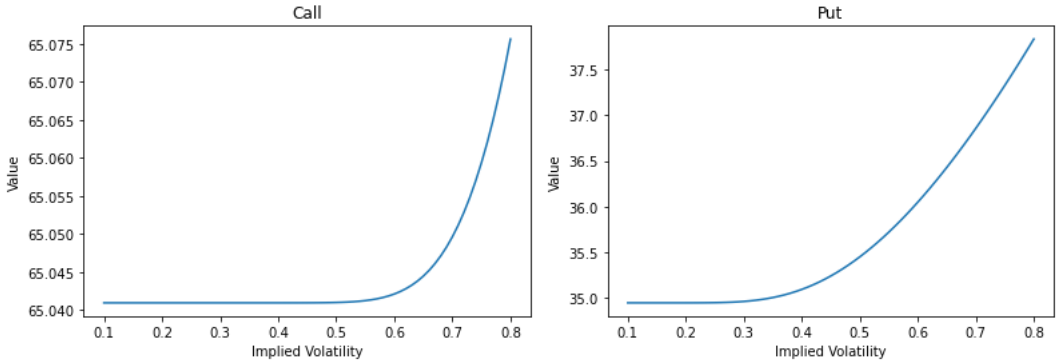
Project Week06
Hongren Jiang

Problem 1
Question:

Assume you 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 do the supply and demand affect the implied volatility?

Answer:
Time to maturity is 21/365
Assuming the strike price of the call option is $100, that of the put option is $200, use the BSM formula to calculate the option value. Here is the graph:

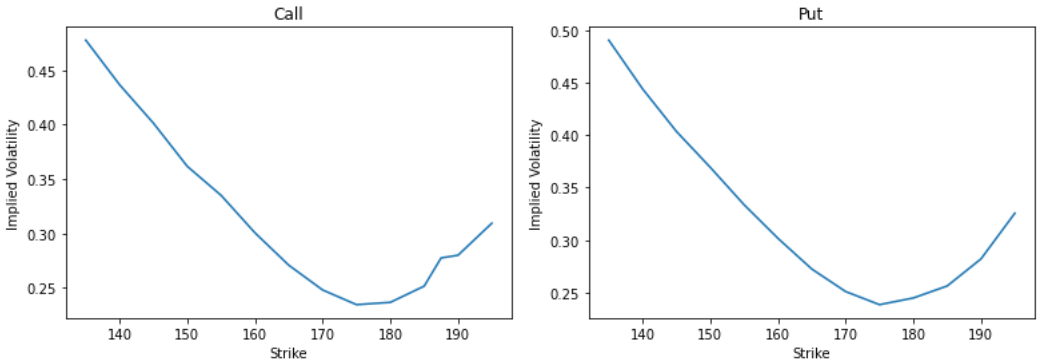


The option value increases with implied volatility, slowly at first and quickly thereafter.

Problem2:

Question:
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.
Answer:



In this problem, the relationship between Strike Price and implied volatility is consistent with the smile curve. I looked up some information on the smile curve from the Internet.

A volatility smile is a common graph shape that results from plotting the strike price and implied volatility of a group of options with the same underlying asset and expiration date. The volatility smile is so named because it looks like a smiling mouth. Implied volatility rises when the underlying asset of an option is further out of the money (OTM), or in the money (ITM), compared to at the money (ATM). The volatility smile does not apply to all options.

Volatility smiles are created by implied volatility changing as the underlying asset moves more ITM or OTM. The more an option is ITM or OTM, the greater its implied volatility becomes. Implied volatility tends to be lowest with ATM options.

