Trading strategies implemented on python Part I : Options

Chenjie LI, Maxime LE FLOCH, ESILV Msc Financial Engineering

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Abstract

We would like to firstly thank Zura Kakushadze and Juan Andrés Serur for their work on 151 trading strategies and also the inspiration that this paper gave us. The aim of our work is to reproduce these strategies in Python and have a clear view on the P&L of each strategy. You can find the Python implementation on: Chenjie's Github Trading strategies. For more mathematical and trading description details, please refer to Zura Kakushadze and Juan Andrés Serur 's work on 151 trading strategies.
This first edition contains all options linked trading strategies with numerical and python implementation of P&L. Other strategies on other products would be implemented in further editions.

introduction

conventional notation of our paper

- S_T is the stock price at expiration.
- S_0 is the initial stock price.
- K is the strike price of the call option.
- C is the premium received
- D is the premium paid

Capital Gain Strategy: A capital gain strategy is designed to profit from significant movements in the price of the underlying asset, whether up or down. These strategies typically involve buying options, which have a limited downside (the premium paid) and unlimited upside potential. The goal is to achieve a substantial increase in the value of the options as the underlying asset's price moves favorably.

Net Credit Strategy: A net credit strategy involves selling options to collect premium income. The initial cash inflow from selling the options creates a net credit. These strategies are often designed to profit from a neutral or sideways market, where the underlying asset's price is not expected to move significantly.

Income Strategy: An income strategy focuses on generating regular income through the collection of premiums by writing (selling) options. These strategies are typically employed by traders who expect the underlying asset's price to remain within a certain range. Income strategies are designed to take advantage of time decay and the fact that most options expire worthless.

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1 Options Strategies

1.1 Strategy: Covered Call

Key Components

- **Stock Purchase**: Buy the underlying stock at the current price S_0.
- **Call Option Writing**: Sell a call option with a strike price K and receive a premium C.

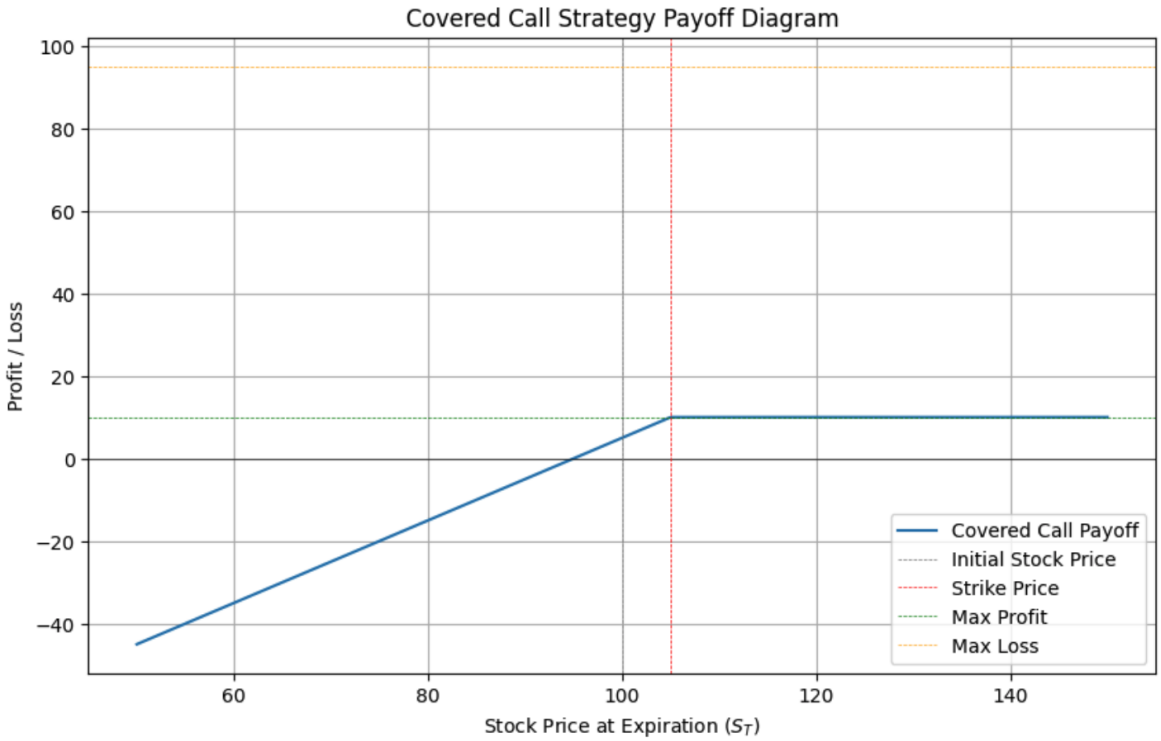
Payoff and P&L

$$\textbf{Payoff et expiration} = S_T - S_0 - \max(0, S_T - K) + C \tag{1}$$

$$\textbf{Max Profit} = K - S_0 + C \tag{2}$$

$$\textbf{Max Loss} = S_0 - C \tag{3}$$

- Current stock price (S_0): 100
- Strike price (K): 105
- Net premium received (C): 5



1.2 Strategy: Covered Put

Key Components

- **Stock Shorting**: Short the underlying stock at the current price S_0.
- **Put Option Writing**: Sell a put option with a strike price K and receive a premium C.

Payoff and P&L

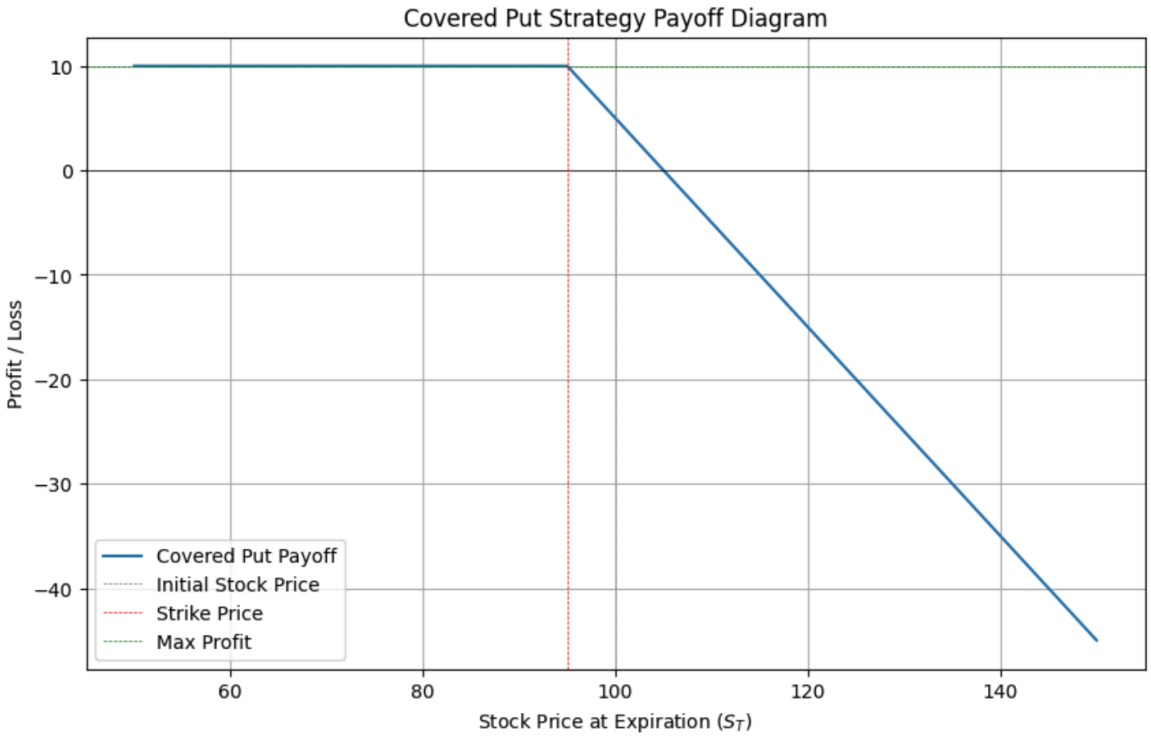
$$\textbf{Payyoff} = S_0 - S_T - \max(0, K - S_T) + C \tag{4}$$

$$\textbf{Max Profit} = S_0 - K + C \tag{5}$$

$$\textbf{Max Loss} = \text{Unlimited} \tag{6}$$

- Current stock price (S_0): 100
- Strike price (K): 95
- Net premium received (C): 5

P&L



1.3 Strategy: Protective Put

Key Components

- **Stock Purchase**: Buy the underlying stock at the current price S_0.
- **Put Option Purchase**: Buy a put option with a strike price $K \leq S_0$ and pay a premium D.

Payoff and P&L

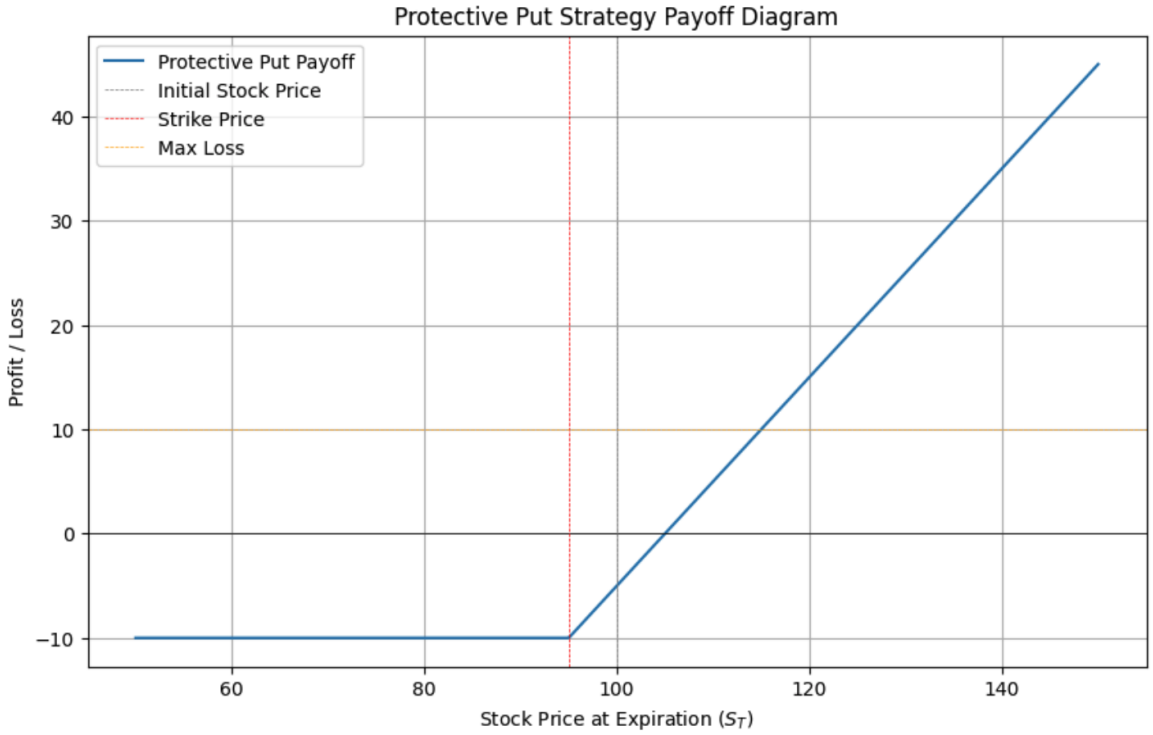
$$\textbf{Payyoff} = S_T - S_0 + \max(0, K - S_T) - D \tag{7}$$

$$\textbf{Max Profit} = \text{Unlimited} \tag{8}$$

$$\textbf{Max Loss} = S_0 - K + D \tag{9}$$

- Current stock price (S_0): 100
- Strike price (K): 95
- Net premium paid (D): 5

P&L



1.4 Strategy: Protective Call

Key Components

- **Stock Shorting**: Short the underlying stock at the current price S_0.
- **Call Option Purchase**: Buy a call option with a strike price $K \geq S_0$ and pay a premium D.

Payoff and P&L

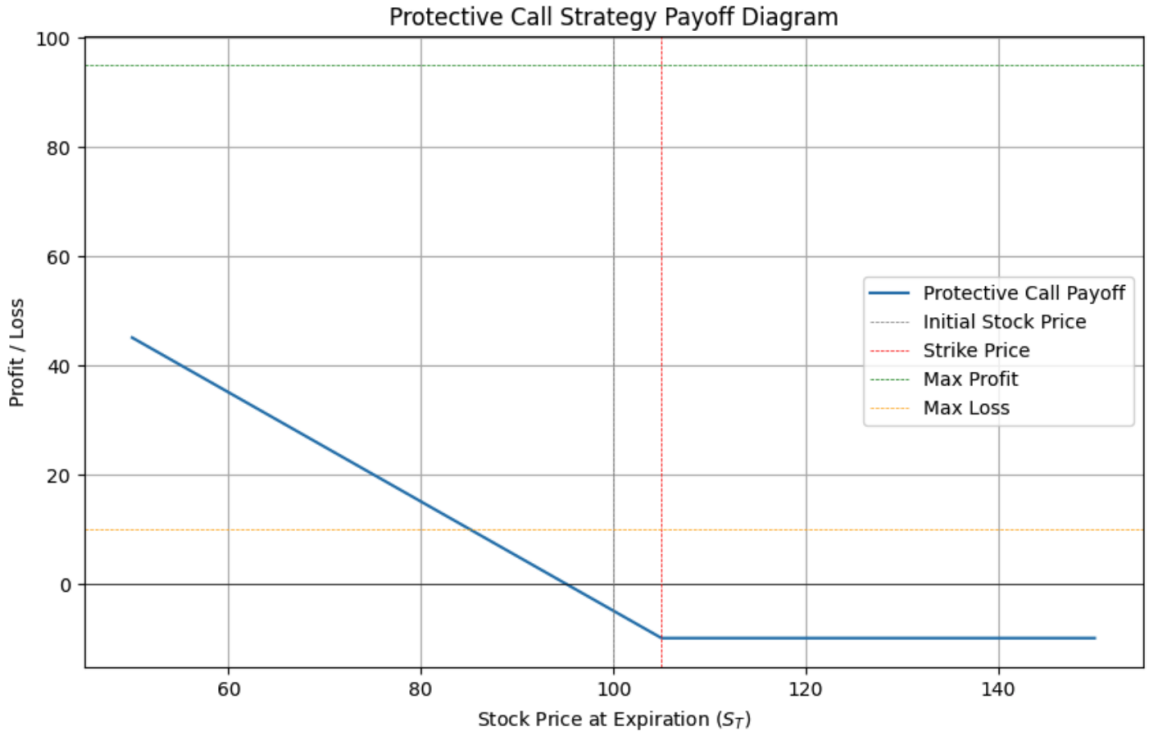
$$\textbf{Payyoff} = S_0 - S_T + \max(0, S_T - K) - D \tag{10}$$

$$\textbf{Max Profit} = S_0 - D \tag{11}$$

$$\textbf{Max Loss} = K - S_0 + D \tag{12}$$

- Current stock price (S_0): 100
- Strike price (K): 105
- Net premium paid (D): 5

P&L



1.5 Strategy: Bull Call Spread

Key Components

- **Long Call Option**: Buy a call option with a strike price K_1 and pay a premium D.
- **Short Call Option**: Sell a call option with a higher strike price K_2 and receive a premium.

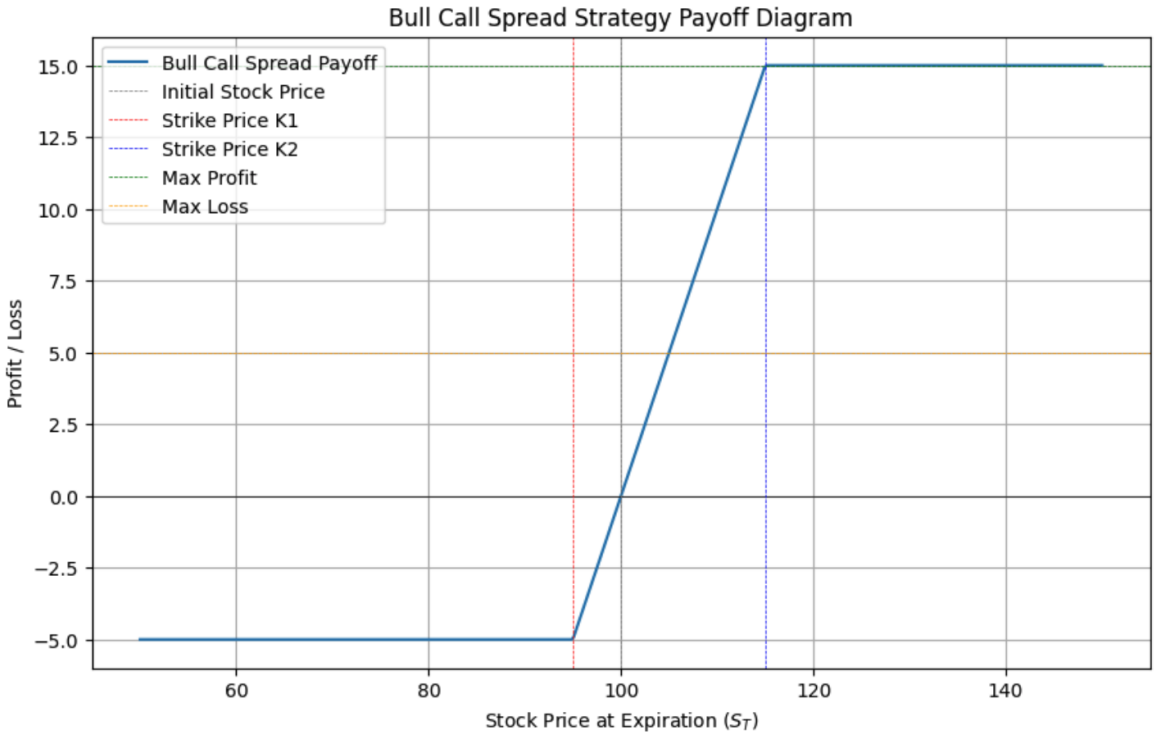
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K_1)) - (\max(0, S_T - K_2)) - D \tag{13}$$

$$\textbf{Max Profit} = K_2 - K_1 - D \tag{14}$$

$$\textbf{Max Loss} = D \tag{15}$$

- Current stock price (S_0): 100
- Strike price of the long call ($K1$): 95
- Strike price of the short call ($K2$): 115
- Net premium paid (D): 5



1.6 Strategy: Bull Put Spread

Key Components

- **Long Put Option**: Buy an OTM put option with a strike price K_1 and pay a premium.
- **Short Put Option**: Sell an OTM put option with a higher strike price K_2 and receive a premium C.

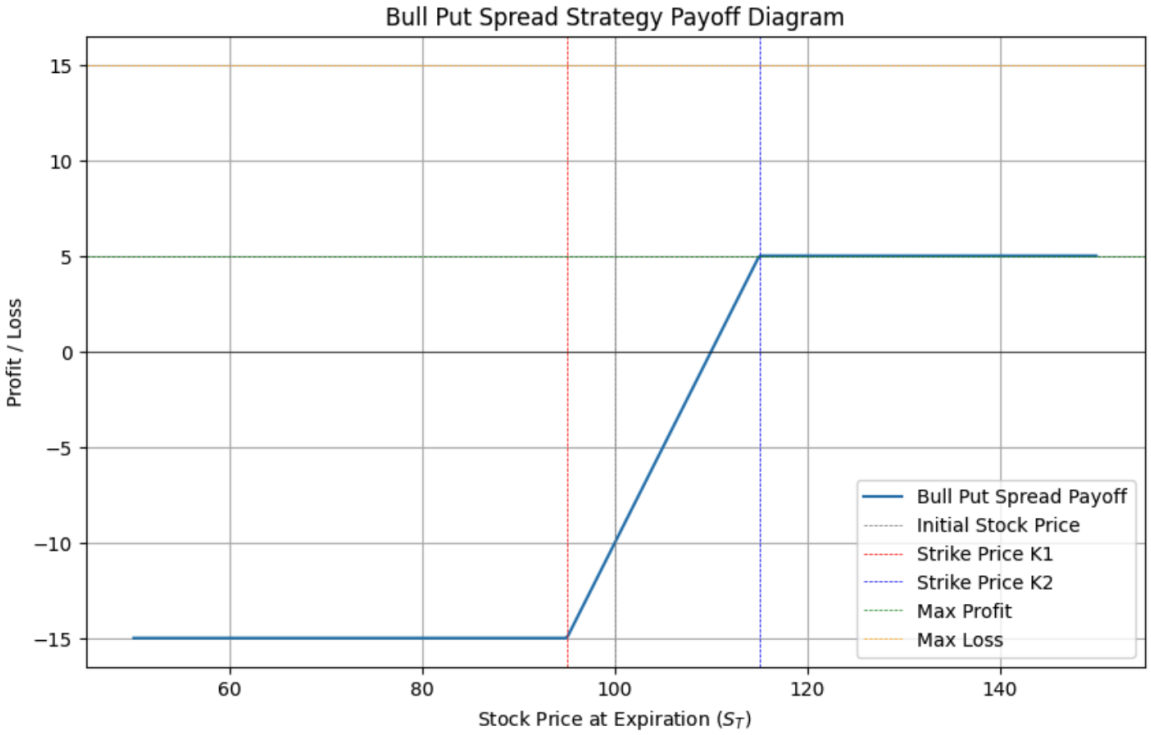
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K_1 - S_T)) - (\max(0, K_2 - S_T)) + C \tag{16}$$

$$\textbf{Max Profit} = C \tag{17}$$

$$\textbf{Max Loss} = K_2 - K_1 - C \tag{18}$$

- Current stock price (S_0): 100
- Strike price of the long put ($K1$): 95
- Strike price of the short put ($K2$): 115
- Net premium recieved (C): 5



1.7 Strategy: Bear Call Spread

Key Components

- **Long Call Option**: Buy an OTM call option with a strike price K_1 and pay a premium.
- **Short Call Option**: Sell an OTM call option with a lower strike price K_2 and receive a premium C.

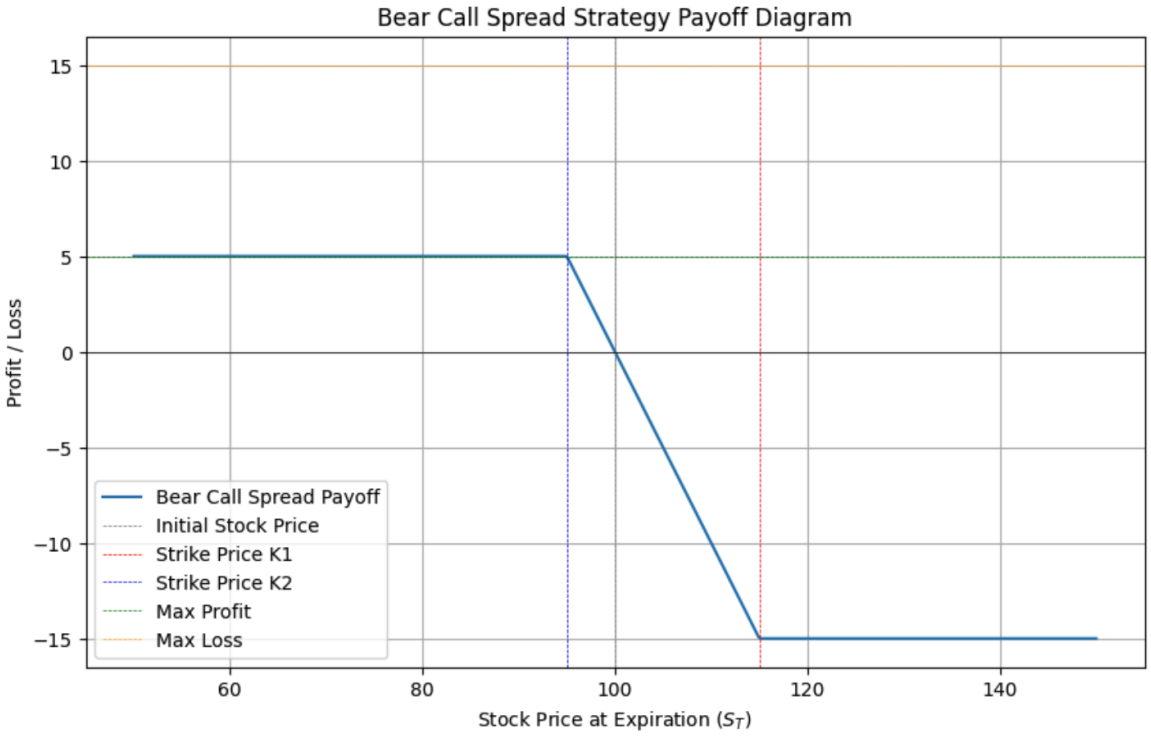
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K_1)) - (\max(0, S_T - K_2)) + C \tag{19}$$

$$\textbf{Max Profit} = C \tag{20}$$

$$\textbf{Max Loss} = K_1 - K_2 - C \tag{21}$$

- Current stock price (S_0): 100
- Strike price of the long call ($K1$): 115
- Strike price of the short call ($K2$): 95
- Net premium recieved (C): 5



1.8 Strategy: Bear Put Spread

Key Components

- **Long Put Option**: Buy a close to ATM put option with a strike price K_1 and pay a premium D.
- **Short Put Option**: Sell an OTM put option with a lower strike price K_2 and receive a premium.

