FINTECH 545 Week07 Project Report

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Problem 1:

The implementation of the closed form Greeks for GBSM and a finite difference derivative calculation, and the binomial tree valuation for American options with and without discrete dividends are shown in the Problem 1 Section of the code file (code.ipynb).

The values between the two methods for both a call and a put are as follows:

Closed Form Greeks:

	Call	**Put**
Delta	0.083	-0.917
Gamma	0.017	0.017
Vega	6.939	6.939
Theta	-8.127	-1.941
Rho	-0.03	-1.243
Carry_rho	1.133	-12.515

Finite difference derivative:

	Call	**Put**
Delta	0.083	-0.917
Gamma	0.017	0.017
Vega	6.939	6.939
Theta	-8.127	-1.941
Rho	-0.03	-1.243
Carry_rho	1.133	-12.515

We can figure out that the values between the two methods are really close to each other. The detailed values are shown in the Problem 1 Section of the code file.

The value of the Call without dividend is **0.336**, and the value of the Put without dividend is **14.037**, and the Greeks without dividend are the same as the values in the tables above.

The value of the Call without dividend is **0.296**, and the value of the Put without dividend is **14.566**, and the Greeks without dividend are shown in the tables below:

	Call	**Put**
Delta	0.069	-0.938
Gamma	-4.441	1.066
Vega	5.913	5.491
Theta	-6.954	-0.303
Rho	0.881	-12.277

The sensitivity of the Call option is **-0.025**, and the sensitivity of the Put option is **0.941**.

Problem 2:
The calculation detail of all VaR and ES is shown in the Problem 2 Section of the code file (code.ipynb), and the result is shown below:

Mean, VaR and ES using Simulated Prices from AAPL returns:

	Mean	VaR	ES
Straddle	1.907300	9.093464	9.300737
SynLong	-0.199850	21.922218	25.836500
CallSpread	-1.881371	9.851777	9.965620
PutSpread	0.590558	1.077219	1.111019
Stock	0.329614	18.797547	24.109966
Call	0.853725	15.034248	15.148092
Put	1.053575	1.227297	1.261801
CoveredCall	-1.227020	8.621601	13.933258
ProtectedPut	1.086864	14.359546	16.426178

VaR and ES using Delta-Normal

	Mean	VaR	ES
Straddle	0	3.028787	3.798221
SynLong	0	18.272682	22.91468
CallSpread	0	10.650734	13.356451
PutSpread	0	2.611549	3.274987
Stock	0	17.581895	22.048405
Call	0	10.650734	13.356451
Put	0	7.621947	9.55823
CoveredCall	0	12.893474	16.168937
ProtectedPut	0	10.955516	13.73866

Based on the result presented above and the results from last week's project, we can figure out that the VaR and ES of the simulated prices based on normal distribution is quite different and with higher variations. The reason behind this might be the fact that the AR(1) model is a more suitable model for stock/option prices and returns comparing to normal distribution model. Yet the basic patterns still holds--both SynLong and Stock has high risks due to their high Value at Risk and Expected Shortfall. The CoveredCall and ProtectedPut has higher risk than pure Call or pure Put but lower risk comparing to Stock and SynLong, as they are the mixture of Stocks and Options (also mentioned in the previous part above).

Problem 3:
The computation detail of the expected annual return and the super efficient portfolio are shown in the Problem 3 Section of the code file (code.ipynb).

The expected annual return of each stock is shown below:

Stock	Expected Annual Return
AAPL	0.157
META	0.018
UNH	0.254
MA	0.223
MSFT	0.156
NVDA	0.280
HD	0.121
PFE	0.077
AMZN	-0.043
BRK-B	0.130
PG	0.082
XOM	0.522
TSLA	-0.033
JPM	0.098
V	0.241
DIS	-0.155
GOOGL	-0.017
JNJ	0.124
BAC	-0.112
CSCO	0.148

The super efficient portfolio is shown below:

	AAPL	META	UNH	MA	MSFT	NVDA	HD	PFE	AMZN	BRK-B	PG	XOM	TSLA	JPM	V	DIS	GOOGL	JNJ	BAC	CSCO
weight %	0.0	0.0	26.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.78	0.0	0.0	12.19	0.0	0.0	3.08	0.0	0.0

And the portfolio's Sharpe ratio is 1.468