

Characteristics of Options Markets

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Option Contracts

- An **option** is a type of derivative contract.
- Its payoff depends on the value of another asset, such as stock, an index, a commodity, etc.
- There are two type of options:
 - A **call** option gives the holder the right to buy an asset by a certain date for a certain price
 - A **put** option gives the holder the right to sell an asset by a certain date for a certain price
- It is important to note that only the buyer of the option can choose whether or not to exercise the contract:
 - The buyer of the option holds the **long** position.
 - The seller or **writer** of the option holds the **short** position.

Underlying Assets

- Options can be written on a variety of assets such as:
 - Stocks
 - Exchange-Traded Funds (ETFs)
 - Exchange-Traded Notes (ETNs)
 - Indices
 - Futures
 - Currencies
 - Commodities
 - Interest Rates
 - Bonds
 - Swaps
- Options can also be embedded in other financial assets such as bonds or swaps.

Options Terminology

- The asset on which the option is written is called the **underlying** asset whose price is usually denoted by S .
- The date specified in the contract is called the **expiration** or **maturity** date.
- The time remaining until the expiration date is called **time-to-maturity** and is denoted by T .
- The price specified in the contract is known as the **exercise** or **strike** price and is denoted by K .
- The option's price per unit of underlying asset is usually called the option **premium**.

Early Exercise

- Options can be of American or European type, among others.
- An **American** option can be exercised anytime up to the expiration date.
 - Most options traded on exchanges are American, such as options on stocks and futures.
 - It is in general hard to determine when it is optimal to exercise early.
- A **European** option can be exercised only at maturity.
 - European options are found, for example, in the OTC currency market, and most recently in futures exchanges as well.
 - It is easier to analyze and price European options, although the methods we will learn in this class will apply for American type options as well.

Call Option Payoff

- Consider a stock call option with maturity 1 year, strike price \$100 and currently trading at \$14.
- If the stock price at expiration is \$120:
 - It makes sense for the buyer of the option to exercise it and purchase the stock for \$100.
 - The payoff (per share) for the buyer is $120 - 100 = \$20$ generating a profit of $20 - 14 = \$6$.
 - The return on investment is $6/14 = 42.9\%$.
- If on the other hand the stock price at expiration is \$80:
 - It does not make sense to exercise the option and pay \$100 for an asset that trades for \$80.
 - The payoff is therefore \$0 and the profit is $0 - 14 = -\$14$.
 - The return on investment in this case is $-14/14 = -100\%$.

Call Option Payoff Table

- We can compute the payoff, profit and return (per share) for different values of the stock price at exercise.

Stock Price	60	80	100	120	140
Payoff	0	0	0	20	40
Profit	-14	-14	-14	6	26
Return (%)	-100	-100	-100	42.9	185.7

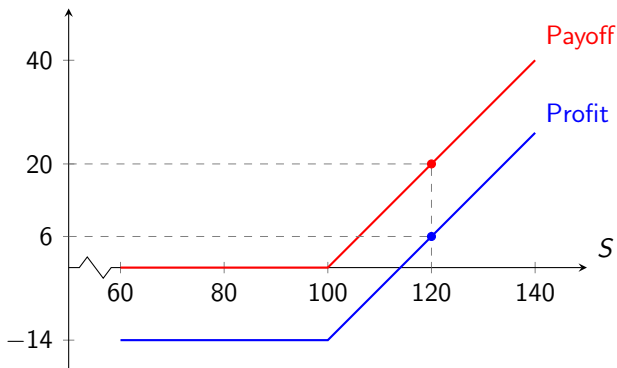
- It is apparent from the table that the payoff for the buyer of the call option can be computed as:

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

- The profit is just equal to the payoff minus the option premium.

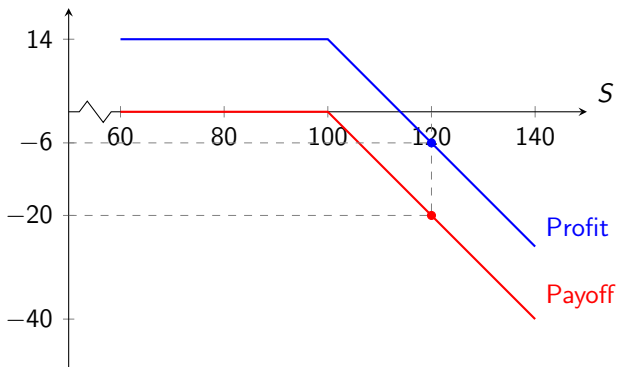
Call Option Diagram: Buyer's Perspective

- It is useful to plot the payoff and profit of the call option in a graph.



Call Option Diagram: Seller's Perspective

- The payoff and profit diagram of the short position is the mirror image of the long position with respect to the x-axis.

