MGMTMFE 407: Empirical Methods in Finance
Homework 1

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Please use Matlab/R to solve these problems. You can just hand in one set of solutions that has all the names of the contributing students on it in each group. Use the electronic drop box to submit your answers. Submit the Matlab or R file and the file with a short write-up of your answers separately.

[The quality of the write-up matters for your grade. Please imagine that you're writing a report for your boss at Goldman when drafting answers these questions. Try to be be clear and precise.]

Problem 1: Modeling heavy-tails with jumps

The distribution of stock returns has fat tails (see lecture 1). As a result, we need models that deliver fat-tailed distributions (e.g., to price options on stocks). One way of doing this is to introduce jumps in the model. This problem describes the building blocks of how to do that.

Consider a Bernoulli-distributed variable:

$$B_t = \begin{cases} 0 & \text{with probability } 1 - p \\ 1 & \text{with probability } p \end{cases},$$

and two independent Standard Normal variables ε_t and δ_t. Define the jump as

$$J_t = B_t \times (\mu_J + \sigma_J \delta_t)$$

and let return follow the process:

$$r_t = \mu + \sigma\varepsilon_t + J_t.$$

1. Derive the mean, variance, skewness and excess kurtosis of this distribution.

2. Explain carefully why this Bernoulli-normal mixture is potentially a better model of returns than the log-normal model.

3. Suppose that log returns r_t are simply i.i.d. distributed $N(0.008, 0.063^2)$. Plot a simulated series of 600 observations (50 years). Does it look like the data? What is missing?

   Next, suppose that log returns r_t are given by the above jump model with the following 5 parameters:
   $$(\mu, \sigma, p, \mu_J, \sigma_J) = (0.012, 0.05, 0.15, -0.03, 0.1)$$

   Using these parameter estimates, what are the unconditional mean, standard deviation, skewness and kurtosis of log stock returns? Again, plot a simulated series of 600 observations (50 years). Does it look like the data? What is missing?

Problem 2: The Currency Carry Trade

The Deutsche Bank G10 Currency Future Harvest Index is, at any one time, composed of long futures contracts on the three G10 currencies associated with the highest interest rates and short futures contracts on the three G10 Currencies associated with the lowest interest rates.* The Index re-evaluates interest rates quarterly and, based on the evaluation, re-weights the futures contracts it holds. Immediately after each re-weighting, the Index will reflect an investment on a 2:1 leveraged basis in the three long and three short futures contracts (unless USD is one of the six currencies associated with the highest or lowest interest rates, in which case the Index will reflect an investment on a 1.66:1 leveraged basis). The PowerShares DB G10 Currency Harvest Fund tracks this index. Its ticker symbol is *DBV*. The price data is provided to you in the spreadsheet. Also provided in a second spreadsheet is the S&P500 index, whose ticker symbol is *GSPC*.

Throughout this problem, use the adjusted closing values of the index. These values have adjusted for dividends and splits.

1. Visualizing the data.

   (a) Create time series plots of the daily log-returns for *DBV* and *GSPC*.

   (b) Create histograms of the daily log-returns for *DBV* and *GSPC*.

2. Shape of Return Distribution:

   (a) Test the null that the skewness of daily log returns is zero at the 5% significance level.

   (b) Test the null that the excess kurtosis of daily log returns is zero at the 5% significance level.

   (c) Test the null that the daily log returns are normally distributed at the 5% significance level using the Jarque-Bera test.

3. Compare all of these numbers in (a) and (b) to the same numbers for daily log returns on the S&P 500 measured over the same sample in one single table.

4. Suppose you are a fund manager with a target return in mind (say 20 % per annum), and suppose that the ratio of expected returns to standard deviation is 0.50 for both

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investments. Using these numbers, discuss the different nature of the risks you would face if you invested in equity or currency markets to achieve that target return (with the appropriate leverage).

5. Regress the log DBV returns on the log $GSPC$ returns. Report the standard errors of the slope and intercept coefficients using both standard OLS assumptions and allowing for non-normalities and heteroskedastic errors (White standard errors). Explain why the two are different and give the intuition for why White standard errors are smaller/larger than the classic OLS standard errors in this case.