**Portfolio Risk Management Project**

**Group Formation (Due 11:59pm 19/8/2021 Thursday, before Week 2’s class)**

1. Expected group size is 5. Depending on the final enrollment (after the module add/drop period), we may assign leftover students to groups especially if the final class size is not divisible by 5.
2. Once you have a group of 4 or 5 students, please sign up as a group on LumiNUS.
3. If you sign up with only 4 students, we reserve the right to randomly assign one team member to your group if required.
4. If your group only has 3 students, you are allowed to sign up on LumiNUS. But that is just like notifying me and the TAs that the 3 of you prefer to be in the same group. We will try our best to put you together in the final group formation but no guarantee.
5. If you are alone or only have 2 members, **do not** sign up on LumiNUS AND do not join existing groups without the consensus from that group’s members. Notify me and the TAs.
6. We will assume the group with a smaller group number (1,2,3…etc.) has a higher priority to remain as a group. Your group number won’t have a direct effect on grading in this module. You are allowed to sign-up with your lucky number, e.g., Group 18, but we may move you forward if there are only 17 groups in the end.

Marking scheme: The proportion of marks allocated for each part is to help you decide the length of your answers. Of course the quality of how well you answer will be taken into account. We also reserve the right to adjust marks upwards/downwards on a relative basis.

**Initial report (Due 11:59pm 12/9/2021 Sunday, End of Week 5) – 5 marks**

Submit an initial report **no longer than 3 pages single-spaced** in the main section and supporting information (graphs/tables) in the appendix. The appendix will not be counted in report length but should not be more than 3 pages.

1. Set the time point for this exercise at **December 31st 2020**.
2. Scenario Description:

You are a **long-only** portfolio fund manager that has just started a fund attracting 5 billion Assets Under Management (AUM) from various clients. You are deciding how best to allocate the funds for your investment clients. Let’s assume you are working for clients with risk preference similar to Temasek, which is more aggressive than GIC but is less aggressive than emerging market equity mutual funds.

1. Dr. Huang checked the ranking of technology funds at the following website and picked 15 funds by the following criteria: (1) not too much international stocks (2) interesting theme, such as AI, FinTech, …etc. (3) variety of technology funds

