OPTIONS TRADING STRATEGIES

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1 Project Overview

In this project, we explore various option strategies based on market expectations, using the Black-Scholes model and Monte Carlo simulations. The goal is to determine under which economic conditions each strategy is optimal, by studying payoffs, sensitivities to market parameters (Greeks), and the impact of volatility on the profit/loss profile.

2 Strategies According to Market Conditions

Common Parameters for All Simulations :
— Underlying asset price : $S_0 = 100$
— Maturity : $T = 1$ year
— Implied volatility : $\sigma = 20\%$
— Risk-free rate : $r = 5\%$

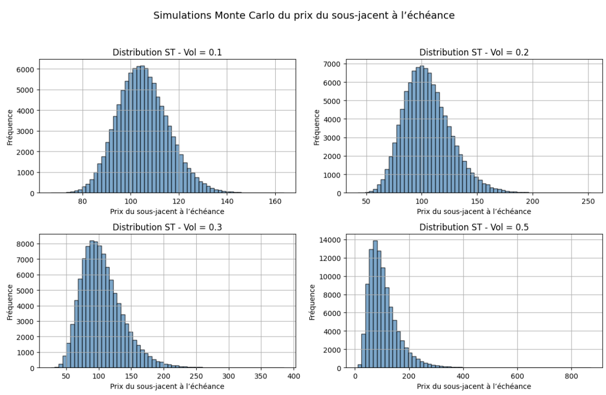
Note : Throughout the analysis, the prices of bought or sold options are calculated using the Black-Scholes (BS) model, and Greeks are also computed via the BS model. Thus, call and put prices are obtained from the following formulas :

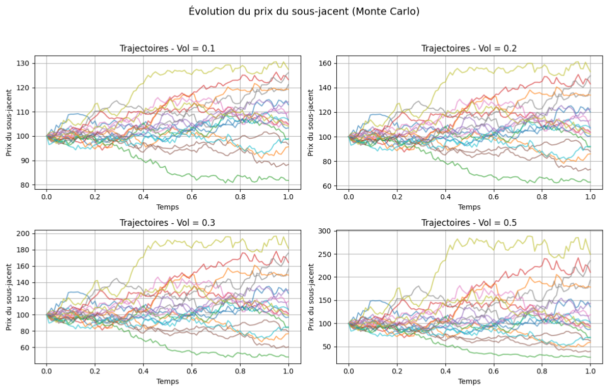
$$\text{Call Price} = \text{Black-Scholes Call}(S_0, K, T, r, \sigma)$$

$$\text{Put Price} = \text{Black-Scholes Put}(S_0, K, T, r, \sigma)$$

The Greeks such as Delta, Gamma, Vega, Theta, and Rho are computed using standard Black-Scholes formulas for each option.

Simulation Analysis : After implementing each strategy, a Monte Carlo simulation is performed to analyze its behavior under different volatility scenarios.
— Number of simulations : 10 000
— Tested volatilities : $\sigma = 10\%, 20\%, 30\%, 50\%$





The goal is to understand how volatility impacts the performance of different strategies, especially in an uncertain and changing financial market environment.

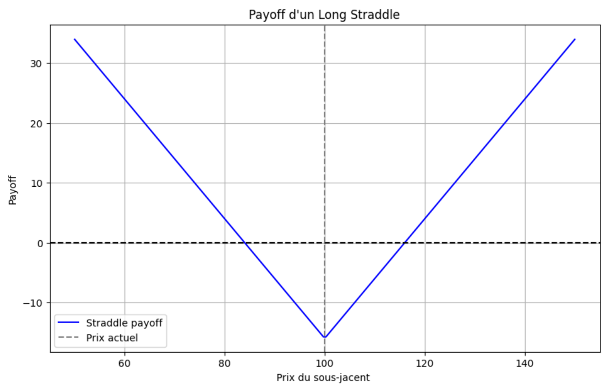
2.1 Expected High Volatility Market

2.1.1 Straddle

Strategy Definition Simultaneous purchase of a call and a put with the same strike price $K = 100$ and same maturity.

