Brunel University
Msc., EC5504, Financial Engineering
Prof Menelaos Karanasos

Lecture Notes: Option Concepts and Fundamental Strategies

- Options and futures are known as derivative securities. They derive their value from the movement of the underlying asset (stocks, stock indices, foreign currencies, debt instruments, commodities, future contracts). Derivatives are important as a risk management tool. Farmers, portfolio managers, multinational businesses, and financial institutions often buy and sell derivatives to hedge positions they have in the derivative's underlying asset against adverse price changes. Derivatives are also used in speculation. Many investors find buying or selling options or futures an attractive alternative to buying or selling the derivative's underlying security. Finally, many investors and portfolio managers use derivatives for financial engineering, buying and selling different derivatives and the underlying security to create a portfolio that has certain desired features. Because of their speculative, hedging, and financial engineering uses, derivatives are an important part of our financial system.

- **Simple or linear forms of derivatives: forwards and futures.** They represent a right and the obligation to buy/deliver the underlying asset at a certain future time for a certain price (the delivery price). One of the parties to a forward/futures contract takes a long position and agrees to buy the underlying asset at the given date and price, while the other party takes a short position and agrees to sell the asset at the given date and price. Because of their simplicity, forwards and futures are also used as "underlying assets" upon which other derivatives (typically options) are written. Forwards and futures are used almost exclusively for "Directional Trades". Forwards and futures can be contrasted with spot contracts which are agreements to buy or sell the asset today. A forward contract is traded in the over-the-counter market, usually between two financial institutions or between a financial institution and its clients. Forward contracts are tailor made to meet the requirements of the two counterparties and as such they are neither very liquid nor very marketable. Unlike forwards, futures contracts are standardized agreements for future delivery of an asset and are normally traded on an exchange. At the time the contract is entered into, the delivery price is chosen so that the value of the forward

contract is zero to both sides. In general, the payoff from a position in a forward/futures contract on one unit of asset is

$$\begin{aligned} \text{long position} &: \quad \text{payoff} = S_T - K, \\ \text{short position} &: \quad \text{payoff} = K - S_T, \end{aligned}$$

where K is the delivery price, and S_T is the spot price of the asset at maturity (see Figure 1.1). The relationship between spot and forward prices will be examined in some detail in future lectures. The reason why the two prices are related can be illustrated with the following example. Suppose that the spot price of gold is \$300 per ounce, the risk-free interest rate for investments lasting one year is 5% per annum, and there are no storage costs associated with gold. In this case, using arbitrage arguments, we can show that the one-year forward price of gold is: $300\,(1 + 0.05) = \$315$.

- **Options or non-linear forms of derivatives.**[1] Since their valuation by Black and Scholes (1973) they provide the most accomplished leveraged way to trade both the direction and above all the volatility of the underlying market. Depending on the parties and types of assets involved, options can take on many different forms. However, certain features are common to all options. First, with every option contract there is a right, but not the obligation, either to buy or to sell. This fact distinguishes options from forwards and futures, where the holder is obligated to buy or sell the underlying asset. By definition, a call option gives the holder the right to buy the underlying asset by a certain date (exercise or expiration date or maturity) for a certain price (strike or exercise price). A put option gives the holder the right to sell the underlying asset by a certain date for a certain price. Second, every option contract has a buyer and a seller. The option buyer is referred to as the holder, and as having a long position. The holder buys the right to exercise, or evoke the terms of the option claim. The seller, often

[1] The option market in the US can be traced back to the 1840s, when options on several agricultural commodities were traded in New York. The early market for commodity option trading was relatively thin. The market did grow marginally in the early 1900s when a group of investment firms formed the Put and Call Brokers and Dealers Association to trade options on stocks on the over-the-counter (OTC) market. An investor who wanted to buy an option could do so through a member of the association who would find a seller. The OTC market was functional but failed to provide an adequate secondary market. In 1973, the Chicago Board of Trade (a futures exchange) formed the Chicago Board Option Exchange (CBOE). The CBOE was the first organized exchange for option trading. Since then there has been a dramatic growth in option markets.

referred to as the option writer, has a short position and is responsible for fulfilling the obligations of the option if the holder strikes. Third, every option has an option price, an exercise price and an exercise date. The price paid by the buyer to the writer for the option is referred to as the option premium (call premium and put premium). The exercise or strike price is the price specified in the option contract at which the underlying asset can be purchased (call) or sold (put). The exercise date is the last day the holder can exercise. Associated with the exercise date are the following definitions. A European option is one that can be exercised only on the expiration date. An American option can be exercised at any time on or before maturity.[2]

- Many types of **option strategies** exist, with esoteric names such as straddles, strips, spreads, and combinations. All these strategies can be understood easily once we grasp the features of the following fundamental option strategies. In all cases, it is worth noticing the non-linearity of the options payoff/profit functions.

