OPTIONS

PRELIMINARY SUBJECT OUTLINE

I INTRODUCTION AND DESCRIPTION

* An option is a special type of derivative
* Nature of the option contract; the parties involved
* The vocabulary and jargon of options
* Various option types and their parameters
* American, European and Bermuda styles
* Exotics
* Explicit, embedded and implicit options
* Exchange-traded vs. OTC; performance risk

II PERFORMANCE RISK

* The nature of performance risk
* Exchange traded options
* Margin and marking-to-market
* Index Options

III FUNDAMENTAL CONCEPTS AND BASIC APPLICATIONS

* Why and how options are used: general concepts
* Option payoffs; participation vs. protection
* ATM, OTM, ITM
* Basic option strategies
* Combinations
* Options for protection, enhancement or synthesization
* Ordinary and binary
* Options in M&A

IV OPTION RELATIONSHIPS

* Relationships among options; minimum values
* Arbitrage values
* Fair forward pricing; ATM spot vs. ATM forward
* Put-Call parity
* Option spread trading
* Butterflies

V PRICING AND THE “GREEKS”

* Factors determining an option’s premium
* Intrinsic and time value: what do these mean in plain English
* All the “Greeks”
* Delta hedging and hedge ratios
* Crucial role of volatility
* Buying and selling vol
* Convexity and gamma; dynamic hedging
* “Gamma buyers” vs. “delta buyers”
* Barrier options
* Identifying risk exposure

VI VOLATILITY

* Measuring volatility
* Historical vs. implied vs. realized vol
* GARCH
* Term structure of volatility

VII SOME ADVANCED CONCEPTS

* Developing the Black-Scholes formula
* Relation between binary and ordinary option
* “Smile” and “skew”
* Binomial pricing approach
* Asian-type payoffs
* Early exercise

VIII MODERN APPLICATIONS: EMBEDDED, FIXED INCOME, FX AND OTHER OPTIONS PRODUCTS

* Convertible securities
* PIK bonds
* Duration of call option
* Yield curve strategies using options
* Callable bond; cancellable swap
* Swaptions
* Caps and floors
* Capped and inverse floaters
* Range Notes
* Principal protected notes
* Reverse convertibles
* Accumulation products
* Target redemption forward products
* Premium/discount currencies via options
* Indirect volatility via FX correlations
* Common stock as an implicit option

INTRODUCTION

This chapter has a number of purposes:

* To introduce the most basic terminology;
* To make you familiar with, albeit on a simple level, some fundamental options concepts that will come up over and over again later in the course (when we will delve more deeply into them);
* To present the myriad of option varieties in a structured format that minimizes confusion.

An option is a derivative, but a special type of derivative. What is a (non-option) derivative? Very simply, a derivative is a contract, or agreement, between two parties. Like any contract, a derivative contract describes obligations each party takes upon himself for the benefit of the other. Consider the following agreement between Groucho and Chico:

Groucho agrees to pay Chico $27/share for 1,000 shares of General Electric stock on September 30

Chico agrees to sell 1,000 shares of General Electric stock to Groucho for $27/share on September 30.

This is a forward contract – “forward” because Groucho and Chico have agreed to do something for each other at a later date. They entered the contract today, the “contract” date. They must perform on their obligations according to the contract on September 30, the “settlement” date. Chico and Groucho are known as the “counterparties” to the contract.

It is important to recognize that Chico and Groucho need do nothing today other than sign the contract.[[1]](#footnote-1) Their agreement involves activities only on the settlement date. In particular, Groucho is not paying Chico anything today (nor is Chico paying Groucho anything today). Why? Because only General Electric stock has value - $27 per share on September 30 – *not the contract itself*. In finance we describe this situation by saying the forward contract has a *net present value (NPV) equal to zero*. If this were not the case, one of the counterparties would need to pay the other some money today For example, if the value of GE in the marketplace, for settlement September 30, is 26 per share, then Chico would need to pay Groucho (the present value of) a dollar per share today in order to compensate him for agreeing to pay 27 later. The contract is worth a dollar to Chico – which he has to pay for – and minus a dollar to Groucho, for which he has to be compensated for. At 27 a share, the contract is “fair” [[2]](#footnote-2) No money changes hands at inception. The forward contract is neither purchased nor sold; it is entered into cash or spot price.

Now you are ready to understand the specialness of an option derivative contract. An option is a contract between two counterparties. But only one has an obligation. The other counterparty has a right, not an obligation. You’ll see what this means in the next section. For now the crucial implication is the following. Because the two counterparties to the contract do not enter equally – unlike the forward contract above where Groucho and Chico agree to exchange items of equal value (Groucho agrees to give Chico $27 for each share, Chico agrees to give Groucho shares worth $27 each) – the option contract *does not have a net present value equal to zero*. Hence, the counterparty being granted the right must compensate the counterparty accepting the obligation to enter the contract. Money *does* change hands at the option’s inception.[[3]](#footnote-3) The option is actually bought and sold, at a price (the option “premium”).

REVIEW QUESTIONS

John agrees today, July 5, to buy 100 ounces of gold from Joan on September 5, at $1,250/oz. The market (“fair”) price today for gold to be purchased/sold on September 5 is $1,262.50/oz.

1. What is the contract date? Settlement date?

The contract date is July 5. The settlement date is Sept 5.

1. Who pays how much to whom today, and why?

John should pay the present value of $1250 to Joan today. This is because John needs to pay some money to compensate Joan for agreeing to sell gold at $1250/oz on Sept 5.

