Project 07

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Problem 1

- Current Stock Price $165
- Current Date 02/25/2022
- Options Expiration Date 03/18/2022
- Risk Free Rate of 0.25%
- Continuously Compounding Coupon of 0.53%

Implement the closed form greeks for GBSM. Implement a finite difference derivative calculation.

Compare the values between the two methods for both a call and a put.

Implement the binomial tree valuation for American options with and without discrete dividends. Assume the stock above:

- Pays dividend on 4/11/2022 of $0.88

Calculate the value of the call and the put. Calculate the Greeks of each.

What is the sensitivity of the put and call to a change in the dividend amount?

Problem 1 Solution

GBSM (European) Greeks closed form solutions (the results from numerical method are the same):

	Call	Put
Delta	0.5103150338214995	-0.48968496617850055
Gamma	0.040192071131753174	0.040192071131753174
Vega	19.786061099476896	19.786061099476896
Theta	-21.62860677878208	-22.090281063696036
Rho	7.253304276901479	-7.661132489946645
Carry Rho	7.609134801578659	-7.301526843244096

Problem 1 Solution

Binomial tree valuation for american options **without** dividend:

- Call: 3.9712211422455805
- Put: 3.9356607180892844

Binomial tree valuation for american options **with** dividend:

- Call: 3.844705214527796
- Put: 4.406498686439346

Problem 1 Solution

Binomial Tree (American) Greeks:

	Call	Put
Delta	0.5069898474061585	-0.5147689593596461
Gamma	0.042556305359782165	0.03347707060581584
Vega	19.62875609090542	19.802282397992865
Theta	-21.892622546609395	-21.691500679029474
Rho	6.570936753961032	-7.640829804087534

Problem 1 Solution

Sensitivity to change in dividend amount.

Suppose the change is 1e-3:

- Call: -0.114
- Put: 0.536

Problem 2

Using the options portfolios from Problem3 last week (named problem2.csv in this week's repo) and assuming :

- American Options
- Current Date 02/25/2022
- Current AAPL price is 164.85
- Risk Free Rate of 0.25%
- Dividend Payment of $1.00 on 3/15/2022

Using DailyReturn.csv. Fit a Normal distribution to AAPL returns – assume 0 mean return. Simulate AAPL returns 10 days ahead and apply those returns to the current AAPL price (above). Calculate Mean, VaR and ES.

Calculate VaR and ES using Delta-Normal.

Present all VaR and ES values a $ loss, not percentages.

Compare these results to last week's results.

Problem 2 Solution

Fit a Normal distribution to AAPL returns.

Calculate Mean, VaR and ES.

	Mean	VaR	ES
Call	-0.456855	4.396249	4.471327
CallSpread	-0.600917	3.676363	3.751333
CoveredCall	-0.727452	9.661461	13.625566
ProtectedPut	0.018829	3.239450	3.257070
Put	1.203136	4.216102	4.341854
PutSpread	0.938195	2.640985	2.749500
Stock	-1.184307	14.057710	18.096893
Straddle	0.746281	2.340510	2.359838
SynLong	-1.659991	15.214509	19.311149

