Chapter 13
Secondary Markets:
Derivative Investments:
Options Strategies, Analysis & Valuation

This chapter will give an overview of the options market. It will describe various strategies used by investors for hedging or speculating on significant stock increase or decrease. It will then discuss how you value such options including various methods such as the Binomial Option Pricing Models (BOPM), Black-Scholls and Call-Put Parity. The chapter will first re-introduce mathematical concepts such as probability theory, normal distribution, natural logarithms and standard deviation as the basis of predicting the stock movements.

Learning Objectives

After reading this chapter, students will be able to**:**

- Understand how the options' markets works and how these types of investments are traded and managed as part of an overall investment strategy.
- Understand the various option strategies including buy and sell covered and uncovered (naked) options
- Understand how the options are valued and calculated using various methods including the Binomial Option Pricing Models (BOPM), Black-Scholes, Call-Put Parity, Hedge and Leverage methods.

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AUTHOR'S NOTES:

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https://www.google.com/search?q=mcelligot%27s+pool&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjsoZHYgNXhAhWtc98KHRpeA_oQ_AUIECgD&biw=1696&bih=970#imgrc=H65-6j7JaE42wM:

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I didn't know it at the time, but my very first "finance" book is Dr. Seuss's McElligot's Pool. I was four year's old and I was so fascinated with the story. I read this to my daughter, Amanda, when she was two years old and she still remembers it after all these years. Now, at the age of 30 she is an elementary school art teacher and told me that she read the book to the class of second graders. McElligot's Pool is of course a children's book written by Dr. Seuss. Its about a boy named Marco who is sitting by a small 6 ft pool with a fishing rod waiting there patiently for three hours to catch a fish. The very first page of the book sets the mood. It shows a farmer laughing at Marco and saying, in Dr. Seuss's brilliant rhymed way:

> *"Young man…. you are sort of a **fool**! You'll never catch fish in McElligot's **Pool**!*
> *The pool is too small. And, you might as well **know it**, when people have junk, here is when they **throw it**.*
> *You might catch a boot, or you might catch a can. You might catch a bottle, but listen, young man… If you sat fifty years with your worms and your **wishes**, you'd grow a long beard, long before you'd catch **fishes**!"*

Marco strongly believed that this pool is connected to an underground brook that connect to a river that connect to the sea. Marco then imagines a school of fish at sea heading over to McElligot's pool – all kinds of fish including a fish with checkerboard stomach, an eel with heads on both ends and an imaginary dogfish that will be chasing the catfish as they make way to McElligot's pool. The imagination of kind of fish it makes it a very entertaining children's book. The book ends with the boy saying:

> *"Oh, the sea is so full of number of fish, if a fellow is patient, he might get his wish!*
> *And that's why I think, that I'm not such a fool, when I sit here and fish in McElligot's Pool!*

This children's story illustrated brilliantly by Dr. Seuss represents many investors that are hoping that the unlikely event will happen in the future - expecting huge payoff and they are willing to bet or buy out-of-the-money options today. Betting for the collapse of the housing market as is depicted in the book (and movie) by Michael Lewis the "The Big Short" where few investors try to *position themselves for a large payoff if the mortgage-back securities default as the housing market defaults in 2008/2009 financial crisis. The derivatives market which includes options, futures, forwards and swaps are all type of investments that the expect a large payoff in the future. Since I joint Kinisis Ventures after 30+ years in banking I devoted many hours in valuing start-up companies that have zero revenues and hoping once day their innovative product will turn profitable. How do you value a company that has negative cash flow? Using many option valuation techniques is one way of setting up such outcome in the future.*

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KEY TAKEAWAYS:

- *Future events such as a significant rise or fall of a stock price or movements of interest rates or a specific default of a bond can be measured with probability theory found in many of the methodology models such as the Binomial Option Pricing Model and Black-Scholes.*
- *Many option strategies are designed to either protect the underline investments or enhance the overall exposure to a future event for maximum profit. Other option strategies, such spreads are designed to minimize the upfront costs of premiums.*
- *An investor that trades options gains a better understanding of stock movements and patents.*

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Option Markets- Overview

Options paly a significant role in the financial markets. These types of securities are derived by the process of other securities such stock or bond prices. Options and futures (futures discussed in the next chapter) are derivative securities. Their payoff is depended on other securities. Option contracts are traded in many exchange markets such as the Chicago Board Option Exchange (CBOE) and over-the-counter markets. These option contracts include two types of options: Call options and put options. Each type can be used in conjunction with other strategies. These strategies described in this chapter can be buying or selling "uncovered" or "covered" contracts. Uncovered or "naked" are speculative strategies of buying or selling these options without owning the underline investment or stock. Covered strategies involve buying or selling the option securities in conjunction of owning of buying the stock.

They are two types of option contract structures: American and European. The American option contract is structured in such that the buyer of the option can exercise his or her rights to buy or sell the stock anytime from the day the contract is signed until expiration. The European option contract is structured as such that the investor can only exercise the option on the expiration day. You can get out of both options anytime by selling your contract at the market premium anytime until expiration. Given the difference, the price of each type of structure is priced at such. The valuation methods that will be discussed later in the chapter takes into consideration each of these structures.

Uncovered (naked) Option Strategy Contracts

Uncovered or also known as “naked” option strategies are buying or selling options primarily on speculation where the investor does not hold any of the underline asset, in this case stock, that the option premium is derived from. The following three strategies including buying and selling call options, put options and straddles are described below:

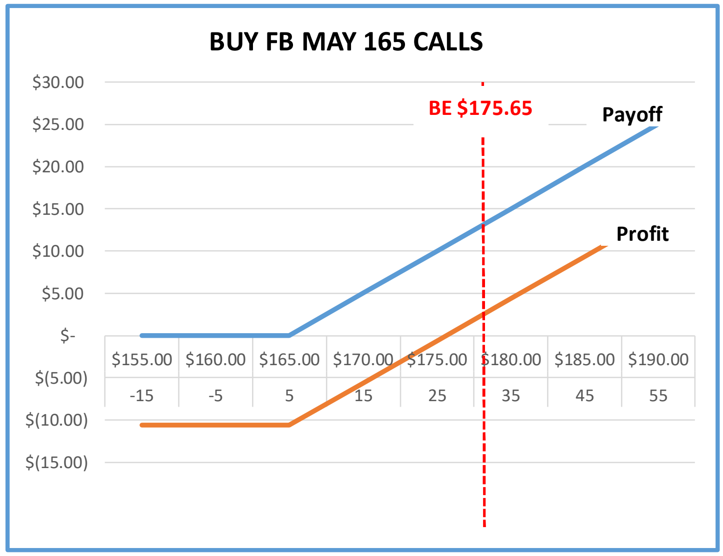
1. Buying Call Option

A call option is a contract that gives the holder the right, not the obligation, to buy 100 shares at a set price called the exercise price (X) at and before the set date, referred to as the expiration date, no matter what happens to the stock. Of course, if you have the right to buy the stock at a set price, you are hoping that the stock goes up significantly so you could profit the difference representing a **bullish view** on the stock. For example, a May call option on shares of Facebook with exercise price of $165 entitles its owner to buy 100 shares of Facebook at price of $165 at any time up until the third week of May (contract expiration date). If the Facebook stock goes to $180 before the third week of May, the option holder will exercise the right to buy Facebook at $165 and then turn around and sell the stock to the market at $180 profiting the $15 difference. If the stock of Facebook goes below $165, the option holder will let the contract expire without exercising. To purchase the option the investor needs to pay upfront a set price per share called premium. Figure 13.1 below shows the Payoff, Profit, Return (HPR), Break Even (BE) stock of Facebook at various scenarios of the stock (using range $155 - $190).

Insert Figure 13.1

1. UNCOVERED (NAKED) OPTION STRATEGIES - Buying a Call Option

FB	CALLS		
Exercise Price (X)	**MARCH**	**APRIL**	**MAY**
150	20.00	21.50	23.00
155	15.50	16.25	17.75
160	12.50	12.85	13.50
165	8.10	9.00	10.65
170	5.20	6.30	8.50
175	3.25	4.25	5.75
180	2.50	3.40	4.45



ACTION

Buy Call @ Exercise (X) = $ 165.00

Pay Premium **(p)** = $ 10.65

Break Even = $ 175.65

Max Loss = $ (10.65)

Max Gain = Unlimited

Out-of-the-money Option

On-the-money Option

In-of-the-money Option

INPUT		
	X	p
ACTION	**Exercise Price (X)**	**Premium Per Share (p)**
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)
Buy May	$ 165.00	$ (10.65)

WHAT IF SCENARIO
S
Stock Price (S)
$ 155.00
$ 160.00
$ 165.00
$ 170.00
$ 175.00
$ 180.00
$ 185.00
$ 190.00

OUTPUT				
	O = max (0,S-X)	(π) = O - p	HPR % = π / p	X + p
Exercise Y/N?	**Payoff (O)**	**Profit (π)**	**HPR (%)**	**Break Even Stock**
No	$ -	$ (10.65)	-100.0%	$ 175.65
No	$ -	$ (10.65)	-100.0%	$ 175.65
No	$ -	$ (10.65)	-100.0%	$ 175.65
Yes	$ 5.00	$ (5.65)	-53.1%	$ 175.65
Yes	$ 10.00	$ (0.65)	-6.1%	$ 175.65
Yes	$ 15.00	$ 4.35	40.8%	$ 175.65
Yes	$ 20.00	$ 9.35	87.8%	$ 175.65
Yes	$ 25.00	$ 14.35	134.7%	$ 175.65

Figure 13.1

Figure 13.1 above shows that if the range of the stock is below $165, the call option is not exercisable since the Stock (S) minus Exercise Price (X) is negative representing the out-on-money option. At $165 where the Stock (S) is equal to the Exercise Price (X) the call option is at the money and not also exercisable since there is zero payoff (S – X = 0). If the stock is higher than $165, the call option is exercisable or in-the-money option. It's important to note that being in-the-money does not necessarily mean that the option is profitable. It means that there is a payoff. Using the example in Figure 13.1, it shows that if the stock is at $170 on the last day that the investor needs to exercise the option, the payoff per share is $5 (S-X=Payoff or $170 - $165 = $5). The investor will still exercise even though the transaction is not profitable since he or she paid $10.65 for the option. By exercising they at least recover some of the premium paid, so instead of losing the entire premium of $10.65, by exercising the call option at $165 the investor recovers $5 back showing a loss of $5.65 per share. The rule is that the investor always exercises the option if the option is in the money or S-X>0.

The following formulas are used for calculating the output when buying the call option:

Call Option Payoff = Maximum (0, Stock Price – Exercise Price), Max (0, S-X)
Call Option Profit = Payoff – Premium
Holding Period Return % = Profit / Premium
Break Even Stock Price for Call Option = Exercise Price + Premium
Maximum Loss on buying a Call Option = The Premium
Maximum Gain on buying a Call Option = Unlimited

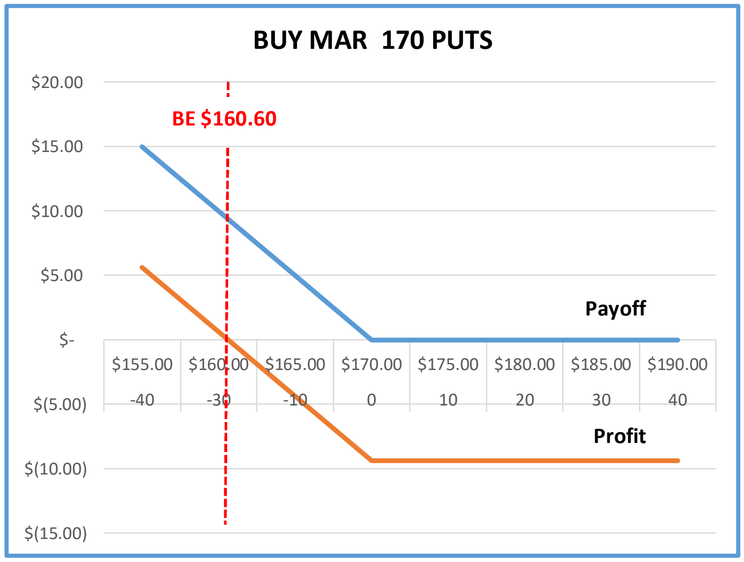
2. Buying Put Option

A put option is a contract that gives the holder the right, not the obligation, to sell 100 shares at a set price called the exercise price (X) at and before the set date, referred to as the expiration date, no matter what happens to the stock. Of course, if you have the right to sell the stock at a set price, you are hoping that the stock goes down significantly so you could profit the difference representing a **bearish view** on the stock. For example, a March put option on shares of Facebook with exercise price of $170 entitles its owner to sell 100 shares of Facebook at price of $170 at any time up until the third week of March (contract expiration date). If the Facebook stock goes down $155 before the third week of March, the option holder could buy the stock from the market at $155 and exercise the right to sell at $170 profiting the $15 difference. If the stock of Facebook goes above $170, the option holder will let the contract expire without exercising. To purchase the option the investor needs to pay upfront a set price per share called premium. Figure 13.2 below shows the Payoff, Profit, Return (HPR), Break Even (BE) stock of Facebook at various scenarios of the stock (using range $155 - $190).

