Introduction to Derivatives

Business Club

Finance Team

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PREFACE

Derivatives are an important part of trading and it is used frequently to hedge positions by investors, that is investors minimize their risk by using these financial instruments. Many also use them to speculate. A total of 6 billion contracts were traded in 2019 in NSE, making it the world's largest exchange in trading derivatives.

This module deals with introduction of major types of derivatives available for exchange with their payoffs. It also deals with the valuation of certain derivatives and the factor affecting it. A few trading strategies are also discussed and the motive for one to enter in such a contract.

For learning more on these topics, one can refer to Options, Futures and other Derivatives by John C. Hull.

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Introduction

What is a derivative?

It is a financial security which derives its value from the fluctuation of the value or return of the underlying asset or security (another asset or security).

Why do we need derivatives?

- **To minimize risk** - To minimize our losses against the adverse price fluctuation of a financial instrument, we use derivatives where the financial instrument is used as the underlying asset/security. This process is also called hedging.

  For eg. Airlines are largely affected by changes in fuel prices on a day to day basis. Companies generally prefer stable income thus there is a need for a financial instrument which can ensure stable prices regardless of the price fluctuation in the market.

- **To speculate**- Speculators have no interest in the underlying asset but only use derivatives to gain out of day to day market fluctuation.

  For eg. You feel that the value of dollars will depreciate against the euro in a few days so you decide to make profits out of this price fluctuation.

- **To circumvent regulations**- Many institutions like pension funds are not allowed to invest in securities as they are considered risky. Derivatives help in de-risking the securities and making it legal for the pension funds to purchase them.

  For eg. Consider the case of mortgage-backed securities. Pension funds were not allowed to invest money in real estate since it was considered a risky bet. However, investment bankers created de-risked mortgage-backed securities that were backed by agencies like Freddie Mac and Fannie Mae. These securities appeared to be risk-free and hence pension funds could legally trade in them.

- **To minimize trade cost**- Investors all over the world do not like transaction costs. Derivatives provide a great way to avoid and evade them.

  For eg. Consider the case of a company that has taken a fixed-rate loan from a bank. However, now they believe that the interest rates will go down. Hence, they feel like they should take a floating rate loan. However, closing the loan before its due date would attract a prepayment penalty. Also, taking a new loan would generally attract processing charges. Hence to avoid these transaction costs on both sides, a firm can simply structure a swap wherein they can switch over to floating interest rates without bearing any of the above-mentioned transaction charges.

History

Derivatives may have found their way into the media in very recent times. However, they have been used by mankind for a very long time. Since the inception of time, humans have not liked the idea of uncertainty. Moreover, they did not like the idea of economic uncertainty. Hence, the need to offset this uncertainty gave rise to the evolution of contracts. Earlier contracts were verbal agreements and were not as sophisticated as the ones today. However, they were contracts nonetheless.

There have been instances of contracts for farmers dating back to Babylonian times in 1750BC but the first record of an organized market for derivatives trading comes from Osaka and dates back to17th century.

In early Japan, commodities were exchanged on the Dojima Rice Exchange prior to the currency being developed. Workers paid their taxes in rice. Feudal lords ran stores for the rice collected at ports where rice receipts were used to conduct purchases and sales. Receipts also were generated against the upcoming harvest, and these were the first futures contract. They were called empty rice contracts since there was no physical ownership of rice.

In 1848, the first derivatives exchange was created in Chicago, United States. It is the Chicago Board of Trade (CBOT), the oldest organized futures market still operating in the world. However, it merged with the Chicago Mercantile Exchange in 2007 to become the CME Group.
Chicago, thanks to the Midwestern grain and its strategic location, was developing as a major center for the storage, sale, and distribution of grain. A group of merchants formed the CBOT originally as a centralized market place for exchanging grain, but forward contracts so-called “to-arrive” contracts were soon negotiated. It allowed farmers to lock in the price and later deliver the crop.

Types of derivatives

1. Forwards
2. Futures
3. Swaps
4. Credit Derivatives
5. Options
6. Interest Rate Derivatives

Forwards

In a forward contract, one party agrees to buy and the counterparty agrees to sell a physical or financial asset at a specific price on a specific date in the future.

Forward contracts can be used to lock into a specific price to avoid volatility in pricing. The party who buys a forward contract is entering into a long position, and the party selling a forward contract enters into a short position. If the price of the underlying asset increases, the long position benefits. If the underlying asset price decreases, the short position benefits.

Forward contracts have four main components to consider. The following are the four components:

- Asset Class: This is the underlying asset that will be specified in the contract.
- Expiration Date: The contract will need an end date when the agreement is settled and the asset is delivered.
- Quantity: This is the size of the contract, and will give the specific amount in units of the asset being bought and sold.
- Price: The price that will be paid at the expiration date must also be specified. This will also include the currency that will be used.

Forwards are not traded on centralized exchanges and are instead customized contracts that are created between the two parties. At the expiration date, the contract must be settled. One party will deliver the underlying asset, while the other party will pay the agreed-upon price and take possession of the asset. Forwards can also be cash-settled at the date of expiration rather than delivering the physical underlying asset. This means that one party pays cash to the other when the contract expires based on the difference between the forward price and the market price of an underlying asset at the settlement date.

There are two kinds of forward-contract participants: hedgers and speculators. Hedgers do not usually seek a profit but rather seek to stabilize the revenues or costs of their business operations. Their gains or losses are usually offset to some degree by a corresponding loss or gain in the market for the underlying asset. Speculators are usually not interested in taking possession of the underlying assets. They essentially place bets on which way prices will go. Forward contracts tend to attract more hedgers rather than speculators.

Futures

A futures contract is a forward contract that is standardized and exchange-traded. The primary way in which forwards and futures differ is that futures are traded in an active secondary market, subject to greater regulation, backed by a clearinghouse and require a daily cash settlement of gains and losses.

For example, if someone buys a July crude oil futures contract (CL), they are entering into a contract which forces them to buy 1,000 barrels of oil from the seller at a predetermined price (mentioned in the futures contract) on the expiry date. The seller is agreeing to sell the buyer the 1,000 barrels of oil at the agreed-upon price.

Similarities between Forwards and Futures:

- They can be either deliverable or cash-settled contracts.

Differences between Forwards and Futures

- Futures contracts trade on organized exchanges whereas forwards are private contracts and typically do not trade.
- A clearing house is the counterparty to all futures contracts. Forwards have counterparty (credit) risks.
- The expiry date for a futures contract is standardized whereas for a forwards contract it depends on the transaction
- The government regulates the futures market. Forwards contracts are usually unregulated.
- Forwards contracts are traded on the primary market whereas futures are traded on both the primary and secondary markets.
- Futures are standardised whereas forwards are not.

What do you mean by Standardization?

Future contracts specify the quality and quantity of goods to be delivered, the delivery time or the expiration date and the manner of delivery. It also tells the maximum price fluctuation which is also called the tick size. Contracts also specify the daily price limit that is the maximum price movement allowed in one day. It also specifies the trading time periods for the contract.

Mechanics of Future Markets

Every future is with clearinghouse, so to safeguard the clearinghouse, exchange requires traders to post margins and settle their account on a daily basis.

Initial Margin- It is the amount the trader deposits in a futures account before trading. It is equal to the maximum price movement of the underlying asset in a single day over the whole contract. It is set for each type of the underlying asset.

Maintenance Margin- It is the amount which must be maintained in a futures account. If the account balance is below the maintenance margin then the trader has to deposit until the total margin is equal to the initial margin. Maintenance margin is also set before.

Variation Margin- The amount that is deposited in the futures account to bring is back to the initial margin.

Settlement price- It is the closing price of the underlying asset. It is used to calculate the margins for the next day.

Marking-to-market - It is the process of adjusting the margin balance in a futures account each day for the change in the value of the underlying assets from the previous trading day, based on the new settlement price.