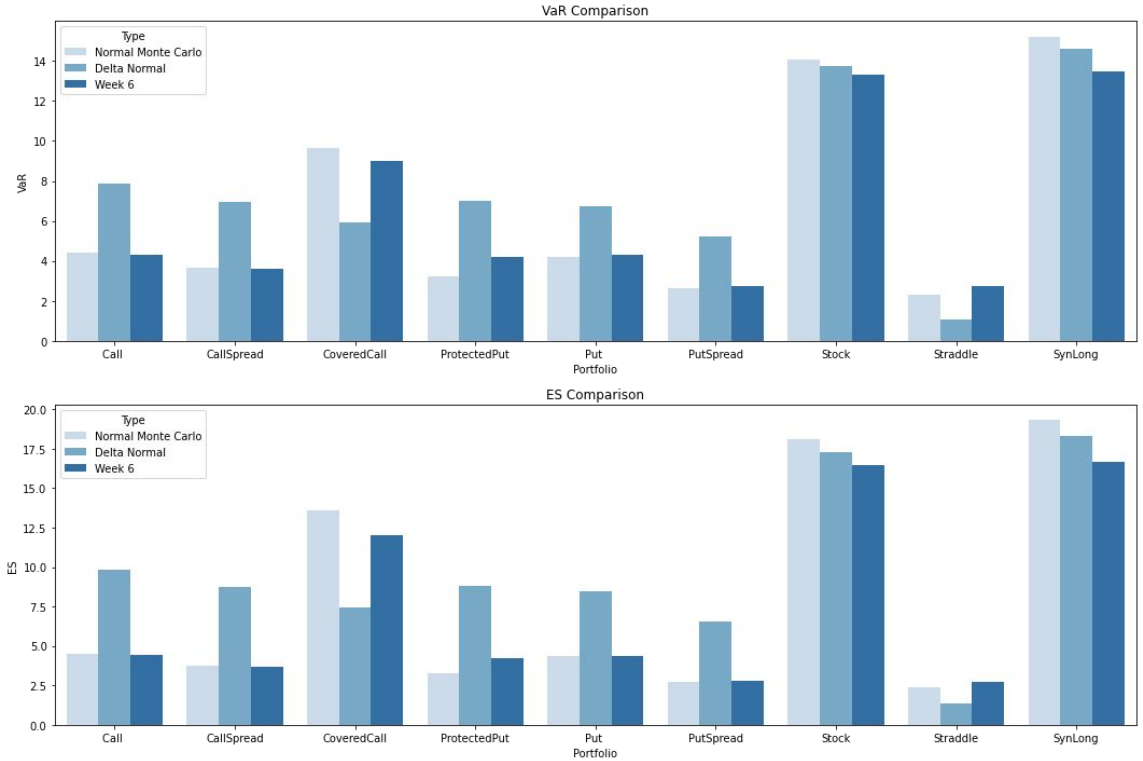
Problem 2 Solution

Calculate VaR and ES using Delta-Normal.

	VaR	ES
Call	7.84314	9.835613
CallSpread	6.943888	8.707916
CoveredCall	5.915268	7.417984
ProtectedPut	7.004823	8.78433
Put	6.753585	8.469267
PutSpread	5.23457	6.564362
Stock	13.758407	17.253598
Straddle	1.089555	1.366346
SynLong	14.596724	18.304881

