

CMSC 5718 Introduction to Computational Finance

Assignment 1: Asset Allocation (20% of total grade)

Instructions

- 1) Submit a copy of your work by **uploading to Blackboard on or before March 6, 2023, 11:59pm**. The report, supporting worksheets/programs should be submitted as a zipped file. The **file name** of the zipped file should include your surname and have the following format, **e.g. ChauKL_Assign1**. [If uploading to Blackboard is not successful, you may consider sending a email to kalokchau@cuhk.edu.hk, but submission through Blackboard is preferred.]
- 2) Late submission of one week or less will attract a penalty of 20% of the assignment mark. ***Submission will not be accepted after March 13, 2023, 11:59pm.***
- 3) You can either submit your work **individually** or work together in a **group of two or three students**. Students in the same group will get the same assignment grade. Please state the name(s) and student number(s) clearly in the report. However, if you are submitting as a group, you only need to submit one copy of the report with one of the names in the file name (described in (1) above).
- 4) **Please observe the university's plagiarism guidelines.**

Introduction

Assume that you are a financial advisor and the equity analysts in your company have identified ten stocks trading in the Hong Kong market that can potentially be included in the portfolio. The attached spreadsheet contains historical data for these stocks, as well as some forecast expected returns. All of these companies are constituent stocks of the Hang Seng Index (HSI).

In this assignment, you are asked to suggest weightings of the stocks in order to generate an optimal portfolio under various kinds of constraints, making use of the models that you have learned in the lectures. There is no restriction on programming language used.

Report format

- 1) You are required to give the numerical answers to the questions, as well as showing how these answers are generated.
- 2) If you are invoking the optimization routine with a program (e.g. with Python), include the code for the calling routine in your report.

1. Collecting historical data (12 marks)

Using the 2-year historical daily stock prices from the attached spreadsheet (from 31/12/2020 to 30/12/2022), compute the parameters for each stock and stock pairs, which would be used in the next part of this assignment. [Formulas as in Lecture Powerpoint Topic 1-1, slide 97 or Course Notes Chapter 2, p.33]

- i. Annualized standard deviation of daily return.
- ii. Annualized covariance between each pair of stocks.
- iii. Correlation coefficient between each pair of stocks.

2. Finding the optimal portfolio for different asset allocation models (83 marks)

Assume that the risk free asset has an expected return $r_f = 4.30\%$. Standard deviations and covariances should come from question 1 above, and the “**expected 1-yr return**” as provided in the spreadsheet should be used as the expected return of each stock.

- i. With Modern Portfolio Theory [58 marks]
 - a. Find the standard deviation and expected return of an equal weight (EW) portfolio, where all the stocks have a weight $w_i = 0.1$.
 - b. Find the global minimum variance (MV) portfolio. Give the standard deviation and expected return of the portfolio, and the weights of the stocks.
 - c. Draw the efficient frontier, short sale not allowed.
 - d. Find the optimal portfolio to be combined with the risk free asset, short sale not allowed (corresponds to case (c) above). State the standard deviation and expected return of this portfolio. Give the weights of the stocks.
 - e. Your company’s analyst has updated her forecast of WH Group and Link REIT, where the expected 1-yr returns of these stocks have changed to 16.90% and 12.70%. Repeat 2(i)(d) above. Comment on the expected and/or unexpected changes in the weights of the stocks.
- ii. With the Risk-Parity strategy¹ [25 marks]
 - a. Find the optimal ERC portfolio. State the marginal risk contribution of each stock and give the weights of the stocks.
 - b. Calculate the leverage factor for the leveraged ERC portfolio, with a standard deviation of the portfolio equal to your answer in 2(i)(a) above. Find the expected return of this portfolio.

3. Presenting the performance of the portfolios (5 marks)

Assume that you have a client who has invested \$1,000,000 in each of the optimal portfolios that you obtained in 2(i)(a), (b), (d), 2(ii)(a), (b) above using the closing prices of the stocks as of January 31, 2023.² Obtain the closing prices of the stocks and the HSI on February 21, 2023 and calculate the values of the portfolios. Compare the percentage return of the portfolios against the return for HSI during this period (no compounding required).

¹ Risk Parity strategy normally applies to different asset classes, but only stocks are used in this assignment.

² This is a simple assumption. The correct approach should make use of the utility function of the investor.