

Options strategies

A seminar report in Analytical Finance I

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Abstract:

This report is aimed to give introduction and explanation of strategies by using different options in different market circumstances. The authors of report explain some common strategies which could give better understanding about use of options strategies.

Introduction:

Warren buffet, CEO of Berkshire Hathaway, says about options in a report that he and his company “view them as time bombs both for the parties that deal in them and economic system”. Nowadays one of the famous financial instruments traded in market is option.

Since many people are afraid of valuing and making strategies, the authors begin the report with simple definitions and terminologies. Further they explain some common strategies with examples in different market circumstances.

Background:

What is an *option*?

A financial derivative that represents a contract between two parties, option holder and option writer. It gives the right but not obligation to option holder to buy or sell underlying asset at some reference price.

There are two types of options, namely *call* and *put* option.

A *call* option gives the holder the right but not obligation to buy the underlying asset by a certain date for certain price.

A *put* option gives the holder the right but not obligation to sell the underlying asset by a certain date for certain price.

The price in the contract is known as *strike price* and the date is known as *expiration date* or *time to maturity*. An options is further divided into three categories, *American*, *Bermudian* and *European* options. *American* option can be exercised at any time period up to maturity. *Bermudian* options allow for some time intervals before maturity. *European* options can be exercised only at maturity. In this report only European options are discussed further.

An option can be further classified into three types, *in-the-money*, *at-the-money* and *out-of-money*.

Suppose you have a call or put option and it gives positive payoff when exercised immediately, the option is said to be *in-the-money*. Similarly it is *at-the-money* if payoff is zero and *out-of-money* if payoff is negative when exercised immediately.

The *premium* is cost of option paid by holder to option writer. It is calculated by addition of *intrinsic value* and *time value* of option.

$$\text{Premium} = \text{Intrinsic value} + \text{Time value}$$

Intrinsic value is the amount realized by option holder upon exercising it immediately. It reflects the effective financial advantage that would result from immediate exercise of that option. Its value is either positive or zero. It doesn't depend on time left until maturity. *Time value* is the amount by which it exceeds intrinsic value. It is directly related to the time left until maturity of option. More the time is left; greater chances are to ending up in-the-money. And of course time value would also have an exposure to variation in prices of underlying asset, dividend yield of asset and risk free interest rates.

One of the important aspects while pricing options is *volatility*. It is a measure of variation in prices of underlying asset. It is measured by standard deviation of prices. It is not directly observable and also not constant over time.

After describing some basic terms, the authors further explain call and put option.

Firstly, the analysis of call option holder is explained. The payoff function is described as

$$\text{Payoff} = \text{Max}(S_T - K, 0) \quad \text{Where } S_T = \text{Security price at maturity} \\ K = \text{Strike price}$$

When security price at maturity is greater than strike price it would be a golden opportunity for buyer to exercise the option and purchase it at strike price and sell it at security price. Thus his payoff would be security price minus strike price. Of course you can't get it for free; holder has to pay a certain premium which is determined by market. Thus his profit would be

$$\text{Profit} = \text{Max}(S_T - K, 0) - \text{Premium paid}$$

Option writer has an obligation to sell the asset at strike price if holder exercises the option. Writer's payoff and profit is opposite to holders.

Payoff function of Put option holder is,

$$\text{Payoff} = \text{Max}(K - S_T, 0)$$

When security price is greater than strike price, it won't be optimal to exercise the option and hence payoff of zero. If $S_T < K$, buyer can buy the security at S_T and sell it at strike price by exercising the option. Hence gets a payoff of strike price minus security price at maturity.

Profit can be obtained by subtracting cost of option from payoff.

$$\text{Profit} = \text{Max}(K - S_T, 0) - \text{Premium paid}$$

Seller of this option has obligation to buy the underlying security if buyer decides to exercise this. Payoff and profit function would be mirror image of buyer's functions.

Generally two financial terms are used for purchasing and selling of an option i-e., "long" for buying and "short" for selling. Long position benefits from increase in price of underlying security and short position benefits from decrease in price of underlying security.

