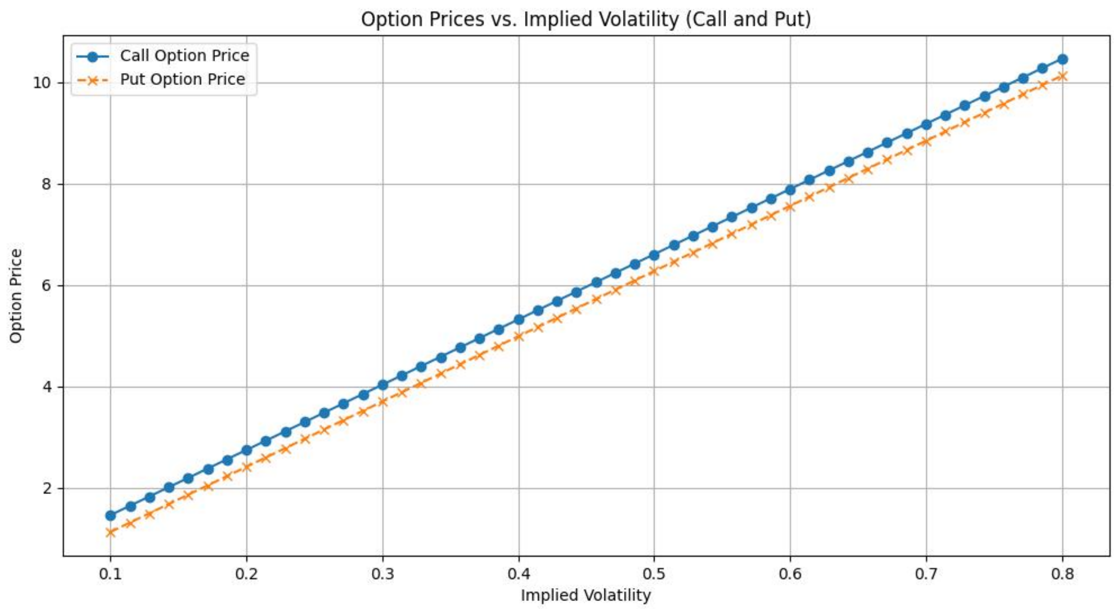
Week06
Problem1



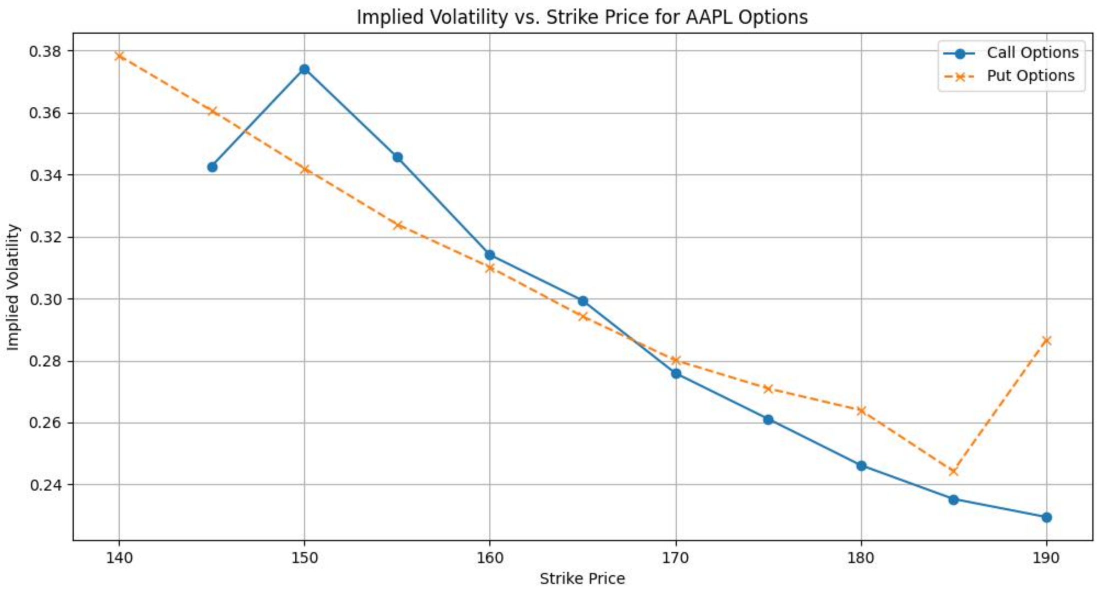
・Graph Discussion

The graph displays the relationship between implied volatility and option prices for both call and put options. As implied volatility increases, the prices of both call and put options also increase. This is because higher volatility indicates a greater range of potential future prices, which increases the probability of the option ending in-the-money, thus raising its value.

