What Is an Option, and How Do Options Work?

An option is a contract to buy or sell any specific item, which is referred to as the **underlying instrument,** asset, or interest. As with all contracts, there are two parties involved. An option contract is an agreement that gives the buyer or owner of the contract the opportunity, but not an obligation, to buy or sell the underlying instrument at their discretion. The seller, on the other hand, has the obligation to perform the seller's end of the bargain should the buyer choose to exercise their right to transact under the terms of the agreement.

The underlying instrument is commonly a financial instrument like a stock, an index of financial instruments, a basket of stocks such as an ETF, a bond or a currency. The underlying instrument does not have to be a financial instrument, however. An option may reference a physical good such as a commodity (oil, gas, gold, silver or copper) or an economic good such as electricity, water, or real estate, and so on. Since investors are interested in options as a means of pursuing certain financial and/or risk management objectives in their investment portfolios, this book will focus on options referencing financial assets, such as stocks and stock indexes. Rest assured that the principles underlying an option contract are universal. It is easy to take the concepts presented and apply them to other aspects of your economic life, be it the purchase or sale of real estate or the management of a business.

The terms and conditions of an option contract must be very precise. The contract defines when, how, and at what price the contract will be executed. For options on financial assets, there are a number of standard terms the buyer and seller must agree upon. Fortunately, options listed on exchanges have standardized terms. This makes financial options liquid and easy to trade. Once you know the basic standardized terms of an option contract, you are good to go. Firstly, an option contract will establish the price of a trade, if a transaction were to occur. A transaction only occurs, if and only if, the owner of the option choses to **exercise** their right to transact. When an owner of an option exercises their right to transact, they make the demand that the seller of the option perform to the terms and conditions of the option contract. When a contract is exercised, the obligation is fulfilled and the contract is terminated. The price at which a trade occurs is known as the **strike price**. The **contract multiplier** defines the amount of stock or commodity transacted under the option agreement. For options on equities, the contract multiplier is typically 100. This means that a single option contract references 100 shares of stock. As a result, when the owner of a call option on a stock exercises their right, the option seller must deliver 100 shares of stock. Options do not last forever. The contract will define the length of time an option will remain effective. Should the buyer choose to exercise their right under the option agreement and transact, the buyer must do so within this window of time. The date upon which an option expires is known as the **expiration date**. If the buyer of an option chooses not to exercise this right during the life of an option, it simply ceases to exist, and both parties go their merry way.

There are two basic types of options, puts and calls. The type of option the investors select to use is dependent on their investment goals and risk management objectives. Since there are millions of investors employing different strategies trading options, both types are actively traded in the financial markets every day. A **call** option is a bullish instrument. It gives the buyer the right, but not the obligation, to purchase the underlying instrument at a predetermined price. Investors buy call options with the expectation that the price of the underlying security will rise. The seller of a call does so with the expectation that the price of the underlying instrument will stagnate or fall. Investors might buy a call to manage risk as well. Investors who hold a short position on the underlying instrument, with the expectation the price of that asset will fall, are at risk the price will spike higher. Buying a call allows short sellers to limit their risk by allowing them to buy back their short position at a predefined price. A **put** option is a bearish instrument. It gives the buyer the right, but not the obligation, to sell the underlying instrument at a predefined price. Investors buy put options with the expectation that the price of the underlying instrument will fall. Like calls, puts can be used for hedging as well. If you are long the underlying stock, you might purchase a put option to limit losses should the price of that stock fall.

How Options Are Created, Extinguished, and Settled

Companies issue a fixed amount of stock, and those shares typically trade on an exchange. While options trade on exchanges much the same way stocks do, there is not a fixed amount of options outstanding. Options differ from stock in that they are created and destroyed as investors take positions during the normal course of trading. If Investor A wants to buy a call option on company XYZ, he instructs his broker to go to the exchange and find someone who wants to sell the same option. If he finds another investor or market maker, call her Investor B, who wants to sell that call with the same terms, and the two parties agree on a price, then a transaction takes place. Since Investor A does not own an option, he will "**buy to open**" a new position. If Investor B already owns the option she wants to sell, she will **sell to close** her current holding. In this process, an option is created and one is destroyed, and the total number of options outstanding does not change. If, on the other hand, there are no options outstanding or existing owners of the options do not want to sell, all is not lost. The broker finds a third party or market maker—call him Investor C, who wants to sell a call option he does not already own. Investor C **writes** a call option that does not currently exist and sells it to Investor A. Since Investor C does not own the option and is creating a new one, he **sells to open** a new position. Since Investor C sold something he did not own, he is now short an option. The writer of the option now has an obligation to perform against the option written should the buyer of that newly created option wish to exercise. Whenever an investor initiates a new long position while the writer simultaneously sells to open a new position, an option is created and open interest expands.