Payoff

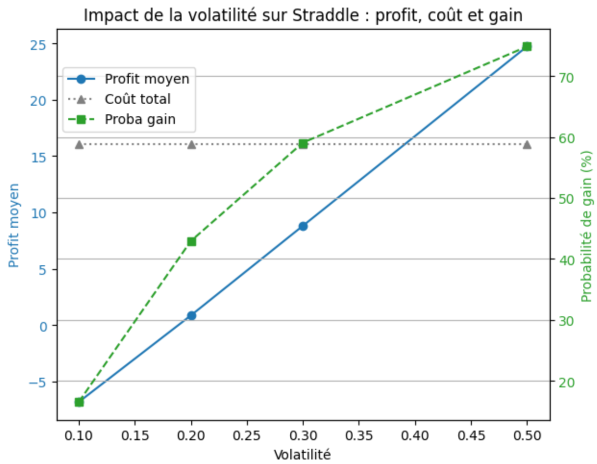
$$\text{Payoff} = \max(S_T - K, 0) + \max(K - S_T, 0) - \text{Total Cost}$$



Greeks Analysis The straddle exhibits high sensitivity to volatility (high Vega) and significant time decay exposure (negative Theta).


```
Greeks du Straddle
Delta  : 0.2737
Gamma  : 0.0375
Vega   : 0.7505
Theta  : -0.0807
Rho    : 0.1134
```

Monte Carlo Simulation Simulations show that average profit increases with volatility. The probability of profit is also higher in highly volatile markets.



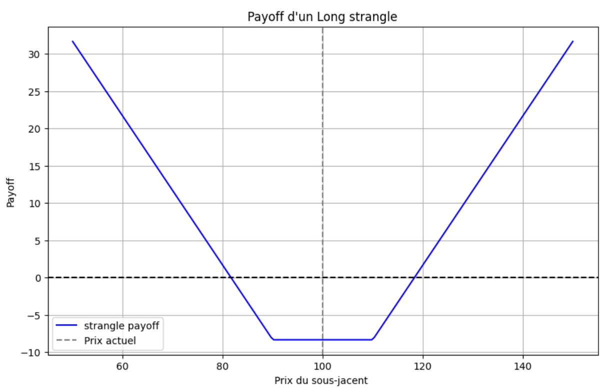
Conclusion The straddle is optimal when expecting strong volatility, with no specific market direction forecasted.

2.1.2 Strangle

Strategy Definition Purchase of a call with $K_1 = 110$ and a put with $K_2 = 90$, both with the same maturity.

Payoff

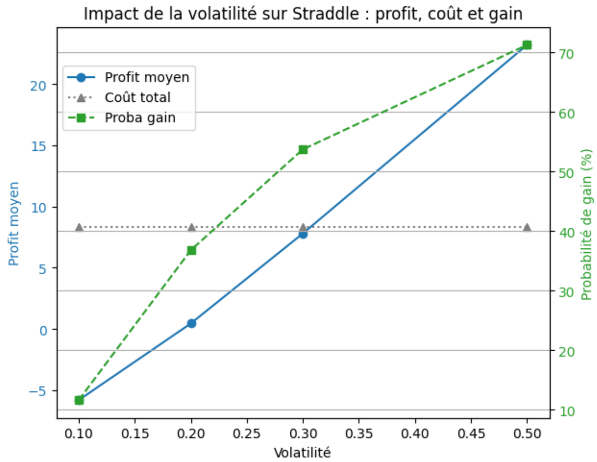
$$\text{Payoff} = \max(S_T - K_1, 0) + \max(K_2 - S_T, 0) - \text{Total Cost}$$



Greeks Analysis Compared to the straddle, the strangle has slightly lower Vega but offers similar exposure to volatility.

```
Greeks du strangle:
Delta   : 0.2594
Gamma   : 0.0334
Vega    : 0.6674
Theta   : -0.0755
Rho     : 0.1758
```

Monte Carlo Simulation Simulations indicate that the strangle is profitable under high volatility conditions, with a lower initial cost than the straddle.



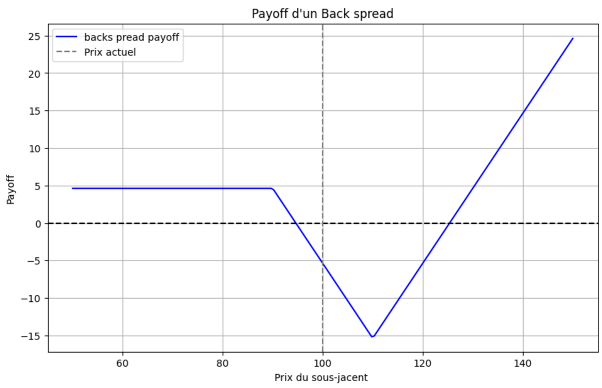
Conclusion The strangle suits highly volatile markets, providing a cheaper alternative to the straddle.

