Project 7

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Problem 1

- Current Stock Price $165
- Strike Price $165
- Current Date 03/13/2022
- Options Expiration Date 04/15/2022
- 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.

Problem 1

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?

Solution 1

European Option Greeks (closed form solutions)

	Call	Put
Delta	0.51	-0.49
Gamma	0.04	0.04
Vega	19.77	19.77
Theta	-22.07	-21.66
Rho	7.21	-7.70
Carry Rho	7.56	-7.34

Solution 1

American Option Price and Greeks (numerical solutions)

	Call	Put
Price	3.80	4.48
Delta	0.518	-0.515
Gamma	0.036	0.035
Vega	19.583	19.798
Theta	-21.844	-21.682
Rho	6.658	-7.843
Sensitivity to Dividend	-0.064	0.537

Problem 2

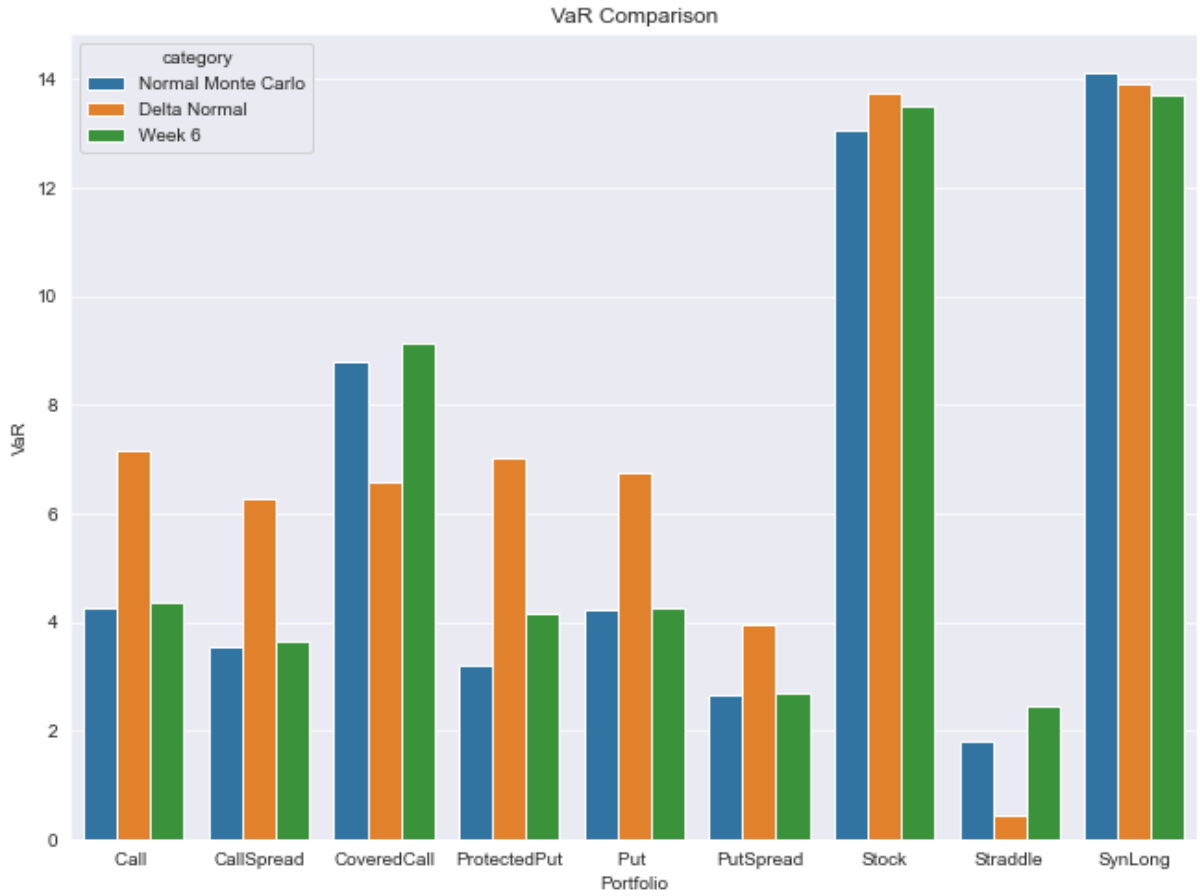
Using the options portfolios from Problem3 last week (named problem2.csv in this week's repo) and assuming :