For Example: You bought a future for 5000 stocks of ABC at the contract price of $2.00. The daily price limit is $0.03. The contract requires the initial margin deposit of $150 and a maintenance margin of $100. On Day 1 the price falls by 1 cent, on Day 2 it falls by 1 cent again, and on Day 3 it increases 1 cent.

Day	Required Deposit	Price of Stock ABC	Gain/ Loss	Balance in Futures Account
0 (Purchase)	$150	$2.00	0	$150
1	0	$1.99	-$50	$100
2	0	$1.98	-$50	$50
3	$100	$1.99	+$50	$200

At the end of Day 1 the balance is not less than the maintenance margin ($100), so no need to deposit anymore. But at the end of Day 2 the balance goes to $50, thus you add $100 to bring it up to $150.

Swaps

- An interest rate swap is an agreement between two parties to exchange interest payments based on a specified principal over a period of time. In a plain vanilla interest rate swap, one of the interest rates is floating, and the other is fixed.

  Example for interest rate swap: Suppose two companies A and B enter in one year interest rate swap with a nominal value of $1 million. Company A offers B a fixed annual rate of 5% in exchange for the rate of the LIBOR. Suppose at the end of one year LIBOR is trading at 4.75% then company A pays $2500 to company B.

- For valuation purposes, swaps can be thought of as a long and short position in two different bonds or as a package of forward rate agreements.

- A currency swap exchanges both principal and interest rate payments with payments in different currencies. The exchange rate used in currency swaps is predetermined. Usually one rate is fixed and the other is floating. The valuation and application of currency swaps are similar to the interest rate swap.

  Swaps can be considered similar to forwards in the following ways:

  - Swaps typically require no payment by either party at the initiation.
  - Swaps are not traded in any organized secondary market.
  - Default risk is an important aspect of the contracts.

  Uses of Swaps:

  - To hedge against adverse movements
  - As an asset-liability management tool

  Example of currency swaps: Suppose we have two companies, A and B, that enter into a fixed-for-fixed currency swap with periodic payments annually. Company A pays 6% in Great Britain pounds (GBP) to Company B and receives 5% in U.S. dollars (USD) from Company B. Company A pays a principal amount to B of USD 175 million, and B pays GBP 100 million to A at the outset of the swap. Notice that A has effectively borrowed GBP from B and so it must pay interest on that loan. Similarly, B has borrowed USD from A. Every period (12 months), A will pay GBP 6 million to B, and B will pay USD 8.75 million to A. At the expiration of the swap, the principal amounts are re-exchanged.

Role of Institutions in Swaps

A swap bank is an institution that acts as a broker between two counterparties who wish to enter into an interest rate or currency swap agreement and possibly remain anonymous. The swap bank brings together both sides of the deal and typically earns a slight premium from both counterparties for facilitating the swap. This reduces the risk as institutions act as an intermediate.

Credit Derivatives

A credit derivative is a financial instrument that allows parties to handle their exposure to risk. Credit derivative consists of a privately held bilateral contract between two parties in a creditor/debtor relationship. It allows the creditor to transfer the risk of the debtor's default to a third party.

Mainly two types of credit derivatives exist, including

- Credit default swaps (CDS)
- Collateralized debt obligations (CDO)

Credit Default Swap (CDS)

A credit default swap (CDS) is a financial derivative or contract that allows an investor to "swap" or offset his or her credit risk with that of another investor. For example, if a lender is worried that a borrower is going to default on a loan, the lender could use a CDS to offset or swap that risk. To swap the risk of default, the lender buys a CDS from another investor (CDS seller) who agrees to reimburse the lender in the case the borrower defaults. For this, the lender pays a premium to the CDS seller.

Collateral Debt Obligation (CDO)

- CDOs, or collateralized debt obligations, are financial tools that banks use to repackage individual loans into a product sold to investors on the secondary market. These packages consist of auto loans, credit card debt, mortgages or corporate debt. They are called collateralized because the promised repayments of the loans are the collateral that gives the CDOs their value.
- Reasons, why banks used CDOs, were:
    1. It removed the loan’s default risk from the bank and moved it to the investor.
    2. It gave them more funds.
- CDOs were a major cause of the financial crisis of 2008 because:
    1. The banks that sold the CDOs didn't worry about people defaulting on their debt. They had sold the loans to other investors, who now owned them. That made them less disciplined in adhering to strict lending standards. Banks gave loans to borrowers who weren't credit-worthy.

2. The computer models based the CDOs' value on the assumption that housing prices would continue to go up which created a bubble
3. This opaqueness and the complexity of CDOs created a market panic in 2007. Banks realized they couldn't price the product or the assets they were still holding.
4. The first CDOs to go south were the mortgage-backed securities. When housing prices started to drop in 2006, the mortgages of homes bought in 2005 were soon upside-down.

Options

Options is a derivative that derives its value from the market fluctuations.

Vanilla Options:

Vanilla stock options give the owner the right, but not the obligation, to buy or sell a stock at a specific price on or before a specific date. Call options give the owner the right to buy the stock, and put options give the owner the right to sell the stock. An option is exercised when the owner executes the right to buy or sell the stock. The price at which the option can be exercised at the time of maturity is called the strike price

a) Call option

A call option gives the owner the right, but not the obligation, to buy the stock from the seller of the option. The owner is also called the buyer or the holder of the long position. The buyer benefits, at the expense of the option seller, if the underlying stock price is greater than the exercise price. The option seller is also called the writer or holder of the short position.

- Payoff and mechanics of long call option:

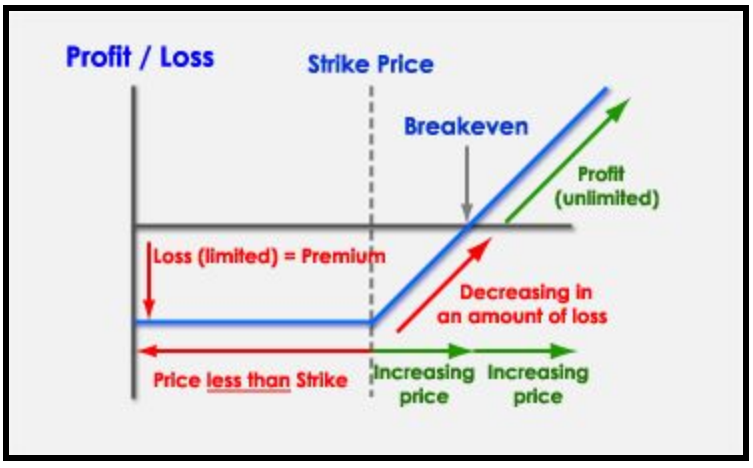


Fig. 1 Payoff graph of Long Call option

Clearly from the graph, At the time of maturity if the price of the asset is less than the strike price the buyer won't exercise the option hence would incur a loss equal to the premium paid. If the price of the asset is more than the strike price, the option would be exercised and the buyer will have

Payoff = Max(0 , S - X) - C

C = price of the call option also called premium

S = spot price or the current market value of the underlying asset

X = strike price of the underlying asset

- Payoff and mechanics of short call option:

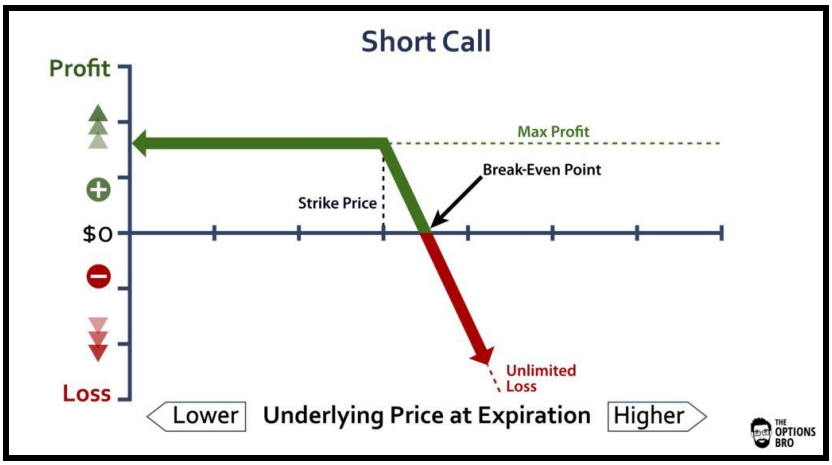


Fig. 2 Payoff graph of Short Call option

At the time of maturity if the price of the asset is less than the Strike Price then the buyer won't exercise the option and the option seller will gain a profit equal to the option premium. If the price of the asset becomes more than the strike price the seller will incur a loss equal to

Payoff = C - Max(0 , S - X)

C = price of the call option also called premium

S = spot price or the current market value of the underlying asset

X = strike price of the underlying asset

b) Put option

A put option gives the owner the right, but not the obligation, to sell the stock to the writer of the option. The owner is also called the seller or the holder of the long position. The owner benefits at the expense of the option writer if the underlying stock price goes lower than the exercise price. The option seller is also called the writer or holder of the short position.