2.1.3 Backspread

Strategy Definition Sell one call at $K = 100$ and buy two calls at $K = 110$, all with the same maturity.

Payoff

$$\text{Payoff} = 2 \times \max(S_T - 110, 0) - \max(S_T - 100, 0) - \text{Net Cost}$$



Greeks Analysis The backspread features high Vega and variable Theta, offering asymmetric exposure to market movements.

```
Greeks du Backspread:
Delta  : 0.0896
Gamma  : 0.0260
Vega   : 0.5199
Theta  : -0.0588
Rho    : 0.1358
```

Conclusion The backspread is ideal when expecting a strong upward move in the market along with increased volatility.

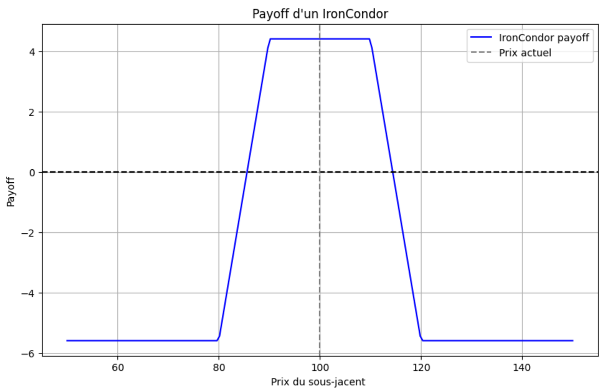
2.2 Calm Market

2.2.1 Iron Condor

Strategy Definition Combination of a bull put spread and a bear call spread : sell a put at $K = 100$, buy a put at $K = 95$, sell a call at $K = 105$, buy a call at $K = 115$.

Payoff

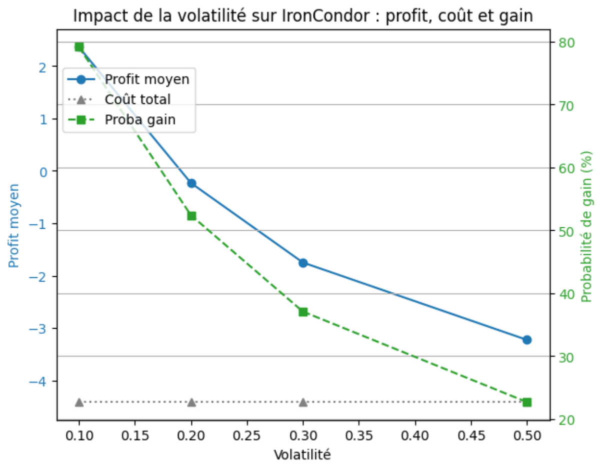
$$\text{Payoff} = -\max(S_T - 105, 0) + \max(S_T - 115, 0) + \max(95 - S_T, 0) - \max(100 - S_T, 0) - \text{Net Cost}$$



Greeks Analysis The Iron Condor has positive Theta and negative Vega, benefiting from market stability.

```
Greeks du IronCondor:
Delta  : -0.0435
Gamma  : -0.0095
Vega   : -0.1904
Theta  : 0.0190
Rho    : 0.0006
```

Monte Carlo Simulation Simulations confirm that this strategy is profitable in low-volatility markets, with a high probability of gain.



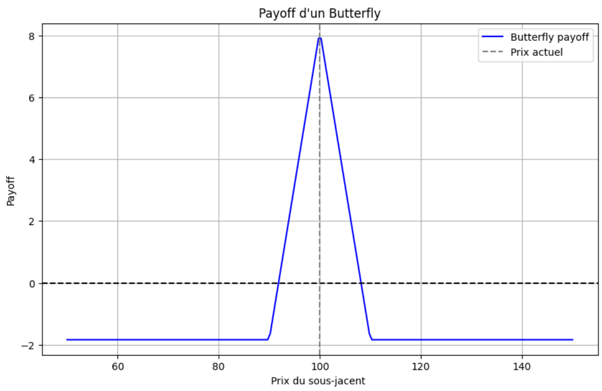
Conclusion The Iron Condor is optimal in calm markets, offering steady returns with limited risk.

2.2.2 Butterfly Spread

Strategy Definition Buy one call at $K = 95$, sell two calls at $K = 100$, and buy one call at $K = 105$.