1. Who pays how much to whom on September 5?

John pays $125000 to Joan on Sept 5.

Although we will often employ stocks as the underlying asset of the option contract, market participants create and trade options on all types of assets (as well as non-assets!):

* equity shares
* equity indices
* notes and bonds
* interest rates
* swaps
* foreign exchange
* commodities
* forwards and futures
* options (not a typo!)

THE OPTION CONTRACT

An investment manager approaches an investment bank with a request to purchase 1,000 shares of General Electric in one month. The price of GE in the market today is 27 per share, but the investor does not need the shares today. The dealer quotes a price of 27/share, which is agreeable to the investor. In the course of their conversation, however, it becomes clear to the dealer that while the manager wants to own GE, he is worried that GE may fall by Sept 30. In that case, the investor will need to pay a price above the market. In response, the dealer makes the following offer to the investor:

I will sell you 1,000 shares of General Electric on September 30, should you wish to purchase at that price. But you are not obligated to.

This is a great deal for the investor, is it not? If GE’s stock price is above 27/share on September 30, she will call on the dealer to honor his promise. If GE is below 27 on that date, say 26, she will purchase it in the market for 26/share. If GE is exactly 26, it doesn’t matter. In any case, she can’t lose.

What about the dealer? The dealer can’t win. Suppose the dealer has the GE shares in inventory. If GE is above 27 on September 30 he will be forced by the investor to give it up for 27. If GE is below 27 he either retains it or sells it in the market for that lower price.

Suppose the dealer does not own GE. If GE is above 27, say 28, on September 30, he will need to purchase it in the market and sell it to the investor who will certainly require him to honor his obligation. He loses a dollar per share. If GE is (at or) below 27, he will not need to do anything, but he certainly doesn’t gain. In short, the dealer can only win with this contract.

Why would the dealer sign the contract; i.e., make the above offer? Clearly, only if he is compensated. The dealer needs to be paid. And the investor is willing to pay, because for her it’s a “can’t lose” deal. Let’s say this in terms of our discussion of the forward contract discussion above. The agreement is certainly not fair. *It does not have a zero present value.* Rather, it has a positive present value for the investor, a negative present value for the dealer. Why, then, would the dealer accept an agreement with a negative present value, indeed offer it to the investor? If he is paid up front to do so. How much? That very present value.

Say the present value of the agreement is 2 per share of GE (+2 to the investor, -2 to the dealer). The dealer writes the agreement on a piece of paper. The paper is worth $2,000 ($2 for each of the 1,000 GE shares). The dealer hands the paper to the investor and receives two thousand green pieces of paper in return, or $2,000, from the investor. They have exchanged equals for equals. The dealer has just sold an option to the investor, for which the investor has paid $2 per share. The price of the option, therefore, is 2/share.

REVIEW QUESTIONS

Suppose that instead of offering the investor the right to purchase GE shares in one month for 27/share, which is the same as GE’s price in the cash market, the dealer offers to sell at 30/share. Again, the investor is not required to pay 30 on September 30, she simply has the right to do so if she so desires.

1. Is this option worth anything; i.e., must the dealer be compensated up front to grant it to the investor?

Yes. Investor have to compensate dealer for agreeing to sell certain mount of GE shares at 30/share.

1. Compared to the option contract in the text, is this option worth more or less to the investor?

This option worth less to the investor. Investor would get profit only if GE’s price is above 30/share in one month. However, it is less possible for the GE’s price to be above 30/share than 27/share, not to mention that investor thinks that GE’s price in one month will fall under 27/share.

CONTRACT PARAMETERS

Figure xx displays an option contract. There are (at least) six parameters in every contract:

* Buyer and Seller. As explained above, the terms “buyer” and “seller” are appropriate for an options contact, as the contract itself has a net present value at its outset – it is “worth something” and, therefore, must be paid for by the buyer. Costello, the seller of the option is also known as the “writer” (for historical reasons[[4]](#footnote-4)). Abbot, the buyer may also be described as the “investor,” reasons for which will become clear later.
* Underlying Asset. This option is a contract for General Electric stock.
* Size. Abbot, by purchasing the option, has the right to buy 1,000 shares of GE stock at the agreed upon price.
* Strike/Exercise Price. If he so chooses, Abbot will pay $27 per share of GE. In that case he is exercising his right, hence the term “exercise” price. $27 is alternatively known as the “strike” price, because the buyer and seller have struck a deal at 27/share.
* Expiration. Abbot’s right to buy ends after September 30, known as the expiration date. (Whether he can exercise his right *prior* to September 30 or only *on* September 30 is an issue we’ll take up later.)
* Option Type. Costello has sold Abbot the right to purchase GE for 27/share. This is termed a “call” option. There are other types, which we’ll discuss later.

Abbot buys/ Costello sells Call option

General Electric stock 1,000 shares

September 30 $27/share

Notice the absence of the cost of the option from the contract and the parameter list. It is not a parameter, or “detail,” of the contract. It is the “price” of the contract. Here’s why.

Suppose GE begins trading in the market this morning at 26 per share. This is known as GE’s spot, or cash, price. Let’s continue with the earlier assumption that the net present value of this call option is 2 per share, which is the option’s price. This tells us that “the market” (buyers like Abbot and writers like Costello) on average feels that the right to pay 27 per share for GE (by September 30) without the obligation to do so is worth 2 when GE is 26.