- Payoff and mechanics of long Put option:

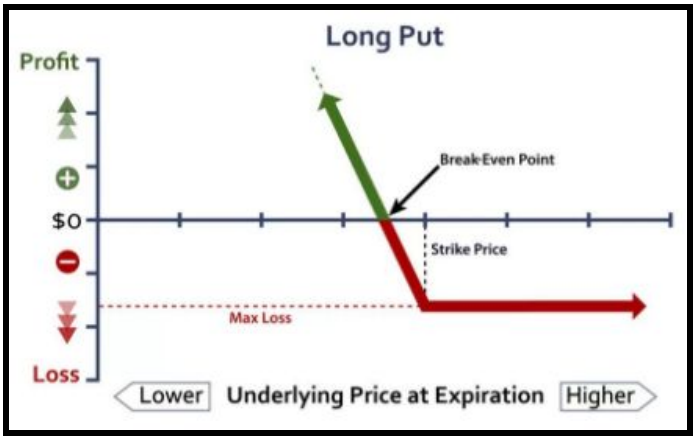


Fig. 1 Payoff graph of Long Put option

Clearly from the graph, At the time of maturity if the price of the asset is more than the strike price the seller of the asset won't exercise the option hence would incur a loss equal to the premium paid. If the price of the asset is less than the strike price, the option would be exercised and the asset seller will have

Payoff = Max(0 , X - S) - P

P = price of the put option also called premium

S = spot price or the current market value of the underlying asset

X = strike price of the underlying asset

- Payoff and mechanics of short Put option:

Fig. 2 Payoff graph of Short Put option

At the time of maturity, if the price of the asset is more than the Strike Price then the seller of the asset won't exercise the option and the person in short position will gain a profit equal to the option premium. If the price of the asset becomes less than the strike price the option seller will incur a

Payoff = P - Max(0 , X - S)

P = price of the put option also called premium

S = spot price or the current market value of the underlying asset

X = strike price of the underlying asset

Put-Call Parity

Put Call parity states that simultaneously holding a short put and a long call option of the same class will give the same returns. If the prices of the put and call options differ, an arbitrage opportunity exists.

The equation expressing put-call parity is:

$$\mathbf{C + PV(X) = P + S}$$

where:

C = price of the European call option

PV(X) = the present value of the strike price (x), discounted from the value on the expiration date at the risk-free rate.

P = price of the European put

S = spot price or the current market value of the underlying asset

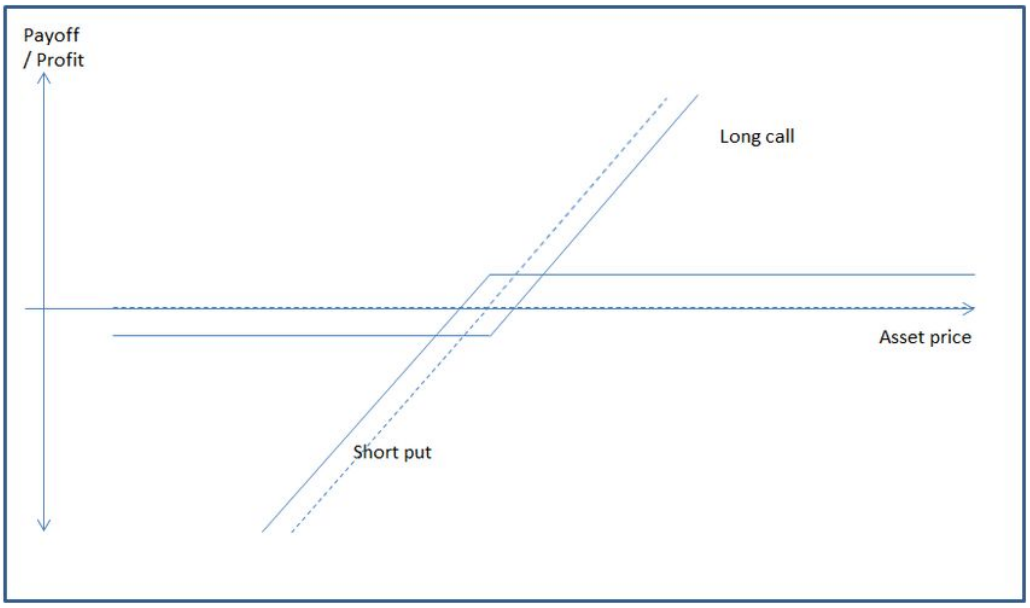


Fig. Graph showing put call parity

No-Arbitrage principle:

Given a set of prices, there is no investment strategy that produces a certain return with net investment of zero (or that produces an infinite return from a finite investment).

It is very important to note that arbitrage might be possible with one set of prices but not possible with another set of prices. The definition of the "no-arbitrage" principle is contingent upon a given set of asset prices – one for each asset. A market that is in equilibrium automatically satisfies the no-arbitration principle, but a market may be in disequilibrium and nevertheless satisfy the no-arbitrage principle.

Clearly, if markets are in equilibrium, the no-arbitrage principle must be satisfied. Otherwise participants will attempt to take advantage of the available arbitrage opportunities until eventually the market comes to equilibrium

Using the no arbitrage principle we can also replicate portfolios. Dynamic replication is fundamental to the Black Scholes model, which assumes that derivatives can be replicated by portfolios of other securities, and thus their prices determined. An example of this, is the put call parity

Different types of Exotic Options-

1. Binary Options

- Binary options generate discontinuous payoff profiles because they pay only one price at expiration if the asset value is above the strike price. The term binary means that the option payoff has one of two states: the option pays a set dollar amount at expiration if the option is above the strike price, or the option pays nothing if the price is below the strike price. Hence, a payoff discontinuity results from the fact that the payoff is only one value— it does not increase continuously with the price of the underlying asset as in the case of a traditional vanilla option.
- A binary option may be as simple as whether the share price of ABC will be above $25 on April 22, 2019, at 10:45 a.m. The trader makes a decision, either yes (it will be higher) or no (it will be lower). Let's say the trader thinks the price will be trading above $25, on that date and time, and is willing to bet $100 on it. If ABC shares trade above $25 at that date and time, the trader receives a payout per the terms agreed. For example, if the payout was 70%, the binary broker credits the trader's account with $70. If the price trades below $25 at that date and time, the trader was wrong and loses their $100 investment in the trade.

2. American Options-

An American option is a version of an options contract that allows holders to exercise the option rights at any time before and including the day of expiration.

3. European Options-

A European option is a version of an options contract that limits execution to its expiration date.

4. Asian Options-

An Asian option is an option type where the payoff depends on the average price of the underlying asset over a certain period of time.

