Index options under NGARCH

Assignment #3 – Derivatives (60-206) – HEC Montréal
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The objective is to evaluate European call options on the S&P TSX assuming an NGARCH specification for the index returns.

1. Download the Excel data file containing the time series of the adjusted closing price for the S&P TSX index over the November 23, 2015 - November 20, 2020 period. Plot the evolution of the index price and that of the index returns. Compute the sample retun volatility assuming 252 trading days within a year. Explain why the NGARCH model could be a sensible way to model the index returns.
2. Estimate the NGARCH model from maximum likelihood. Initialize the variance with the square of the first sample return. Use a daily risk-free rate of 2%/365. Verify that the unconditional volatility of your estimation is comparable to the level of the sample volatility.
3. Simulate 100,000 paths of daily index returns for the next 63 days. Evaluate the 51 European 3-month (63-day) calls with strikes ranging from 15,000 to 20,000 by increments of 100.
4. Plot the smile corresponding to the 51 simulated call prices.