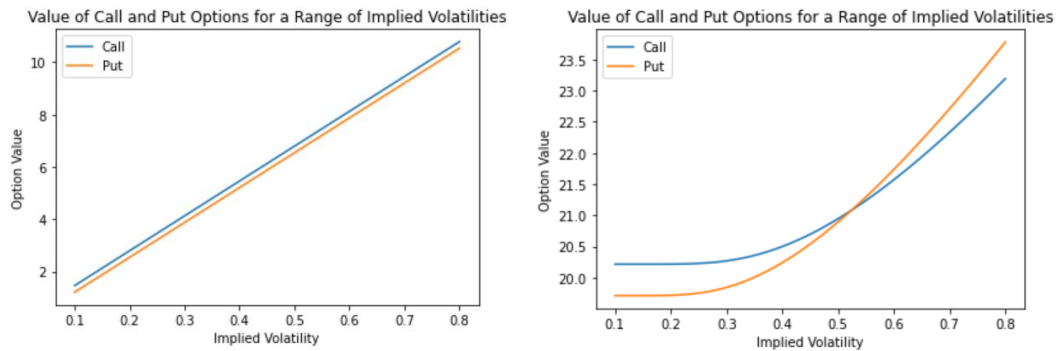Problem 1

The plots show the value of a call and a put option for a range of implied volatilities between 10% and 80%. The Black-Scholes model assumes that the volatility of the underlying asset is constant over the life of the option, but in reality, it can vary.

The plot on the left shows that the value of the call and the put options increases as the implied volatility increases, which is expected. This is because the higher the implied volatility, the greater the potential for the stock price to move in the option holder's favor, increasing the option's value. It also shows that the value of the call and the put options are very close when they have the same strike price as the current stock price, which is $165. This is the at-the-money option, the call and the put options have the same value at expiration.

The plot on the right shows that when the strike price of call is $145 and the strike price for put is $185, the value of the call option is higher than the value of the put option when the implied volatility is 10%. As the implied volatility increases, the value of both options increases, but the value of the put option increases faster than the value of the call option.

Problem 2
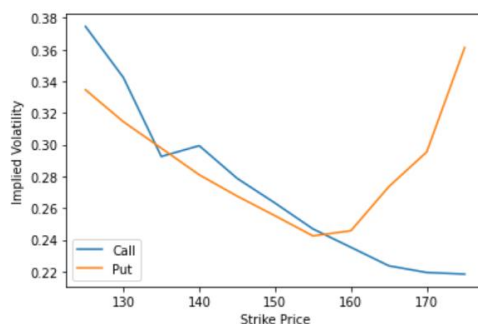
The implied volatility of the call options starts at a high implied volatility value for the lower strike prices and then gradually decrease as the strike price increases. The implied volatility of the put options starts at a low implied volatility value for the lower strike prices and then gradually decrease as the strike price increases. When the strike price reaches a certain value, the implied volatility starts to increase again.

The shape of the graph is typically referred to as the volatility smile which shows a

smile shape, with a higher implied volatility for lower and higher strike prices, and a lower implied volatility for the at-the-money options. The market dynamics that could cause the volatility smile include:

1. Skewness: The implied volatility of options with lower strike prices is typically higher than that of options with higher strike prices. This skewness in the implied volatility curve can be caused by market participants perceiving higher downside risk compared to upside risk.

2. Tail risk: The implied volatility of options with higher strike prices is typically higher than that of options with lower strike prices. This can be caused by the perception of greater tail risk or the potential for large moves in the underlying asset's price.

3. Market supply and demand: The volatility smile can also be influenced by market supply and demand dynamics, as investors who are looking to hedge downside risk may be more likely to buy put options with lower strike prices, leading to a higher implied volatility for those options.

4. Liquidity: The liquidity of the options market can also affect the shape of the volatility smile, as options with lower strike prices tend to have higher trading volumes and more liquidity, which can result in a higher implied volatility.

