

Week 6

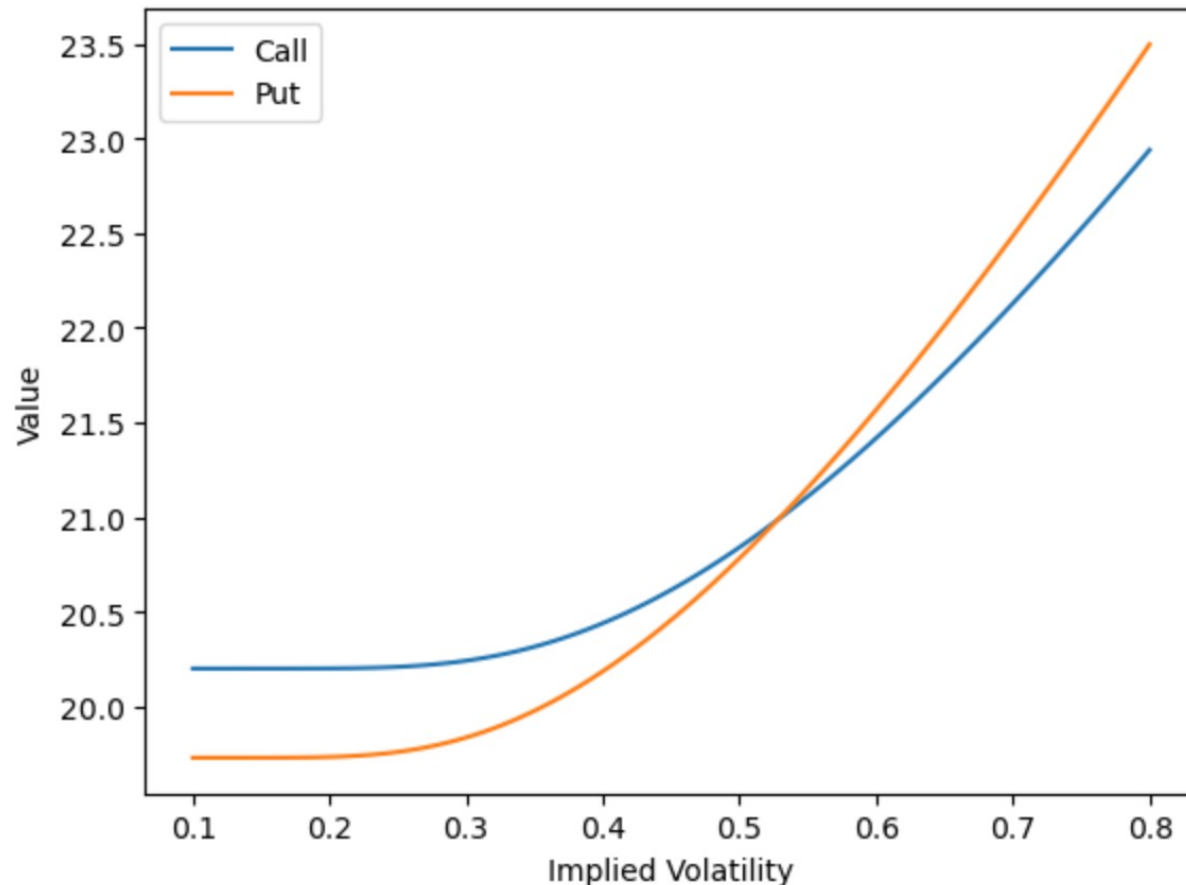
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Question 1

- 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 4.25%
 - ● 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?

Question 1 Answer

Time to maturity: 0.038356164383561646



According to the plot, we can see that the values of the options rise with the implied volatilities. 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.

