

Lecture 6 Homework: Maximum Likelihood Estimations

(Homework Due by Lecture 7 in Chalk FINM331 Digital Dropbox or otherwise acceptable to TA/CA/Graders)

**You must show your work, code and/or worksheet for full credit.**

1. (20 points) For this problem, assuming the market is a pure diffusion with constant mean and volatility parameters,
  - (a) Use your 2005-2008 log-return data or any other four-year (or more) data range;
  - (b) Assume the market is a pure diffusion with constant mean, volatility/variance and time-step (use the mean time-step to 5 digits in years appropriate for the number trading days per year of your data, and not the generic value of 252 trading days per year) for parameters (do not laugh);
  - (c) Select a MATLAB optimizer like general derivative-free `fminsearch` or least-squares derivatives-optional (recommended) `lsqnonlin`, or equivalent, to find the optimal estimates of the mean and variance diffusion parameters;
  - (d) Find the optimal estimates of the mean and variance diffusion parameters to 4 significant digits (if you do not know what that means, look it up);
  - (e) Use MATLAB's `mean` and `variance` to compute the first four gross moments directly from the log-return data, also presenting the skewness and excess kurtosis coefficients from the moments .
  - (f) Clearly state and label your results and discuss them.
2. (20 points) Do the same for the data with method used in Problem 1, except use the actual time-step in trading days of days between closings counting week-ends, holidays and missing or NAN days (see Lect. 6, Sect. 6.1). In addition,
  - (a) Report mean and standard deviations for your time-step data;
  - (b) Computationally compare the mean, standard deviation and variance parameters of the constant and nonconstant time-step diffusion results in absolute and relative differences relative to the constant case;
  - (c) Discuss the differences.
3. (20 points) Do the same for the data in Problem 1 and 2 for the truncated simple 1-jump-amplitude, 4-parameter  $(\widetilde{m}, \widetilde{v}, \lambda, q_0)$  jump-diffusion model, with non-constant time-steps but otherwise constant parameters, at the bottom of page 12 of Lect. 6, Sect. 6.3, except that the general method `fminsearch` would be needed since it is not a nonlinear least squares problem (but see decision table on p. 17).
  - (a) Computationally compare the diffusion component mean, standard deviation and variance  $(\widetilde{m}, \sqrt{\widetilde{v}}, \widetilde{v}, )$  parameters of the constant and nonconstant time-step diffusion results in absolute and relative differences relative to the constant case.