Now suppose that GE rises to 28/share as trading progresses in the cash market today. It stands to reason that, because the market was willing to pay 2/share for the right to pay 27/share when GE was worth 26/share, it should be willing to pay a higher price for the right to pay 27/share when GE is 28/share! This is shown in Figure zzz where the assumption is that the call’s price incases from 2 to 3/share in response to GE’s price rise in the cash market. A new options contract, with the same parameters, will be worth more because of the rise in price of the underlying asset, GE.

GE stock price now: 26

call option price now: 2

GE stock price later 28

call option price now: 3

GE stock price later 24

call option price later: 1.25

You can see this another way. Suppose you purchased the original call option in the morning for 2 per share when GE was trading at 26 per share. Later in the day GE rises to 28. You still have your contract, which is the same as *new* contracts written with identical parameters. It is, therefore, now worth 3/share and you can sell it for a profit of 1/share. In short, what should be clear is that the contract itself, that is, the parameters, haven’t changed. But because the market – GE’s cash price – has changed, the *value* of the contract has changed.[[5]](#footnote-5)

Figure zzz also shows the possibility of GE declining, by the same amount, to 24/share. By similar reasoning to that above, a call option with the right to pay 26 for an asset now worth 24 should be worth less than before the decline. That explains the drop in price of the option to 1.25.[[6]](#footnote-6) Newly written call options struck at 26 and expiring September 30 carry a price of 1.25, and so does yours.

This analysis allows us to look at the call option from another perspective, one that will lead to a crucial conclusion. Recall that the investment manager bought the option as insurance: he was worried about paying too high a price for GE stock on September 30. Purchasing the option assured him that he will never need to pay more than $27 a share, and might he possibly pay less. Now think about an investor who wishes to buy GE shares *today*. As shown in Figure xxx, the call option’s value or price, moves in the same direction as the price of GE. An investor expecting GE to appreciate in value can choose between buying GE stock or calls on GE stock. In other words, the call option can be used as a substitute for the underlying asset! Of course, just as a decline in price in GE produce a loss for the stock purchaser, the same decline will produce a loss for the GE call buyer. But that’s what a substitute is supposed to do. However, the substitution is imperfect; as the figure shows, GE’s price change is not perfectly mimicked by that of the call option.[[7]](#footnote-7)

Before we go on with this analysis, make sure you understand the relationships among three prices:

1. cash price of the underlying asset
2. strike price according to the options contract
3. premium of the call option

The option allows the buyer to purchase the underlying asset at a price b). The attractiveness of doing depend on the cash price a). The relationship between a) and b) determines c).[[8]](#footnote-8)

EFFECT OF CHANGE IN STRIKE

Return to the contract in Figure xxx. Suppose we change the strike price, to 30/share. The right to pay $30 for something, whatever the price of that something in the cash market, is clearly worth less than the right to pay $27 for that same something. We conclude quite easily that the higher the exercise price, the less valuable the call option, hence the lower its price. Opposite reasoning tells us that the lower the strike, the more valuable the call. As we continually raise the strike, the call’s price should continue to decline. But it can never fall below zero, because it’s a right, not an obligation; you wouldn’t pay someone to take the option off your hands – just discard it. It may be infinitesimally above 0, but its present value is still positive to the buyer. Now consider the dynamics in Figure zzz, but for this call option struck at 30. An increase in GE’s cash price makes the call more valuable (though still less valuable than that of the 2 strike call). And a decrease in GE causes the premium to decline. In short, regardless of the exercise price, call prices move in the same direction as the price of the underlying asset, all else the same.[[9]](#footnote-9)

EFFECT OF WIDER PRICE RANGE

Let’s continue with the call option of the preceding paragraph, struck at 30 and expiring in one month. Suppose market participants feel that there is no chance that between now and the end of the month the price of GE shares will rise above 29 of fall below 23. Indeed, its current price of 26 reflects the market’s assessment that there is an equal (50%) likelihood of GE’s price residing in the 26─29 range as in the 23─26 range. What is this call option worth? Zero, of course. Because GE’s price is restricted to the 23 – 29 range for the next month, the right to purchase GE for 30 is worthless. Said differently, the call provides no benefit to the buyer (or cost to the writer) because no one believes it will ever be used, or exercised (NPV = 0).

Now suppose an “event” occurs, one that causes market participants to reassess their view of GE’s price range over the next month without affecting its price. An example might be a disclosure that GE is in talks with another company which made lead to a major acquisition. This may work out very well for GE, but there is also a good chance GE will overpay. As a result, the price range for GE widens to 21─31, with the midpoint remaining at 26. GE’s price has not changed but, crucially, a call option struck at 30 and expiring after the window of opportunity for the possible merger now has positive value whereas it didn’t have any before. It would not be wrong to describe the widening of GE’s price range as an increase in GE’s price "volatility.” [[10]](#footnote-10)

*An increase in volatility raises the value of a call option even with the price of the*

*underlying unchanged.*

In other words, a call option on an asset can “decouple” from the asset itself. Because volatility impacts the call’s price *independently* of the price of the underlying, it is possible for the option’s price to change even as the underlying’s price does not and, indeed, for the underlying’s price and the call’s price to *move in opposite directions*.

What about a decline in volatility? This is considered in the following Review Question.

REVIEW QUESTION

Coca Cola is trading currently at 42/share. Consider a one-year call option with an exercise price of 42. How is it possible for Coke shares to rise in price, say, over the next week, yet the call option to fall in price?

If the market think that the volatility of CC’s price would decline, say no major change will happen to CC over the next week, and CC would develop stably, the call option of CC would fall in price and CC’ price would go up.