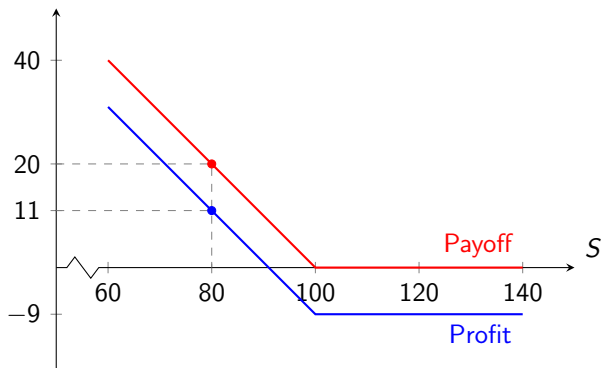


Put Option Payoff

- Consider a stock put option with maturity 1 year, strike price \$100 and currently trading at \$9.
- If the stock price at expiration is \$80:
 - It makes sense for the buyer of the option to exercise it and sell the stock for \$100.
 - The payoff (per share) for the buyer is $100 - 80 = \$20$ generating a profit of $20 - 9 = \$11$.
 - The return on investment is $11/9 = 122.22\%$.
- If on the other hand the stock price at expiration is \$120:
 - It does not make sense to exercise the option and get \$100 for an asset that trades for \$120.
 - The payoff is therefore \$0 and the profit is $0 - 9 = -\$9$.
 - The return on investment in this case is $-9/9 = -100\%$.

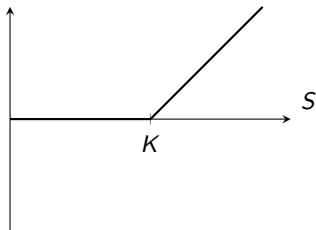
Put Option Diagram: Buyer's Perspective

- As before, we can plot the payoff and profit of the put option.

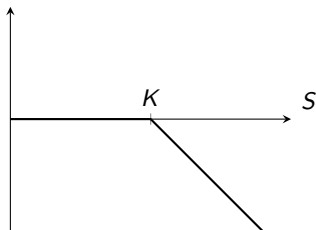


Summary – Option Payoff Diagrams

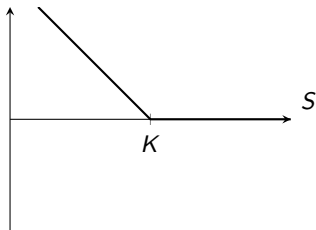
Long Call



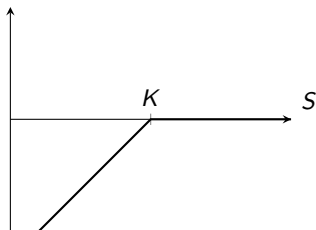
Short Call



Long Put



Short Put



Option Moneyness

- An option is said to be:
 - **In-the-money** (ITM) if it is profitable to exercise it immediately.
 - **At-the-money** (ATM) if the strike is equal to the current spot price.
 - **At-the-money-forward** (ATMF) if the strike is equal to the forward price with the same maturity as the option.
 - **Out-of-the-money** (OTM) if it is not profitable to exercise it immediately.
- The following table describes the moneyness of call and put options based on the level of the spot price.

	Call	Put
Out-of-the-money	$K > S$	$K < S$
At-the-money	$K = S$	
At-the-money-forward	$K = F$	
In-the-money	$K < S$	$K > S$

Contract Size

- Call and put option contracts are in general written over several units of the underlying asset, such as 100 shares, but their prices are quoted per unit of the underlying asset.
- For example, consider a put option contract on 100 shares of AAPL stock with strike \$110.
- If the current stock price is \$122 and the price of an option to sell one share in 3 months is \$0.85, the payoff and profit of a contract (100 shares) for different values of the spot price at maturity is:

Stock Price	80	90	100	110	120	130
Payoff	3,000	2,000	1,000	0	0	0
Profit	2,915	1,915	915	-85	-85	-85
Return (%)	3,429	2,253	1,076	-100	-100	-100

Traded Volume vs. Open Interest

- For both call and put options, for every long position there is a corresponding short position, i.e., the contracts are in zero net-supply.
- The total number of long positions, which is the same as the total number of short positions, is called open-interest.
- The traded volume on the other hand is the number of contracts that are bought or sold.
- Note that a trader can buy a contract, then sell it the same day.
 - The volume for that day would be 2 but the open-interest would not change.
- Traders look carefully at the ratio of long puts vs. calls in the S&P 500 which is commonly known as the put/call ratio.

Intrinsic and Time Value

- The intrinsic value of an option is the payoff that the buyer would get if the option was exercised immediately:

$$\text{Intrinsic Value} = \begin{cases} \max(S - K, 0) & \text{for a call} \\ \max(K - S, 0) & \text{for a put} \end{cases}$$

- The time value of the option is defined as the difference between the option premium and its intrinsic value:

$$\text{Time Value} = \text{Option Premium} - \text{Intrinsic Value}$$

- We will see later that even though the time value of an American options is always non-negative, the time value of a European option can be negative.