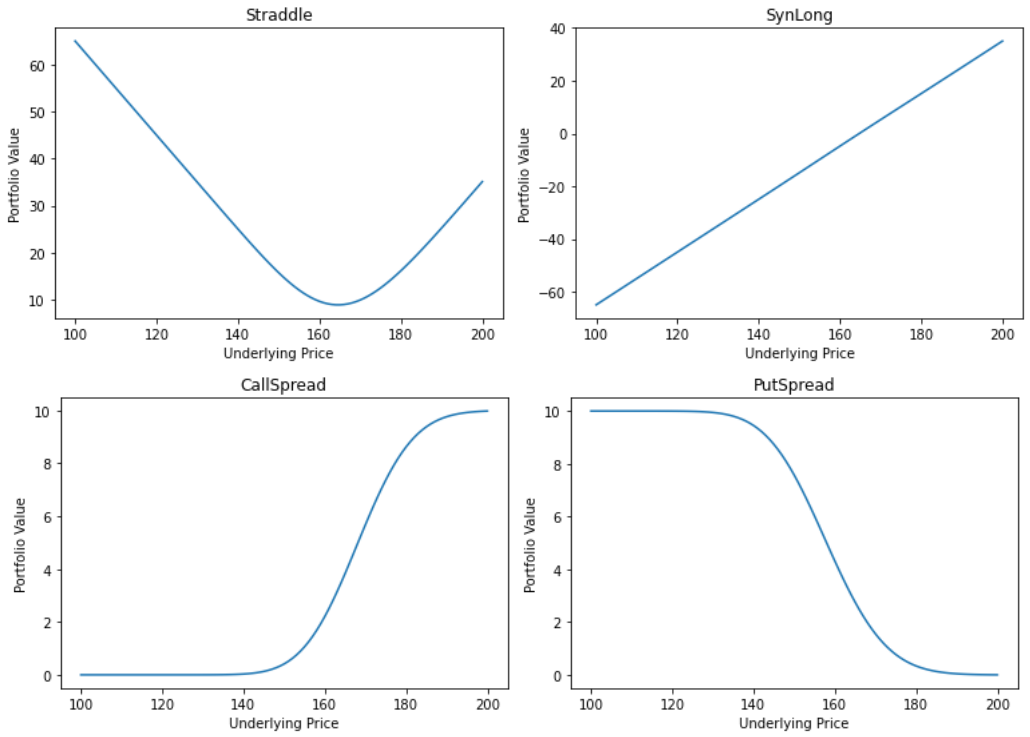
The volatility smile is not predicted by the Black-Scholes model, which is one of the main formulas used to price options and other derivatives. The Black-Scholes model predicts that the implied volatility curve is flat when plotted against varying strike prices. Based on the model, it would be expected that the implied volatility would be the same for all options expiring on the same date with the same underlying asset, regardless of the strike price. Yet, in the real world, this is not the case.

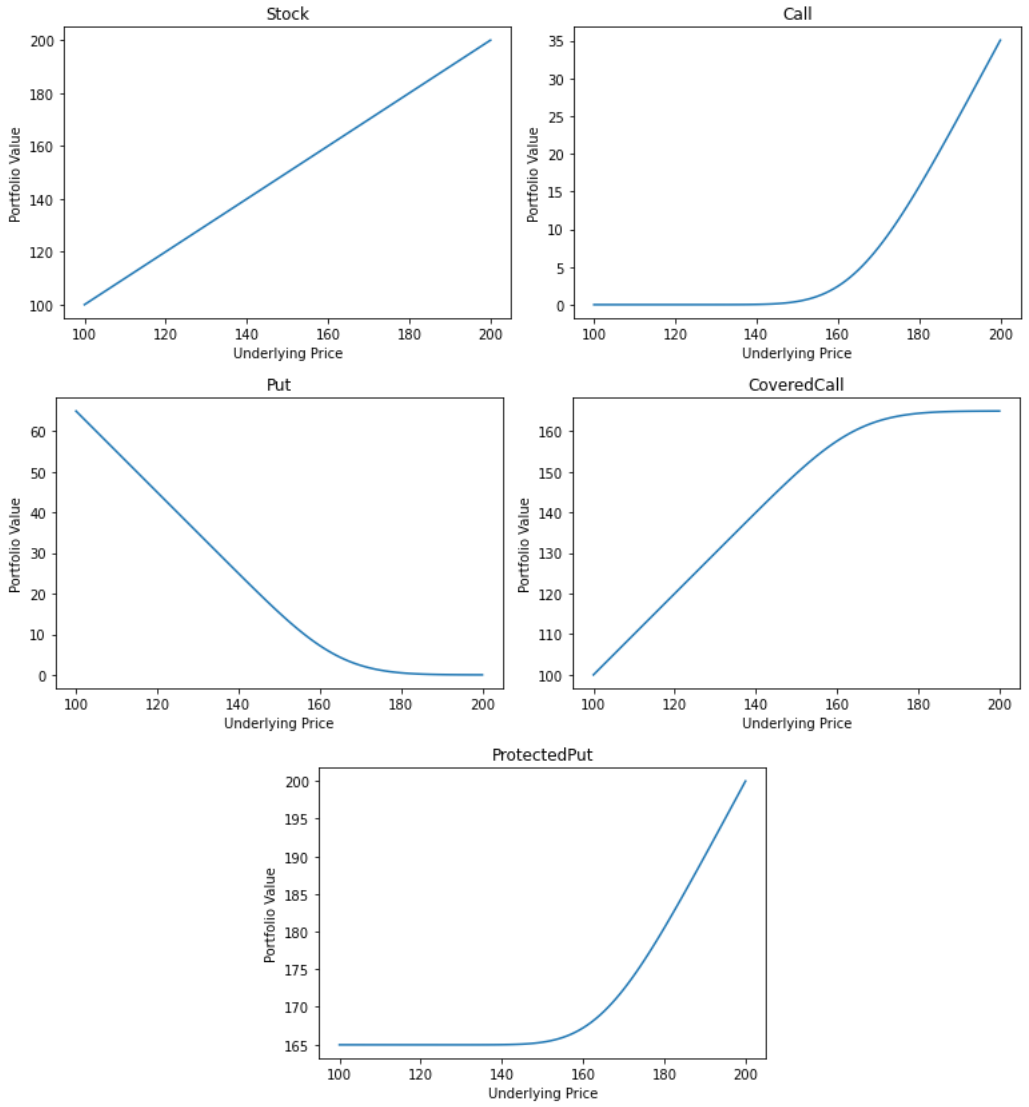
Volatility smiles started occurring in options pricing after the 1987 stock market crash. They were not present in U.S. markets beforehand, indicating a market structure more in line with what the Black-Scholes model predicts. After 1987, traders realized that extreme events could happen and that markets have a significant skew. The possibility for extreme events needed to be factored into options pricing. Therefore, in the real world, implied volatility increases or decreases as options move more ITM or OTM.
(https://www.investopedia.com/terms/v/volatilitysmile.asp#:~:text=The%20smile%20shows%20that%20the,have%20an%20implied%20volatility%20smile.)

