HW5

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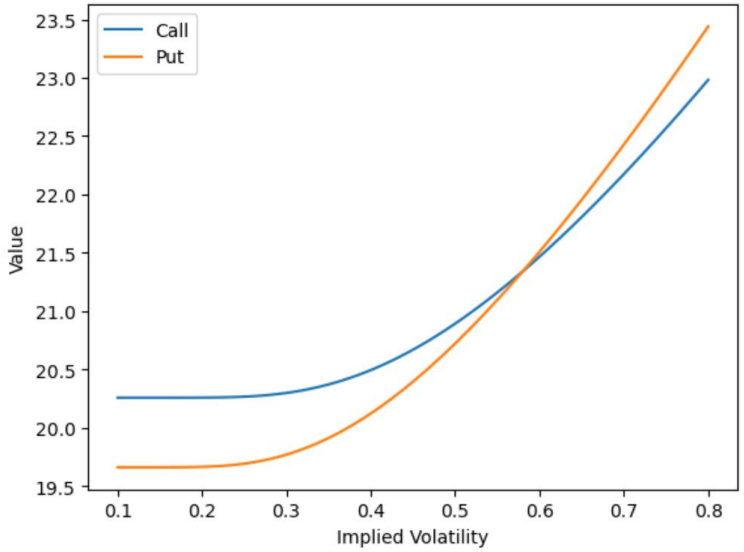
Problem1

- Assume you a call and a put option with the following
- Current Stock Price $165
- Current Date 03/03/2023
- Options Expiration Date 03/17/2023
- Risk Free Rate of 5.25%
- Continuously Compounding Coupon of 0.53% Calculate the time to maturity using calendar days (not trading days).
- For a range of implied volatilities between 10% and 80%, plot the value of the call and the put.
- Discuss these graphs. How does the supply and demand affect the implied volatility?

Problem1



Ans:

- According to the plot, we can see that the values of the options rise with the implied volatilities. It follows the economic theory.
- It is natural that the increase in demand or decrease in supply for an option will cause its price to rise, and with the relationship we discovered above, it's clear that the implied volatility will move in same directions.
- The increase in demand or decrease in supply for an option will cause its implied volatility to rise.
- The decrease in demand or increase in supply for an option will cause its implied volatility to fall.

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Time to maturity: 0.038356164383561646
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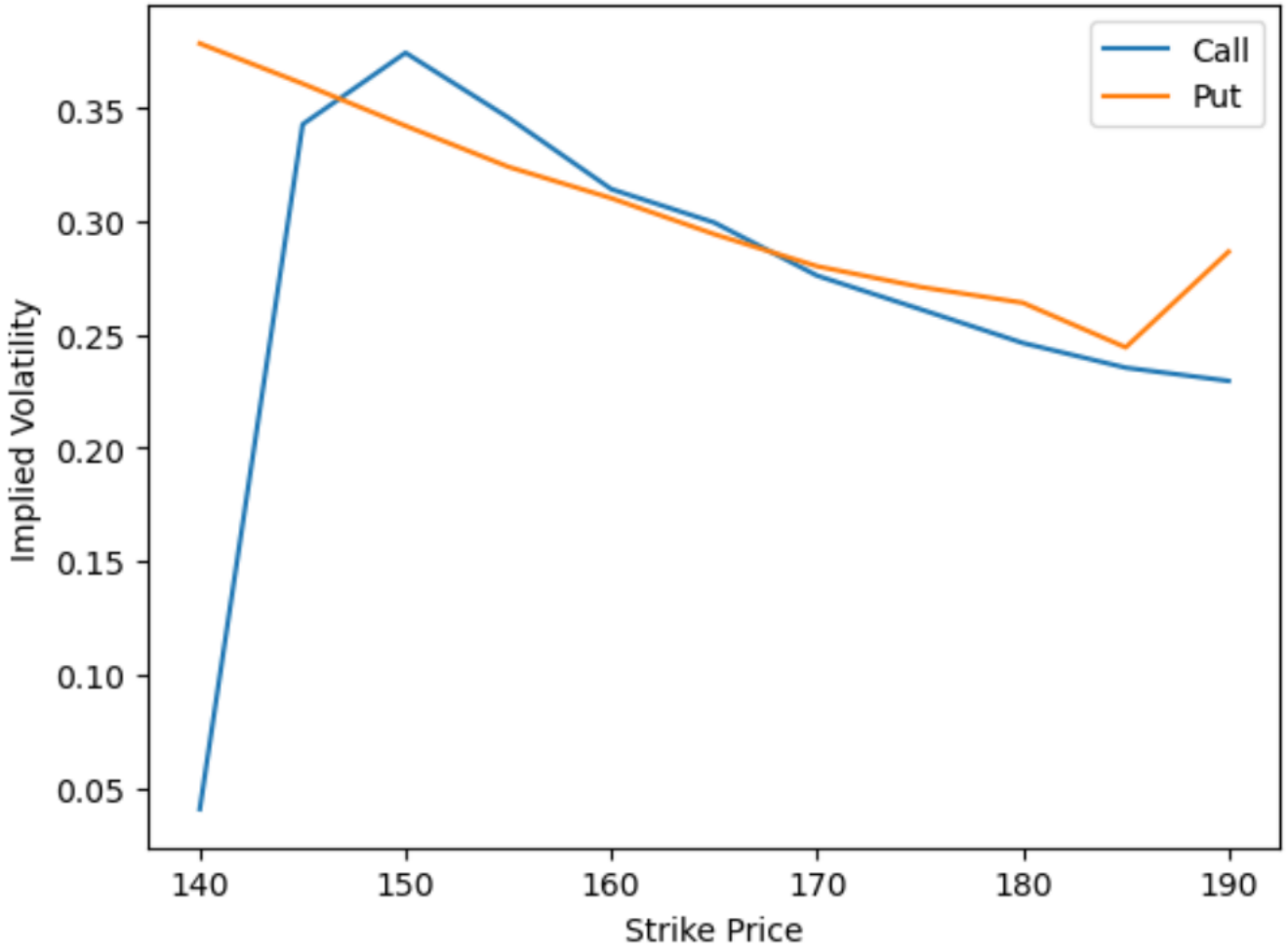
Problem2

