Market Risk – ESILV – 2024-2025

You will be partly evaluated on this project. You will work in groups of two students of the same TD group (an odd number of students must lead to a single "group" of one student: I will not allow groups of three students). Before the end of **Monday 30th December**, you will send by mail to your TD teacher your report in pdf (explain briefly what you did in addition to the result) as well as the code that you created to answer the questions (please, put the code related to each question in the report). The choice of the programming language is free (you can even mix different languages), but the use of packages is forbidden.

Any plagiarism, use of ChatGPT or other software that automatically generates text, code or images is dishonest for academic work and is therefore strictly prohibited. Any violation of this rule for part of your work will result in a grade of 0 for the entire project.

Question A (Ex2, part of Q1 and of Q2 of TD1)

a – From the time series of the daily prices of the stock Natixis between January 2015 and December 2016, provided with TD1, estimate a historical VaR on price returns at a one-day horizon for a given probability level (this probability is a parameter which must be changed easily). You must base your VaR on a non-parametric distribution (logistic Kernel, that is K is the derivative of the logistic function $x \mapsto 1/(1+e^{-x})$).

b – Which proportion of price returns between January 2017 and December 2018 exceed the VaR threshold defined in the previous question? Do you validate the choice of this non-parametric VaR?

Question B (Ex2, Q4 of TD2)

We want to calculate the VaR (on the arithmetic variation of price, at a one-day horizon) for a call option on the Natixis stock. You will implement a Monte-Carlo VaR since the call price is a non-linear function of the underlying price, that we are able to model thanks to historical data. Here is, in detail, how you must proceed:

- Estimate the parameters of a standard Brownian motion on the Natixis stock between 2015 and 2018, using an exponential weighting of the data.
- Simulate a number N (say N=1000 or else, but justify your choice for this number) of prices of the stock in a one-day horizon (we are working at the last date of 2018).
- Transform each of these prices of underlying in prices of the corresponding call (say at the money, with one-month maturity and 0 risk-free rate and dividend).
- Pick the empirical quantile of these N call prices to build the VaR of the call.

Question C (Ex2, Q1 and Q3 of TD3)

With the dataset provided for TD1 on Natixis prices, first calculate daily returns. You will then analyse these returns using a specific method in the field of the EVT.

a – Estimate the GEV parameters for the two tails of the distribution of returns, using the estimator of Pickands. What can you conclude about the nature of the extreme gains and losses?

b – Determine the extremal index using the block or run de-clustering.

Question D (Ex2, Q3 and Q4 of TD4)

With the dataset provided for TD4:

a – Estimate all the parameters of the model of Almgren and Chriss. Is this model well specified?

b – In the framework of Almgren and Chriss, what is your liquidation strategy (we recall that you can only make transactions once every hour).

Question E (Q2 and Q3 of TD5)

a – With Haar wavelets and the dataset provided with TD5, determine the multiresolution correlation between all the pairs of FX rates, using GBPEUR, SEKEUR, and CADEUR (work with the average between the highest and the lowest price and transform this average price in returns on the smallest time step). Do you observe an Epps effect and how could you explain this?

b – Calculate the Hurst exponent of GBPEUR, SEKEUR, and CADEUR. Determine their annualized volatility using the daily volatility and Hurst exponents.