5. Bermuda Options-

A Bermuda option is an options contract that can only be exercised on predetermined dates, often on one day each month. Bermuda options allow investors to buy or sell a security or underlying asset at a preset price on specific dates as well as the option's expiration date.

Factors Affecting Value of Options

1. Price of the underlying asset-
    - The price of the underlying asset has a +ve correlation with the value of the call option.
    - The price of the underlying asset has a -ve correlation with the value of the put option.
2. Exercise price-
    - The exercise price has a -ve correlation with the value of the call option.
    - The exercise price has a +ve correlation with the value of the put option.
3. Risk-free rate-
    - The risk-free rate has a +ve correlation with the value of the call option.
    - The risk-free rate has a -ve correlation with the value of the put option.
4. The volatility of underlying asset-
    - The volatility of the underlying asset has a +ve correlation with the value of the call option.
    - The volatility of the underlying asset has a +ve correlation with the value of the put option.
5. Time to expiration-
    - Time to expiration has a +ve correlation with the value of the call option.
    - Time to expiration has a +ve correlation with the value of the put option.
6. Costs of holding underlying asset-
    - Costs of holding the underlying asset have a +ve correlation with the value of the call option.
    - Costs of holding the underlying asset have a -ve correlation with the value of the put option.

7. Benefits of holding underlying asset-

- The benefits of holding underlying assets has a -ve correlation with the value of the call option.
- The benefits of holding underlying assets has a +ve correlation with the value of the put option.

Valuing Options (Black Scholes Model)

1. Black-Scholes is a pricing model used to determine the fair price or theoretical value for a call or a put option based on six variables such as volatility, type of option, underlying stock price, time, strike price, and the risk-free rate.

2. Black Scholes model uses a few assumptions:
    a) The model is used to determine the price of a European call option, which simply means that the option can only be exercised on the expiration date.

    b) There are no transaction costs in buying the option.

    c) Markets are efficient (i.e., market movements cannot be predicted).

3. The mathematical formula for the price of a Call Option is given by

$$
\begin{aligned}
C(S_t, t) &= N(d_1)S_t - N(d_2)PV(K) \\
d_1 &= \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)\right] \\
d_2 &= d_1 - \sigma\sqrt{T-t} \\
PV(K) &= Ke^{-r(T-t)}
\end{aligned}
$$

Where

N( ) = represents the cumulative distribution function for a normal (Gaussian) distribution and may be thought of as 'the probability that a random variable is less or equal to its input (i.e. d_1 and d_2) for a normal distribution.

S = price of security

T = date of expiration

t = current date

K = exercise price

r = risk-free interest rate

σ = volatility (standard deviation of the underlying asset)

Similarly, for a put option, it is given by:

$$P_E(S,t) = N(-d_2)Xe^{-r(T-t)} - SN(-d_1)$$

DERIVATION:

The value of a European call option on a non dividend paying stock could depend upon a number of factors; the current price of the stock S, the exercise price X, the time until expiration t, the risk-free interest rate r, the volatility of the stock price q, and the expected rate of return on the stock μ. Let C be the price of the call option. The functional dependence can then be expressed as:

C = C(S, X, t, r, q, μ).

The change in stock price dS is assumed to be given by:

dS = μSdt + qSdz

By Ito's Lemma

dC = [(∂C/∂t) + (∂C/∂S) μS + (1/2)(∂^{2}C/∂S^2)q^{2}S^2]dt + (∂C/∂S)qSdz.

Now consider a portfolio containing one written call (whose value is -C) and h shares of the underlying stock. The value V of this portfolio is given as:

V = hS - C

The change in value is then:

dV = hdS - dC

If h is equal to ∂C/∂S then

dV = (∂C/∂S)dS -dC.

This means that the change in the value of the portfolio dV over the interval dt is:

dV = (∂C/∂S)(μSdt + qSdz) - [(∂C/S)μS + (∂C/∂t) + (1/2)(∂^{2}C/∂S^2)q^{2}S^2]dt - (∂C/∂S)qSdz.

When terms are combined we find that those involving dz cancel out. Also the terms involving μ cancel out leaving:

dV = [-(∂C/∂t) - (1/2)(∂^{2}C/∂S^2) q^{2}S^2]dt.

Thus V is independent of the random variable dz; i.e., is a risk free portfolio. Also the value of dV is independent of the expected rate of return μ (which is also the expected rate of growth of stock price S).

Since the value of the portfolio is independent of the random variable it should increase in value at the same rate as the risk free interest rate; i.e.,

$$\mathbf{dV = rVdt = r[(\partial C/\partial S)S - C]dt}$$

For this to hold for all dt requires that:

$$\mathbf{(\partial C/\partial t) + (1/2)(\partial^2 C/\partial S^2)q^2S^2 = - r(\partial C/\partial S)S + rC,}$$

Or

$$\mathbf{(\partial C/\partial t) + (\partial C/\partial S)rS + (1/2)(\partial^2 C/\partial S^2)q^2S^2 = rC.}$$

This is the Black-Scholes differential equation for call option value. The solution of the above equation for C = max(S-X,0) on expiration day gives the Black-Scholes formula for call option value.

Trading Strategies in Options

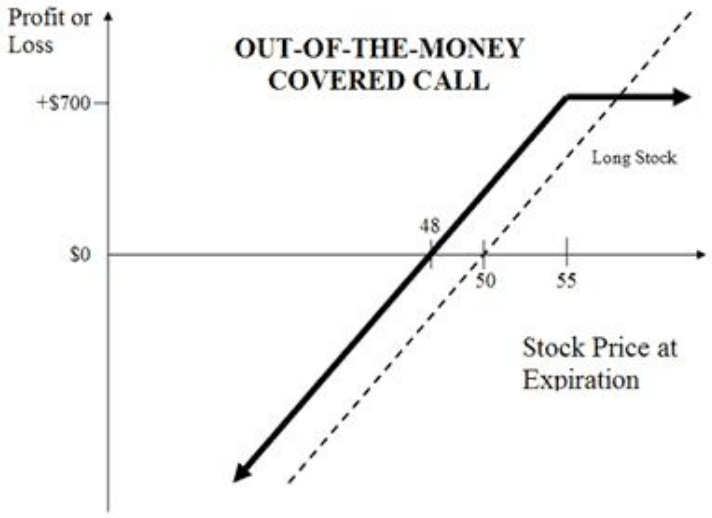
1. Covered call

A covered call is a popular options strategy used to generate income in the form of options premiums. To execute a covered call, an investor holding a long position in an asset then writes (sells) call options on that same asset.

It is often employed by those who intend to hold the underlying stock for a long time but do not expect an appreciable price increase in the near term.

This strategy is ideal for an investor who believes the underlying price will not move much over the near-term.

For example: You bought 100 stocks at $50, the premium on the call option is $2 and the strike price is $55. If you feel the price of the stock will land up to be less than $50 giving you a loss but by selling a call option on those stocks you can reduce the loss by $2.



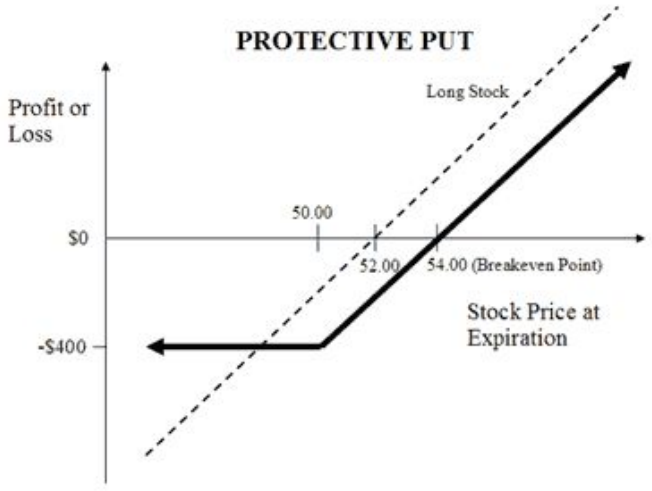
2. Protective put

A **protective put** is a risk management and options strategy that involves holding a long position in the underlying asset (e.g., stock) and purchasing a **put** option with a strike price. An option is a contract with the right to exercise the contract at a specific price, which is known as the strike price.

