

Assignment 3 (Part 2)

Background

Straddles or strangles are often suggested as a way for market participants to trade the future realized variance of a stock.

In this Assignment, you will be asked to use Monte Carlo simulation to assess the effectiveness of a naked or delta-hedged straddle in capturing the realized variance of the underlying stock when the stock volatility varies randomly.

Working Assumptions

Assume that:

- The current cash price of XYZ stock is \$100.
- XYZ will not pay any dividends over the next year.
- The overnight risk-free rate is 5% and is expected to remain constant at this level over the next year.
- One-year ATMS European calls or puts on XYZ can be traded at a BSM implied volatility of $\sigma_{imp} = 27.625\%$.

Questions

- (a) The Excel spreadsheet *SimulatedPaths.xlsx* contains 500 simulated risk-neutral XYZ price paths with time step $h = 1/252$ (1 business day).¹ Compute the realized variance of XYZ along each simulated price path. Produce a histogram showing the distribution of the realized variance and compute the mean and standard deviation of the distribution.

¹The paths were simulated using the Heston model.

- (b) Compute the cumulative PnL along each price path of a naked long position in a 1-year ATMS straddle on XYZ held to expiration. Produce a histogram showing the distribution of the cumulative PnL and compute the mean and standard deviation of the distribution. Finally, explain why the sign of the mean cumulative PnL is reasonable.
- (c) Estimate the univariate OLS regressions of the cumulative PnLs in part (b) on the stock price on the expiration date and on the realized variance. For each regression, report the estimated regression coefficients and the regression R^2 .
- (d) Compute the cumulative PnL along each price path of a long position in the straddle in part (b) held to expiration and delta-hedged daily using the BSM model with constant volatility $\bar{\sigma} = 25\%$. Produce a histogram showing the distribution of the cumulative PnL and compute the mean and standard deviation of the distribution. Finally, explain why the sign of the mean cumulative PnL is reasonable.
- (e) Estimate the univariate OLS regressions of the cumulative PnLs in part (d) on the stock price on the expiration date and on the realized variance. For each regression, report the estimated regression coefficients and the regression R^2 .
- (f) Would you expect a delta-hedged ATMS straddle to be more effective than a delta-hedged ATMS call or put as a way to trade the future realized variance of a stock? Explain why or why not.