

Project guidelines

Econometrics of Financial Asset Pricing Models

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The objective of this project is to help you work around GARCH models by applying it and by discussing the results obtained. The project is based on the dataset "cac.csv", that should be loaded before any computation.

1. Explain rapidly what a GARCH(1,1) model is. Explain why this modeling framework has been that fruitful over the past 30 years: what makes it work, for what kind of purpose is this model designed and what is the intuition behind the parameters of the model.
2. Estimate the parameters of the model using the whole dataset cac.csv. Comment the parameters' values. Estimate the parameters using only the last 400 observations. Comment these new parameters' value. Can you guess what changed these values, when comparing the whole sample's estimation with the end of the sample's one?
3. Based on these two sets of parameters, compute the implied volatility surfaces obtained in each case, for moneynesses ranging from 0.8 to 1.2, maturities up to 6 months (that is 180 days, roughly speaking), by assuming that the risk free rate is equal to 5% and that μ is equal to 5% too. Plot both of them using the `persp` function. For a maturity of 3 months, plot the smiles obtained with the two sets of parameters on the same chart. Comment the result. Plot the term structures of implied volatility for at-the-money options obtained with both sets of parameters. Comment the results.
4. Create a function (copy/paste it in your report) that computes the log-likelihood of a GARCH-GJR model, by modifying the existing GARCH(1,1) likelihood function. This model is as follow

$$r_t = \mu + \sigma_t \epsilon_t \tag{1}$$

$$\sigma_t^2 = \omega + \alpha(r_{t-1} - \mu)^2 + \beta\sigma_{t-1}^2 + \delta \max(0, -(r_{t-1} - \mu))^2 \tag{2}$$

5. Use this function to estimate the same sets of parameters as in the GARCH(1,1) case. What is a leverage effect? How is it captured in the GARCH-GJR model? Explain the results obtained and compare again the two sets of parameters.

6. Perform the same computations and comments as in question 3 using these GARCH-GJR estimates (use the same moneynesses, maturities, risk free rate and drift).

The project is due on the **4th of April**. A single **.pdf** document should be sent at florian.ielpo@ensae.org before midnight. Any email sent after this deadline will not be considered. No exception for any reason will be accepted. Only email-sent projects will be considered. The document should include your answers to each question and the requested figures, along with the names of the authors and their emails so that I can reach each of you in case of problem. **Maximum number of students for each project is 4**, without any exception. When sending your project via email, you will receive an answer acknowledging the reception of your work within two days. If not, contact me explaining your situation.