The main goal of a protective put is to limit potential losses that may result from an unexpected price drop of the underlying asset.

Adopting such a strategy does not put an absolute limit on potential profits of the investor. Profits from the strategy are determined by the growth potential of the underlying asset. However, a portion of the profits is reduced by the premium paid for the put.

For example: You bought 100 stocks at $52, the premium on the put option is $2 and the strike price is $50. If you feel the price of the stock will land up to be less than $50 giving you a loss but by buying a put option on those stocks you can set a lower limit for your loss thus decreasing your risk.



3. Bull spread

a) Bull call spread

We use this strategy when we feel that the market price of the stock is going to be high in the future.

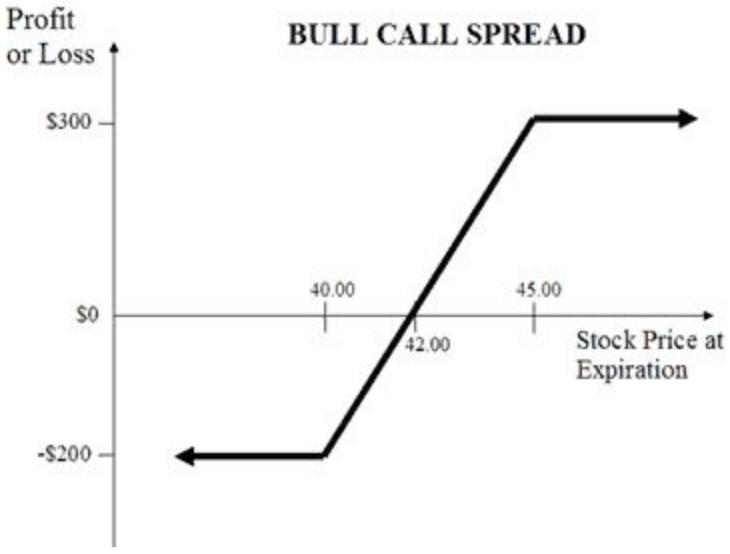
We buy two call options with the same expiry date and different strike prices. You buy the call option with a lower strike price and sell the call option with a higher strike price. In this way, you not only put a cap on your losses but also limit your gains.

Max Profit = Strike Price of Short Call - Strike Price of Long Call - Net Premium Paid

Max Loss = Net Premium Paid

Break-Even Point = Strike Price of Long Call + Net Premium Paid

For example: you buy the call option for 100 shares for $3 per share and a strike price of $40 and sell a call option for 100 shares for $1 per share and a strike price of $45. And the current price of the share is $42.



b) Bull put spread

We use this strategy when we feel that the market price of the stock is going to be high in the future.

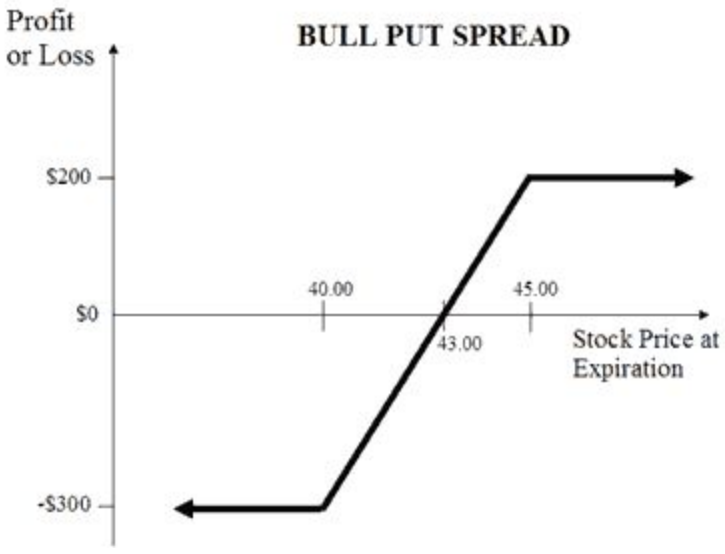
We buy two put options with the same expiry date and different strike prices. You sell the put option with a higher strike price and buy the put option with a lower strike price. In this way, you not only put a cap on your losses but also limit your gains.

Max Profit = Net Premium Received

Max Loss = Strike Price of Short Put - Strike Price of Long Put Net Premium Received

Break-even Point = Strike Price of Short Put - Net Premium Received

For example: you buy the put option for 100 shares for $1 per share and a strike price of $40 and sell a call option for 100 shares for $3 per share and a strike price of $45. And the current price of the share is $43.



4. Bear spread

a) Bear call option

We use this strategy when we feel that the market price of the stock is going to be low in the future.

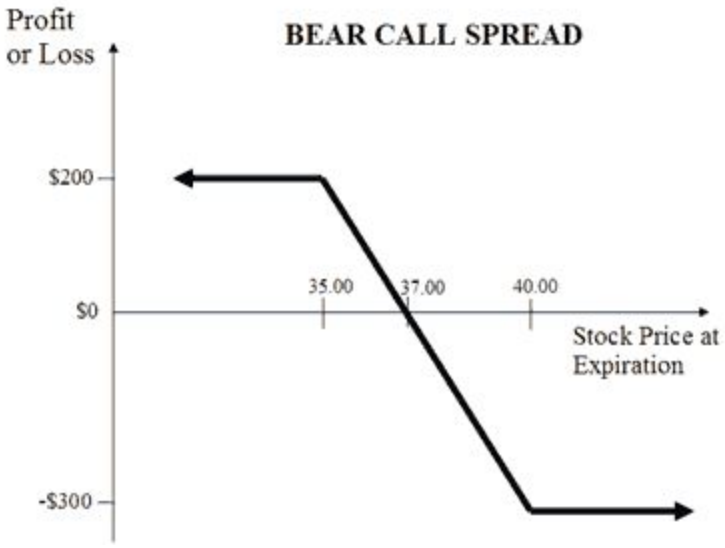
We buy two call options with the same expiry date and different strike prices. You buy the call option with a higher strike price and sell the call option with a lower strike price. In this way, you not only put a cap on your losses but also limit your gains.

Max Profit = Net Premium Received

Max Loss = Strike Price of Long Call - Strike Price of Short Call - Net Premium Received

Break-Even Point = Strike Price of Short Call + Net Premium Received

For example: you buy the call option for 100 shares for $1 per share and a strike price of $40 and sell a call option for 100 shares for $3 per share and a strike price of $35. And the current price of the share is $37.



b) Bear put option

We use this strategy when we feel that the market price of the stock is going to be low in the future.

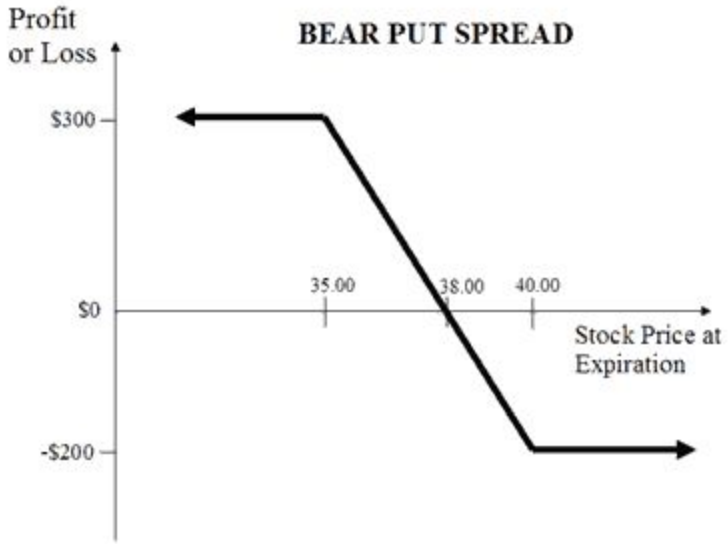
We buy two put options with the same expiry date and different strike prices. You buy the put option with a higher strike price and sell the put option with a lower strike price. In this way, you not only put a cap on your losses but also limit your gains.