EFFECT OF MORE TIME

Similar logic to increase in volatility.

PUT OPTIONS

Up to now we have been concerned exclusively with call options – the right, without the obligation, to purchase an underling asset. A “put” option, by contrast, grants the owner the right, without the obligation, to sell an underlying asset at a pre-set exercise price. Let’s alter the parameters in figure xxx. Write put in place of call and change $27 to $25/share. Suppose an investment manager owns 1,000 shares of GE. Due to a client’s need for cash at the end of September, the manager is planning to sell the shares by that date. She is worried, of course, that GE shares will drop in price between now and then. Locking in a forward sale at $25 per share certainly addresses her worries. But it will prevent her from enjoying a possible increase in GE’s price. This put option would be perfect for her. It gives her the right, without any obligation, to sell the 1,000 shares to the writer for 25 per share on September 30. If GE drops below 25 then, she’ll exercise her option and require the put writer to buy the shares from her at 25 per share. If GE is (at or) above 25, she’ll forego the option and sell the shares in the market at the higher price. She can’t lose.

Consider the writer’s position. If GE is, for example, 23, he will need to pay 25 for 1,000 shares. Should he desire to own GE stock, he will be paying $2 per share more than necessary. If he doesn’t want to own the shares, he will sell them in the market for a loss of $2,000. What’s in it for the put writer? The premium that the investor pays for the put at the time of purchase. Why is there a premium? Because the put has a positive net present value for the buyer, a negative NPV for the seller.

GE stock price now: 26

put option price now: 2

GE stock price later 28

put option price later: 1.25

GE stock price later 24

put option price later: 3

Figure zzz shows the effect of changes in GE’s cash price on the value of the put. Note the symmetry compared to figure xxx. At GE’s current price of 26/share, the put option is worth 2/share to the buyer. If GE were to rise to 28, the put’s value would decline to 1.25/share. Why? The right to sell GE for 25 (without the obligation to do so) when GE is 26 is certainly less attractive than the right to sell it for 25 when GE is 28. Remember, the buyer of the put is assuring herself of receiving no less than the strike price of 25. This assurance is clearly less attractive when GE is 28 than when it is 26.

What if GE falls to 24? The right to sell GE at 25 is now more attractive, hence the premium jumps to 3. Again, think of this in two ways. An investor wishing to purchase a put now must pay $3 per share of GE. Or, our original investor, who purchased the put for $2 when GE stock was at 26 can now sell the put for a $1/share profit. Looking at the latter way shows that. Similar to the call, the put is a substitute for a cash position. Unlike the call, which can serve as a substitute for owning GE, the put serves as a substitute for being *short* GE. A short seller is of the view that a stock, or another asset, will decline in price. Rather than establishing a short position in the cash market, we now see that purchasing a put produces similar exposure: a profit for the put buyer should the underlying asset fall in price, a loss should the asset rise in price.[[11]](#footnote-11)

Earlier we determined that, all else the same, increasing the exercise price for the call option from 26 to 30 decreases the option’s value. A put’s reaction to a change in the strike is the opposite. The right to sell an asset at a higher price is clearly more valuable than at a lower price. The lower the strike, on the other hand, the lower the put premium.

The effect of a change in volatility on a put’s value is a different story entirely. Here, the call and put respond in the same direction. Consider a three-month put on GE with an exercise price of 22. GE is presently trading at 26. Suppose market participants believe that GE will remain within the range of 22 – 30 over the next three months (and symmetrically so, which is why the current price is 26). A put allowing the holder to sell at 22 clearly has no net present value. Now suppose an event occurs which causes market participants to widen the range, say, to 20 – 32, yet leaves the price intact. The 22 put suddenly rises in price from 0 to a positive amount. In short, an increase in volatility of the underlying asset raises the value of a put, while in a decrease in violability reduces its value. The review question below is a crucial summary.

REVIEW QUESTIONS

1. Explain intuitively why an increase in the price of the underlying asset has opposite effects on a call and a put, holding volatility constant, while an increase in volatility has similar effects, holding the underlying price constant.

An increase in volatility means wider price range of the underlying asset. It increases the likelihood that the price of the underlying asset will go up and then the call option become more valuable. Also, it increases the likelihood that the price of the underlying asset will go down and then the put option become more valuable. However, for the price of underlying asset going up, the call premium increases but the put premium decreases. This is because the right to buy certain mount of shares at a relative lower price becomes more attractive and the right to sell certain mount of shares at a relative lower price becomes less attractive.

Hint: Think separately about an option’s connection to the underlying asset as a *substitute* for a position in the underlying versus its characteristic as a *choice*.

1. Why do you think the name “premium” is given to the price of an option?

If the call premium is $2/share and strike price is $27/share, you exercise the call option; It costs you $29/share to get the certain amount of shares because you need to pay not only the strike price which is $27/share but also the the premium which is $2/share.

The reason this explanation seems problematic is that you sell shares and get cash when you exercise a put option.

Hint: What is the total amount spent on GE using any of the call option examples above if the call is exercised, recognizing both components? Why is this explanation somewhat problematic when applied to a put premium?