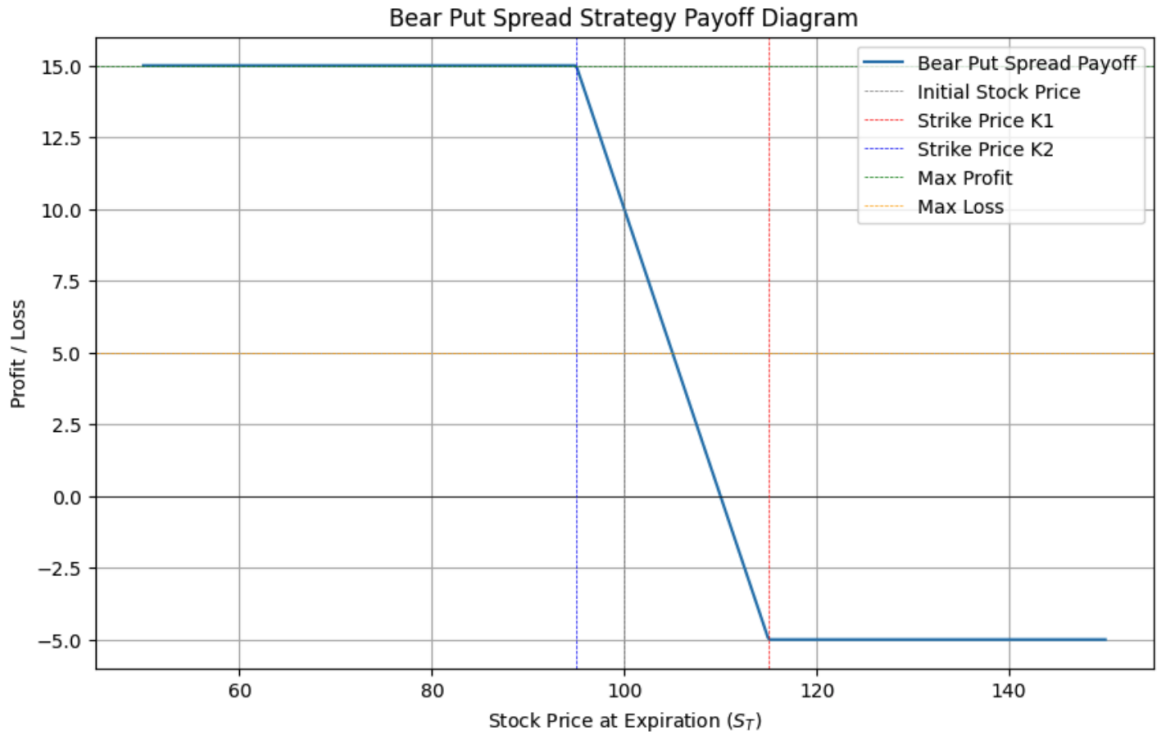
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K_1 - S_T)) - (\max(0, K_2 - S_T)) - D \tag{22}$$

$$\textbf{Max Profit} = K_1 - K_2 - D \tag{23}$$

$$\textbf{Max Loss} = D \tag{24}$$

- Current stock price (S_0): 100
- Strike price of the long put ($K1$): 115
- Strike price of the short put ($K2$): 95
- Net premium Paid (D): 5



1.9 Strategy: Long Synthetic Forward

Key Components

- **Long Call Option**: Buy an ATM call option with a strike price $K = S_0$ and pay a premium H.
- **Short Put Option**: Sell an ATM put option with a strike price $K = S_0$ and receive a premium.

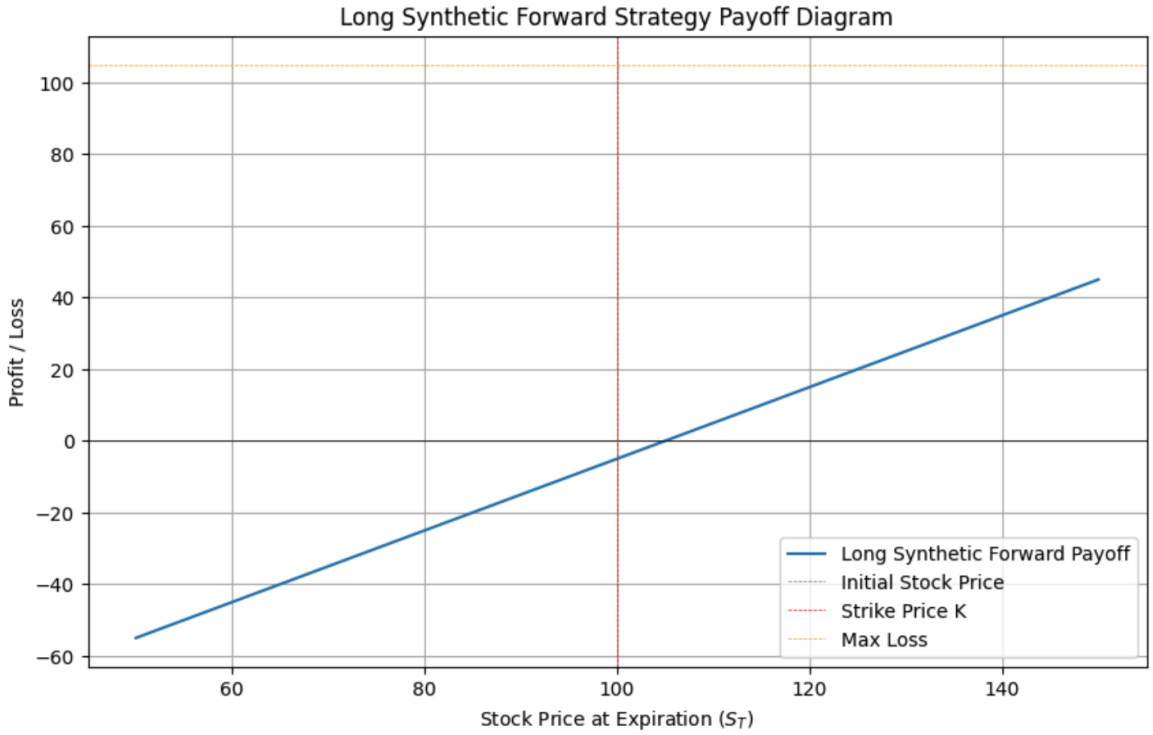
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K)) - (\max(0, K - S_T)) - H \tag{25}$$

$$\textbf{Max Profit} = \text{Unlimited} \tag{26}$$

$$\textbf{Max Loss} = K + H \tag{27}$$

- Current stock price (S_0): 100
- Strike price of option (K): 100
- Net premium Paid or received (H): 5



1.10 Strategy: Short Synthetic Forward

Key Components

- **Long Put Option**: Buy an ATM put option with a strike price $K = S_0$ and pay a premium H.
- **Short Call Option**: Sell an ATM call option with a strike price $K = S_0$ and receive a premium.

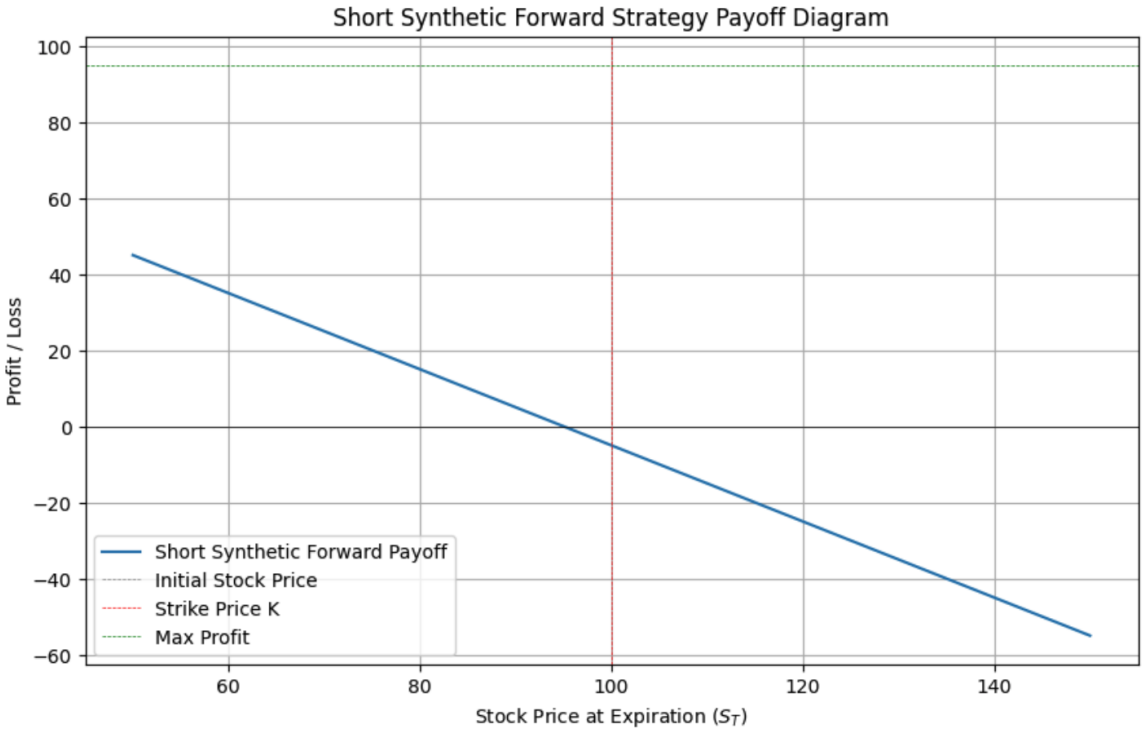
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K - S_T)) - (\max(0, S_T - K)) - H \tag{28}$$

$$\textbf{Max Profit} = K - H \tag{29}$$

$$\textbf{Max Loss} = \text{Unlimited} \tag{30}$$

- Current stock price (S_0): 100
- Strike price of option (K): 100
- Net premium Paid or received (H): 5



1.11 Strategy: Long Combo

Key Components

- **Long Call Option**: Buy an OTM call option with a strike price K_1 and pay a premium H.
- **Short Put Option**: Sell an OTM put option with a strike price K_2 and receive a premium.

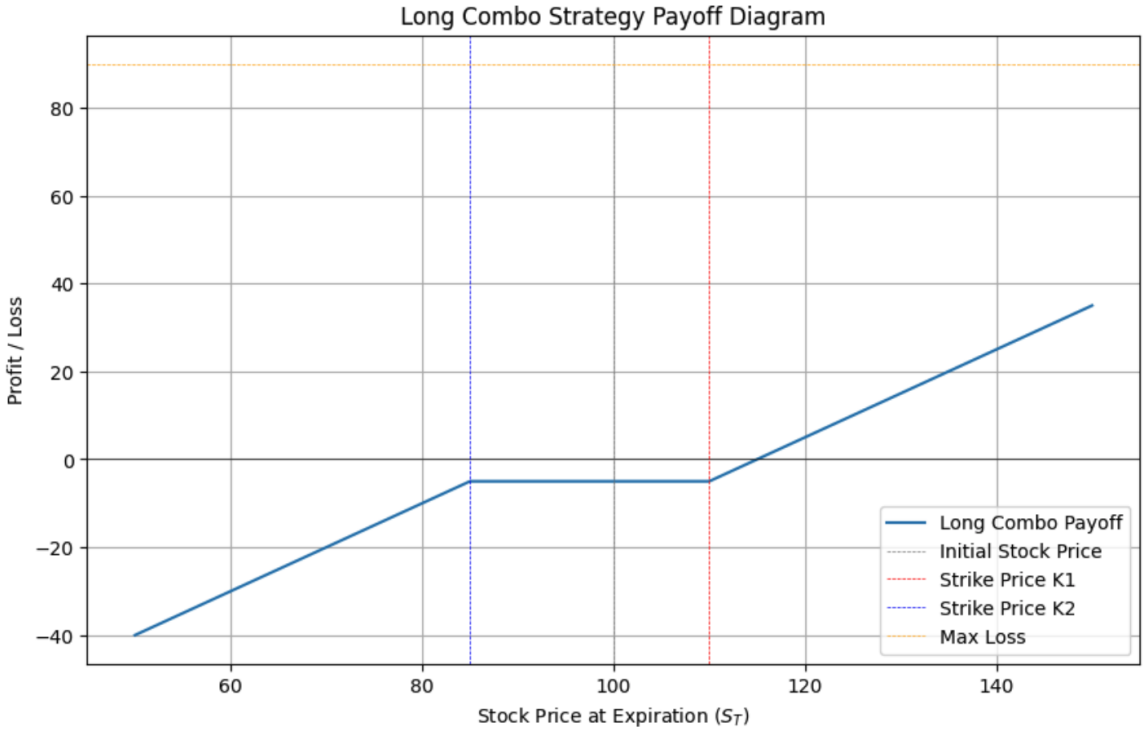
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K_1)) - (\max(0, K_2 - S_T)) - H \tag{31}$$

$$\textbf{Max Profit} = \text{Unlimited} \tag{32}$$

$$\textbf{Max Loss} = K_2 + H \tag{33}$$

- Current stock price (S_0): 100
- Strike price of long call ($K1$): 110
- Strike price of short put ($K1$): 85
- Net premium Paid or received (H): 5



1.12 Strategy: Short Combo

Key Components

- **Long Put Option**: Buy an OTM put option with a strike price K_1 and pay a premium H.
- **Short Call Option**: Sell an OTM call option with a strike price K_2 and receive a premium.

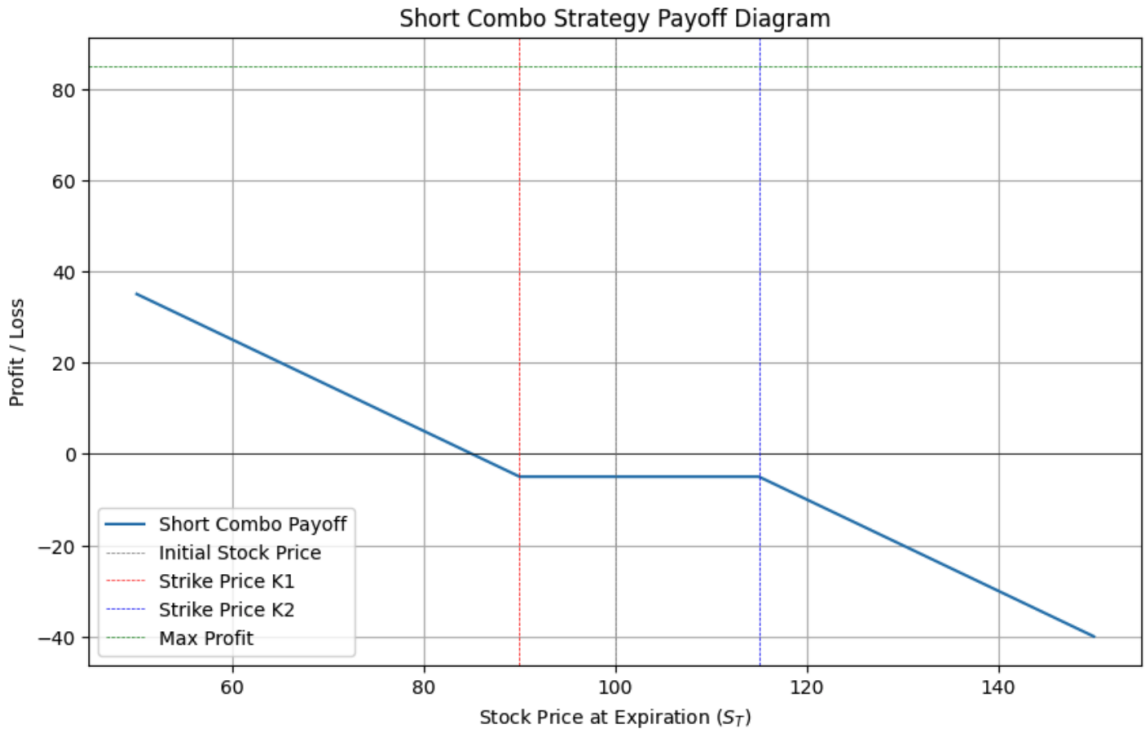
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K_1 - S_T)) - (\max(0, S_T - K_2)) - H \tag{34}$$

$$\textbf{Max Profit} = K_1 - H \tag{35}$$

$$\textbf{Max Loss} = \text{Unlimited} \tag{36}$$

- Current stock price (S_0): 100
- Strike price of long put ($K1$): 90
- Strike price of short call ($K1$): 115
- Net premium Paid or received (H): 5



1.13 Strategy: Bull Call Ladder

Key Components

- **Long Call Option**: Buy a close to ATM call option with a strike price K_1 and pay a premium H.
- **Short Call Option 1**: Sell an OTM call option with a strike price K_2 and receive a premium.
- **Short Call Option 2**: Sell another OTM call option with a higher strike price K_3 and receive a premium.

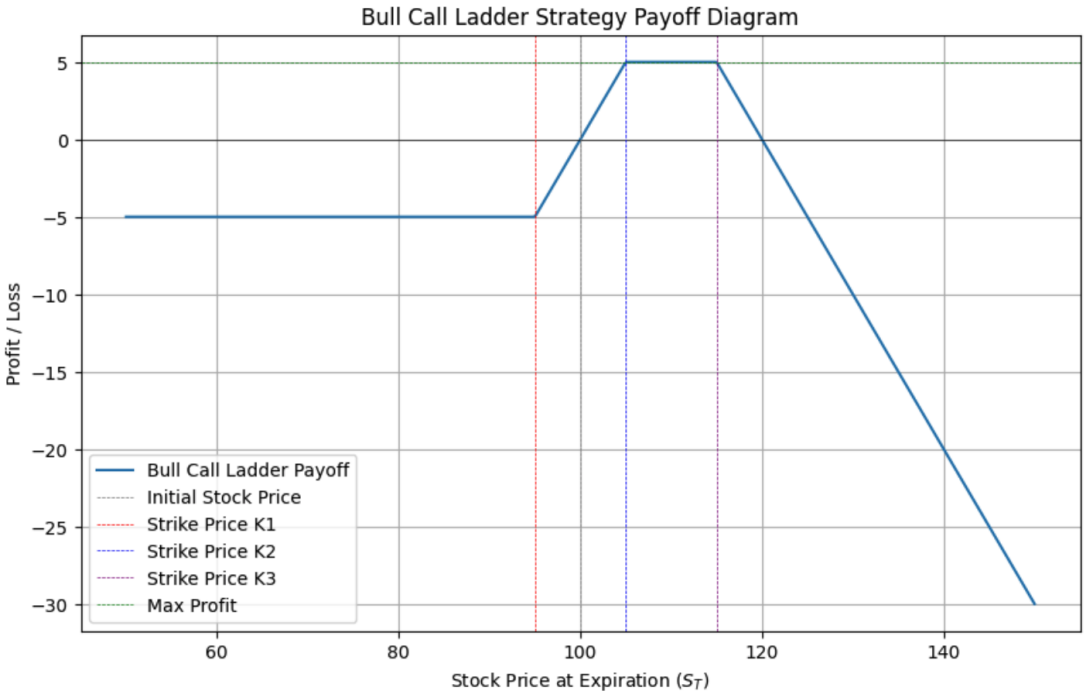
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K_1)) - (\max(0, S_T - K_2)) - (\max(0, S_T - K_3)) - H \tag{37}$$

$$\textbf{Max Profit} = K_2 - K_1 - H \tag{38}$$

$$\textbf{Max Loss} = \text{Unlimited} \tag{39}$$

- Current stock price (S_0): 100
- Strike price of long call ($K1$): 95
- Strike price of first short call ($K2$): 105
- Strike price of second short call ($K3$): 115
- Net premium Paid or received (H): 5



1.14 Strategy: Bull Put Ladder

Key Components

- **Short Put Option**: Sell a close to ATM put option with a strike price K_1 and receive a premium.
- **Long Put Option 1**: Buy an OTM put option with a lower strike price K_2 and pay a premium.
- **Long Put Option 2**: Buy another OTM put option with a lower strike price K_3 and pay a premium.

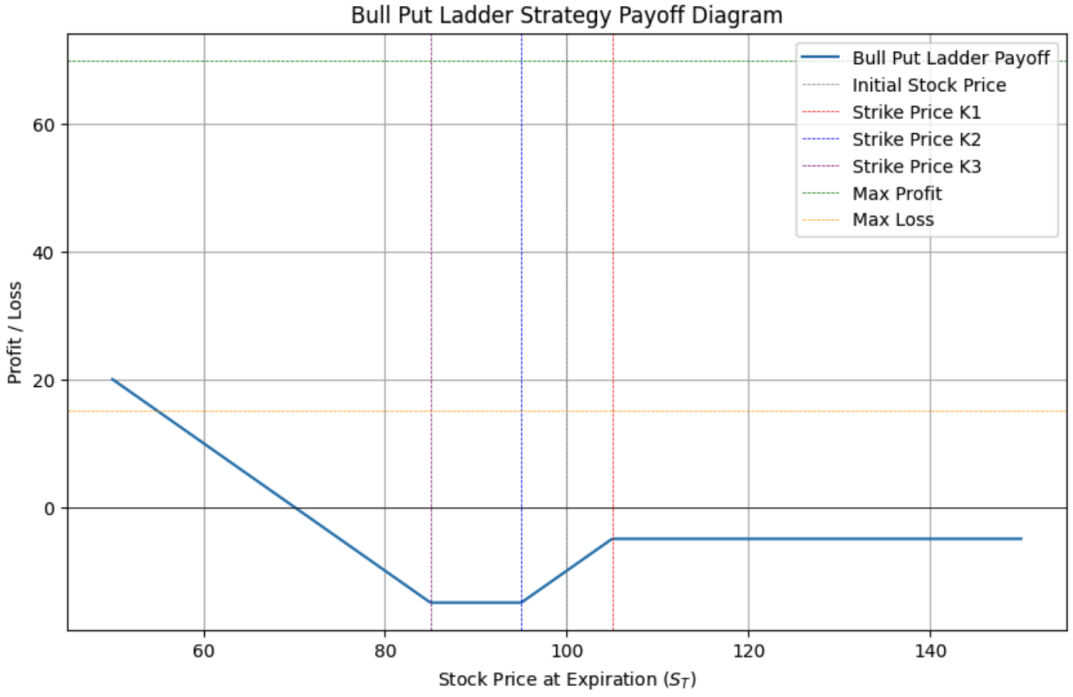
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K_3 - S_T)) + (\max(0, K_2 - S_T)) - (\max(0, K_1 - S_T)) - H \tag{40}$$

$$\textbf{Max Profit} = K_3 + K_2 - K_1 - H \tag{41}$$

$$\textbf{Max Loss} = K_1 - K_2 + H \tag{42}$$

- Current stock price (S_0): 100
- Strike price of short put ($K1$): 105
- Strike price of first long put ($K2$): 95
- Strike price of second long put ($K3$): 85
- Net premium Paid or received (H): 5



1.15 Strategy: Bear Call Ladder

Key Components

- **Short Call Option**: Sell a close to ATM call option with a strike price K_1 and receive a premium.
- **Long Call Option 1**: Buy an OTM call option with a higher strike price K_2 and pay a premium.
- **Long Call Option 2**: Buy another OTM call option with a higher strike price K_3 and pay a premium.