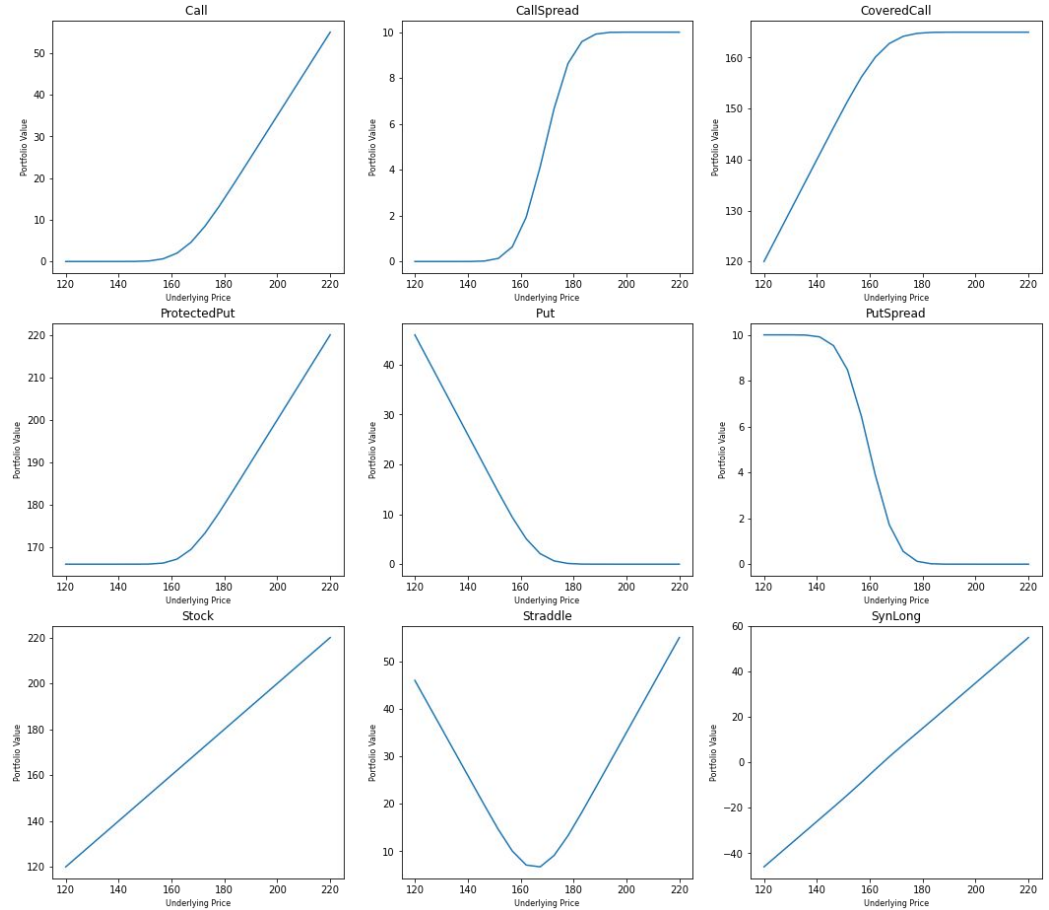
Problem 2 Solution

Compare these results to last week's results.



Problem 2 Solution

Simulate through a price range for 10 days ahead.



Problem 3

Use the Fama French 3 factor return time series (F-F_Research_Data_Factors_daily.CSV) as well as the Carhart Momentum time series (F-F_Momentum_Factor_daily.CSV) to fit a 4 factor model to the following stocks.

AAPL	FB	UNH	MA	MSFT	NVDA	HD	PFE	AMZN	BRK-B
PG	XOM	TSLA	JPM	V	DIS	GOOGL	JNJ	BAC	CSCO

Fama stores values as percentages, you will need to divide by 100 (or multiply the stock returns by 100) to get like units.

Based on the past 10 years of factor returns, find the expected annual return of each stock.

Construct an annual covariance matrix for the 10 stocks.

Assume the risk free rate is 0.0025. Find the super efficient portfolio.

Problem 3 Solution

Expected annual return (arithmetic):

AAPL	0.219339	NVDA	0.797174	PG	0.081514	DIS	0.169874
FB	0.298898	HD	0.176160	XOM	0.243151	GOOGL	0.259894
UNH	0.165101	PFE	-0.027567	TSLA	0.712362	JNJ	0.064275
MA	0.321203	AMZN	0.220488	JPM	0.176181	BAC	0.219665
MSFT	0.258526	BRK-B	0.121886	V	0.249593	CSCO	0.169785

The covariance matrix is too large to display here. Please see notebook.

Problem 3 Solution

Super efficient portfolio (number means weight percentage):

AAPL	0.00	**NVDA**	0.44	**PG**	2.93	**DIS**	0.00
FB	4.26	**HD**	11.07	**XOM**	6.75	**GOOGL**	3.25
UNH	3.76	**PFE**	9.08	**TSLA**	1.84	**JNJ**	4.62
MA	1.26	**AMZN**	9.59	**JPM**	4.27	**BAC**	0.41
MSFT	5.60	**BRK-B**	24.80	**V**	0.00	**CSCO**	6.09

The Portfolio's Sharpe Ratio is: **1.3042745402283054**