・Analysis of Supply and Demand Impact on Implied Volatility

Higher Demand: Increased demand for options generally pushes implied volatility higher, as market participants expect larger price swings. This results in higher option prices.
Higher Supply: When supply is high relative to demand, implied volatility may decrease, reflecting market expectations of lower price fluctuation, and thus reducing option prices.

Problem2



・Observations

1.Smile or Skew Pattern: There is a slight pattern where implied volatility changes with the strike price, which can often resemble a "volatility smile" or "volatility skew." This is common in options markets and indicates that options with strike prices far from the current stock price often have higher implied volatilities.

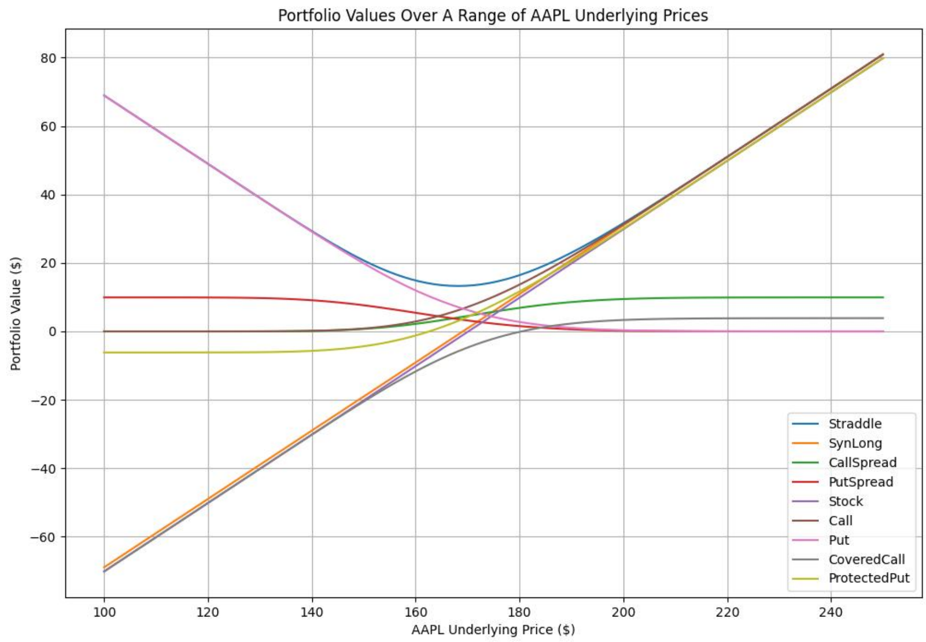
2.Higher Volatility at Lower Strikes for Puts: The implied volatility tends to be higher for put options at lower strike prices, likely due to increased demand for protective puts, which hedges against a significant drop in the stock's price.

・Market Dynamics

1.Demand for Out-of-the-Money Options: Higher demand for out-of-the-money puts (lower strikes) and out-of-the-money calls (higher strikes) may increase their implied volatilities.

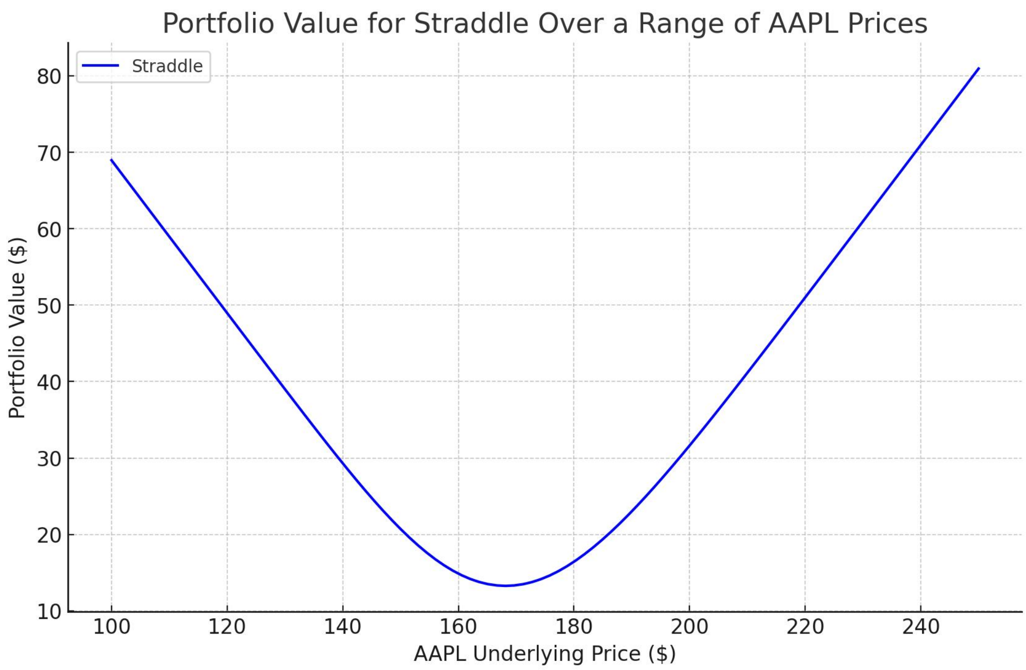
2.Risk Perceptions: Traders might perceive more risk at extreme price movements, hence the higher volatility at those strikes.

