add-in is not listed in the Add-Ins available box, click Browse to locate the add-in. If you can't find it, it may be that Solver was not installed in your machine when Microsoft-Office was initially loaded. You should install Solver using the Office Installation file.
- After you load the Solver Add-in, the Solver command is available in the Analysis group on the Data tab.

Once Solver is installed, you are ready to solve the following optimization problem:

"For each value of expected return (highlighted in yellow in column B), calculate the portfolio weights (w_1, w_2, w_3, w_4 in columns D to G) that will minimize the portfolio variance (in column C)."

That is, you are asked to plot the minimum variance frontier.

To use solver, you need to set up the rows 27 to 36 in the 'Efficient Frontier' spreadsheet:

- Column C must equal the four-asset portfolio standard deviation. Recall that the N-asset portfolio variance has N individual variance components and [N*(N-1)] covariance components. The covariance matrix has been created in rows 19 to 22.
- Use Solver.
  - Our objective ('Target Cell' or 'Set Objective'): **Minimize** portfolio standard deviation
  - Our choice variables ('By Changing Variable Cells') is Portfolio weights.
  - Under Box 'Subject to the Constraints', Click Add to impose two constraints:
    - The portfolio return must equal the target portfolio return (in column B).
    - The sum of portfolio weights must equal 1.
- Click Solve. When the user input box appears, Click 'keep solver solution'.

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3. Optimal Capital Allocation (3 points)

Consider three investors with significantly different risk profiles. Let us assume that all three investors have total wealth of $1 million. The optimal weight (y*) in the tangency portfolio is 0.20 for the super conservative investor (Alex), 0.60 for the conservative investor (Roberto), and 0.90 for the moderate-risk investor (Cathy).

- Calculate the dollar investment in each asset class for each of the three investors.
- Is the composition of the risky portfolio the same for all three investors? If so, explain why, and discuss the role of risk aversion in the allocation decision.
- Estimate the average risk profile of your group. What should be the optimal allocation for your team? (Note: Theory suggests that the investor with moderate risk tolerance has a y* close to 1.)