<https://money.usnews.com/funds/mutual-funds/rankings/technology>

1. Janus Henderson Glb Tech and Innovt Fd
2. Fidelity® Select Semiconductors Portfolio
3. Fidelity Advisor® Technology Fund
4. Fidelity Advisor® Semiconductors Fund
5. BlackRock Technology Opportunities Fund
6. Columbia Seligman Global Technology Fund
7. Red Oak Technology Select Fund
8. Fidelity® Select IT Services Portfolio
9. Jacob Internet Fund
10. ICON Health and Information Technology Fd
11. Wells Fargo Specialized Technology Fund
12. TCW Artificial Intelligence Equity Fd
13. Black Oak Emerging Technology Fund
14. DWS Science and Technology Fund
15. Berkshire Focus Fund
16. Extract the equity portfolio holding compositions of one best and one worst mutual funds from the SEC N-PORT P filings. (You do not need to submit this for the initial report. This is more for your mid-term report when you start working with the data.)
    1. Some of the international companies may have USA listed ADR. You can use the stock prices of the USA counterpart. For example, the largest company in Taiwan is TSMC, which is also one of the hottest stocks. It is mainly listed in Taiwan, and has an ADR listed in USA.
    2. Make sure you know how to get the data about portfolio composition of mutual funds in that category from the SEC N-PORT P filings. We need those to calculate something in later project exercises. For the purposes of analysing the funds in this initial report, you may simply refer to the fund prospectus to get an overview of their holdings at one time point, but you will eventually need to know how to get the full composition of holdings by the time you start your mid-term report.
    3. Make sure you know how you can track the stock prices of the portfolio stocks given the stock tickers.
    4. We need to know the portfolio composition on 31 December 2020 (If you cannot find the portfolio composition exactly on 31 December 2020, +/- 2 months from the date is fine). We will assume the holdings are the same throughout this semester. You don’t need to know the portfolio composition dynamically.
    5. Setup your stock tracking account or web crawling to start tracking the performance of stocks of those two mutual funds in 2021, assuming they don’t change their portfolio composition.
17. **Question 1 (3 marks).** Pick one mutual fund each that you think will be the best and worst after one year (from 31 December 2020 - 31 December 2021). Explain qualitatively with supporting references why your chosen best mutual fund may fit your investment objective in 2021. Do not use information in 2021. Use only information before the end of 2020 as the time point is December 31st 2020. Pretend you are forecasting on December 31st 2020.
    1. Provide 5 best qualitative arguments that supports your best and worst funds, respectively. So I expect to see 5 arguments in total.
    2. Those 5 arguments should not be the
    3. Qualitative discussion refers to arguments like: AI is hot and related stocks will go up in 2021, Covid19 makes everyone working from home so cloud computing related firms are hot…etc. It is fine that you copy from investment magazines, blogs, or analysts reports, but do provide references and citations. Do not copy the full report, which counts as plagiarism. Specifically, it is perfect if you consolidate 5 strong/convincing/correct arguments from 5 references without your own opinion, which is what I hope you to do: find and learn from good forecasts of real experts. It is not fine if you simply copy and paste from 1 or 2 reports without even reading it. Even if your quoted experts gave you wrong forecasts, this is a good learning experience. Believe me, if you are in finance, you will read many reports with wrong forecasts in the future.
    4. Your argument could be for the theme of the mutual fund (e.g., AI, Semiconductor, or FinTech). Or, it can be for the individual firms when the fund manager heavily bet on few stocks.
    5. Choice of mutual fund will not be graded directly. This is not graded by the actual performance in 2021. This is graded based on your efforts to compile quality and convincing arguments.
    6. In this question, the explanations that I expect are qualitative answers. We will practice quantitative methods in the midterm report.
18. **Question 2 (2 marks). Track Records of Mutual Funds**. Historical performance can provide clues about the future performance of mutual funds. Try to collect the following information for your best and worst mutual fund. This is better to be somewhat consistent with your answer in Question 1. I mean it cannot be your best fund reads worse than worst fund in Q2 in all aspects.
19. Historical performance of your best and worst mutual fund. The annual return, standard error of return, and Sharpe Ratio in 2018, 2019, and 2020.
20. Track record of the mutual fund manager

* Number of years as mutual fund manager
* Awards (if any)
* Education background and work experiences of the fund manager in 2020.
* Positive endorsement or mentions in reputable media. Usually, it is difficult to find negative news. If you can find that, it is also good to include to support your worst mutual fund.
* (bonus) Try to get career average return, standard error of return, and Sharpe Ratio of the fund manager

1. (optional) Turnover rate of the best and worst fund at the end of 2020 if available.

**Mid-term report (Due 11:59pm 17/10/2021 Sunday, End of Week 9) – 15 marks**

Submit a midterm report **no longer than 10 pages single spaced** in the main report and include supporting information (graphs/tables) in the appendix.

1. You are encouraged to start working on this report earlier than Week 5 and it is better to do so. No deadline extension for this part since we already set it quite late.
2. **Question 1 (1 mark).** Again, the time point is the beginning of 2021 (December 31 2020). State your one-year investment goal **quantitatively** that is consistent with your risk attitude in the initial report. Explain why you specify this objective function. This is also the objective function for your portfolio optimization.

Examples (non-exhaustive list):

* Achieve the highest Sharpe ratio
* Achieve highest return with VaR <= XXX
* Achieve highest probability of realized return >= 20%
* A mean-variance utility function
  1. This “objective function” can be commonly-used formula in academic literature or in practice. It could be as straight-forward as a utility function that considers risk and return. It could also be your own customized utility function as long as it makes sense to fit your investment profile in the first report.
  2. Please also list and explain any constraints clearly you may have placed on the objective function – marks will be awarded for this!
  3. It is required that your objective function considers “risk”. So do not simply tell me that you try to maximize expected return. In reality, it could be fine. But for this project’s purpose, it will not help you practice risk management by diversification.
  4. Make sure the objective function you choose works with your optimization packages later. Mathematically, if your objective function is relatively smooth (continuous and differentiable everywhere) and also convex/concave, then you should be fine in all packages. However, those objective functions could be over-simplified.
  5. All portfolio weights should be between 0% and 25%.

