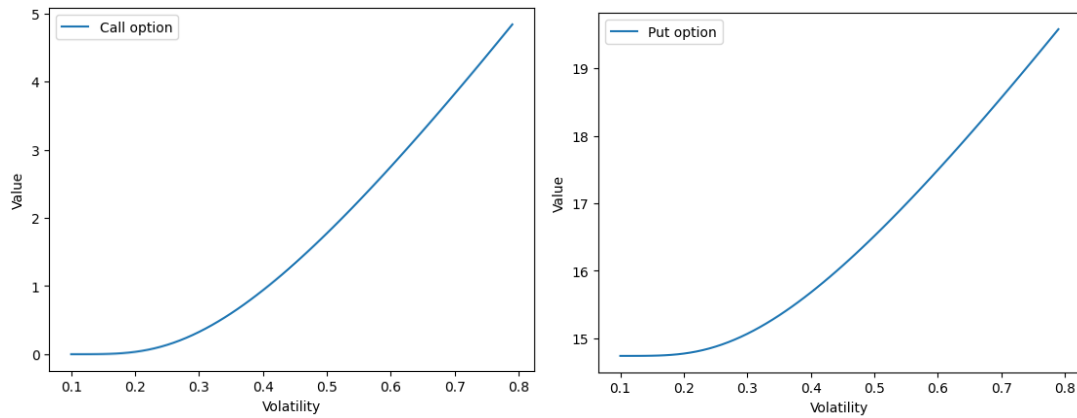


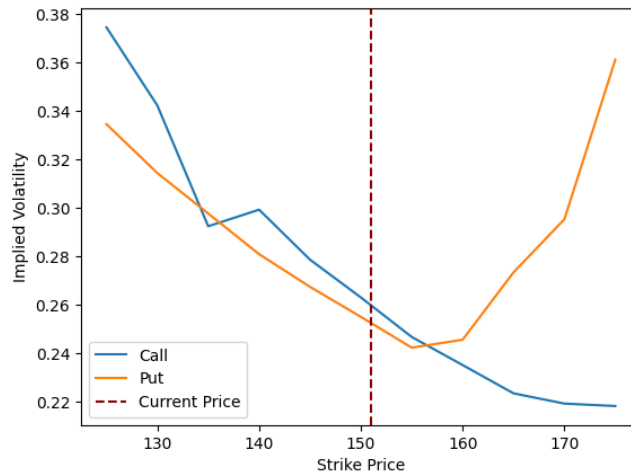
Project 6

Problem1:



The value of both the call option and put option increase as the implied volatility increases, because larger volatility can lead to larger price movement and greater opportunity of making money from the options. When the demand is greater than supply, the price of the option will increase because people are willing to pay more to buy the option. As the price increases, the implied volatility also tends to increase because the option becomes more valuable, vice versa.

Problem2:

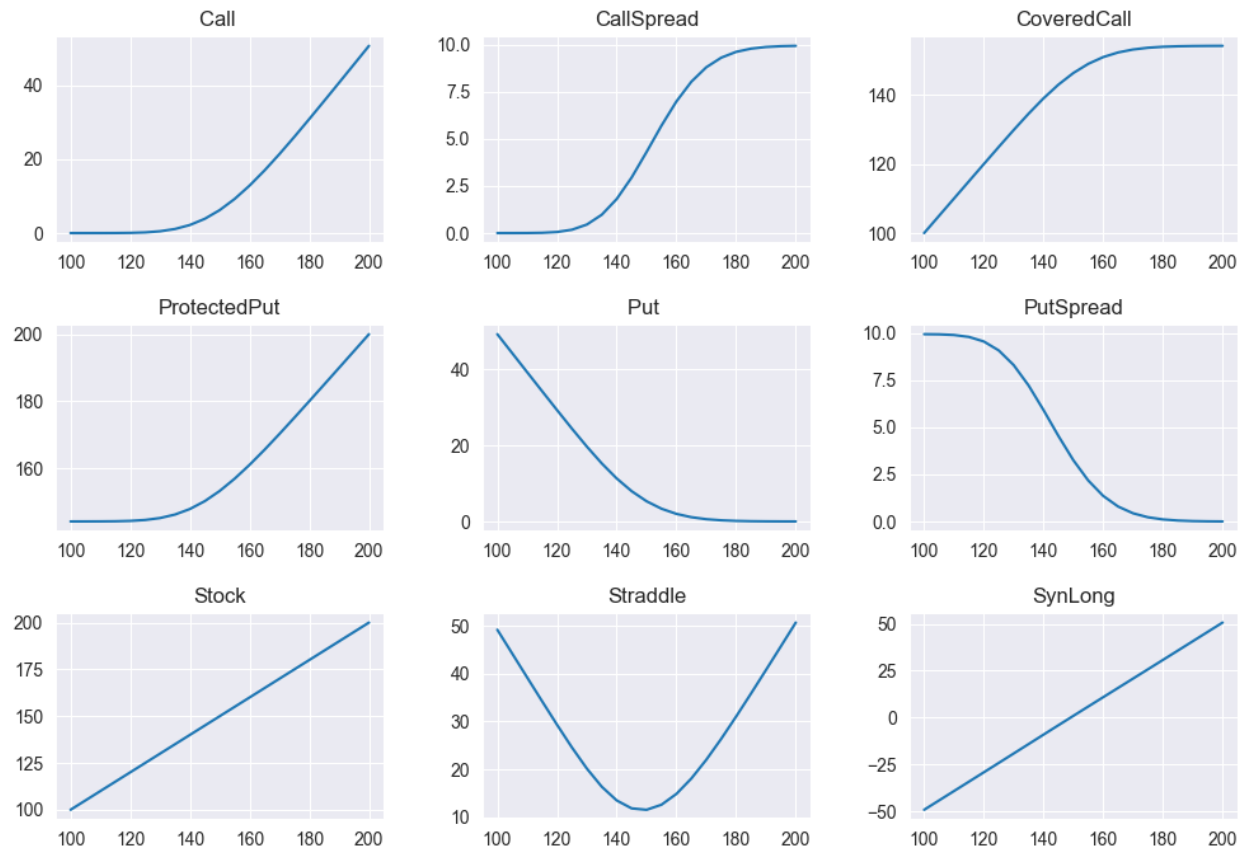


The shape of the call option is downward trended, while the put option is U-shaped. After searching, I find that the U-shape is called Volatility Smile, and the asymmetric shape is called Volatility Skew. The volatility smile (U-shape) happens when the implied volatility increases as the strike price moves away from the current price, for both in the money and out of the money directions. In our graph, the left part is out of money for put, the right part is out of money for call. We can see that for out of money call the implied volatility decreases as the strike price moves away, while for out of money put the implied volatility increases as the strike moves away. This implies that out of money put is more attractive than out of money call. This happens in a market that people are concerned about a market crash in the future and are willing to use out of money put as an

insurance. It is a phenomenon that people want to become protected when an another bear market comes.

Problem3:

Underlying range: 100-200



1. The protected put and covered call are similar strategies that is used by pairing a stock and an option. The protected put has the same shape with a call, which reflects the relation of the put call parity equation: $C + Xe^{-rT} = P + S$. The covered call is the opposite of Put, which can also be derived from the equation: $S - C = P - Xe^{-rT}$
2. Both the value of call spread and put spread have a smaller range of the portfolio value than call or put itself because shorting the option with the same underlying hedges the price movement.
3. The straddle has a U-shape because it pairs a call and a put with the same underlying, ttm, and strike price, which makes the portfolio “In the money” both below and above the current price.
4. SynLong is like a stock with a straight line. When the underlying is below current price, the call is out of money and the shorted put is an upward line approaching to 0. When the underlying is above current price, the put is out of money and the call is in the money.

The AR1 simulation result:

Portfolio	Mean	VaR	ES
Call	1.03819555	5.98825203	6.34713992
CallSpread	-0.0017414	3.84734467	4.1676537
CoveredCall	-0.5229992	11.8386966	15.5692071
ProtectedPut	1.16065233	7.98526793	8.65295345
Put	0.64303253	4.42645075	4.61822472
PutSpread	0.23037532	2.67525529	2.82430627
Stock	0.59979538	15.6345187	19.493916
Straddle	1.68122808	1.37896673	1.38720784
SynLong	0.39516301	15.8743342	19.7574296

The volatility rank in terms of VaR/ES:

Stock, SynLong > CoveredCall, ProtectedPut > Call, Put > CallSpread, PutSpread > Straddle

SynLong and Stock have significant larger VaR and ES than other portfolios. Covered call and protected put have larger VaR and ES than Call and Put, which implies that the combination of a call/put decreases the volatility of stock, but is still more volatile than a pure call/put. The spread strategy has even smaller VaR and ES because the long and short position builds a hedge, making money by the difference between strike price and limiting the loss. The Straddle has the largest mean and smallest VaR and ES, because the perfect pair of put and call largely limits the possibility of loss while making the best use of price volatility to make profit.