Week 7

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Question 1

- ● Current Stock Price $151.03
- ● Strike Price $165
- ● Current Date 03/13/2022
- ● Options Expiration Date 04/15/2022
- ● Risk Free Rate of 4.25%
- ● 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?

Question 1 Answer

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

	call	put
delta	0.083011070896268 69	-0.9169889291037313
gamma	0.016830979206204362	0.016830979206204362
vega	6.942036604441163	6.942036604441163
theta	-8.126522359668838	-1.9409914783019566
rho	1.1025939156368187	-13.758003122735788
Carry rho	1.132953825011723	-12.515271800549371

Question 1 Answer

- Binomial tree valuation for american options **without** dividend:
- Call: 0.3420415058233237
- Put: 14.02022659787544
- Binomial tree valuation for american options **with** dividend:
- Call: 0.2981599372927687
- Put: 14.55911431446306

Question 1 Answer

- Binomial Tree (American) Greeks:

	call	put
delta	0.0694035170404339	-0.9384266902472405
gamma	0.0188730869562459	0.01769300200598422 6
vega	6.143196715376997	5.664125621646754
theta	-7.2765273123804315	-0.46564521876213405
rho	0.9426794754235357	-12.407586180172459

Question 1 Answer

- Sensitivity to change in dividend amount.
- Suppose the change is 1e-3:
- Call: -0.025
- Put: 0.941

Question 2

- Using the options portfolios from Problem3 last week (named problem2.csv in this week's repo) and assuming :
- ● American Options
- ● Current Date 03/03/2023
- ● Current AAPL price is 165
- ● Risk Free Rate of 4.25%
- ● Dividend Payment of $1.00 on 3/15/2023
- Using DailyPrices.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.

Question 2 Answer

- Fit a Normal distribution to AAPL returns.

Portfolio	Mean	VaR	ES
Call	-0.127644	6.199831	6.562053
CallSpread	-0.525824	4.029122	4.361915
CoveredCall	-1.731967	13.914309	18.791813
ProtectedPut	0.042517	7.650810	8.040817
Put	1.952323	4.355154	4.649564
PutSpread	0.818268	2.627620	2.853856
Stock	-1.509956	17.804164	22.788306
Straddle	1.824678	1.348182	1.385833
SynLong	-2.079967	19.074750	24.324425