Max Profit = Strike Price of Long Put - Strike Price of Short Put - Net Premium Paid

Max Loss = Net Premium Paid

Break Even Point = Strike Price of Long Put - Net Premium Paid

For example: you buy a put option for 100 shares for $1 per share and a strike price of $40 and sell a put option for 100 shares for $3 per share and a strike price of $45. And the current price of the share is $38.



5. Straddles

a) Long straddles

The goal of a straddle is to profit from a substantial change in the price of the underlying asset in either direction.

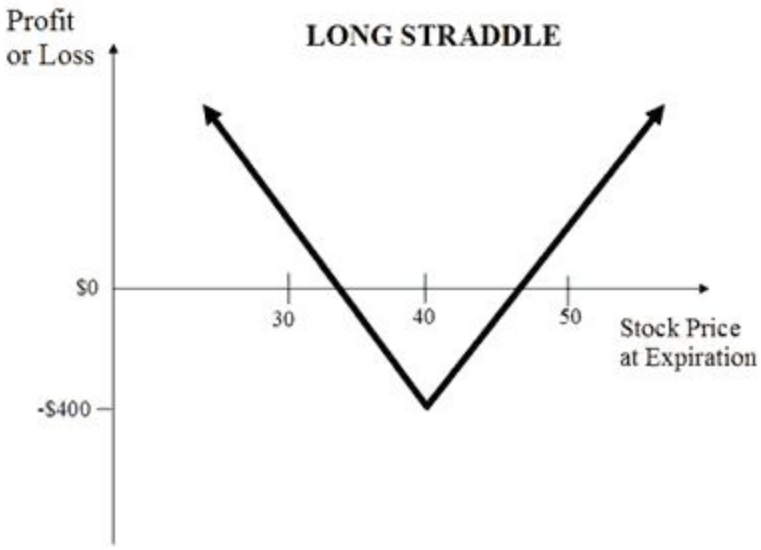
A long straddle is an options strategy where the trader purchases both a long call and a long put on the same underlying asset with the same expiration date and strike price.

Max Loss = Net Premium Paid

Upper Break even Point = Strike Price of Long Call

Lower Break even Point = Strike Price of Long Put

For example: you buy a put option for 100 shares for $2 per share and a strike price of $40 and buy a call option for 100 shares for $2 per share and a strike price of $40. And the current price of the share is $40.



b) Short straddles

Short straddles allow traders to profit from the lack of movement in the underlying asset, rather than having to place directional bets hoping for a big move either higher or lower.

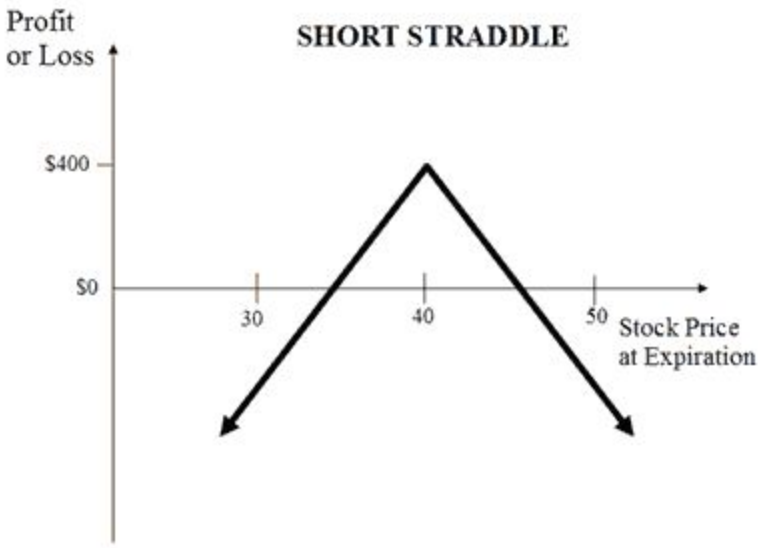
A short straddle is an options strategy consisting of selling both a call option and a put option with the same strike price and expiration date.

Max Profit = Net Premium Received

Upper Breakeven Point = Strike Price of Short Call + Net Premium Received

Lower Breakeven Point = Strike Price of Short Put - Net Premium Received

For example: you sell a put option for 100 shares for $2 per share and a strike price of $40 and sell a call option for 100 shares for $2 per share and a strike price of $40. And the current price of the share is $40.



6. Butterfly spread

a) Long call butterfly

Long call butterfly spreads are entered when the investor thinks that the underlying stock will not rise or fall much by expiration.

The long butterfly call spread is created by a long call option with a lower strike price than the market price of the underlying asset, writing two call options at the market price of the underlying asset, and buying one call option with a higher strike price than the market price of the underlying asset.

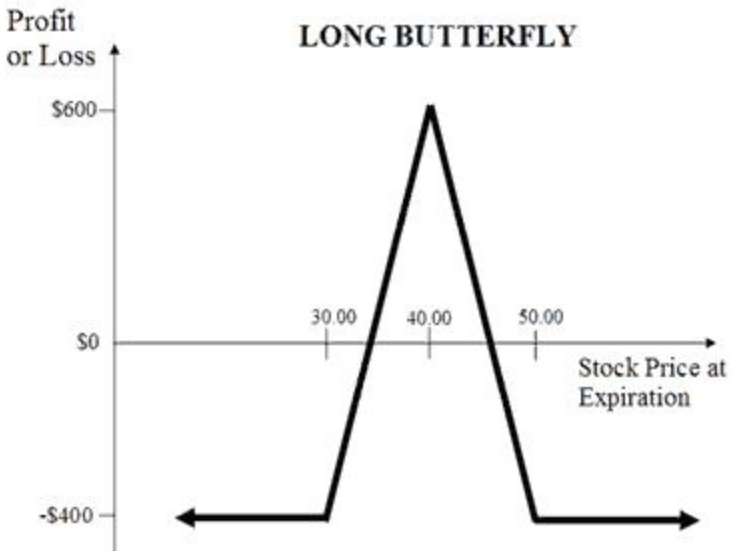
Max Profit = Strike Price of Short Call - Strike Price of Lower Strike Long Call

Max Loss = Net Premium Paid

Upper Breakeven Point = Strike Price of Higher Strike Long Call - Net Premium Paid

Lower Breakeven Point = Strike Price of Lower Strike Long Call + Net Premium Paid

For example: you buy a call option for 100 shares for $11 per share and a strike price of $30, sell two call options for 100 shares for $4 per share and a strike price $40and buy a call option for 100 shares for $1 per share and a strike price of $50. And the current price of the share is $40.



b) Long put butterfly

Long put butterfly spreads are entered when the investor thinks that the underlying stock will not rise or fall much by expiration.

The long put butterfly spread is created by buying one put option with a lower strike price than the market price of the underlying asset, selling two puts options at a strike price equal to market price of the underlying asset, and buying a put with a higher strike price than the market price of the underlying asset.