Problem3:
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.
Hints:
● you will need to calculate the implied volatility – not the same value as in #2
● you need to take into account the change in dates for option valuations. You are simulating forward in time and options valuations are a function of time
● Calculate the PL from the current portfolio value using Current Date

Answer:





Observation:

1. SynLong and Stock behave the same. Neither serves a hedging purpose.
2. Call and ProtectedPut behave the same. Both hedge the risks associated with low prices of the underlying assets.
3. CoveredCall sets the upper limit for earnings, while Put sets the lower limit. callSpread and PutSpread set the upper and lower limits.
4. Straddle can make money from price changes, whether it becomes lower or higher.

Portfolio	Current Value	Mean	VaR	ES	Mean(%)	VaR(%)	ES(%)
SynLong	0.1	-0.2938	13.2798	16.6586	-293.80%	13279.80%	16658.60%
PutSpread	2.8	0.411	2.6559	2.7294	14.68%	646.20%	664.09%
Call	4.5	-0.01	4.3433	4.4312	-0.22%	96.52%	98.47%
Put	4.4	0.2836	4.2339	4.3188	6.45%	96.23%	98.15%
CallSpread	3.78	-0.296	3.6237	3.7113	-7.83%	95.87%	98.18%
Straddle	8.9	0.2734	2.4464	2.4543	3.07%	27.49%	27.58%
Stock	164.85	-0.1715	13.0875	16.4501	-0.10%	7.94%	9.98%
CoveredCall	160.35	-0.1612	8.7442	12.0189	-0.10%	5.45%	7.50%
ProtectedPut	169.25	0.1122	4.151	4.2226	0.07%	2.45%	2.49%

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From a relative value perspective, Stock, CoveredCall and ProtectedPut have lower VaR vs. ES and mean values around 0. Strictly speaking, Stock cannot be considered a hedging method because it is the underlying asset itself. And Stock has a larger value base, which is what makes it relatively less risky. Straddle also has a low VaR and ES, and it has performed well considering that the portfolio plays a role of arbitrage (profiting from price movements whether prices go higher or lower), rather than preservation of value. In terms of absolute values, SynLong and Stock exhibit similar properties. the absolute sizes of CoveredCall and ProtectedPut risks are small and serve to set upper and lower limits.