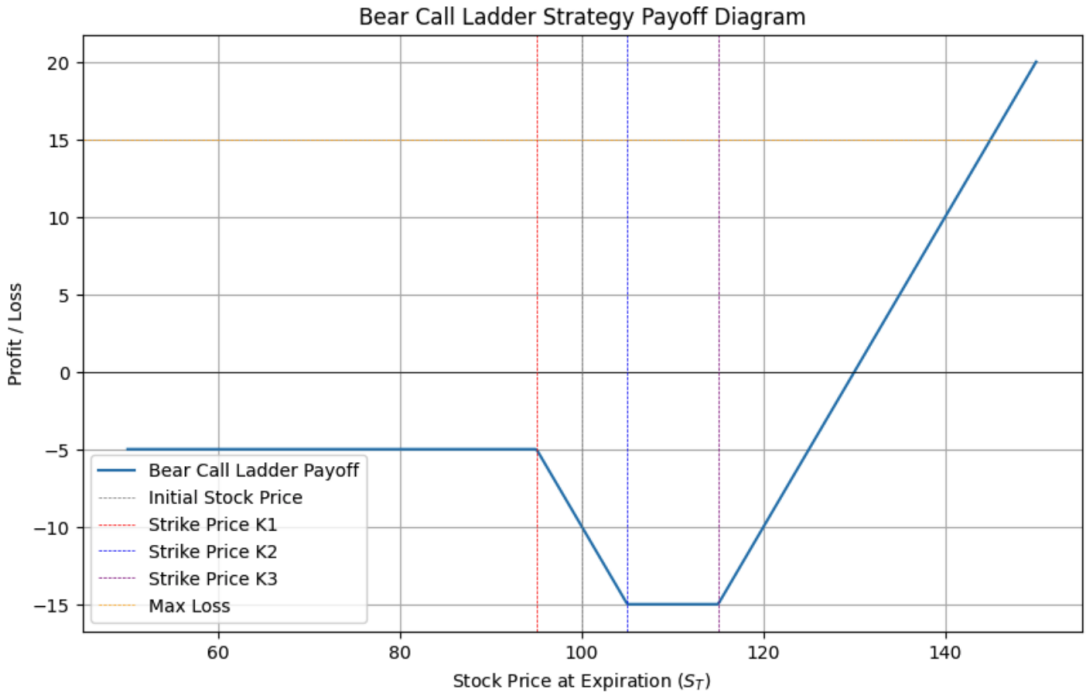
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, S_T - K_3)) + (\max(0, S_T - K_2)) - (\max(0, S_T - K_1)) - H \tag{43}$$

$$\textbf{Max Profit} = \text{Unlimited} \tag{44}$$

$$\textbf{Max Loss} = K_2 - K_1 + H \tag{45}$$

- Current stock price (S_0): 100
- Strike price of short call ($K1$): 95
- Strike price of first long call ($K2$): 105
- Strike price of second long call ($K3$): 115
- Net premium Paid or received (H): 5



1.16 Strategy: Bear Put Ladder

Key Components

- **Long Put Option 1**: Buy a close to ATM put option with a strike price K_1 and pay a premium H.
- **Short Put Option**: Sell an OTM put option with a lower strike price K_2 and receive a premium.
- **Short Put Option 2**: Sell another OTM put option with a lower strike price K_3 and receive a premium.

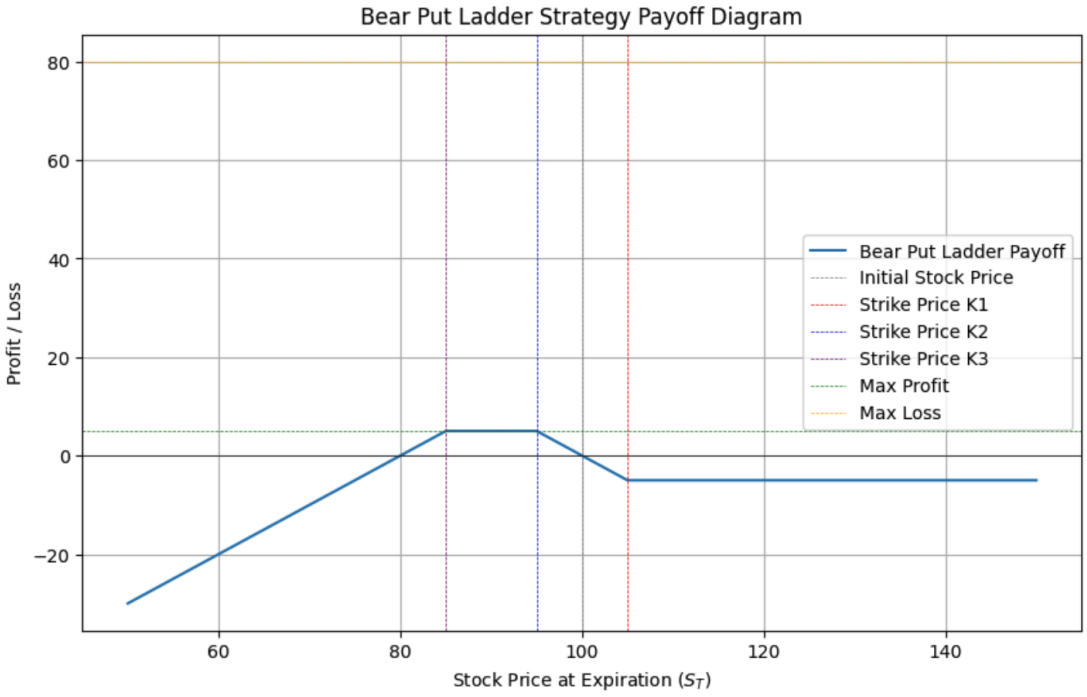
Payoff and P&L

$$\textbf{Payyoff} = (\max(0, K_1 - S_T)) - (\max(0, K_2 - S_T)) - (\max(0, K_3 - S_T)) - H \tag{46}$$

$$\textbf{Max Profit} = K_1 - K_2 - H \tag{47}$$

$$\textbf{Max Loss} = K_3 + K_2 - K_1 + H \tag{48}$$

- Current stock price (S_0): 100
- Strike price of long put ($K1$): 105
- Strike price of first short put ($K2$): 95
- Strike price of second short put ($K3$): 85
- Net premium Paid or received (H): 5



1.17 Strategy: Calendar Call Spread

Key Components

- **Long Call Option**: Buy a close to ATM call option with a strike price K and TTM T' and pay a premium D.
- **Short Call Option**: Sell a call option with the same strike price K and shorter TTM $T < T'$ and receive a premium.

Payoff and P&L

Using the Black-Scholes Model

To model the Calendar Call Spread strategy accurately, we need to account for the value of the long call option at the expiration of the short call option. The Black-Scholes model is used to calculate the theoretical price of options, considering factors such as the current stock price (S), the strike price (K), the time to maturity (T), the risk-free rate (r), and the volatility (σ) of the stock.

The Black-Scholes formula for the price of a call option is given by:

$$C(S, K, T, r, \sigma) = S \cdot N(d_1) - K \cdot e^{-rT} \cdot N(d_2) \tag{49}$$

where

$$d_1 = \frac{\ln(S/K) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}} \tag{50}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{51}$$

Here, $N(\cdot)$ represents the cumulative distribution function of the standard normal distribution.

Parameters Used

For our example, we use the following parameters:

- Current stock price (S_0): 50
- Strike price (K): 50
- Time to expiration for the short call (T): 2 months (2/12 years)
- Time to expiration for the long call (T'): 12 months (12/12 years)
- Volatility (σ): 20% (0.2)
- Risk-free rate (r): 3% (0.03)
- Net premium paid (D): 2

Calculating the Value of the Long Call Option

At the expiration of the short call option, the remaining time to expiration for the long call option is $T' - T$. Using the Black-Scholes model, we calculate the value of the long call option at this time as:

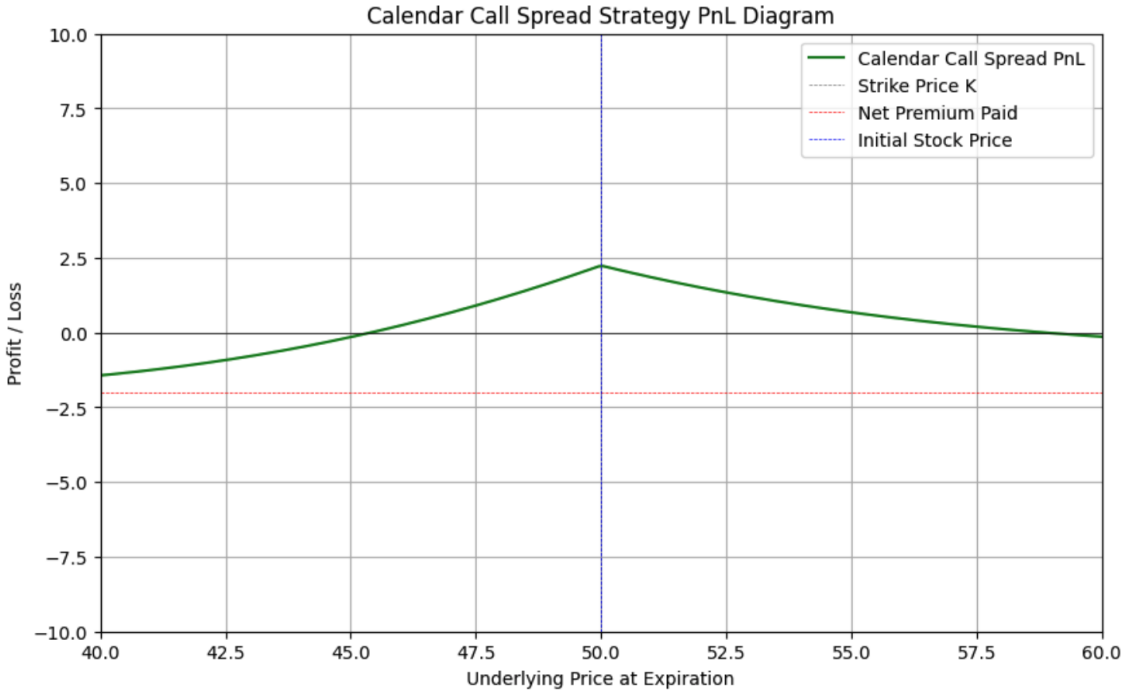
$$C_{\text{long}} = C(S_T, K, T' - T, r, \sigma) \tag{52}$$

Total PnL Calculation

The total profit or loss (PnL) for the Calendar Call Spread at the expiration of the short call option is given by:

$$\text{PnL} = C_{\text{long}} - \text{Payoff}_{\text{short call}} - D \tag{53}$$

where $\text{Payoff}_{\text{short call}} = \max(S_T - K, 0)$ is the payoff of the short call option at expiration.



1.18 Strategy: Calendar Put Spread

Key Components

- **Long Put Option**: Buy a close to ATM put option with a strike price K and TTM T' and pay a premium D.
- **Short Put Option**: Sell a put option with the same strike price K and shorter TTM $T < T'$ and receive a premium.

Payoff and P&L

Using the Black-Scholes Model

The Black-Scholes formula for the price of a put option is given by:

$$P(S, K, T, r, \sigma) = K \cdot e^{-rT} \cdot N(-d_2) - S \cdot N(-d_1) \tag{54}$$

where

$$d_1 = \frac{\ln(S/K) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}} \tag{55}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{56}$$

Here, $N(\cdot)$ represents the cumulative distribution function of the standard normal distribution.

Parameters Used

For our example, we use the following parameters:

- Current stock price (S_0): 50
- Strike price (K): 50
- Time to expiration for the short put (T): 2 months (2/12 years)
- Time to expiration for the long put (T'): 12 months (12/12 years)
- Volatility (σ): 20% (0.2)
- Risk-free rate (r): 3% (0.03)
- Net premium paid (D): 2
- V is the value of the long put option (expiring at $t = T'$)

Calculating the Value of the Long Put Option

At the expiration of the short put option, the remaining time to expiration for the long put option is $T' - T$. Using the Black-Scholes model, we calculate the value of the long put option at this time as:

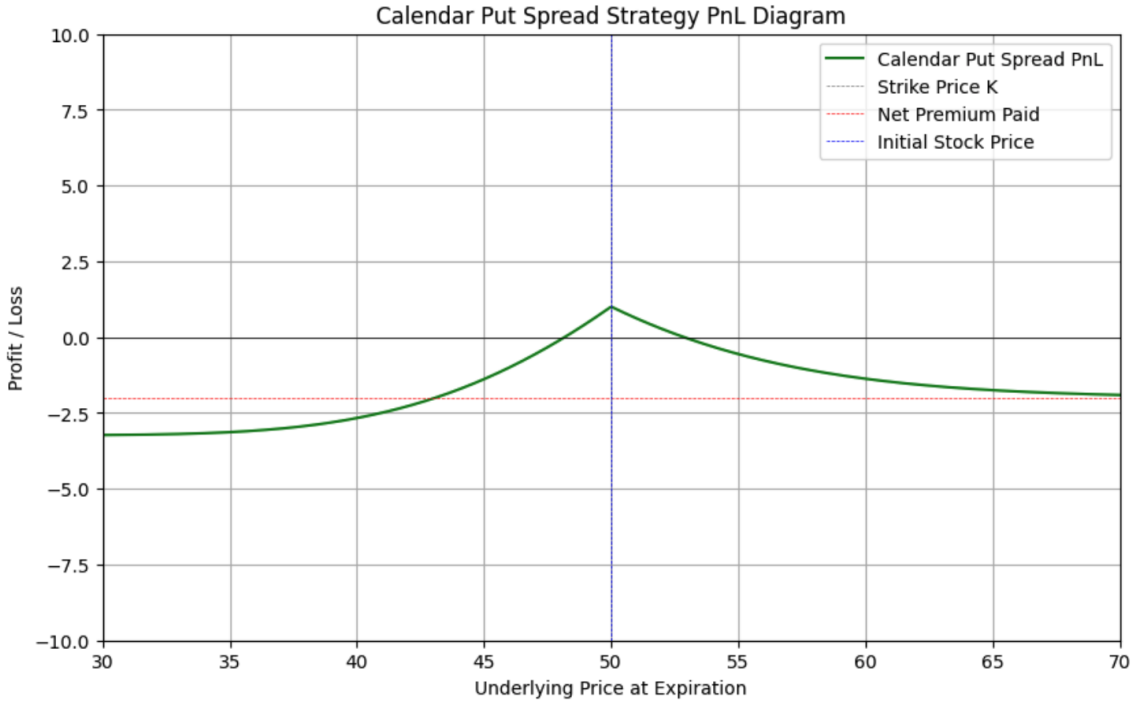
$$P_{\text{long}} = P(S_T, K, T' - T, r, \sigma) \tag{57}$$

Total PnL Calculation

The total profit or loss (PnL) for the Calendar Put Spread at the expiration of the short put option is given by:

$$\text{PnL} = P_{\text{long}} - \text{Payoff}_{\text{short put}} - D \tag{58}$$

where $\text{Payoff}_{\text{short put}} = \max(K - S_T, 0)$ is the payoff of the short put option at expiration.



1.19 Strategy: Diagonal Call Spread

Key Components

- **Long Call Option**: Buy a deep ITM call option with a strike price K_1 and TTM T' and pay a premium D.
- **Short Call Option**: Sell an OTM call option with a higher strike price K_2 and shorter TTM $T < T'$ and receive a premium.

Payoff and P&L

Using the Black-Scholes Model

The Black-Scholes formula for the price of a call option is given by:

$$C(S, K, T, r, \sigma) = S \cdot N(d_1) - K \cdot e^{-rT} \cdot N(d_2) \tag{59}$$

where

$$d_1 = \frac{\ln(S/K) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}} \tag{60}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{61}$$

Here, $N(\cdot)$ represents the cumulative distribution function of the standard normal distribution.

Parameters Used

For our example, we use the following parameters:

- Current stock price (S_0): 50
- Strike price of long call (K_1): 45
- Strike price of short call (K_2): 60
- Time to expiration for the short call (T): 2 months (2/12 years)
- Time to expiration for the long call (T'): 12 months (12/12 years)
- Volatility (σ): 20% (0.2)
- Risk-free rate (r): 3% (0.03)
- Net premium paid (D): 2
- V is the value of the long call option (expiring at $t = T'$)

Calculating the Value of the Long Call Option

At the expiration of the short call option, the remaining time to expiration for the long call option is $T' - T$. Using the Black-Scholes model, we calculate the value of the long call option at this time as:

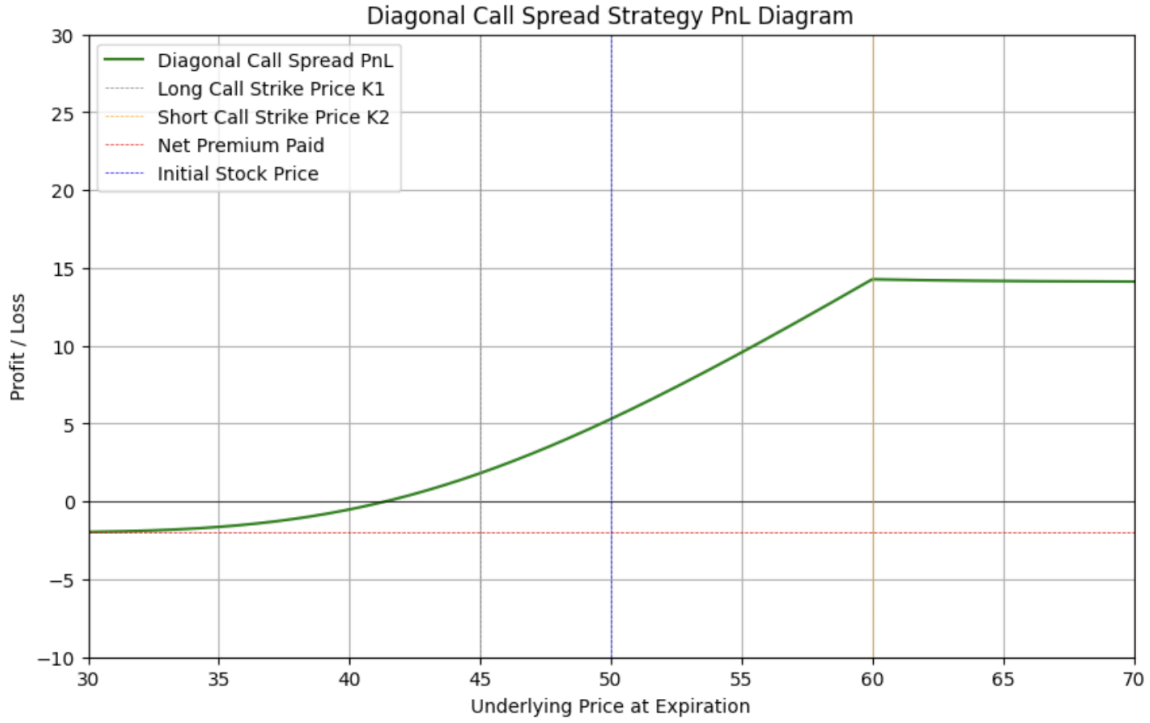
$$C_{\text{long}} = C(S_T, K_1, T' - T, r, \sigma) \tag{62}$$

Total PnL Calculation

The total profit or loss (PnL) for the Diagonal Call Spread at the expiration of the short call option is given by:

$$\text{PnL} = C_{\text{long}} - \text{Payoff}_{\text{short call}} - D \tag{63}$$

where $\text{Payoff}_{\text{short call}} = \max(S_T - K_2, 0)$ is the payoff of the short call option at expiration.



1.20 Strategy: Diagonal Put Spread

Key Components

- **Long Put Option**: Buy a deep ITM put option with a strike price K_1 and TTM T' and pay a premium D.
- **Short Put Option**: Sell an OTM put option with a lower strike price K_2 and shorter TTM $T < T'$ and receive a premium.

Payoff and P&L

Using the Black-Scholes Model

To model the Diagonal Put Spread strategy accurately, we need to account for the value of the long put option at the expiration of the short put option. The Black-Scholes model is used to calculate the theoretical price of options, considering factors such as the current stock price (S), the strike price (K), the time to maturity (T), the risk-free rate (r), and the volatility (σ) of the stock.

The Black-Scholes formula for the price of a put option is given by:

$$P(S, K, T, r, \sigma) = K \cdot e^{-rT} \cdot N(-d_2) - S \cdot N(-d_1) \tag{64}$$

where

$$d_1 = \frac{\ln(S/K) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}} \tag{65}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{66}$$

Here, $N(\cdot)$ represents the cumulative distribution function of the standard normal distribution.

Parameters Used

For our example, we use the following parameters:

- Current stock price (S_0): 50
- Strike price of long put (K_1): 55
- Strike price of short put (K_2): 45
- Time to expiration for the short put (T): 2 months (2/12 years)
- Time to expiration for the long put (T'): 12 months (12/12 years)
- Volatility (σ): 20% (0.2)
- Risk-free rate (r): 3% (0.03)
- Net premium paid (D): 2
- V is the value of the long put option (expiring at $t = T'$)

Calculating the Value of the Long Put Option

At the expiration of the short put option, the remaining time to expiration for the long put option is $T' - T$. Using the Black-Scholes model, we calculate the value of the long put option at this time as:

$$P_{\text{long}} = P(S_T, K_1, T' - T, r, \sigma) \tag{67}$$

Total PnL Calculation

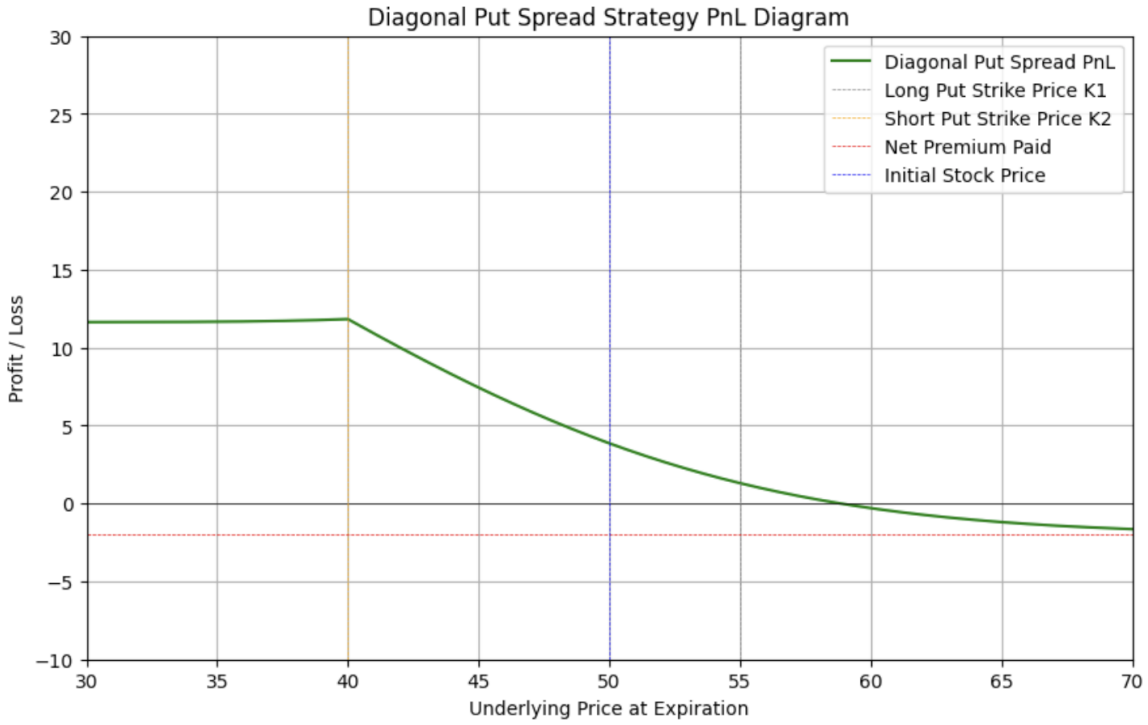
The total profit or loss (PnL) for the Diagonal Put Spread at the expiration of the short put option is given by:

$$\text{PnL} = P_{\text{long}} - \text{Payoff}_{\text{short put}} - D \tag{68}$$

where $\text{Payoff}_{\text{short put}} = \max(K_2 - S_T, 0)$ is the payoff of the short put option at expiration.

PnL Diagram

To visualize the PnL of the Diagonal Put Spread strategy, we plot the PnL against different underlying prices at expiration.



