Course: ESSEC Masters in Finance – Python

Written Assignment

Instructions:

1. This written assignment consists of 80% of your final grade. The remaining 20% will be from your class participation
2. In groups of maximum 3 persons per group, please present your answers in Python scripts
3. Once complete, please email me the soft copy of your scripts [ it should clearly mention your group members as well as individual emails] as well as the Python source files. Please zip up all the files into one final zipped file

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1. Please ensure that you do not split the questions among each group member but work on them collectively as it is to encourage team building and group spirit. The questions are set to a reasonable level of difficulty. If you feel any team member is free loading or not contributing enough, please drop me an email and I will investigate the matter. Your email will be kept fully confidential in line with ESSEC’s university standards and guidelines
2. Each team member will get the same grade/marks as your team members ie the same mark is allocated to the entire team.
3. Please show your individual workings clearly. Marks are given for structured thinking, analysis and the ability to present your thoughts clearly. Remember certain key concepts of keeping your code DRY (don’t repeat yourself) as well as providing adequate comments to anybody trying to understand your code.

It was a pleasure to train you in Python and thank you for giving me the opportunity.

You have recently joined Bank XYZ as a front office junior quantitative analyst. Your tasks are as below

**BackGround:**

Part A: (30 marks)

In Europe, the EURO STOXX 50 Volatility (VSTOXX) market index is based on the market prices of a basket of Euro STOXX 50 Index Options (OESX) and measures the implied market volatility over the next 30 days on the EURO STOXX 50 Index.

The VSTOXX or EURO STOXX 50 Volatility is a class of volatility derivatives serviced by the Eurex Exchange. The VSTOXX market index is based on the market prices of a basket of OESX quoted at-the-money or out-of-the-money. It measures the implied market volatility over the next 30 days on the EURO STOXX 50 Index.

The EURO STOXX 600 Index historical daily data can be obtained at http://www.stoxx.com/download/historical\_values/hbrbcpe.txt under Benchmark Indices of the Historical Data category of the website. file.

The VSTOXX historical daily data can be obtained at http://www.stoxx.com/download/historical\_values/h\_vstoxx.txt. The EURO STOXX 50 Volatility link is found under Strategy Indices of the Historical Data category of the website.

The column definitions of the STOXX Europe 600 data file are given in the following table:

|  |  |
| --- | --- |
| Abbreviation | Benchmark index |
| SX5P | STOXX Europe 50 |
| SX5E | Euro STOXX 50 Index |
| SXXP | STOXX Europe 600 |
| SXXE | EURO STOXX |
| SXXF | STOXX Europe 600 ex UK |
| SXXA | STOXX Europe 600 ex Eurozone |

The column definitions of the VSTOXX data file are given in the following table:

|  |  |
| --- | --- |
| Abbreviation | Benchmark index |
| V2TX | The actual EURO STOXX 50 Volatility values |
| V6I1 | VSTOXX 1 month |
| V6I2 | VSTOXX 2 months |
| V6I3 | VSTOXX 3 months |
| V6I4 | VSTOXX 6 months |
| V6I5 | VSTOXX 9 months |
| V6I6 | VSTOXX 12 months |
| V6I7 | VSTOXX 18 months |
| |  | | --- | | V6I8 | | VSTOXX 24 months |

1. Prepare a Python module that can fetch data upon request from this 2 websites.

Your manager wants the file to be downloaded daily around 8am Singapore time.

The file should be stored in a location of your choice and have the name of the file + date/timestamp the file was downloaded at. Example, xxxxxxx2019040100800.xxx

Eg the file was downloaded on 1 April 2019 at 0800am.

1. Next you observe several issues with the data and need to prepare some scripts to clean the data
2. The Eurostoxx file original data has unwanted headers and extra ; after line 3887. Prepare a Python module to get rid of this
3. Write a simple module to “test” the data is consistent in its format and structure for both data sources each time you download it after cleaning it
4. Merge Euro STOXX 50 Index and actual EURO STOXX 50 Volatility value from the 2 different sets of data into a single dataframe. Study the data carefully before doing so
5. Perform a simple time series analysis of both graphs on the same chart and comment

**Part B: Stochastic differential equation for Merton jump diffusion model (40 marks)**

It is common to model jumps in equities and FX modelling space where the jumps are modelled using a Poisson process

St Index level at date t

r Constant riskless short rate

Drift correction for jump to maintain risk neutrality

σ Constant volatility of S

Zt Standard Brownian motion – random numbers generated

Yt  Jump at date t with a Poission distribution

N t Poisson process with intensity

The Euler discretization of the equation is below:

1. Write a Python module using procedural programming which can simulate a stock price following the jump distribution described above. Feel free to use the parameters below. Your code should be able to read in and validate entries from the user for all variables in the equation. Use an appropriate number of simulations

S0 = 100 (Initial stock price)

r = 0.05 σ = 0.2 λ = 0.75 μ = -0.6 Δt = 0.25 T = 1.0

1. Plot the first 20 simulated index level paths and describe them.
2. Using your code to modify the jump values, plot the new distribution and comment on them

Part C: Class Design for the jump diffusion equation (30 marks)

Write a class using an object-oriented approach(OOP) that can do the following

1. Read in input variables the user enters for the jump diffusion equation
2. The user can retrieve default values
3. The user can override default values in the code
4. Price a vanilla European Call and European Put using the jump diffusion equation