Basic Theory:

Put-Call Parity:

The parity reveals the static relationship between price of call and put options with same characteristics (underlying security, time to maturity and strike price). Here an option trader has long position in call and short position in put at time period 't'. At maturity i-e., time period 'T' either of the two scenarios can happen

$S_T < K \rightarrow$ put option would be exercised and get underlying security at strike price K

$S_T > K \rightarrow$ exercise the call option and get security at strike price K

It is clear that in both of the cases an individual ends at getting security for strike price K. Hence to avoid any arbitrage the security price at maturity must be equal to the total cost of buying the security by using call and put options. To compare the prices we write them in current time period as;

$$C(K,T) - P(K,T) + PV(K) = PV(S_T)$$

This relationship signifies that there is no free lunch in business. There are many theories and models based on no arbitrage principle. One of those models is pricing options via creating a replicating portfolio. We create a portfolio in such a manner that its payoff become equivalent to option's payoff and to avoid arbitrage their prices must be equivalent. This practice of pricing is widely used because it is able to handle certain conditions which other models may not hold.

Black-Scholes Pricing Model:

A formula which boomed the option trading all over around the world was articulated in 1973 by two economists Fisher Black and Myron Scholes but Robert Merton was first to expand the understanding of formula and termed it as Black-Scholes option pricing formula. We would only write the formula rather than deriving it here.

$$C(K,T) = S_t N(d_1) + Ke^{-r(T-t)} N(d_2)$$

$$P(K,T) = Ke^{-r(T-t)} N(-d_2) - S_t N(-d_1)$$

$$Ke^{-r(T-t)} - S_t + C(K,T)$$

Where,

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}}$$
$$d_2 = \frac{\ln\left(\frac{S}{K}\right) + \left(r - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} = d_1 - \sigma\sqrt{T-t}$$

Where,

C(K,T) = premium of call option

P(K,T) = premium of put option

T - t = time to maturity

S_t = Security price at time 't'

S_T = Security price at time 'T'

K = Strike price

r = Annualized risk free interest rate

σ = Volatility of returns of underlying security

N(.) = Cumulative distribution function of standard normal distribution

This formula assumes that prices follow geometric Brownian motion with constant drift and volatility. When applied to stock, it assumes constant variation in price and constant risk free interest rate. In the formula we only need to put values of inputs for calculation of price. For derivation and further assistance about this formula please refer to Jan Roman, Lecture notes, Page 133-143.

Strategies:

Strategies are simultaneous, sometimes mixture, of buying and selling of put and call options that differ in at least one of its variables. In option trading there is a lot of flexibility and an individual can customize it in any way to fulfill his objective.

People use different strategies for hedging and thus reducing their risk of losing money. A classic example of hedging can be of a farmer who wants to sell his wheat after two months but not sure about the price. The farmer hedge it by buying a put option and thus limit his loses.

Further a person can make certain strategies that could act as insurance and are cheaper than buying insurance from insurance companies. A put option can be thought as an insurance against a price decrease.

Most common use of different option strategies is to benefit from movements in price of underlying security. Beliefs of movements can be *bullish*, *bearish* and *neutral*. Neutral strategies are further classified into those that are *bullish in volatility* and *bearish in volatility*.

Bullish strategies:

Bullish strategies are applied when trader expects that price of underlying security would move upward. While making a strategy, it is important to assess how much price would move up and what is the time range in which it would move upward. There can be many strategies for such type of belief but only some widely used strategies are discussed in the report.

Long call:

Construction: Long 1 call option.

Long call strategy is employed when trader expects that underlying security price would go upward without any bound. Trader chooses to long one at-the-money call option.

Breakeven point: A point at which profit function is equal to zero. In other words a point at which profit graph intersects x-axis.

$$\text{Breakeven point} = \text{Strike price} + \text{Premium paid}$$

Limited downside risk: If trader's expectations betray him and price doesn't take any value greater than breakeven point then he will be in loss. Loss is maximum when price is less than strike price.