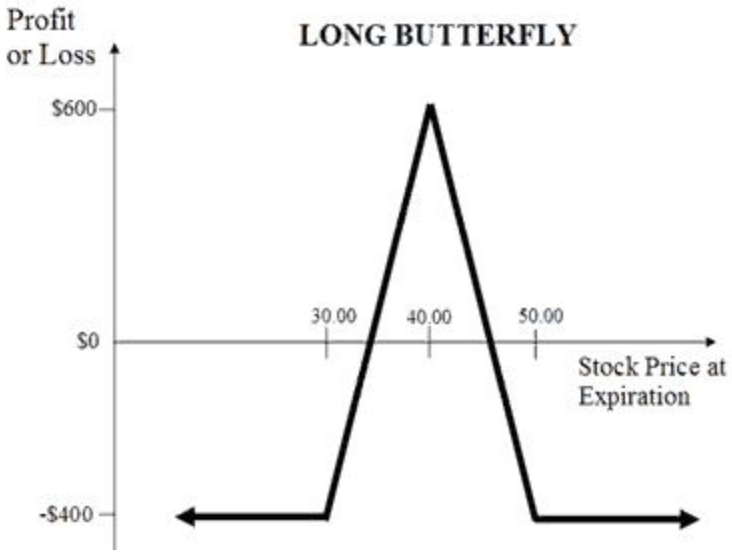
Max Profit = Strike Price of Higher Strike Long Put - Strike Price of Short Put - Net Premium Paid

Max Loss = Net Premium Paid

Upper Breakeven Point = Strike Price of Highest Strike Long Put - Net Premium Paid

Lower Breakeven Point = Strike Price of Lowest Strike Long Put

For example: you buy a put option for 100 shares for $1 per share and a strike price of $30, sell two put options for 100 shares for $4 per share and a strike price $40 and buy a put option for 100 shares for $11 per share and a strike price of $50. And the current price of the share is $40.



c) Short call butterfly

Short call butterfly spreads are entered when the investor thinks that the underlying stock will fluctuate at expiration.

The short call butterfly spread is created by selling one call option with a lower strike price than the market price of the underlying asset, buying two call options at a strike price equal to market price of the underlying asset, and selling a call option at a higher strike price than the market price of the underlying asset.

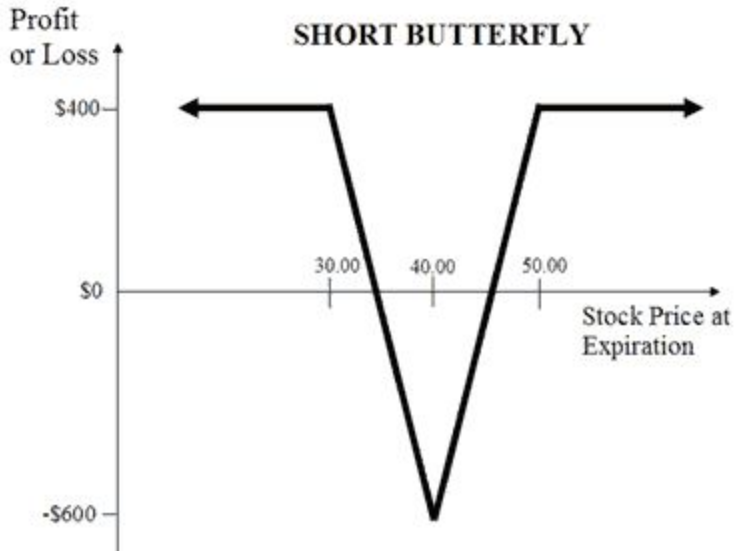
Max Profit = Net Premium Received

Max Loss = Strike Price of Long Call - Strike Price of Lower Strike Short Call - Net Premium Received

Upper Breakeven Point = Strike Price of Highest Strike Short Call - Net Premium Received

Lower Breakeven Point = Strike Price of Lowest Strike Short Call + Net Premium Received

For example: you sell a call option for 100 shares for $11 per share and a strike price of $30, buy two call options for 100 shares for $4 per share and a strike price $40 and sell a call option for 100 shares for $1 per share and a strike price of $50. And the current price of the share is $40.



d) Short put butterfly

Short put butterfly spreads are entered when the investor thinks that the underlying stock will fluctuate at expiration.

The short put butterfly spread is created by selling one put option with a lower strike price than the market price of the underlying asset, buying two put options at the strike price equal to the market price of the underlying asset, and selling a put option at a higher strike price than the market price of the underlying asset.

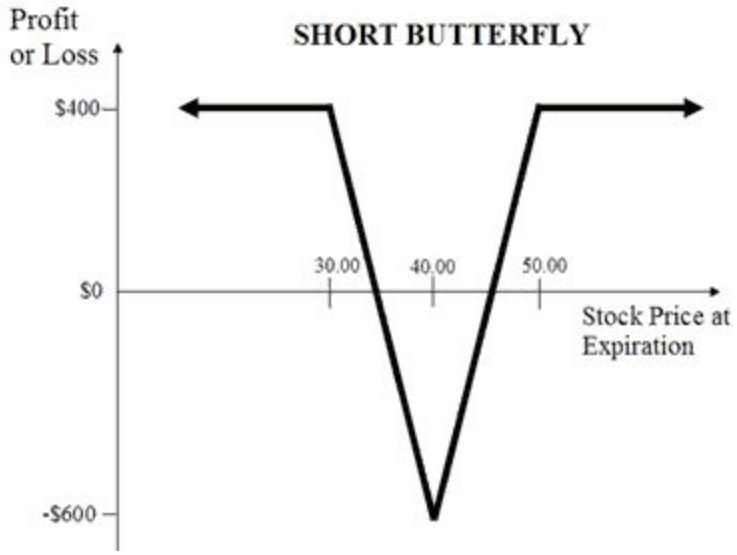
Max Profit = Net Premium Received

Max Loss = Strike Price of Higher Strike Short Put - Strike Price of Long Put - Net Premium Received

Upper Breakeven Point = Strike Price of Highest Strike Short Put - Net Premium Received

Lower Breakeven Point = Strike Price of Lowest Strike Short Put + Net Premium Received

For example: you sell a call option for 100 shares for $11 per share and a strike price of $30, buy two call options for 100 shares for $4 per share and a strike price $40 and sell a call option for 100 shares for $1 per share and a strike price of $50. And the current price of the share is $40.



7. Strangle

a) Long strangle

The investor simultaneously buys an out-of-the-money call and an out-of-the-money put option. The call option's strike price is higher than the underlying asset's current market price, while the put has a strike price that is lower than the asset's market price.

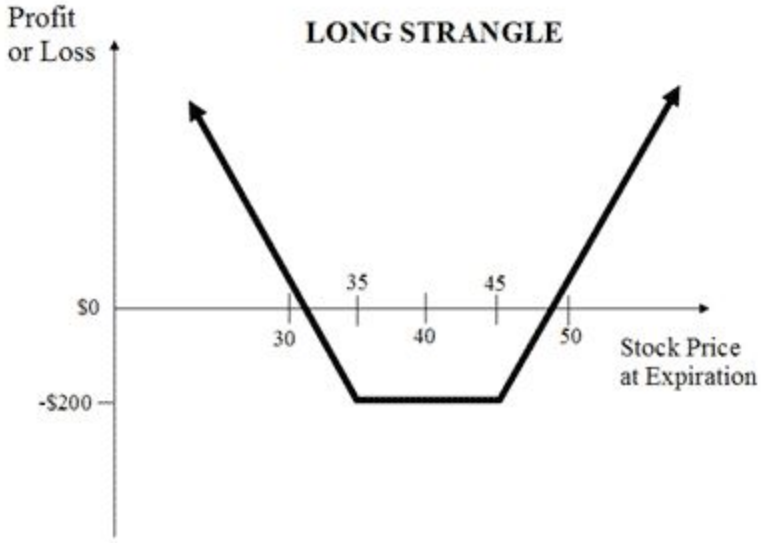
Large gains for the long strangle option strategy is attainable when the underlying stock price makes a very strong move either upwards or downwards at expiration.

Max Loss = Net Premium Paid

Upper Breakeven Point = Strike Price of Long Call + Net Premium Paid

Lower Breakeven Point = Strike Price of Long Put - Net Premium Paid

For example:you buy a put option for 100 shares for $1 per share and a strike price of $35 and buy a call option for 100 shares for $1 per share and a strike price of $45. And the current price of the share is $40.



b) Short strangle

The investor simultaneously sells an out-of-the-money call and an out-of-the-money put option. The call option's strike price is higher than the underlying asset's current market price, while the put has a strike price that is lower than the asset's market price.

