Risk Management course, 2019-2020
Université Paris 1 Panthéon-Sorbonne – Mosef

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Quantifying model risk of risk models

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Due on 15th March, at noon

The aim of this project consists in quantifying model risk, in particular in the framework of market risk measures. You are going to implement simple market risk measures such as VaR or ES (expected shortfall), and to study different kinds of model risk. Please note that your VaR and ES must be estimated on the daily price returns and not on the price itself. All risk measures will be at a one-day horizon.

The first step for you consists in downloading market data for a financial asset of your choice. Choose a three-year daily dataset. For example, you can find all these historical data in the website abcbourse.com.

What I expect from you is a sole pdf file (either in English or in French) with all your detailed answers (do not hesitate to include graphs if it is relevant). In addition, provide me with the files you used for the calculations (for instance an Excel file, but you can choose any other type of file). I will not take into account your mastering of a difficult programming language (simply choose the one you prefer) since I only want to evaluate your abilities in quantitative risk management. Moreover, everything you want me to see must be in your pdf (do not ask me to look at your answer in another file, for example).

Groups of three or two students.

1 About various calculation methods for the VaR

In this section, you will calculate VaRs following various methods.

Question 1. *Determine your VaR at* 99% *at a one-day horizon using alternatively the following methods:*

- ▷ *empirical quantile,*
- ▷ *parametric distribution,*
- ▷ *nonparametric distribution.*

Describe each of these methods in your particular framework. Which method do you prefer in your framework?

Question 2. *Using the estimator of Pickands, determine the parameter of the GEV function of losses. Comment its value.*

Question 3. *Determine the VaR at* 99% *at a one-day horizon using the EVT approach.*

Question 4. *What is Leadbetter's extremal index for the dataset? Comment its value and explain how you should change your VaR to take this into account (only provide an explanation, with equations, do not calculate a new VaR).*

Question 5. *What is a Hurst exponent and how can one interpret its value?*

Question 6. *Propose a risk measure taking into account the Hurst exponent and calculate its value for the price series used in this project. The Hurst exponent must be estimated with the absolute-moment estimator. This risk measure must take into account the autocovariance of a fBm (like in the Nuzman-Poor approach for predictions).*

2 From VaR to ES

Question 7. *For each of the methods exposed above for calculating VaR, expose a method to extend them to ES. Calculate the* 99% *ES on the same sample.*

Question 8. *Backtest the ESs and the corresponding VaRs on your sample. Pay attention to the strict separation of estimation sample and test sample for this question (for the other questions, simply estimate the risk measures on the whole sample). Comment the result about the relative accuracy of ES and VaR.*

3 Model risk as estimation uncertainty

The first question is very general and not focused on our case study.

Question 9. *What is model risk and what are the different natures of model risk?*

We now go back to our case study and try to quantify one aspect of model risk.

Question 10. *For the parametric VaR, determine the distribution of your parameters and determine, either theoretically or by simulations, the corresponding distribution of VaR (each parameter is a random variable; if we draw a vector of parameters, we have one value for the VaR which is different from the VaR obtained for another drawn vector of parameters).*

Question 11. *If we suppose that price returns are iid Gaussian variables, determine, with the help of simulations, the distribution of the EVT parameters as well as the corresponding distribution of VaR.*

Question 12. *Apply the same method than the one exposed in Question 11 to determine the distribution of VaR in the fBm case.*

Question 13. *Represent in a graph the nonparametric VaR as a function of the bandwidth parameter of the kernel. Explain the method used to get this result.*

4 Model risk as specification uncertainty

First, you are going to see the uncertainty as the maximal difference between all your models for a same risk measure. We are going to call this measure a diameter.

Question 14. *Using the VaRs and ESs implemented in the first two sections, determine the diameter for VaRs as well as the diameter for ESs. Comment the result with respect to model risk: is it more relevant to use ES or VaR?*

Question 15. *Is your conclusion at Question 14 the same if you change the confidence level from* 99% *to* 90%, 95%, 98%, 99.5%, 99.9%, *and* 99.99%*?*

You are now going to implement differently the risk of bad specification. Every model can be seen as real phenomenon augmented by a noise. We want to see the impact of noise on the VaR measure for all the models. We can do this in various manners:

- ▷ by adding some noise to the price return series,
- ▷ by removing the noise from the price return series.

Question 16. *Add a noise process (say a Gaussian white noise) to the price return process and calculate the average impact on the VaR for each model. Which VaR method is the most robust? Display your results for various amplitudes of noise.*

Question 17. *Remove the noise of the price return process using the projection of your signal at one scale. Do this with scaling functions (also called father wavelet).*

Question 18. *How do your VaR measures vary if they are applied to the denoised series? Display your results for various projection scales. Compare qualitatively your results with the ones of Question 16.*

Travaillez bien !