- Use the options found in AAPL_Options.csv
- Current AAPL price is 170.15
- Current Date: 10/30/2023
- Risk Free Rate: 5.25%
- Dividend Rate: 0.57%.
- Calculate the implied volatility for each option.
- Plot the implied volatility vs the strike price for Puts and Calls.
- Discuss the shape of these graphs. What market dynamics could make these graphs?
- There are bonus points available on this question based on your discussion. Take some time to research if needed

Problem2


Call
Put
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Implied Volatility
140
150
160
170
180
190
Strike Price

Problem2

Ans:

- As what we can see

Call Option:

- From around $150 to $190, it shows typical volatility skew(a smile). However, when its strike price around $140, which is very deep in-the-money, it shows a low volatility, which is counterintuitive. This might because its low liquidity. Low liquidity can lead to less reliable price discovery, which might not accurately reflect the implied volatility based on the market's consensus. Or it is because Delta and Sensitivity to Stock Price Movement: Deep in-the-money options have a high delta, meaning their price moves almost one-for-one with the stock price, behaving similarly to the underlying stock. This can sometimes lead to a lower implied volatility since the option's price is less sensitive to changes in volatility when compared to at-the-money options.
- Market dynamic: May due to Less Concern for Upside Movement: The lower implied volatility for call options at lower strike prices implies less concern or lower probability assigned to significant upward price movements. This indicates that investors are not expecting substantial positive movements, or there is less demand for such calls.

Put Option:

- When put option is deep in-the-money or deep out-of-money, its volatility increase as strike price increase(decrease). It is a very typical “smile”, which is also called an option skew.
- Market dynamic: May due to Downside Fear: The increase in implied volatility for put options as the strike price increases suggests a market fear of downside risk. Investors may be concerned about potential negative events or declines in the underlying asset, leading to a greater demand for protective put options and thus higher implied volatilities at those strikes.

