**C. (Monte Carlo Method)**

a) The program compiles and runs.

b) Results of MC method with Batches 1 and 2 option parameters

Exact solution of Batch 1 is C = 2.13293, P = 5.84584. The following table shows call price, put price, call SD, call SE, put SD, and put SE as a function of NT and NSIM.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NSIM  NT | 102 | 103 | 104 | 105 | 106 | 107 |
| 10 | C = 2.38525  P = 6.02450 | C = 2.11159  P = 6.07324 | C = 2.09379  P = 5.82172 | C = 2.10859  P = 5.84487 | C = 2.11637  P = 5.84018 | C = 2.11916  P = 5.83518 |
| Call SD = 5.68943  Call SE = 0.56894 | Call SD = 4.56751  Call SE = 0.14444 | Call SD = 4.38781  Call SE = 0.04388 | Call SD = 4.43197  Call SE = 0.01402 | Call SD = 4.44504  Call SE = 0.00445 | Call SD = 4.45136  Call SE = 0.00141 |
| Put SD = 6.34635  Put SE = 0.63463 | Put SD = 6.17285  Put SE = 0.19520 | Put SD = 6.05003  Put SE = 0.06050 | Put SD = 6.07578  Put SE = 0.01921 | Put SD = 6.08472  Put SE = 0.00608 | Put SD = 6.08158  Put SE = 0.00192 |
| 100 | C = 2.00892  P = 6.54862 | C = 2.14877  P = 5.88702 | C = 2.10932  P = 5.88443 | C = 2.13295  P = 5.87260 | C = 2.13288  P = 5.85106 | C = 2.13280  P = 5.84255 |
| Call SD = 4.21343  Call SE = 0.42134 | Call SD = 4.48775  Call SE = 0.14192 | Call SD = 4.47478  Call SE = 0.04475 | Call SD = 4.53000  Call SE = 0.01433 | Call SD = 4.52151  Call SE = 0.00452 | Call SD = 4.51104  Call SE = 0.00143 |
| Put SD = 6.57275  Put SE = 0.65727 | Put SD = 6.06444  Put SE = 0.19177 | Put SD = 6.06949  Put SE = 0.06069 | Put SD = 6.07197  Put SE = 0.01920 | Put SD = 6.05452  Put SE = 0.00605 | Put SD = 6.04795  Put SE = 0.00191 |
| 500 | C = 2.08171  P = 5.88529 | C = 2.17492  P = 6.13859 | C = 2.12329  P = 5.94285 | C = 2.14885  P = 5.83729 | C = 2.13249  P = 5.84333 | C = 2.13413  P = 5.84580 |
| Call SD = 4.23565  Call SE = 0.42356 | Call SD = 4.69434  Call SE = 0.14845 | Call SD = 4.49627  Call SE = 0.04496 | Call SD = 4.55679  Call SE = 0.01441 | Call SD = 4.51633  Call SE = 0.00452 | Call SD = 4.51710  Call SE = 0.00143 |
| Put SD = 6.19692  Put SE = 0.61969 | Put SD = 6.10368  Put SE = 0.19302 | Put SD = 6.08976  Put SE = 0.06090 | Put SD = 6.04876  Put SE = 0.01913 | Put SD = 6.04807  Put SE = 0.00605 | Put SD = 6.04719  Put SE = 0.00191 |
| 1000 | C = 2.36385  P = 6.14841 | C = 2.10416  P = 6.02480 | C = 2.12827  P = 5.93043 | C = 2.13874  P = 5.86757 | C = 2.13658  P = 5.83817 | C = 2.13320  P = 5.84573 |
| Call SD = 4.36268  Call SE = 0.43627 | Call SD = 4.54809  Call SE = 0.14382 | Call SD = 4.55583  Call SE = 0.04556 | Call SD = 4.55622  Call SE = 0.01441 | Call SD = 4.51429  Call SE = 0.00451 | Call SD = 4.51605  Call SE = 0.00143 |
| Put SD = 6.09495  Put SE = 0.60949 | Put SD = 5.92219  Put SE = 0.18728 | Put SD = 6.08910  Put SE = 0.06089 | Put SD = 6.05476  Put SE = 0.01915 | Put SD = 6.04834  Put SE = 0.00605 | Put SD = 6.04705  Put SE = 0.00191 |

As shown in the above table and Fig. 1, for a small number of NSIM (e.g., 102), neither C or P converges as NT increases from 10 to 1000; in contrast, for a large number of NSIM (e.g., 107), both call and put price converge fast that an accuracy to two places behind the decimal point is achieved as NT increases from 10 to 100. In general, accurarcy gets higher as NSIM and NT increase, and P converges faster than C.

Exact solution of Batch 2: C = 7.96632, P = 7.96632. An accuracy to two places behind the decimal point is achieved for P when NT = 100 and NSIM = 250000, while the accuracy for C can only be achieved when NT = 100 and NSIM = 900000.



Figure 1 Call price as a function of NT (a) and NSIM (c), and put price as a function of NT (b) and NSIM (d).

c) Stress-testing for Batch 4

Exact solution of Batch 4 is C = 92.1747, P = 1.24651.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NSIM  NT | 105 | 5x105 | 106 | 5x106 | 107 |
| 100 | C = 90.1399  P = 1.29849 | C = 90.2964  P = 1.29122 | C = 89.7999  P = 1.29253 | C = 89.4015  P = 1.29027 | C = 89.3694  P = 1.28947 |
| 500 | C = 93.0212  P = 1.25552 | C = 91.7952  P = 1.25896 | C = 91.9222  P = 1.25418 | C = 91.8413  P = 1.25380 | C = 91.7006  P = 1.25528 |
| 1000 | C = 92.3483  P = 1.25723 | C = 91.9491  P = 1.24841 | C = 91.9457  P = 1.24882 | C = 91.8552  P = 1.25105 | C = 91.8599  P = 1.25072 |

It is much expensive to achieve the same accuracy for Batch 4 as for Batches 1 and 2. To achieve 2 decimal accuracy for P we need at least NT = 1000 and NSIM greater than 107. It requires even higher numbers for both NT and NSIM to achieve a 2 decimal accuracy for C. In general, larger NT and NSIM yield higher accuracy, but the convergence rate is significantly lower than that for Batches 1 and 2.