CISC5352: Financial Programming and Data Analytics Homework (1)

Evaluate IT and Bank stock risk from volatility (40 points)

Go through your Lecture 3 to digest the stock retrieve, volatility calculation details via using Pandas and related materials. Then finish the following assignments.

1. Retrieve stock data for the following two types of companies (IT and Bank industry) from Jun 01, 2006 to June 01, 2016 in Excel files[1]
   (a) GOOGLE(GOOG),
   (b) YAHOO (YHOO),
   (c) APPLE (AAPL),
   (d) Microsoft (MSFT),
   (e) Amazon (AMZN),
   (f) JPMorgan Chase & Co. (JPM),
   (g) Bank of America (BAC)
   (h) HSBC USA Inc (New)
2. Compare the stock price patterns of these companies during the ten years (need plots)
3. Compute the mean, median, standard deviation, skewness, kurtosis for close price and volume for each data set (need plots).
4. Output all stock prices (close price) which are >= 95% percentile and their corresponding volumes and dates for each data set.
5. Compare their stock volatility values during the period (need plots).
6. Give your analysis about the performance of the two types of stocks.

[1] Extra credits will be given for folks who retrieved them in one Excel file via programming

How to compute skewness and kurtosis for a data set (sample)?

Given a sample $X : x_1, x_2 \cdots x_n$, its skewness and kurtosis can be calculated as follows

$$shewness(X) = \frac{n}{(n-1)(n-2)} \frac{\sum_{i=1}^{n}(x_i - \bar{X})^3}{s^3}$$

$$Kurtosis(X) = \frac{1}{n} \frac{\sum_{i=1}^{n}(x_i - \bar{X})^4}{s^4} - 3$$

where s is the standard deviation of X

Pricing Barrier Options (30 points)

As an exotic option, the payoff of a barrier option is no longer dependent on the underlying asset price at expiration time. Instead, it has a special asset price S_b selected as a barrier value, which can be crossed or not. Here 'crossed' means the barrier value S_b above or below the current asset S. It is noted that the option holders has the right to exercise their European call or put option at the exercise price K, provided S does not cross S_b

- A knock-*out* (in) option is a European option whose contracts will be *canceled* (activated), if the barrier value is crossed,
- There are four main barrier options
  - Down-and-out options: the option will be void if $S_b < S$
  - Down-and-in options: the option will be activated if $S_b < S$
  - Up-and-out options: the option will be cancelled if $S_b > S$
  - Up-and-in options: the option will be activated if $S_b > S$

For some barrier options, there are analytic pricing solution available. Given *a down-and-out put* with strike price K, expiring time T and a barrier value S_b, we have the following results:

$$P = Ke^{-rT}\{N(d_4)-N(d_2)-a[N(d_7)-N(d_5)\}-S\{N(d_3)-N(d_1)-b[N(d_8)-N(d_6)]\}$$

where we have the following parameters:

- $a = (S_b/S)^{-1+2r/\sigma^2}$, $b = (S_b/S)^{1+2r/\sigma^2}$
  - $d_1 = \frac{\log(S/K)+(r+\sigma^2/2)T}{\sigma\sqrt{T}}$
  - $d_2 = \frac{\log(S/K)+(r-\sigma^2/2)T}{\sigma\sqrt{T}}$
  - $d_3 = \frac{\log(S/S_b)+(r+\sigma^2/2)T}{\sigma\sqrt{T}}$
  - $d_4 = \frac{\log(S/S_b)+(r-\sigma^2/2)T}{\sigma\sqrt{T}}$

- $d_5 = \frac{\log(S/S_b) - (r - \sigma^2/2)T}{\sigma\sqrt{T}}$
- $d_6 = \frac{\log(S/S_b) - (r + \sigma/2)T}{\sigma\sqrt{T}}$
- $d_7 = \frac{\log(SK/S_b^2) - (r - \sigma^2/2)T}{\sigma\sqrt{T}}$
- $d_8 = \frac{\log(SK/S_b^2) - (r + \sigma^2/2)T}{\sigma\sqrt{T}}$

Complete the following assignment

- Price the following down-and-out put option with by using a sequence of barrier values: $S_b = [70, 60, 50, ...20, 10, 1]$ and compare the prices with its price under BS model.

  $S = 100$

  $K = 105$

  $r = 0.05$

  $T = 0.75$

  $\sigma = 0.4$

- Price the down-and-out-put option with by using a sequence of σ : $\sigma = [0.55, 0.5, 0.45, 0.4, 0.35..., 0.1]$ and visualize the relationship between volatility and such a barrier option price.

  $S = 100$

  $K = 105$

  $r = 0.05$

  $T = 0.75$

  $S_b = 60$

What should you turn in?

- 1. A folder contains your source files and related output.
- 2. Please name your folder as first-name_last-name_CISC5352_homework_1. For example, John_Smith_CISC5352_homework_1 if your name is John Smith.
- 3. Send the zipped file (.zip instead of ,rar) of your folder to Blackboard before 11:59 pm Sept 30, 2016