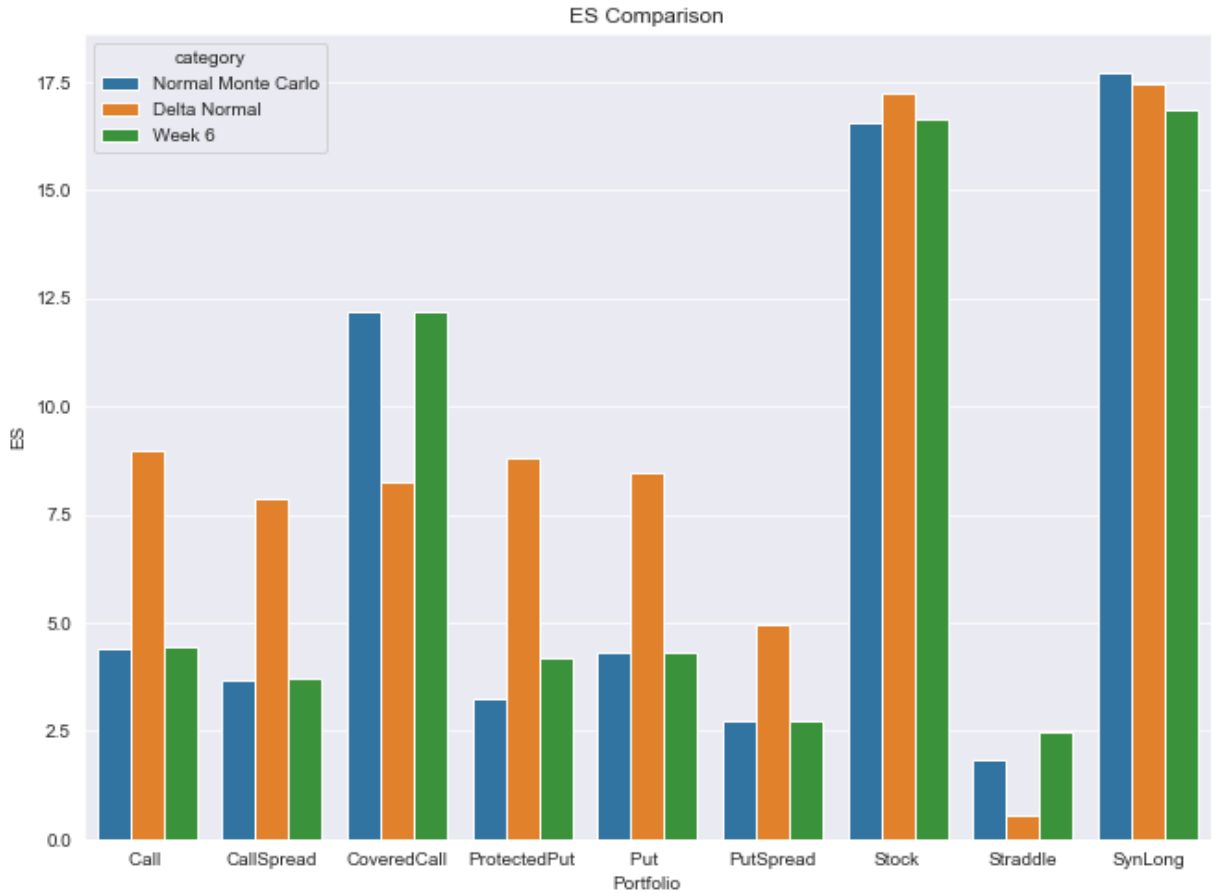
- American Options
- Current Date 02/25/2022
- Current AAPL price is 164.85
- Risk Free Rate of 0.25%
- Dividend Payment of $1.00 on 3/15/2022

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.

