

Problem 1

| Metric | GBSM | Finite Difference Deriv |
|------------------|-------------|-------------------------|
| Call's Delta | 0.535040923 | 0.54245454352 |
| Put's Delta | -0.42454562 | -0.3245994234 |
| Call's Gamma | 0.040038592 | 0.04003793208 |
| Put's Gamma | 0.040038592 | 0.04003793208 |
| Call's Vega | 19.71017932 | 19.7101788199 |
| Put's Vega | 19.71017932 | 19.7101788199 |
| Call's Theta | -29.4354352 | -26.4534542090 |
| Put's Theta | -14.4002435 | -19.569532454 |
| Call's Rho | 7.583453234 | -2.5646245422 |
| Put's Rho | -7.27745244 | -1.6996545254 |
| Call's Carry Rho | 7.932425425 | 7.34832934452 |
| Put's Carry Rho | -6.98459425 | -6.95435435211 |

Variance Analysis

| Metric | GBSM | Finite Difference Deriv | Percentage Difference |
|------------------|-------------|-------------------------|-----------------------|
| Call's Delta | 0.535040923 | 0.54245454352 | 1.39% |
| Put's Delta | -0.42454562 | -0.3245994234 | 23.54% |
| Call's Gamma | 0.040038592 | 0.04003793208 | 0.0016% |
| Put's Gamma | 0.040038592 | 0.04003793208 | 0.0016% |
| Call's Vega | 19.71017932 | 19.7101788199 | 0.0000025% |
| Put's Vega | 19.71017932 | 19.7101788199 | 0.0000025% |
| Call's Theta | -29.4354352 | -26.4534542090 | 10.13% |
| Put's Theta | -14.4002435 | -19.569532454 | 35.75% |
| Call's Rho | 7.583453234 | -2.5646245422 | 133.83% |
| Put's Rho | -7.27745244 | -1.6996545254 | 76.65% |
| Call's Carry Rho | 7.932425425 | 7.34832934452 | 7.37% |
| Put's Carry Rho | -6.98459425 | -6.95435435211 | 0.43% |

Both methods yield similar results, indicating consistency in the calculation of Greeks. However, there are some differences between the two approaches.

For Call's Delta, the GBSM model produces a value of 0.535040923, while the Finite Difference method shows 0.54245454352. Both values indicate a positive sensitivity of the call option price to changes in the underlying asset price. Similarly, both methods produce negative Delta values for put options, indicating a negative sensitivity to underlying asset price changes. Call's and Put's Gamma values are almost identical for both methods, suggesting that the Delta sensitivity to changes in the underlying asset price is consistent between the two approaches. Vega values for both call and put options are also very close, indicating that the option price sensitivity to changes in volatility is similar for both methods. There is a slight discrepancy in Theta values between the GBSM and Finite Difference methods, with the GBSM showing more negative Theta values for both call and put options. This implies a higher sensitivity to the passage of time in the GBSM model. Rho values differ significantly between the two methods for call options, while the differences for put options are smaller. This suggests that the sensitivity of option

prices to changes in interest rates might differ depending on the method used. Finally, Carry Rho values for both call and put options are relatively close between the two methods, indicating that the sensitivity of option prices to changes in the cost of carry is consistent across both methods.

Binomial tree Model:

| | Call | Put |
|-------------|----------|----------|
| Dividend | 4.74 | 4.16 |
| No Dividend | 3.55 | 4.52 |
| Delta | 0.5246 | -0.6772 |
| Gemma | -1.5632 | 6.12561 |
| Vega | 22.5654 | 26.5429 |
| Theta | -26.4245 | -15.4538 |
| Rho | -0.26531 | -0.35521 |
| Carry Rho | 7.34351 | -6.99246 |

The Binomial Tree Model results show that for both call and put options, the presence of dividends impacts their prices. For call options, the price is higher when dividends are considered, while for put options, the price is lower. In terms of Greeks, the call option Delta indicates a 52.46% sensitivity to changes in the underlying asset price, while the put option Delta suggests a 67.72% sensitivity. The call option Gamma value is negative, which might indicate an issue with the calculation, as Gamma is typically positive. Vega values for both options show sensitivity to changes in volatility. Theta values for both options are negative, indicating the option prices will decrease as time passes. Rho values suggest that call option prices will decrease as interest rates increase, while put option prices will increase. Carry Rho values indicate that call option prices will increase as the cost of carry increases, while put option prices will decrease.

Problem 2:

Normal Simulated

| | Mean | VaR | ES |
|---------------|----------|---------|----------|
| Call | 7.66345 | 0.95465 | 7.24524 |
| Call Spread | 4.52456 | 3.76546 | 4.08239 |
| Covered Call | 156.672 | 16.2342 | 17.4354 |
| Protected Put | 154.425 | 6.65097 | 16.6765 |
| Stock | 151.5452 | 16.5632 | 20.4525 |
| Syn Long | 1.542359 | 18.0983 | 23.6530 |
| Put | 5.942512 | 4.24542 | 4.76424 |
| Straddle | 13.54325 | 1.16534 | 1.35651 |
| Put Spread | 3.455673 | 2.66745 | 2.768709 |

Last week

| | Mean | VaR | ES |
|--------------|-----------|-----------|-----------|
| Call | 7.643733 | 6.039037 | 6.362422 |
| Call Spread | 4.519231 | 3.8597801 | 4.185693 |
| Covered Call | 146.33235 | 12.199211 | 15.564563 |

| | | | |
|---------------|-----------|-----------|----------|
| Protected Put | 154.9453 | 8.5435 | 8.764216 |
| Stock | 151.33452 | 16.065462 | 19.65346 |
| Syn Long | 2.654690 | 16.255654 | 19.65492 |
| Put | 5.59234 | 4.406591 | 4.750356 |
| Straddle | 13.25564 | 1.376456 | 1.38564 |
| Put Spread | 3.098345 | 2.54357 | 2.810306 |

After doing the variance analysis, we found that Using Delta-Normal Hedge portfolios can give us lower Risk.

Problem 3

Sharp Ratio: 1.47

| Symbol | Return | Weight |
|--------|-----------|--------|
| APPL | 0.157144 | 0 |
| META | 0.017941 | 0 |
| UNH | 0.2538 | 22.57 |
| MA | 0.222901 | 0 |
| MSFT | 0.155944 | 0 |
| NVDA | 0.279721 | 0 |
| HD | 0.120591 | 0 |
| PFE | 0.076962 | 0 |
| AMZN | -0.042945 | 0 |
| BRK-B | 0.129923 | 0 |
| PG | 0.08154 | 0 |
| XOM | 0.521821 | 57.44 |
| TSLA | -0.033253 | 0 |
| JPM | 0.098273 | 12.93 |
| V | 0.241054 | 0 |
| DIS | 0.1194 | 0 |
| Googl | 0.2918 | 0 |
| JNJ | 0.1121 | 7.05 |
| BAC | 0.1359 | 0 |
| CSCO | 0.2178 | 0 |