1.21 Strategy: Long Straddle

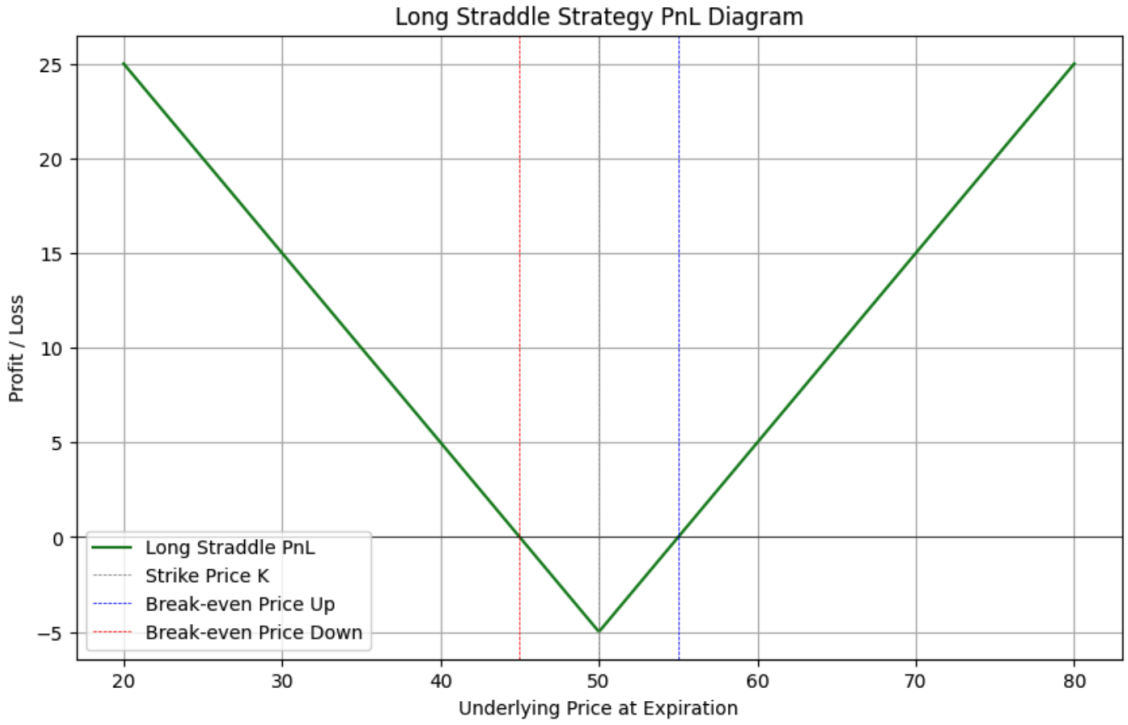
Key Components

- **Long Call Option**: Buy an ATM call option with a strike price K and pay a premium D.
- **Long Put Option**: Buy an ATM put option with a strike price K and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K)^+ + (K - S_T)^+ - D \tag{69}$$

- $S_{\text{up}} = K + D$
- $S_{\text{down}} = K - D$
- **Max Profit** = unlimited
- **Max Loss** = D
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium paid (D): 5



1.22 Strategy: Long Strangle

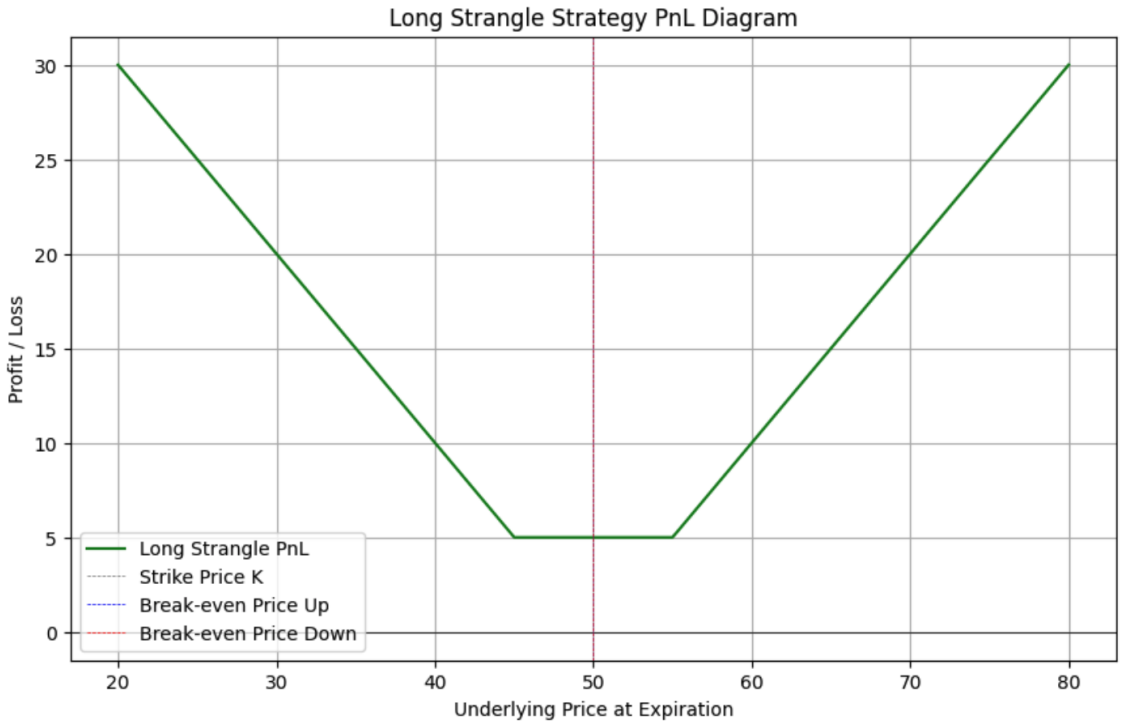
Key Components

- **Long Call Option**: Buy an OTM call option with a strike price K_1 and pay a premium D.
- **Long Put Option**: Buy an OTM put option with a strike price K_2 and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K_1)^+ + (K_2 - S_T)^+ - D \tag{70}$$

- $S_{\text{up}} = K_1 + D$
- $S_{\text{down}} = K_2 - D$
- **Max Profit** = unlimited
- **Max Loss** = D
- Current stock price (S_0): 50
- lower Strike price (K_1): 45
- higher strike price (K_2): 55
- Net premium paid (D): 5



1.23 Strategy: Long Guts

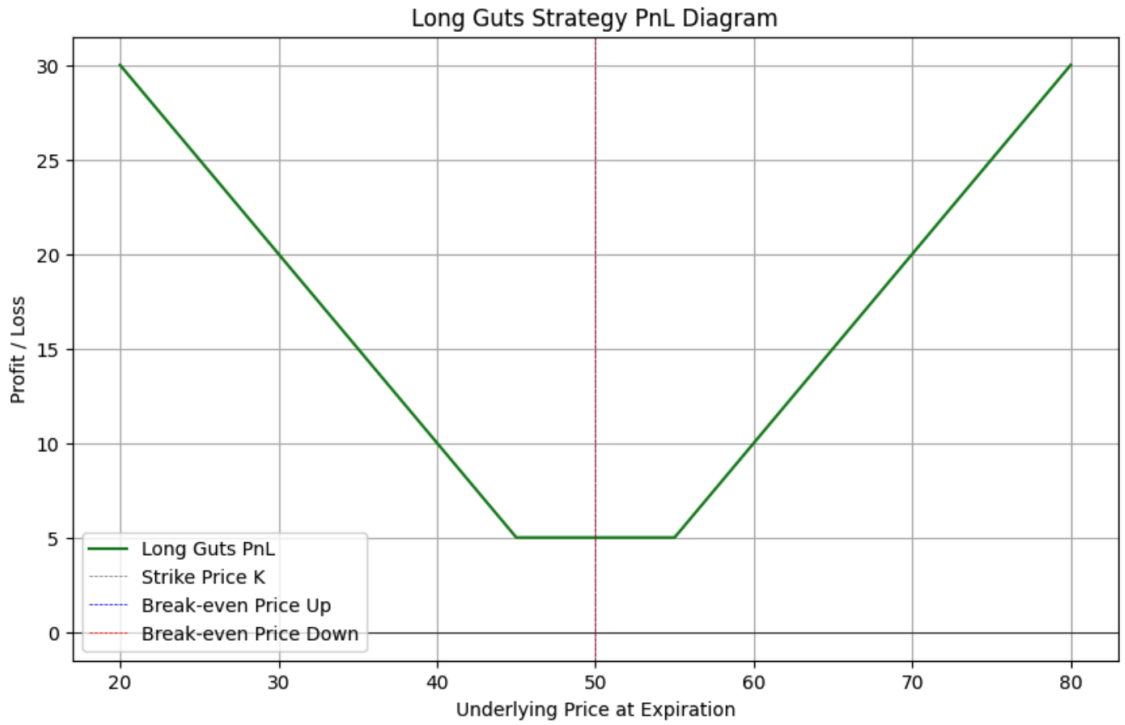
Key Components

- **Long Call Option**: Buy an ITM call option with a strike price K_1 and pay a premium D.
- **Long Put Option**: Buy an ITM put option with a strike price K_2 and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K_1)^+ + (K_2 - S_T)^+ - D \tag{71}$$

- $S_{\text{up}} = K_1 + D$
- $S_{\text{down}} = K_2 - D$
- **Max Profit** = unlimited
- **Max Loss** = D
- Current stock price (S_0): 50
- lower Strike price (K_1): 45
- higher strike price (K_2): 55
- Net premium paid (D): 5



1.24 Strategy: Short Straddle

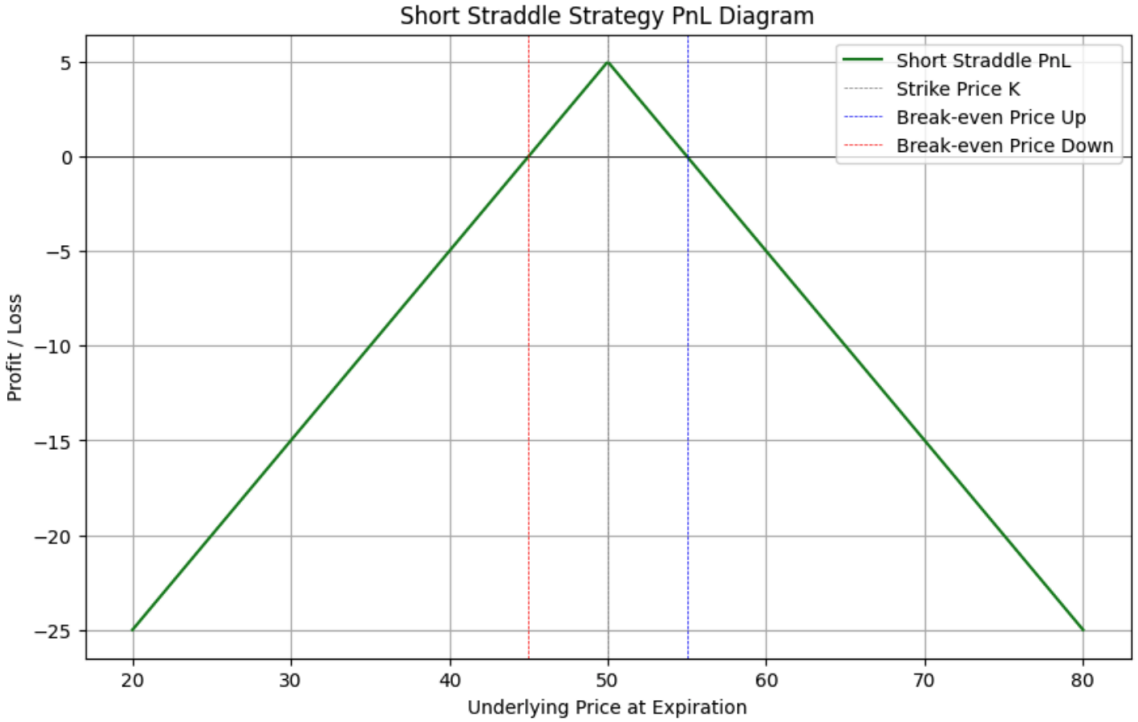
Key Components

- **Short Call Option**: Sell an ATM call option with a strike price K and receive a premium C.
- **Short Put Option**: Sell an ATM put option with a strike price K and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = -(S_T - K)^+ - (K - S_T)^+ + C \tag{72}$$

- $S_{\text{up}} = K + C$
- $S_{\text{down}} = K - C$
- **Max Profit** $= C$
- **Max Loss** = unlimited
- Current stock price (S_0): 50
- Strike price (K_1): 50
- Net premium received (C): 5



1.25 Strategy: Short Strangle

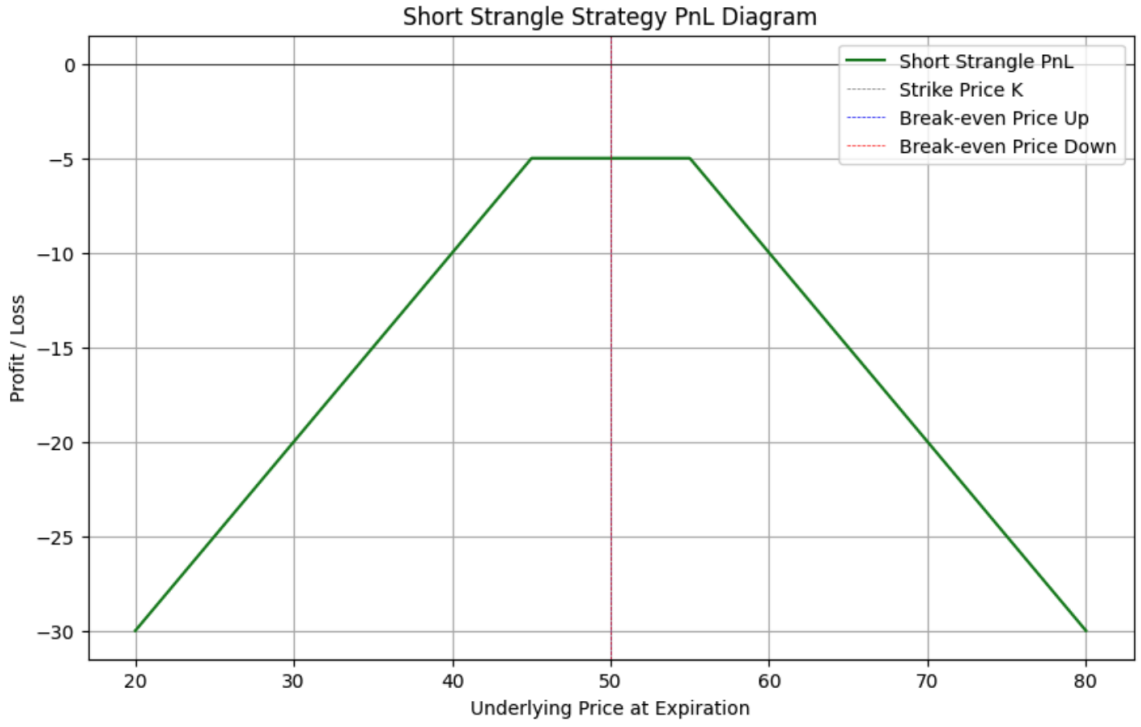
Key Components

- **Short Call Option**: Sell an OTM call option with a strike price K_1 and receive a premium C.
- **Short Put Option**: Sell an OTM put option with a strike price K_2 and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = -(S_T - K_1)^+ - (K_2 - S_T)^+ + C \tag{73}$$

- $S_{\text{up}} = K_1 + C$
- $S_{\text{down}} = K_2 - C$
- **Max Profit** $= C$
- **Max Loss** = unlimited
- Current stock price (S_0): 50
- lower Strike price (K_1): 45
- higher strike price (K_2): 55
- Net premium received (C): 5



1.26 Strategy: Short Guts

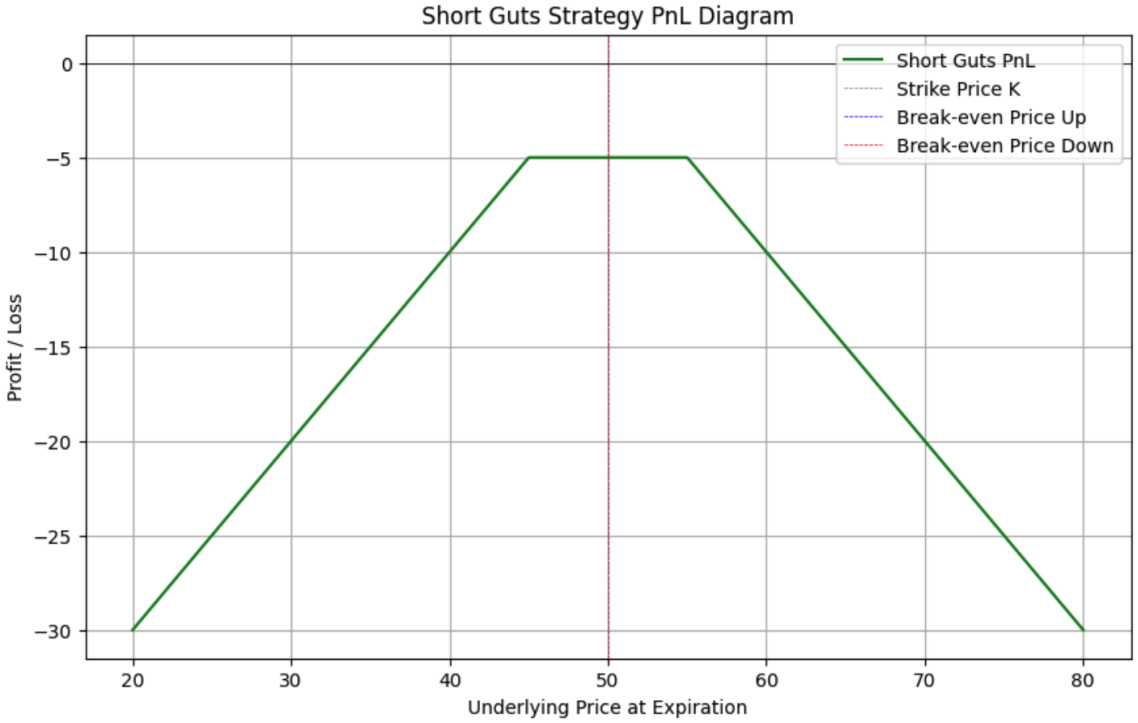
Key Components

- **Short Call Option**: Sell an ITM call option with a strike price K_1 and receive a premium C.
- **Short Put Option**: Sell an ITM put option with a strike price K_2 and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = -(S_T - K_1)^+ - (K_2 - S_T)^+ + C \tag{74}$$

- $S_{\text{up}} = K_1 + C$
- $S_{\text{down}} = K_2 - C$
- **Max Profit** $= C - (K_2 - K_1)$
- **Max Loss** = unlimited
- Current stock price (S_0): 50
- lower Strike price (K_1): 45
- higher strike price (K_2): 55
- Net premium received (C): 5



1.27 Strategy: Long Call Synthetic Straddle

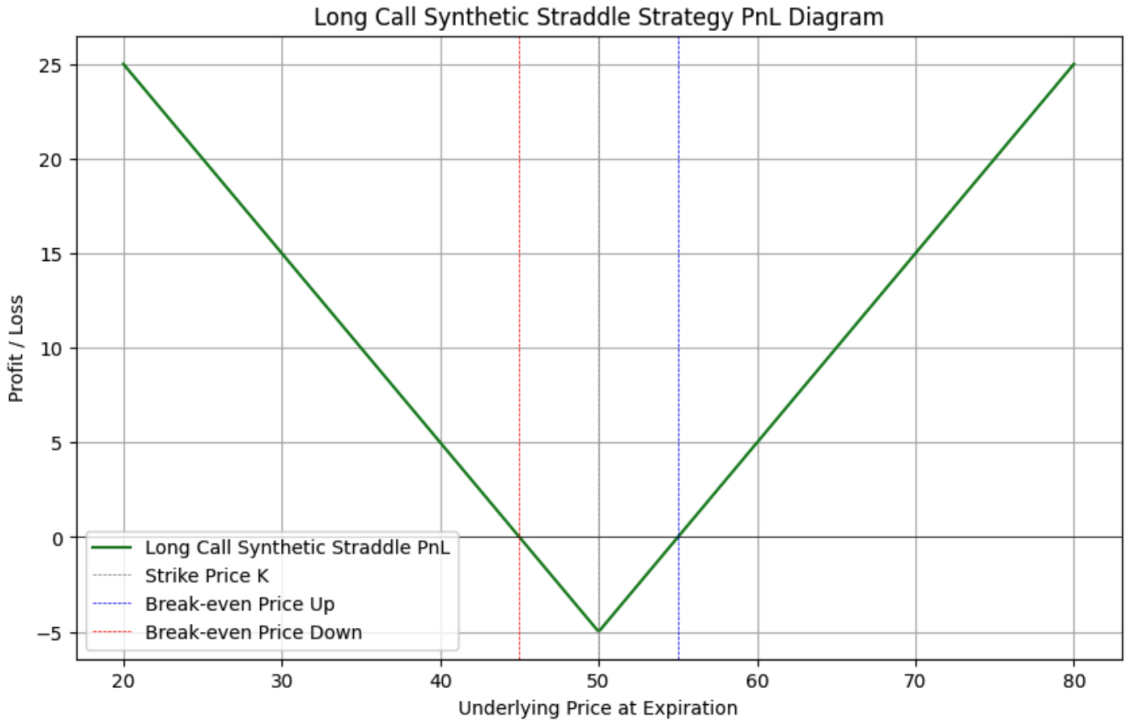
Key Components

- **Short Stock**: Short the underlying stock.
- **Long Call Options**: Buy two ATM call options with a strike price K and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = S_0 - S_T + 2 \times (S_T - K)^+ - D \tag{75}$$

- $S_{\text{up}} = 2 \times K - S_0 + D$
- $S_{\text{down}} = S_0 - D$
- **Max Profit** = unlimited
- **Max Loss** $= D - (S_0 - K)$
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium paid (D): 5



1.28 Strategy: Long Put Synthetic Straddle

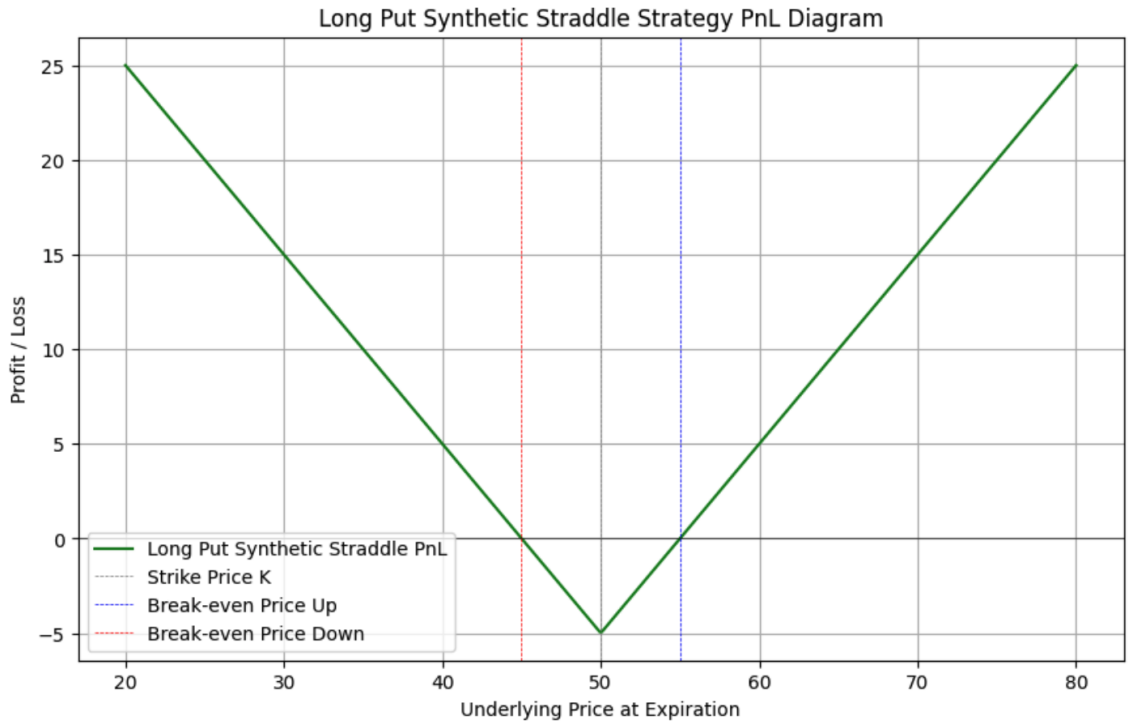
Key Components

- **Long Stock**: Buy the underlying stock.
- **Long Put Options**: Buy two ATM put options with a strike price K and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = S_T - S_0 + 2 \times (K - S_T)^+ - D \tag{76}$$

