Group assignment

The students should study a particular model (or type of models) based on a Lévy process and some of its applications to finance. The main sources of information should be: (i) the paper in the list about the model (or type of models), (ii) the book of Schoutens "Lévy processes in Finance", where the main Lévy models are discussed in chapters 5 and 6 (also in chapter 7 for stochastic volatility models), numerical simulation is discussed in chapter 8; (iii) the book of Cont and Tankov "Financial Modelling with jump processes", where the main Lévy models are discussed in Chapter 4 (and chapter 15 for stochastic volatility models), numerical simulation is studied in chapter 6, and option pricing modeling in chapter 11.

The students should produce an original report about the studied model, its main properties and some of its financial applications.

Moreover, the students should try to simulate the model and use the model to calculate the price of some options, as described below. The results obtained should also be presented in the report.

Consider parameters for the model that were estimated in the book of Schoutens, "Lévy processes in Finance" - see Tables 6.3. or 7.3 (stochastic volatility models) in this book - and with these parameters try to:

(1) Simulate trajectories of the Lévy process considered in the paper. About the simulation of Lévy processes, we recommend chapter 8 of Schoutens book and/or chapter 6 of the book of Cont and Tankov.

(2) By Monte-Carlo simulation or using an appropriate closed form formula, calculate the price of some call options over the S&P 500 Index at the close of the market on 18 April 2002. This data is presented in a Table in Appendix C (pages 155-156) of Schoutens book. Use the maturity date of September 2002 and use strike prices from $K = 975$ to $K = 1225$ that are listed in the table with data for September 2002 ($K = 975, 995, 1025, 1050, 1075, 1100, 1125, 1135, 1150, 1175,$ $1200, 1225$). Compare the obtained prices with the real prices (presented in appendix C) and with the prices obtained by the Black-Scholes formula (using $\sigma = 0.1812$ - See Schoutens, pages 39-41). Calculate also the Root Mean Square Error (RMSE - Book of Schoutens, page 7) for this set of call option prices and comment.

(3) By Monte-Carlo simulation, calculate the price of an exotic Barrier option of the type "up-and-out barrier call" (UOBC), which is worthless unless its maximum remains below some high barrier H, in which case it retains the structure of a European call with strike K (see Schoutens, chapter 9). Take the time to maturity $T = 1$, the strike $K = S_0 = 1124.47$ and compare the price obtained with the ones in Table 9.1 (Chapter 9 of Schoutens). You can consider 10 000 simulations of paths covering a one-year period and 250 equally small time steps. The barrier H is given by $H_{UOB} = 1.3 \times S_0 = 1461.811$.

Moreover, the students should present their work in a 20 minutes short talk, followed by a period of questions and answers of 10 minutes.

The maximum number of pages of the report text should be 20 (without appendixes). The total maximum number of pages (with bibliography and appendixes) should be 24. It should be delivered in a pdf file, sent by e-mail to jguerra@iseg.ulisboa.pt before (or on) December, 7, 2020. The files used for the numerical simulations (code and outputs) should also be sent on the same date by e-mail or a link for the files should be provided. The group reports should be presented online trough the Teams platform on December, 9 or December, 14 or December, 16.