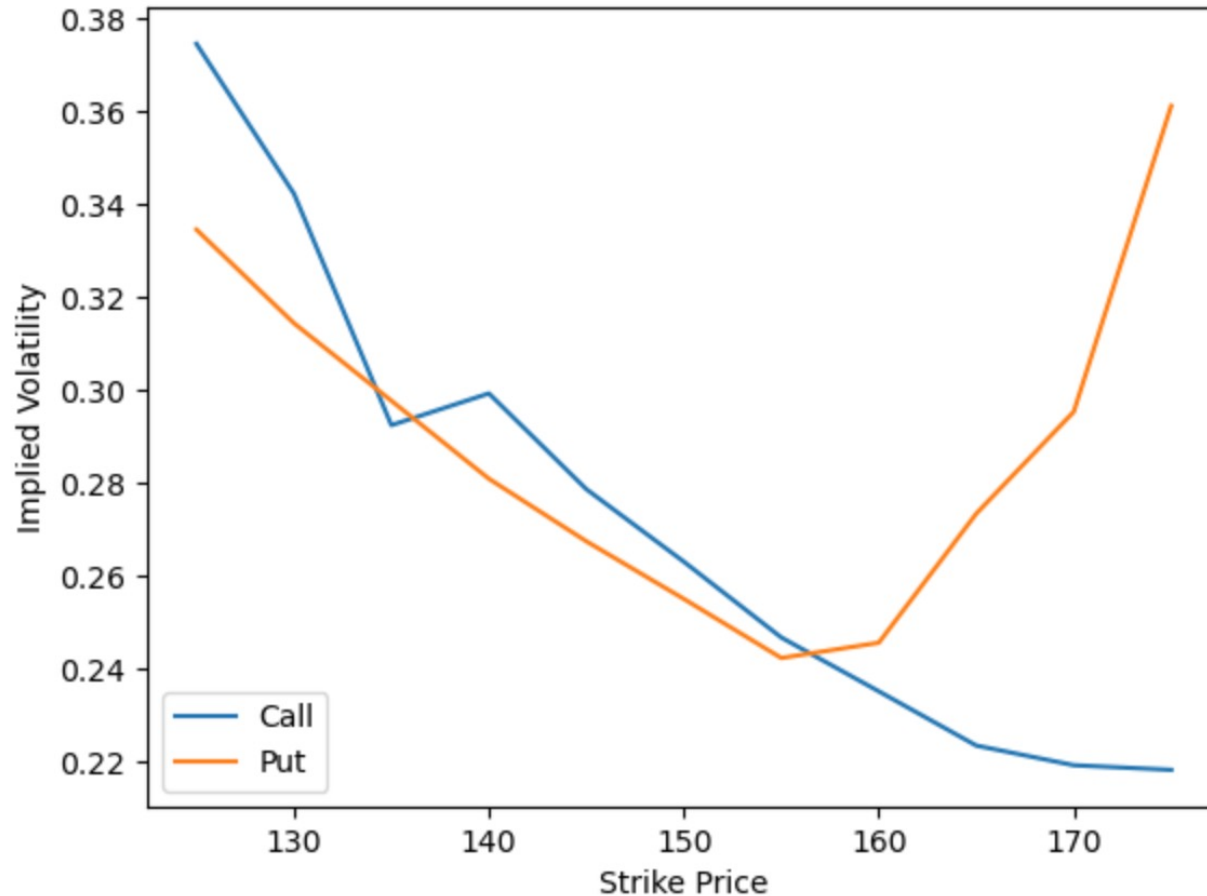
- The increase in demand or decrease in supply for an option will cause its implied volatility to rise.
- The decrease in demand or increase in supply for an option will cause its implied volatility to fall.

Question 2

Use the options found in AAPL_Options.csv

- ● Current AAPL price is 151.03
- ● Current Date, Risk Free Rate and Dividend Rate are the same as problem #1.
- 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.