Just as an option is created when a willing buyer and writer are willing to transact, they can also be destroyed. While there is just one way to create an option, there are two ways for an option to be extinguished. If an owner—say, Investor B—of a call sells the existing position, she "sells to close." This takes the option out of her portfolio. If Investor C on the other side of the trade wrote the option in question, he "buys to close." This takes the short position out of his portfolio. With both sides of the agreement now terminated, the option no longer exists. Alternatively, the buyer of the call option can exercise the right to transact. The owner of the call informs the writer of the intention to exercise, and the writer must fulfill the obligation. The writer does so by selling stock to the owner of the call at the previously agreed upon strike price. Once the transaction is consummated, the terms of the option contract are fulfilled and the contract is extinguished. In the case of a put, the put owner could decide to exercise the right to sell at the agreed-on strike price. Once the writer fulfills the obligation to buy the put owner's stock, the option is extinguished.

To get a feel for the market interest and liquidity of a particular option, it is useful to know how many options are outstanding. One can observe how many options exist on exchange-traded options by examining the **open interest**. The open interest represents the total number of option contracts that are outstanding at any point in time. Open interest increases when options are created, and it falls when options are closed or exercised. The exchanges publish the open interest data for every stock, stock index, ETF, or any other asset underlying those options, parsed by strike price and expiration date.

There is another very important aspect to the mechanics of trading options. When trading a derivative instrument, investors make an agreement to perform some action in the future. In the case of a call option, the writer agrees to sell stock to the call buyer at a predetermined price, if the call buyer wants it. Within this arrangement, there is a risk that the writer may not fulfill their obligation due to financial distress or some other reason. The industry has addressed this risk by forming a nonprofit entity called the **Options Clearing Corporation** (OCC). The OCC regulates the trading of exchange-traded options and guarantees the performance of those contracts by standing between the buyer and seller of options. In this way, the OCC is the counterparty to all option contracts outstanding. The OCC is well capitalized and has strict collateral requirements investors must adhere to, if they want to write options. These collateral requirements ensure that the option seller will perform as promised. With this discipline, Standard and Poor's and Moody's rate the OCC AAA/Aaa respectively. This is an indication that the chances of a counterparty failure are immeasurably small. Since the OCC is financially strong and maintains an AAA credit rating, investors are assured the terms of their contract will always be fulfilled. If there were not a high-quality counterparty to all option transactions, investors who buy options would have to worry about the financial stability and reputation of their counterparties. Under these conditions, the value of options would be subject to the credit quality of the counterparty and liquidity would be suppressed, as investors would have to find creditworthy counterparties. By having the OCC as the counterparty for all transactions, investors can focus on the investment issues at hand and not counterparty risk. As an aside, financial institutions trade over the counter (OTC) between themselves when they need certain types of customized options. When executing these transactions, counterparty risk is an issue, and option buyers must do in-depth credit analysis to determine if the option writer has the wherewithal to perform as they promise.

Exercising an Option

Investors who trade options do so with the intention of speculating on the price of the underlying security or hedging an existing position. After a trade has matured as intended, the owner of an option has two choices. They can either sell their position at a gain or loss, or they can exercise the option. When call buyers exercise, they do so because they want to take delivery of the underlying instrument to add the position to their portfolio or to cover a short position. Most option traders close out their investment by selling their position prior to expiration. While the owner has the right to exercise, the option contract specifies *when* they can do so.

The exercise clause of an option contract comes in three basic forms, and they are referred to as the American, the European, and the Bermudan styles. In a **European**-style option, the owner of a call (put) can only exercise their right to buy (sell) the underlying security on the expiration date of the option. Option writers usually prefer to sell European options as this eliminates the surprise of having to deliver or buy stock when they might not be ready to do so.

At the other end or the spectrum is the **American**-style option. In an American-style option, the owner of an option has the right to exercise at any time on or before the expiration date. At the extreme, the owner can exercise an American-style option a split second after they buy it. Buyers of options tend to prefer American-style options as it gives them greater flexibility. Options always have value, so it is generally suboptimal to exercise early. There are rare occasions, however, when it is advantageous to do so. For example, a company might issue a large special dividend. Since the owner of a call does not have rights to the dividend, the owner must exercise a call and take delivery of the stock to get it. Since there is more flexibility in an American-style option, its value will always be as high as, or higher than, an equivalent European-style option.