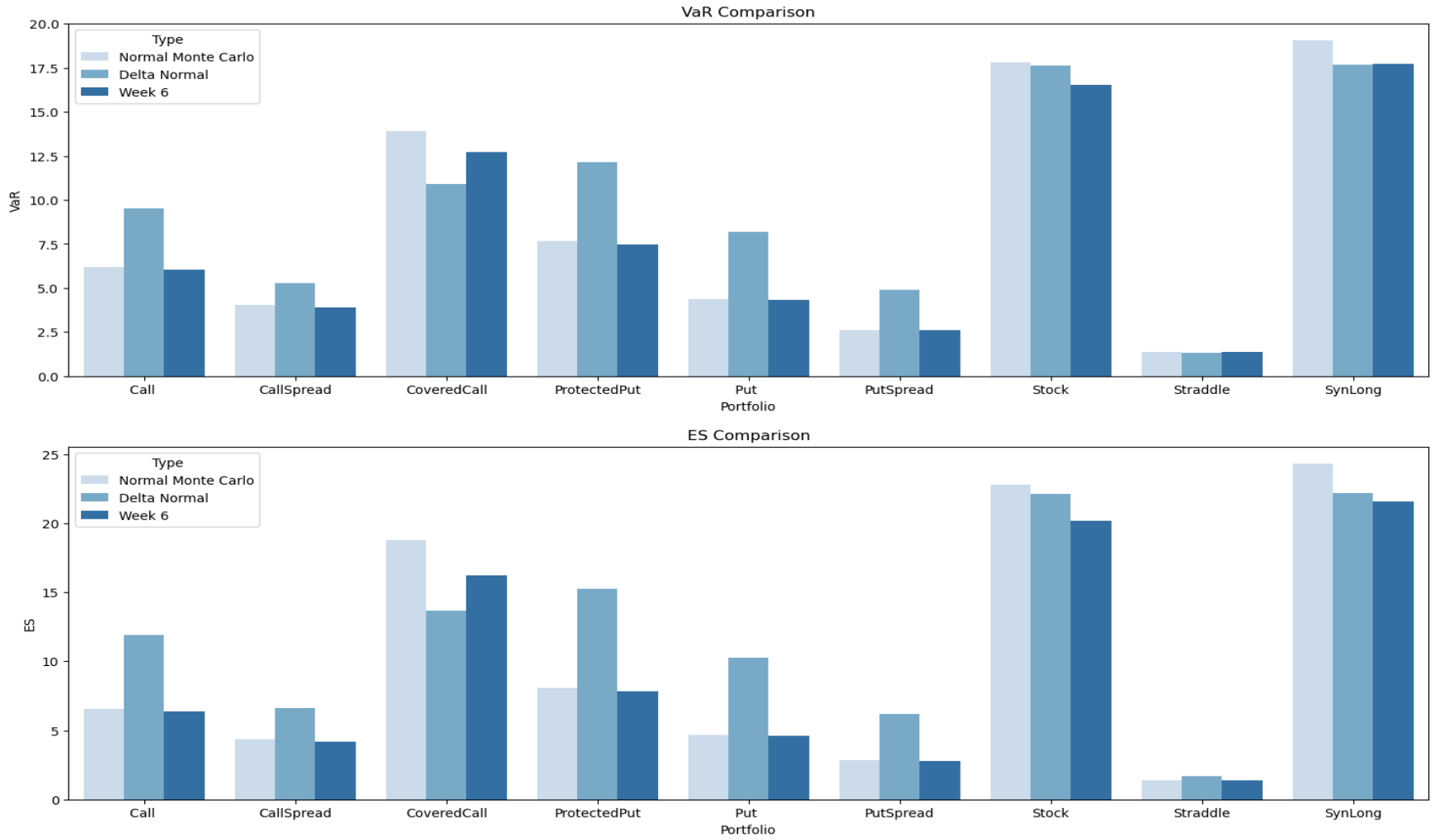
Question 2 Answer

- Calculate VaR and ES using Delta-Normal.

Portfolio	Mean	VaR	ES
Call	0	9.514631	11.931731
CallSpread	0	5.260949	6.597442
CoveredCall	0	10.895474	13.663364
ProtectedPut	0	12.13468	15.217378
Put	0	8.183037	10.261858
PutSpread	0	4.91428	6.162705
Stock	0	17.61745	22.092993
Straddle	0	1.331594	1.669873
SynLong	0	17.697668	22.193589