Insert Figure 13.2

2. UNCOVERED (NAKED) OPTION STRATEGIES - Buying a Put Option

FB	PUTS		
Exercise Price (X)	MARCH	APRIL	MAY
150	3.00	3.50	4.45
155	4.10	4.90	5.90
160	5.30	6.00	6.80
165	7.00	8.00	9.20
170	9.40	10.75	12.45
175	13.00	14.30	14.20
180	15.00	16.10	17.75



ACTION

Buy Put @ Exercise (X) = $ 170.00

Pay Premium (p) = $ 9.40

Break Even = $ 160.60

Max Loss = $ (9.40)

Max Gain = X - Premium at S=0

	Out-of-the-money Option
	On-the-money Option
	In-of-the-money Option

INPUT			WHAT IF SCENARIO	OUTPUT				
	X	p	S		O = max (0,X-S)	(π) = O - p	HPR % = π / p	X + p
ACTION	Exercise Price (X)	Premium Per Share (p)	Stock Price (S)	Exercise Y/N?	Payoff (O)	Profit (π)	HPR (%)	Break Even Stock
Buy May	$ 170.00	$ (9.40)	$ 155.00	Yes	$ 15.00	$ 5.60	59.6%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 160.00	Yes	$ 10.00	$ 0.60	6.4%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 165.00	Yes	$ 5.00	$ (4.40)	-46.8%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 170.00	No	$ -	$ (9.40)	-100.0%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 175.00	No	$ -	$ (9.40)	-100.0%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 180.00	No	$ -	$ (9.40)	-100.0%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 185.00	No	$ -	$ (9.40)	-100.0%	$ 160.60
Buy May	$ 170.00	$ (9.40)	$ 190.00	No	$ -	$ (9.40)	-100.0%	$ 160.60

Figure 13.2

Figure 13.2 above shows that if the range of the stock is above $170, the put option is not exercisable since the Exercise Price (X) minus the Stock price (S) is negative representing the out-on-money option. At $170 where the Stock (S) is equal to the Exercise Price (X) the call option is at the money and not also exercisable since there is zero payoff (X – S = 0). If the stock is lower than $170, the put option is exercisable or in-the-money option. It's important to note that being in-the-money does not necessarily mean that the option is profitable. It means that there is a payoff. Using the example in Figure 13.2, it shows that if the stock is at $165 on the last day that the investor needs to exercise the option, the payoff per share is $5 (X – S =Payoff or $170 - $165 = $5). The investor will still exercise even though the transaction is not profitable since he or she paid $9.40 for the option. By exercising they at least recover some of the premium paid – in this case $5 calculating the loss of $4.40 per share instead of the entire premium of $9.40. The rule is that the investor always exercises the option if the option is in the money or X-S>0.

The following formulas are used for calculating the output when buying the put option:

Put Option Payoff = Maximum (0, Exercise Price – Stock Price), Max (0, X-S)
Put Option Profit = Payoff – Premium
Holding Period Return % = Profit / Premium
Break Even Stock Price for Put Option = Exercise Price – Premium
Maximum Loss on buying a Put Option = The Premium
Maximum Gain on buying a Put Option = Exercise Price – Premium at Stock=0

Selling Call and Put Options

Selling call and put options are contracts that the seller has the obligation to sell or buy 100 shares, respectively when the buyer exercises his or her option at the exercise price. The seller of options receives the premium and is hoping that the stock remains out-of-the money until expiration, so he or she could keep the premium. Selling uncovered or naked call options is the most dangerous play since the loss could be unlimited if the stock significantly rises above the exercise price. Selling uncovered or naked puts is also very dangerous if the stock goes down to zero. It's usually advised to sell call or put options in conjunction with either holding the stock (covered later in this chapter) or in combination with a buy of option (covered later in this chapter).

The following formulas are used for calculating the output when selling the call and put options:

Call Option Payoff = Stock Price – Exercise Price
Break Even Stock Price for Call Option = Exercise Price + Premium
Maximum Loss on selling a Call Option = Unlimited
Maximum Gain on selling a Call Option = Premium

Put Option Payoff = Exercise Price – Stock Price
Break Even Stock Price for Put Option = Exercise Price – Premium
Maximum Loss on selling a Put Option = Exercise Price – Premium at Stock=0
Maximum Gain on selling a Put Option = Premium

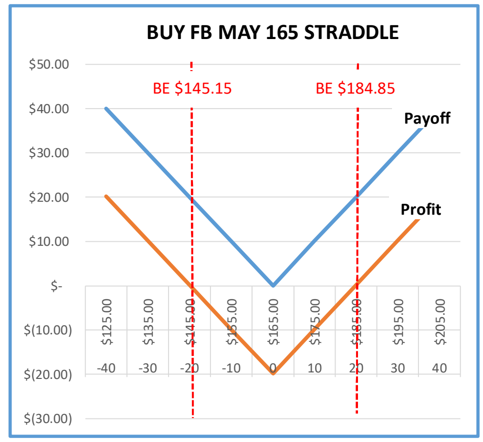
3. Buying and Selling Straddles

A Straddle contract involves a buy of both calls and puts at the same exercise price. This is a contract that gives the holder the right, not the obligation, to buy or sell 100 shares at a set exercise price (X) at and before the set date, referred to as the expiration date, no matter what happens to the stock. The strategy for buying both the call the put options represents the view of buying the stock volatility. This is a strategy that the investor expects that the stock will significantly move up or down based on a coming announcement. For example, if a pharmaceutical company will announce that the only drug they sell is approved or disapproved by the Federal Drug Administration (FDA). If it's approved, the stock expects to increase significantly, and the straddle holder will be exercising the option (supported by call option side of the straddle) to buy 100 shares of the stock at the exercised price (X). If the company announces that the FDA did not approve the drug so sell to the market, the stock expects to significantly decline especially if the company does not have any cash left to continue their research and development for another round. The seller of a straddle is hoping that the news will not have as much as an effect to of the stock price and stay within the breakeven points. Of course, the best-case scenario of the seller of straddles, which is the worst-case scenario of the buyer of straddles, is when the stock expires exercise price (S=X). For example, let's assume that the May call and put options on shares of Facebook with exercise price of $165 entitles its owner to buy or sell 100 shares of Facebook at price of $165 at any time up until the third week of May (contract expiration date). If the Facebook stock goes above or below $165 by expiration day, the straddle option holder will exercise the right to buy or sell Facebook, at $165, respectively and get paid the difference. To purchase the straddle option the investor needs to pay upfront both call and put premiums. Figure 13.3 below shows the Payoff, Profit, Return (HPR), the two Break Evens (BE1 and BE2) of Facebook's stock at various scenarios of the stock (using range $125 - $205).

Insert Figure 13.3

3. UNCOVERED (NAKED) OPTION STRATEGIES - Buying Straddles

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



ACTION

Strategy: Buying a Call and Put at the same X

Buy Call & Put @ (X) = $ 165.00

Pay both Total Prem. **(p)** = $ 19.85 (10.65+9.20)

Two Break Evens = $ 184.85 $ 145.15

Max Loss = $ (19.85)

Max Gain = Unlimited

On-the-money Option

In-of-the-money Option

INPUT			WHAT IF SCENARIO	OUTPUT					
	X	p	S		O = (S-X) or (X-S)	(π) = O - p	HPR % = π / p	X + p	X -p
ACTION	Exercise Price (X)	Premium Per Share (p)	Stock Price (S)	Exercise Y/N?	Payoff (O)	Profit (π)	HPR (%)	Break Even Stock 1	Break Even Stock 2
Buy May	$ 165.00	$ (19.85)	$ 125.00	Yes	$ 40.00	$ 20.15	101.5%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 135.00	Yes	$ 30.00	$ 10.15	51.1%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 145.00	Yes	$ 20.00	$ 0.15	0.8%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 155.00	Yes	$ 10.00	$ (9.85)	-49.6%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 165.00	No	$ -	$ (19.85)	-100.0%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 175.00	Yes	$ 10.00	$ (9.85)	-49.6%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 185.00	Yes	$ 20.00	$ 0.15	0.8%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 195.00	Yes	$ 30.00	$ 10.15	51.1%	$ 184.85	$ 145.15
Buy May	$ 165.00	$ (19.85)	$ 205.00	Yes	$ 40.00	$ 20.15	101.5%	$ 184.85	$ 145.15

Figure 13.3

Figure 13.3 above shows that if the range of the stock is above or below $165, the straddle option is-in-the-money, is exercisable and the payoff is the S – X or X – S. At $165 where the Stock (S) is equal to the Exercise Price (X) the call option is at the money and not exercisable since there is zero payoff (X – S = 0). Looking at Figure 13.3, let's assume the stock significantly increases to $205 by the expiration day. The straddle holder will exercise the right to buy the stock at $165 calculating a payoff of $40 (S – X = $205 - $165). With the $40 payoff the profit will be $20.15 (Payoff – Total Premiums for both call and put options = $40.00 – $19.85). In general, the Straddle holder will always exercise except in the unlikely event that the stock is equal to the exercise price – basically no volatility.

The following formulas are used for calculating the output when buying the straddle option:

Straddle Option Payoff = Exercise Price – Stock Price or Stock Price – Exercise Price
Straddle Option Profit = Payoff – Both Call and Put Premiums
Holding Period Return % = Profit / Both Call and Put Premium
Both Break Even Stock Price for Straddle Option = Exercise Price – Premium and Exercise

+ Premium
Maximum Loss on buying a Straddle Option = The Premium (assuming S – X = 0)
Maximum Gain on buying Straddle Option = Unlimited

Covered Option Strategy Contracts

Covered option strategies are buying or selling options primarily for hedging purposes. The strategy called covered option strategy is typically a strategy where the investor buys or sells options in conjunction with buying or selling the underline stock that these option premium prices are derived. Another reason to use this covered strategy is to enhance the overall exposure by maximizing the gain on both the underline stock and option securities. The following three strategies including Protective Puts, Covered Calls and the combination for the two called Collars are described below:

1. Protective Put Strategy

A protective put strategy is a strategy where the investor buys or owns the underline stock and simultaneously buys put options to hedge his or her holdings in case the stock drops. This is like buying insurance on the stock. If the stock drops in price the price is protected by exercising the option to sell the stock at X price. For example, let's assume the investor buys 100 shares of Facebook at the current price of $163.00 (February 20) investing $16,300 ($163 x 100 shares). The investor is concern that the stock will drop in the next few months so he buys the $165 May call option paying premium of $9.20 per share for 100 shares or $920.00. The total cost of the investment including the option is $17,220 ($16,300 + 920.00). Figure 13.4 below shows the protective put strategy on various stock price scenarios assuming the investor sells the stock at the market price. The output shows the profit and loss as well as the Holding Period Return on the strategy. Figure 13.4 shows the maximum loss on selling the stock at any price below $165 is capped at $720. If the stock was not hedged by setting a protective put, assuming the stock drops to $125 the loss will be at $3,800 ($163-125 = $38 loss x 100 shares). By having the protective put option, the maximum loss is capped at $720 as the investor exercises the right to sell the stock at $165 no matter what. If the stock increases to $205, the investor could sell the stock record the gain on the stock as demonstrated in Figure 13.4 showing $3,280 of profit net of premium. At $205, the put expires.

