HW6

Jingyu Tan

jt393

Problem 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?

Problem 1

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

	call	put
delta	0.083011070896 27	-0.916988929103 73
gamma	0.016830979206 20	0.016830979206 20
vega	6.942036604441 16	6.942036604441 16
theta	-8.126522359668 83	-1.940991478301 95
rho	1.102593915636 81	-13.75800312273570
carry rho	1.132953825011 72	-12.51527180054930

Problem 1

- Binomial tree valuation for American options without dividend:
- Call: `0.3420415058233237`
- Put: `14.020226597875 44`
- Binomial tree valuation for American options with dividend:
- Call: `0.2981599372927687`
- Put: `14.55911431446306`

Problem 1

- Ans: Greeks with binomial tree

	call	put
delta	0.06940351704043	-0.93842669024724
gamma	0.01887308695625	0.01769300200598
vega	6.14319671537699	5.66412562164675
theta	-7.27652731238043	-0.46564521876213
rho	0.94267947542354	-12.40758618017240

- Sensitivity:

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Sensitivity to dividend amount: Call: -0.025, Put: 0.941
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Problem 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.

Problem 2

Ans: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

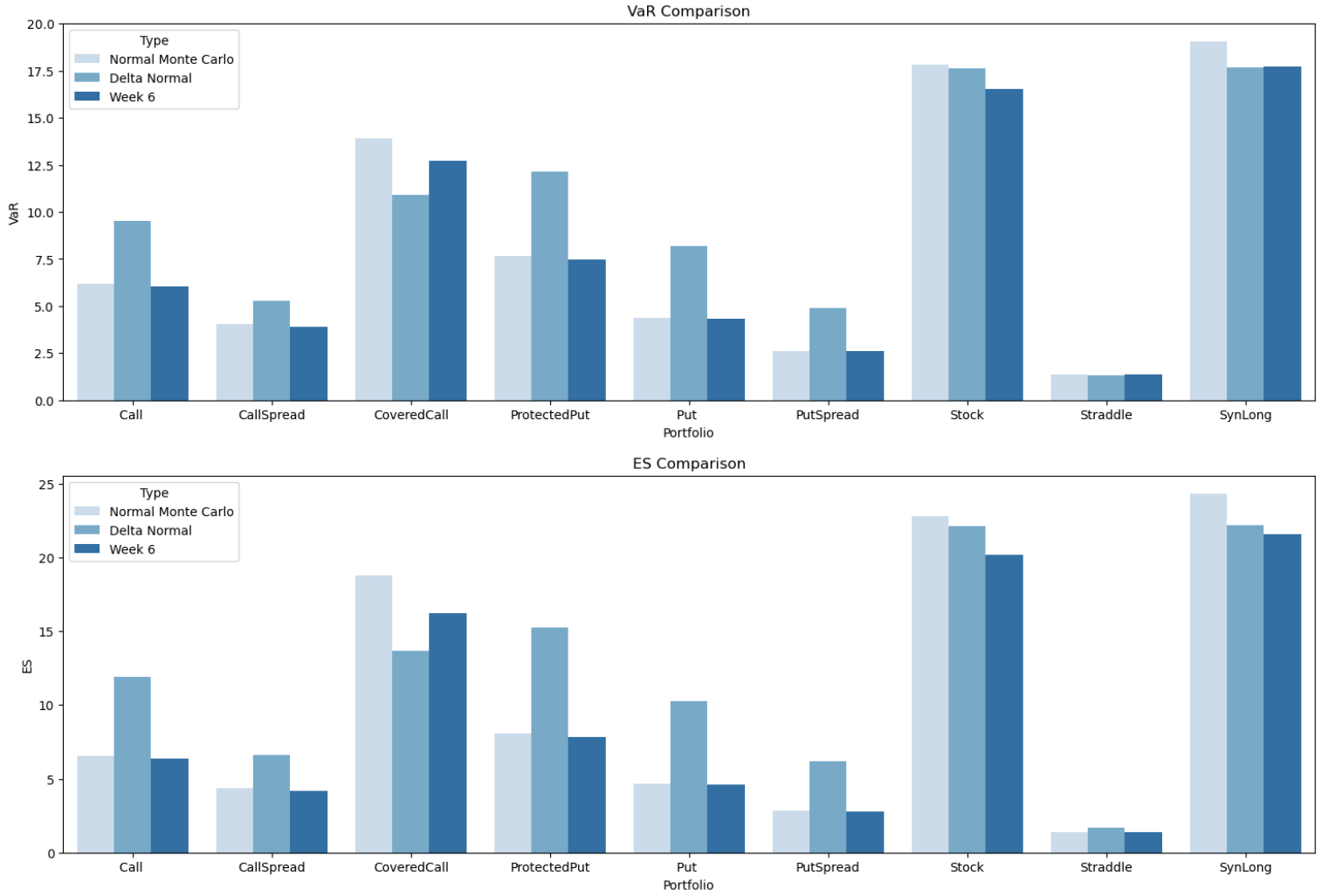
Problem 2

Ans: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

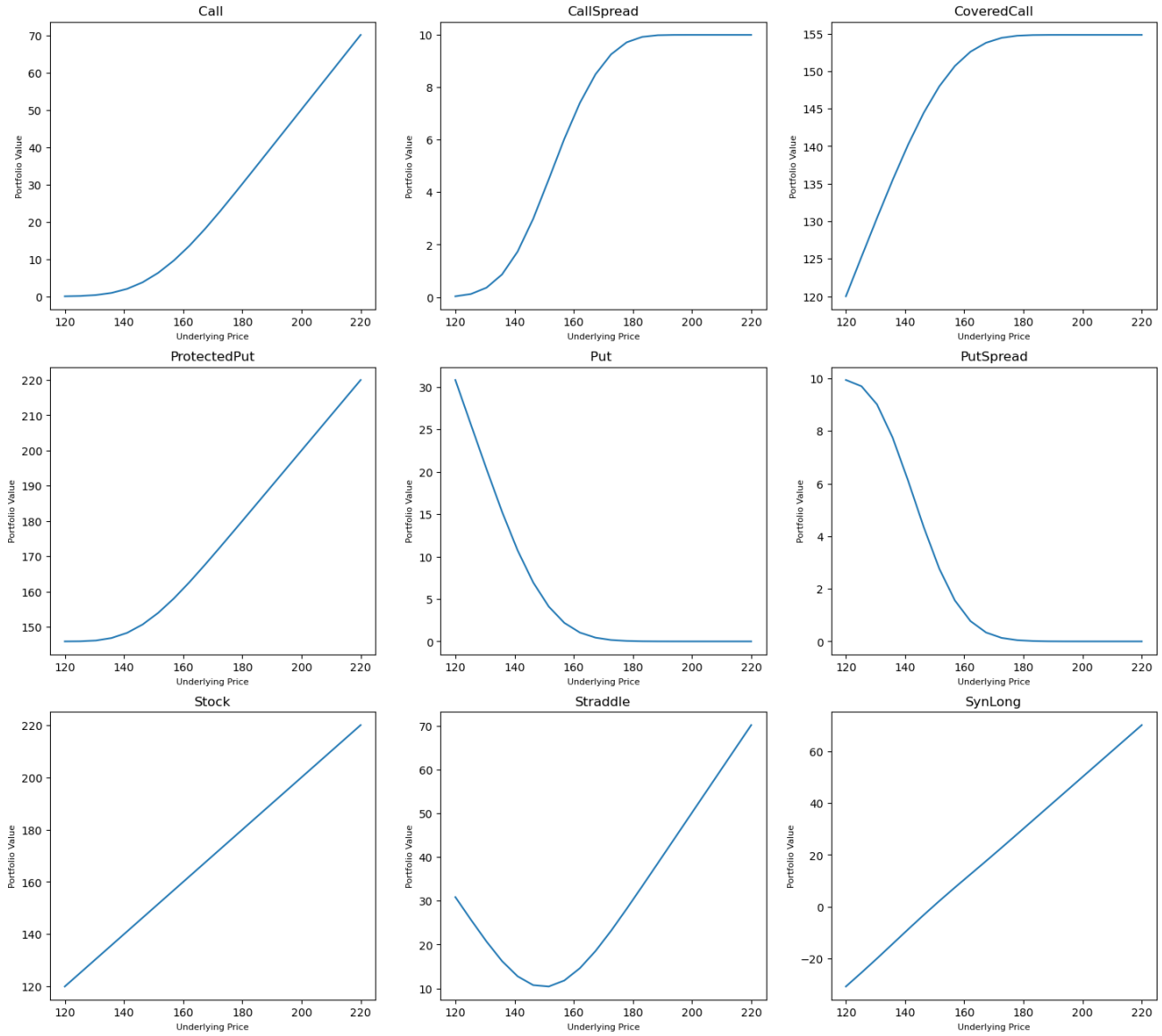
Problem 2

Ans: Compare these results to last week's result.



Problem 2

Ans: 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.
- 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

Problem 3

- Ans: Expected annual return (arithmetic):
- Covariance matrix is too large to show here, please refer to notebook.

AAPL	META	UNH	MA	MSFT	NVDA	HD	PFE	AMZN	BRK-B	PG	XOM	TSLA	JPM	V	DIS	GOOGL	JNJ	BAC	CSCO
0.157144	0.017941	0.2538	0.222901	0.155944	0.279721	0.120591	0.076962	-0.042945	0.129923	0.08154	0.521821	-0.033253	0.098273	0.241054	-0.155372	-0.017075	0.124206	-0.112301	0.147807

Problem 3

- Ans: Super efficient portfolio (number means weight percentage)
- The Portfolio's Sharpe Ratio is: 1.47

	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	22.57	0	0	0	0	0	0	0	0	57.44	0	0	12.93	0	0	7.05	0	0