Why is this contract termed an option? Because the key distinguishing feature is that the buyer of the contract – n this case the investor – has been given (sold) a choice. She is not required to pay 27 for each of the 1,000 shares of General Electric. But she may, *if she so chooses*. And, as explained above, she will only choose to do so when it is to her advantage. [[12]](#footnote-12)

OTHER OPTION TYPES

Calls and puts account for the vast majority of option types. A conversion option gives the buyer the right, but not the obligation, to exchange one asset for another, at a predetermined rate of exchange. This is a much more complex instrument than standard calls and puts. The latter also involve an exchange – an asset for cash. But since there is only one none-cash asset, only one volatility factor needs to be considered. A conversion option involves two assets, which requires consideration of two volatilities as well as the correlation between them.

A further complication is that conversion options are usually not sold as stand-alone products. A stand-alone conversion option would be the following: Abigail pays Claire $2 for the right to exchange a General Electric bond for 4 shares of GE stock.[[13]](#footnote-13) Should Abigail choose to exercise, she gives Claire the bond, and Claire gives Abigail the shares. However, conversion options are usually *embedded*, or contained within, an asset. The most common of these is a “convertible bond.” Abigail purchases a bond issued by General Electric Corporation. It pays a 5% annual coupon, for example, until it matures, say, in ten years. But it has a special feature: Abigail may present the bond to GE – not to a third party – and ask that it be exchanged for 4 shares of stock. How is this conversion option paid for? When it was sold, the price of the bond was higher – at a “premium” – compared to what an otherwise equivalent bond without the conversion feature would cost.[[14]](#footnote-14) Convertible bonds are explained in chapter xx.

Another type of option is a delivery option. Some financial contracts, especially those that involve delivery of the asset at a later date, allow the seller to choose from a number of “deliverable” varieties. For example, a seller of gold may choose the degree of fineness. Another example is a bond futures contract. The counterparty who agrees to sell the bond can choose bonds of various coupon and maturity combinations. In each of these cases the price the buyer pays upon receiving delivery will change according to the choice made by the seller. Still, the choice the seller has a positive net present value.

CASH SETTLED OPTIONS

As illustrated above, exercising a call option means the holder pays the strike price and the writer delivers the underlying asset. If Abbot purchased a call on 100 shares of Coca-Cola struck at $40/share from Costello, and Coke shares are 42/share at expiration, Abbot will exercise: pay 40x100 to Costello who must deliver the shares to Abbot.[[15]](#footnote-15) If Abbot wishes to own Coca-Cola shares, paying 40/share is better than paying 42. If he’s uninterested in owning the shares, he will sell them at a $2x100 profit. This is known as a “physical delivery” contract.

Instead, Abbot and Costello may agree at the outset to “settle the contract in cash.” This means that, at expiration, Costello does not deliver shares. Rather, he pays Abbot the profit Abbot would earn *were he* to exercise. In the example above, he pays Abbot $2x100, or the difference between the strike price and the price of the stock.[[16]](#footnote-16) If Coke is 45 at expiration, Abbot receives $5x100 from Costello. If Abbot is below (or equal to) 40 at expiry, there is no payment. Why? Because Abbot would certainly not exercise. Had Abbot purchased a put contract on 100 shares of Coca-Cola struck at 40 from Costello, the cash settlement would work similarly. Both are summarized in Figure 4.

FIGURE 4

PHYSICAL DELIVERY VS. CASH SETTLEMENT

Abbot buys call on 100 Coca-Cola shares from Costello, exercise price of 40

Physical Delivery Cash Settled

Price of Coca-Cola shares at expiration: 42 Price of Coca-Cola shares at expiration: 42

Abbot pays $40x100 to Costello Costello pays ($42-$40)x100 to Abbot

Costello delivers 100 shares to Abbot

Price of Coca-Cola shares at expiration: 38 Price of Coca-Cola shares at expiration: 38

Abbot does not exercise No payment

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Abbot buys put on 100 Coca-Cola shares from Costello, exercise price of 40

Physical Delivery Cash Settled

Price of Coca-Cola shares at expiration: 42 Price of Coca-Cola shares at expiration: 42

Abbot does not exercise No payment

Price of Coca-Cola shares at expiration: 38 Price of Coca-Cola shares at expiration: 38

Abbot delivers 100 shares to Costello Costello pays ($40-$38)x100 to Abbot

Costello pays $40x100 to Abbot

Suppose now Coke is 42 at expiration and Abbot, having purchased the 40 call, wishes to own the shares. What if the option contract is cash settled? No difference. Abbot receives $2x100 from Costello due to the call, purchases the 100 shares in the market for $42/share, so that his net cost is $40/share – exactly the same as the exercise price. In short, *there is no economic difference between physical delivery and cash settlement.* Suppose instead Abbot owns 100 shares of Coke and purchased the 40 put. Coke is 38 at the options expiration, and it is cash settled. Abbot receives $200 from Costello due to the put, sells the shares in the market for $38, which produces a total of $40/share.

OPTION STYLES

Like clothing, options come in a number of styles. Two styles cover almost all options: **American and European**. Each option type can be in either of the styles.

An American style option allows the option buyer to exercise anytime until the option expires.[[17]](#footnote-17) A European style permits exercise only at the option’s expiration. At first blush, it would certainly appear that the European is far less attractive than an otherwise similar American. Hence, it should be worth much less. After all, the American presents (infinite) more “options.” We will see, however (in chapter xxx) that in many, if not most, cases, particularly for calls, the holder of the option would not want to exercise the option earlier than at expiration. Indeed, in those cases early exercise actually reduces the option’s value. That being the case, the right to exercise earlier than at expiration has no value. Therefore, all we can say is that an American style option is never worth less than its European counterpart.

A relatively new style of option is a **Bermuda** option. It is a hybrid of an American and European. It allows exercise prior to expiration, but only at specific dates (or after certain events which “trigger” an early exercise feature).