In between the European- and American-style options is the **Bermudan**. In a Bermudan-style option, owners may only exercise their right to transact on specific dates defined by the contract. Most individual investors are not aware that this type of option exists, as they are most commonly used in the interest rate option and swap markets, which are dominated by institutional investors.

Assignment

A very important aspect of exchange-traded options is that they are generic. If there are 100 different investors holding call options on company XYZ stock with the same strike price and expiration date, every one of those investors holds an identical option. All the sellers of those options have written identical contracts as well. When an investor exercises an option, the question of assignment comes into play.

This might seem like a trivial issue, but it is something to consider when trading American-style options. When one of the hundred owners of the call options decides to exercise early, who among the option writers will have to perform on the other end of the transaction? As mentioned earlier, the counterparty for all option contracts traded on the exchange is the Options Clearing Corp (OCC). From the perspective of the OCC, its counterparty is the broker/dealer or customer that owns the option. When an option is assigned, the OCC chooses a broker(s) *at random* who has a customer(s) who has written the call option being exercised. At this point, the OCC has made an assignment to a broker/dealer, but the broker/dealer is not the ultimate counterparty. The broker/dealer has to assign the option exercise to one of their customers. They do so by one of two methods. They can assign the option on a purely random basis, or they can rank order their customer positions by the time and date the option was written and then assign the options on a first-in, first-out (FIFO) basis. The broker has the leeway to choose the method at its discretion. There is a limitation, however. The broker/dealer is required to use the same method all the time. This way, the broker/dealer cannot cherry-pick assignments to less-favored customers, or assign to customers instead of the firm's own proprietary trading book.

There was a time when customers had to instruct their broker to exercise their options at expiration. If a customer forgot to instruct the broker to exercise an in-the-money option, it would expire and the customer would lose out. At the same time, there would be an option writer who was not assigned when he should have been. In this case, the writer would collect a windfall. This is not an issue today, as most all brokers automatically exercise options for their customers at expiration if they are in the money.

Over-the-counter (OTC) options are more straightforward. OTC options are bilateral contracts, usually between large financial institutions or between a large financial institution and a large institutional investor such as a hedge fund. All the owner of the option has to do is simply inform the seller of his or her desire to exercise and the transaction occurs.

Deliverables

The deliverable on an option contract is usually the underlying instrument, but not always. For options on stocks and ETFs, the deliverable is the underlying stock or ETF. So when an investor exercises an option to buy XYZ stock, the option writer must deliver shares of that stock to the owner of the option. Options on indexes are different. Instead of delivering the basket of stocks to the owner of an option who chooses to exercise, which would be cumbersome and expensive, the option writer delivers cash. The amount of cash delivered is equal to the option's intrinsic value. For a call, this is equal to the index's closing price minus the strike price or zero if the option is out of the money. For a put option, it is equal to the strike price minus the closing index value or zero if the option is out of the money. So if the S&P 500 index is trading at 1,600 and the strike price of the call option is 1,500, the option writer must deliver $\$10,000$ ($[1,600 - 1,500] \times 100$, where 100 is the contract multiplier) to the owner of the option.

Behavior of Option Prices

A stockowner enjoys a return if the price of that stock rises and suffers a loss if the price of the stock falls. In this case, the payoff is symmetrical, as price changes lead to an equal return or loss. If the stock goes up 10 percent, the investor earns that amount. If the stock falls by 10 percent, the investor loses the same amount. Options, on the other hand, give the buyer an asymmetric payoff. Take the case of an *at-the-money* call, where the strike price of the option is identical to the price of the underlying stock. If someone owns an at-the-money call option and the price of the underlying stock rises, the owner can exercise their right under the option contract to buy the stock. In doing so, the investor buys the stock at the strike price of the option and immediately sells the stock at the higher market price. The difference between these two prices less the option premium paid represents the profit the investor earns. If the price of the underlying falls, the owner can simply let the option expire and avoid a large loss. The loss is limited to the premium paid on the option. Likewise, if someone owns at-the-money put options, and the price of the underlying stock falls, the owner can exercise the right to sell the underlying stock. In doing so, the owner sells stock at the strike price of the option and covers that short position by purchasing stock in the market at a lower price. Once again, the difference between the price paid in the marketplace and sold by exercising the option less the option premium paid is the profit the investor earns. If the price of the underlying rises instead, the owner of the put can simply let the option expire and avoid a large loss. This loss is simply limited to the premium paid for the option.

