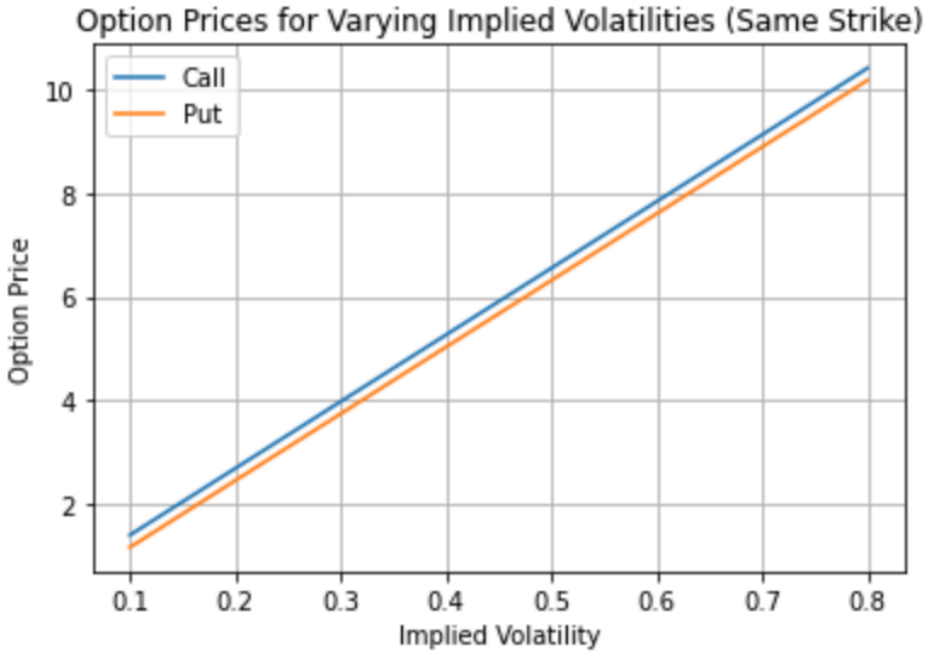
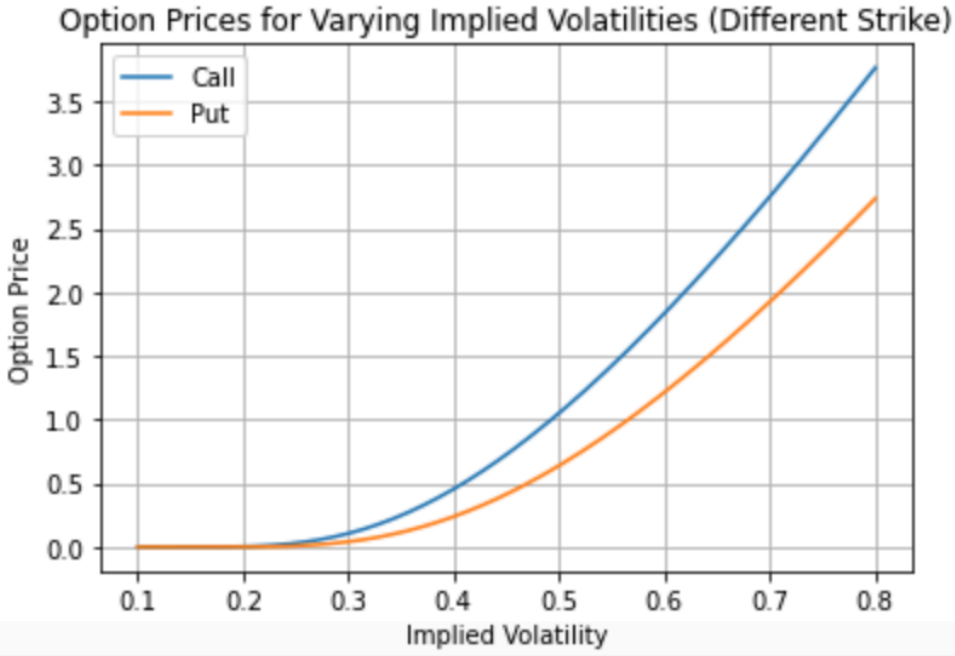
Problem1

```
Time until Expiration: 0.0384
```



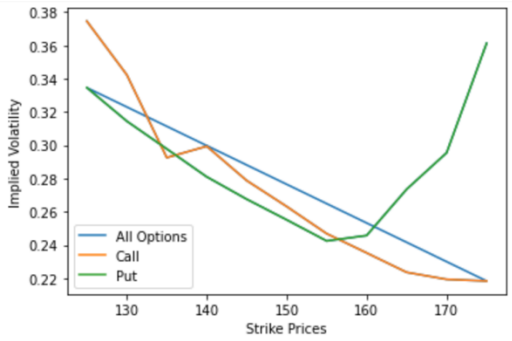


These two graphs tell us how calls and put options change with the volatility. To begin with, the first graph shows the same strike price for different option values. Specifically, when the implied volatility increases, both the call and put options value will increase. This occurs because higher volatility implies a larger potential price movement in the underlying stock, which results in a higher probability of the option finishing in-the-money at expiration. And for the second graph, it shows different strike prices in call and put options. The trend is similar to