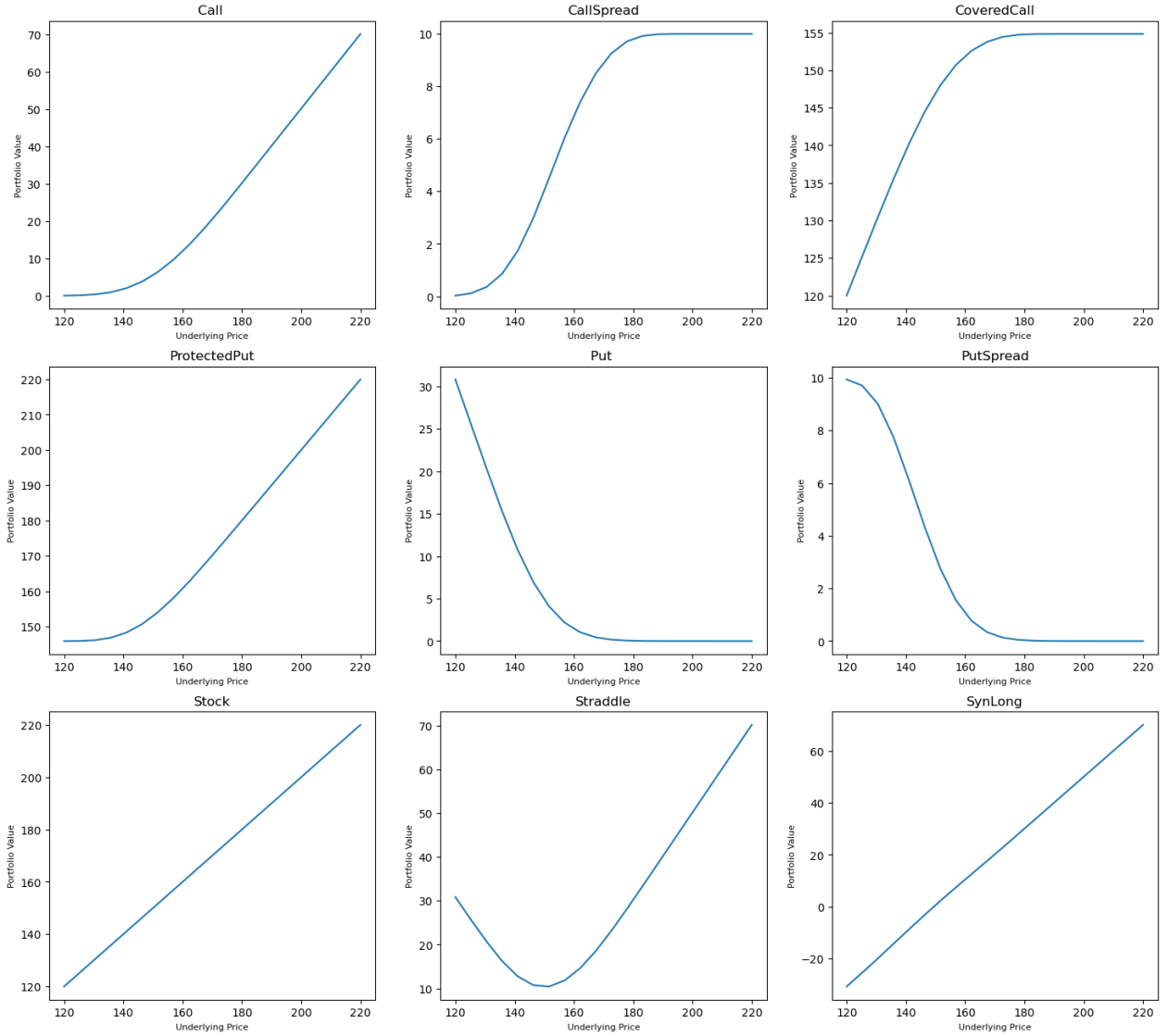
Question 2 Answer

- Compare these results to last week's result.



Question 2 Answer

- Simulate through a price range for 10 days ahead.



Question 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.
- 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 0.0425. Find the super efficient portfolio.

Question 3 Answer

Expected annual return (arithmetic):

AAPL	0.168126	NVDA	0.928453	PG	0.141542	DIS	0.448933
META	0.767960	HD	0.277411	XOM	0.114874	GOOGL	0.253676
UNH	-0.034531	PFE	0.015748	TSLA	0.128736	JNJ	-0.031274
MA	0.258958	AMZN	0.304627	JPM	0.408032	BAC	0.370995
MSFT	0.190769	BRK-B	0.152897	V	0.254922	CSCO	0.270013

Covariance matrix is too large to show here, please refer to notebook.

Question 3 Answer

- Super efficient portfolio (number means weight percentage):

AAPL	0	NVDA	0.41	PG	4.69	DIS	14.59
META	4.67	HD	7.36	XOM	0	GOOGL	0
UNH	0	PFE	0	TSLA	0	JNJ	0
MA	0	AMZN	0	JPM	59.78	BAC	0
MSFT	0	BRK-B	0	V	0	CSCO	8.50

The Portfolio's Sharpe Ratio is: 1.0440801177075165