Problem3

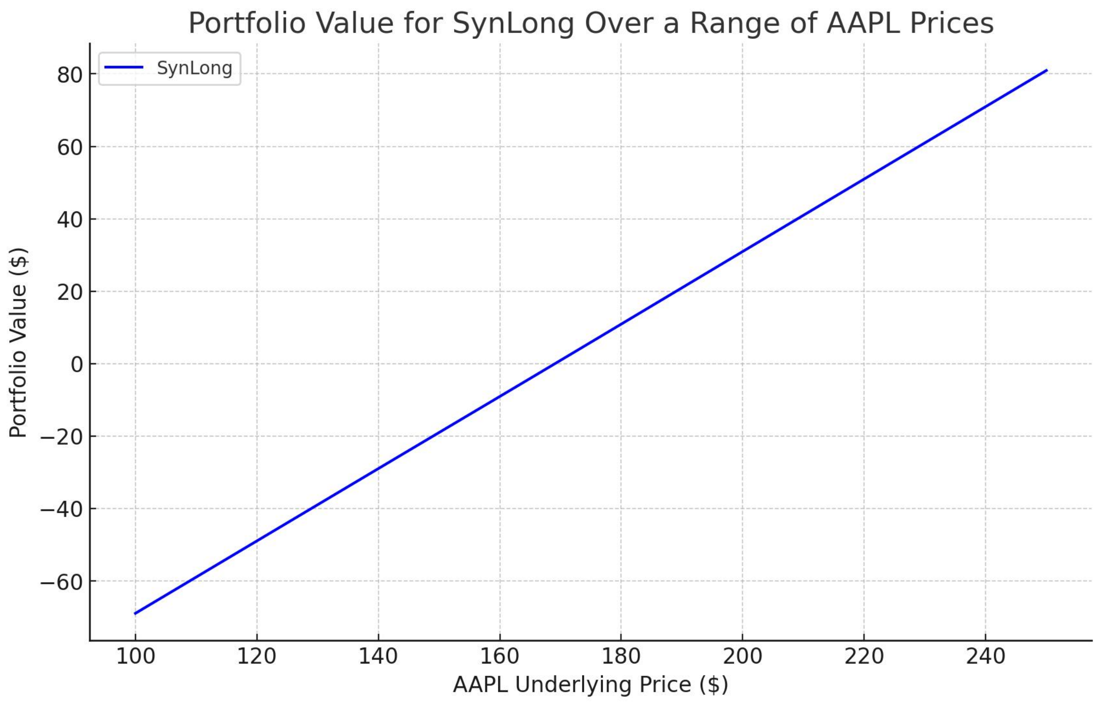


・Graph Analysis: Portfolio Values over AAPL Price Range

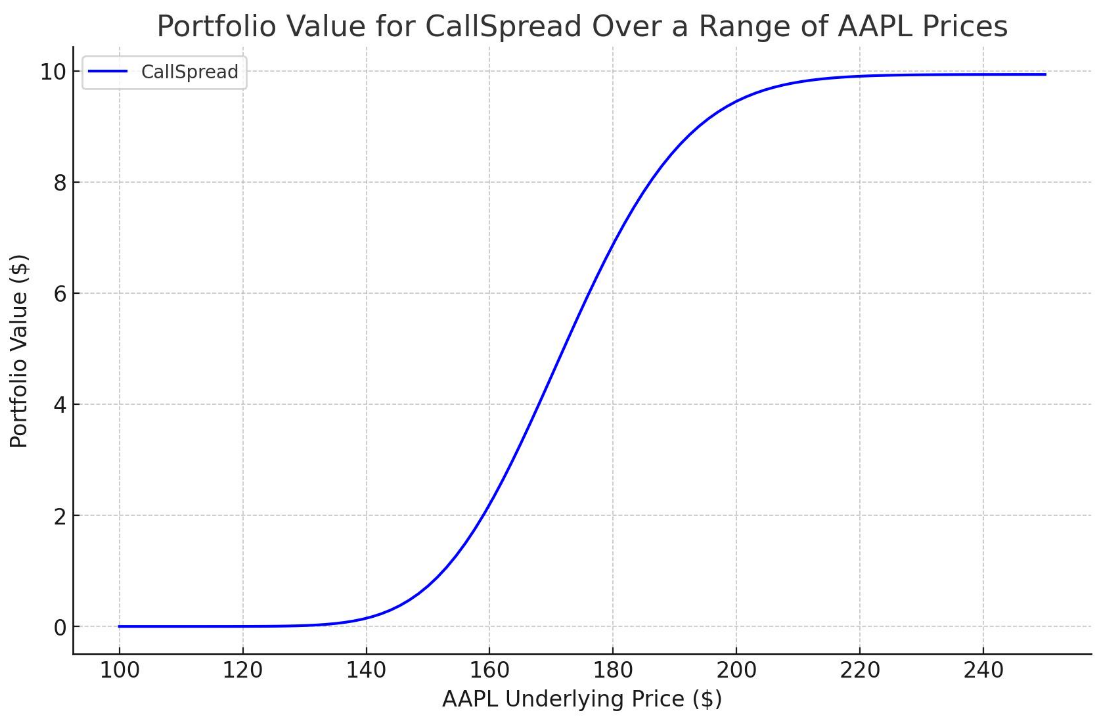
1.Straddle: The straddle portfolio, consisting of a long call and a long put with the same strike price, shows a symmetric "V" shape. This strategy profits from large price movements in either direction