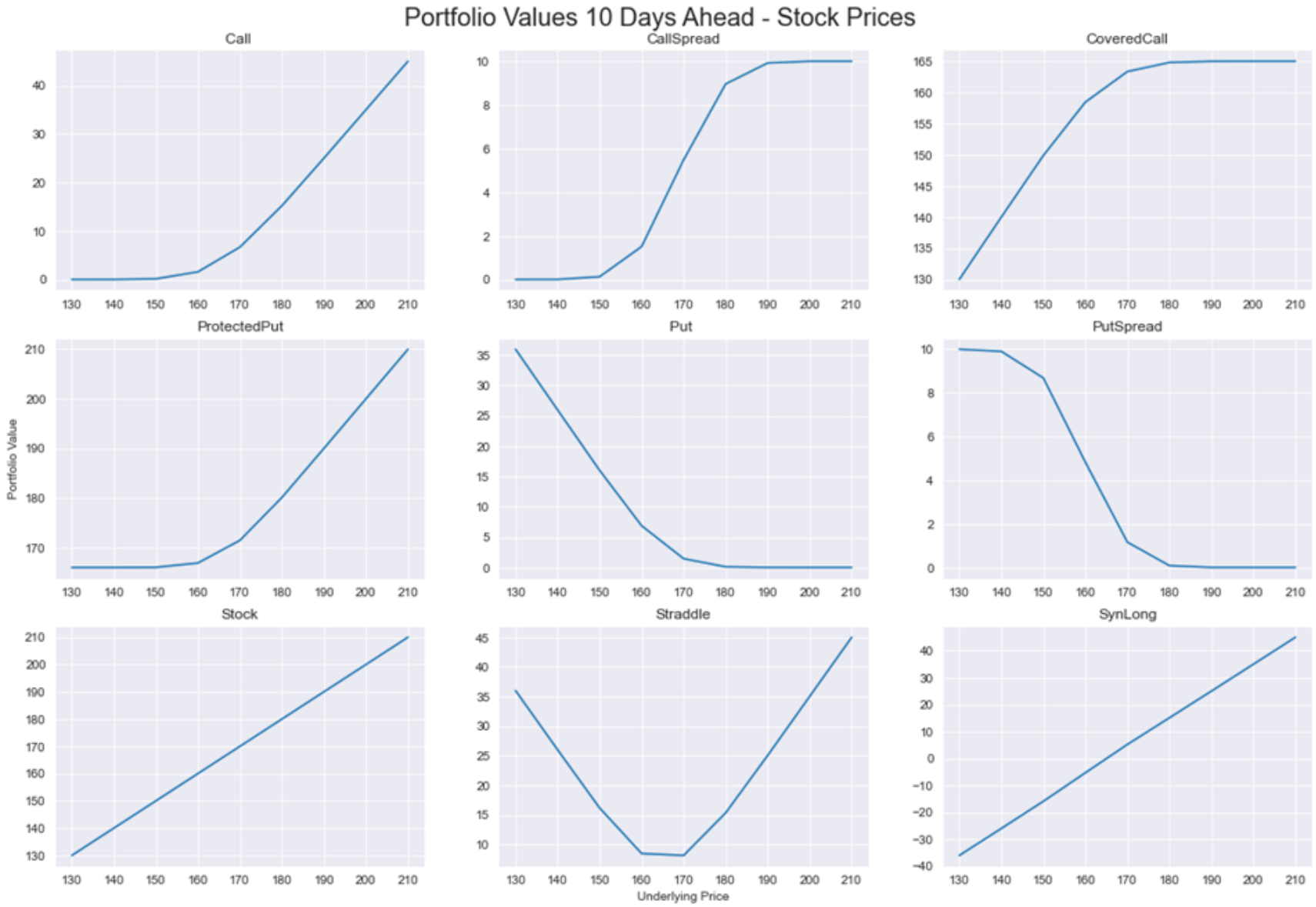
Solution 2

	Normal Monte Carlo			Delta Normal			Week6		
Portfolio	mean	VaR	ES	mean	VaR	ES	mean	VaR	ES
Call	0.256	4.267	4.395	0	7.164	8.984	0.115	4.359	4.435
CallSpread	-0.156	3.548	3.676	0	6.261	7.851	-0.242	3.639	3.715
CoveredCall	-0.303	8.796	12.170	0	6.594	8.270	-0.150	9.129	12.182
ProtectedPut	0.633	3.199	3.239	0	7.016	8.798	0.239	4.143	4.202
Put	0.677	4.224	4.327	0	6.743	8.456	0.275	4.255	4.334
PutSpread	0.547	2.654	2.741	0	3.946	4.948	0.396	2.674	2.743
Stock	-0.044	13.063	16.566	0	13.758	17.253	-0.0356	13.49	16.617
Straddle	0.937	1.811	1.8256	0	0.421	0.529	0.3896	2.443	2.452
SynLong	-0.417	14.131	17.722	0	13.907	17.440	-0.160	13.703	16.850

