

Project 6

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Problem 1

Assume you have a call and a put option with the following

- Current Stock Price \$165
- Current Date 02/25/2022
- Options Expiration Date 03/18/2022
- Risk Free Rate of 0.25%
- 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?

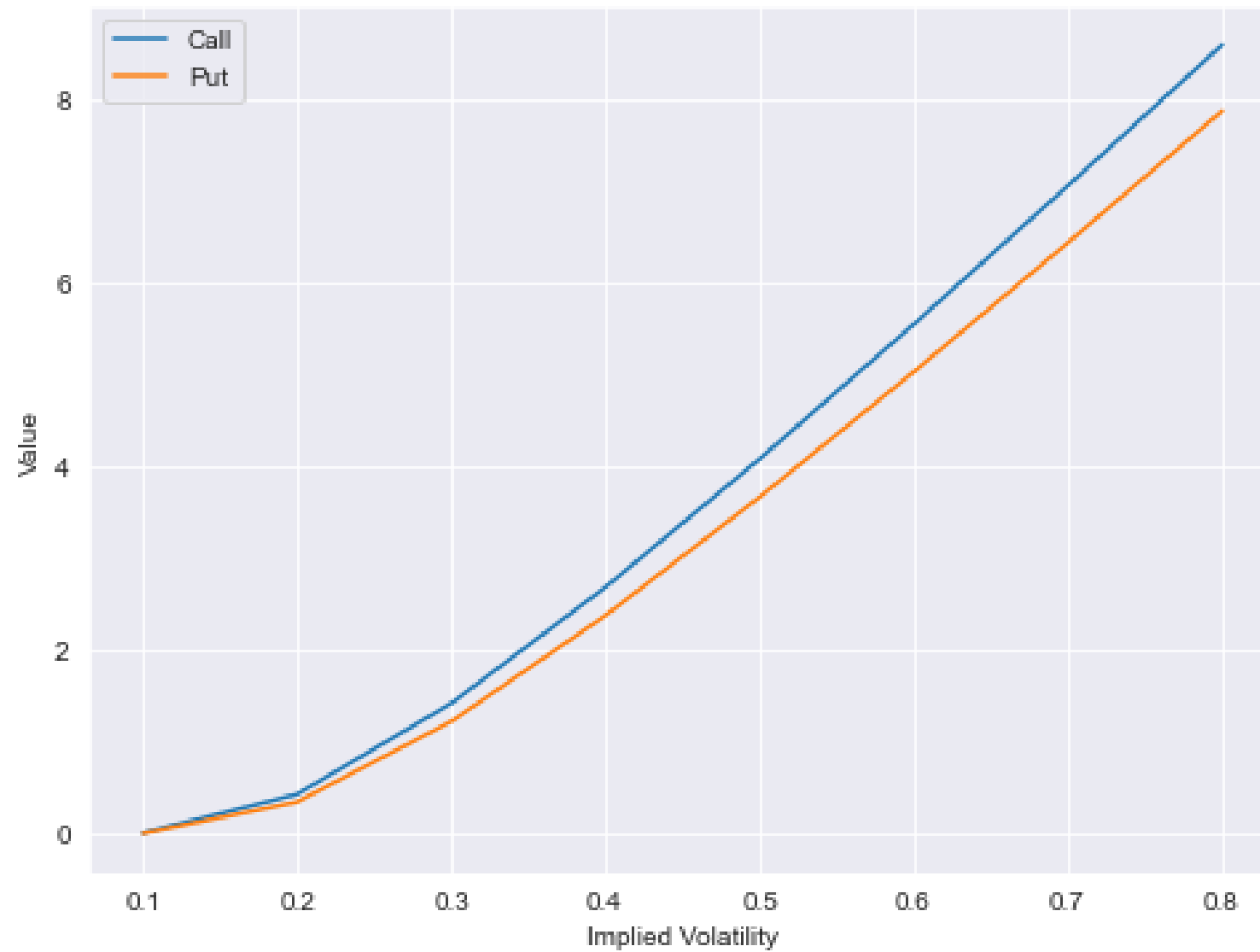
Solution

As we can see from the graph, the more volatile the underlying asset becomes, the more valuable the options are.

The rise in demand or decrease in supply for an option will cause its price to rise. Given all other conditions equal (e.g., the price of the underlying asset), this means the implied volatility must rise, as it moves in the same direction with option value.

For the same reason, rise in supply or decrease in demand will result in a lowered implied volatility.