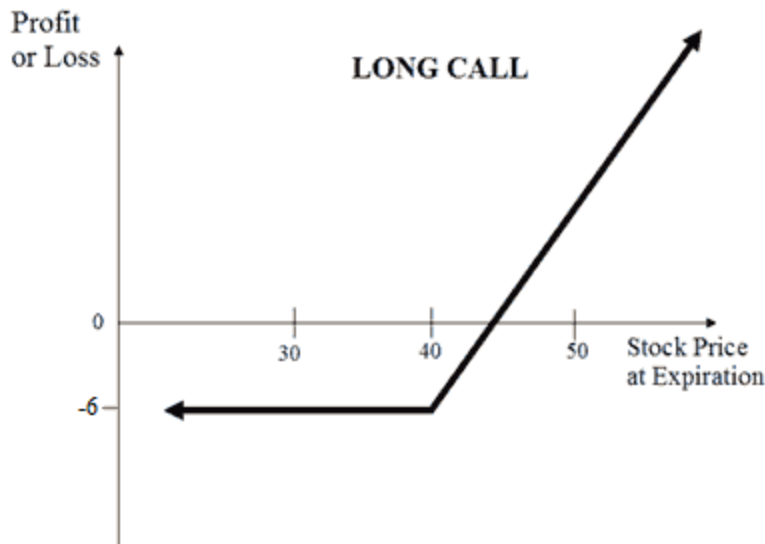
$$\text{Maximum Loss} = \text{Premium}$$

Unlimited upside potential: If underlying security price is greater than breakeven point, trader starts making profit. Profit becomes maximum when price shoot up and takes infinite value.

$$\text{Maximum Profit} = +\infty$$

Example:

Suppose that current price of Ericson's stock is 40kr and there is a chance that Ericson may launch a new product by next 2 months. Thus trader expects that after two months price of Ericson stocks would shoot up and he can get a decent profit. Trader chooses to buy a call option with strike price 40kr with expiration date two months from now. She purchases it at a price of 6kr.



The breakeven point is 46. Further suppose that Ericson launches a new product and prices get high up to 50kr at expiration date of option. Trader's profit would be 4kr(=50 – 40 – 6).

Bull Spread:

Construction: Long 1 in-the-money call option and short 1 out-of-the-money call option
Short 1 in-the-money put option and long 1 out-of-the-money put option

This strategy is employed when prices are expected to go up moderately in near future. Trader decides to buy 1 at-the-money call option and write 1 out-of-the-money call option. As compared to long call strategy, this strategy reduces the cost by shorting 1 out-of-the-money option but forgoes unlimited gain.

Breakeven point: The breakeven point of bull spread strategy is calculated as

$$\text{Breakeven point} = \text{Strike price of long call} + \text{Net premium paid}$$

At breakeven point only long call option get exercised and other option with higher strike price expires worthless.

Limited upside potential: Trader gets profit when price is higher than breakeven point. Maximum gain occurs when both options get exercised. Formula for maximum profit is written as

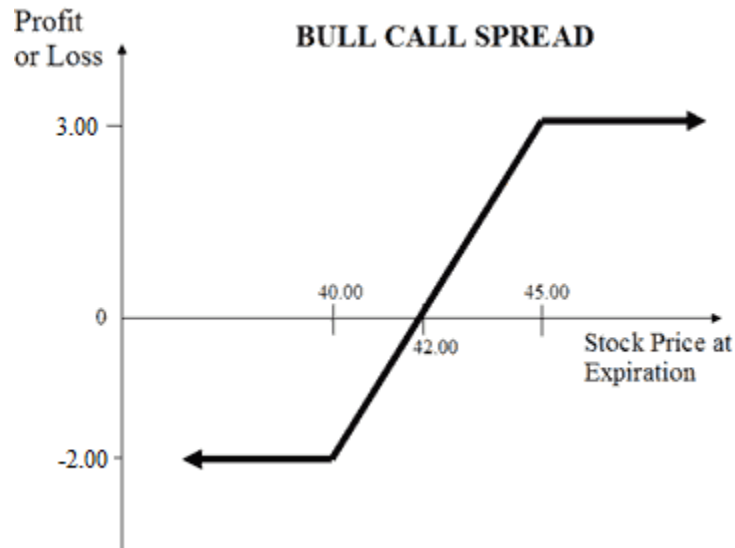
$$\text{Maximum profit} = \text{Strike price of short call option} - \text{strike price of long call option} \\ - \text{Net premium paid}$$