EMBEDDED vs. STAND-ALONE

Options often are contained, or embedded, in other securities. The vast majority of options are stand-alone, that is, written and sold as independent products. Embedded options abound in the fixed income universe. We’ve already come across one such option, a convertible bond. Another prominent example is a callable bond. Both the conversion option and the call option embedded in bonds are explicit. Some embedded options are implicit. For example, a capped floating rate note does not give the buyer of the note an actual choice of taking some action. Still, the cap contained in the note does act as an option, hence it is implicit.[[18]](#footnote-18)

There are even options embedded in other derivatives. One example is the delivery option in a bond futures contract. Another is a cancellable interest rate swap – an interest rate swap which grants one of the counterparties the right to terminate the swap prior to its stated maturity date.[[19]](#footnote-19)

EXOTICS

The options introduced above are often labeled as “ordinary,” or “traditional.” This is because they have the standard features: a single underlying asset, a fixed exercise price, European or American expiration, etc. As such, they are the most common varieties of option encountered in the financial markets.

In recent years, market participants have felt the need to create many new varieties of options. Because they are different from the traditional ones, they have acquired the label “exotic options.” Exotic options are created regularly, as dealers work to accommodate the needs and risk preferences of customers. Most are custom-made, so a complete list would be impossible. However, the most popular fall into the three “classes” listed below. Indeed, we may refer to the traditional options as falling into the “ordinary” class. What follows is a list of exotic options, organized by class, with brief descriptions. Later chapters will elaborate on many of these and show how they are used in practice.

A CLASS

Asian options (hence the letter “A”) are also known as LookBack options. The decision to exercise, hence the value of doing so, does not depend on the relationship between two prices, the strike and that of the underlying, at expiration. Rather, it depends upon the relationship between one of those prices and a whole set of prices reached by the underlying asset over some historical period, typically over the life of the option contract. Asian options are generally cash settled.

* Average Price. The cash settlement is not the difference between the strike price and the underlying asset’s price at expiration, assuming it is positive. Rather, we “look back” over the life of the option and calculate the average price of the underlying asset during that period.[[20]](#footnote-20) If the average price exceeds the strike, the call writer pays the difference to the call holder. If the average (equals or) is below the strike, there is no payment. For an average price put, payment is made only if the average is below the strike.
* Average Strike. These options also require looking back and calculating the average price of the asset over a period of time. This average then becomes the exercise price of the call or put!
* Maximum/Minimum. For a call, the cash settlement equals the maximum price reached by the asset over the chosen historical period less the strike price, if positive. For a put it equals the exercise price less the minimum price reached by the asset, if positive.[[21]](#footnote-21)

Because the payoffs – hence the values – of the Asian options listed here depend on what transpired prior to the options’ expirations, they are termed *path dependent*. Actually, we’ve already encountered path dependent options. American style options are path dependent, as they may be exercised prior to expiration.

B CLASS VARIETIES

The class gets its name simply because many of the members begin with the letter “B”:

* Basket. Instead of a call or put on an individual asset, this is an option on a portfolio of assets. The portfolio could be equally weighted, for example, 100 shares each of GE, Coke and Apple. Or, it can be weighted in some fashion. For example, the portfolio comprises GE, Coke and Apple, but the share of each stock in the portfolio is proportional to its market capitalization. If all the members of a particular group of securities are included in the portfolio and properly weighted, the portfolio is known as an index. The most prominent example is the S&P 500 Index of stocks. An option on such a portfolio is known as an “index option.”[[22]](#footnote-22) All else the same, a basket option should have a lower premium than an option on an individual asset in the basket. Why? We concluded earlier that volatility plays a crucial role in determining an option’s value. A basket, or portfolio, of assets displays less volatility than a single component of the basket (as long as the components are not perfectly correlated).
* Bermuda. We’ve come across Bermuda options earlier. They are actually just a hybrid of an American and European style option. They enter the “B” class only because they are different from what options market participants have been accustomed to – they are exotic.
* Binary. A binary option, as its name suggests, is an option with only two outcomes. Should the underlying asset trade above its exercise price at expiration, a call option pays a fixed amount – the payoff – to the buyer. Unlike an ordinary call, an ever higher price for the underlying does not increase the payoff. Should it trade below the strike at expiration, the payoff is zero. For a put, the fixed payoff occurs when the asset finishes below the strike. Binaries trade on a stand-alone basis. They have also become essential ingredients in new types of bonds and swaps, and in structured products. Because of their ubiquity, we won’t wait much to analyze and apply them; we’ll get to them in chapter 3.[[23]](#footnote-23)
* Barrier. As opposed to a binary option, which produces a payoff pattern altogether different from an ordinary option, a barrier option retains all the fundamental characteristics of an ordinary option; it just adds another parameter: the barrier. For example, a call on Coca-Cola may be struck at 42 and expire in three months. If a barrier of 35 is inserted into the option contract, then should the price of Coke shares fall below 35 during the life of the call, the option the option expires then and there. Hence, it is also known as a “knock-out” or “down-and-out” (or “exploding”) option. Obviously, this potential early expiration feature – similar to the early exercise feature of American options – makes Barrier options path-dependent. More important, it reduces their value compared to an otherwise identical call without the barrier. Why? Because a barrier cannot help; it can only hurt. A barrier put option, using the same Coke example, might have a barrier (also known as a “trigger”) of 50. In that case, should Coca shares rise above 50 the put is knocked out; i.e., an “up-and-out” put.[[24]](#footnote-24)
* Best-of. This option is straightforward to understand, but difficult to analyze. A best-of option, as the name suggests, gives the holder of the call the higher payoff of two assets. For example, GE stock has an exercise price of 25, while Coke’s strike is 40. At expiration, Coke’s price excess over 40 is compared to GE’s excess over 25, and the buyer receives the greater. The complication is due to the interaction of the inherent optionality of the call and the correlation between the two stock prices. Clearly, though, this option is more valuable than a call option on one of the stocks (with the given strike). And even more valuable when the assets in the group among which the best performer is chosen are more than two.
* Bivariate. Not a very common variety, but worth noting, are bivariate options. These options require two events to occur in order for the option to pay off. Using the example immediately above, only if the price of Coca-Cola shares are above 40 *and* General Electric shares are above 25 will a payment (the excess of Coke above 40 or the excess of GE above 25 or a weighted combination of the two, or a fixed amount) be made. From elementary probability theory, the likelihood of both events occurring is lower than each alone (because Coke and GE are not perfectly correlated), which makes the option relatively cheap.[[25]](#footnote-25)