away from the strike, benefiting from volatility.



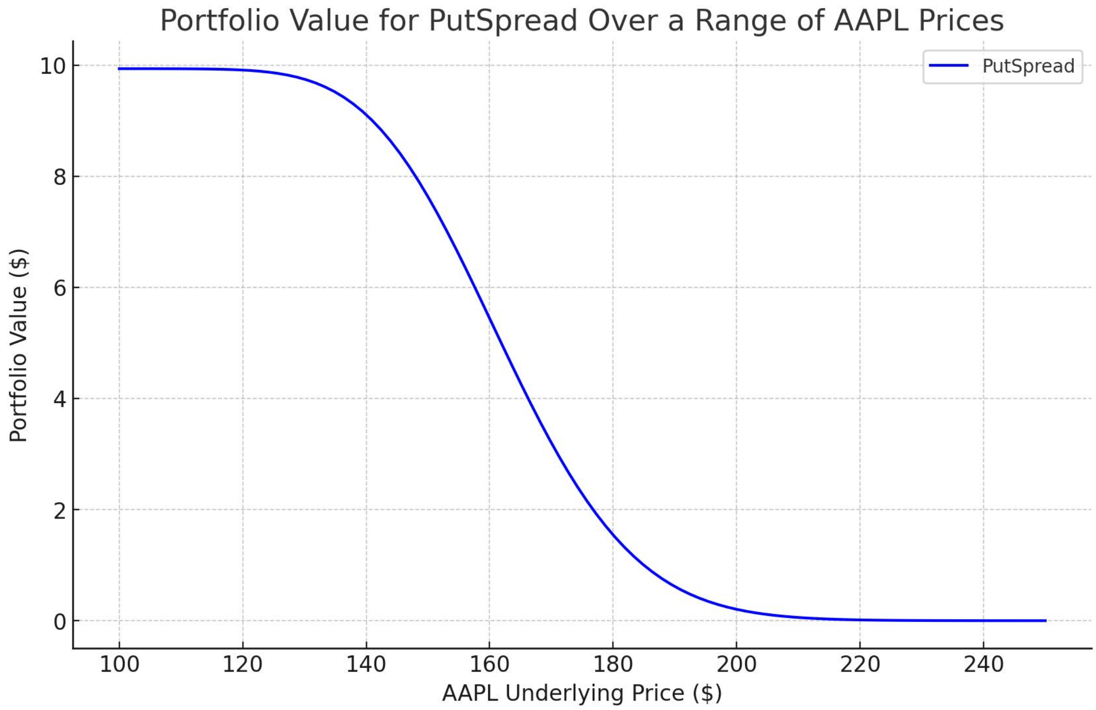
2. SynLong: The synthetic long position, created by a long call and a short put at the same strike, behaves similarly to holding stock. The linear upward trend mirrors a direct stock holding, consistent with put-call parity for a synthetic long position.



