PROJECT 1

Written formulation including definition of decision variables, constraints and objective function, before class starts on Wednesday, October 16, 2019 (80 points)

A complete formulation will be provided during class on October 16

Solution files are available for sale any time after you have turned in your formulation. The solution files will cost you 20 points

Final report due Wednesday, October 23, 2019 before class (120 points)

This project is to be completed without assistance from anyone else. Collaboration is not allowed. If you need clarification, please post to the Canvas Discussion Forum or contact the instructor or TA.

PROBLEM STATEMENT

A collection of local advisory firms has been purchased by a national firm. The national firm would like to encourage consistency across all of the newly acquired advisory firms as well as advisory groups they already own, but does not want to disrupt business activities or cause dramatic changes in portfolios that might upset clients.

You are an advisor at one of the recently acquired firms. The portfolios that your firm has been recommending to clients contain a slightly different line up of preferred market exposures than what is contained in the models of your new parent company. Over time the acquiring company would like to transition each client's portfolio toward its official portfolio allocations.

The Home Office (the central investment manager for the national firm) outlines three models they want advisors to use for clients. In recognition of the potential tax impact of investment sales and in order to not alarm clients, each advisor is required to tailor the appropriate model for each client they serve based on the funds in which each client currently invests.

As a first step to integrating your investment process with that of the Home Office, they would like you to re-allocate your client portfolios to be as consistent as possible with the Home Office models (within the restrictions described below) and to gradually include additional funds (also as described below).

The three Home Office models are

	Model 1	Model 2	Model 3
U.S. Large Cap Equity	30%	24%	16%
U.S. Mid Cap Equity	9%	9%	6%
U.S. Small Cap Equity	7%	6%	4%
Developed Non-U.S. Equity	20%	11%	8%
Emerging Markets Equity	8%	5%	4%
Global Equity	6%	5%	3%
Global Small Cap Equity	3%	3%	2%
Real Estate Investment Trusts (REITs)	3%	3%	2%
Listed Infrastructure	2%	1%	1%
Commodities	2%	1%	1%
Emerging Market Debt	1%	1%	2%
High Yield Bonds	2%	3%	4%
Core U.S. Bonds	7%	26%	35%
Short Duration Credit Bonds	0%	0%	4%
Treasury Inflation Protected Securities (TIPS)	0%	2%	8%

The re-weighting process should arrive at a portfolio for each client that matches the characteristics of the Home Office models relative to three primary characteristics

1. exposure to growth assets – the first twelve items in the Home Office models (i.e. everything from U.S. Large Cap Equity to High Yield Bonds),
2. exposure to capital protection assets – Core U.S. Bonds, Short Duration Credit Bonds and TIPS, and
3. exposure to inflation-sensitive investments – the three Real Assets and TIPS

and that is similar to the Home Office models in five secondary characteristics

1. exposure to domestic equities,
2. exposure to small cap equities,
3. exposure to real assets – REITs, Infrastructure and Commodities,
4. exposure to return-seeking fixed income, and
5. exposure to short-duration bonds.

An additional consideration is the similarity between client allocations to the fifteen asset classes listed above.

For the secondary characteristics, each percentage difference between the Home Office model and the new client portfolio that you determine receives a penalty of 3.0 per 1% difference. Furthermore, deviations of the actual client portfolio (the one you develop based on this process, not the current client portfolios) from the Home Office models for each of the asset classes receive a penalty of 2.0 per 1% difference.

You have been asked to determine new client portfolios that have the lowest penalty. There is no penalty for how much the new client portfolio differs from the current client portfolio. The only penalties are associated with differences between the new client portfolio and the closest Home Office portfolio.

You can assume that

- Global Equity represents 55% U.S. exposure and 45% foreign exposure. As well, it represents 10% small capitalization stocks. Global Small Cap Equity represents 60% U.S. investments and 40% non-U.S. investments.
- Return-seeking fixed income is composed of High Yield Bonds and Emerging Market Debt.
- Even though tax impact is a consideration in the Home Office's guidance, there is no need to explicitly account for it in your solution.
- Assume there are no transaction costs associated with changes to the portfolio weights.

The client portfolios that require your attention are as shown below:

	Client	
	Zachary Zenic	Yolanda Yeats
U.S. Large Cap Equity	20%	
U.S. Mid Cap Equity		
U.S. Small Cap Equity		20%
Developed Non-U.S. Equity	10%	
Emerging Markets Equity		20%
Global Equity		
Global Small Cap Equity		10%
Real Estate Investment Trusts (REITs)		10%
Listed Infrastructure		10%
Commodities		
Emerging Market Debt		15%
High Yield Bonds		15%
Core U.S. Bonds	40%	
Short Duration Credit Bonds	10%	
Treasury Inflation Protected Securities (TIPS)	20%	

The portfolio you recommend for each client should be limited to funds that the client already has *plus no more than one additional fund*, simply with possibly different weights than the client is currently holding.

YOUR BOSS IS INTERESTED IN LEARNING

1. Which Home Office model requires the smallest changes in each client's portfolio in order to shift it toward a portfolio that is more consistent with Home Office policy?

2. What allocations do you suggest for each client?
3. Which primary characteristic is most restrictive for each client? What would the value be of allowing a 1% deviation between the client portfolio and the Home Office model for this characteristic?
4. At what rate would the objective function change if the penalty on secondary characteristics is increased?
5. Any other valuable insights you can share.

REPORT FORMAT The formulation portion of your report due October 16 should at a minimum contain the following information:

1. 1 paragraph summary of problem statement
2. A description of the decision variables
3. A description of the constraints
4. A description of the objective function

It should not include a solution.

Note, completing the analysis may require solving multiple optimization problems all with similar structure. You may limit your formulation to a description of a single one of these problems, but please indicate which items may change for other problems that need to be solved.

The solution portion of your report due October 23 should have a professional look and feel and at a minimum contain the following information:

1. A statement of the optimal allocation weights for each client
2. Responses to the items your boss is interested in

Your solution report should be no longer than 4 pages. I imagine most of you will only need 2 or 3 pages. Be sure to summarize the key points of the situation, but don't waste a lot of space restating the problem.

You may assume that your reader is familiar with linear programming terminology and all information provided in the problem statement. You may also hand in any supplemental materials that you see fit. Like the main report, these materials should be easy for the reader to peruse (i.e., well-organized and legible) should he/she choose to do so.

Please include pertinent details of your modeling approach or special steps you took in developing a solution, but don't feel compelled to write out all of the mathematical formulation in the solution

portion of your report.

You may solve this problem with whichever tools you choose. I would suggest glpkAPI or AMPL.