Note that these option variations can be combined. A binary call may contain a barrier. And it may have Bermuda-style exercise dates. No wonder options have been voted, year after year, the most fun financial product.

C CLASS

Believe it or not, B class options are not considered complex. Truly complex options are in category C, hence the name. The salient feature of options in this class is their contingency.

* Inside contingency. A parameter of the option depends upon an event, or some history, related to the underlying asset. For example, with GE currently at 24/share, a put on GE exercisable at 27 becomes operative only if and when GE crosses 30. Or, the exercise price of a Coca-Cola call depends on the earnings per share announced for the company prior to the option’s expiration. They appear frequently in option series. A series of calls, for example, might be five calls on the S&P500 index, the first expiring in one year, the second in two years, etc. The strike prices are set equal to the average of the index’s value over the previous year.
* Outside contingency. In this group, an option’s parameter is contingent upon a market variable related to other than the underlying asset. For example, a call on GE struck at 25 will pay off only if the price of gold is below $1250 an ounce when the call expires (or, averaged less than $1250 during the life of the call). Or, the payoff on a binary put with the S&P500 as the underlying index increases by $10 for every 1% increase in the yield on the US thirty year bond.

Another name for this class is conditional options. The second group are sometimes referred to as correlation options, because they involve the correlation between the underlying asset and the asset the option is further contingent upon. Their inherent complexity gives rise to the best name of all: “crazy” options.

Review Questions

I Which of the following option varieties are path-dependent?

* European put❌
* American call✅
* Bermuda put✅
* European average price call ✅
* European binary put❌
* Convertible bond✅

II How are a Best-of and Conversion option alike? How do they differ: i.e., which is preferable, all else similar?

Abigail pays Claire $2 for the right to exchange 2 shares of GE stock for 1 shares of Coke stock. Should Abigail choose to exercise, she gives Claire the GE stock, and Claire gives Abigail the Coke stock.

GE stock has an exercise price of 25, while Coke’s strike is 40. At expiration, Coke’s price

Hint: Consider GE and Coke. Propose a fixed rate of conversion between them for the conversion option, a pair of strikes for the best-of option.

III Consider the following three options contracts:

a) A call on a single stock, X, with an exercise price, Ex.

b) PORT is a portfolio of stocks containing X, Y and Z. A call on PORT has an exercise price of Eport. The distance between Ex and the current price of X is relatively the same as the distance between Eport and the current value of the portfolio.

c) A Best-Of contract involving X, Y and Z, with strikes of Ex, and Ey and Ez, respectively. The distance between the strikes and the current values of the stocks are relatively the same. At expiration, you receive the greatest of the three payoffs.

Rank them in terms of value. How should an increase in correlation among X, Y and Z affect the value of II compared to I and the value of III compared to I? Explain.

III > I > II

The value of II will increase, approaching to the value of I.

The value of III will decrease, approaching to the value of I.

CHAPTER HIGHLIGHTS

§ Unlike other (“pure”) derivatives, options are created with net present values greater than zero. This is known as the premium, or price, of the option, which the buyer pays the seller (also known as the writer).

§ A call option gives the buyer the right – but not the obligation – to purchase the underlying asset at an agreed upon strike, or exercise, price. The writer of the call has no choice but to comply with the buyer’s choice. The choice has a limited life, that is, until expiration.

§ A put option gives the buyer of the option the right to sell the underlying asset at an agreed upon exercise price, to which the writer must comply, until the put expires.

§ All else the same, a call option responds positively to an increase in the price of the underlying asset. Among other applications, this means a call can serve as a substitute to buying the underling. A put option responds positively to a *decrease* in the price of the underlying asset. This means a put can serve as a substitute to being “short” the underling.

§ It is important to understand the interactions among three prices: cash price of the underlying asset; exercise price of the option contract; premium of the option. For example, a higher strike reduces the call premium but raises the put premium, holding the underlying price (and other parameters) constant.

§ An increase in volatility of the underlying asset price raises the values of both puts and calls, holding other parameters constant. A fundamental implication is that the price of the option and that of the underlying may potentially decouple.

§ A physical delivery option entails actual delivery of the underlying asset from the call writer to the call buyer, or from the put buyer to the put writer, and payment of the exercise price in the other direction should the option be exercised. A cash settled option requires, in those situation where exercise is optimal, payment of the option’s net value by the option writer to the option buyer. There is no economic difference between the two option types.