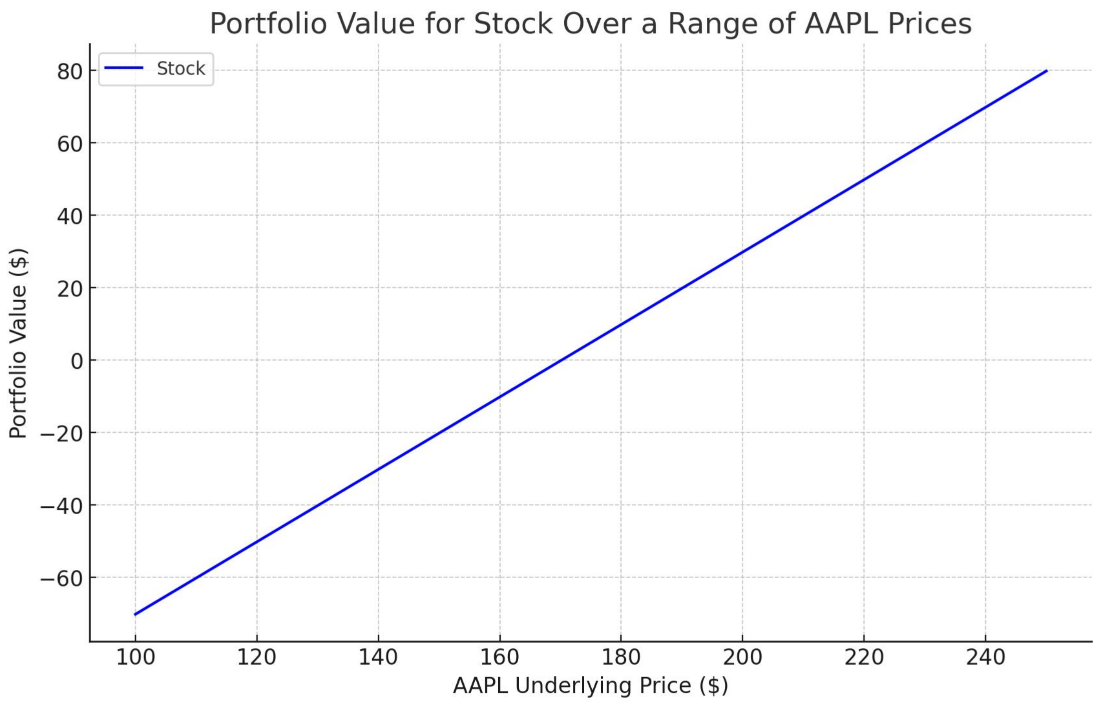
3. Call Spread: This spread involves buying a call at a lower strike and selling a call at a higher strike, creating a capped gain. The graph shows a plateau effect above the higher strike, limiting the profit potential.



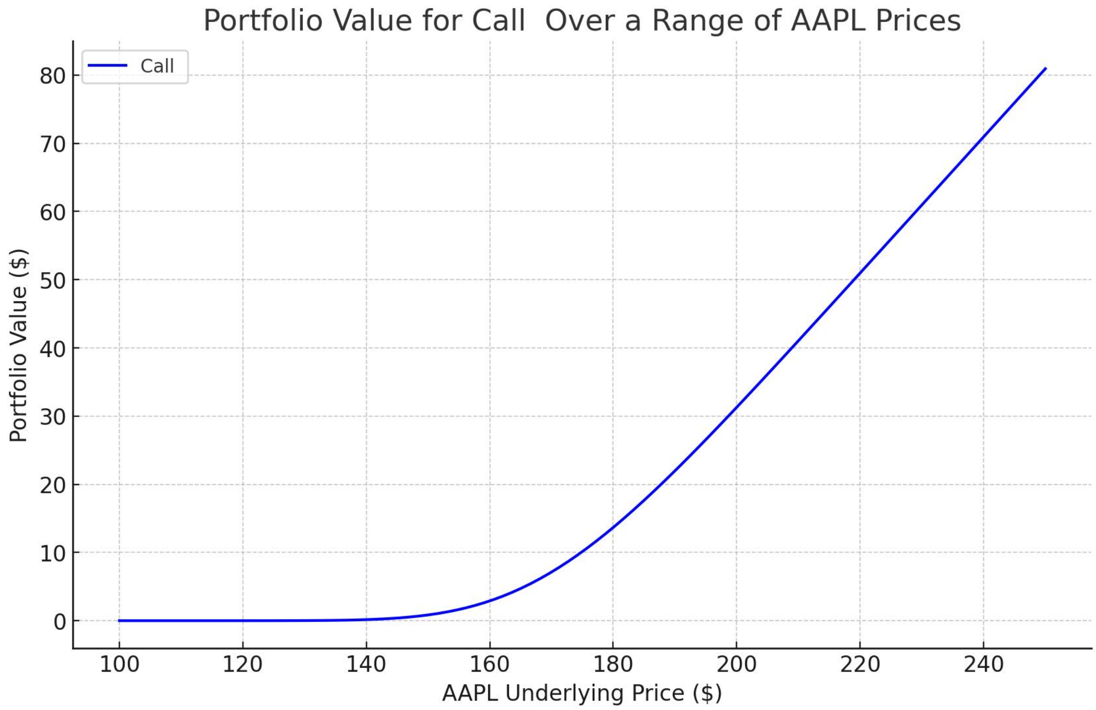
4.Put Spread: The put spread consists of buying a put at a higher strike and selling a put at a lower strike, limiting both upside and downside. The graph has a capped value below the lower strike price, where maximum profit is achieved.