Limited downside risk: Loss occurs when price get lower than breakeven point. Maximum loss occurs when price gets lower than strike prices of both long and short option. It is written as

$$\text{Maximum loss} = \text{Net premium paid}$$

It is important to note that maximum loss in bull spread is less than maximum loss in long call strategy

Example: Suppose that trader expects that prices would move upward only to a certain extent. He decides to cut down his cost and lower the downside risk by forgoing unlimited upside potential. Let the current price of stock be 42kr. Trader buys in-the-money call option with strike price of 40kr and writes out-of-the-money call option with strike price of 45kr. Trader buys a call option at 6kr and sells a call option at 4kr. Total net premium paid becomes 2kr.



The breakeven occurs at underlying stock price of 42kr. If price at expiration of option becomes 50kr then the profit would be 3kr which is less than profit from long call case. It implies that if price is less than 45 then bull call strategy performs better than long call strategy.

Call back spread:

Construction: Short 1 in-the-money call option and long 2 out-of-the-money call options with same strike price and same expiration date

This strategy is used when option trader expects big move in prices of high volatile security. Trader wants to realize unlimited profit but at same time she also wants good protection against downside risk.

Breakeven points: In this strategy, the breakeven occurs at two points. They are

- 1) Breakeven point = Strike price of short call option + Net premium paid
- 2) Breakeven point = $2 \times (\text{Strike price of long call option}) - \text{Strike price of short call option} - \text{Net premium paid}$

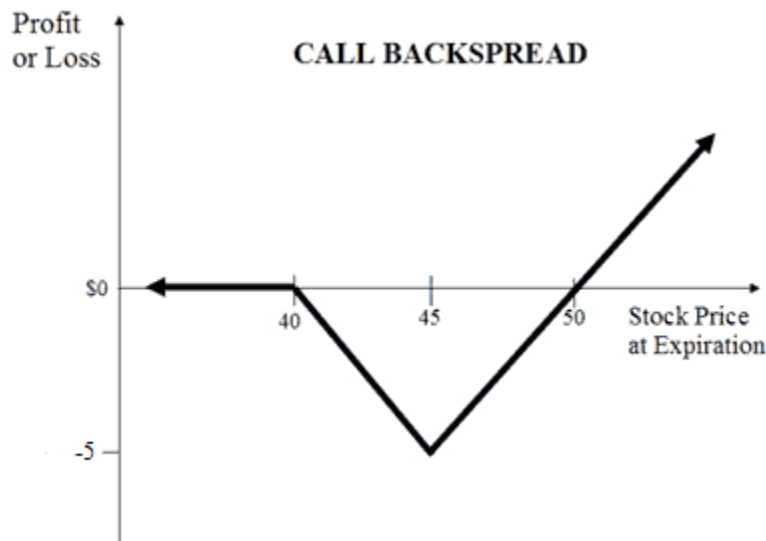
Unlimited profit potential: Option trader starts gaining when underlying security's price is greater than second breakeven point. If the maximum price skyrockets then she can have unlimited profit.

Limited risk: Maximum loss for call back spread is limited and it occurs when underlying price is equal to strike price of long call options. At that price long call options go worthless and short call option expires in-the-money.

$$\text{Maximum loss} = \text{Strike price of short call option} - \text{Strike price of long call options} - \text{Net premium paid}$$

Example:

Suppose that trader expects big increase in stock price. She worries about high volatility of stock and hence needs protection for downside risk. Suppose option trader sells a call option with 40kr strike price for 6Kr and buys two call options with 45kr strike price for 3kr each. The net premium paid becomes zero. Trader has a zero cost but she loses money price is between 40kr and 50kr.



It is clear from diagram that maximum loss is 5kr but below price of 40kr trader has zero loss.

Bearish Strategies:

Bullish strategies are applied when trader expects that price of underlying security would move downwards. There can be many strategies for such type of belief but only some widely used strategies are discussed.