- $S_{\text{up}} = S_0 + D$
- $S_{\text{down}} = 2 \times K - S_0 - D$
- **Max Profit** = unlimited
- **Max Loss** $= D - (K - S_0)$
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium paid (D): 5



1.29 Strategy: Short Call Synthetic Straddle

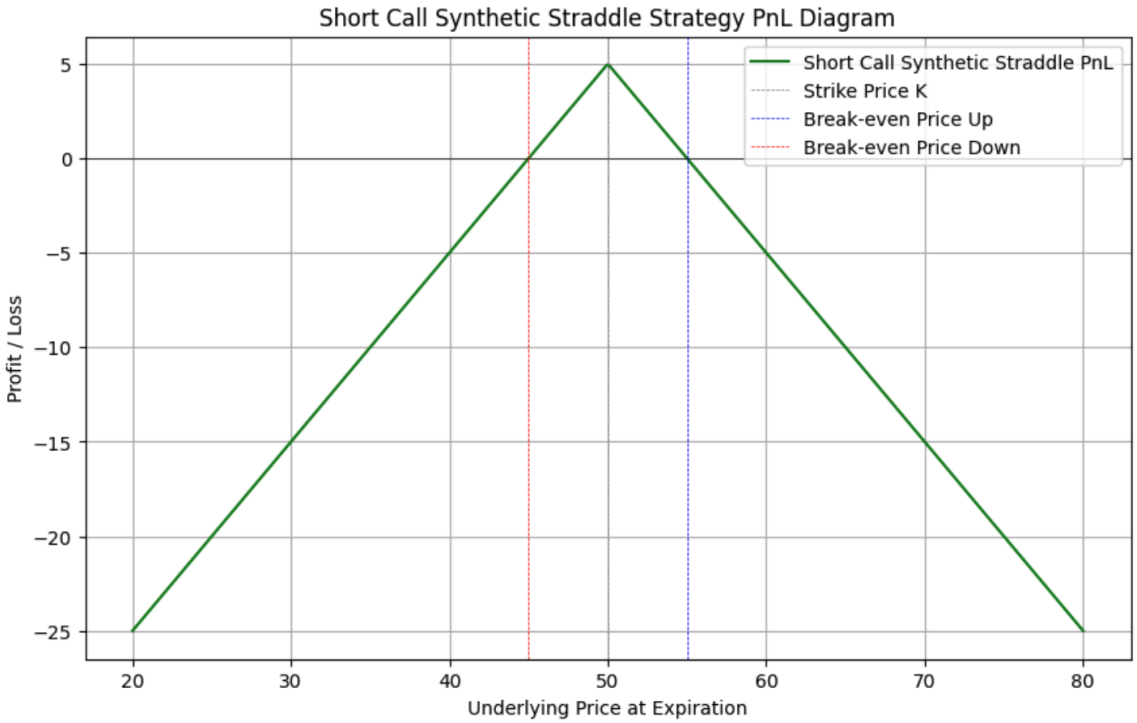
Key Components

- **Long Stock**: Buy the underlying stock.
- **Short Call Options**: Sell two ATM call options with a strike price K and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = S_T - S_0 - 2 \times (S_T - K)^+ + C \tag{77}$$

- $S_{\text{up}} = 2 \times K - S_0 + C$
- $S_{\text{down}} = S_0 - C$
- **Max Profit** $= K - S_0 + C$
- **Max Loss** = unlimited
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium received (C): 5



1.30 Strategy: Short Put Synthetic Straddle

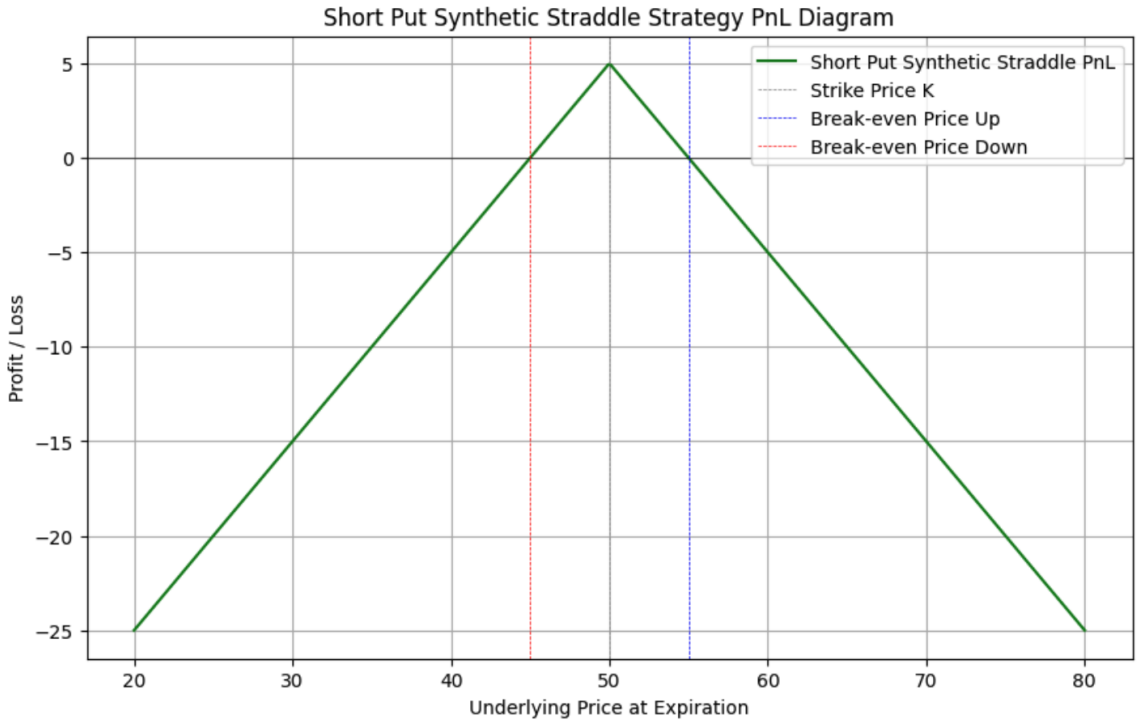
Key Components

- **Short Stock**: Short the underlying stock.
- **Short Put Options**: Sell two ATM put options with a strike price K and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = S_0 - S_T - 2 \times (K - S_T)^+ + C \tag{78}$$

- $S_{\text{up}} = S_0 + C$
- $S_{\text{down}} = 2 \times K - S_0 - C$
- **Max Profit** $= S_0 - K + C$
- **Max Loss** = unlimited
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium received (C): 5



1.31 Strategy: Covered Short Straddle

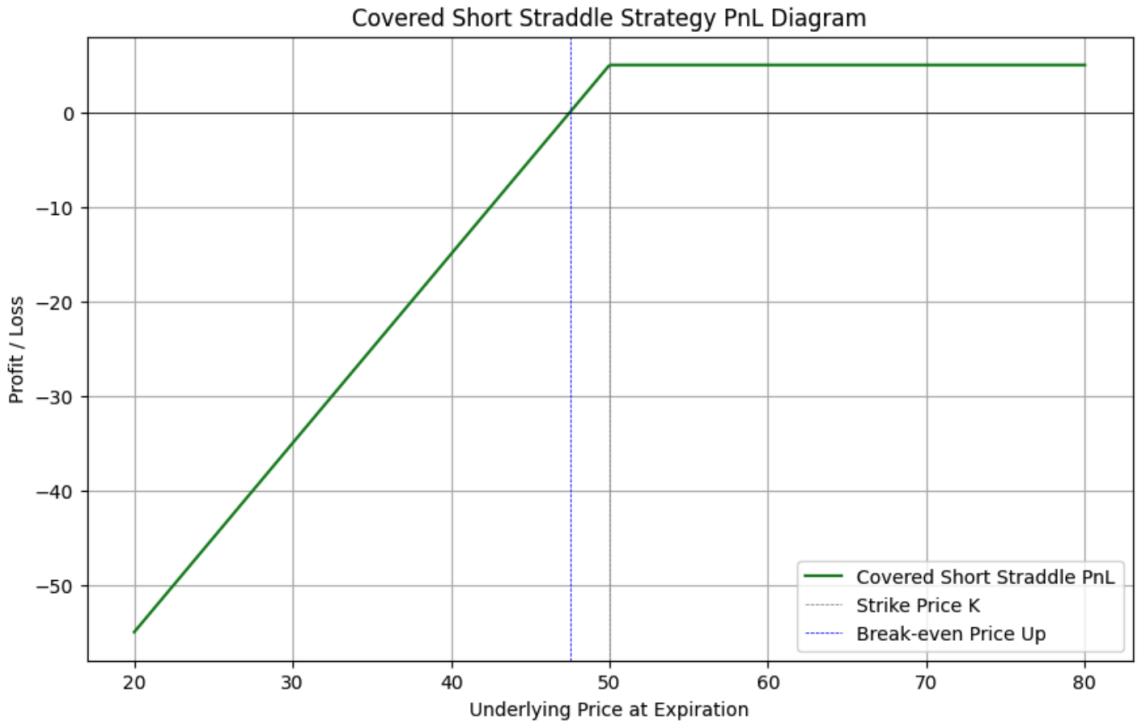
Key Components

- **Long Stock**: Buy the underlying stock.
- **Short Call Option**: Sell an ATM call option with a strike price K and receive a premium C.
- **Short Put Option**: Sell an ATM put option with a strike price K and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = S_T - S_0 - (S_T - K)^+ - (K - S_T)^+ + C \tag{79}$$

- $S_{\text{up}} = \frac{1}{2}(S_0 + K - C)$
- **Max Profit** $= K - S_0 + C$
- **Max Loss** $= S_0 + K - C$
- Current stock price (S_0): 50
- Strike price (K): 50
- Net premium received (C): 5



1.32 Strategy: Covered Short Strangle

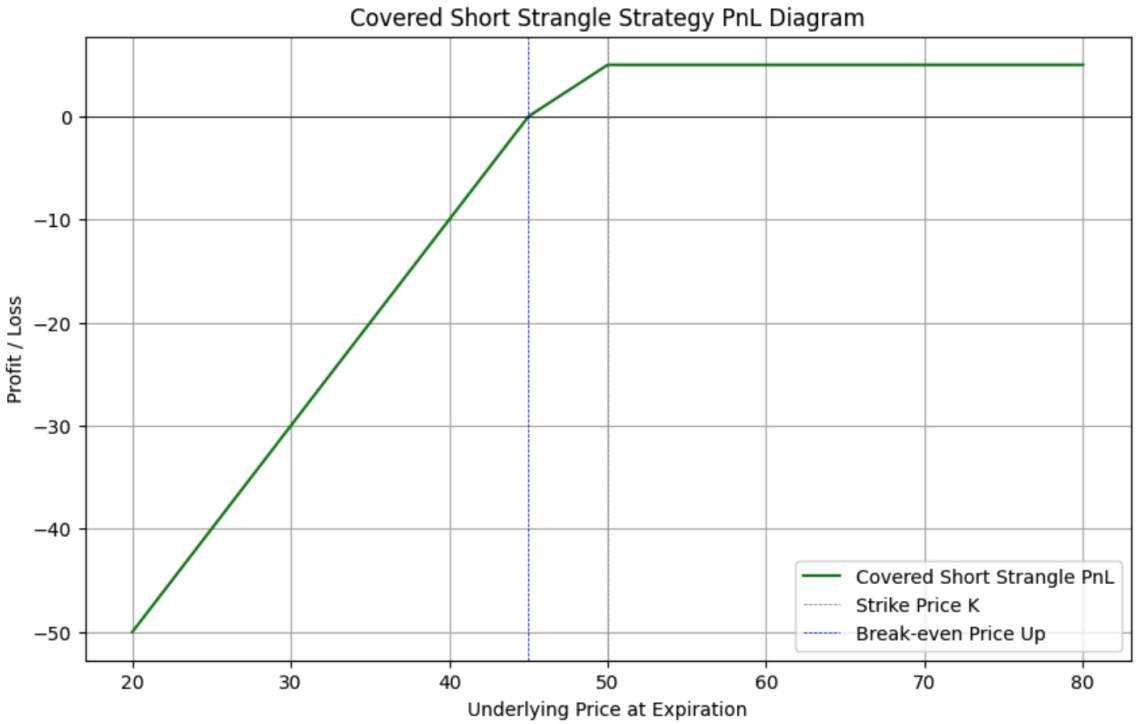
Key Components

- **Long Stock**: Buy the underlying stock.
- **Short Call Option**: Sell an ATM call option with a strike price K and receive a premium C.
- **Short Put Option**: Sell an OTM put option with a strike price K' and receive a premium C.

Payoff and P&L

$$\textbf{Payyoff} = S_T - S_0 - (S_T - K)^+ - (K' - S_T)^+ + C \tag{80}$$

- **Max Profit** $= K - S_0 + C$
- **Max Loss** $= S_0 + K' - C$
- Current stock price (S_0): 50
- Strike price for call (K): 50
- Strike price for put (K'): 45
- Net premium received (C): 5



1.33 Strategy: Strap

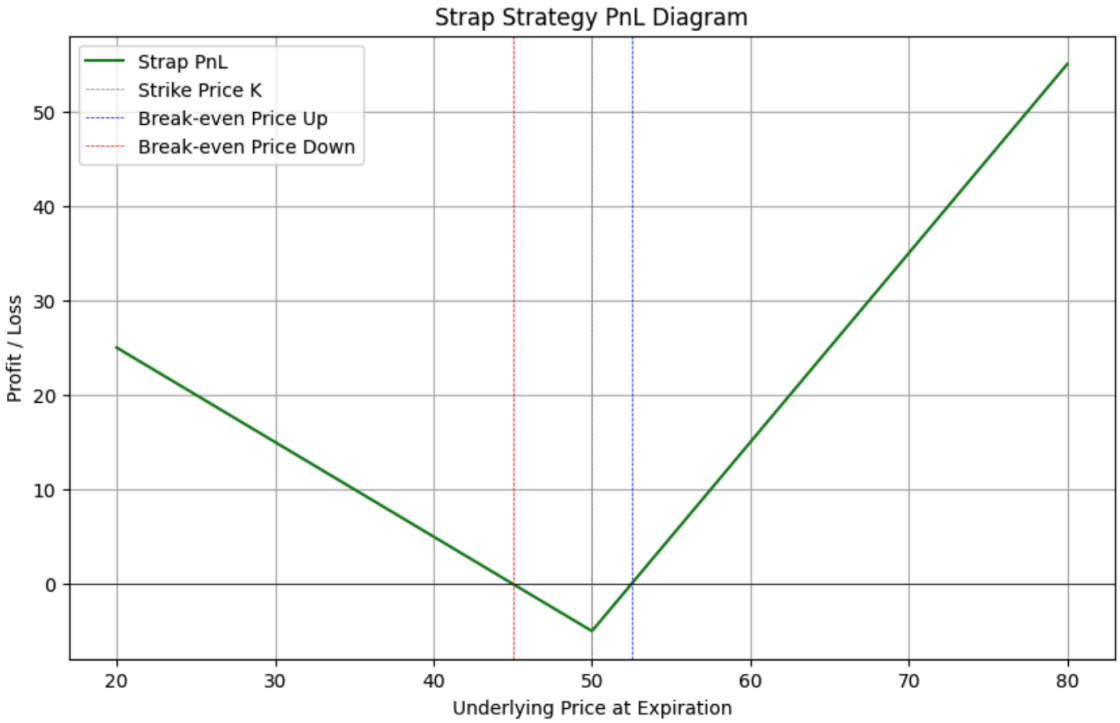
Key Components

- **Long Call Options**: Buy two ATM call options with a strike price K and pay a premium D.
- **Long Put Option**: Buy an ATM put option with a strike price K and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = 2 \times (S_T - K)^+ + (K - S_T)^+ - D \tag{81}$$

- $S_{\text{up}} = K + \frac{D}{2}$
- $S_{\text{down}} = K - D$
- **Max Profit** = unlimited
- **Max Loss** = D
- Current stock price (S_0): 50
- Strike price for call (K): 50
- Net premium paid (D): 5



1.34 Strategy: Strip

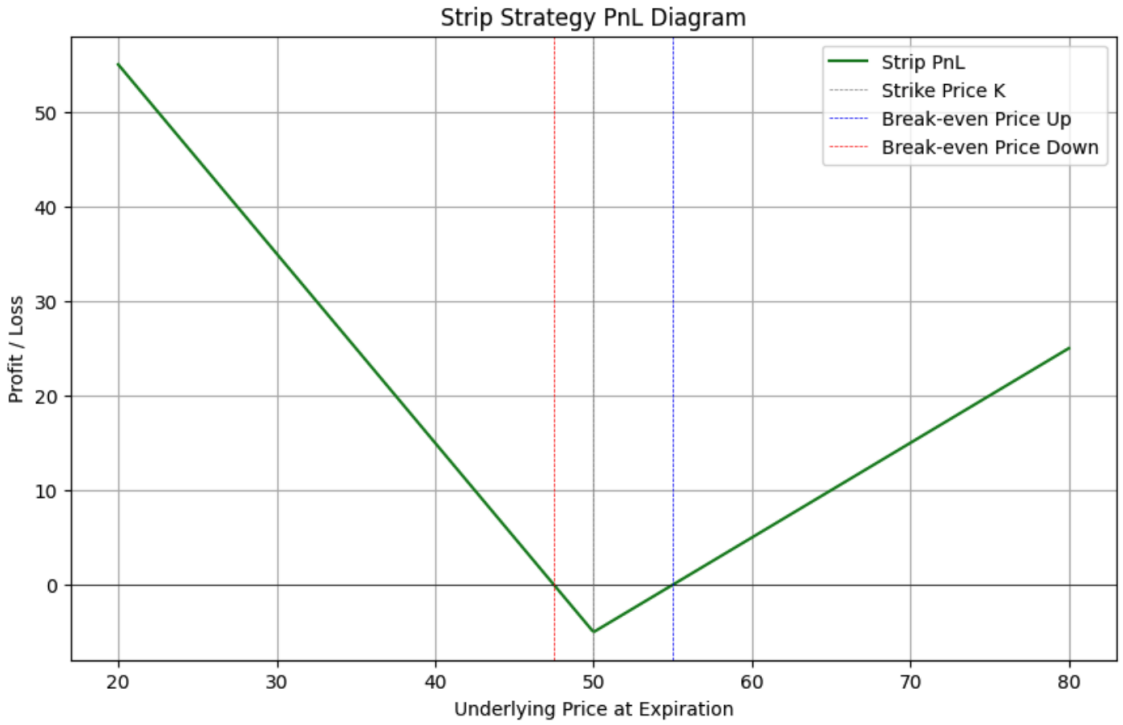
Key Components

- **Long Call Option**: Buy an ATM call option with a strike price K and pay a premium D.
- **Long Put Options**: Buy two ATM put options with a strike price K and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K)^+ + 2 \times (K - S_T)^+ - D \tag{82}$$

- $S_{\text{up}} = K + D$
- $S_{\text{down}} = K - \frac{D}{2}$
- **Max Profit** = unlimited
- **Max Loss** = D
- Current stock price (S_0): 50
- Strike price for call (K): 50
- Net premium paid (D): 5



1.35 Strategy: Call Ratio Backspread

Key Components

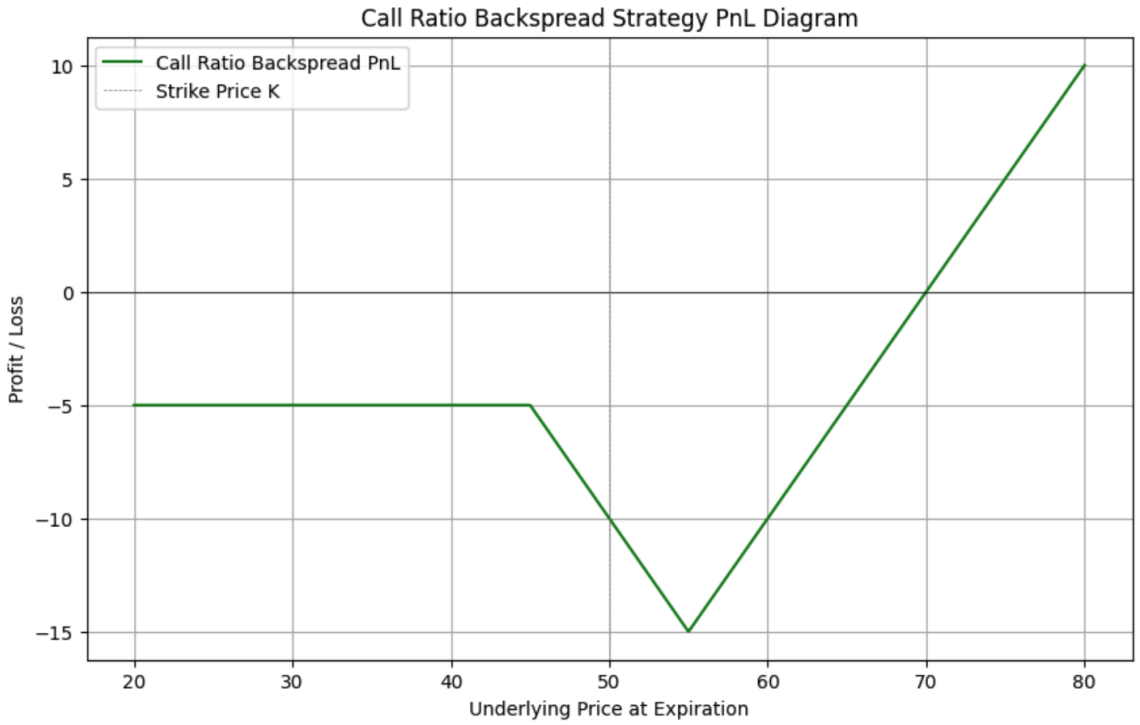
- **Short Call Options**: Sell N_S close to ATM call options with a strike price K_1 and receive a premium H.
- **Long Call Options**: Buy N_L OTM call options with a strike price K_2 and pay a premium H.

Payoff and P&L

$$\textbf{Payyoff} = N_L \times (S_T - K_2)^+ - N_S \times (S_T - K_1)^+ - H \tag{83}$$

- $S_{\text{down}} = K_1 + \frac{H}{N_S}$
- $S_{\text{up}} = \frac{N_L \times K_2 - N_S \times K_1 + H}{N_L - N_S}$
- **Max Profit** = unlimited
- **Max Loss** $= N_S \times (K_2 - K_1) + H$

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 55$ (Higher strike price)
- $N_S = 1$ (Number of short options)
- $N_L = 2$ (Number of long options)
- $H = 5$ (Premium difference)



1.36 Strategy: Put Ratio Backspread

Key Components

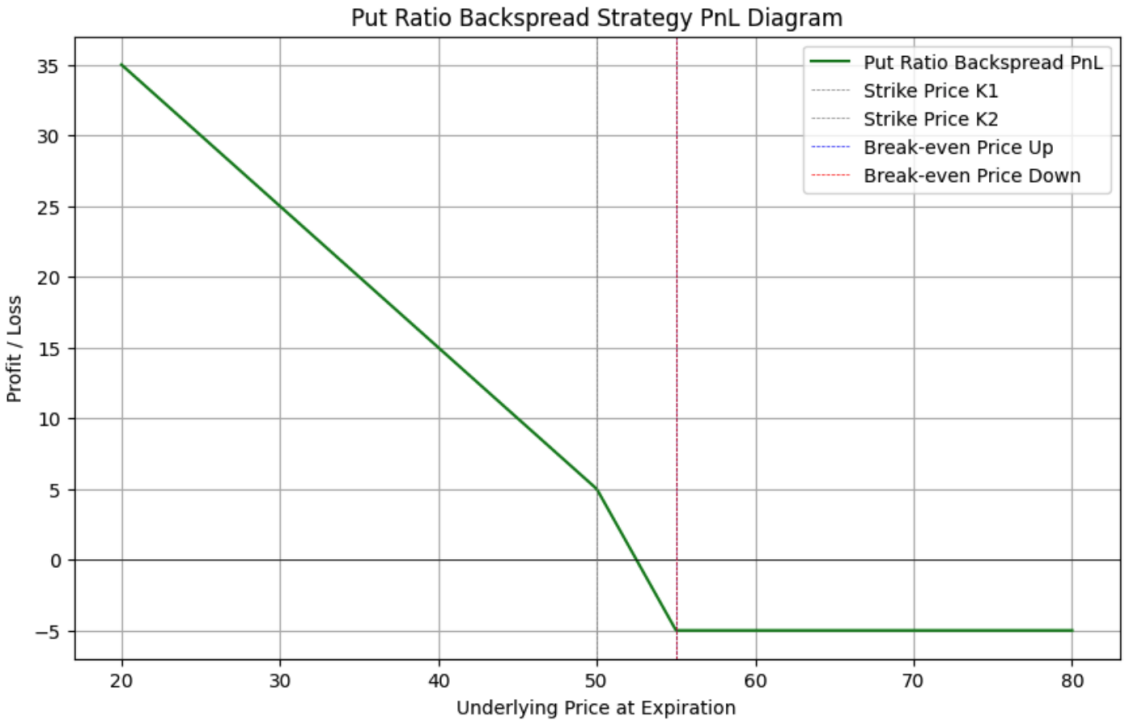
- **Short Put Options**: Sell N_S close to ATM put options with a strike price K_1 and receive a premium H.
- **Long Put Options**: Buy N_L OTM put options with a strike price K_2 and pay a premium H.