Insert Figure 13.4

1. COVERED OPTION STRATEGIES - Protective Puts — Current Price Facebook (FB) So = $163.00 (Feb 20)

FB	PUTS		
Exercise Price (X)	MARCH	APRIL	MAY
150	3.00	3.50	4.45
155	4.10	4.90	5.90
160	5.30	6.00	6.80
165	7.00	8.00	9.20
170	9.40	10.75	12.45

<u>Strategy: Buying or holding the Stock and Buying Put Option at X</u>

ACTION	Exercise (X)	Stock (S)/ Premium (p)	Number of Shares	Investment (I)
Buy the Stock =		$163.00	100	$ (16,300)
Buy Put at X =	$ 165.00			
Pay Prem. **(p)** =		$ 9.20	100	$ (920)

Total Initial Investment =	**$(17,220)**

INPUT					OUTPUT						
	STOCK INVEST	OPTION SECURITY		WHAT IF SCENARIO	STOCK INVEST	OPTION SECURITY		BOTH STOCKS AND OPTIONS			
	So	X	p	S	CG = S -So	O	π - p	(π - p + CG)	(π - p + CG) x Sh	I	NP / I
STRATEGY	Stock Purchase per share	Exercise Price (X)	Paid Premium Per Share (p)	Market Price Stock Price (S)	Stock Capital Gain/ (Loss)	Put Option Payoff (Hedging)	Profit from the Option per share	Net Profit per share	Net Profit (Total $) (NP)	Initial Investment	HPR%
Buy Stock & May Puts	$163.00	$ 165.00	$ (9.20)	$ 125.00	$ (38.00)	$ 40.00	$ 30.80	$ (7.20)	$ (720.00)	$ 17,220	-4.18%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 135.00	$ (28.00)	$ 30.00	$ 20.80	$ (7.20)	$ (720.00)	$ 17,220	-4.18%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 145.00	$ (18.00)	$ 20.00	$ 10.80	$ (7.20)	$ (720.00)	$ 17,220	-4.18%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 155.00	$ (8.00)	$ 10.00	$ 0.80	$ (7.20)	$ (720.00)	$ 17,220	-4.18%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 165.00	$ 2.00	$ -	$ (9.20)	$ (7.20)	$ (720.00)	$ 17,220	-4.18%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 175.00	$ 12.00	$ -	$ (9.20)	$ 2.80	$ 280.00	$ 17,220	1.63%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 185.00	$ 22.00	$ -	$ (9.20)	$ 12.80	$ 1,280.00	$ 17,220	7.43%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 195.00	$ 32.00	$ -	$ (9.20)	$ 22.80	$ 2,280.00	$ 17,220	13.24%
Buy Stock & May Puts	$ 163.00	$ 165.00	$ (9.20)	$ 205.00	$ 42.00	$ -	$ (9.20)	$ 32.80	$ 3,280.00	$ 17,220	19.05%

Figure 13.4

2. Covered Call Strategy

A covered call strategy is a strategy where the investor buys or owns the underline stock and simultaneously sells a call option of the same stock. This popular strategy referred to as writing cover calls is a low risk hedge strategy. What's interesting is that selling uncovered calls discussed earlier is the riskiest strategy with possible unlimited losses but if you sell calls while you own the stock it becomes the most conservative strategy. An example of who will be using this strategy is an investor that is planning to sell the stock soon at a higher than market level; so instead of setting up a limit order that instructs his broker to sell the stock when that higher price is met he or she could sell the equivalent shares in call options so he or she will receive the premium at a set future price. If the stock hits that higher price instead of paying the difference between the exercise price and the market price as a seller of calls, he or she can deliver the stock at that price or sel the stock in the market and cover the call option obligation from the profits made from selling the stock. For example, let's assume the investor holds 100 shares of Facebook, so at the current price of $163.00 (February 20) the investment is worth $16,300 ($163 x 100 shares). The investor is expected to sell the stock when the price gets to $180. Instead of putting a limit order, he enters into a cover call contract at the $180 level where he will be obliged to pay the difference between the market value above $180 and the exercise price of $180 (S – X). In return he will be receiving a premium of $4.45. If the stock goes above $180, he will either sell the stock at market price or deliver the stock to the buyer of the call option. If the stock goes to $180 exact (on-the-money), the stock will not be exercised. The investor holding the stock could sell it at $180 and record the gain in addition to the premium he received. The strategy is basically giving up a sudden upside of the stock but the investor no need to compliant if the stock jumps higher than $180 because the alternative was that he would have be selling the stock at the $180 though the limit order. Figure 13.5 shows the that the profit is capped at $2,145 if at any stock price above $180.00.

Insert Figure 13.5

2. COVERED OPTION STRATEGIES - Covered Calls — **Current Price Facebook (FB) So = $163.00 (Feb 20)**

FB	CALLS		
Exercise Price (X)	MARCH	APRIL	MAY
150	20.00	21.50	23.00
155	15.50	16.25	17.75
160	12.50	12.85	13.50
165	8.10	9.00	10.65
170	5.20	6.30	8.50
175	3.25	4.25	5.75
180	2.50	3.40	4.45

Strategy: Holding the Stock and Selling Call Option at X

ACTION	Exercise (X)	Stock (S)/ Premium (p)	Number of Shares	Investment (I)
Own the Stock (**So**) =		$163.00	100	$ (16,300)
Sell Call at (**X**) =	$ 165.00			
Pay Prem. (**p**) =		$ (4.45)	100	$ 445

Total Initial Investment =	**$(15,855)**

INPUT					OUTPUT						
	STOCK INVEST	OPTION SECURITY		WHAT IF SCENARIO	STOCK INVEST	OPTION SECURITY		BOTH STOCKS AND OPTIONS			
	So	X	p	S	CG = S -So	O	π - p	(π - p + CG)	(π - p + CG) x Sh	I	NP / I
STRATEGY	Market Price	Exercise Price (X)	Received Premium Per Share (p)	Market Price Stock Price (S)	Stock Capital Gain/ (Loss)	Call Option Payoff (Hedging)	Profit from the Option per share	Net Profit per share	Net Profit (Total $) (NP)	Initial Investment	HPR%
Buy Stock & Sell May Calls	$163.00	$ 180.00	$ 4.45	$ 180.00	$ 17.00	$ -	$ 4.45	$ 21.45	$ 2,145.00	$ 15,855	13.53%
Buy Stock & Sell May Calls	$163.00	$ 180.00	$ 4.45	$ 190.00	$ 27.00	$ (10.00)	$ (5.55)	$ 21.45	$ 2,145.00	$ 15,855	13.53%
Buy Stock & Sell May Calls	$163.00	$ 180.00	$ 4.45	$ 200.00	$ 37.00	$ (20.00)	$ (15.55)	$ 21.45	$ 2,145.00	$ 15,855	13.53%
Buy Stock & Sell May Calls	$163.00	$ 180.00	$ 4.45	$ 210.00	$ 47.00	$ (30.00)	$ (25.55)	$ 21.45	$ 2,145.00	$ 15,855	13.53%
Buy Stock & Sell May Calls	$163.00	$ 180.00	$ 4.45	$ 220.00	$ 57.00	$ (40.00)	$ (35.55)	$ 21.45	$ 2,145.00	$ 15,855	13.53%

Figure 13.5

3. Collars

A collar option strategy is one that holders of stock want to hedge their downside by giving up the upside. In previous section discussing protective puts, the investor obtains a protective put to hedge in case the stock declines, but it costs money to buy put options. The collar option strategy is customized to minimize or eliminate the premiums paid to buy puts by selling calls at a much higher level of stock. Basically, collars are a combination of protective puts and covered call. Figure 13.6 below shows an example where the investor holding 100 shares of Facebook with a current price of $163 wants to set up a floor to cap his losses at $150 by buying the May puts. The May puts cost $4.45 per share or $445 on 100 shares. The investor scans the pricing page and finds that the May $180 calls are also $4.45. Given that the premiums match he enters into a collar option contract where he buys the May $150 puts and sells the $180 calls netting the premiums at zero since he needs to pay for the puts and receives premium from the calls. Figure 13.6 shows the Payoff, Profit, and overall Return (HPR) of Facebook at various scenarios of the stock (using range $120 - $210).

Insert Figure 13.6

3. COVERED OPTION STRATEGIES- Collars — Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75

Collars Strategy: Own Stock, Buy Put, Sell Calls (combination of Protective Puts and Covered Calls) - the intention is to minimize or eliminate the premium
Action: Own 100 shares of Facebook (current price at $163)
Buy the May 150 Puts -pay $4.45 premium
Sell (Write) the May 180 Calls - receive $4.45 premium

INPUT					OUTPUT								
	STOCK INVEST	OPTION SECURITY			WHAT IF SCENARIO	STOCK INVEST	OPTION SECURITY			BOTH STOCKS AND OPTIONS			
	So	X puts	X calls	p	S	CG = S -So	O1	O2	π - p	(π - p + CG)	(π - p + CG) x Sh	I	NP / I
STRATEGY	Market Price M2M	Exercise Call Price (X1)	Exercise Put Price (X2)	Net Premium Paid Per Share (p)	Market Price Stock Price (S)	Stock Capital Gain/ (Loss)	Put Option Payoff	Call Option Payoff	Profit from the Option per share	Net Profit per share	Net Profit (Total $) (NP) 100 shares	Based on original February 20 Date	HPR%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 120.00	$ (43.00)	$ 30.00	$ -	$ 30.00	$ (13.00)	$ (1,300.00)	$ 16,300	-7.98%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 130.00	$ (33.00)	$ 20.00	$ -	$ 20.00	$ (13.00)	$ (1,300.00)	$ 16,300	-7.98%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 140.00	$ (23.00)	$ 10.00	$ -	$ 10.00	$ (13.00)	$ (1,300.00)	$ 16,300	-7.98%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 150.00	$ (13.00)	$ -	$ -	$ -	$ (13.00)	$ (1,300.00)	$ 16,300	-7.98%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 160.00	$ (3.00)	$ -	$ -	$ -	$ (3.00)	$ (300.00)	$ 16,300	-1.84%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 170.00	$ 7.00	$ -	$ -	$ -	$ 7.00	$ 700.00	$ 16,300	4.29%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 180.00	$ 17.00	$ -	$ -	$ -	$ 17.00	$ 1,700.00	$ 16,300	10.43%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 190.00	$ 27.00	$ -	$ (10.00)	$ (10.00)	$ 17.00	$ 1,700.00	$ 16,300	10.43%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 200.00	$ 37.00	$ -	$ (20.00)	$ (20.00)	$ 17.00	$ 1,700.00	$ 16,300	10.43%
Collars 150 Puts/180 Calls May	$163.00	$ 150.00	$ 180.00	$ -	$ 210.00	$ 47.00	$ -	$ (30.00)	$ (30.00)	$ 17.00	$ 1,700.00	$ 16,300	10.43%

Figure 13.6

Advance Option Strategies

Advanced option strategies involved simultaneously multiple buying and selling of options. The strategies that buy and sell across different exercise prices but keeping the same expiration dates are called Vertical Spreads or Money Spreads and the buying and selling of options across different expiration dates with the same exercise price are called Horizontal Spreads or Time Spreads. Spread options typically involves two or more options where the investor buys one option and pays a premium and sells another and receives a premium. The objective of spread strategies is to minimize the net premium paid. Figure 13.7 below shows the differences between vertical spreads or money spreads to horizontal spreads or time spreads. Choosing vertical spreads as an option strategy, the investor buys and sells call or put options at different exercise prices with the same date – in this case April is the chosen expiration day and the exercise prices are listed vertically. Choosing horizontal spreads as an option strategy, the investor buys and sells options by choosing the same exercise price at different dates – in this case the Exercise Price is 165 and the chosen dates are listed horizontally.