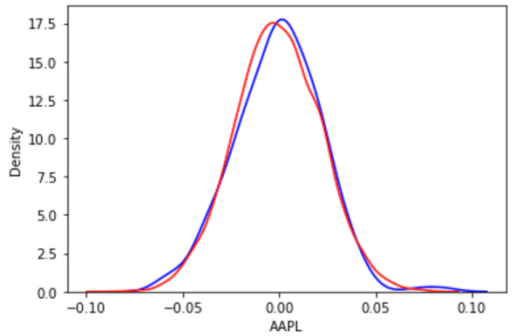
the first graph: as implied volatility increases, the value of both call and put options increases. The different strike prices result in different starting points, but the overall trend remains consistent.

Supply and demand dynamics can affect implied volatility in the options market. When the demand for options increases, market participants are willing to pay higher prices for the options, resulting in higher implied volatilities. Conversely, if the supply of options exceeds demand, option prices decrease, which leads to lower implied volatilities.

Problem2



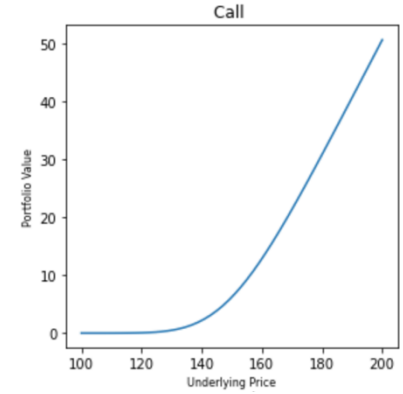

```
/tmp/ipykernel_3936/2344943484.py:35: PerformanceWarning: DataFrame is highly fragmented.  This is usually the resu
lt of calling `frame.insert` many times, which has poor performance.  Consider joining all columns at once using p
d.concat(axis=1) instead. To get a de-fragmented frame, use `newframe = frame.copy()`
  output[price_vars[i]] = returns_df.iloc[:, i]
```

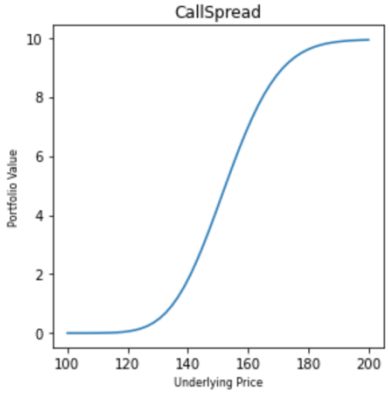


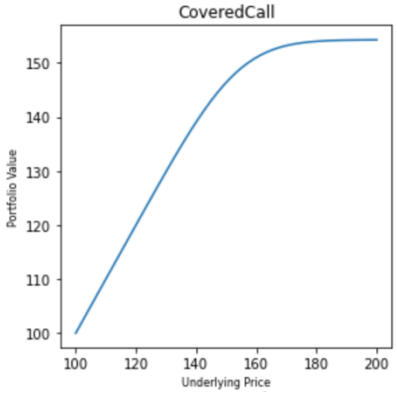
Based on the implied volatility graph, it shows a volatility smile pattern, in which implied volatilities are higher for both deep in-the-money and deep out-of-the-money options. And the AAPL shows the normal distribution.

For the market dynamics, it has demand and supply imbalances, in which can be explained as market participants will have a preference for specific strike prices or option types, causing imbalances in demand and supply. In addition, market inefficiencies and behavioral biases can also be found. Specifically, the implied volatilities may reflect behavioral biases, such as overreaction to recent news or underestimation of the likelihood of extreme events.