Payoff and P&L

$$\textbf{Payyoff} = N_L \times (K_2 - S_T)^+ - N_S \times (K_1 - S_T)^+ - H \tag{84}$$

- $S_{\text{up}} = K_1 + \frac{H}{N_S}$
- $S_{\text{down}} = \frac{N_L \times K_2 - N_S \times K_1 - H}{N_L - N_S}$
- **Max Profit** $= N_L \times K_2 - N_S \times K_1 - H$
- **Max Loss** $= N_S \times (K_1 - K_2) + H$

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 55$ (Higher strike price)
- $N_S = 1$ (Number of short options)
- $N_L = 2$ (Number of long options)
- $H = 5$ (Premium difference)



1.37 Strategy: Ratio Call Spread

Key Components

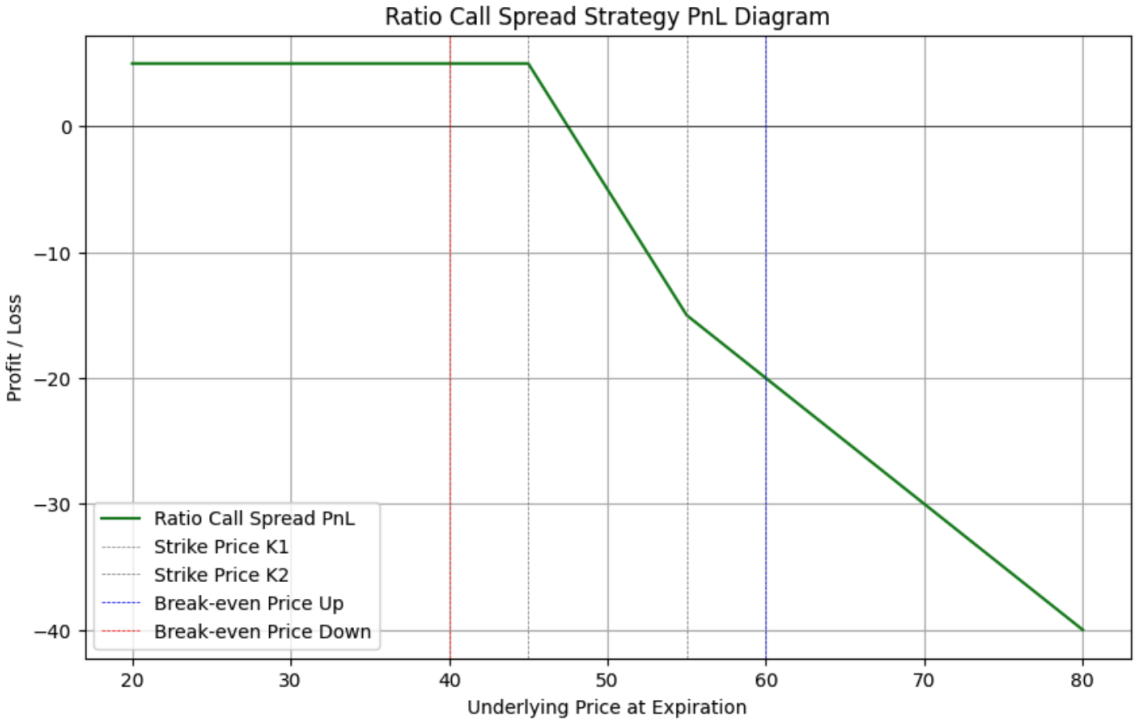
- **Short Call Options**: Sell N_S close to ATM call options with a strike price K_1 and receive a premium H.
- **Long Call Options**: Buy N_L ITM call options with a strike price K_2 and pay a premium H.

Payoff and P&L

$$\textbf{Payyoff} = N_L \times (S_T - K_2)^+ - N_S \times (S_T - K_1)^+ + H \tag{85}$$

- $S_{\text{up}} = K_2 + \frac{H}{N_L}$
- $S_{\text{down}} = \frac{N_S \times K_1 - N_L \times K_2 + H}{N_S - N_L}$
- **Max Profit** $= N_L \times (K_2 - K_1) - H$
- **Max Loss** = unlimited

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 55$ (Higher strike price)
- $N_S = 2$ (Number of short options)
- $N_L = 1$ (Number of long options)
- $H = 5$ (Premium difference)



1.38 Strategy: Ratio Put Spread

Key Components

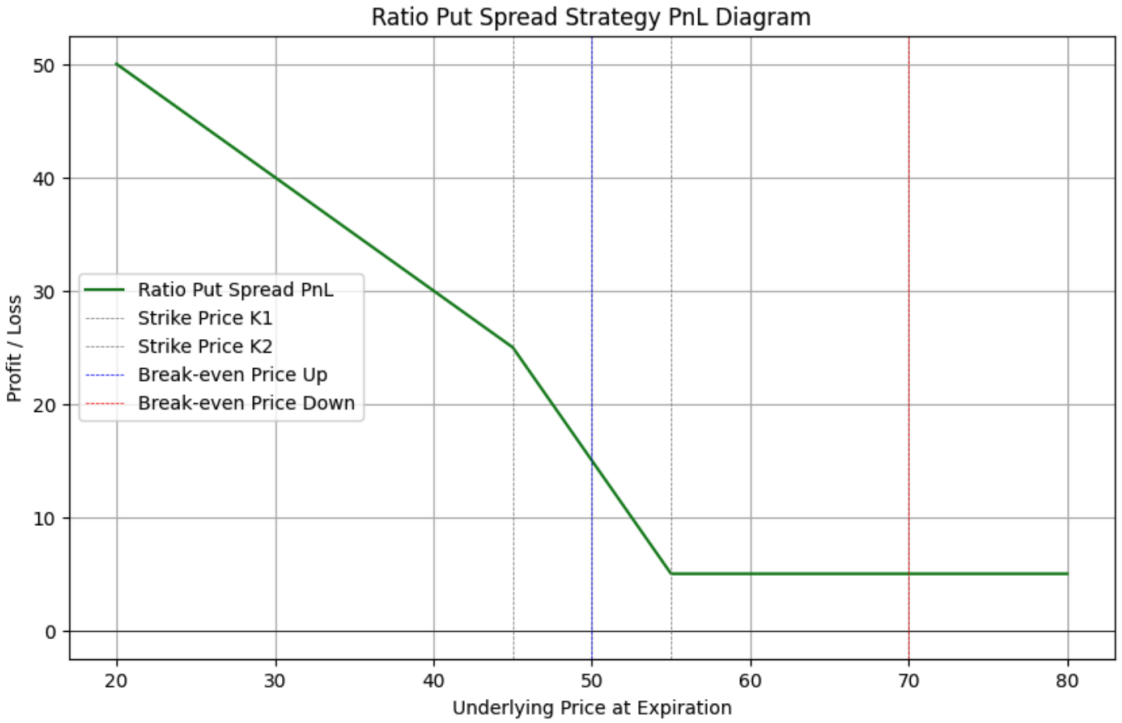
- **Short Put Options**: Sell N_S close to ATM put options with a strike price K_1 and receive a premium H.
- **Long Put Options**: Buy N_L OTM put options with a strike price K_2 and pay a premium H.

Payoff and P&L

$$\textbf{Payyoff} = N_L \times (K_2 - S_T)^+ - N_S \times (K_1 - S_T)^+ + H \tag{86}$$

- $S_{\text{up}} = K_1 + \frac{H}{N_S}$
- $S_{\text{down}} = \frac{N_L \times K_2 - N_S \times K_1 + H}{N_L - N_S}$
- **Max Profit** $= N_L \times (K_2 - K_1) + H$
- **Max Loss** = unlimited

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 55$ (Higher strike price)
- $N_S = 1$ (Number of short options)
- $N_L = 2$ (Number of long options)
- $H = 5$ (Premium difference)



1.39 Strategy: Long Call Butterfly

Key Components

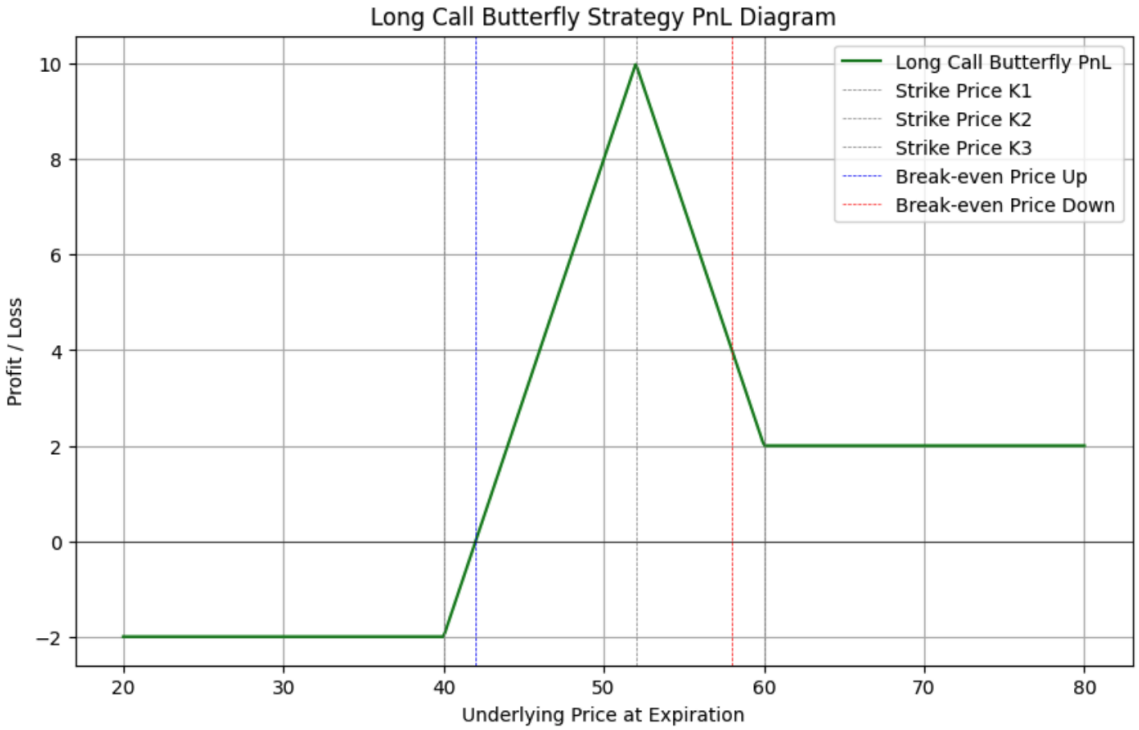
- **Long Call Options**: Buy an OTM call option with a strike price K_1 and pay a premium D.
- **Short Call Options**: Sell two ATM call options with a strike price K_2 and receive a premium D.
- **Long Call Options**: Buy an ITM call option with a strike price K_3 and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K_1)^+ + (S_T - K_3)^+ - 2 \times (S_T - K_2)^+ - D \tag{87}$$

- $S_{\text{up}} = K_1 - D$
- $S_{\text{down}} = K_3 + D$
- **Max Profit** $= \kappa - D$
- **Max Loss** $= D$

- $S_0 = 50$ (Current stock price)
- $K_1 = 40$ (Lower strike price)
- $K_2 = 52$ (Higher strike price)
- $K_3 = 60$ (Higher strike price)
- $D = 2$ (Premium paid)
- $Kappa = K_2 - K_1$ (strike distance)



1.40 Strategy: Modified Call Butterfly

Key Components

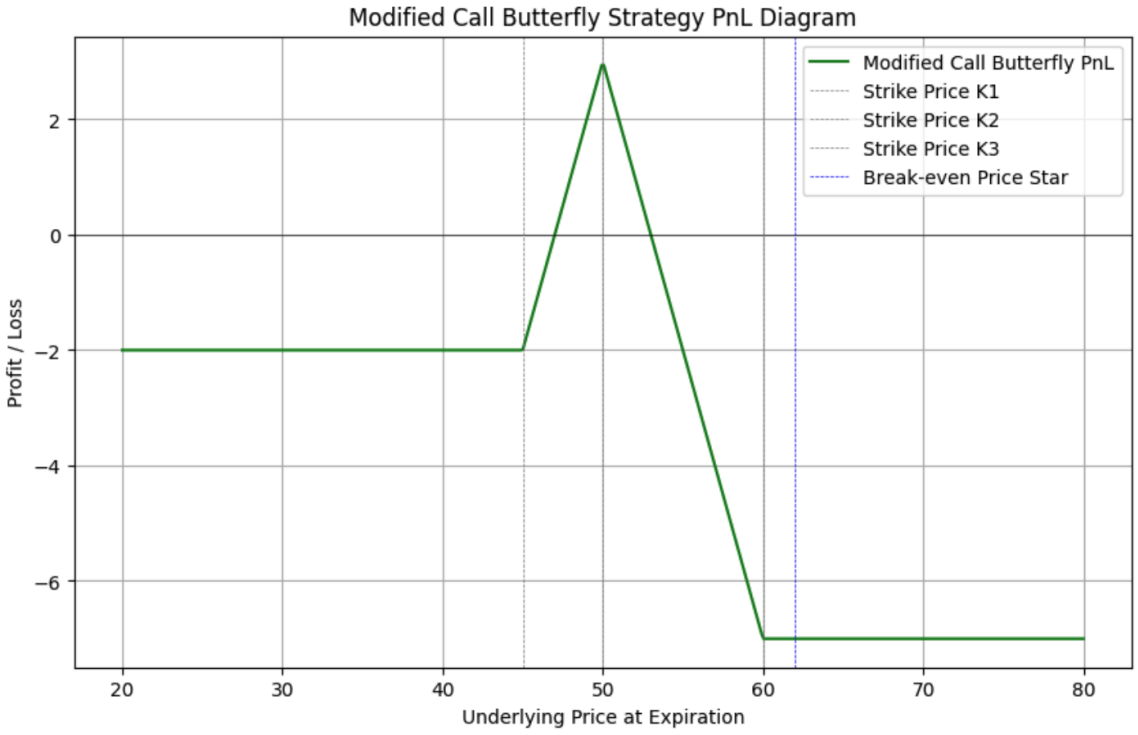
- **Long Call Options**: Buy an OTM call option with a strike price K_1 and pay a premium D.
- **Short Call Options**: Sell two ATM call options with a strike price K_2 and receive a premium D.
- **Long Call Options**: Buy an ITM call option with a strike price K_3 and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (S_T - K_1)^+ + (S_T - K_3)^+ - 2 \times (S_T - K_2)^+ - D \tag{88}$$

- $S_* = K_3 + D$
- **Max Profit** $= K_2 - K_3 - D$
- **Max Loss** $= D$

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 50$ (Higher strike price)
- $K_3 = 60$ (Higher strike price)
- $D = 2$ (Premium paid)



1.41 Strategy: Long Put Butterfly

Key Components

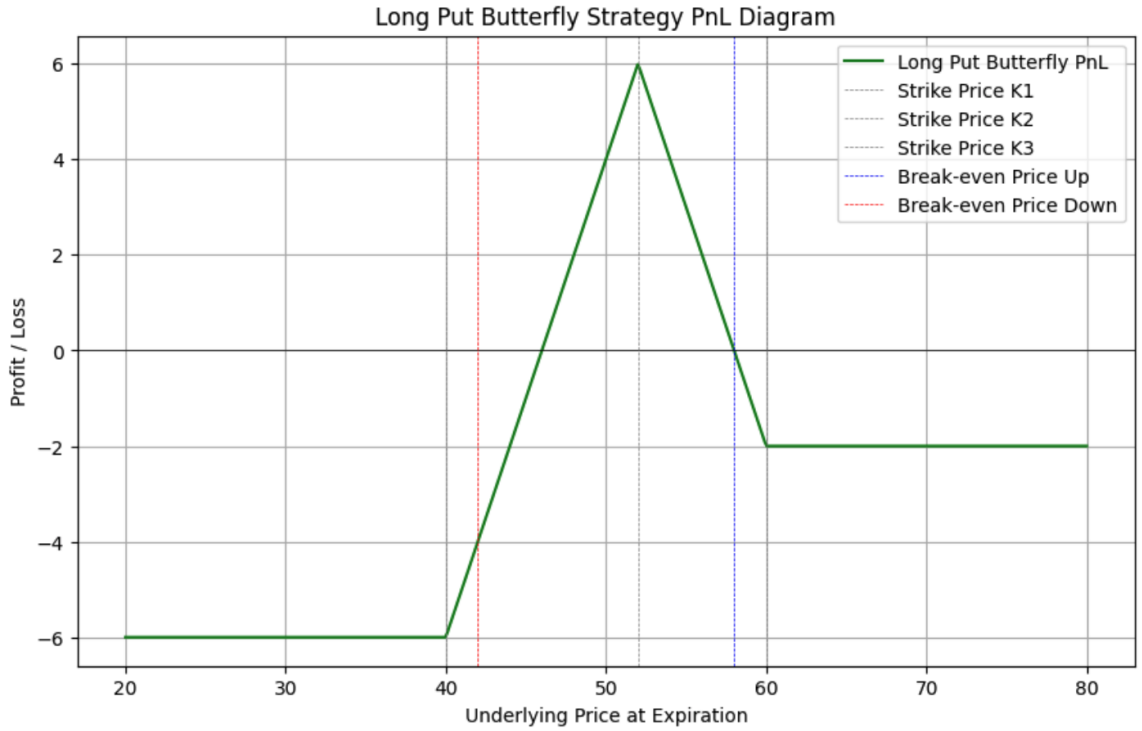
- **Long Put Options**: Buy an OTM put option with a strike price K_1 and pay a premium D.
- **Short Put Options**: Sell two ATM put options with a strike price K_2 and receive a premium D.
- **Long Put Options**: Buy an ITM put option with a strike price K_3 and pay a premium D.

Payoff and P&L

$$\textbf{Payyoff} = (K_1 - S_T)^+ + (K_3 - S_T)^+ - 2 \times (K_2 - S_T)^+ - D \tag{89}$$

- $S_{\text{up}} = K_3 - D$
- $S_{\text{down}} = K_1 + D$
- **Max Profit** $= \kappa - D$
- **Max Loss** $= D$

- $S_0 = 50$ (Current stock price)
- $K_1 = 40$ (Lower strike price)
- $K_2 = 52$ (Higher strike price)
- $K_3 = 60$ (Higher strike price)
- $D = 2$ (Premium paid)
- $Kappa = K_2 - K_1$ (strike distance)



1.42 Strategy: Modified Put Butterfly

Key Components

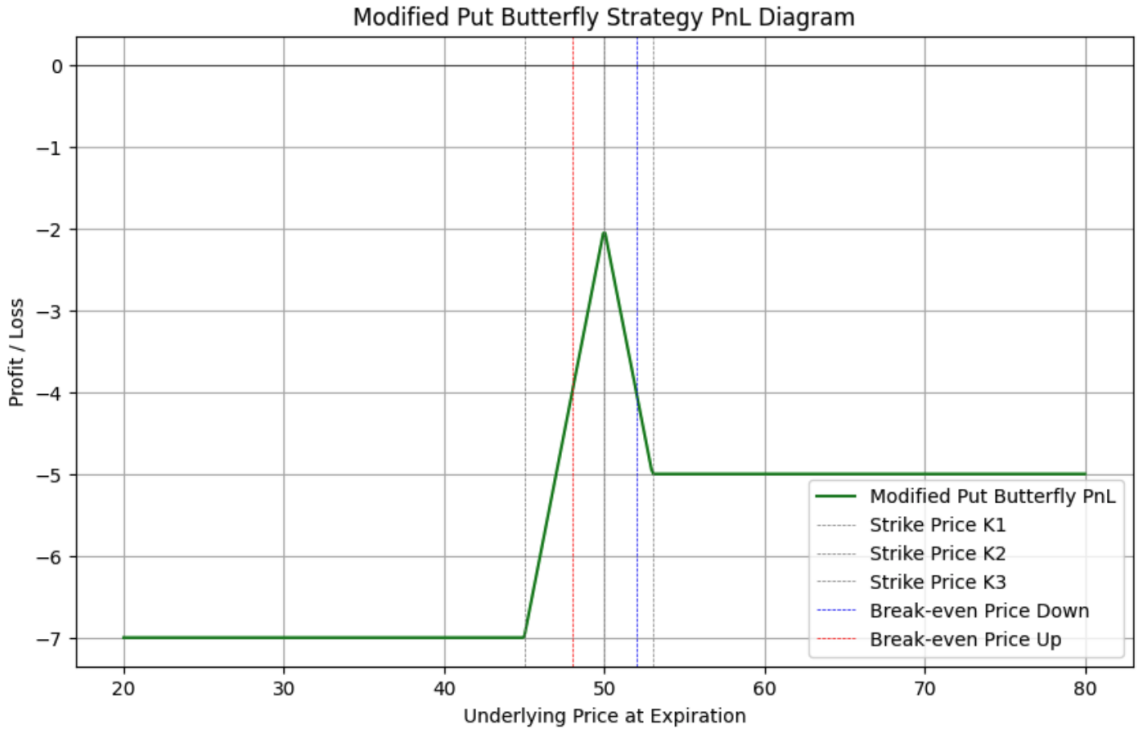
- **Long Put Options**: Buy an OTM put option with a strike price K_1 and pay a premium H.
- **Short Put Options**: Sell two ATM put options with a strike price K_2 and receive a premium H.
- **Long Put Options**: Buy an ITM put option with a strike price K_3 and pay a premium H.

Payoff and P&L

$$\textbf{Payyoff} = (K_1 - S_T)^+ + (K_3 - S_T)^+ - 2 \times (K_2 - S_T)^+ - H \tag{90}$$

- $S_{\text{down}} = 2 \times K_2 - K_3 + H$
- **Max Profit** $= K_3 - K_2 - H$
- **Max Loss** $= 2 \times K_2 - K_1 - K_3 + H$

- $S_0 = 50$ (Current stock price)
- $K_1 = 45$ (Lower strike price)
- $K_2 = 50$ (Higher strike price)
- $K_3 = 53$ (Higher strike price)
- $H = 5$ (Premium paid)



1.43 Strategy: Short Call Butterfly

Key Components

- **Short ITM Call Option**: Sell a call option with a strike price K_1.
- **Long ATM Call Options**: Buy two ATM call options with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.
- **All strikes are equidistant**: K_3 - K_2 = K_2 - K_1 =κ.