1. **Question 2 (4 marks).** Optimize your best mutual fund’s holdings using your objective function (keeping the same composition of stocks as the best mutual fund but adjusting only the weights). In other words, re-weight the portfolio of your best mutual. The new portfolio should deliver better performance that maximizes your objective function. Grading for this question will be based on quantitative approaches only.
   1. You may focus on the top 30 stocks when your portfolio includes too many stocks.
   2. The requirement is only about investing in the same composition stocks of your best mutual fund. You don’t need to include new stocks.
   3. For simplicity, invest all money into risky assets.
   4. The optimization method is open. If you have a mean-variance utility function or differentiable concave utility function, you may be able to derive closed-form formulas of your weightages. You can explore techniques such as risk-parity optimization or mean-semi-variance optimization but for the sake of fairness of all groups, you are not to trouble the TAs for help on these advanced methods if you’re facing technical problems while implementing them. You can use gradient descent method, Newton Method, or even more complicated methods.
   5. To make the TA’s job easier, only Python is allowed. You need to submit your data and code so that the TA can replicate your analysis to get your answers.
   6. You can use any historical time-period for estimating the return and var-covariance matrix. You are also allowed to make reasonable adjustments.
      1. If you use realized historical return, some firms may have too high or too low return and this will affect your optimization problem. One way is to check the target price by analysts from the Internet. Then you can use that analysts’ target return or subjectively adjust based on that.
      2. For the Variance-Covariance matrix, you can just use the historical data. Adjustment is allowed but not required. Again, if you use historical var-covariance matrix, sometimes it may not be technically tractable/solvable by optimization algorithms. Theoretically, var-covariance matrix may need to be positive definite.
   7. There is no need to change the weights daily. This means you only need to optimize once.
2. **Question 3 (3 marks)**. Some models or optimization methods may not lead to reasonable output. Explain all the optimisation approaches you have tested for Question 2, and explain why you have arrived at the final selected approach. Your explanation should cover elements such as the choice of objective function, data selected, and adjustments/constraints specified in the optimisation. Explain what works and what does not work. What you have observed during the exercises.
3. **Question 4 (3 marks)**. Calculate the VaR (5%) and Expected Short-fall (5%) of 3 portfolios (best-performing, worst-performing, your own optimal portfolio) using the historical data by HS and Parametric (normal distribution) methods. For each portfolio, you should have 4 numbers calculated from **at least** previous 12 months of daily return data. You are allowed to use data with longer sample period.
4. **Question 5 (2 marks)** Compare your VaR predictions in #6 with the realized return and standard deviation of return in the first half of 2021 (up to 2021 Q2), similar to the example in the textbook **(page 28-30 of the textbook - the pdf corresponding to the Historical Simulation VaR section analysis will be uploaded and found in the folder).** Briefly discuss your results for all three portfolios.
5. **Question 6 (2 marks)** The time point is now shifted to the end of September 2021 (end of Week 8 of NUS Calendar). Discuss how you can adjust your “optimal portfolio” so it can outperform all other 14 chosen mutual funds in 2021 Q4.
   1. One difference between this portfolio and the earlier one is you can use the information in 2021 (historical data in 2021 and all updated news about Covid-19 developments).
   2. The other difference regarding optimization is: for bullet #3, you can simply use 2020 (or longer period’s) historical return and var-covariance matrix of return. Next, you apply optimization techniques to decide weights. In Question 6, (1) you can use your own forward-looking expected return (e.g. analysts forecasted prices from the internet) (2) you can use your own forward-looking var-covariance matrix (3) after you optimize your portfolio by standard theory, you can adjust weights subjectively. But for each decision, briefly explain why you do that. For example, you can reduce the weights on stocks that you subjectively feel those stocks will not go up. You can bet on only 4 stocks with 25% each if you believe the stock market will go up.