Insert Figure 13.7

VERTICAL AND HORIZONTAL SPREADS

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	**21.50**	23.00	3.00	**3.50**	4.45
155	15.50	**16.25**	17.75	4.10	**4.90**	5.90
160	12.50	**12.85**	13.50	5.30	**6.00**	6.80
165	**8.10**	**9.00**	**10.65**	**7.00**	**8.00**	**9.20**
170	5.20	**6.30**	8.50	9.40	**10.75**	12.45
175	3.25	**4.25**	5.75	13.00	**14.30**	14.20
180	2.50	**3.40**	4.45	15.00	**16.10**	17.75

HORIZONTAL SPREAD (TIME SPREADS)

VERTICAL SPREADS (MONEY SPREADS)

VERTICAL SPREADS (MONEY SPREADS)

Figure 13.7

The investors can be bullish or bearish on a stock, so they use a combination of spreads to take advantage of their view. The spread strategies include vertical bull and bear spreads for both calls and puts are described in detailed below (please note that the chapter will not cover horizontal or time spreads – not as popular as the vertical or money spreads):

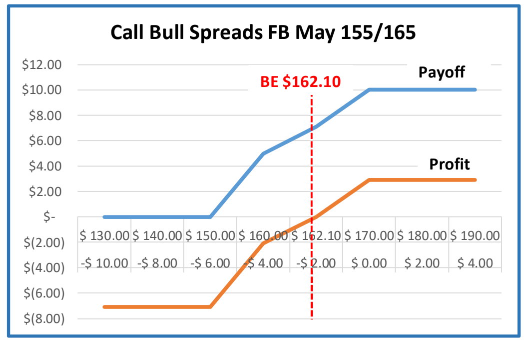
1. Call Bull Spreads

Call bull spreads are vertical spreads that involves the buying of the call option with a low exercise price and selling the call option with the high exercise price with the same expiration date. To remember this strategy, think how an investor that is bullish on the stock, he or she will be buying the stock at its low price and selling it at a higher price in the future – the same for call bull spreads. The investor buys the low exercise call price and sells the high exercise price and hopes that the stock goes up. Spread strategies such as call bull spreads are conservative strategies with maximum profit and maximum loss because an investor is giving up the significant upside to be protected on the downside. Figure 13.8 shows a call bull spread strategy where the investor buys the 155 May Calls and pays $17.75 premium and sells the 165 May Calls and receives $10.65 premium calculating a net premium paid of $7.10. The investor in this case is bullish expecting the stock to go up higher than $165 to maximize the $2.90 per share. Obviously if the stock drops below $155 the maximum loss will be capped at $7.10. The Breakeven stock is calculated at $162.10. Figure 13.8 shows the Payoff and profit at various stock prices

Insert Figure 13.8

1. ADVANCED OPTION STRATEGIES- Call Bull Spreads Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Call Bull Strategy: Buy the Low Exercise Call Price and sell the high Call Exercise Price at the same expiration date (Vertical Spread)
Action Example: Buy the May Call 155 -pay $17.75 premium
Sell the May 165 Calls - receive $10.65 premium

INPUT							OUTPUT				
	Low X	p1	High X	p2	p	S	S - X1 + X2				
STRATEGY	Buy Exercise Call (X1)	Premium Paid Per Share (p1)	Sell Exercise Call (X2)	Premium Received Per Share (p2)	Net Premium Paid Per Share	Market Price Stock Price (S)	Net Payoff	Net Profit	Maximum Profit	Maximum Loss	
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 130.00	$ -	$ (7.10)		$ (7.10)	
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 140.00	$ -	$ (7.10)		$ (7.10)	
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 150.00	$ -	$ (7.10)		$ (7.10)	
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 160.00	$ 5.00	$ (2.10)		$ (7.10)	
Buy Low and Sell High Call	**$ 155.00**	**$ (17.75)**	**$ 165.00**	**$ 10.65**	**$ (7.10)**	**$ 162.10**	**$ 7.10**	**$ -**			**Breakeven**
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 170.00	$ 10.00	$ 2.90	$ 2.90		
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 180.00	$ 10.00	$ 2.90	$ 2.90		
Buy Low and Sell High Call	$ 155.00	$ (17.75)	$ 165.00	$ 10.65	$ (7.10)	$ 190.00	$ 10.00	$ 2.90	$ 2.90		

Figure 13.8

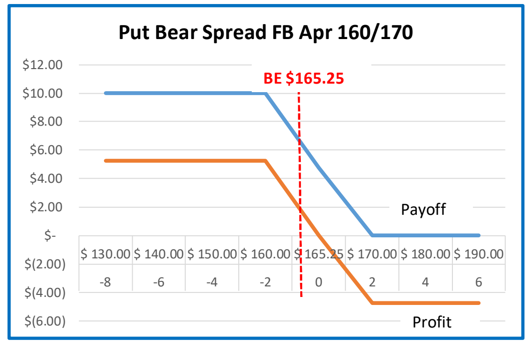
2. Put Bear Vertical Spreads

Put bear spreads are vertical spreads that involves the buying of the put option with a high exercise price and selling the put option with the low exercise price with the same expiration date. To remember this strategy, think how an investor that is bearish on the stock, he or she will be shorting or selling the stock at its high price today and buying the stock back at a lower price in the future – the same for put bear spreads. The investor buys the high exercise put price and sells the low exercise price and hopes that the stock drops. Spread strategies such as put bear spreads are conservative strategies with maximum profit and maximum loss because an investor is giving up the significant upside of the stock going down to be protected on the downside if the stock goes. Figure 13.9 shows a put bear spread strategy where the investor buys the 170 April Puts and pays $10.75 premium and sells the 160 April puts and receives $6.00 premium calculating a net premium paid of $4.75. The investor in this case is bearish expecting the stock to drop lower than $160 to maximize the $5.25 per share. Obviously if the stock increases above $170, the maximum loss will be capped at $4.75. The Breakeven stock is calculated at $165.25. Figure 13.8 shows the payoff, profit maximum profit and maximum loss at various stock prices

Insert Figure 13.9

2. ADVANCED OPTION STRATEGIES- Put Bear Spreads — Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Put Bear Strategy: Buy the High Exercise Put Price and sell the Low Put Exercise Price at the same expiration date (Vertical Spread)
Action Example: Buy the Apr 170 Puts -pay $10.75 premium
Sell the Apr 160 Puts - receive $6.00 premium

INPUT						S	OUTPUT				
	High X	p1	Low X	p2	p	S	X1 - X2 -S				
STRATEGY	Buy Exercise Put (X1)	Premium Paid Per Share (p1)	Sell Exercise Call (X2)	Premium Received Per Share (p2)	Net Premium Paid Per Share	Market Price Stock Price (S)	Net Payoff	Net Profit	Maximum Loss	Maximum Profit	
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 130.00	$ 10.00	$ 5.25		$ 5.25	
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 140.00	$ 10.00	$ 5.25		$ 5.25	
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 150.00	$ 10.00	$ 5.25		$ 5.25	
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 160.00	$ 10.00	$ 5.25		$ 5.25	
Buy High and Sell Low Put	**$ 170.00**	**$ (10.75)**	**$ 160.00**	**$ 6.00**	**$ (4.75)**	**$ 165.25**	**$ 4.75**	**$ -**			**Breakeven**
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 170.00	$ -	$ (4.75)	$ (4.75)		
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 180.00	$ -	$ (4.75)	$ (4.75)		
Buy High and Sell Low Put	$ 170.00	$ (10.75)	$ 160.00	$ 6.00	$ (4.75)	$ 190.00	$ -	$ (4.75)	$ (4.75)		

Figure 13.9

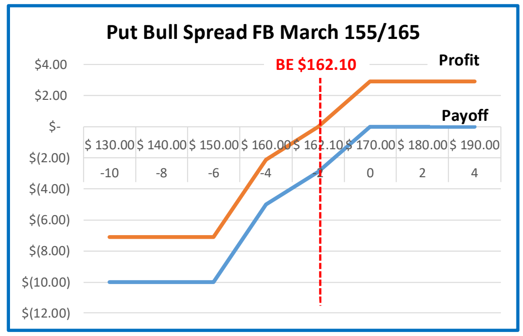
3. Put Bull Vertical Spreads

Put bull spreads are vertical spreads that involves the buying of the put option with a low exercise price and selling the put option with the high exercise price with the same expiration date. Like the call bull spreads previously discussed, this strategy is bullish even though the investor is buying put options. Put bull spreads sound like mixed thinking as typically an investor that buys puts has more pessimistic view on the stock while the spread is called bull which represents an optimistic strategy. The strategy here though is to hope that the options are not exercised so the investor can keep the net premium received – all spread strategies that has that contradiction between puts and bulls or calls with bears the net proceeds are received by the investor. Figure 13.10 shows a put bull spread strategy where the investor buys the 165 March puts and pays $17.75 premium and sells the 165 May Calls and receives $10.65 premium calculating a net premium paid of $7.10. The investor in this case is bullish expecting the stock to go up higher than $165 to maximize the $2.90 per share. Obviously if the stock drops below $155 the maximum loss will be capped at $7.10. The Breakeven stock is calculated at $162.10. Figure 13.8 shows the Payoff and profit at various stock prices

Insert Figure 13.10

3. ADVANCED OPTION STRATEGIES- Put Bull Spreads **Current Price FaceBook (FB) So = $163.00 (Feb 20)**

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Put Bull Strategy: Buy the Low Exercise Put Price and sell the high Exercise Put Price at the same expiration date (Vertical Spread)
Action Example: Buy the March 155 Puts -pay $4.10 premium
Sell the March 165 Puts - receive $7.00 premium

INPUT						S	OUTPUT				
	Low X	p1	High X	p2	p	S	S - X1 + X2				
STRATEGY	Buy Exercise Puts (X1)	Premium Paid Per Share (p1)	Sell Exercise Puts (X2)	Premium Received Per Share (p2)	Net Premium Received Per Share	Market Price Stock Price (S)	Net Payoff	Net Profit	Maximum Profit	Maximum Loss	
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 130.00	$ (10.00)	$ (7.10)		$ (7.10)	
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 140.00	$ (10.00)	$ (7.10)		$ (7.10)	
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 150.00	$ (10.00)	$ (7.10)		$ (7.10)	
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 160.00	$ (5.00)	$ (2.10)		$ (7.10)	
Buy Low and Sell High Put	**$ 155.00**	**$ (4.10)**	**$ 165.00**	**$ 7.00**	**$ 2.90**	**$ 162.10**	**$ (2.90)**	**$ (0.00)**			**Breakeven**
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 170.00	$ -	$ 2.90	$ 2.90		
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 180.00	$ -	$ 2.90	$ 2.90		
Buy Low and Sell High Put	$ 155.00	$ (4.10)	$ 165.00	$ 7.00	$ 2.90	$ 190.00	$ -	$ 2.90	$ 2.90		

Figure 13.10

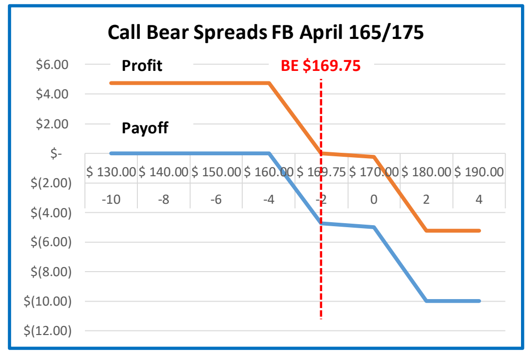
4. Call Bear Vertical Spreads

Call bear spreads are vertical spreads that involves the buying of the call option with a high exercise price and selling the call option with the low exercise price with the same expiration date. Call bear spreads sound like mixed thinking as typically an investor that buys calls has more optimistic view on the stock while the spread is called bear which represents a pessimistic strategy. The strategy here though is to hope that the options are not exercised so the investor can keep the net premium received – all spread strategies that has that contradiction between calls and bears or puts with bulls discussed earlier, the net proceeds are received by the investor. Figure 13.11 shows a put bear spread strategy where the investor buys the 170 April Puts and pays $10.75 premium and sells the 160 April puts and receives $6.00 premium calculating a net premium paid of $4.75. The investor in this case is bearish expecting the stock to drop lower than $160 to maximize the $5.25 per share. Obviously if the stock increases above $170, the maximum loss will be capped at $4.75. The Breakeven stock is calculated at $165.25. Figure 13.8 shows the payoff, profit maximum profit and maximum loss at various stock prices

Insert Figure 13.9

4. ADVANCED OPTION STRATEGIES- Call Bear Spreads	Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Call Bear Strategy: Buy the high Exercise Call Price and sell the low Exercise Call Price at the same expiration date (Vertical Spread)
Action Example: Buy the April 175 Calls -pay $4.25 premium
Sell the April 165 Calls - receive $9.00 premium

INPUT							OUTPUT				
	High X	p1	Low X	p2	p	S	S - X1 + X2				
STRATEGY	Buy Exercise Call (X1)	Premium Paid Per Share (p1)	Sell Exercise Call (X2)	Premium Received Per Share (p2)	Net Premium Received Per Share	Market Price Stock Price (S)	Net Payoff	Net Profit	Maximum Loss	Maximum Profit	
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 130.00	$ -	$ 4.75		$ 4.75	
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 140.00	$ -	$ 4.75		$ 4.75	
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 150.00	$ -	$ 4.75		$ 4.75	
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 160.00	$ -	$ 4.75		$ 4.75	
BuyHigh and Sell Low Call	**$ 175.00**	**$ (4.25)**	**$ 165.00**	**$ 9.00**	**$ 4.75**	**$ 169.75**	**$ (4.75)**	**$ -**			**Breakeven**
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 170.00	$ (5.00)	$ (0.25)	$ (5.25)		
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 180.00	$ (10.00)	$ (5.25)	$ (5.25)		
BuyHigh and Sell Low Call	$ 175.00	$ (4.25)	$ 165.00	$ 9.00	$ 4.75	$ 190.00	$ (10.00)	$ (5.25)	$ (5.25)		

Figure 13.10

5. Long and Short Call Butterfly Spreads

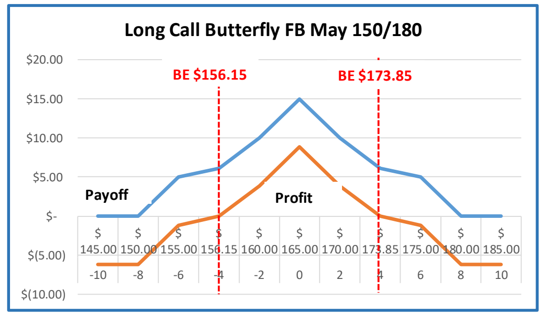
Long Butterfly call spreads are vertical spreads that involves the buying of the call options for both the high and low exercise prices and selling the average of the two call options twice with the same expiration date. The investor could also short the butterfly spread representing the reverse strategy – selling the high and low exercise call prices and buying the average of the two prices twice with the same expiration date. The long call butterfly investor is expecting that the stock will not have any volatility. Figure 13.12 shows the long call butterfly spread of Facebook buying the May 150 and May 180 call options and selling the May 165 call options twice – basically four options (Buy, Buy, Sell and Sell). The net premium paid is $6.15. The investor in this case is expecting no volatility on the stock and the best-case scenario with the maximum profit is when the stock gets to the average price of $165. At $165 the investor will exercise the low call exercise price so it could get the maximum payoff – in this case $15 per share yielding a profit of $8.85 per share. In butterfly spreads there are two breakeven points – in this case the stock prices expiring at $156.15 and $173.85 as shown in figure 13.12 below. The figure also shows the payoff and profit levels at various stock prices.

