Optimal Asset Allocation for a pension fund

Your asset management company “Secure Investments” (SI) has been assigned to find an investment strategy for a major pension fund “Fund of Future” (FoF).

FoF requires that you should provide them with an index based investment strategy and you should report historical performance of that strategy and compare it with a simple 1/N strategy. You may only choose from a positive list of 25 ETFs. FoF provides you with historical data series on weekly reported ETF prices (25ETFs.txt). These are data from 28/01/2005 to 10/11/2014.

They want you to report how your strategy would have performed from 28/02/2008 and onwards, if we were to go back in time and actually started investing according to your suggestion. You are also required to document the strategy.

Steps:

1- Scenario generation (20%)

FoF management has indicated that they would like to see whether a CVaR minimizing strategy provides good re sults on their data set. So you decide to implement a CVaR model. For that reason you need to generate scenarios. You decide to use data from 28/01/2005 to 28/02/2008 (see file trtime.txt) to generate your first set of scenarios. You use the bootstrap method to generate scenarios.

Hints: Generate the scenarios in the following manner:

1.1 Use the random generator function in GAMS **uniformint(A,B)** to pick uniformly distributed random integer numbers in the interval A to B.
1.2 Change index prices to weekly returns.
1.3 Generate a scenario with a length of four weeks by randomly picking four dates in the interval you are sampling from (28/01/2005 to 28/02/2008).
1.4 Accumulate the four weeks’ returns to have a scenario over four weeks. Now you have one monthly scenario with the starting date 28/02/2008.
1.5 Repeat step 1.3 and 1.4 to generate 250 monthly (4-weekly) scenarios.
1.6 Now roll the sampling period forward with four weeks (28/02/2005 to 28/03/2008) and generate another 250 scenarios.
1.7 Go on rolling four weeks forward at a time for as long as you data series allow.
1.8 Save the scenario sets in a GDX file, so you can use them as you need them in the rest of this project.

2- Implementing the CVaR model (10%)

Use the first set of scenarios (start date 28/02/2008) and for that implement the Mean/CVaR model. Find the efficient frontier (mean return as a function of CVaR) using 10 optimal solutions starting from the solution which minimized CVaR and going forward in equal increases in CVaR until you reach the 10^{th} solution which is only maximizing average return. Document the model, your start solution (portfolio mix) as well as the values of mean return and CVaR for the 10 solutions. Draw the efficient frontier and also draw histograms over portfolio returns for each of the 10 solutions.

3- Updating the model to a portfolio revision model (15%)

Now you start the first step of your back testing process. Assume that four weeks are gone and you need to revise your existing portfolios on the 28/03/2008. Pick one of the existing portfolios - the most risk averse strategy from the Mean/CVaR model that you obtained by solving the Mean/CVaR model for the first time. Change the Mean/CVaR model so that it allows revising of existing solutions. The transaction cost for each transaction (sell or buy) is 0.1% of the traded amount in kr., but at least 50 kr. per trade.

Run the updated model once for the very risk averse investor. Then run the model for the risk neutral investor. Are there any revisions and if so in what way and why?

Document the updated model in your report.

4- Implementing the back-test (20%)

For the two strategies that you picked under step 3, you will now extend the experiment using all the remaining scenario trees. Your last portfolio revision will take place on the 18/06/2014.

For each strategy draw the following graphs:

4.1 The optimal portfolio mix (total of 100%), including all its revisions.

4.2 Actual index price growth from following the strategy (ex-post), starting with an index of 100. In the same graph include the average, the worst and the best case as suggested by the scenarios (ex-ante).

4.3 Compare the actual performance of the two strategies (the ex-post graphs from 4.2) in the same graph and comment your findings.

Now compare your strategies with the benchmark:

Pick as the benchmark a simple 1/N fix-mix strategy, where you simply pick equal amounts of each asset in the portfolio in the beginning of the test period and make no changes all the way through the testing period. Add this benchmark to the performance graph 4.3.

5- Changing the scenario generation method (15%)

The scenarios you have been using so far are uniformly sampled from historical data. Now use the moment matching model instead.

Calculate monthly sample estimates for mean, standard deviation, skewness, kurtosis and covariance based on the training period. Generate your first 250 scenarios going one month ahead from 28-02-2008, matching the 5 properties of historical data. Then roll one month over like in step 1 and generate another set of 250 scenarios. Repeat the process as long as the time series allow and save the scenarios in a GDX file.

Perform the back-test from step 4 on your strategies and compare the results with the results found under step 4.