- **Call Purchase or Long Call**: **the right to buy.** Suppose an investor buys a call option on ABC stock with an exercise price (X) of \$50 at a call premium (C_0) of \$3. If the stock price reaches \$60 and the holder exercises, a profit of \$7 will be realized: \$10 capital gain minus the \$3 premium. If the holder exercises when the stock is trading at \$53, s/he will break even. Finally, if the price of the stock is at \$50 or below, the holder will not find it profitable to exercise. Note that the maximum loss from the call purchase is \$3. So for a long position in the call option we have (see Figure 1.3-1)

$$\begin{aligned} \text{payoff} &: \max\left(S_T - X,\ 0\right), \\ \text{profit } \pi &= (S_T - X) - C_0, \end{aligned}$$

where S_T is the market price of the underlying asset at the time of the exercise, X is the strike price, and C_0 is the initial cost of the call at $t = 0$. Observe that the position provides an investor with unlimited profit potential; on the other hand the losses are limited to an amount equal to the call premium. These two features help explain why some speculators prefer buying a call rather than the underlying stock itself. Why is it necessary to pay for options? By paying the premium, you pay for an unlimited upside potential and you have the ability to walk

[2]Note that the terms American and European do not refer to the location of the option or the exchange.

away from it with a fixed loss (the premium). Suppose that you didn't have to pay for a call premium. This would be akin to going to the casino and the croupier gives you an unlimited supply of free chips. If this were the case, what would you do? Play roulette all the time. However, to prevent you from playing the roulette wheel infinitely the casino charges you for the chip. Likewise, to keep you from playing the option market perpetually with no risk, you are charged a premium, and that premium is what you stand to loose.

- **(Naked) Call Write or Short Call.** This involves the sale of a call in which the seller does not own the underlying stock. The payoffs to a call write are just the opposite of those to the call purchase, i.e. gains/losses for the buyer of a call are exactly equal to the losses/gains of the seller (see Figure 1.3-2). For a short position in the call option we have

$$\begin{aligned} \text{payoff} \quad &: \quad -\max\left(S_T - X,\ 0\right), \\ \text{profit } \pi \quad &= \quad -\left(S_T - X\right) + C_0. \end{aligned}$$

  Thus, in contrast to the long call, the short position in a call option provides the investor with only a limited profit opportunity (equal to the value of the premium) with unlimited loss possibilities. The motivation for an investor to write a call is the cash received and the expectation that the call will not be exercised.

- **Covered Call Write.** This is one of the most popular option strategies, it involves writing a call on a stock already owned. The benefit of the covered short call occurs when the stock price declines. (For an example see the relevant exercise in Problem Set 1.)

- **Put Purchase or Long Put.** Since a put gives the holder the right to sell the stock, profit is realized when the stock price declines. Assume again that the exercise price on the ABC stock is \$50 and the put premium (P_0) is \$3. If the stock price declines to \$40, the put holder could purchase the stock at \$40, then use the put contract to sell the stock at the strike price of \$50. Thus the put holder would realize a profit of \$7 (equal to \$10 capital gain minus the \$3 premium). Note that the break-even price in this case is \$47. Finally, if the stock is \$50 or higher at expiration, it will not be rational for the holder to exercise. As a result, a maximum loss equal to the \$3 premium will occur when the stock is trading at \$50 or more. For a long position in the put

option we generally have (see Figure 1.3-4):

$$\begin{aligned} \text{payoff} &: \max(X - S_T,\ 0), \\ \text{profit } \pi &= (X - S_T) - P_0, \end{aligned}$$

where S_T is the market price of the underlying asset at the time of the exercise, X is the strike price, and P_0 is the initial cost of the put at $t = 0$. Therefore, similar to a call purchase, a long put position provides the buyer with potentially large profit opportunities (not unlimited, since the price of the stock cannot be less than zero), while limiting the losses to the amount of the premium. Unlike the call purchase strategy, the long position in a put requires the stock price to decline before profit is realized.