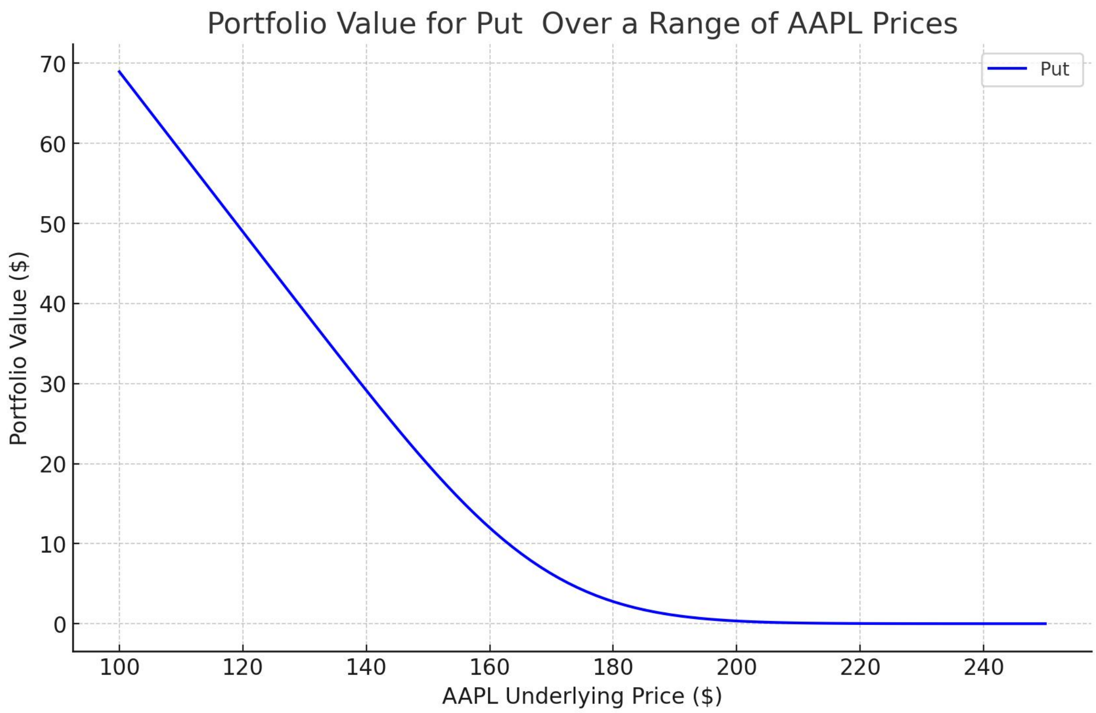
5.Stock: The stock holding reflects a straightforward linear relationship with the AAPL price. Profits increase as the price rises, and losses accumulate as it falls.