Payoff

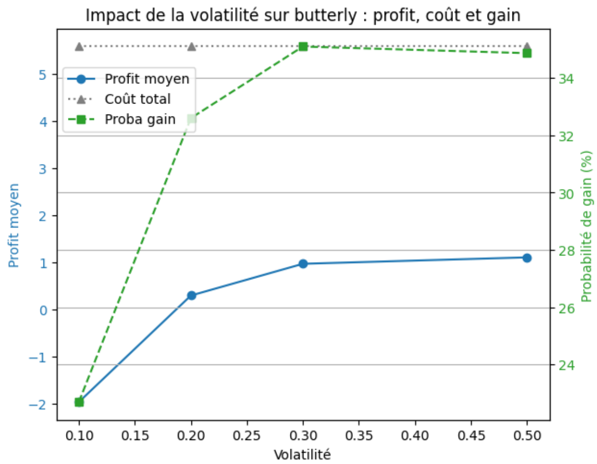
$$\text{Payoff} = \max(S_T - 95, 0) - 2 \times \max(S_T - 100, 0) + \max(S_T - 105, 0) - \text{Net Cost}$$



Greeks Analysis The Butterfly Spread has positive Theta and negative Vega, with Delta close to zero.

```
Greeks du butterfly  :
Delta   : -0.0143
Gamma   : -0.0042
Vega    : -0.0831
Theta   : 0.0099
Rho     : -0.0327
```

Monte Carlo Simulation Simulations show that this strategy is profitable when the underlying remains close to $K = 100$.



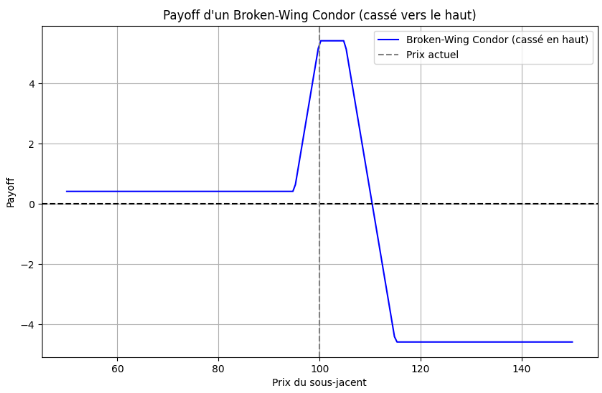
Conclusion The Butterfly Spread is suited to stable markets, taking advantage of low volatility.

2.2.3 Broken-wing Condor

Strategy Definition A variation of the Iron Condor, where the strikes of the calls or puts are not symmetric, creating an asymmetry in the payoff profile.

Payoff

$$\text{Payoff} = -\max(S_T - 100) + \max(S_T - 110) + \max(85 - S_T, 0) - \max(95 - S_T, 0) - \text{Total Cost}$$



Greeks Analysis The Broken-wing Condor has a neutral Delta and positive Theta, but its sensitivity to volatility (Vega) may be slightly higher due to the asymmetry in strikes.

Conclusion The Broken-wing Condor is an interesting strategy in calm to slightly volatile markets, offering reduced risk exposure while allowing strike flexibility.

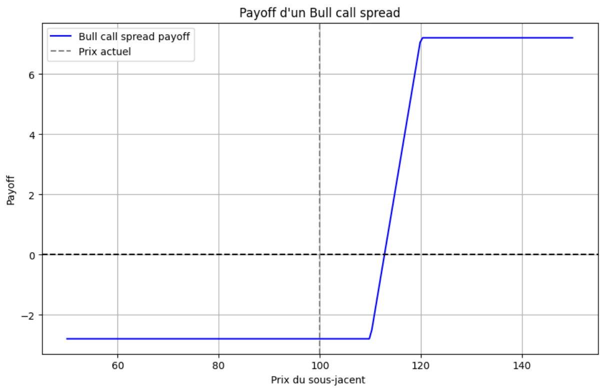
2.3 Moderate Bullish Trend

2.3.1 Bull Call Spread

Strategy Definition Buy a call at $K = 100$ and sell a call at $K = 110$, both with the same maturity.