Problem 3
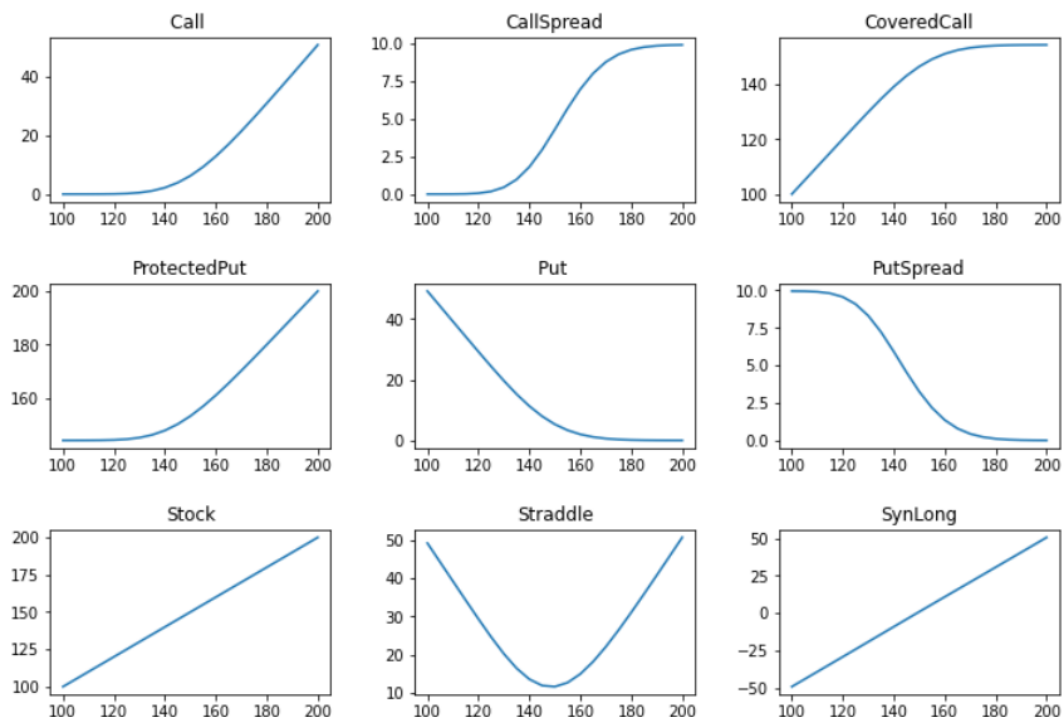
The graphs for Stock SynLong are a linear line, with the value increasing in a straight line as the underlying stock price increases. But Stock has higher values. The graph for Call shows the value increasing slowly as the underlying stock price increases in

the beginning. As the underlying stock price reaches certain amount, the value begins to increase faster. The graph for Put shows the opposite variation of Call. The graph for CoveredCall shows the value increases linearly as the underlying stock price increases. As the underlying stock price reaches certain amount, the value begins to increase slower. It also shows that CoveredCall has higher value than Call. The graph for ProtectedPut shows the opposite variation of CoveredCall. The graph for CallSpread shows that the value increases slowly when the underlying stock price is low or high. In the middle, the value increases faster. It also shows that CallSpread has lower value than Call. The graph for PutSpread shows the opposite variation of CallSpread. The graph for Straddle is in a "V" shape, with the lowest point at the strike price and the value increasing as the underlying stock price moves farther away from the strike price in either direction. The maximum value of Straddle is similar to the maximum value of Call.

	Mean	VaR	ES
Portfolio			
Call	0.664601	20.747003	25.667588
CallSpread	-0.030729	0.232417	0.624668
CoveredCall	0.122450	0.018650	0.339815
ProtectedPut	0.800090	20.675137	25.707939
Put	0.013772	0.004791	0.004793
PutSpread	0.011168	0.003838	0.003840
Stock	0.794273	20.703858	25.814628
Straddle	0.678373	20.673275	25.425521
SynLong	0.650829	20.820732	25.909655

CallSpread is the only one with negative mean. Call, ProtectedPut, PutSpread, Stock, Straddle and Synlong has high VaR and ES.