Volatility - Option Value



Problem 2

Use the options found in AAPL_Options.csv

- Current AAPL price is 164.85
- Current Date, Risk Free Rate and Dividend Rate are the same as problem #1.

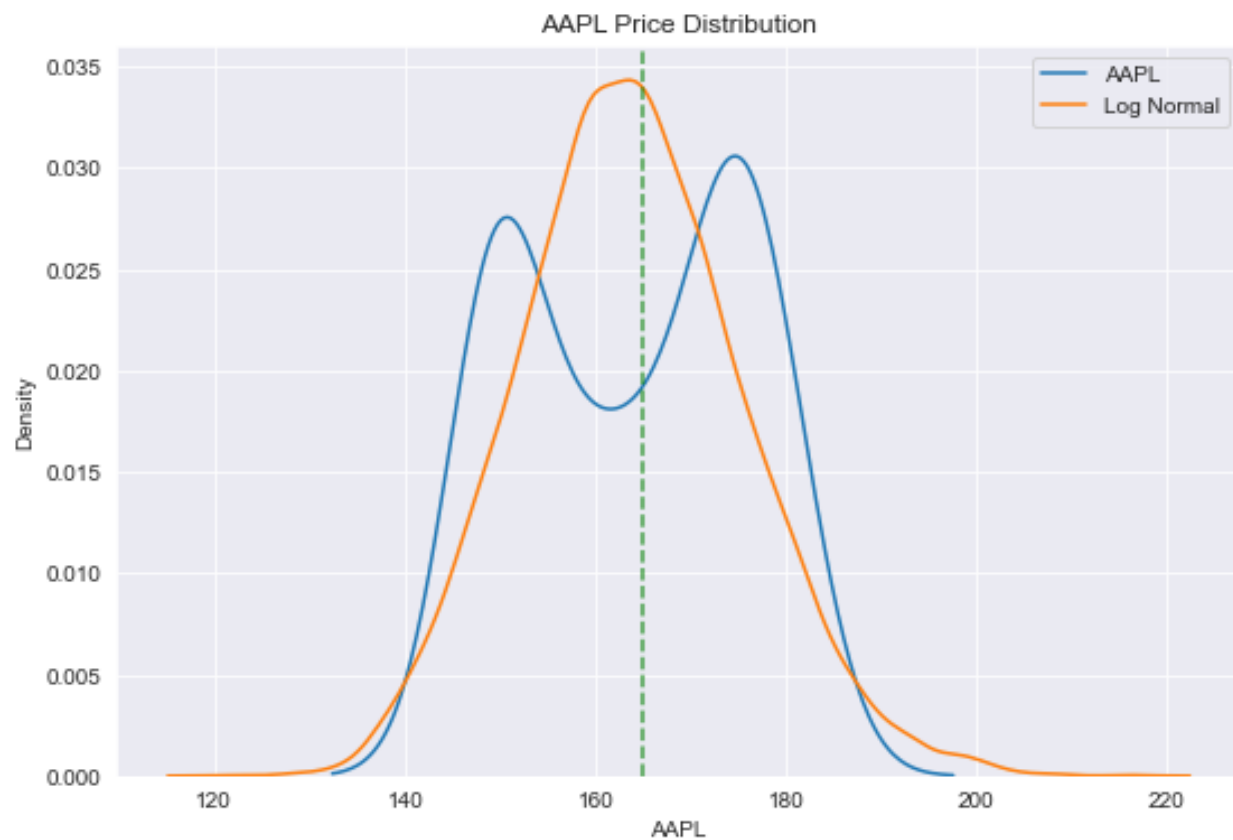
