Group assignment

Each group of 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 and some technical details about the models are also described in Appendix B; (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 modelling in chapter 11.

The students should produce an **original report** about the **studied model**, its **main properties** and some of its financial applications. The students should also describe what is the effect of the different parameters of the basic process used in the behaviour of the Lévy measure and in the statistical properties of the model. The reports will be submitted to anti-plagiarism software and use of artificial intelligence detection systems.

Moreover, the students should **simulate the model** and use the model to **calculate the price of some options, as described below**. **The results obtained must 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 considering these parameters:

(1) Simulate some trajectories of the underlying Lévy process of your model and plot these trajectories for the parameter values estimated in the book and also for a set of different values of the parameters, in order to analyse the effect of the parameters on the trajectories. Describe the algorithm you use for the simulation of these trajectories. About the simulation of Lévy processes, we recommend as main sources of information the chapter 8 of Schoutens book and/or chapter 6 of the book of Cont and Tankov.

(2)

(i) By using an appropriate closed form formula for your model (these closed form formulas are briefly presented in page 20 of the Book of

Schoutens), 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 dates of September 2002 and December 2002 and use all the strike prices in the Table for these maturity dates.

(ii) Calculate the same prices as in (i) but using the Monte-Carlo simulation method for your model and compare prices obtained with the prices obtained in (i).

(iii) Compare the obtained prices obtained in (i) and (ii) with the real prices (for the strikes in the Table where you have real prices) and calculate the average percentage error (or average absolute error as a percentage of the mean price – APE, see book of Schoutens, chapter 1) for the set of call option prices that you calculated and that are presented in the Table of appendix C. Compare this APE value with the APE value obtained by using the Black-Scholes formula (see the parameters estimated for the Black-Scholes model on pages 39-40 in Schoutens book) and the real prices.

(3)

By Monte-Carlo simulation, calculate the price of an exotic option of the type "Lookback Call option" (LC), which gives the right to the holder of the contract to buy the underlying risky asset by the minimum price it has achieved over the life of the option (see Schoutens, chapter 9). Take the time to maturity T to be 1 year and S_0 = 1124.47. Compare the value obtained with the ones in Table 9.1 (Chapter 9 of Schoutens). You can consider 3000 simulations of paths and 250 equally small time steps. Study also the effect on the price of the LC option of changing the maturity and of changing slightly (about 10%) the value of one estimated parameter of the model (select the parameter you think can have more influence in the price).

The students should present their work in a 20 minutes short talk, followed by a period of questions and answers of 5-10 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) November 20, 2025. 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 on class on November 25 or November 26.