Long put:

Construction: Long 1 put option

Long put strategy is a very bearish strategy. This strategy is employed when trader expects that underlying security's price would go downward till zero. Trader chooses to long one at-the-money put option.

Breakeven point: It is equal to strike price of put option minus premium paid to option writer.

$$\text{Breakeven point} = \text{Strike price of put option} - \text{Premium paid}$$

Limited upside potential: If underlying security price is less than breakeven point, the trader starts making profit. Profit is maximum when underlying security price become zero.

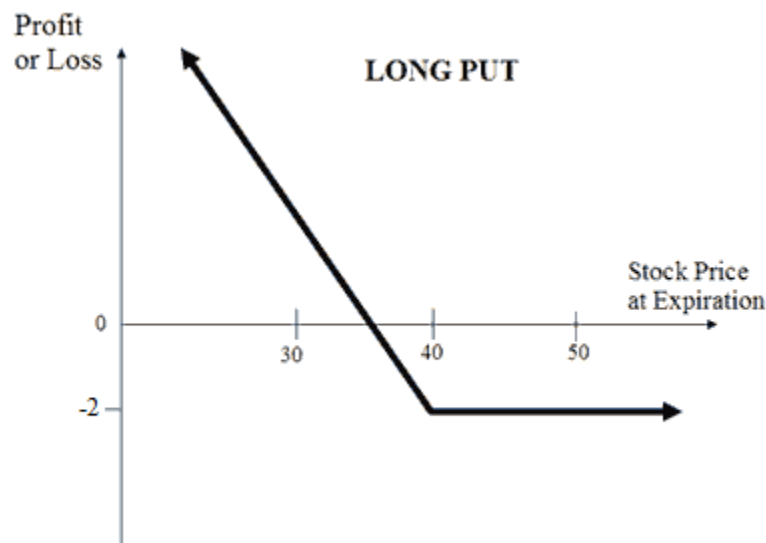
$$\text{Maximum profit} = \text{Strike price} - \text{Premium paid}$$

Limited risk: If trader's expectations betray him and price doesn't take any value less than breakeven point then he would have loss. If underlying security price is greater than strike price at maturity then option expires worthless.

$$\text{Maximum loss} = \text{Premium paid}$$

Example:

Suppose that current price of ABB stock is 40kr and there is a chance that a crisis in Europe may affect ABB by next 2 months. Thus trader expects that after two months prices of ABB stocks would go downward and he can get a decent profit. Trader chooses to buy a put option with strike price 40kr and expiration date is two months from now. He purchases it at a price of 2kr.



The breakeven point and maximum profit is 38kr.

Bear Spread:

Construction: short 1 in-the-money put option and long 1 out-of-the-money put option, or

long 1 in-the-money call option and short 1 out-of-the-money call option

This strategy is employed when prices are expected to go down moderately in near future. Trader decides to buy 1 at-the-money put option and write 1 out-of-the-money put option. As compared to long put strategy, this strategy reduces the cost by shorting one out-of-the-money option but forgoes some upside profit potential.

Breakeven point: The breakeven point of bear spread strategy is calculated as

$$\text{Breakeven point} = \text{Strike price of long put} - \text{Net premium paid}$$

At breakeven point only long put option get exercised and other option with lower strike price gets worthless on expiration.

Limited upside potential: Option trader gets profit when price is lower than breakeven point. Maximum gain occurs when both options get exercised.