Problem3


Call
Portfolio Value
Underlying Price


CallSpread
Portfolio Value
Underlying Price


CoveredCall
Portfolio Value
Underlying Price

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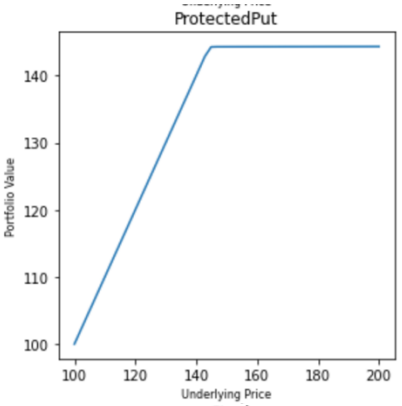
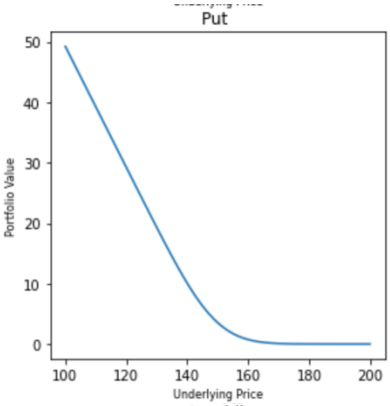
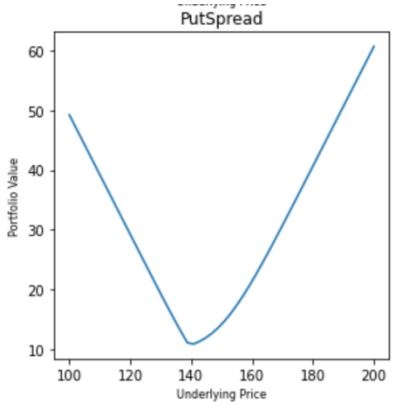
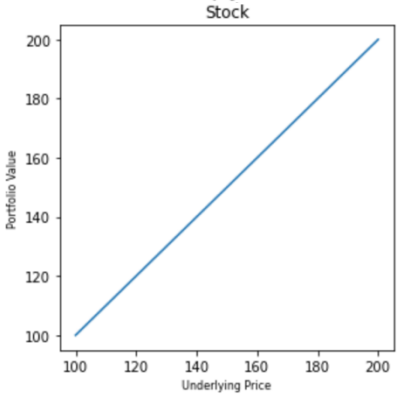
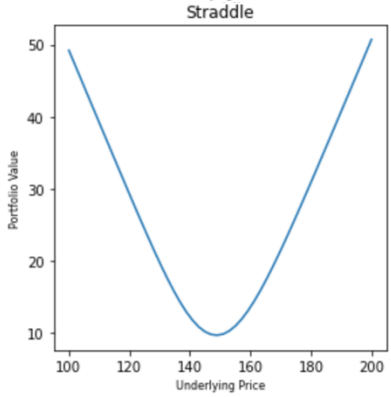
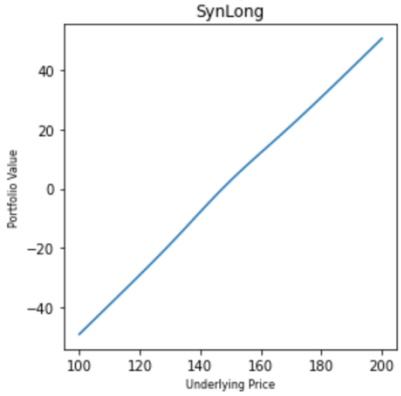

ProtectedPut
Portfolio Value
Underlying Price


Put
Portfolio Value
Underlying Price


PutSpread
Portfolio Value
Underlying Price


Stock
Portfolio Value
Underlying Price


Straddle
Portfolio Value
Underlying Price


SynLong
Portfolio Value
Underlying Price

	Mean of Portfolio Value($)	Mean of Losses/Gains($)	VaR($)	\
Call	7.658136	-0.858136	6.029616	
CallSpread	4.520349	4.489651	8.303258	
CoveredCall	146.327506	8.752494	20.224298	
ProtectedPut	142.975579	11.064421	18.946662	
Put	4.440543	0.409457	4.795103	
PutSpread	16.887988	-10.197988	-4.051839	
Stock	151.352973	-0.322973	15.936662	
Straddle	12.098679	-0.448679	2.967587	
SynLong	3.217593	8.432407	25.322299	

	ES($)	VaR(%)	ES(%)	Current Value (on 2023/3/3)
Call	6.356759	88.670829	93.481754	6.80
CallSpread	8.596278	92.156022	95.408187	9.01
CoveredCall	23.778481	13.041203	15.333042	155.08
ProtectedPut	22.616558	12.299832	14.682263	154.04
Put	4.827900	98.868105	99.544333	4.85
PutSpread	-3.913311	-60.565611	-58.494931	6.69
Stock	19.606558	10.551984	12.981896	151.03
Straddle	2.977462	25.472851	25.557610	11.65
SynLong	29.236821	217.358792	250.959835	11.65

From the plots and data presented above, we can observe the following characteristics for each portfolio strategy:

Call and Put: These are basic options that generate profits when the stock price increases or decreases, respectively. They have moderate risk levels.
CallSpread and PutSpread: These strategies incorporate limits into the basic Call and Put options, reducing risk at the expense of potential returns.
CoveredCall and ProtectedPut: These strategies combine stocks and options, resulting in patterns similar to Call or Put options. Their risks lie between those of stocks and options.
SynLong and Stock: The SynLong strategy exhibits a straightforward pattern similar to stocks but with double the returns. Both strategies carry high risks.
Straddle: This unique portfolio strategy profits as long as the stock price moves in either direction. Among all the portfolios, the straddle has the lowest risk level.