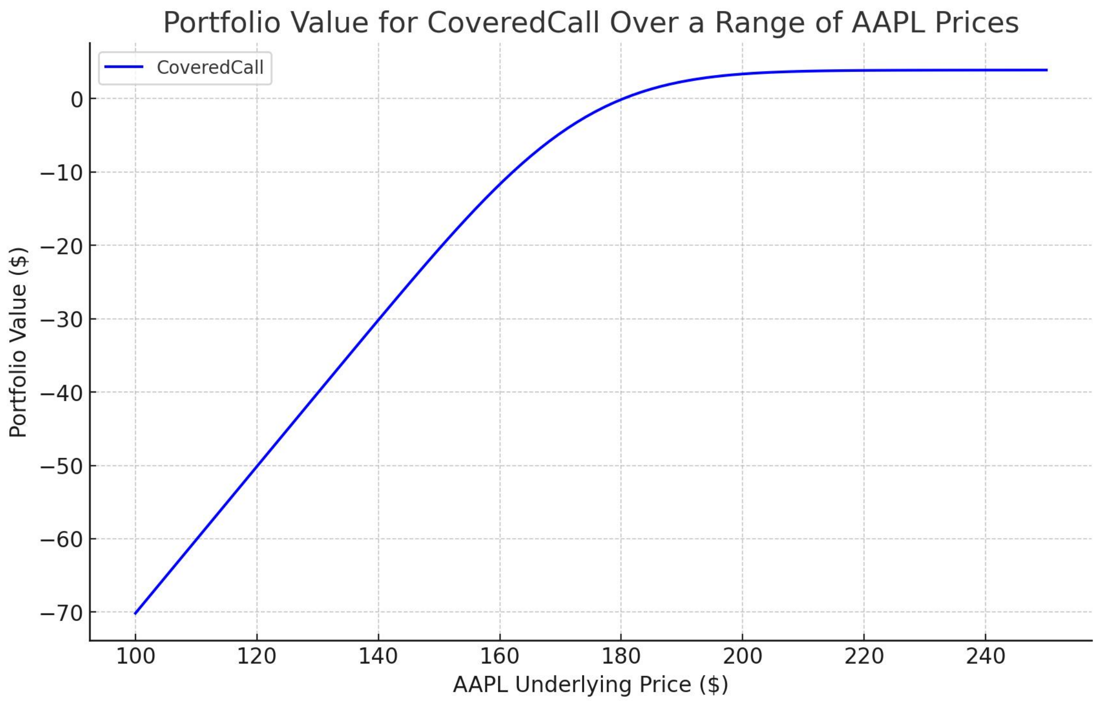
6.Call: The call option portfolio value increases as the AAPL price rises. This graph has a convex shape, with the option value growing exponentially as the price moves higher.



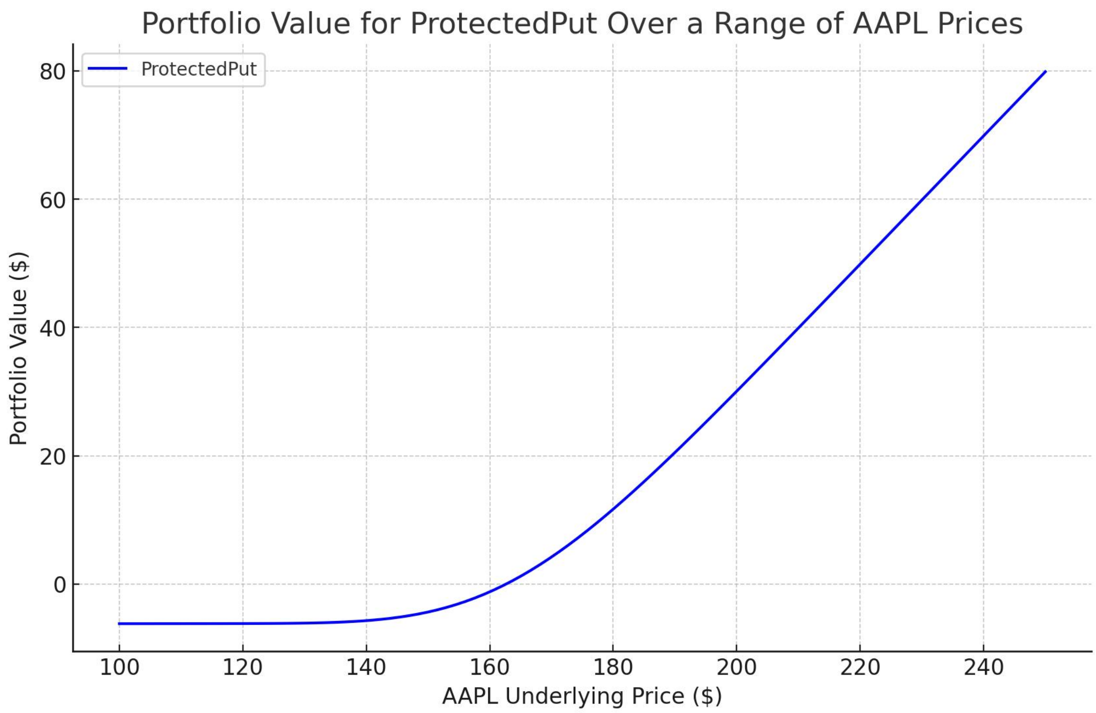
7.Put: The put option portfolio increases in value as the AAPL price drops. This graph has a concave shape, with the put value decreasing as the underlying price rises.