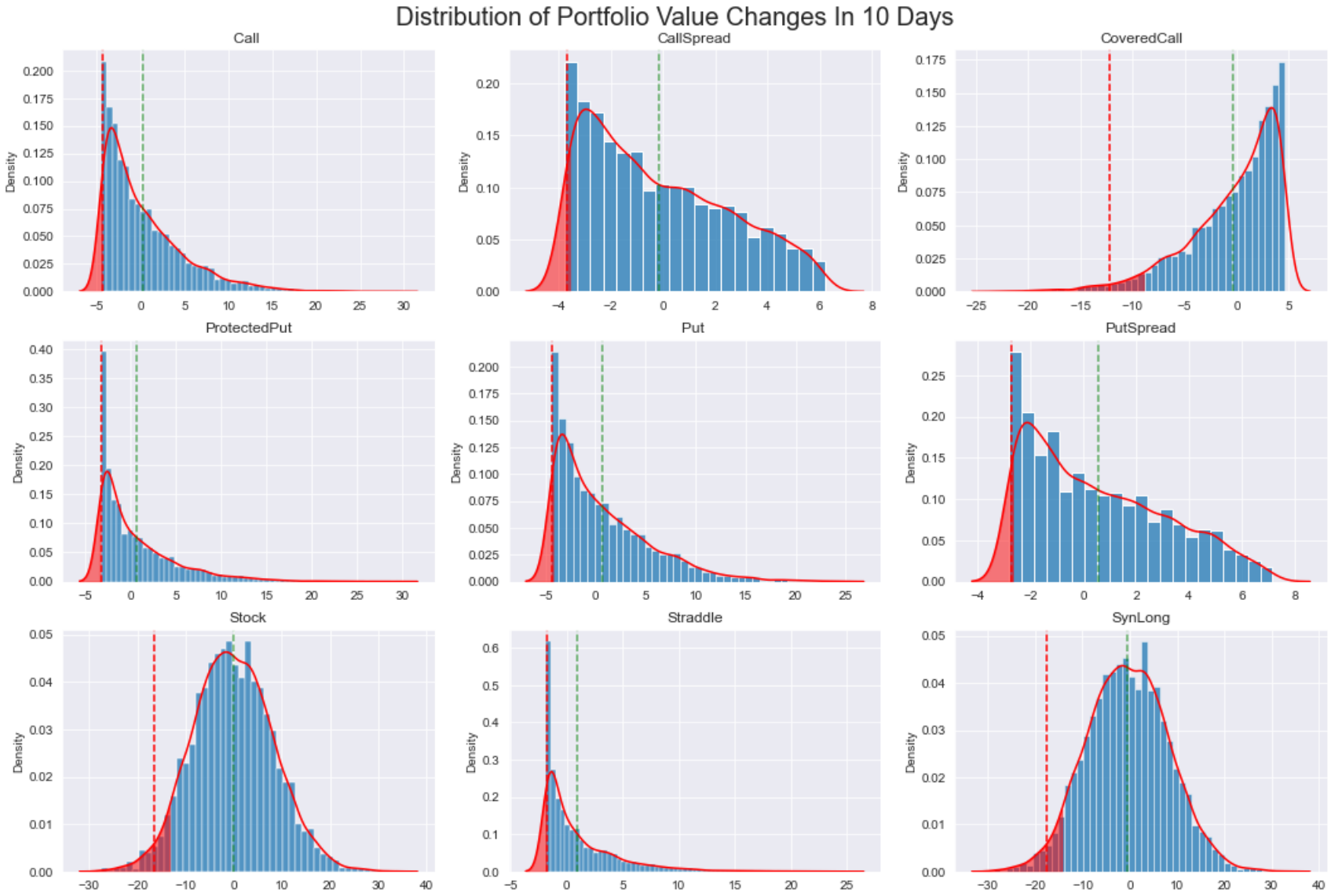

VaR Comparison
category
Normal Monte Carlo
Delta Normal
Week 6
VaR
0
2
4
6
8
10
12
14
Call
CallSpread
CoveredCall
ProtectedPut
Put
PutSpread
Stock
Straddle
SynLong
Portfolio


ES Comparison
category
Normal Monte Carlo
Delta Normal
Week 6
ES
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Call
CallSpread
CoveredCall
ProtectedPut
Put
PutSpread
Stock
Straddle
SynLong
Portfolio

Normal Monte Carlo



Normal Monte Carlo



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.

Solution 3

1. calculate arithmetic E(r) in past 10 years

$$E(r) = E(r_f) + \beta_1 * E(r_{mkt} - r_f) + \beta_2 * E(SMB) + \beta_3 * E(HML) + \beta_4 * E(Mom)$$

2. Calculate geometric annual return's mean and covariance

$$g = \log(1 + r)$$

3. Calculate arithmetic annual return's mean and covariance

$$E(r_i) = E(e^{g_i} - 1) = \exp\left(\mu_i + \frac{\sigma_i^2}{2}\right) - 1$$

$$cov(r_i, r_j) = \exp\left(\mu_i + \mu_j + \frac{\sigma_i^2 + \sigma_j^2}{2}\right) * (e^{\sigma_{ij}} - 1)$$

4. Calculate the most efficient portfolio which has the highest Sharpe ratio, which is 1.32

Solution 3

	Weights(%)
AAPL	0.00
FB	5.45
UNH	5.32
MA	2.96
MSFT	2.12
NVDA	0.18
HD	5.23
PFE	6.35
AMZN	10.00
BRK-B	10.00

	Weights(%)
PG	10.00
XOM	4.51
TSLA	1.48
JPM	3.70
V	0.00
DIS	2.60
GOOGL	6.41
JNJ	10.00
BAC	6.71
CSCO	6.98