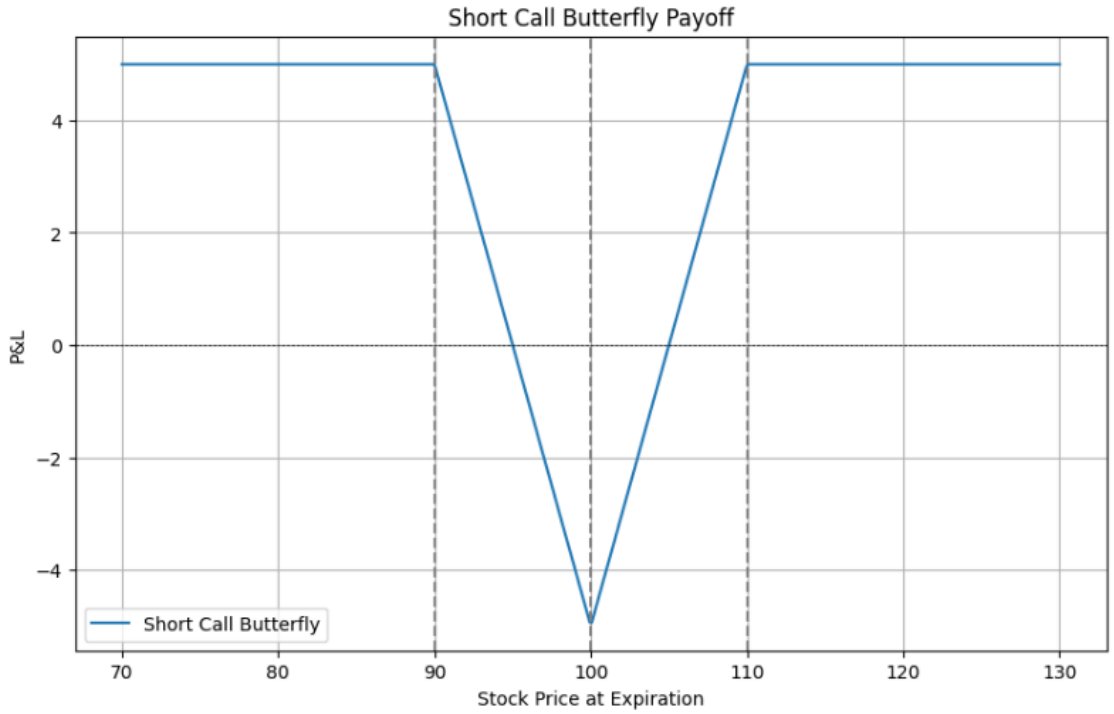
Payoff and P&L

$$\textbf{Payoff at expiration} = 2 \times (S_T - K_2)^+ - (S_T - K_1)^+ - (S_T - K_3)^+ + C \tag{91}$$

$$\textbf{Max Profit} = C \tag{92}$$

$$\textbf{Max Loss} = \kappa - C \tag{93}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Net premium received (C): 5



1.44 Strategy: Short Put Butterfly

Key Components

- **Short ITM Put Option**: Sell a put option with a strike price K_1.
- **Long ATM Put Options**: Buy two ATM put options with a strike price K_2.
- **Short OTM Put Option**: Sell a put option with a strike price K_3.
- **All strikes are equidistant**: K_3 - K_2 = K_2 - K_1 =κ.

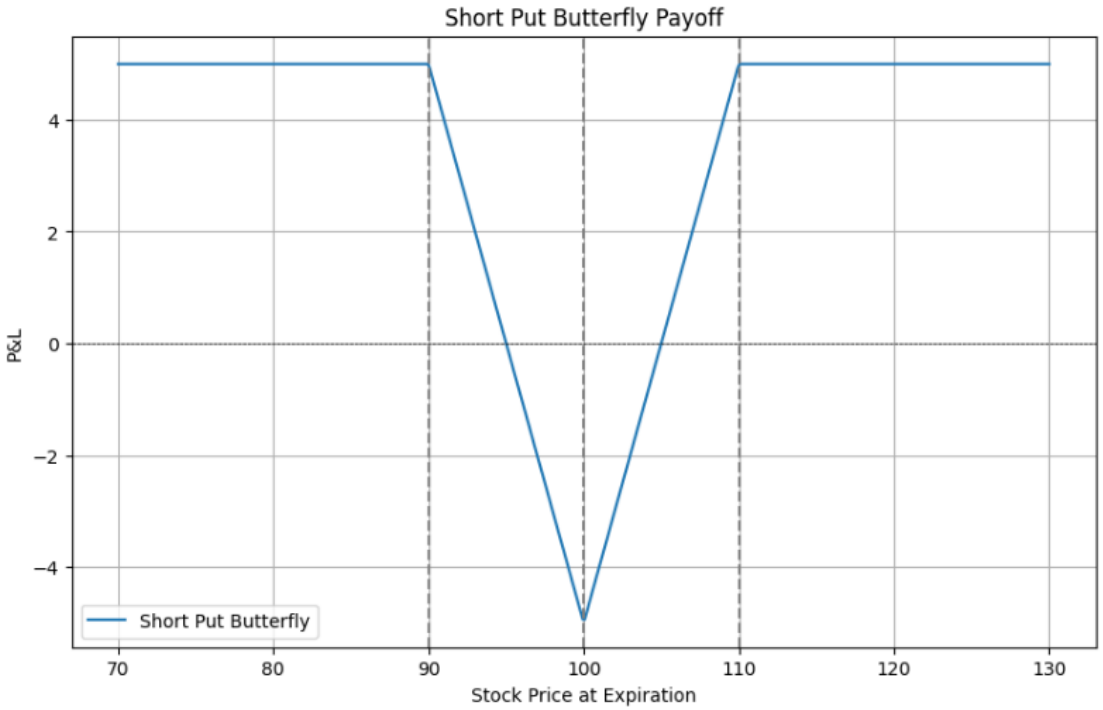
Payoff and P&L

$$\textbf{Payoff at expiration} = 2 \times (K_2 - S_T)^+ - (K_1 - S_T)^+ - (K_3 - S_T)^+ + C \tag{94}$$

$$\textbf{Max Profit} = C \tag{95}$$

$$\textbf{Max Loss} = \kappa - C \tag{96}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Net premium received (C): 5



1.45 Strategy: Long Iron Butterfly

Key Components

- **Long OTM Put Option**: Buy a put option with a strike price K_1.
- **Short ATM Put Option**: Sell a put option with a strike price K_2.
- **Short ATM Call Option**: Sell a call option with a strike price K_2.
- **Long OTM Call Option**: Buy a call option with a strike price K_3.
- **All strikes are equidistant**: K_3 - K_2 = K_2 - K_1 =κ.

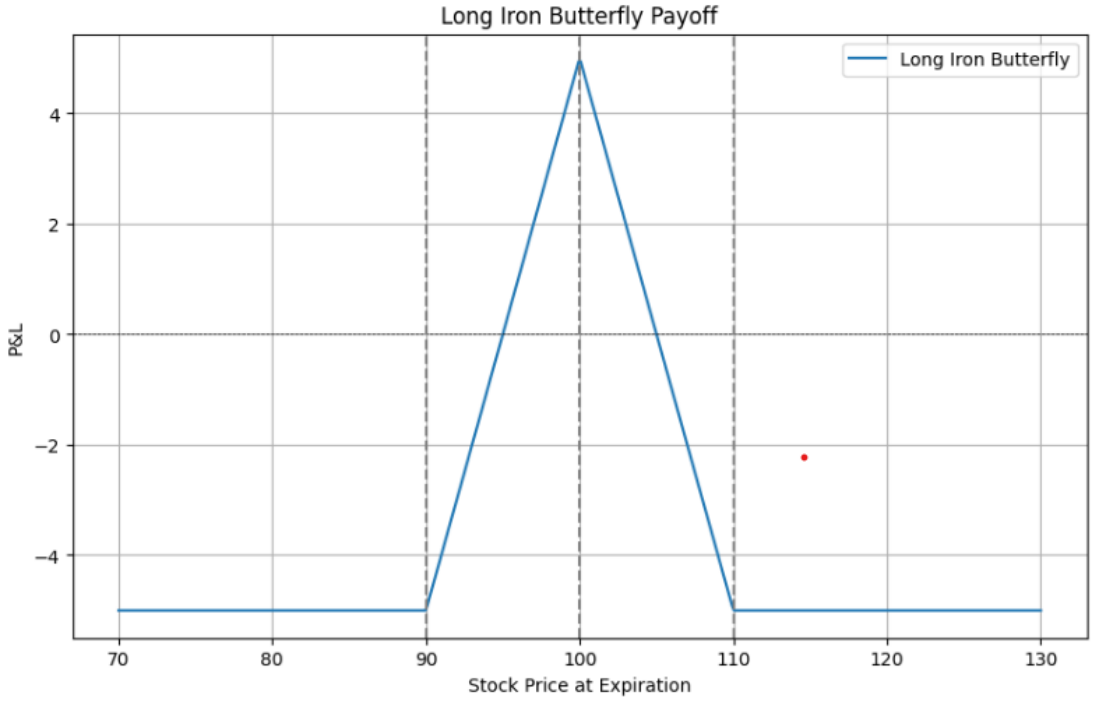
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ - (K_2 - S_T)^+ - (S_T - K_2)^+ + (S_T - K_3)^+ + C \tag{97}$$

$$\textbf{Max Profit} = C \tag{98}$$

$$\textbf{Max Loss} = \kappa - C \tag{99}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (C): 5



1.46 Strategy: Short Iron Butterfly

Key Components

- **Short OTM Put Option**: Sell a put option with a strike price K_1.
- **Long ATM Put Option**: Buy a put option with a strike price K_2.
- **Long ATM Call Option**: Buy a call option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.
- **All strikes are equidistant**: K_3 - K_2 = K_2 - K_1 =κ.

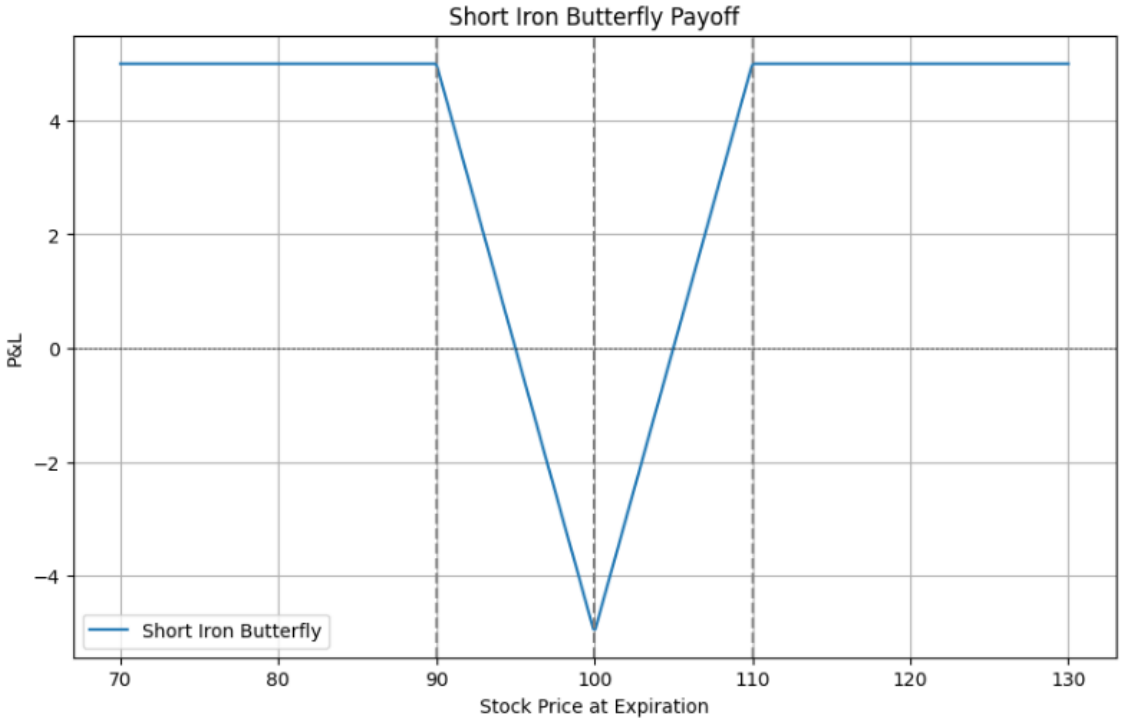
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_2 - S_T)^+ + (S_T - K_2)^+ - (K_1 - S_T)^+ - (S_T - K_3)^+ - D \tag{100}$$

$$\textbf{Max Profit} = \kappa - D \tag{101}$$

$$\textbf{Max Loss} = D \tag{102}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (D): 5



1.47 Strategy: Long Call Condor

Key Components

- **Long ITM Call Option**: Buy a call with a strike price K_1.
- **Short ITM Call Option**: Sell a call option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.
- **Long OTM Call Option**: Buy a call option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

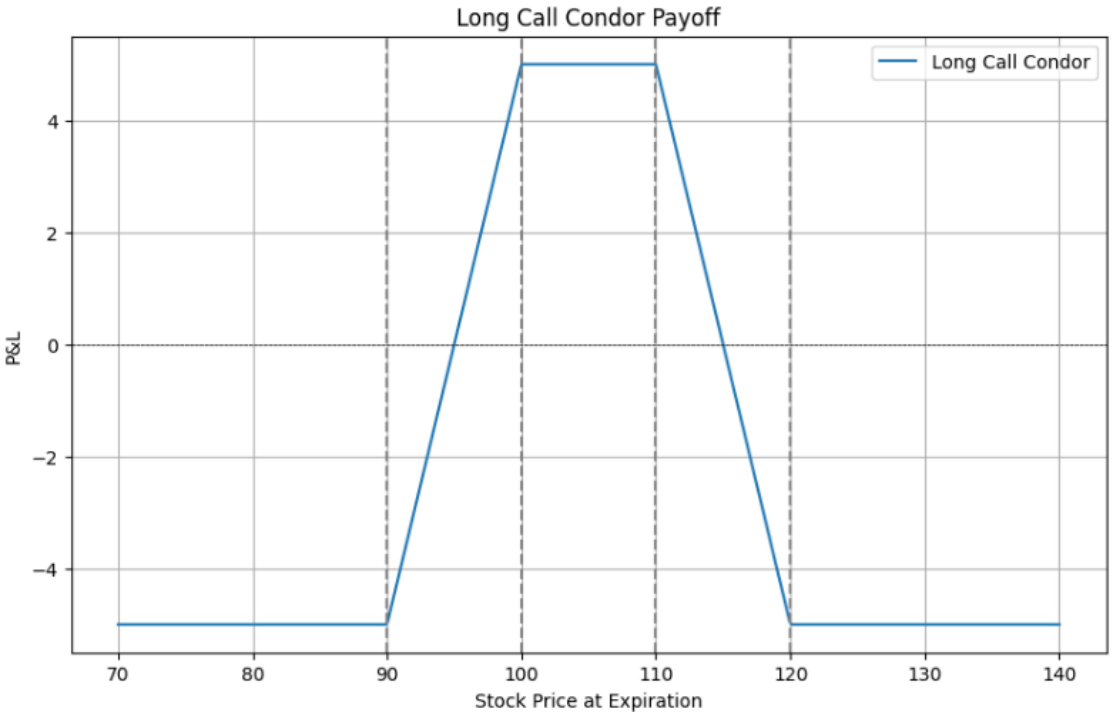
Payoff and P&L

$$\textbf{Payoff at expiration} = (S_T - K_1)^+ - (S_T - K_2)^+ - (S_T - K_1)^+ + (S_T - K_4)^+ - D \tag{103}$$

$$\textbf{Max Profit} = \kappa - D \tag{104}$$

$$\textbf{Max Loss} = D \tag{105}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (D): 5



1.48 Strategy: Short Call Condor

Key Components

- **Short ITM Call Option**: Sell a call with a strike price K_1.
- **Long ITM Call Option**: Buy a call option with a strike price K_2.
- **Long OTM Call Option**: Buy a call option with a strike price K_3.
- **Short OTM Call Option**: Sell a call option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

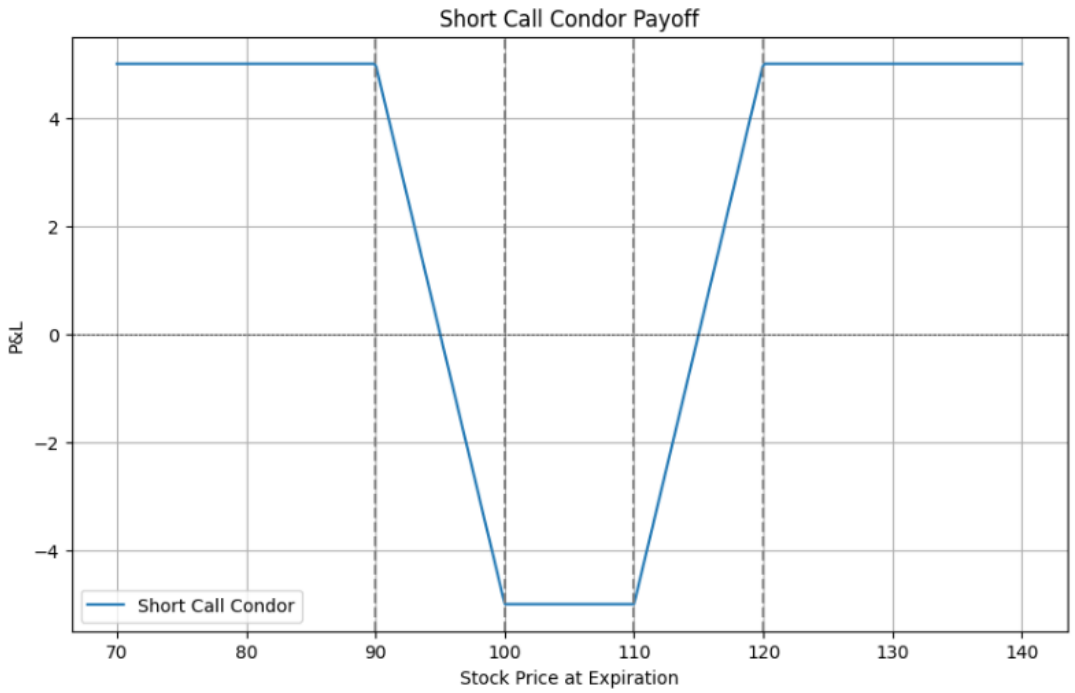
Payoff and P&L

$$\textbf{Payoff at expiration} = (S_T - K_2)^+ + (S_T - K_3)^+ - (S_T - K_1)^+ - (S_T - K_4)^+ + C \tag{106}$$

$$\textbf{Max Profit} = C \tag{107}$$

$$\textbf{Max Loss} = \kappa - C \tag{108}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (C): 5



1.49 Strategy: Long Put Condor

Key Components

- **Long OTM Put Option**: Buy a put with a strike price K_1.
- **Short OTM Put Option**: Sell a put option with a strike price K_2.
- **Short ITM Put Option**: Sell a put option with a strike price K_3.
- **Long ITM Put Option**: Buy a put option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

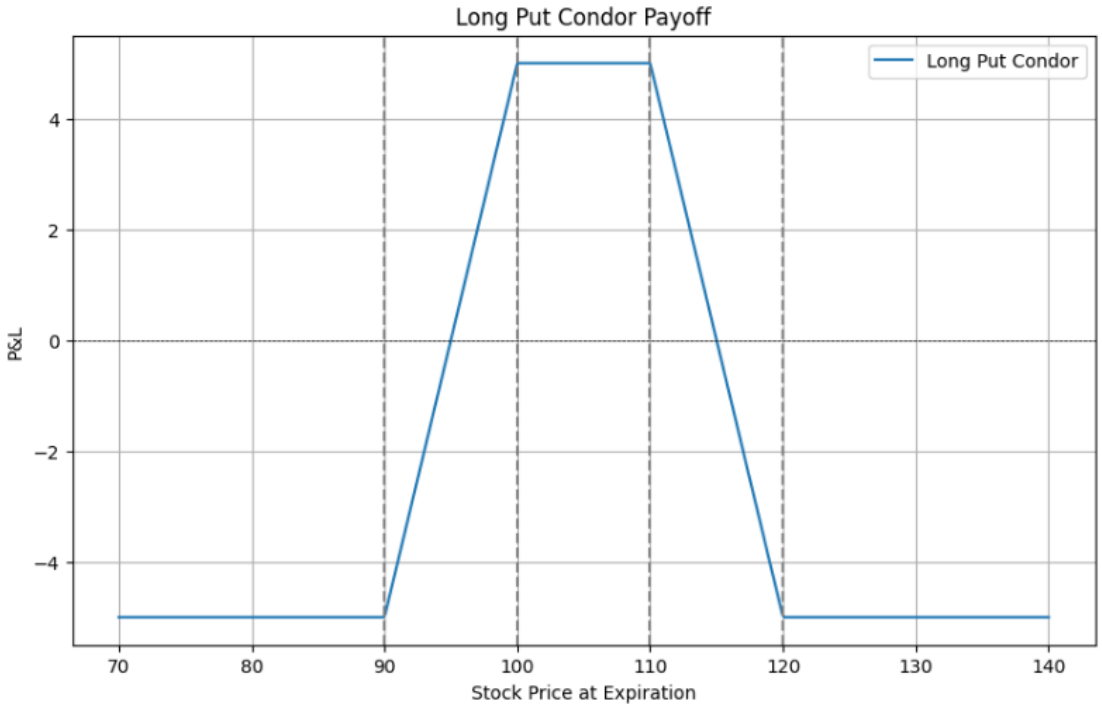
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ - (K_2 - S_T)^+ - (K_3 - S_T)^+ + (K_4 - S_T)^+ - D \tag{109}$$

$$\textbf{Max Profit} = \kappa - D \tag{110}$$

$$\textbf{Max Loss} = D \tag{111}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (D): 5



1.50 Strategy: Short Put Condor

Key Components

- **Short OTM Put Option**: Sell a put with a strike price K_1.
- **Long OTM Put Option**: Buy a put option with a strike price K_2.
- **Long ITM Put Option**: Buy a put option with a strike price K_3.
- **Short ITM Put Option**: Sell a put option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

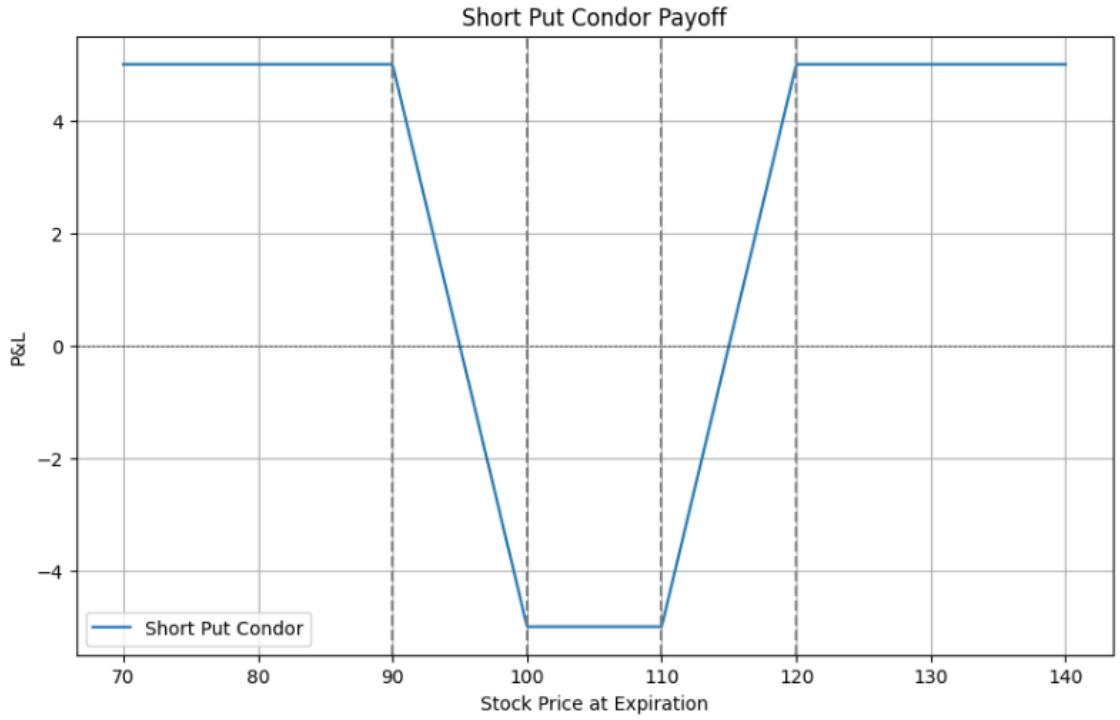
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_2 - S_T)^+ + (K_3 - S_T)^+ - (K_1 - S_T)^+ - (K_4 - S_T)^+ + C \tag{112}$$

$$\textbf{Max Profit} = C \tag{113}$$

$$\textbf{Max Loss} = \kappa - C \tag{114}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (C): 5



1.51 Strategy: Long Iron Condor

Key Components

- **Long OTM Put Option**: Buy a put with a strike price K_1.
- **Short OTM Put Option**: Sell a put option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.
- **Long OTM Call Option**: Buy a call option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

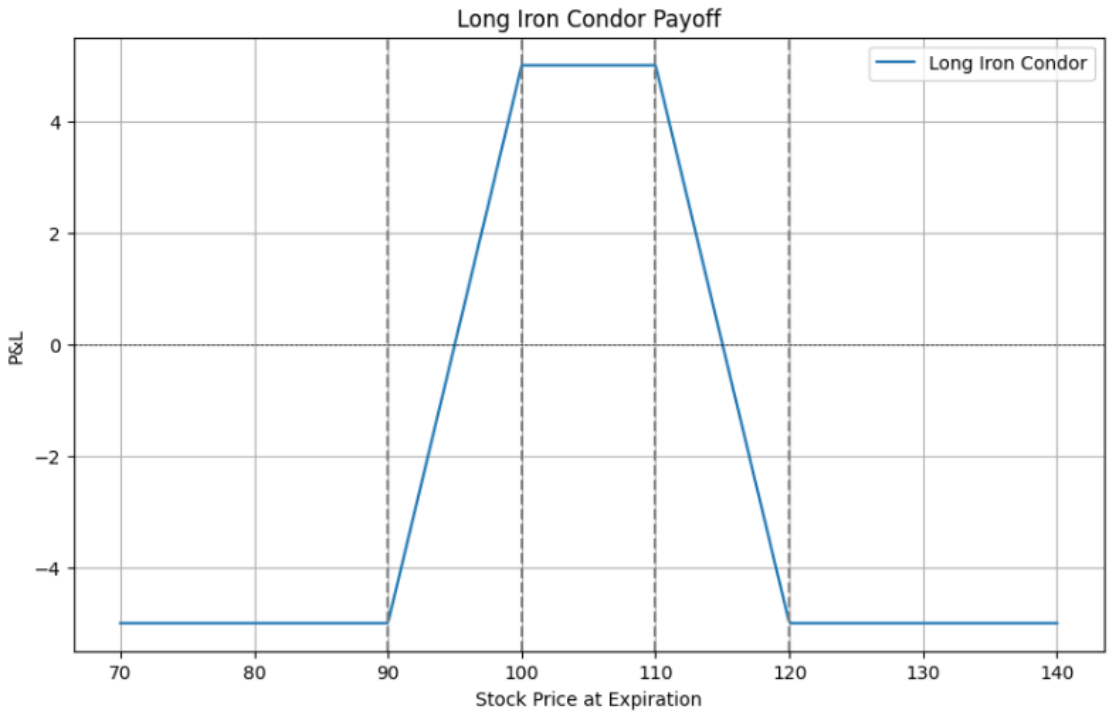
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ + (S_T - K_4)^+ - (K_2 - S_T)^+ - (S_T - K_3)^+ + C \tag{115}$$

$$\textbf{Max Profit} = C \tag{116}$$

$$\textbf{Max Loss} = \kappa - C \tag{117}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (C): 5



1.52 Strategy: Short Iron Condor

Key Components

- **Short OTM Put Option**: Sell a put with a strike price K_1.
- **Long OTM Put Option**: Buy a put option with a strike price K_2.
- **Long OTM Call Option**: Buy a call option with a strike price K_3.
- **Short OTM Call Option**: Sell a call option with a strike price K_4.
- **All strikes are equidistant**: K_4 - K_3 = K_3 - K_2 = K_2 - K_1 =κ.