**Final Report (Due 11:59pm 11/11/2021, midnight before the last class) – 9 marks**

A comprehensive report **no longer than 10 pages single-spaced** is due at the end of the semester. The goal of the final report is to demonstrate the application of concepts covered in class. Remember, you will not be graded on the actual performance of your portfolio, but you will be graded by applying techniques about risk management.

1. **Question 1** (2 marks). Compare and briefly discuss the risk and return performance of 4 portfolios until October 2021: (i) best, (ii) worst, (iii) portfolio before subjective adjustment, and (iv) portfolio after subjective adjustment.
   1. For portfolios (i), (ii), (iii): compare the performance in the first 10 months of 2021.
   2. For portfolio (iv): discuss whether your adjustment helped to improve the performance in October 2021.
   3. For returns, report the total monthly return for each month. For risk, report the annualized standard deviation of the daily returns in each month.
2. **Question 2** (2 marks). The actual mutual fund’s stock composition could be different in 2021. Find information on how **the best mutual fund** adjusted their holdings in 2021. Discuss what the fund manager did and whether their decisions improved the fund performance (compared to doing nothing).
   1. It is sufficient to have changes of weights at any only one time point in 2021.
   2. Using the time point of new portfolio weights, analyse whether the original portfolio or the new portfolio performs better after the adjustment.
   3. If there are too many stocks, you can focus on the top 30 stocks again.
3. **Question 3** (5 marks) Hedging. Assume we are back in 31 December 2020. Estimate the risk of each of your stocks by VaR and ES at 5%. Together with your subjective assessment. Identify 2 stocks with the highest downside risks in your portfolio. Email me the ticker/id of those two companies and I will share with put options prices with the expiration date of options in September 2021. Assume that you will hold the options you buy until the expiration date. Also assume that you buy the options with strike price at your VaR 5%.

Explain in detail how you decide those two stocks for hedging. Also explain how you decide the number of options for hedging. It is better you provide both quantitative and qualitative discussion. Report the return of your own optimal portfolio without/without hedging when the options expire at the end of September 2021. Also report the profit/loss of those two stocks with or without hedging. We will grade more based on how you decide the two stocks and how much to put options to buy to reduce risk.

* 1. This exercise is not asking you to short-sell to earn higher profits.
  2. You do not need to hedge the best-performing or worst performing funds.

**Final Presentation (6 marks, Tentative and may be updated later)**

Because we have too many groups this year, each group will make a **video presentation** not more than **12 minutes in length**.

You should cover the following in your presentation (you can decide the order of the required contents). You can cover more than the following bullets if you have time.

1. What are your best and worst mutual funds?
2. Why you choose those two funds?
3. Explain your investment goal and objective function quantitatively and qualitatively.
4. Explain the main difference of weights between your portfolio and the 3 portfolios: best/worst/index in terms of portfolio composition.
5. Report the performance of your 4 portfolios in 2020 and 2021, respectively.
6. Does your optimization improve the risk-return performance in 2021? Briefly explain why or why not.
7. Present and compare the 4 values of VaR and ES of 4 portfolios in 2021. Which one of the 4 methods works the best?
8. Report the two stocks for hedging, number of put options bought, and the outcome of hedging results.

**We may arrange separate interview Q&A sessions with each group to ask questions upon watching the videos and to ensure that everyone understands the project fully. We will confirm the logistics of this later if we decide to do so.**

**Final Peer Assessment Report**

For the group project's peer assessment report, the rule is the following.

1. The default is that members in the same group receive the same mark. At the end of your final report, you only need to add an appendix with a short description (one sentence) that your group did not have problems working together and I will give the same group the same project marks.
2. If there is an unequal contribution, your group has two options:
   1. Add an appendix at the end of your final report and tell me who did which part of the project throughout the semester. I will give each team member an individual grading case-by-case.
   2. If you cannot agree on the contributions or feel sensitive to share it directly, you can state in the appendix that each of your team members will email me separately about your view of the contribution of the group project. Given all inputs, I will decide how to grade case-by-case.

<<end of project>>