Insert Figure 13.12

5. ADVANCED OPTION STRATEGIES-Long Call Butterfly Spreads

Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Long Call Butterfly Strat.: Buy the Low Exercise Call Price, Buy the High Exercise Price and sell the average Call Exercise Price twice at the same expiration date (Vertical Spread)
Action Example: Buy the May Call 150 -pay $23 premium
Buy the May 180 Calls - pay $4.45 premium
Sell the May 165 Calls - receive $10.65 premium
Sell the May 165 Calls - receive $10.65 premium

	INPUT									OUTPUT			
	Low X1	p1	High X2	p2	2 x Avg X3	2 x p3	p	S		S - X1 + X2			
STRATEGY	Buy Exercise Call (X1)	Premium Paid Per Share (p1)	Buy Exercise Call (X2)	Premium Paid Per Share (p2)	Sell Exercise Call (X2)	Premium Received Per Share (p3)	Net Premium Paid Per Share	Market Price Stock Price (S)		Net Payoff	Net Profit	Maximum Profit	Maximum Loss
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 140.00		$ -	$ (6.15)		$ (6.15)
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 145.00		$ -	$ (6.15)		$ (6.15)
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 150.00		$ -	$ (6.15)		$ (6.15)
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 155.00		$ 5.00	$ (1.15)		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 156.15	BE	$ 6.15	$ 0.00		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 160.00		$ 10.00	$ 3.85		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 165.00		$ 15.00	$ 8.85	$ 8.85	
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 170.00		$ 10.00	$ 3.85		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 173.85	BE	$ 6.15	$ 0.00		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 175.00		$ 5.00	$ (1.15)		
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 180.00		$ -	$ (6.15)		$ (6.15)
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 185.00		$ -	$ (6.15)		$ (6.15)
Buy Low, High and Sell Avg Call	$ 150.00	$ (23.00)	$ 180.00	$ (4.45)	$ 165.00	$ 21.30	$ (6.15)	$ 190.00		$ -	$ (6.15)		$ (6.15)

Figure 13.12

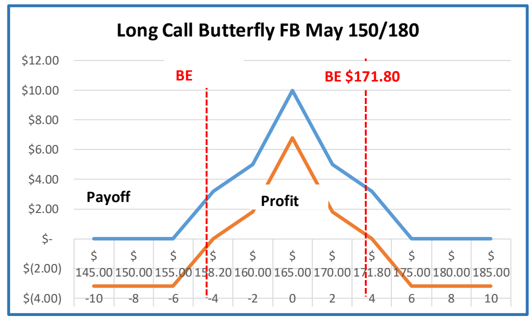
6. Long and Short Put Butterfly Spreads

Similar to the long butterfly call spreads, long put spreads have the same exact strategy. Basically, it's a vertical spread that involves the buying of put options for both the high and low exercise prices and selling the average of the two put options twice with the same expiration date. The investor could also short the butterfly spread representing the reverse strategy – selling the high and low exercise put prices and buying the average of the two prices twice with the same expiration date. The long-put butterfly investor is expecting that the stock will not have any volatility. Figure 13.12 shows the long-put butterfly spread of Facebook buying the April 155 and April 175 call options and selling the April 165 put options twice – basically four options (Buy, Buy, Sell and Sell). The net premium paid is $3.20. The investor in this case is expecting no volatility on the stock and the best-case scenario with the maximum profit is when the stock gets to the average price of $165. At $165 the investor will exercise the high put exercise price so it could get the maximum payoff – in this case $10 per share yielding a profit of $6.80 per share. In butterfly spreads there are two breakeven points – in this case the stock prices expiring at $158.20 and $171.80 as shown in figure 13.13 below. The figure also shows the payoff and profit levels at various stock prices.

Insert Figure 13.13

6. ADVANCED OPTION STRATEGIES-Long Put Butterfly Spreads							Current Price FaceBook (FB) So = $163.00 (Feb 20)

FB	CALLS			PUTS		
Exercise Price (X)	MARCH	APRIL	MAY	MARCH	APRIL	MAY
150	20.00	21.50	23.00	3.00	3.50	4.45
155	15.50	16.25	17.75	4.10	4.90	5.90
160	12.50	12.85	13.50	5.30	6.00	6.80
165	8.10	9.00	10.65	7.00	8.00	9.20
170	5.20	6.30	8.50	9.40	10.75	12.45
175	3.25	4.25	5.75	13.00	14.30	14.20
180	2.50	3.40	4.45	15.00	16.10	17.75



Long Put Butterfly Strategy: Buy the Low Exercise Put Price, Buy the High Exercise Put Price and sell the average Put Exercise Price twice at the same expiration date (Vertical Spread)
Action Example: Buy the Apr 155 Puts -pay $4.90 premium
Buy the Apr 175 Puts - pay $14.30 premium
Sell the Apr 165 Puts - receive $8.00 premium
Sell the Apr 165 Puts - receive $8.00 premium

INPUT								S		OUTPUT			
	Low X1	p1	High X2	p2	2 x Avg X3	2 x p3	p	S		X1 + X2 - S			
STRATEGY	Buy Exercise Call (X1)	Premium Paid Per Share (p1)	Buy Exercise Call (X2)	Premium Paid Per Share (p2)	Sell Exercise Call (X2)	Premium Received Per Share (p3)	Net Premium Paid Per Share	Market Price Stock Price (S)		Net Payoff	Net Profit	Maximum Profit	Maximum Loss
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 140.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 145.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 150.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 155.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 158.20	BE	$ 3.20	$ (0.00)		
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 160.00		$ 5.00	$ 1.80		
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 165.00		$ 10.00	$ 6.80	$ 6.80	
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 170.00		$ 5.00	$ 1.80		
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 171.80	BE	$ 3.20	$ (0.00)		
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 175.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 180.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 185.00		$ -	$ (3.20)		$ (3.20)
Buy Low, High and Sell Avg Put	$ 155.00	$ (4.90)	$ 175.00	$ (14.30)	$ 165.00	$ 16.00	$ (3.20)	$ 190.00		$ -	$ (3.20)		$ (3.20)

Figure 13.13

Option Valuation Methods

So far, the chapter covered various option strategies that the investor can use to benefit based on his or her view on the direction of the stock. Using the right option strategy based on the view of how the stock will perform in the future, the investor used two input variables including the Exercise Price (X) and Premium (p) to determine the potential payoff (O), profit (π) and holding period return (HPR%) at various stock prices (S) by expiration day (t) or (Stock at expiration (St). For the call option buyer, the payoff is either S – X or 0 if the X > S and for the put option buyer, the payoff is either X – S or 0 if the S > X. To obtain such option the investor needs to pay a premium (p) representing the upfront money or the bet per share and hoping the stock by expiration day (St) covers the original bet.

This section of the chapter will focus on various valuation methods to calculate the fair premium that the investor should pay to receive such payoff. The thinking and calculations should be very similar to betting on a game of chance. Using probability concepts, for example, someone that bets on coin toss with two outcomes represents 50% chance of winning and 50% chance of losing. In this simple example, let's assume that the payoff is $20 if the coin turns up to be Heads (H) and $0 if the coin turns out to be Tails (T). On a toss of a dice that the winner will be paid $60 if the dice gets a “6” on one single throw is one in six (1/6) and the probability of not getting a “6” is five out of six (5/6). To evaluate what will the fair bet be on these games of chances the formula starts with the following decision tree shown on Figure 13.14 below:

Insert Figure 13.14

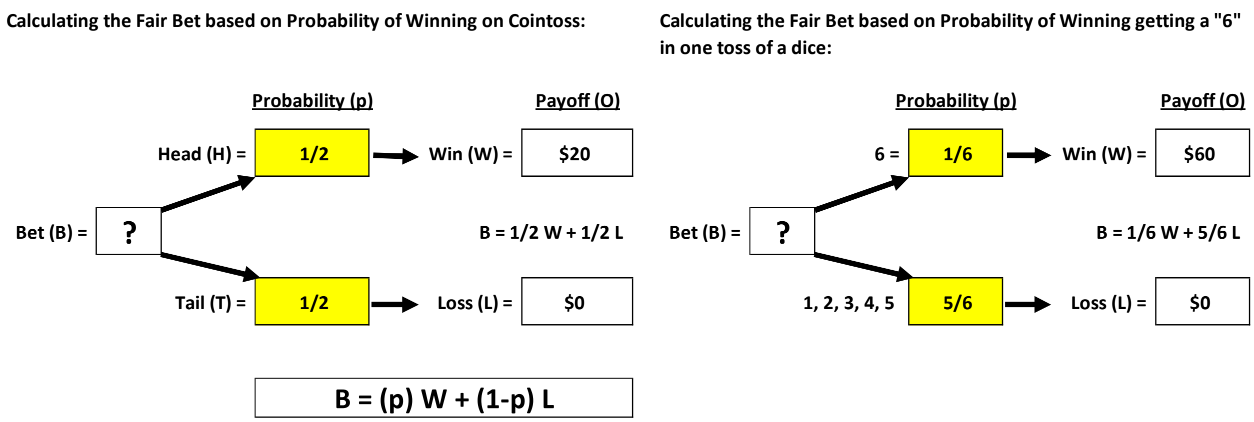


Figure 13.14

Figure 13.14 above shows that the winnings or payoffs as \$20 and \$60 for the coin toss and dice throwing, respectively. Using the probability formulas derived from the decision tree the bets are calculated as follows:

$$Coin\ Toss\ Bet = \frac{1}{2}(\$20) + \frac{1}{2}(\$0) = \$10$$

$$Dice\ Toss\ Bet = \frac{1}{6}(\$60) + \frac{5}{6}(\$0) = \$10$$

The wins or loses of these games of chance represent the option payoff and the outcome from the toss of a coin and a dice represent the stock price. This probability formula concept can be used to determine the fair bet that the player needs to pay up front to enter this game. This fair bet represents the premium that the investor needs to pay upfront to have the right to exercise such option when there is a positive payoff outcome. The challenge is to derive such probabilities when the investor is betting on the direction of the stock in the future. Such direction is measured by historical stock movements expressed in statistics as the variance (σ^2) of the stock or standard deviation (σ). Few such valuation models that use stock variances and standard deviations are the Bionomial Option Pricing Model and Black-Scholes described below.