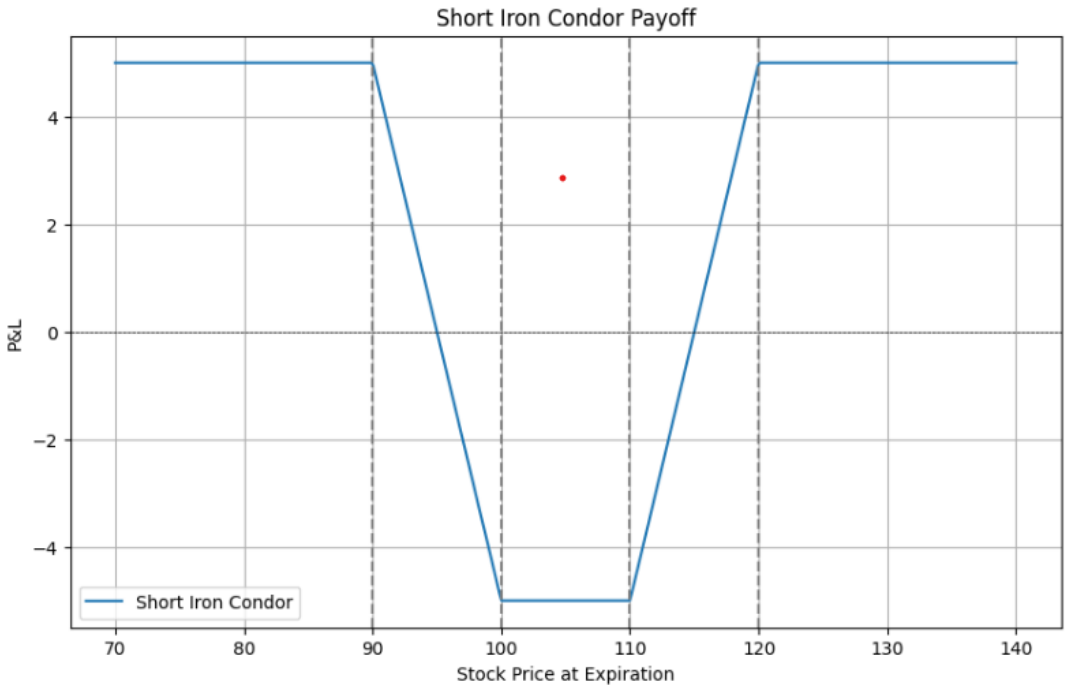
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_2 - S_T)^+ + (S_T - K_3)^+ - (K_1 - S_T)^+ - (S_T - K_4)^+ - D \tag{118}$$

$$\textbf{Max Profit} = \kappa - D \tag{119}$$

$$\textbf{Max Loss} = D \tag{120}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_3): 110
- Strike price 4 (K_4): 120
- Net premium received (D): 5



1.53 Strategy: Long Box

Key Components

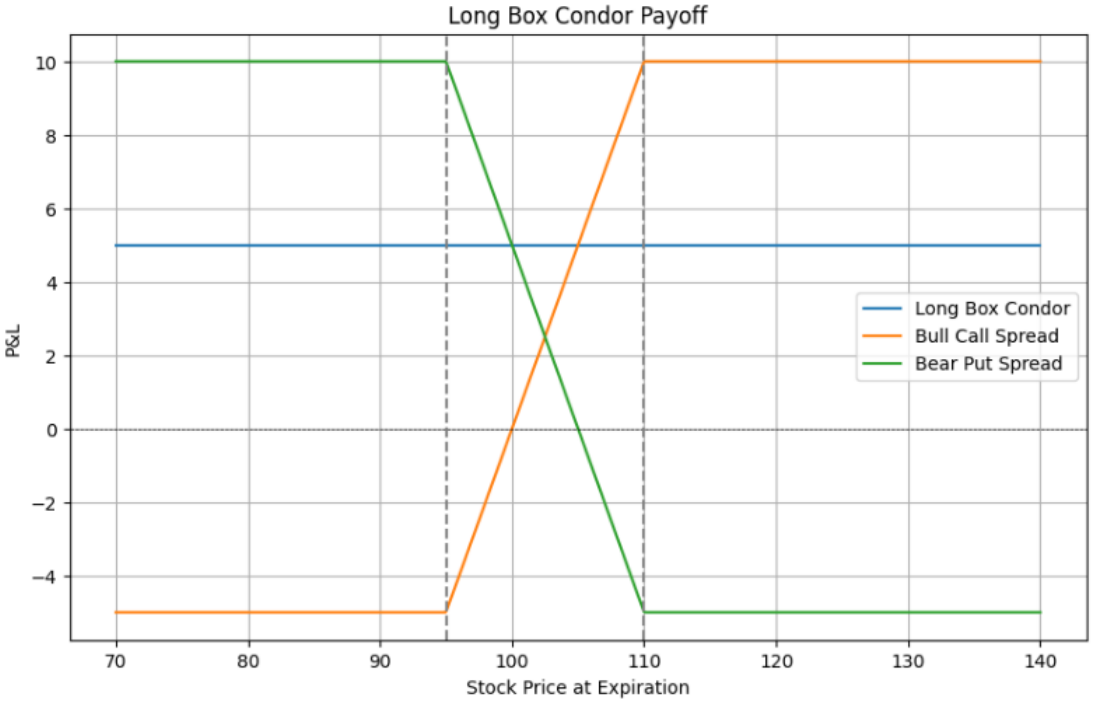
- **Long ITM Put Option**: Buy a put with a strike price K_1.
- **Short OTM Put Option**: Sell a put option with a strike price K_2.
- **Long ITM Call Option**: Buy a call option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_1.
- **Condition**: $(K_2 + \mathrm{D}) \leq K_1$

Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ - (K_2 - S_T)^+ + (S_T - K_2)^+ - (S_T - K_1)^+ - D = K_1 - K_2 - D \quad (121)$$

$$\textbf{Max Profit} = (K_1 - K_2) - D \quad (122)$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 110
- Strike price 2 (K_2): 95
- Net premium received (D): 5



1.54 Strategy: Collar

Key Components

- **Long Stock**: Buy the stock with a price S_0.
- **Long OTM Put Option**: Buy a put option with a strike price K_1.
- **Short OTM Call Option**: Sell a call option with a strike price K_2.
- **Condition**: K_1 ¡ K_2

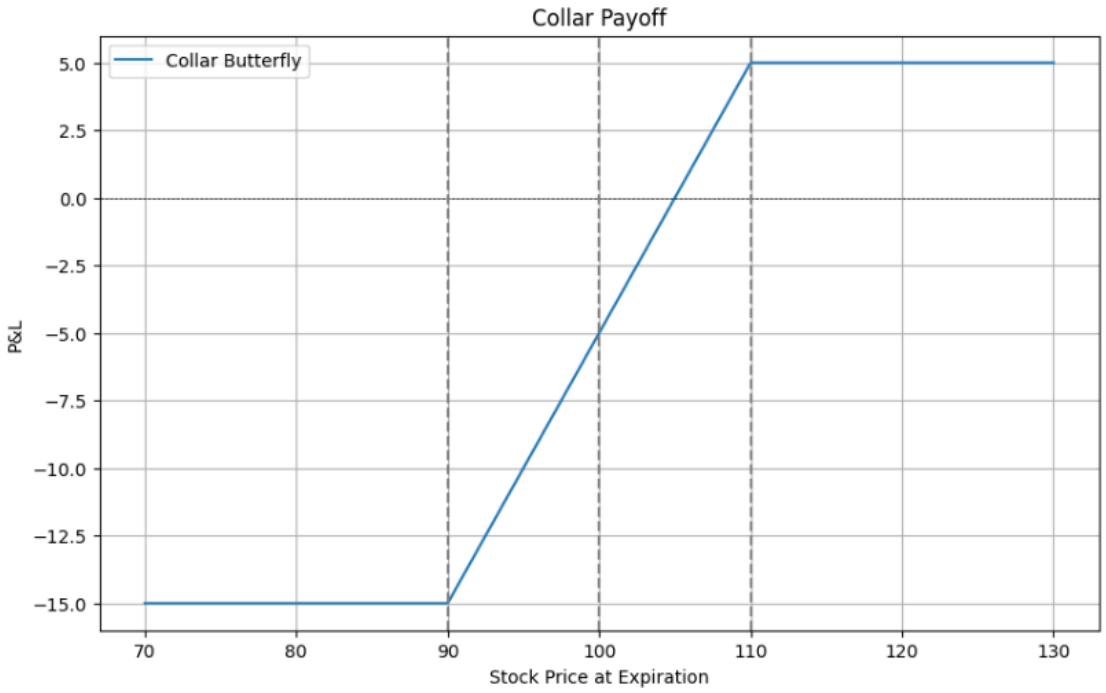
Payoff and P&L

$$\textbf{Payoff at expiration} = S_T - S_0 + (K_1 - S_T)^+ - (S_T - K_2)^+ - H \tag{123}$$

$$\textbf{Max Profit} = K_2 - S_0 - H \tag{124}$$

$$\textbf{Max Loss} = S_0 - K_1 + H \tag{125}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 110
- Net premium received (H): 5



1.55 Strategy: Bullish Short Seagull Spread

Key Components

- **Short OTM Put Option**: Sell a put option with a strike price K_1.
- **Long ATM Call Option**: Buy a call option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.

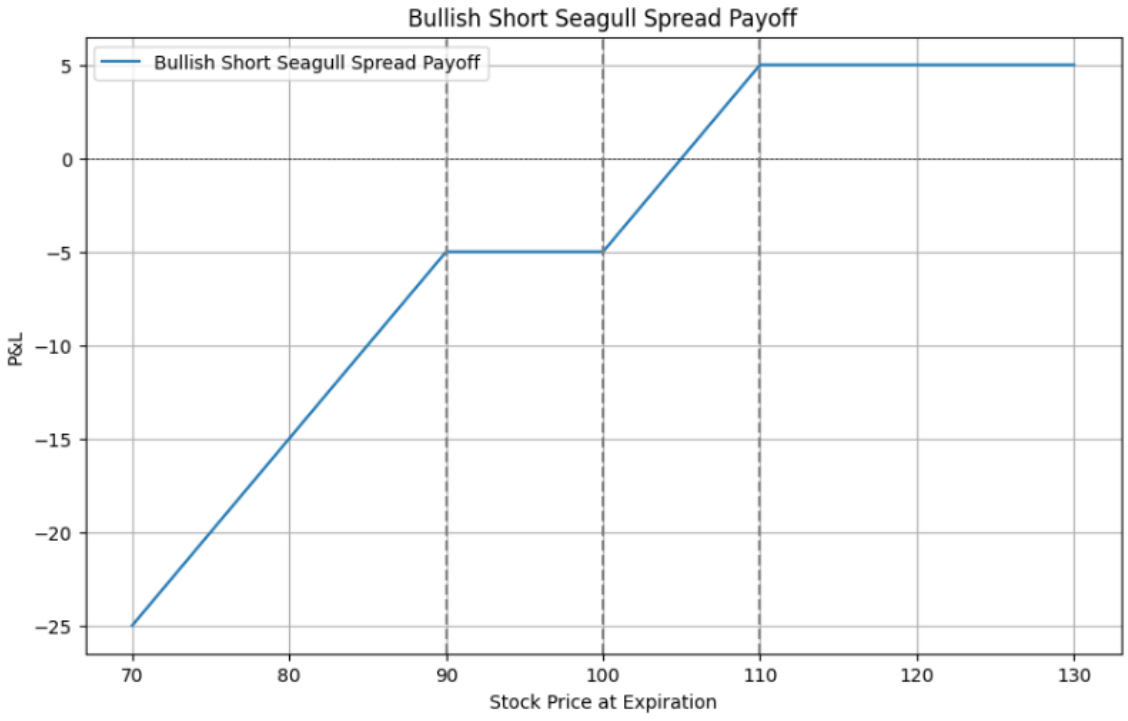
Payoff and P&L

$$\textbf{Payoff at expiration} = -(K_1 - S_T)^+ + (S_T - K_2)^+ - (S_T - K_3)^+ - H \tag{126}$$

$$\textbf{Max Profit} = K_3 - K_2 - H \tag{127}$$

$$\textbf{Max Loss} = K_1 + H \tag{128}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (H): 5



1.56 Strategy: Bullish Long Seagull Spread

Key Components

- **Long OTM Put Option**: Buy a put option with a strike price K_1.
- **Short ATM Put Option**: Sell a put option with a strike price K_2.
- **Long OTM Call Option**: Buy a call option with a strike price K_3.

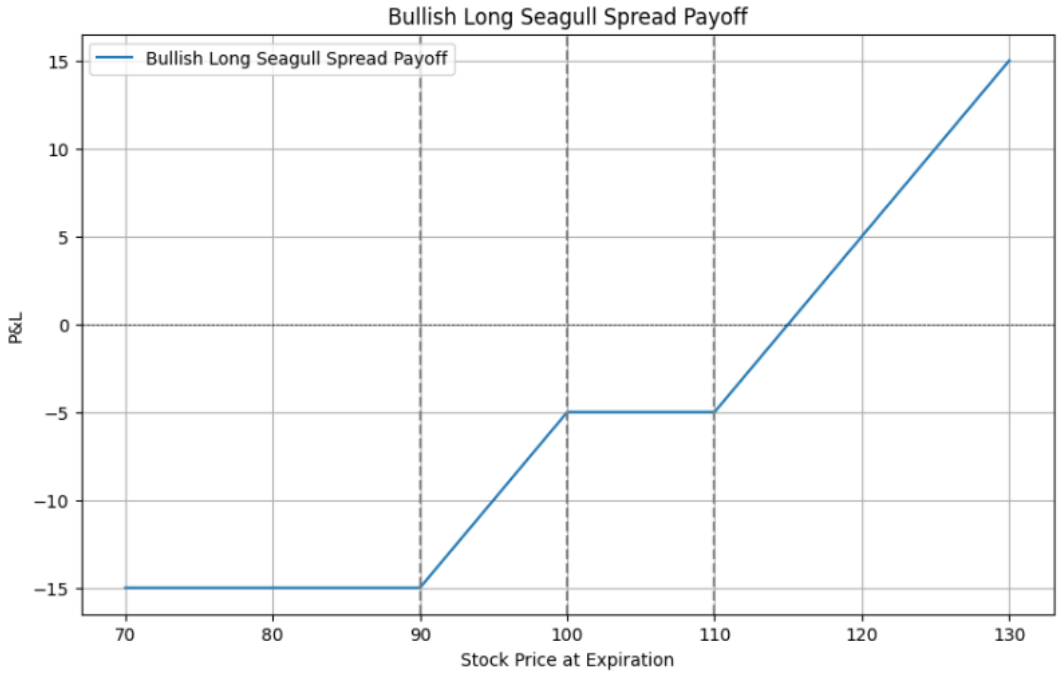
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ - (K_2 - S_T)^+ + (S_T - K_3)^+ - H \tag{129}$$

$$\textbf{Max Profit} = \textit{unlimited} \tag{130}$$

$$\textbf{Max Loss} = K_2 - K_1 + H \tag{131}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (H): 5



1.57 Strategy: Bearish Short Seagull Spread

Key Components

- **Short OTM Put Option**: Sell a put option with a strike price K_1.
- **Long ATM Put Option**: Buy a put option with a strike price K_2.
- **Short OTM Call Option**: Sell a call option with a strike price K_3.

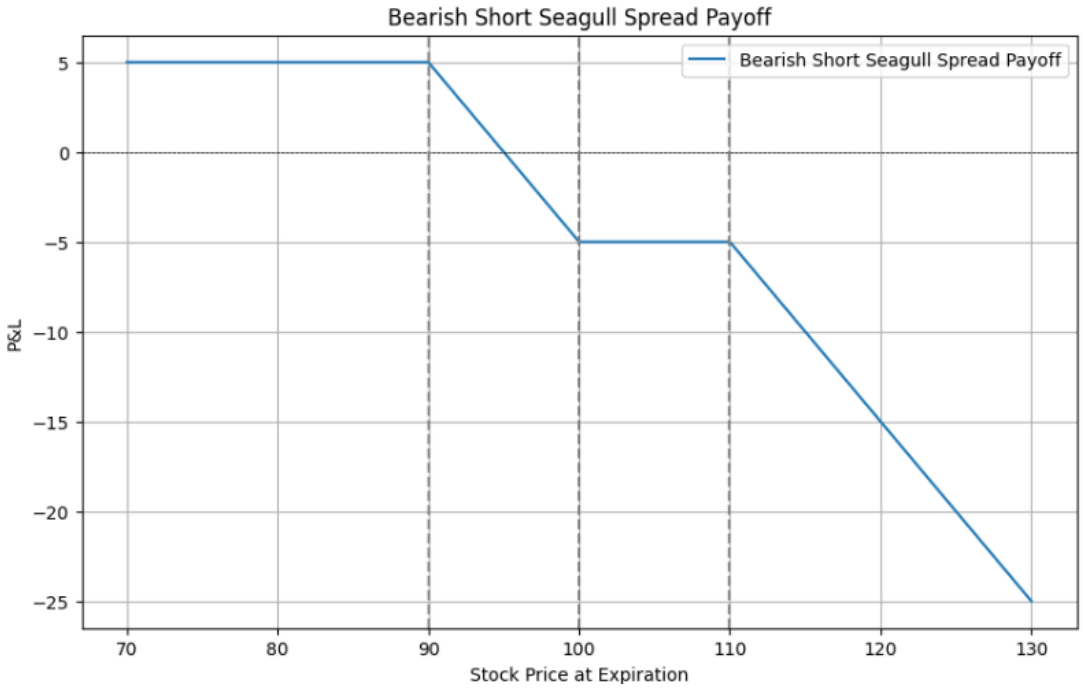
Payoff and P&L

$$\textbf{Payoff at expiration} = -(K_1 - S_T)^+ + (K_2 - S_T)^+ - (S_T - K_3)^+ - H \tag{132}$$

$$\textbf{Max Profit} = K_2 - K_1 - H \tag{133}$$

$$\textbf{Max Loss} = \textit{unlimited} \tag{134}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (H): 5



1.58 Strategy: Bearish Long Seagull Spread

Key Components

- **Long OTM Put Option**: Buy a put option with a strike price K_1.
- **Short ATM Call Option**: Sell a call option with a strike price K_2.
- **Long OTM Call Option**: Buy a call option with a strike price K_3.

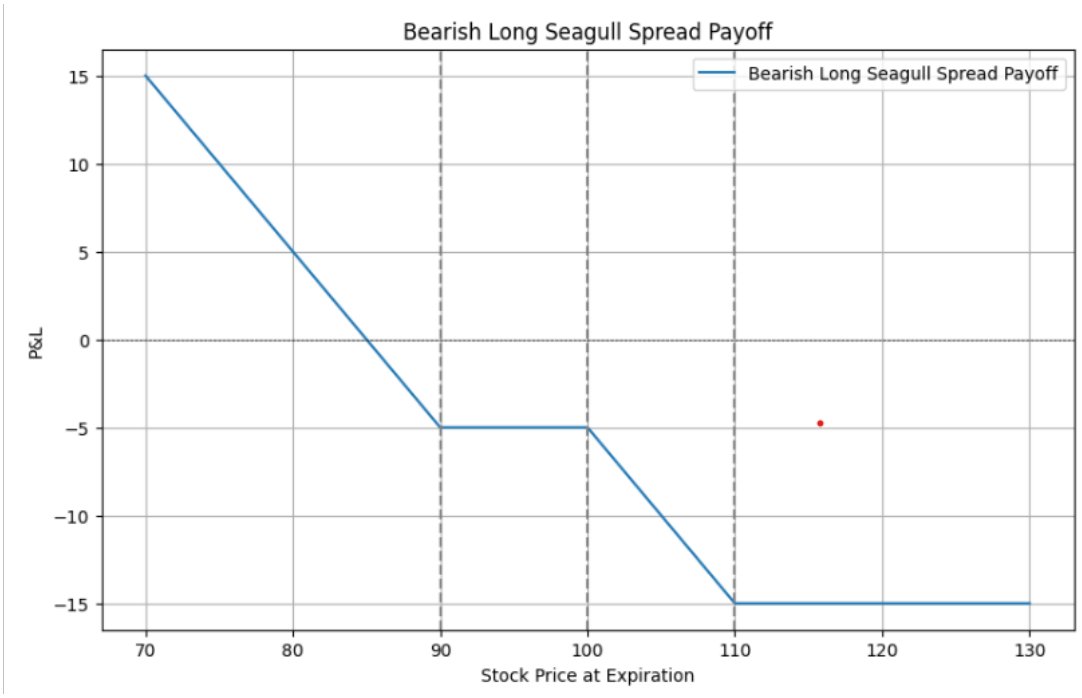
Payoff and P&L

$$\textbf{Payoff at expiration} = (K_1 - S_T)^+ - (S_T - K_2)^+ + (S_T - K_3)^+ - H \tag{135}$$

$$\textbf{Max Profit} = K_1 - H \tag{136}$$

$$\textbf{Max Loss} = K_3 - K_2 + H \tag{137}$$

- Current stock price (S_0): 100
- Strike price 1 (K_1): 90
- Strike price 2 (K_2): 100
- Strike price 3 (K_2): 110
- Net premium received (H): 5



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