- **(Naked) Put Write or Short Put: the obligation to buy.** The exact opposite position to a put purchase (in terms of profit or loss) is the sale of a put. Here, if the stock price is at \$50 or more, the holder will not exercise and the writer will profit by the amount of the premium \$3. In contrast, if the stock decreases, a loss is incurred. For example, if the holder exercises at \$40, the put writer must buy the stock at \$50. So the loss is \$7, i.e. \$10 capital loss minus the \$3 premium. For a short position in the put option we generally have (see Figure 1.3-5):

$$\begin{aligned} \text{payoff} &: -\max(X - S_T,\ 0), \\ \text{profit } \pi &= -(X - S_T) + P_0. \end{aligned}$$

  This situation can be compared to insurance. Insurance companies assume the potentially unlimited losses of their policy holders. What do they get from the insurance buyer in exchange for taking this risk? They receive a premium. An insurance company assumes all the risks in return for the receipt of a premium. Furthermore, the maximum gain it can hope for is the amount received for assuming that risk. Therefore, writers of options, like insurance writers, face an unlimited loss potential in exchange for a limited gain.

- **Covered Put Write.** This is the last fundamental option strategy, it requires the seller of a put to cover her position. Because the put writer has to buy the stock at the exercise price if the holder exercises, the only way she can cover the obligation is by selling the underlying stock short. Losses from covered put writes occur when the stock price rises above the break-even price. (For an example see the relevant exercise in Problem Set 1.)

- **Options as the "good" and "bad" features of the underlying asset.** Option markets split buying or selling positions in the underlying market into purely "good" and "bad" parts (see Figures 1a-1b). If we wanted to establish a buying position, meaning trades which benefit as prices rise we could either

  - purchase a futures contract with unlimited profit and loss potential, or
  - hold a call option with unlimited profit potential and a limited loss, or
  - write a put option with limited profit potential and an unlimited loss.

- If we wish to establish selling positions, meaning trades which profit as prices fall we could either

  - sell a futures contract with unlimited profit and loss potential, or
  - hold a put option with unlimited profit potential and a limited loss, or
  - write a call option with limited profit potential and an unlimited loss.

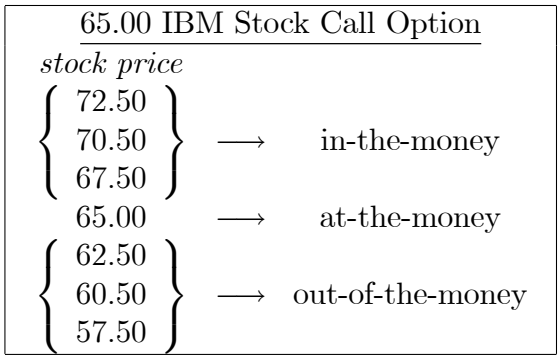
These positions are presented below:

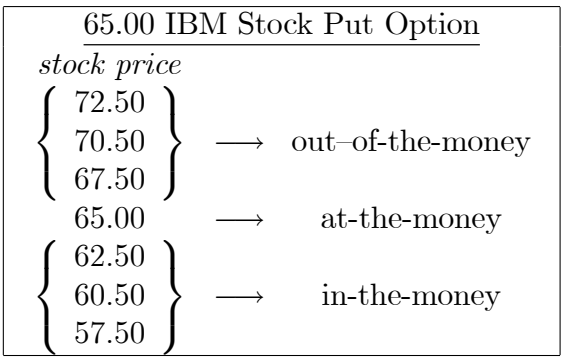
$$\begin{array}{ccc} \text{Underlying Market} \\ \text{Buying} \end{array} : \left\{ \begin{array}{c} \text{Holding a Call} \Longrightarrow \text{Right to Buy} \\ \text{Writing a Put} \Longrightarrow \text{Obligation to Buy} \end{array} \right\}$$

$$\begin{array}{ccc} \text{Underlying Market} \\ \text{Buying} \end{array} : \left\{ \begin{array}{c} \text{Holding a Put} \Longrightarrow \text{Right to Sell} \\ \text{Writing a Call} \Longrightarrow \text{Obligation to Sell} \end{array} \right\}$$

