Review of Option Payoffs

An option contract gives its owner the right, but not the obligation to buy or sell an asset in the future at a price today. A call option gives its owner the right, but not the obligation to buy the underlying asset by the expiration or the maturity date at the exercise (strike) price. A put option gives its owner the right, but not the obligation to sell the underlying by the expiration date at the exercise price.

If you buy an option, you have the long position and you will exercise your option, only if it is profitable to do so – or when the option is in the money. In contrast, the party who has written the option contract or sold the option has the short position. The option will not be exercised if it does not yield a positive payoff – or when the option is out of the money.

Let's review the payoffs at expiration to long call and short call positions. Remember a call option gives its owner to buy the underlying asset at the exercise price. Let X denote the exercise price of the option and S_T be the market price of the underlying asset at the expiration date T. A call option will be exercised if doing so yields a positive payoff to the holder of the option – that is, if $S_T > X \rightarrow S_T - X > 0$. Otherwise, if $S_T < X$, then the call option will not be exercised and the payoff is zero.

Payoff to long call position:
$$S_T - X \text{ if } S_T > X$$
$$0 \text{ if } S_T < X$$

The short position has the obligation to sell the underlying asset at the exercise price if holder of the option chooses to exercise. Therefore the payoff to the short call position is given by:
$$-(S_T - X) \text{ if } S_T > X$$
$$0 \text{ if } S_T < X$$

The profit to long call position takes into account the premium – that is, how much the option's holder paid for the option. Let P denote the option premium.
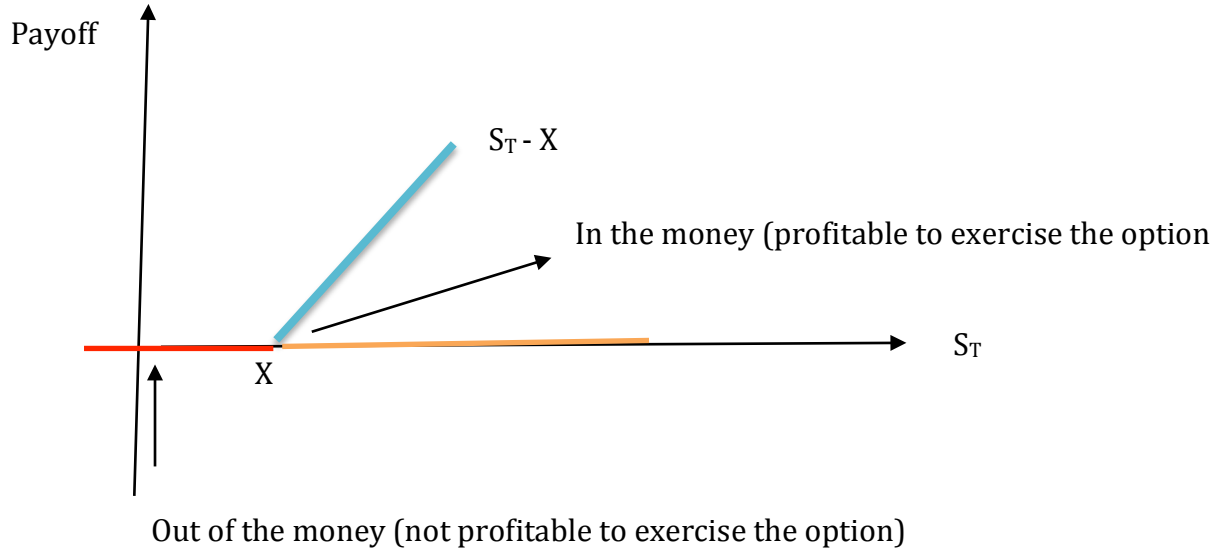
Profit to long call position:
$$S_T - X - P \text{ if } S_T > X$$
$$-P \text{ if } S_T < X$$

Payoff to short call position:
$$P - (S_T - X) \text{ if } S_T > X$$
$$P \text{ if } S_T < X$$

Payoff diagram for a long call position

The payoff diagram for the short call position will be the mirror image of this flipped along the x-axis.