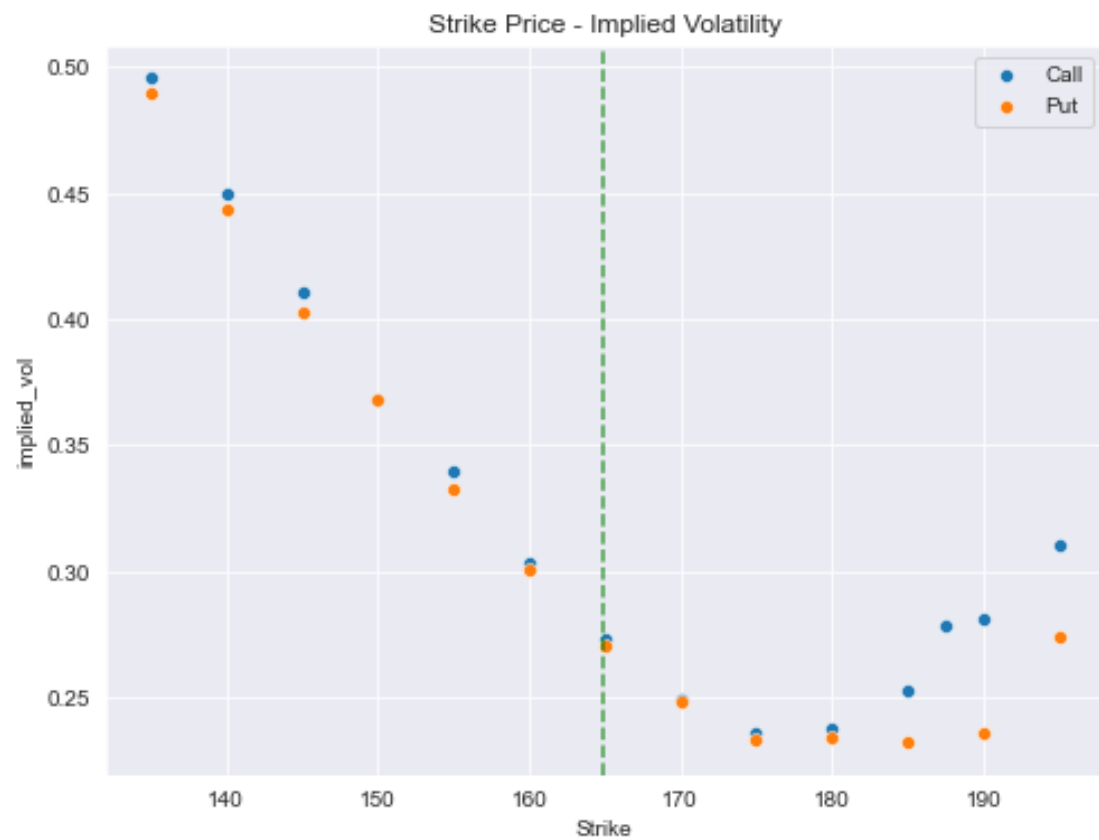
Calculate the implied volatility for each option. Plot the implied volatility vs the strike price for Puts and Calls. Discuss the shape of these graphs. What market dynamics could make these graphs?