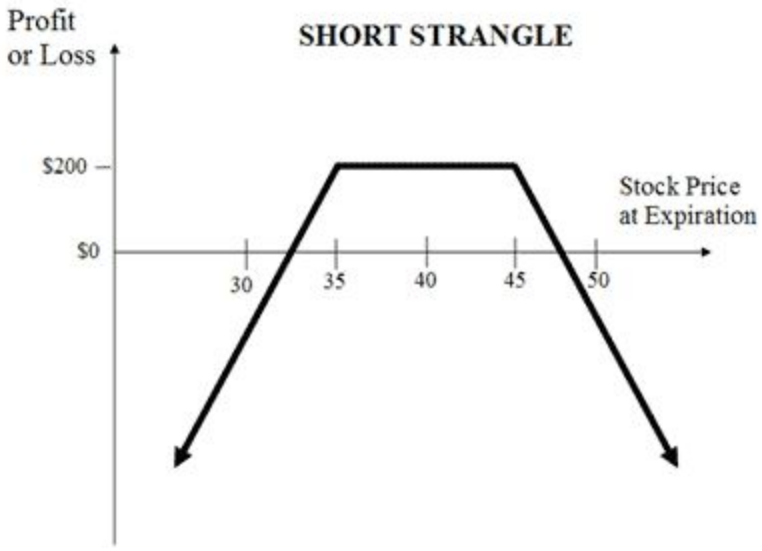
Large gains for the long strangle option strategy is attainable when the underlying stock price makes a very strong move either upwards or downwards at expiration.

Max Profit = Net Premium Received

Upper Breakeven Point = Strike Price of Short Call + Net Premium Received

Lower Breakeven Point = Strike Price of Short Put - Net Premium Received

For example: You sell a put option for 100 shares for $1 per share and a strike price of $35 and sell a call option for 100 shares for $1 per share and a strike price of $45. And the current price of the share is $40.



Interest Rate Derivatives

1. Bond Futures

The bonds are the underlying assets for the futures. Investors enter such an agreement to safeguard them from the changing interest rates. The buyer and seller of the bond agrees to buy and sell at a specific date in future at a specific price, strike price.

An example to show how to calculate the value of a bond at any time before maturity using discounted rate as the rate at that given time:

Suppose we have a 4 year bond with a coupon rate of 10% paid annually and face value of 1000. We wish to calculate the bond price at the end of 1.2 years, interest rate at the end of 1.2 years is 16%

Initially we calculate the value of the bond at the end of 1st year discounted at 16%.

Bond value at the end of 1st year = 1100/ 1.16^3 + 100/ 1.16^2 + 100/ 1.16 = $865.25

Now we calculate the value of the above value at 1.2 years, this is known as the dirty price.

$$\textit{Dirty Price} = \textit{Bond Value at the end of preceding year} \times (1+r)^m$$

Note: we use the discount rate given at the time of maturity to calculate the bond value at the end of the preceding year.

Where,

$$m = \frac{no.\ of\ days\ from\ last\ coupon\ to\ the\ settlement\ date}{no.of\ days\ in\ coupon\ period}$$

In our example, Dirty price = $865.25 $\times$ $1.16^{0.2}$ = $891.32

Finally we calculate the clean price,

$$\textit{Clean Price} = \textit{Dirty Price} - \textit{Accrued Interest}$$

Where,

$$\textit{Accrued Interest} = \textit{coupon} * m$$

Day conventions for accrued interest are

1. U.S. Treasury bonds use actual/actual.
2. U.S. corporate and municipal bonds use 30/360.
3. U.S. money market instruments (Treasury bills) use actual/360.

In our example,

Clean Price = $891.32 - 100*0.2 = $871.32

Thus the value of the bonds at 1.2 years is $871.32.

The profit earned by the buyer of the bond = clean price - strike price

Conversely, the profit earned by the seller of the bond = strike price - clean price

Bond futures don't require large payment at the beginning of the trade like bonds, you only need a specific low margin in your accounts.

2. Eurodollar Futures

Eurodollars are time deposits denominated in U.S. dollars and held in banks outside of the United States. A time deposit is simply an interest-yielding bank deposit with a specified date of maturity. As the deposits are held outside the US, thus they are not subjected to US banking regulations.

The Chicago Mercantile Exchange (CME) started the eurodollar futures. The underlying asset is a Eurodollar deposit with principal amount of $1 million and maturity period of 3 months. Buying the contract is equivalent to staying at a long position, and selling the contract short is equivalent to staying at a short position.

The eurodollar future contract price varies with the LIBOR interest rate. For settlement of the contract the LIBOR rate is taken as the prevailing 3-month LIBOR rate at the time of maturity. For example you have a maturity period of 1 year then the prevailing 3 month LIBOR rate at the end of 1 year is taken.

If Z is the quoted price for a eurodollar futures contract, the contract price is:

Then, LIBOR interest rate = 100-Z.

Eurodollar future price = $10,000 [100 - (0.25) (100 - Z)]

For example, if the quoted price, Z, is 97.8, LIBOR interest rate = 2.2%:

=> Eurodollar future price = $ 10,000[100 - (0.25) (100.0 - 97.8)] = $994,500

Now, if the LIBOR interest rate decreases by one basis point(0.01%), then LIBOR rate = 2.19% , Z = 97.81:

=> Eurodollar future price = $ 10,000[100 - (0.25) (100.0 - 97.81)] = $994,525

i.e. buyer gains $25 for every one basis point decrease in LIBOR interest rate

Vice-versa seller gains $25 for every one basis point increase in LIBOR interest rate

Eurodollar futures provide an effective means for companies and banks to secure an interest rate for money it plans to borrow or lend in the future.

Let's say it's January and you wish to borrow $1 million in July this year, but you feel that the LIBOR interest rate is going to rise later so you sell a eurodollar future with maturity in July. Current LIBOR rate is 4% and in july it becomes 5% then you will gain $25*100 = $2,500, as the LIBOR rate increased by 100 basis points.

3. Interest Rate Cap

An interest rate cap is a derivative in which the buyer receives payments at the end of each period in which the interest rate exceeds the agreed rate. The buyer is required to pay premiums to the seller.

This protects a buyer against the rising interest rates on a loan, the payment helps the buyer to pay the interest for the loan.

Although the cap limits the percentage increase, the rates on the loan still increase in a rising rate environment. In other words, borrowers must be able to afford the worst-case scenario rate on the loan if rates rise significantly.

For Example: An agreement to receive payment for each month the LIBOR rate exceeds 2.5%.

4. Interest Rate Floor

An interest rate floor is a derivative in which the buyer receives payments at the end of each period in which the interest rate is below the agreed rate. The buyer is required to pay premiums to the seller.

This is generally used by the banks to protect them against the falling interest rates on the loan given by them.

For Example: An agreement to receive payment for each month the LIBOR rate goes below 1.5%.

5. Interest Rate Collars and Reverse Collars

An interest rate collar is the simultaneous purchase of an interest rate cap and sale of an interest rate floor on the same index for the same maturity and notional principal amount. The rate of the cap is higher than the floor.

This protects the buyer against rising interest rates in exchange for the gains earned on the lower interest rates.

The buyer buys this when he feels the interest rates are going to rise. He expects to earn from the payment from the interest rate cap and also premiums from the interest rate floor.

An interest rate reverse collar is the simultaneous sale of an interest rate cap and purchase of an interest rate floor on the same index for the same maturity and notional principal amount. The rate of the cap is higher than the floor.

This is generally taken up by banks who feel that interest rates are going to fall on the loans given by them. It gives them a source of earning to cover up for falling interest payments.

They expect to earn from the payment from the interest rate floor and premiums from the interest rate cap.

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