8.Covered Call: Combining stock with a sold call option limits upside gains. The graph shows a capped effect above the strike price, reflecting the offsetting impact of the short call on the stock gains.



9.Protected Put: This portfolio combines stock with a protective put option. The downside is limited by the put, while the stock allows for unlimited upside, creating a payoff profile with limited losses as prices fall and gains as they rise.



・Risk Analysis Results　(AAPL mean var es)

1.Mean Price: The average price over the 10-day simulation period is $167.16, which is slightly below the current price of $170.15, indicating a minor downward trend in the forecast.

2.VaR (95%): The Value at Risk (VaR) at the 95% confidence level is $161.52. This suggests a 5% chance that the AAPL price will drop below this level within the next 10 days.

3.Expected Shortfall (95%): The Expected Shortfall (ES) at the 95% confidence level is $160.74. This represents the average price in the worst 5% of outcomes, providing insight into potential extreme losses.

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Mean Price: 167.15835533742438
VaR (95%): 161.5182482565593
Expected Shortfall (95%): 160.7448606192631
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	Simulated AAPL Price
0	170.150000
1	170.373811
2	174.121390
3	172.987184
4	165.227167
5	162.463500
6	165.022095
7	160.744861
8	165.844992
9	164.648555

・Risk Analysis Results　(Portfolio mean var es)

	Mean	VaR	ES
Straddle	13.468777	13.296756	13.277944
SynLong	1.028781	-2.299106	-3.573932
CallSpread	4.536437	3.715407	3.405553
PutSpread	3.187500	2.656175	2.487240
Stock	-0.021976	-3.353479	-4.630532
Call	7.248779	5.536084	4.936851
Put	6.219998	5.032782	4.669464
CoveredCall	-4.695267	-6.726180	-7.562674
ProtectedPut	4.350134	2.259610	1.509448

1. Straddle Portfolio

・Mean: 13.35 – A positive mean indicates the straddle is likely capturing profits from AAPL's price movements, regardless of direction. Straddle strategies typically benefit from volatility, as gains are realized if the price moves significantly in either direction.

・VaR: 13.28 – At a 95% confidence level, this is a strong positive VaR, indicating minimal expected loss. The high VaR suggests that, within typical fluctuations, this portfolio isn't at significant risk of loss.
・ ES: 13.28 – The ES closely aligns with VaR, showing a limited range of extreme downside scenarios. Given the straddle's structure, this suggests that the option premiums effectively cushion against larger losses.

2. Synthetic Long (SynLong)
・Mean: -0.34 – The negative mean reflects sensitivity to price declines, expected for a synthetic long position which relies on upward price movement for profit.
・VaR: -2.89 – This indicates that, at the 95% confidence level, SynLong is susceptible to moderate downside risk, with losses capped by the long call and short put structure.
・ES: -3.72 – The slightly more negative ES indicates that in extreme scenarios, losses could extend beyond VaR, but not drastically. This result aligns with a synthetic long's exposure to downward movement but with partial protection.

3. Call Spread
・ Mean: 4.20 – The positive mean suggests that this call spread has benefited from modest increases in AAPL's price. Call spreads generally profit within a range, capturing gains in upward movement without excessive volatility.
・VaR: 3.57 – With a moderately high VaR, this spread shows a controlled downside risk, limited by the short call that caps losses.
・ES: 3.37 – The ES is slightly below VaR, which indicates that the portfolio experiences only small losses even in the worst scenarios due to the hedging effect of the spread.

4. Put Spread
・Mean: 3.46 – This positive mean suggests that the put spread capitalizes on moderate downside movement or stability in AAPL's price. Similar to the call spread, the structure profits within a range, protected by the short put.
・ VaR: 3.04 – The VaR aligns well with the put spread strategy, indicating limited downside exposure in most scenarios, controlled by the put protection.
・ ES: 3.01 – The close match to VaR suggests a tight risk range. Losses in extreme scenarios are minor, indicating the effectiveness of the put spread in reducing risk.

5. Stock Portfolio
・Mean: -1.39 – This negative mean reflects an exposure to AAPL's price volatility, which likely saw some declines over the simulation period. A stock position is fully exposed to downward movements, hence the loss.
・VaR: -3.95 – The VaR shows that, at a 95% confidence level, this portfolio could see a moderate downside, indicating typical risk for holding stock directly.
・ES: -4.78 – The ES is more negative than VaR, suggesting that in extreme scenarios, losses could extend beyond the typical range. This aligns with direct stock exposure, where tail risk can lead to larger-than-expected losses.