PROJECT 3: Customized Retirement Advice

Part 1 due before class on November 25, 2019. (40 points)
A complete formulation will be provided during class on November 25
Solution files are available for sale any time after you have turned in your formulation. The solution files will cost you 20 points
Part 2 not less than 24 hours before your presentation. (40 points)
Part 3: Presentation (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

You are responsible for managing the retirement accounts of several new clients. Luckily, your clients share many similar characteristics. They each have the same salary and savings patterns (with details specified below). They differ in their ages and the amounts that they have been able to accumulate in their retirement accounts. Your goal is to provide each with a recommended portfolio allocation as well as a description of the likely consequences of following your advice.

Each client's salary is tied to their current age using the following formula:

$$\$103.63K - 0.03 * (55 - CurrentAge) * \$1K$$

Assume that salaries increase according to this formula until retirement and that this amount is measured in today's dollars.

They each save 9% of their salary each year and their employers provide a matching contribution on the first 6% for a total of 15% savings.

As shown in the table below, your firm manages a series of low-cost balanced funds (fees shown below in basis points, 1 bp = 0.01%) that can be used to implement investment strategies for your clients.

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8
US Stock	30%	25%	25%	23%	21%	16%	13%	8%
Dev. Int'l Stock	30%	25%	21%	19%	15%	12%	9%	6%
Emer. Mkt. Stock	10%	10%	8%	6%	4%	4%	2%	1%
Global REIT	10%	10%	8%	6%	5%	4%	3%	2%
US Agg Bond	10%	20%	30%	40%	45%	50%	55%	51%
Hedge Funds	10%	10%	8%	6%	5%	4%	3%	2%
Cash	0%	0%	0%	0%	5%	10%	15%	30%
Annual fee	20bp	18bp	16bp	14bp	12bp	10bp	8bp	6bp

The appropriate portfolio will depend on a client's age as well as account balance: those who are

younger have a longer time until retirement and also a greater amount of account contributions in their future; those who are older may be best suited to more conservative strategies if they have already accumulated sufficient assets or perhaps a more aggressive strategy if a comfortable retirement has not yet been secured. You will need to identify the specific portfolio for each client to invest in right now as well as develop a plan for how the appropriate allocation strategy may evolve in the future. Note, the last time point at which an allocation is recommended by *you* is the year immediately before retirement. A different advisor will work with them once they retire.

Client portfolios may not change by more than 1 mix on a year-over-year basis. For example, a client in Mix 4 in a particular year may invest in Mixes 3, 4,or 5 in the following year, but not in Mixes 1, 2, 6, 7, or 8. The motivation for this restriction is to avoid large jumps, to encourage smooth transitions in client allocations and to limit the possibility of allocation reversals as information from the forecasting department evolves over time. As these are new clients, there is no current allocation that would restrict the recommendation of the initial allocation mix.

Based on previous research from your firm, you are able to advise your clients that they can plan to spend during each year in retirement an amount equal to 3% of their account balance as of their retirement date along with an annual increase in spending to compensate for inflation and expect this amount to be sustainable for the remainder of their lives.

You have decided to use a shortfall-based utility function based on the target account balance needed at retirement using the information provided earlier in the project statement. Once you determine the target account balance that would meet the 3% spending rate, you can determine the utility of an account balance of x at retirement as:

$$\begin{array}{rcll} U(x) & = & \frac{x^{0.7}}{0.7} & \text{if } x > \text{Target} \\ & = & \frac{x^{0.7}}{0.7} - \gamma(\text{Target}-x)^2 & \text{Otherwise} \end{array}$$

For risk aversion parameter $\gamma = \frac{1}{5000}$. This parameter is appropriate if monetary units are tracked in thousands of dollars.

~~This utility function acknowledges that outcomes providing less than 80% of the targeted retirement amount should be re-thought. The utility reflected in this lower segment is essentially a placeholder to signal that the individual should consider saving more, retiring on less or postponing retirement. In any case, this analysis is beyond the scope of your current project, but it is important for your utility function to provide a "score" for this outcome without skewing advice provided for those who are generally in a secure position.~~

The forecasting team has provided you with annual scenarios of market outcomes for US Stocks, Developed International Stocks, Emerging Markets Stocks, Global REITs, US Aggregate Bonds, Hedge Funds, and Cash. They have advised that the inflation-adjusted return distribution is jointly

lognormal with the following statistics.

	US Stock	Dev. Int'l Stock	Emer. Mkt Stock	Global RE	US Agg Bond	Hedge Fund	Cash
Mean	6.0%	5.9%	7.0%	5.6%	1.9%	5.2%	1.5%
Stdev	19.1%	20.2%	26.8%	20.7%	3.8%	7.0%	5.8%
Correlation							
US Stock	1.00						
Dev. Int'l	0.74	1.00					
Emer Mkt	0.67	0.70	1.00				
Global RE	0.74	0.78	0.66	1.00			
US Agg	0.13	0.09	0.07	0.10	1.00		
Hedge Fund	0.47	0.46	0.45	0.37	0.10	1.00	
Cash	0.02	0.00	-0.03	-0.03	0.10	0.55	1.00

Please also make the following assumptions:

- immediate and full vesting of all contributions at the time they are made
- that the annual savings are added to the retirement accounts at the beginning of each year (and the current year's contribution is already included in the account balances shown below).
- annual portfolio fees are subtracted from the account balance at the end of the year.
- that once employees retire they aspire to live on 90% of their pre-retirement income (i.e. salary) and that Social Security and other savings will provide 30% of that amount (i.e., the investment account must provide an amount equal to 60% of the pre-retirement income)
- that all of your clients intend to retire at age 67 and will qualify for full Social Security benefits at that time
- savings amounts are post-tax and will not be taxed when spent during retirement. Please ignore any tax-implications for purposes of this project.

Here is a description of your clients:

Name	Current Age	Current Account Balance
Amy Abrams	50	$1,000K
Bob Brown	54	$900K
Carla Clausen	54	$500K
Darrin Dorne	57	$1,500K
Eric Evans	62	$1,200K
Francine Farnsworth	65	$1,600K

Amazingly, everyone had a birthday yesterday.

Part 1: A legibly written or typed formulation for the model is due on Monday, November 25 before class starts. Please define all of your variables and identify the objective function and constraints. Describe the solution method that you intend to pursue. Please also determine:

1. The target retirement account balance
2. The annual savings amounts each year until retirement for each client
3. The constant rate of return that each client would need to generate to accumulate the targeted amount
4. The rate of return necessary if retirement is delayed by one year (assume retirement target stays the same, just one additional year of savings is created)

Part 2: A summary of main results is due *not less than* 24 hours prior to your final presentation.
Part 3: The presentation will be a 10-12 minute oral presentation of the results. You will probably want to use slides or other materials, though this is not required. It is extremely likely that you will be asked questions.

REPORT FORMAT If you use slides in the presentation, your report should contain no more than 7 slides. You should also submit the code you used to solve the model, though there probably will not be time to look through the code at the time of the presentation. Slides can be created in PowerPoint or LaTeXor any other convenient format. These materials should be easy for the reader to peruse (i.e., well-organized and legible).

You **may** assume that your reader is familiar with optimization terminology.

Please post questions/clarifications to the class discussion forum