1. Binomial Option Pricing Model – Single-Period Probability Method

The Binomial Option Pricing Model (BOPM) is a model that continuously measures the two possible outcomes of the stock, up or down, from any point in time until

expiration. As the stock goes up the probability to continue going up can change versus the probability of going down from that new level. The up (u) and down (d) values are derived from historical experiences and are used in the BOPM to derive such probabilities. This probability of the stock going up or down ultimately measure the fair bet or the premium an investor is willing to pay to meets his or her expectation. Figure 13.15 below uses an example how to calculate the premium using BOPM:

Insert Figure 13.15

ONE -PERIOD BINOMIAL OPTION PRICING MODEL - Calculatig the Call Option Premium

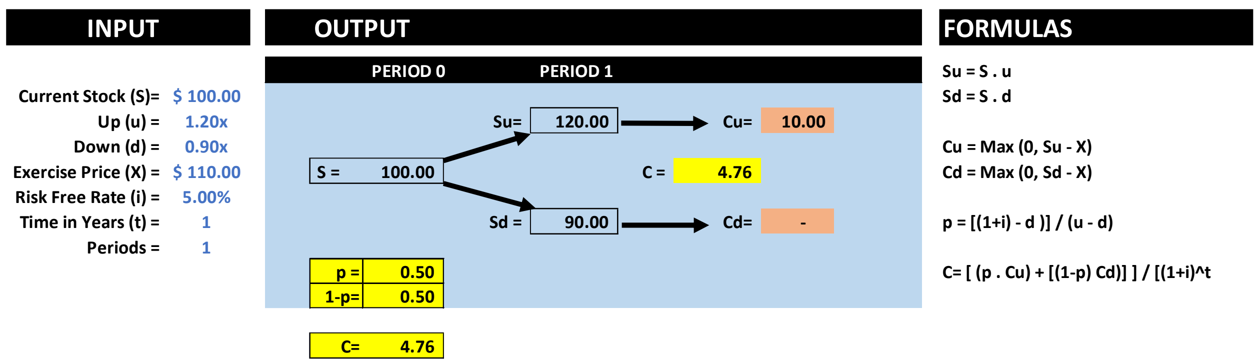


Figure 13.15

Figure 13.15 above shows there is a 50% probability that the stock will go up from its current level \$100 to \$120 and 50% probability that the stock will go down to \$90 within the measurable period – in this case one year. The probability calculation is as follows:

$$p = \frac{[(1+i)-d]}{u-d} = \frac{[(1+0.05)-0.90]}{1.20-0.90} = \frac{1.05-0.90}{1.20-0.90} = \frac{0.15}{0.30} = 0.5 \; and \; i - p = 0.5$$

If the stock goes up \$120, the call option payoff will be \$10 (C=max (0, S-X) = max (0, 120-110). If the stock goes down to \$90, the call option will be out of the money and the payoff will be \$0 based on C= max (0, S-X) = max (0, \$110 - \$120). Given the Bionomial outcome of 50%, in this case, that the payoff is \$10 and the 50% that the payoff is \$0, using the probability theory explained below the fair bet or premium should be at \$5 representing 50% x \$10 + 50% x \$0. If we present value the \$5 back to today's value, since is what are we paying today for the future outcome, the value is calculated at \$4.76 based on the Present Value calculation of PV = FV / [(1+i)^t] or 5 / [(1+.05)^1] = 4.76.

Figure 13.16 below calculates the put option premium using the same probabilities.

Insert Figure 13.16

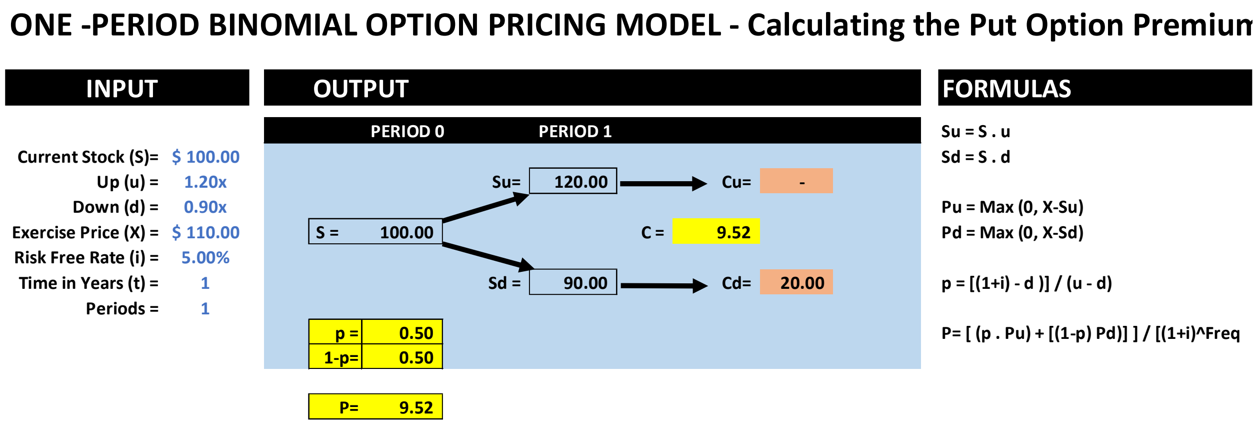


Figure 13.15

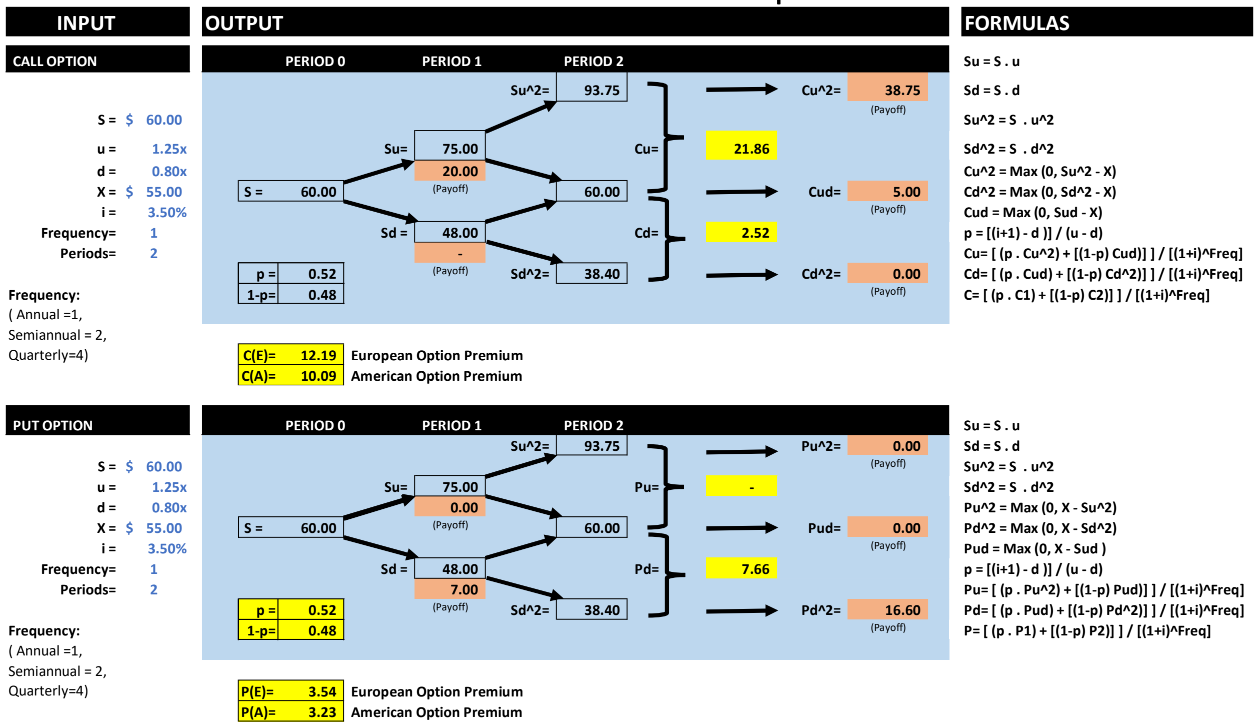
Please notice above that the put option price calculated at $9.52 is below the X – S intrinsic value of $10 which at the offset it does not make sense because you can buy the put option at $9.54 and exercise immediately and receive $10 recording a profit of $0.08. The method though calculates a European structure which the investor can only exercise at expiration day. It's deep in the money but that can change within a year as the probability forces signal an increase of the stock (1.2x or 20% increase) versus the down factor of 0.90x or 10% decline).

2. Binomial Option Pricing Model – Two-Period Probability Method

The Binomial Option Pricing Model (BOPM) using 2 periods measures four possible outcomes of the stock, up and then up, up and the down, down and the up and down and then down again from any point in time until expiration. The four-outcome illustrated in figure 13.17 below shows three possible payoffs since the stock that is going up and then down (Sud) is the same as the stock is going down and then up (Sdu) unless they are dividends paid between these periods (examine that phenomenon later in the chapter). Like before with the single-period BOPM, the up (u) and down (d) values are derived from historical experiences and are used to derive such probabilities. This probability of the stock going up or down ultimately measure the fair bet or the premium an investor is willing to pay to meets his or her expectation. Figure 13.17 below uses an example how to calculate the premium for both call and put options using 2-period BOPM. The example below calculates both the European and American structures

Insert Figure 13.17

TWO-PERIOD BINOMIAL OPTION PRICING MODEL - Call and Put Options



Option premium calculations based on European structure:

The probability calculations for both the call and put option premiums are the same. After the investor calculates the call and put option payoffs for the second period, the probability is applied to the upper/upper, upper/lower and lower/lower payoffs as follows:

Call option premium:

$$\boldsymbol{Cu = \frac{[p(Cu^2)+(1-p)(Cud)}{(1+i/f)} \text{ and } Cd = \frac{[p(Cud)+(1-p)(Cd^2)}{(1+i/f)} \text{ and then } C = \frac{[p(Cu)+(1-p)(Cd)}{(1+i/f)}}$$

$$Cu = \frac{[0.52(38.75) + (0.48)(5)}{(1 + 0.035/1)} = 21.86 \text{ and } Cd = \frac{[0.52(5) + (\ 0.48)(0.0)}{(1 + 0.035/1)} = 2.52$$

$$\text{and then } C(E) = \frac{[0.52(21.86)+(\ 0.48)(2.52)}{(1+0.035/1)} = \mathbf{12.19}$$

Premium option premium:

$$\boldsymbol{Pu = \frac{[p(Pu^2)+(1-p)(Pud)}{(1+i/f)} \text{ and } Pd = \frac{[p(Pud)+(1-p)(Pd^2)}{(1+i/f)} \text{ and then } P = \frac{[p(Pu)+(1-p)(Pd)}{(1+i/f)}}$$

$$Cu = \frac{[0.52(0.0) + (0.48)(0.0)}{(1 + 0.035/1)} = 0.0 \text{ } and \text{ } Cd = \frac{[0.52(0.0) + (\ 0.48)(16.60)}{(1 + 0.035/1)} = 7.66$$

$$and\ then\ C(E) = \frac{[0.52(0.0)+(\ 0.48)(7.66)}{(1+0.035/1)} = \mathbf{3.54}$$

<u>Option premium calculations based on American structure:</u>
The probability calculations for both the call and put option premiums are the same. After the investor calculates the call and put option payoffs for the first period, the probability is applied to the upper and lower payoffs as follows:

<u>Call option premium:</u>

$$\boldsymbol{C = \frac{[p(C\ higher\ payoff) + (\ 1 - p)(C\ lower\ payoff)}{(1 + i/f)}}$$

$$C(A) = \frac{[0.52(20.00)+(\ 0.48)(0.00)}{\left(1+\frac{0.035}{1}\right)} = \mathbf{10.09}$$

<u>Premium option premium:</u>

$$\boldsymbol{P = \frac{[p(P\ higher\ payoff) + (\ 1 - p)(P\ lower\ payoff)}{(1 + i/f)}}$$

$$C(A) = \frac{[0.52(0.0)+(\ 0.48)(7.00)}{(1+0.035/1)} = \mathbf{3.23}$$

3. Binomial Option Pricing Model – Two-Period Probability Method with Dividends

When the company announces that it will be paying dividends, the stock will most likely drop by the current dividend yield as the investor is pricing in the dividend paid affecting the present value of the stock. In option pricing, dividends make the calculation of premium more challenging. In valuing the premium of an option to stock that pays dividends using the BOPM, the analysis needs be adjusted during the predicted binomial up or down of the stock. The four-outcome illustrated in figure 13.18 below shows the yield adjustments prior to calculating the Su^2 and Sd^2. Figure 13.18 below uses an example how to calculate the premium for a call option using 2-period BOPM adjusting for dividend yield and dividend amount paid per share. The example below also calculates both the European and American structures. Suppose that the dividend yield is 4.0%, then the stock after the first period is adjusted to be 4.0% less or 96% of the upper and lower stock prices.