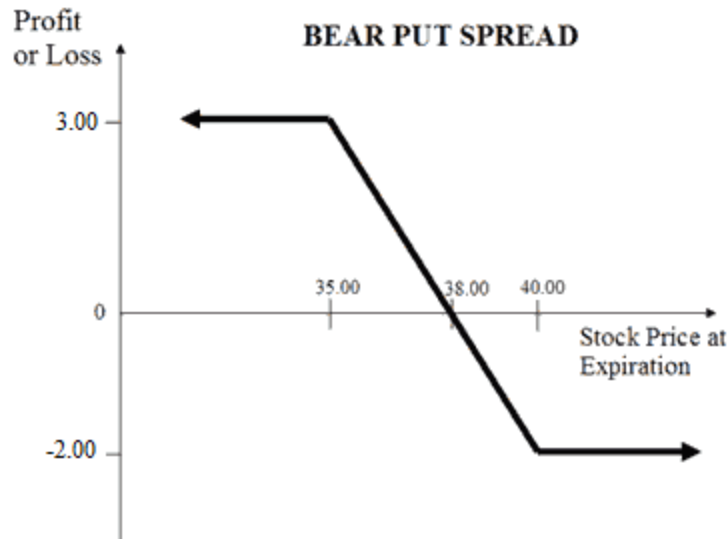
$$\begin{aligned} \text{Maximum profit} &= \text{Strike price of long put option} - \text{Strike price of short put option} \\ &\quad - \text{Net premium paid} \end{aligned}$$

Limited risk: Loss occurs when underlying security price gets higher than breakeven point. Maximum loss occurs when price gets higher than strike prices of both long and short option and both options expires worthless. It is written as

$$\text{Maximum loss} = \text{Net premium paid}$$

It is important to note that maximum loss in bear spread is less than maximum loss in long put strategy.

Example: Suppose that trader expects that prices would move downward only to a certain extent. He decides to cut down his cost and lower the downside risk by forgoing some upside potential. Trader sells one in-the-money put option with strike price of 35kr at 2kr and buys one out-of-the-money put option with strike price of 40kr at 4kr. Total net premium paid becomes 2kr.



The breakeven occurs at underlying stock price of 38kr. If price at expiration of is less than 35kr then the profit would be 3kr. Maximum profit in this strategy is less than maximum profit in long put strategy.

Put back spread:

Construction: Short 1 in-the-money put option and long 2 out-of-the-money put options with same strike price and same expiration date

This strategy is used when option trader expects big move toward downside in price of high volatile underlying security. Trader wants to realize decent profit but at same time she also wants good protection against downside risk.

Breakeven points: In this strategy, the breakeven occurs at two points. They are

- 3) Breakeven point = Strike price of short put option + Net premium paid
- 4) Breakeven point = $2 \times (\text{Strike price of long put option}) - \text{Strike price of short put option} - \text{Net premium paid}$

Limited profit potential: Option trader starts gaining when underlying security's price is less than first breakeven point. If price becomes zero then trader can have maximum profit.

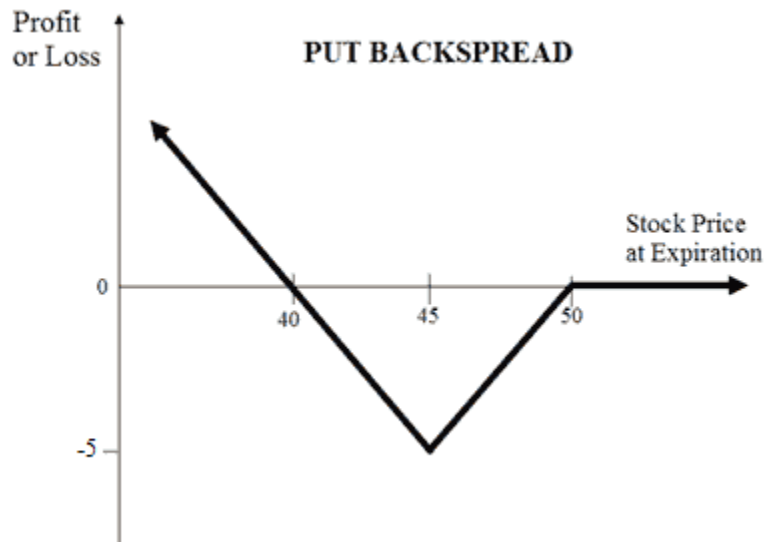
Maximum profit = Strike price of short put option – Net premium paid

Limited risk: Maximum loss for put back spread is limited and it occurs when underlying security price is equal to strike price of long put option. At that price long put options go worthless and short call option expires in-the-money.

