Project 7

Problem1:

Greeks for GBSM:

	Closed Form		Finite Difference		Method Difference	
	Call	Put	Call	Put	Call	Put
Delta	0.53400912	-0.4655118	0.53800885	-0.4615121	0.75%	-0.86%
Gamma	0.04003793	0.04003793	0.04003662	0.04003662	0.00%	0.00%
Vega	19.7101797	19.7101797	19.7111947	19.7111947	0.01%	0.01%
Theta	-24.898522	-18.786997	-24.322439	-18.212375	-2.31%	-3.06%
rho	-0.3826596	-0.332595	-0.3824867	-0.3324447	-0.05%	-0.05%
carry rho	7.96624568	-6.944416	7.99995578	-6.9154252	0.42%	-0.42%

From the comparison of the two methods calculating greeks, we can see that the result is nearly the same. The result difference is within 1% except for the theta which has a difference of 2%.

Note: Because in this problem rf =b does not hold, I used the extended formula calculated by hand for rho:

Call: $S\Phi(d1)e^{(b-r)T}(-T)+TXe^{-rT}\Phi(d2)$

Put: $-TXe^{-rT}\Phi(-d2)+S\Phi(-d1)e^{(b-r)T}T$

Other Greeks use the same formula as that on notes.

Binomial Tree:

	Without Dividend		With Dividend	
	Call	Put	Call	Put
Value	4.26985856	3.68413818	4.1128361	4.11053453
Delta	0.56543463	-0.4476916	0.53503166	-0.7157072
Gamma	0.28050135	0.24295249	0.02127717	1.44E-13
Vega	19.6823376	19.6451858	19.5752836	17.6153449
Theta	-24.781073	-18.386851	-24.293425	-16.952428
rho	7.67155855	-5.8131644	6.86778386	-4.3195014
Delta Dividend			-0.1154974	0.72562343

After trials, my choices of the finite delta are:

Delta: 0.2; Gamma:0.2; Vega:0.01; Theta:0.01; rho:0.01; Dividend:0.01

By comparing values with and without dividend, we can see that the value of call decreases with dividend while the value of put increases with dividend.

As for the sensitivity to the change in dividend amount, I use the same method of calculating the finite difference with respect to dividend. The sensitivity of call is -0.12, while the sensitivity of put is 0.72. It means that Put will have a larger change in value when dividend changes.

Problem2:

The AR1 simulation result (last week):

Portfolio	Mean	VaR	ES
Call	1.03819555	5.98825203	6.34713992
CallSpread	-0.0017414	3.84734467	4.1676537
CoveredCall	-0.5229992	11.8386966	15.5692071
ProtectedPut	1.16065233	7.98526793	8.65295345
Put	0.64303253	4.42645075	4.61822472
PutSpread	0.23037532	2.67525529	2.82430627
Stock	0.59979538	15.6345187	19.493916
Straddle	1.68122808	1.37896673	1.38720784
SynLong	0.39516301	15.8743342	19.7574296

The Normal Simulation result:

Portfolio	Mean	VaR	ES
Call	0.95298692	3.42346444	4.25874758
CallSpread	0.0007248	1.7750857	2.19373683
CoveredCall	-0.4791025	3.44753959	4.27545223
ProtectedPut	1.33417973	3.82371277	4.83562999
Put	0.94817324	2.34977733	3.01342881
PutSpread	0.37303466	1.25054979	1.56718397
Stock	0.54897843	5.566067	6.91122834
Straddle	1.90116016	0.91061426	1.13977718
SynLong	0.00481368	5.84826677	7.06620543

By comparing the result of means, there are some changes in value : the value of call decreases, and the value of put increases; The value of covered call ,protected put and spreads increases; The value of synlong has a significant decrease. The addition of dividend is the main cause to the change of the portfolios, because single call/put changes in value.

By comparing the result of VaR and ES, we can see that the normal simulation generates a smaller loss in general, and it is most significant for stock and Synlong. This difference is mainly due to the delta normal method we use in calculating them. The normal assumption makes the data more centered and less tailed compared to AR(1).

Problem3:

The expected annual return:

	Expected Return
AAPL	0.119606477
META	-0.127564366
UNH	0.238865798
MA	0.191461194
MSFT	0.118127626
NVDA	0.139253352
HD	0.083972265
PFE	0.048819493
AMZN	-0.124544278
BRK-B	0.119856802
PG	0.064836848
XOM	0.486598178
TSLA	-0.227716186
JPM	0.082619397
V	0.211202547
DIS	-0.196625011
GOOGL	-0.06854585
JNJ	0.111449373
BAC	-0.12760639
CSCO	0.119033912

The weights of super portfolio:

AAPL	0
META	0
UNH	0.2745
MA	0
MSFT	0
NVDA	0
HD	0
PFE	0
AMZN	0
BRK-B	0
PG	0
XOM	0.5982
TSLA	0
JPM	0
V	0.0956
DIS	0
GOOGL	0
JNJ	0.0317
BAC	0
CSCO	0

For the super portfolio, we can see that only 4 stocks are selected:

XOM 59.82%, UNH 27.45%, V 9.56%, JNJ 3.17%.

The sharpe ratio of the super portfolio is 1.3574.