Insert Figure 13.18

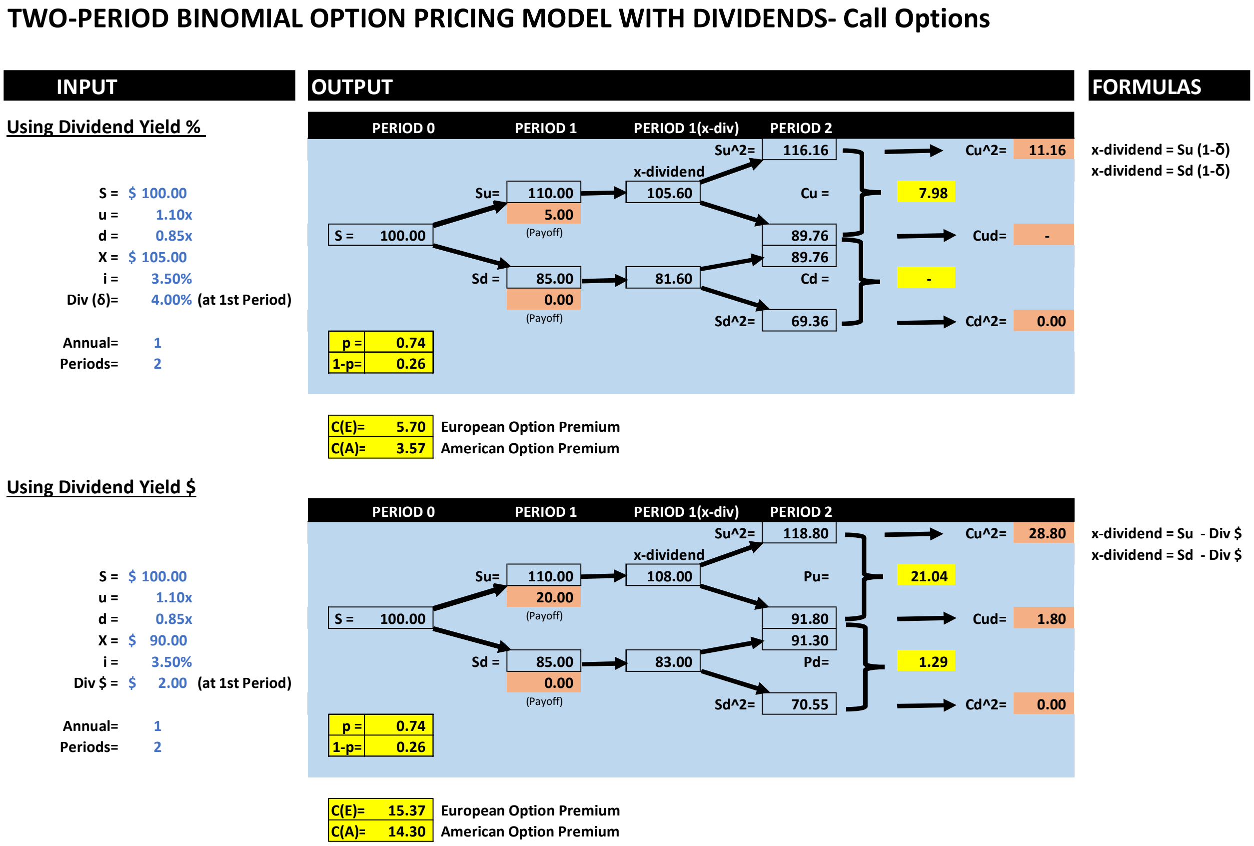


Figure 13.18

4. Black-Scholes-Merton (BSM) Model

Black-Scholes-Merton (BSM), also referred to in short as Black-Scholes is one of the first pricing models that was used to calculate the fair price for a call or a put option premium based on five variables including current stock price, strike price, volatility, time, and risk-free rate. If the company pays dividends the underline stock price is adjusted by the dividend yield – similar to the BOPM that was previously discussed. Before the Black-Scholes formula is stated, the chapter will focus on these five variables and other statistical concepts are described below:

<u>Five Variable:</u>

- **<u>Current Stock Price (S_0)</u>**: Like the BOPM, the current price of the underline stock is one the most important variable to determine the intrinsic value of the option payoff expected in the future. As mentioned earlier the relationship between the current stock price to the future exercise price is the first natural comparison to determine how high the stock needs to go to exceed the exercise price for a call option and how low the stock needs to go below the exercise price for a put option. The value, or intrinsic value of S – X and X – S for the call option and put option payoffs, respectively is the basis of the Black-Scholes formula.

- **Exercise Price (X):** This is the future price of the underline stock at expiration of the option. This price is constant, and the investor is constantly comparing the current stock price (S) to the exercise price as the expiration time comes near and the intrinsic value of S – X or X – S is expanding or contracting to calculate the call option and put option payoff, respectively.

- **Volatility and Standard Deviation (σ):** The Volatility measured by the standard deviation of the historical underline stock price as it changes from day to day or week to week or month to month. The bigger the swing change which translates to higher volatility and higher standard deviation. Basically, this swing determines how probable is for the stock to go higher or lower than the constant exercise price. The higher the standard deviation the most likely the stock will be in-the-money with positive intrinsic value of S – X or X – S for the call and put option, respectively. The higher the standard deviation the option premium is expected to be higher.

- **Time (t):** Time to maturity or time to option expiration is an important variable to measure the value of the option. In general, the premium paid to buy the option is higher if there is more time to exercise. It also gives a higher chance for the stock to reach the exercise price.

- **Risk Free Rate (i):** Using the risk-free rate to calculate the present value of the exercise price. The rate used should be the annualized rate and be adjusted for maturity. The other adjustment is the compounding used as will described below.

Other Statistical Concepts:

- **Compounding using exponential (e):** The number **e** is a mathematical constant 2.7182 that is the base of the natural logarithm and is equal to one. The Future Value calculation discussed in the first chapter is calculated based on the following formula:

  $FV = PV\left(1 + \frac{i}{f}\right)^{t}$ where, PV is the Present Value, i is the interest, t is the time and f is the frequency or compounding payment per year.

  As the frequency increases from annual to semi-annual to quarterly to monthly and to infinite compounding the future value will increase but it won't get higher than 2.718 times the original present value. As illustrated in Figure 13.19 below.

Insert Figure 13.20

COMPOUND INTEREST USING e

Present Value = $ 1.00
Interest = 10%
Years = 10

Description	Compound per year Fregquency (f)	Future Value Compunded
Annual	1	2.5937425
Semi	2	2.6532977
Quarterly	4	2.6850638
Monthly	12	2.7070415
Daily	365	2.7179096
Hourly	8,760	2.7182663
By Minute	525,600	2.7182816
By Second	31,536,000	2.7182819
Infinite	e	2.7182818

Figure 13.19

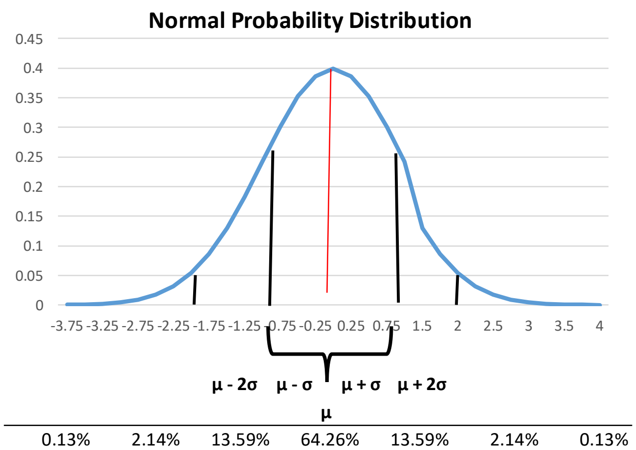
The infinite compounding e is used in the Black-Scholes model to calculate the present value of the exercise price (X) as e^{-it} and is derived based on the following mathematical calculation:

$$e = PV\ (1+i)^t \ then\ PV = \frac{e}{(1+i)^t}\ then\ PV = e^{-it}$$

- **Natural Logarithm (ln):** The model assumes stock prices follow a lognormal distribution because asset prices cannot be negative (they are bounded by zero). This is also known as a Gaussian distribution. Often, asset prices are observed to have significant right skewness and some degree of kurtosis (fat tails). This means high-risk downward moves often happen more often in the market than a normal distribution predicts. The assumption of lognormal underlying asset prices should thus show that implied volatilities are similar for each strike price according to the Black-Scholes model.

- **Normal Probability Distribution (N):** The normal probability distribution in a bell-shaped curve gives the probability that a standard normal random variable will be less than equal to a given value. Figure 13.20 shows that the Normal Distribution Graph represents a standard normal distribution with mean μ= 0 and standard deviation σ = 1. For example, if the stock has a standard deviation of 10.0%, that means that the stock "swings" either way of 10% from the average representing a stock with an average of $100 the upper and lower limits within the period is between $90-$110 (-10% to +10%). Within one standard deviation, the probability that the stock will stay with 10% is 64%. In a game of chance, the investor will bet $6.40 to get a $10 payoff for the stock to move within 10%.

Insert Figure 13.20



NORMAL DISTRIBUTION TABLE

d	N(d)	d	N(d)	d	N(d)	d	N(d)	d	N(d)
3.200	0.999	1.900	0.971	0.600	0.726	-0.700	0.242	-2.000	0.023
3.100	0.999	1.800	0.964	0.500	0.691	-0.800	0.212	-2.100	0.018
3.000	0.999	1.700	0.955	0.400	0.655	-0.900	0.184	-2.200	0.014
2.900	0.998	1.600	0.945	0.300	0.618	-1.000	0.159	-2.300	0.011
2.800	0.997	1.500	0.933	0.200	0.579	-1.100	0.136	-2.400	0.008
2.700	0.997	1.400	0.919	0.100	0.540	-1.200	0.115	-2.500	0.006
2.600	0.995	1.300	0.903	0.000	0.500	-1.300	0.097	-2.600	0.005
2.500	0.994	1.200	0.885	-0.100	0.460	-1.400	0.081	-2.700	0.003
2.400	0.992	1.100	0.864	-0.200	0.421	-1.500	0.067	-2.800	0.003
2.300	0.989	1.000	0.841	-0.300	0.382	-1.600	0.055	-2.900	0.002
2.200	0.986	0.900	0.816	-0.400	0.345	-1.700	0.045	-3.000	0.001
2.100	0.982	0.800	0.788	-0.500	0.309	-1.800	0.036	-3.100	0.001
2.000	0.977	0.700	0.758	-0.600	0.274	-1.900	0.029	-3.200	0.001

Figure 13.20

The values of N (d) are given by table above (Figure 13.20). The value of d is between negative infinite and positive infinite but for valuation purposes showing 3 decimals the levels are basically between -3.00 and 3.00 for almost ~100% of the normal distribution of positive values between 0 zero and one. For example, if d=1.3 the normalized value is 0.903. The table is used in the Black-Scholes model to determine the normal probability of the stock to determine the fair value of the premium.

The formulas for calculating the probability distribution to be used in the calculation of the intrinsic value of S – X or X – S for the call and put options, respectively using the Black-Scholes model (N(d1) and N(d2)) are follows:

$$d1 = \frac{\ln(\frac{S}{X}) + \left(i + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \text{ and } d2 = d1 - \sigma\sqrt{t}$$

Where S is the current price, X is the exercise price, i is the risk-free rate, t is time to expiration and σ is the standard deviation.

The Black-Scholes formula for the call option (C) and put option (P) are as follows:

$$C = S\,N(d1) - Xe^{-it}N(d2) \;\; and \;\; P = Xe^{-it}[1 - N(d2)] - S\,[1 - N(d1)]$$

For example, let's assume that the that the current stock price (S) is $100 and the future exercise price (X) that expires in 6 months is $110. This out-of-the-money call option and in-the-money put option have a standard deviation (σ) of 0.40. Given the risk-free rate of 5.0% what is the fair value for both call and put option premiums?

Input:
S = $100
X = $110
t = 0.50 (6 months)
i = 5.0%
σ = .40

Formulas:

$$d1 = \frac{\ln(\frac{100}{110}) + \left(0.05 + \frac{.4^2}{2}\right) 0.50}{0.40\sqrt{0.5}} = \frac{\ln(0.9091) + (0.05 + 0.08)\, 0.50}{(0.40)(0.7071)} = \frac{-0.0953 + 0.065}{0.2828} = -0.1071$$

and

$$d2 = -0.1071 - 0.2828 = -0.3899$$

N (d1) = 0.4573
N (d2) = 0.3482

The call option for the call option is calculated using the Black-Scholes formula below:

$$C = 100\,(0.4573) - 110\,e^{-(0.05)(0.5)}\,(0.3482) = 45.73 - 110\,(0.9753)(0.3482)$$

$$= 45.73 - 37.36 = 8.37$$

C = 8.37

The put option is calculated as follows:

$$P = 110\,e^{-(0.05)(0.5)}[1 - (0.3482)] - 100\,[1 - 0.4573]$$
$$= 110\,(0.9753)(0.6518) - 100\,(0.5427) = 69.93 - 54.27 = 15.66$$

P = 15.66

5. Black-Scholes-Merton (BSM) Model adjusting for Dividends

Discussed earlier when introducing the Binomial Option Pricing Model (BOPM) that dividend payments impacts how options for that stock is priced. As mentioned previously, in general, stocks fall by the amount of the dividend payment on the ex-dividend date. Since the dividend is important of the mathematics of the pricing of the option, the Black-Scholes formula can be modified to reflect such payment. Since theoretically, the stock should drop by the amount of the dividend, the current stock price needs to be adjusted to anticipate the future dividend. The current stock price (S) which is part of the Black-Scholes equation is modified to $Se^{-\delta t}$ reflecting the present value the stock using a dividend yield (δ). The Black-Scholes formula is modified to include the dividend as part of calculating the $d1$ is below (note that if they are no dividends with δ=0 the $Se^{-\delta t}$ will be written Se^{0} which equal to S as $e^{0} = 1$.

$$d1 = \frac{\ln(\frac{S}{X}) + \left(i - \boldsymbol{\delta} + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \text{ and } d2 = d1 - \sigma\sqrt{t}$$

Where S is the current price, X is the exercise price, i is the risk-free rate, t is time to expiration, σ is the standard deviation and δ is the dividend yield.