Maximum loss = Strike price of short put option – Strike price of long put option – Net Premium Paid

Example:

Suppose that trader expects big decrease in stock price. She also worries about high volatility of stock and hence needs protection for downside risk. Suppose trader sells a put option with 40kr strike price for 4kr and buys two put options with 45kr strike price for 2kr each. The net premium paid becomes zero. Trader has a zero cost but she loses money when price is between 40kr and 50kr.



It is clear from diagram that maximum loss is 5kr but maximum profit is 40kr.

Neutral Strategies:

Neutral strategies are employed when trader expects no change in price of underlying security. Neutral strategies are further classified as bullish on volatility and bearish on volatility.

In neutral – bullish on volatility strategy option trader sees no reason for security prices to change in near time but she knows from past that security prices have been very volatile.

In neutral – bearish on volatility strategy option trader expects price to remain same and volatility of prices to decrease.

Short Strangle:

Construction: Short 1 out-of-the-money call option and short 1 out-of-the-money put option

This is neutral - bearish on volatility strategy. Since trader believes that volatility would decrease and prices would be quite stable, she chooses only to write out-of-the-money call and put option.

Breakeven points: There are two breakeven points

- 1) Breakeven point = Strike price of put option – Premium received

2) Breakeven point = Strike price of call option + Premium received

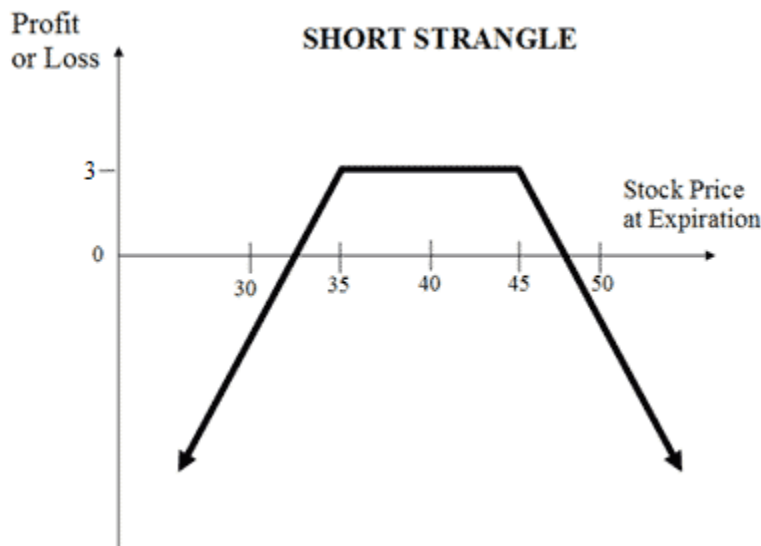
Limited profit potential: Trader is in profit when underlying security price is between breakeven points. If trader expectations are completely correct and security price at expiration remains between strike prices of both options then she receives maximum gain.

Maximum profit = Premium received

Unlimited Risk: If security price is out of range of both breakeven points, trader is in loss. Theoretically if price goes very high till infinity then trader can lose infinite amount of money.

Example:

Suppose current price of stock is 40kr. Trader chooses to short one put option with strike price of 35kr and one call option with strike price of 45kr at premium of 1kr and 2kr respectively.



The breakeven points are 32kr and 48kr. Maximum profit is 3kr and this is achieved when both options expires worthless.

Short Butterfly Spread:

Construction: Short 1 out-of-the-money put option, long 1 at-the-money put option, long 1 at-the-money call option and short 1 out-of-the-money call option.

This is a neutral – bullish on volatility strategy. Both put and call options are used in this strategy. To simplify this strategy it is assumed that difference between at-the-money and in-the-money option and at-the money and out-of-the-money option is same. Unlike other strategies it is difficult to directly imagine its payoff in mind but hopefully the example below would clarify it.

Breakeven Point(s): There are two breakeven points.

- 1) Breakeven point = Strike price of at-the-money option – Net premium paid
- 2) Breakeven point = Strike price of at-the-money option + Net premium paid

Limited upside potential: Trader is in profit when price of underlying security is on left side of first breakeven point and right side of second breakeven point. Maximum profit can occur in two cases

- 1) When stock price is less than strike price of in-the-money put option. At this point both put options are exercised and both call options expires worthless
- 2) When stock price is greater than strike price of out-of-the-money call option. At this point both call options are exercised and both put options expires worthless.

