Fintech545 Project6

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1 Problem 1

Greeks	close_form_call	finite_call	close_form_put	finite_put
Delta	0.0829713	0.0829714	-0.91655	-0.91655
Gamma	0.0168229	0.0168754	0.0168229	0.0173372
Theta	-8.12652	-8.1268	-1.27375	-1.94127
Vega	6.93871	6.93906	6.93871	6.93906
Rho	1.10259	1.10261	-13.758	-13.758
Carry_Rho	1.13295	1.13297	-12.5153	-12.5153

Figure 1: Enter Caption

The value of the call is 0.297 and the value of the Put is 14.562.

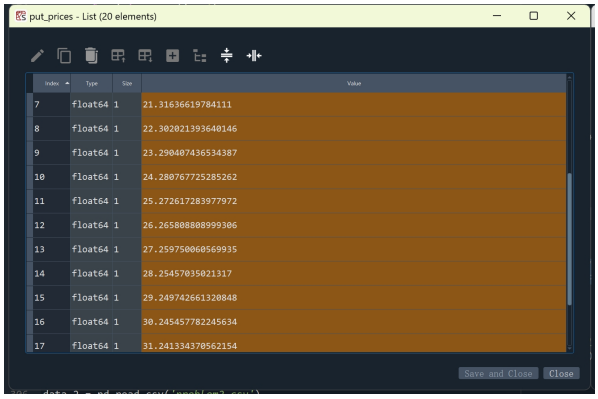

Figure 2: Put price with increasing dividend

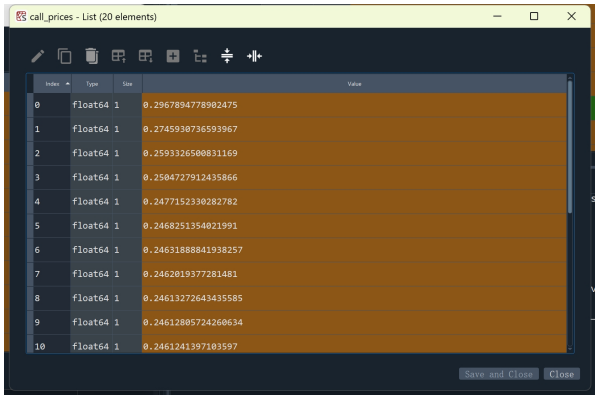

Figure 3: Call price with increasing divedend

Put options are more sensitive to dividends than call options for several reasons: With American options, higher dividends make early exercise more attractive for put holders, as they can capitalize on the underlying price decline following the dividend payment.
For puts, there is no upper limit to how beneficial the dividend impact can be, as the underlying price could continue falling, increasing the put's value. For calls, the benefit of early exercise is limited because the dividend reduces the stock price, which caps the potential gain from exercising early.

2 Problem 2

We'll start by calculating the implied volatility using the traditional method. The steps are as follows:

1. Calculate 10-Day Returns: Compute the returns over 10 days, then sequentially multiply to derive the daily underlying prices.

2. Option Pricing Using Underlying Price and Time to Maturity (TTM): Using the underlying prices and time to maturity (TTM), along with the previously calculated implied volatility, determine the American option prices by applying the existing btamerican function.

3. PnL, VaR, and ES Calculation: Finally, compute the profit and loss (PnL) values, followed by the Value at Risk (VaR) and Expected Shortfall (ES) for risk assessment.

It seems that we can not compute the implied volatility for the call option in the portfolio. Here are the reasons: For the first call option with a strike price of 150 and an underlying price of 165, even if exercised immediately, it would yield a profit of around 15 dollors. However, the market price of this call option is only about 6, which suggests that the implied volatility would be infinitely large.
Then, we only discuss the portfolio that does not include call options–PutSpread.

Comparison:
VaR for an American Put Spread is typically lower than for a European Put Spread, as early exercise reduces the maximum potential loss.
ES for an American Put Spread is also generally lower, reflecting reduced tail risk due to the flexibility to exercise early in adverse conditions.

3 Problem 3

The expected annual return of each stock:

Index	0
AAPL	0.18754
META	0.424897
UNH	0.0422852
MA	0.198233
MSFT	0.294363
NVDA	0.634255
HD	0.198213
PFE	0.0348574
AMZN	0.37109
BRK-B	0.196588
PG	0.0443116
XOM	0.152482
TSLA	0.265372
JPM	0.295125
V	0.191441
DIS	0.182263
GOOGL	0.295639
JNJ	0.0647758
BAC	0.329157
CSCO	0.151914

Figure 4: Enter Caption

Super-Efficient Portfolio Expected Annual Return: 0.42
Super-Efficient Portfolio Volatility: 0.15
Super-Efficient Portfolio Sharpe Ratio: 2.51