

Option: Introduction (Chapter 1, S. Roman)

Our goal is to estimate the *current fair value* of the *option* to buy (or the option to sell) a given asset over some period of time in the future. This is done by assuming that the asset in question will have one of several possible values in the future and trying to determine a current fair value of the option based on these possible future values.

The option to buy (or the option to sell) a stock for a fixed value in the future is called a **stock option**. An option to buy is called a **call** and an option to sell is called a **put**. The buying (or selling) price is called the **strike price**. As we will see, options can be based on assets other than stocks, although stock options are by far the most common form of option.

If a call has a strike price that is less than the current market value of the asset, then the option has immediate value and is said to be **in the money**. Similarly, a put is in the money at a given time if the strike price is greater than the current market price of the asset.

Stock Options

Stock options take two forms: *put options (puts)* and *call options (calls)*. Here are the definitions.

Definition A **stock option** is a contract between the **writer (seller)** of the option and the **buyer** of the option. The writer has a **short position** and the buyer has a **long position**. Every option has an **underlying stock**, an **expiration date** and a **strike price**, also called a **striking price** or **exercise price**.

1) In a **call option**, the buyer has the right to buy the underlying stock from the writer at the strike price O per share.

a) In a **European call**, the right to buy can only be exercised on the expiration date of the call.

b) In an **American call**, the right to buy can be exercised at any time on

or before the expiration date of the call.

2) In a **put option**, the buyer has the right to sell the underlying stock to the writer at the strike price O per share.

a) In a **European put**, the right to sell can only be exercised on the expiration date of the call.

b) In an **American put**, the right to sell can be exercised at any time on or before the expiration date of the call.

We will generally reserve the letter K for the strike price of an option and the letter S for the price of the underlying stock. The cost of a call will be denoted by C and the cost of a put by P .

Exchanges

Most but not all stocks have associated options. Options on major stocks are generally traded through an *options exchange*, the largest of which is the **Chicago Board of Options Exchange (CBOE)**. The exchange determines the terms of an option, such as the expiration date and strike price. Generally speaking, options are traded in **round lots** of 100 underlying shares; that is, each options contract is a contract to buy or sell 100 shares of the underlying stock. (Contract sizes can vary when the underlying stock has undergone a stock split.) However, we will assume for our mathematical models that any *real number* of options can be purchased.

Expiration Dates

The last trading day of an option is the third Friday of the expiration month and the option actually expires on the following Saturday. Every stock option is on one of three **expiration cycles**, which consists of one month per quarter, equally spaced 3 months apart, but starting at different months:

1) *January cycle*: Jan, Apr, July, Oct

2) *February cycle*: Feb, May, Aug, Nov

3) *March cycle*: Mar, June, Sept, Dec

If the expiration date for the current month has not passed, then there exist options that trade with expiration dates in the current month, the next month and the following two months of the cycle for that underlying. If the expiration date for the current month has passed, then there exist options that trade for the next month, the month after that and the following two months in the cycle.

For example, IBM is on the January cycle. At the beginning of January, there are options that expire in January, February, April and July. Late in January, there are options that expire in February, March, April and July. At the beginning of May, options expire in May, June, July and October.

Strike Prices

The CBOE normally sets the strike prices for its options so that they are spaced \$2.50, \$5 or \$10 apart. Stocks at lower prices have smaller spaces between strike prices. When options with a new expiration date are introduced, the CBOE usually introduces two or three options with strikes nearest to the current stock price. If the price moves outside this range, new strikes may be introduced. For example, if new October options are offered on a stock currently priced at \$84, then options striking at \$80, \$85 and \$90 might be created. If the price rises above \$90, a new strike at \$95 might be introduced.

Option Symbol:

For example, in 2010, an IBM July 125 call has expiration date July 17, 2010 and so the symbol is

IBM100717C00125000

- 1 The first portion of the symbol) is the underlying company's root symbol.
- 2) This is followed by two characters each for the maturity year, month and day.
- 3) This is followed by a "C" for call or a "P" for put.
- 4) The final portion of the symbol is the strike price. Here five characters are devoted to the dollar portion and three characters to any decimal portion.

The Role of the Options Clearing Corporation

When an investor instructs his broker to buy or sell an option, the broker transmits this request to the firm's *floor broker* on the appropriate options exchange, who attempts to locate another floor broker (or other official) who has instructions to perform the opposite transaction on behalf of another investor. The trade is then made and both brokers record the details of the transaction. This entire process generally takes only a few minutes.

However, under this simple scenario, the buyer of the option would have to trust the seller to make good on his obligation to buy/sell the underlying. It is the role of the **Options Clearing Corporation (OCC)** to remove this dependency. At the end of the day, the OCC examines all of the day's trading, matching each sale with the corresponding purchase. It then inserts itself between the buyer and the seller, playing the role of the buyer for the seller and the role of the seller for the buyer. Hence, each investor deals only with the OCC (indirectly) and not the other investor. The OCC has sufficient resources to make good on any amounts owed as well as to enforce any collection, should that be required.

Example 1.1 Consider the purchase and sale of options, all with the same expiration date, given by the following expression:

$$-P_{100} + P_{120} + 2C_{150} - C_{180}$$

This position is: short a put with strike price 100, long a put with strike price 120, long two calls with strike price 150 and short a call with strike price 180. The overall payoff curve can be obtained from the individual payoff curves by plotting them all on a single set of coordinates, as shown in Figure 1.4. Note that it is simpler to ignore all costs in drawing the curves and then simply translate the final curve an amount equal to the total cost for all the options in the portfolio, which in this case is

$$-\text{Cost}(P_{100}) + \text{Cost}(P_{120}) + 2\text{Cost}(C_{150}) - \text{Cost}(C_{180}) \quad \square$$