Maximum profit = Strike price of at-the-money option – Strike price of out-of-the-money put option
– Net premium paid

Or

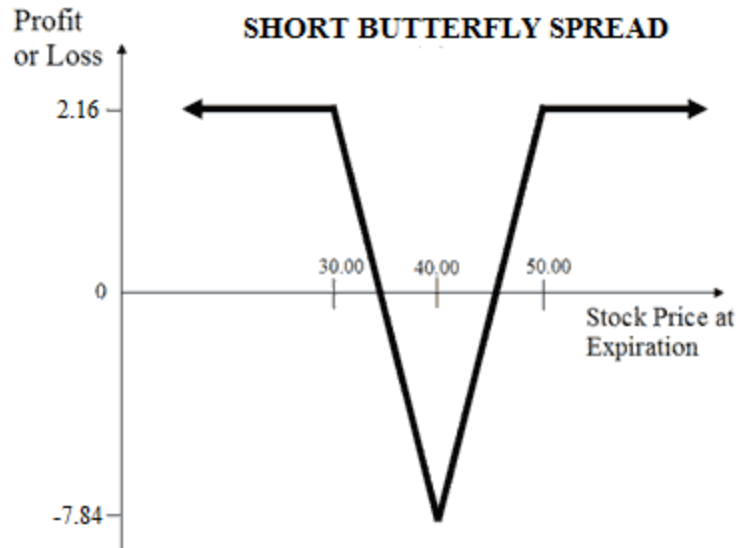
Maximum profit = Strike price of out-of-the-money call option – Strike price of at-the-money option
– Net premium paid

Limited risk: Loss occurs when price of underlying security is between both breakeven points. Maximum loss occurs at strike price of at-the-money options.

Maximum loss = Net premium paid

Example:

Suppose that trader writes a put option with strike price of 30kr and a call option with strike price of 50kr at premium of 2.90kr and 6.11kr. Trader buys a put option with strike price of 40kr and a call option with strike price of 40kr at premium of 6.50kr and 10.55kr respectively. Current price of stock is 40kr. Profit graph of short butterfly spread is;



Net premium paid by holder is 7.84kr. Breakeven points are 32.16kr and 47.84kr.

By making opposite of this strategy trader can create long butterfly spread which would work in scenario of neutral-bearish on volatility. Its profit graph would be mirror image of short butterfly spread.

Now the authors feel to expand the usage of strategies by describing insurance and hedging strategy.

Strategies for insurance or hedging:

Trader can customize the strategy in a way that it works as insurance or hedge for an asset. One of the famous insurance strategy is described below.

Pay later strategy:

Pay later strategy gets red underline from spellcheck. This is what Robert McDonald calls a strategy for paying premium when insurance is needed. Authors would like to give a view of this strategy from perspective of insurance. Since it's little bit difficult to explain in theoretical way, authors would like to explain it with example.

Suppose currently trader is holding an asset which have current price of 80kr. Trader wants to hedge his asset against decline in price with explicit cost of zero. She finds options in such a way that net premium become zero. To do this she purchases two put options with 100 strike price and writes one put option with 112.93 strike price.

Price of underlying asset	Payoff of unhedged asset	Payoff on 2 purchased 100 strike put options	Payoff of written 112.93 strike put option	Combined payoff
60	-20	80	-52.93	7.07
70	-10	60	-42.93	7.07
80	0	40	-32.93	7.07
90	10	20	-22.93	7.07
100	20	0	-12.93	7.07
110	30	0	-2.93	27.07
112.93	32.93	0	0	32.93
120	40	0	0	40

Its visible from the table above that trader pays for insurance when price is less than 112.93kr, otherwise she gets same payoff as on unhedged asset.

Conclusion:

There exist infinitely many strategies for different types of circumstances. Instead of explaining those all authors have explained few strategies which could give good insight about use of strategies. Option trader can make any strategy depending on her preferences and objectives.

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