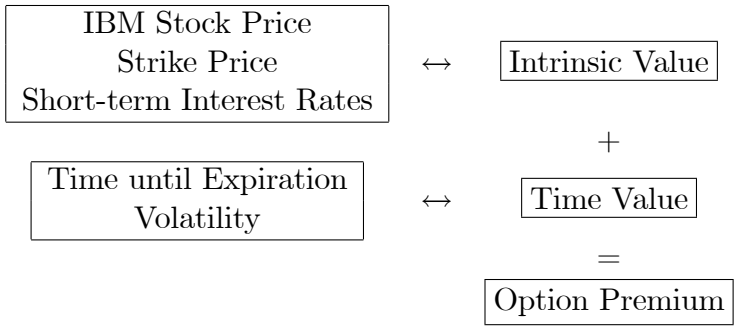
- In Figure 2 the profit and loss profiles of the four basic options strategies are plotted against each other. Note that the resultant pattern resembles the shape of a diamond.

- An option is **at-the-money** when the market price is trading at the same level as the strike price. If you have a \$65 call option on IBM and the current market price of IBM is \$65, the option is an at-the-money call option. If as a holder of an option you transact at the strike price and, relative to the underlying market, you have a cash inflow, that option is called **in-the-money.** For example, if the current price of IBM stock is \$70.50 and you could buy it at \$65 using a call option, you would have money coming in. In fact, for any stock price above \$65, the call will be defined as in-the-money. If you transact at the strike price of the option and, relative to the underlying market, you have a cash outflow, that option is called **out–of-the-money.** Consider a put option on IBM with a strike price of \$65, and suppose the market price of the IBM stock is \$70.50. If you exercised the put option you would buy at \$70.50 and then sell at \$65, so you would have a cash outflow of \$5.50 per share. The \$65 put option would then be called out-of-the-money.





- **The Fundamental Components of an Option Price.** The fundamental idea in option pricing is that an option price can be split into two components, intrinsic value and time value:



- The **intrinsic value** is simply the in-the-money amount. For example, suppose that you hold a \$65 IBM call option and the current stock price is \$65.5. If the option were exercised, the inflow of \$0.5 per share would result, making it an in-the-money option. Thus the intrinsic value is also \$0.5. Note that if the option is out-of-the-money, the in-the-money amount is equal to zero. The intrinsic value must then also be zero. It follows that the intrinsic value of an option will always be greater than or equal to zero. Now suppose that you hold a \$65 IBM put option. If the underlying market price falls to \$62, you could exercise the put and establish a short position at \$65. Then you could buy the underlying market back at \$62 and have a \$3 cash inflow. The put option is in-the-money and so its intrinsic value is \$3.

IBM Stock Price	Intrinsic Value 65.00 Call	Intrinsic Value 65.00 Put
62.00	0.00	3.00
.....	.....	.....
64.50	0.00	0.50
65.00	0.00	0.00
65.50	0.50	0.00
.....	.....	.....
68.00	3.00	0.00

- Taking the actual option's price and subtracting the intrinsic value gives the **time value.** For example, suppose that IBM is trading at \$65 and you hold a \$60 call and a \$60 put. The price of the call is \$5.75, and the price of the put is \$0.75. The in-the-money amount for the call option is \$5, thus the intrinsic value is \$5. As the call option is trading at \$5.75, the remaining amount \$0.75 is the time value for the call. Since the market price is higher than the put strike price, the put is out-of-the-money and its intrinsic value is zero. Since the put has a price of \$0.75, the entire value of the option is composed of time value.

IBM Stock Price	60.00 Call	60.00 Put
65.00	5 3/4	3/4

Call:	Intrinsic Value	=	65.00 - 60.00	=	5.00
	Time Value	=	5 3/4 - 5.00	=	3/4
	Option Premium	=	5.00 + 3/4	=	5 3/4

Put:	Intrinsic Value	=	60.00 - 65.00	or	0.00
	Time Value	=	3/4 - 0.00	=	3/4
	Option Premium	=	0.00 + 3/4	=	5 3/4