There are bonus points available on this question based on your discussion. Take some time to research if needed.

Solution

We can see a “volatility smile”. Why?

- Stock prices are usually not log-normally distributed as the BSM model assumes. The real distribution has two peaks, and stock prices are less concentrated around 164.85.
- The stock price will be more likely to deviate from its current value. With such an expectation, the investors will prefer deeply in-the-money or out-of-the-money options. The BSM model will suggest higher implied volatilities.
- The Prospect Theory: people tend to overestimate the probability for extreme situations to occur.



Problem 3

Use the portfolios found in problem3.csv

- Current AAPL price is 164.85
- Current Date, Risk Free Rate and Dividend Rate are the same as problem #1.

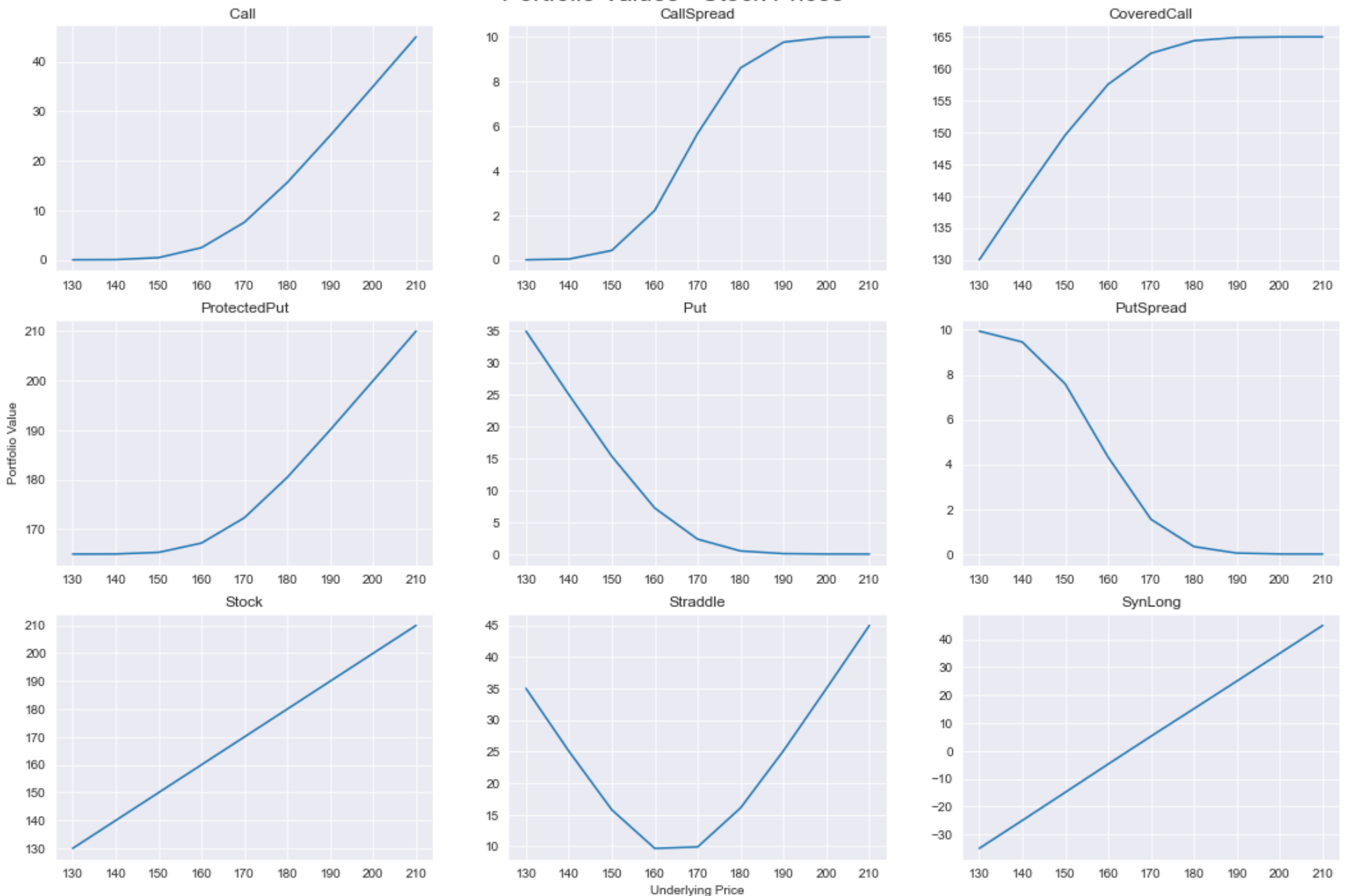
For each of the portfolios, graph the portfolio value over a range of underlying values. Plot the portfolio values and discuss the shapes. Bonus points available for tying these graphs to other topics discussed in the lecture.

Using 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. Discuss.

Solution

- Straddle: Holds 1 Call and 1 Put. It will make money when the price moves in either direction.
- SynLong: Holds 1 Call and shorts 1 Put. It will make more money when the price goes up, and lose more when it goes down.
- Call Spread: Holds 1 Call and shorts 1 Call with higher strike. It will make money when the price goes up, and lose money when price falls, but there is a limit.
- Put Spread: Holds 1 Put and shorts 1 Put with lower strike. It's behavior is opposite to Call Spread.
- Covered Call: Holds 1 stock and shorts 1 Call. The shape on the graph is like shorting 1 Put.
- Protected Put: Holds 1 stock and 1 Put. The shape on the graph is like holding 1 Call.

Portfolio Values - Stock Prices



portfolio return in 10 days

- Most portfolios have average return close to 0, except SynLong. As the effect of price change on portfolio value is greatly enlarged, it is very risky and has extremely high VaR and ES.
- Covered Call & Protected Put: Though they're like shorting a call or holding a put, their risks are much smaller at the cost of profitability.
- Call Spread & Put Spread: Their VaR and ES are close to those of Call and Put, but they are not so profitable as holding options.
- Straddle: Seems to have moderate risk, but still riskier than just holding stocks.

Risk Metrics

Portfolio	mean	VaR	ES
Call	0.031324	0.967577	0.985024
CallSpread	-0.059727	0.961496	0.982199
CoveredCall	-0.000698	0.056325	0.075196
ProtectedPut	0.001569	0.024458	0.024815
Put	0.053753	0.967539	0.985667
PutSpread	0.134295	0.955763	0.980426
Stock	0.000176	0.081200	0.100032
Straddle	0.042412	0.274527	0.275558
SynLong	-0.955592	136.003240	167.230579

Distribution of Portfolio Value Changes In 10 Days