Payoff

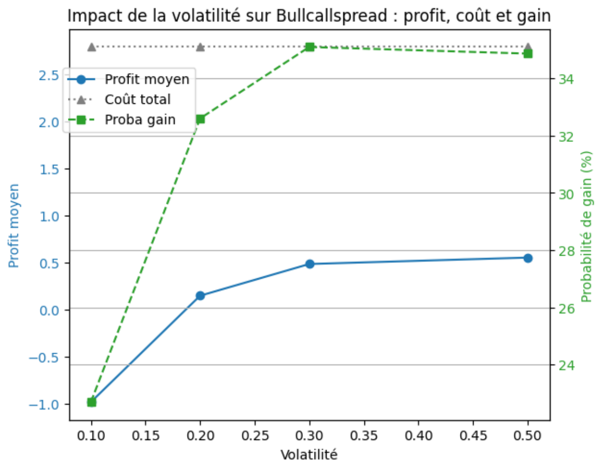
$$\text{Payoff} = \max(S_T - 100, 0) - \max(S_T - 110, 0)$$



Greeks Analysis The Bull Call Spread has a positive Delta (bullish exposure), a moderate Vega, and a negative Theta.

```
Greeks du Bullcallspread:
Delta  : 0.1625
Gamma  : 0.0028
Vega   : 0.0550
Theta  : -0.0122
Rho    : 0.1345
```

Monte Carlo Simulation Simulations show that this strategy is profitable in markets with moderate volatility and a bullish trend.



Conclusion The Bull Call Spread is suitable when expecting a slight upward market trend with moderate volatility.

2.3.2 Covered Call

Strategy Definition Buy a stock at $K = 100$ and sell a call at $K = 110$ on this stock.

Payoff

$$\text{Payoff} = \max(S_T - 110, 0) + (S_T - 100) \quad \text{(stock bought at 100)}$$

Greeks Analysis The Covered Call has a Delta of 1 (full exposure to the underlying) and a positive Theta (because time works in favor of the option seller).

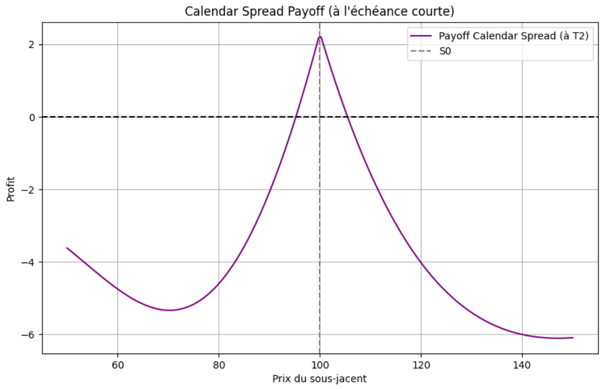
Conclusion The Covered Call is optimal in a moderate bullish trend, offering a regular return with limited risk.

2.3.3 Time Spread

Strategy Definition Buy a call at $K = 100$ with a 1-year maturity and sell a call at $K = 100$ with a shorter maturity (e.g., 3 months).

Payoff

$$\begin{aligned}\text{Payoff} = \max(S_T - 100, 0) &\quad \text{(for the long option, revalued for remaining time)} \\ - \max(S_T - 100, 0) &\quad \text{(for the short option at expiration)}\end{aligned}$$



Greeks Analysis The Time Spread has a Delta close to zero initially, a positive Theta, and a moderate Vega. It benefits from the passage of time (Theta) and implied volatility.

Conclusion The Time Spread is suitable when expecting moderate movements and stable volatility.

2.4 Moderate Bearish Trend

2.4.1 Bear Put Spread

Strategy Definition Buy a put at $K = 110$ and sell a put at $K = 100$, with the same maturity.

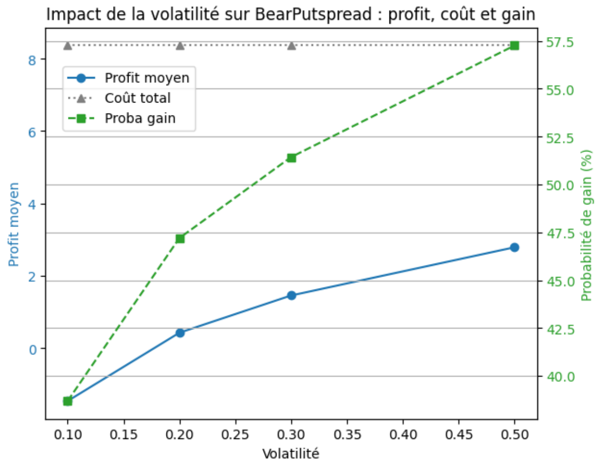
Payoff

$$\text{Payoff} = \max(110 - S_T, 0) - \max(100 - S_T, 0)$$

Greeks Analysis The Bear Put Spread has a negative Delta (bearish exposure) and a negative Theta. The strategy is more sensitive to volatility changes (high Vega).

```
Greeks du Bear put  :
Delta   : -0.3601
Gamma   : 0.0062
Vega    : 0.1241
Theta   : 0.0098
Rho     : -0.4437
```

Monte Carlo Simulation Simulations show that this strategy is profitable in moderately bearish markets.