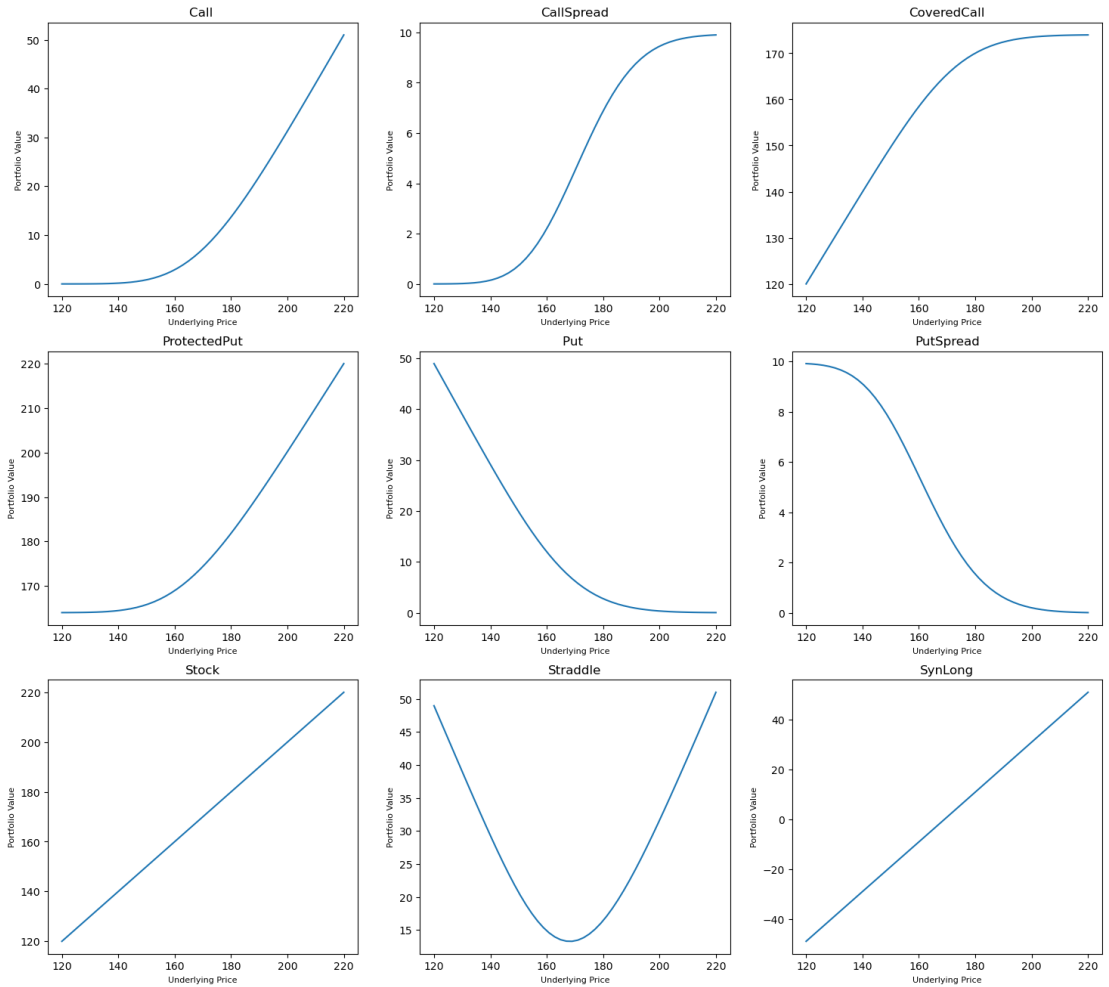
Deviation from theory:

Volatility smiles tell us that demand is greater for options that are in-the-money or out-of-the-money. This anomaly implies deficiencies in the standard Black–Scholes option pricing model which assumes constant volatility and lognormal distributions of underlying asset returns.

Problem3

- Use the portfolios found in problem3.csv
- Current AAPL price is 170.15
- Current Date: 10/30/2023
- Risk Free Rate: 5.25%
- Dividend Rate: 0.57%. For each of the portfolios, graph the portfolio value over a range of underlying values.
- Plot the portfolio values and discuss the shapes.
- Bonus points available for tying these graphs to other topics discussed in the lecture.
- Using DailyPrices.csv. Calculate the log returns of AAPL. Demean the series so there is 0 mean.
- Fit an AR(1) model to AAPL returns.
- Simulate AAPL returns 10 days ahead and apply those returns to the current AAPL price (above). Calculate Mean, VaR and ES. Discuss.

Problem3



Portfolio	Mean	VaR	ES
Call	2.727880	5.261889	5.929010
CallSpread	0.835606	2.932288	3.448473
CoveredCall	1.975570	7.492632	10.642601
ProtectedPut	3.240699	6.562626	7.647089
Put	-1.394301	5.466960	5.735681
PutSpread	-0.572256	2.711849	2.886343
Stock	4.314309	11.219996	14.722912
Straddle	1.333579	1.591310	1.599497
SynLong	4.122181	11.396872	14.884558

Problem3

Ans:

- From the plots and data, we can see
- For Call and Put: The basic options. Makes money as the stock price goes up or down, respectively. The risks are moderate.
- For Call Spread and Put Spread: They add a limit to the basic Call and Put. Lowering the risk by sacrificing returns. They are more attractive to those people, who want to manage risk carefully.
- For Covered Call and Protected Put: Basically, a mix of stocks and options. The patterns are similar as Call or Put. The risks are also between stocks and options. Covered Call is suitable for an investor who expects little to no upside in the stock price or for someone looking to sell the stock at a price above its current market value while earning extra income from the option premium. Protected Put is suitable for an investor who is bullish on the underlying stock in the long term but is concerned about potential short-term losses. It's essentially a bet on continued upward movement with downside protection.
- For SynLong and Stock: SynLong has the same straightforward pattern as Stock. Both have high risks. Traders may choose a synthetic long stock position over actual stock ownership for reasons of capital efficiency, leverage, or strategic flexibility.
- Straddle: The most special portfolio among all these, since it makes money as long as the price moves regardless of the direction, which means that it is a market-neutral strategy. Its VAR, ES are the lowest among all these portfolios. This indicates that its downside risk is low among all.