Question 2 Answer



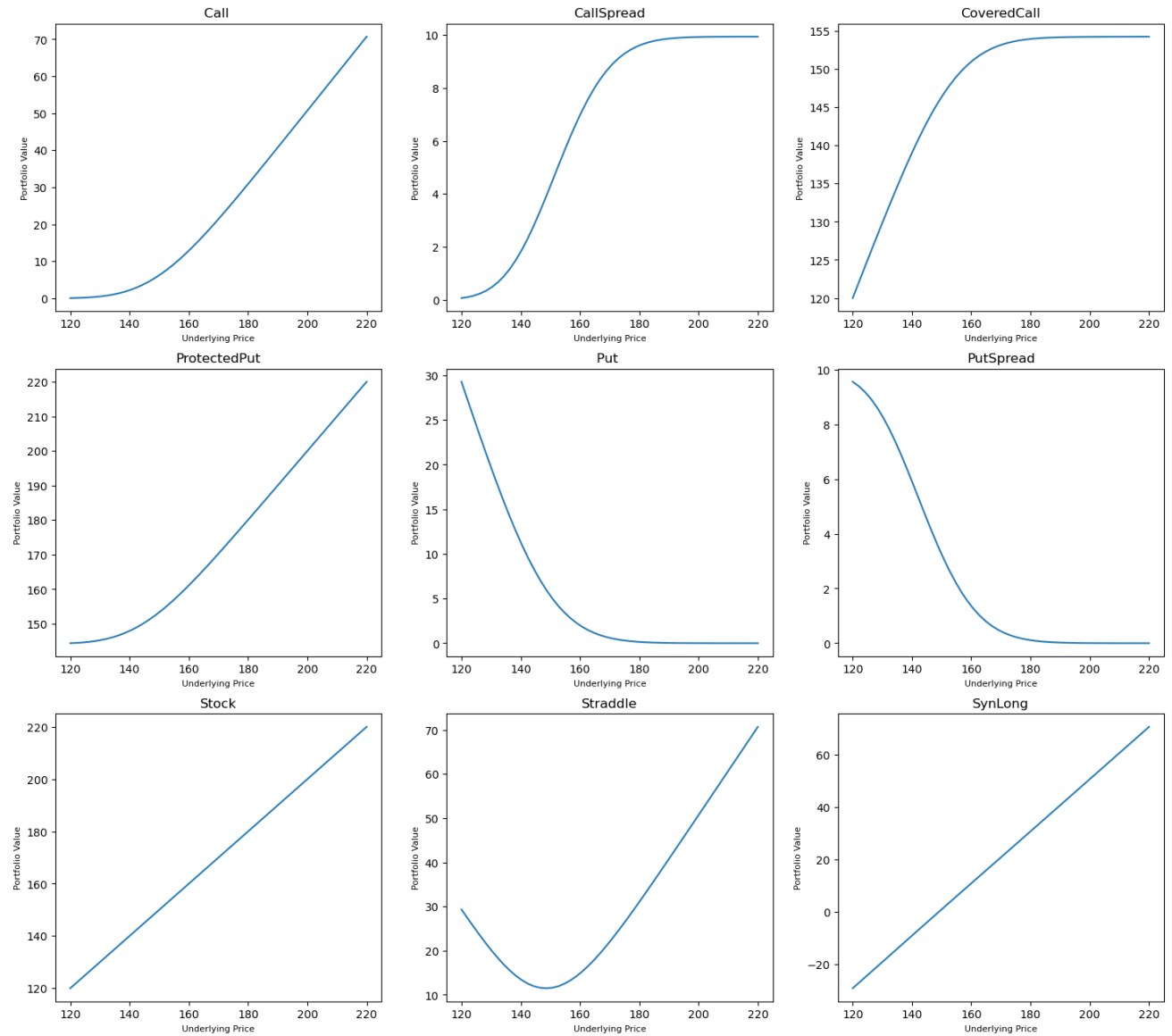
- From the plot, we can see two different patterns of how the implied volatility changes based on different strike prices for call and put. The pattern for call is commonly known as 'Volatility Smirk', and the pattern for put is known as 'Volatility smile'.
- The volatility smile skew pattern is commonly seen in near-term equity options and options in the forex market. 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 log-normal distributions of underlying asset returns.
- The volatility smirk pattern typically appears for longer term equity options and index options. In the reverse skew pattern, the IV for options at the lower strikes are higher than the IV at higher strikes. The reverse skew pattern suggests that in-the-money calls and out-of-the-money puts are more expensive compared to out-of-the-money calls and in-the-money puts. The popular explanation for the manifestation of the reverse volatility skew is that investors are generally worried about market crashes and buy puts for protection. Another possible explanation is that in-the-money calls have become popular alternatives to outright stock purchases as they offer leverage and hence increased ROI. This leads to greater demands for in-the-money calls and therefore increased IV at the lower strikes.

Question 3

- Use the portfolios found in problem3.csv
- • Current AAPL price is 151.03
- • Current Date, Risk Free Rate and Dividend Rate are the same as problem #1.
- 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.

Question 3 Answer

Portfolio values over a range of underlying prices plots for different portfolios.



Question 3 Answer

	Mean	VaR	ES
Portfolio			
Call	0.240672	6.108493	6.411915
CallSpread	-0.283662	3.952209	4.225740
CoveredCall	-1.072510	12.706898	16.236290
ProtectedPut	0.238999	8.197832	8.774393
Put	1.054560	4.230446	4.499064
PutSpread	0.446033	2.527680	2.732404
Stock	-0.612572	16.550084	20.183831
Straddle	1.295232	1.380554	1.387540
SynLong	-0.813888	16.796478	20.451763

Question 3 Answer

- From the plots and data above:
- For Call and Put: The basic options. Makes money as the stock price goes up or down. The risks are moderate.
- For CallSpread and PutSpread: They add a limit to the basic Call and Put. Lowering the risk by sacrificing returns.
- For CoveredCall and ProtectedPut: Basically a mix of stocks and options. The patterns are similar as Call or Put. The risks are also between stocks and options.
- For SynLong and Stock: SynLong has the same straightforward pattern as Stock, but with double returns. Both have high risks.
- Straddle: The most special portfolio among all these, since it makes money as long as the price moves regardless of the direction. The risk is low among all portfolios.