Example

Suppose that the stock of the company "LFI" is trading on January 16 at a price of $60. A call option (each contract size consists of 100 shares) with a strike price of $60 and an expiration date on February 15 is trading on January 16 at $4 each share. What is your total payoff if the market price of LFI is $70 per share at expiration date? What is your profit?

$$S_T = \$70$$
$$X = \$60$$

$$Total\ payoff = 100 \times (70 - 60) = \$1000$$

$$Total\ profit = 100 \times (70 - 60 - 4) = \$600$$

Let's now review the payoffs at expiration to long put and short put positions. Remember a put option gives its owner to sell the underlying asset at the exercise price. Let X denote the exercise price of the option and S_T be the market price of the underlying asset at the expiration date T. A put option will be exercised if doing so yields a positive payoff to the holder of the option – that is, if $S_T < X \rightarrow X - S_T > 0$. Otherwise, if $S_T > X$, then the put option will not be exercised and the payoff is zero.

Payoff to long put position:
$$X - S_T \text{ if } S_T < X$$
$$0 \text{ if } S_T > X$$

The short position has the obligation to buy the underlying asset at the exercise price if holder of the option chooses to exercise. Therefore the payoff to the short put position is given by:
$$-(X - S_T) \text{ if } S_T < X$$
$$0 \text{ if } S_T > X$$

The profit to long put position takes into account the premium – that is, how much the option's holder paid for the option. Let P denote the option premium.
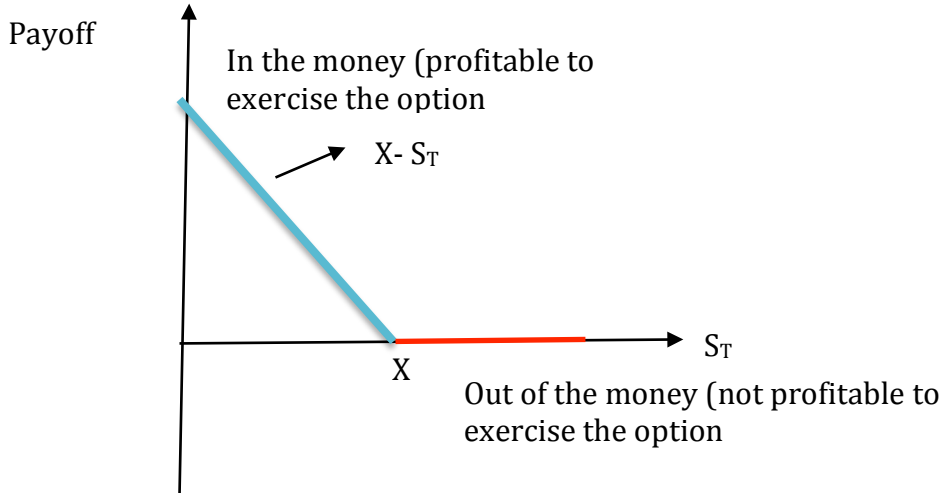
Profit to long put position:
$$X - S_T - P \text{ if } S_T < X$$
$$-P \text{ if } S_T > X$$

Payoff to short put position:
$$P - (X - S_T) \text{ if } S_T < X$$
$$P \text{ if } S_T > X$$

Payoff diagram for a long put position

Payoff

In the money (profitable to exercise the option

$X - S_T$

X

S_T

Out of the money (not profitable to exercise the option

The payoff diagram for the short put position will be the mirror image of this flipped along the x-axis.

Example
Suppose that you have a portfolio of 100 shares of the stock of the company "Econ Plus". On January 16, the stock has a trading price of $50. A put option (each contract size consists of 100 shares) with a strike price of $50 and an expiration date on February 15 is trading at $6 each share. What would your total payoff on the option contract be at expiration date if you bought the put option to protect the value of your portfolio and the stock price dropped to $30? What would your total profit be?

$$S_T = \$30$$
$$X = \$50$$

$$Total\ payoff = 100 \times (50 - 30) = \$2000$$

$$Total\ profit = 100 \times (50 - 30 - 6) = \$1400$$