UNIVERSITY OF CHICAGO
Booth School of Business

Bus 35120 – Portfolio Management | Prof. Lubos Pastor

Assignment #1

Due: March 31 by 8:15am. (First class assignment.)

Be as clear and brief as possible. The data for this assignment can be downloaded either from Canvas or from http://faculty.chicagobooth.edu/lubos.pastor/teaching/.

NOTE: I recommend that you use the MATLAB software to complete this assignment (as well as all future assignments). Although the analysis required in this assignment can also be carried out using other software such as Excel, some of the future assignments will be difficult to implement in Excel. If you have not used MATLAB before, you can download my brief "Introduction to MATLAB" from the course website. You should also attend the MATLAB review session at the beginning of the quarter (see the syllabus for details).

The purpose of this assignment is to examine the distributions of asset returns at different frequencies (daily, monthly, annual). Download three datasets, *returns_daily.txt*, *returns_monthly.txt*, and *returns_annual.txt*, from the class website (right click and save the data on your computer). Each dataset contains three columns: calendar date, returns on the S&P 500 stock index, and returns on a portfolio of long-term government bonds.

1. Load the data into Matlab.[1]
2. Estimate the means, variances, and standard deviations of returns, at all three frequencies. What are the covariances and correlations between the returns on stocks and bonds, at various frequencies?[2]
3. Estimate the skewness and kurtosis of returns.[3] Based on these statistics, do returns appear to be drawn from a normal distribution?

[1] *Matlab hint:* Suppose the data is in the working Matlab directory. (You can find out what that directory is by typing *cd* in Matlab, and you can change it by typing *cd new_directory_name*.) One way to load the data is to type *x=load('returns_annual.txt')*. Matlab then creates a new variable (x) and sets it equal to the contents of the file. You can then define new variables for the calendar date, stocks, and bond returns: "*caldate=x(:,1);*" sets *caldate* equal to the first column of the data (the date), "*Rstock=x(:,2);*" and "*Rbond=x(:,3);*" set the two variables equal to the second and the third column of the data.

Matlab has an extensive help system. To get help on a given command, type *help* followed by the name of the command. For instance, *help whos* displays the description of the *whos* command. You can also search the help files for a keyword, by typing *lookfor* followed by the keyword. For instance, *lookfor mean* will display all commands whose help files contain the word "mean." Try also *doc*.

[2] *Matlab hint:* Consider using the commands *mean*, *var*, *std*, *cov*, and *corrcoef*.

[3] *Matlab hint:* The relevant commands are *skewness* and *kurtosis*.

4. Create the histograms of stock and bond returns at different frequencies.[4] How close are the empirical distributions to the normal distribution?

In the remainder of the assignment, simply assume that the return distribution is normal at each return frequency, even if such an assumption seems imperfect. (In class, we will study how to get around the normality assumption.)

5. Compute the 95% confidence intervals for the stock (bond) return over the next period (day, month, year). Compute the 95% confidence interval for the arithmetic average stock (bond) return over the following 30 periods (days, months, years).
6. Compute the absolute shortfall probabilities for stocks and bonds. That is, for a cutoff level k, compute the probability that the return over the next period (day, month, year) will be lower than k. Plot this probability as a function of the threshold level k, for $k = -20\%, -10\%, 0, 10\%, 20\%$.[5]
7. Assuming that returns are i.i.d. (i.e., independently and identically distributed), compute the probability that the stock return over the next period (day, month, year) will be lower than the bond return.[6]

[4] *Matlab hint:* To create a histogram of data in vector X, use the command *hist(X,n)*, where n is the desired number of bins (bars in the histogram). To superimpose the plot of a normal distribution on the return histogram, you can use the *histfit* command. The syntax is the same as before: e.g., *histfit(X,25)* creates a histogram of X with 25 bins (bars), and it also plots an appropriate normal distribution density on the histogram. This way, you can compare the relative frequencies of returns observed in reality to those expected if the distribution is normal.

[5] *Matlab hint:* Command *normcdf*(k, m, s) returns the probability that a normally distributed random variable with mean m and standard deviation s is lower than k. Use the estimates of means and standard deviations computed earlier in question 2. The command *plot* might also be useful.

[6] *Statistical hint:* Computing $Prob(R_{stocks} < R_{bonds})$ is equivalent to computing $Prob(R_{stocks} - R_{bonds} < 0)$. Since both stock and bond returns are assumed to be normally distributed, their difference is normal as well. Having the expectation and the variance of the difference, you can use the *normcdf* function again.