For example, let's assume that the that the current stock price (S) is $100 and the future exercise price (X) that expires in 6 months is $110. This out-of-the-money call option and in-the-money put option have a standard deviation (σ) of 0.40. The dividend yield (δ) is 3.0%. Given the risk-free rate of 5.0% what is the fair value of both the call and put option premium?

Input:
S = $100
X = $110
t = 0.50 (6 months)
i = 5.0%
σ = .40
δ = 3.0%

Formulas:

$$d1 = \frac{\ln(\frac{100}{110}) + \left(0.05 - 0.03 + \frac{.4^2}{2}\right) 0.50}{0.40\sqrt{0.5}} = \frac{\ln(0.9091) + (0.02 + 0.08)\ 0.50}{(0.40)(0.7071)} = \frac{-0.0953 + 0.050}{0.2828} = -0.1602$$

and

$$d2 = -0.1602 - 0.2828 = -0.4430$$

N (d1) = 0.4364
N (d2) = 0.3289

The call option for the call option is calculated using the Black-Scholes formula below:

$$C = 100\, e^{-(0.03)(0.5)}(0.4364) - 110\, e^{-(0.05)(0.5)}\,(0.3289) = 100\,(0.9851)(0.4364) - 110\,(0.9753)(0.3289)$$

$$= 42.99 - 35.28 = 7.71$$

C = 7.71

The put option is calculated as follows:

$$P = 110\, e^{-(0.05)(0.5)}[1-(0.3482)] - 100\, e^{-(0.03)(0.5)}\,[1-0.4573]$$
$$= 110\,(0.9753)(0.6518) - 100\,(0.9851)(0.5427) = 69.93 - 53.46 = 16.47$$

P = 16.47

The call option calculations using excel is shown in figure 13.21 below (assuming zero dividends):

Insert Figure 13.21

BLACK-SCHOLES VALUATION

CALL OPTION

A	B	C	D	E	F	G	H	I
4								
5	INPUT				OUTPUT			FORMULAS
6								
7		Standard Deviation (σ) =	0.4		d1 =	-0.107		=(LN(D11/D12)+(D10-D13+(D8^2)/2)*D9)/(D8*SQRT(D9))
8		Expiration (in years) (T) =	0.5		d2 =	-0.390		=+G8-D8*SQRT(D9)
9		Risk-Free Rate (Annual) (i) =	0.05		N(d1) =	0.457		=NORMSDIST(G8)
10		Stock Price (S) =	100		N(d2) =	0.348		=NORMSDIST(G9)
11		Exercise Price (X) =	110					
12		Dividend Yield (annual) (δ) =	0		C =	8.3696		=+D11*EXP(-D13*D9)*G10-D12*EXP(-D10*D9)*G11
13								

Figure 13.21

The put option calculations using excel is shown in figure 13.22 below:

Insert Figure 13.22

BLACK-SCHOLES VALUATION

PUT OPTION

A	B	C	D	E	F	G	H	I
4								
5	INPUT				OUTPUT			FORMULAS
6								
7		Standard Deviation (σ) =	0.4		d1 =	-0.107		=(LN(D11/D12)+(D10-D13+(D8^2)/2)*D9)/(D8*SQRT(D9))
8		Expiration (in years) (T) =	0.5		d2 =	-0.390		=+G8-D8*SQRT(D9)
9		Risk-Free Rate (Annual) (i) =	0.05		N(d1) =	0.457		=NORMSDIST(G8)
10		Stock Price (S) =	100		N(d2) =	0.348		=NORMSDIST(G9)
11		Exercise Price (X) =	110					
12		Dividend Yield (annual) (δ) =	0		P =	15.6537		=D11*EXP(-D9*D8)*(1-G10)-D10*EXP(-D12*D8)*(1-G9)
13								

Figure 13.22

6. Put Call Parity

Either the investor needs to calculate the call option or the put option and given that the probability concepts used are the same pricing for the same period the call price

should be in parity of the put price. The difference between the call premium to the put premium should equal to the intrinsic value S – X or X – S with the exception that the X will be adjusted to represent the present value since by definition the exercise price is in the future. The Call-Put Parity is as follows:

C – P = S – PV (X) or C – P = S – Xe^{-it}

If an investor knows the call price and needs to determine the put price and vice versa the formulas translate to the following:

C = S – Xe^{-it} + P and P = Xe^{-it} – S + C

Using the example above where the Stock is $100 and the future exercise price (X) that expires in 6 months is $110, the call option is priced at $8.37. Given the risk-free rate of 5.0% what is the fair value of the put option premium? Using the Call-Put Parity formula you calculate the put option as follows:

P = Xe^{-it} – S + C = 110 $e^{-(0.05)(0.5)}$ – 100 + 8.37 = 110 (0.9753) – 100 + 8.37 = 15.66

P = **15.66**

7. The Hedge Ratio (h) and Leverage (Borrowing) Methods- Using BOPM

There is another method that can be used to determine the option pricing. This method is similar to the Binomial Option Pricing Model (BOPM) discussed earlier but instead of using the probability the values can be derived by using the leverage method. This leverage method is important when the investor is using the BOPM valuation to determine the a fully hedged position for option strategies such as covered calls and protective puts discussed. The method to calculate the call price is demonstrated below. This 6-step method shown in Figure 13.23 below determines first the hedge ratio first and then using a leverage component calculates the fair value of both call and put options.

Insert Figure 13.23

BINOMIAL OPTION PRICING MODEL

LEVERAGE (BORROWING) METHOD - Call option

Parameters	Current Stock Price	Increase / Decrease Factors (u and d)	Stock x (Su) and (Sd)	Call Option Payoff (Cu) and (Cd)	h
Current Price (So)=	$ 100.00				
Up factor (u) =		1.2x	$ 120.00	$ 10.00	
Down factor (d) =		0.9x	$ 90.00	$ -	
Ranges (Su - Sd) and (Cu-Cd) =			$ 30.00	$ 10.00	1/3

Exercise Option =	**$ 110.00**	
Exercise time =	**1**	year
Interest Rate =	**5%**	annual compounding
Step 1: (Su - Sd) =	**$ 30.00**	Range between Upper and Lower Stock
Step 2: (Cu - Cd) =	**$ 10.00**	Range between Upper and Lower Payoff
Step 3: h = (Cu - Cd) / (Su - Sd) =	**1/3**	Hedge Ratio (Buy 1 Stock / Sell 3 Calls)
Step 4: (PV of Sd)	**$ 85.71**	Present Value of the Stock - Borrowing)
Step 5: (So - PV(Sd))	**$ 14.29**	Intrinsic Value (S - Expected X)
Step 6: ([So - PV(Sd)] x h) =	**$ 4.76**	Intrinsic Value times the hedge ratio
Premium =	**$ 4.76**	
Break Even =	**$ 114.76**	Stock Price + Premium
Distance to BE ($) =	**$ 14.76**	Break Even $116.06 - Current Stock $100
Distance to BE (%) =	**14.76%**	Break Even / Stock Price - 1

CALL-PUT PARITY ERROR CHECK
$ 9.52

LEVERAGE (BORROWING) METHOD - Put Option

Parameters	Current Stock Price	Increase / Decrease Factors (u and d)	Stock x (Su) and (Sd)	Put Option Payoff (Pu) and (Pd)	h
Current Price (So)=	$ 100.00				
Up factor (u) =		1.2x	$ 120.00	$ -	
Down factor (d) =		0.9x	$ 90.00	$ 20.00	
Ranges (Su - Sd) and (Cd-Cu) =			$ 30.00	$ 20.00	2/3

Exercise Option =	**$ 110.00**	
Exercise time =	**1**	year
Interest Rate =	**5%**	annual compounding
Step 1: (Su - Sd) =	**$ 30.00**	Range between Upper and Lower Stock
Step 2: (Pu - Pd) =	**$ 20.00**	Range between Upper and Lower Payoff
Step 3: h = (Pu - Pd) / (Su - Sd) =	**2/3**	Hedge Ratio (Buy 2 Stocks / Buy 3 Puts)
Step 4: (PV of Su)	**$ 114.29**	Present Value of the Stock - Borrowing)
Step 5: (So - PV(Su))	**$ 14.29**	Intrinsic Value (Expected X-S)
Step 6: ([PV(Su) - S0] x h) =	**$ 9.52**	Intrinsic Value times the hedge ratio
Premium =	**$ 9.52**	
Break Even =	**$ 100.48**	Stock Price - Premium
Distance to BE ($) =	**$ 0.48**	Break Even $96.36 - Current Stock $100
Distance to BE (%) =	**0.48%**	Break Even / Stock Price - 1

Figure 13.23

Figure 13.23 shows that the European call option should be priced at $4.76 and the put option at $9.52 with hedge ratios of 1/3 and 2/3 respectively. Let's assume that the call option is mispriced versus out calculation. Instead of $4.76 the market quotes the call option at $5.25. This represents an arbitrage opportunity demonstrated in Figure 13.24 below:

Insert Figure 13.24

BINOMIAL OPTION PRICING MODEL

Mispriced Security: Arbitrage Opportunity

Assume Call option is mispriced at	**$**	**5.25**
Calculated the Call option price using BOPM =	$	4.76
Current Stock Price	$	100.00
Using the Hedge ratio you get to the following strategy		1/3
Exerecise Price	$	110.00
Borrowing Interest Rate		5.0%
Time to expiration (years)		1

Sequence	**Strategy**	**Initial CF**	**At Stock $ 90.00**	**At Stock $ 120.00**
FIRST	Write 3 Calls ($5.25 x 3) at cost =	$ 15.75	$ -	$ (30.00)
SECOND	Buy one share ($100 x 1)=	$ (100.00)	$ 90.00	$ 120.00
THIRD	Borrow the difference at 5% =	$ 84.25	$ (88.46)	$ (88.46)
Total		**$ -**	**$ 1.54**	**$ 1.54**
Present Value =			$ 1.46	$ 1.46
Per option profit =			$ 0.49	$ 0.49

Note : Exactly the amount that the option is mispriced $5.25 - $4.76 = $ 0.49

Figure 13.24

Figure 13.23 above calculates an arbitrage opportunity of the call option that is trading at $5.25 while the BOPM suggested value is $4.76. Since the current price is higher, then the investor should take advantage of the mispriced call option and enter a cover call by selling the option by using the hedge ratio that is calculated at 1/3. With the hedge ratio 1/3 the investor should buy 1 share at $100 and sell 3 call options at $5.25 each for a total cost of $15.75 and borrow the difference at 5.0% borrowing rate. If the stock goes to $90 then the investor will sell the stock at $90 and payoff the loan which is projected to be at $88.46 including the original loan of $84.25 and 5.0% interest. At $90, the call options will not be exercised since the price (S is lower than the exercise price (X). The proceeds of selling the stock will be $1.54 per share with no risk. The same is shown if the stock goes to the upper level of $120. The investor will sell the stock, receive $120 and pay $30 to cover the 3 call options (X – S) x # of Call options = ($120 – 110) x 3 = $10 x 3 = $30. The net proceeds of $90 will more than cover the loan of $88.46 including interest. Since $1.54 is a future payment, the investor needs to discount that back to determine today's arbitrage price at a 5.0% discount rate calculated at $1.46. The $1.46 represents todays arbitrage price pe share for 3 call options. If you divide $1.46 by 3 call options the mispriced opportunity per option is $49 which represents the difference between the calculated $4.76 using the BOPM and $5.25 current misprice.

CASE STUDY AND PRACTICE CASES

Based on the information below, complete the projected spreadsheet. (access spreadsheet www.professordrou.com)

TO BE PROVIDED LATER

References (Chapter 13)

TO BE PROVIDED LATER