Conclusion The Bear Put Spread is optimal when expecting a moderate market decline with relatively stable volatility.

2.4.2 Protective Put

Strategy Definition Buy a put at $K = 95$ to protect a long position in the underlying asset bought at $S_0 = 100$.

Payoff

$$\text{Payoff} = \max(S_0 - S_T, 0) + \max(K - S_T, 0)$$

Greeks Analysis The Protective Put has a Delta of -1 (bearish exposure) and a moderate Vega. The Theta is also negative due to the long option.

Conclusion The Protective Put is a useful strategy in bearish markets, offering protection against large losses while retaining upside potential.

2.4.3 Time Spread (Bearish)

Strategy Definition Buy a put at $K = 100$ with a long maturity (e.g., 1 year) and sell a put at $K = 100$ with a short maturity (e.g., 3 months).

Payoff

$$\begin{aligned}\text{Payoff} = \max(K - S_T, 0) \quad & \text{for the long option, revalued based on the remaining time} \\ - \max(K - S_T, 0) \quad & \text{for the short option at expiration}\end{aligned}$$

Greeks Analysis The Bearish Time Spread has a negative Delta, a positive Theta, and a moderate Vega. It is particularly sensitive to volatility.

Conclusion The Bearish Time Spread is ideal for moderately bearish markets with stable or decreasing volatility.

3 General Conclusion

3.1 Conclusion

This project allowed for a deep exploration of various option strategies suited for different market contexts, whether bullish, bearish, or neutral. Through an analysis of payoff profiles, sensitivity to the Greeks, and supported by Monte Carlo simulations, we were able to evaluate the relative performance of each strategy. This study highlights the importance of understanding volatility dynamics and the time factor in managing option portfolios. Finally, it emphasizes that the selection of an optimal strategy depends not only on market expectations but also on risk tolerance and investor objectives.

3.2 Practical Tips for Usage

Final advice : To effectively apply these strategies, it is crucial to anticipate market volatility. This can be done through :

— **Macroeconomic analysis** (interest rates, economic announcements, central bank decisions, etc.)

— Observing indicators like the **VIX** (fear index)

— Or direct modeling using advanced **stochastic models** like the **Heston model**, which estimates the stochastic volatility of the underlying asset.

A good prediction of volatility helps in selecting the optimal strategy and optimizing the risk/reward ratio.

3.3 Summary

Strategy	**Optimal Context**	**Advantages**	**Disadvantages**
Covered Call	Moderate bullish trend	Generates additional income through call selling ; Positive Theta	Limited gain in case of a sharp rise ; requires holding the stock
Time Spread (Call)	Moderate underlying movements with stable volatility	Positive Theta ; exploits maturity differences ; moderate Vega	Sensitive to large volatility shifts ; complex payoff
Bull Call Spread	Moderate upward movement of the underlying asset	Lower cost compared to a simple call ; limited risk	Limited profit ; Negative Theta
Straddle	Expected volatility rise ; large movement in either direction	Profits from significant underlying variation, regardless of direction	Very negative Theta ; high initial cost
Strangle	Violent movements expected with a smaller budget than Straddle	Cheaper than Straddle ; wide potential profit range	Must surpass two thresholds to be profitable ; Negative Theta
Butterfly Spread	Calm market, low volatility expected	Low cost ; payoff centered on the central strike	Profits limited to a narrow range ; low Delta
Iron Condor	Low volatility expected ; stable underlying asset	Benefits from the passage of time ; balanced strategy	Limited gains ; losses in case of large underlying movement
Bear Put Spread	Moderate bearish trend	Lower cost compared to a simple put ; limited loss	Limited gains ; Negative Theta
Protective Put	Hedge for a long position against a potential downturn	Protection against large losses ; keeps upside potential	High cost ; Negative Theta
Time Spread (Put)	Moderately bearish market with low volatility	Positive Theta ; moderate Vega ; good time hedge	Management complexity ; sensitive to volatility