§ American style options allow exercise prior to the option’s expiration. European style permit exercise only at expiration. Because options can be sold prior to expiration, the advantage of a an American over European style will be shown to be minimal.

§ Exotic options come in many varieties, with various degrees of complexity. Later chapters will present applications for some of them.

Looking Ahead

Now that you’ve digested the basics of options, we’re ready to see how options are used in practice – as a stand-alone security, in combination with the underlying asset to produce a particular risk profile and/or to add income, and together with other options. We begin by carefully examining the options at expiration. That is the subject of chapter 3 and ?. We then move on to options prior to expiration. But before any of that, we turn in the next chapter to issues involving a type of risk unique to derivatives: the risk that the counterparty to a derivative contract might not perform. We will see how options exchanges deal with default risk. You my skip the next chapter and go on to chapter 3 without any loss of continuity.

1. Counterparties to a forward contract sometimes agree to post collateral at the outset in order to ensure performance on the settlement date. Futures contracts *require* collateral. [↑](#footnote-ref-1)
2. In chapter xxx we will learn how the market arrives at this “fair forward price” which produces a net present value of zero, and relate it to the current price of the asset. [↑](#footnote-ref-2)
3. We will see, crucially, that this is so even if the price agreed to in the contract is the fair forward value of the asset. [↑](#footnote-ref-3)
4. The seller is sometimes referred to as the “issuer.” This is consistent with other financial products; e.g., banks are said to issue deposits (and, in some circles, are still described as “writing” deposits). [↑](#footnote-ref-4)
5. It should also be clear that the call option can be bought and sold - it is a tradable instrument separate from the underlying asset. [↑](#footnote-ref-5)
6. Why did its price decline by less than a full point when GE fell by 2 dollars per share, whereas it rose by a full point for the same 2 dollar increase in price? If this were not the case, you can readily see that for a large enough decline in GE price, the call option would soon drop below 0. This is impossible – the right to buy something cannot have a negative value, because you are not required to exercise. We’ll have a lot more – tons – to say about this asymmetry throughout this book. [↑](#footnote-ref-6)
7. The reason for, and degree of, the imperfection will be explained in chapter xxx. [↑](#footnote-ref-7)
8. In combination with other contract parameters and market variables, as we will see later. [↑](#footnote-ref-8)
9. Although the *direction* of response is maintained, the *degree* of responsiveness will differ depending on the strike price. See the previous footnote. [↑](#footnote-ref-9)
10. We will formalize this notion of volatility in chapter xx. It will then become clear to you why this example fits the definition. [↑](#footnote-ref-10)
11. The mechanics of establishing a short position involves borrowing the shares. Borrowing creates leverage which, among other institutional necessities, requires collateral. This, and other factors such as marking-to-market, are beyond the needs of our discussion. We will come to short selling when we examine fair forward pricing in chapter qqq. [↑](#footnote-ref-11)
12. When it is to her advantage, it is to the seller’s – in this case the dealer’s – disadvantage. [↑](#footnote-ref-12)
13. Of course, the particular GE bond – maturity, coupon, seniority – needs to be specified in the option contract. [↑](#footnote-ref-13)
14. There is yet a further complication here. Upon conversion, General Electric Corporation issues 4 new shares. Hence, there are balance sheet implications. We will deal with this in our discussion of warrants in chapter zzz, exercise of which has similar implications. [↑](#footnote-ref-14)
15. Note again that knowledge of the premium is unnecessary. Regardless of the premium paid, exercise is the rational action. [↑](#footnote-ref-15)
16. In chapter zzz we will refer to this as the option’s “payoff.” [↑](#footnote-ref-16)
17. There may be a waiting period before which exercise is not permitted. Because the right to exercise is continuous once the period has passed, it is still deemed American (though perhaps “deferred” American). [↑](#footnote-ref-17)
18. Callable bonds and floating rate notes, along with capped floaters, are examined in chapter qqq. [↑](#footnote-ref-18)
19. Interest rate swaps and associated options are covered in chapter zzz. [↑](#footnote-ref-19)
20. The contract will need to stipulate how the average is calculated, that is, the frequency of the observations on the asset’s price – daily (and when during the day), twice daily (morning and afternoon), weekly, monthly, etc. [↑](#footnote-ref-20)
21. Less common, but feasible, lookbacks would use minimum for the call and maximum for the put. [↑](#footnote-ref-21)
22. Basket options have a long history in currency markets. Prior to the creation of the euro currency, international portfolio managers and others would utilize options on a basket of European currencies to adjust their risk profiles. Indeed, in its early days the euro was referred to as a basket currency. [↑](#footnote-ref-22)
23. A binary option is really just a special case of a “digital” option. The payoffs for a digital option increase in discrete stages. Assume, for example, a strike of 25. If the underlying asset is above 25 at expiration the payoff is 4/share; above 30 it is 8/share, above 35, 12/share; above 40, 16/share, etc. A binary has but two stages. [↑](#footnote-ref-23)
24. Less usual are calls with barriers above the strike and puts with barriers below the strike. For these types, should the barrier be breached and the option knocked out, the buyer is typically paid a “rebate” from the writer, equal to the difference between the strike and the barrier. There are also “up-and-in” and “down-and-in” calls and puts. The option is dormant until the barrier is crossed by the underlying, at which point the option comes alive! See the section on C class options. [↑](#footnote-ref-24)
25. As we will shortly see, structuring the bivariate option this way makes it a contingent option. [↑](#footnote-ref-25)