

Project A

FWD Calibration and Monte Carlo simulation (Geometric)

Consider a geometric process driven by Brownian OU and by one Variance Gamma OU ($p=m=n=1$). You are asked to calibrate the model on German electricity swaps and price European options by means of Monte Carlo simulation.

The DATA_DEEEX file contains all liquid maturity for the German power futures. E.g. the NOV4 swap expires on the 29th of November 2024. It is a monthly contract with monitoring dates over the month of December 2024. Settlement is at the end of the monitoring period. The 3Q25 contract expires on the 28th of June 2025 and has monitoring period over the third quarter of 2025. You are on the 4th of November 2024.

- i. Write the spot price considering: i) for the Gaussian OU in (3.13) of Benth 2008 $x_0 = 1, \mu = 0$ and α, σ constant ii) for the additive OU in (3.14) of Benth $y_0 = 1, \delta = 0$ and β, η constant. Consider the Variance Gamma process as driver of the additive OU and assume a yearly seasonal behaviour $\Lambda(t) = A \sin(2\pi t) + B + Ct$. Compute all integrals that can be solved analytically. What is the admissible range for the model parameters?
- ii. Write the future price (under Q) at time t, consider the Esscher transform coefficients $\theta=0$. Compute also in this case all integrals that can be solved analytically.
- iii. Write the swap price at time t as in the finite sum at page 120 of Benth 2008. Consider a discrete weekly observation time. Consider a delivery period that starts on the first day of the month of interest and ends on the last day of the month of interest. Monitoring dates should be the first and the last day of the month and any Monday between beginning and end dates. E.g., for the NOV4 swap monitoring days will be the 2st of December, the 9th, 16th, 23th, and 30st of December. Settlement dates of the futures are on the last day of the month.
- iv. Calibrate the geometric model on the German power futures price provided. You should calibrate $\alpha, \sigma, \beta, \eta, A, B, C$ and the Variance Gamma parameters. Comment on the calibration results and on the calibration speed. Are they reliable? Can you propose some modifications to improve the model parsimony?
- v. Simulate the geometric model and price European options on the Q42025 forward with strikes in the range 400/600 and maturity 6 months. Compute the model price implied volatility and comment on its level and skew (i.e. asymmetry). Is there an analytical formula for option prices?
- vi. Repeat points 1-5 on a Geometric model with based only on Gaussian OU model (i.e. $m=p=1, n=0$), do the results change substantially?

Deliver a MATLAB library