This is a case of "heads I win big, tails I break even or lose a small amount." Every investor, arbitrageurs in particular, wants such an asymmetrical payoff pattern. Asymmetry gives an investor the opportunity to earn positive rates of return with limited downside risk. This unique feature of options is what attracts speculators and hedgers alike to these financial instruments. The beauty of options is their flexibility in terms of time to expiration and strike price. If investors want more time for a trade to work out, they buy a longer-dated option. If they want to change the nature of the asymmetry, or make a trade-off between leverage and price sensitivity, they can do so by adjusting the strike price they select. Exhibit 1.1 shows a stick diagram for the payoff pattern for both a put and call option with a strike price on the underlying security of $25. Stick diagrams are useful for understanding how the price of an option might behave given differing prices of the underlying security. Furthermore, it helps one clarify the payoff pattern for complex transactions that use multiple options to achieve a particular objective. Bear in mind that the analysis of stick diagrams is not just a theoretical exercise; it shows the **intrinsic value** of an option or multi-leg option strategy. For a call option, it is measured by subtracting the strike price of the option from the market price of the underlying security. For a put option, it is measured by subtracting the market price of the underlying

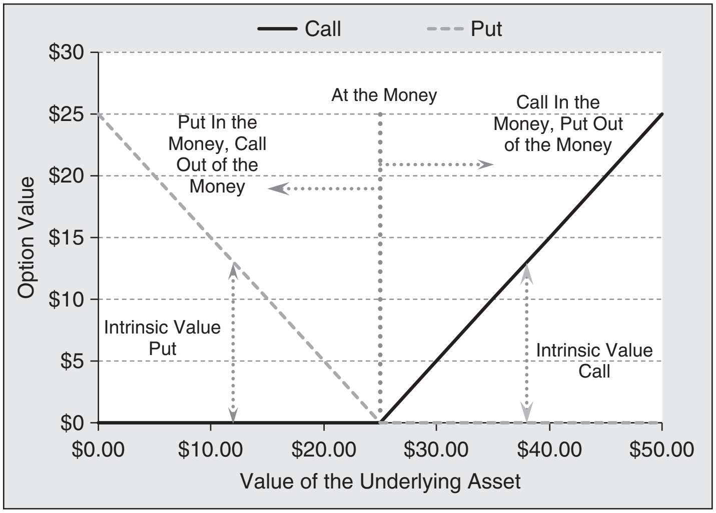

Exhibit 1.1 Payoff Pattern for a Put and Call with a Strike Price of $25

instrument from the strike price of the option. Only options that are in the money have intrinsic value. Furthermore, the intrinsic value of an option is equal to its market price at expiration.

The solid black line in Exhibit 1.1 represents the payoff pattern for a call option based on its intrinsic value (i.e., its value at expiration). Notice that as the price of the underlying instrument increases above the strike price, which is $25 in this case, the intrinsic value of the call option rises on a one-for-one basis. That is to say, if the stock rises by one dollar, so does the intrinsic value of the call. If however the price of the underlying falls below $25, the call does not have any intrinsic value and would expire worthless. The gray dotted line represents the payoff pattern of a put option. Notice that as the price of the underlying instrument falls below the strike price of $25, the intrinsic value of the put rises on a one-for-one basis. If, however, the price of the underlying rises above $25, the intrinsic value falls to zero and the put option would expire worthless.

This chart clearly shows the asymmetric nature of an option's payoff pattern. Assume for a moment that an investor wanted to own the stock of company XYZ, which is trading at $25 a share. One choice is to buy the shares and enjoy the gains if the price rises or suffer a loss if the price fell. An alternative is to buy a call option with a strike price of $25 at its intrinsic value. If the price of the shares rise, the investor enjoys a gain, if the share price falls, no loss is incurred. From the standpoint of a stick chart, this asymmetric pattern shows that owning a call option is always superior to owning the stock outright. As a result, we can conclude that an option has value above and beyond intrinsic value. The price one pays for an option above its intrinsic value is an option's **time value** (aka **time premium or volatility**

premium). The total value of an option, which is usually referred to as an **option premium,** is the sum of its intrinsic value and its time value. The purchaser of an option must pay this premium as a cost of capturing this asymmetric payoff. The premium is paid to the option writer, who takes the risk that the price of the stock will increase and they will have to sell stock to the call option buyer at a price below the stock's market price. This makes an option a **volatility instrument**. As volatility rises, so does the expected value of the option at expiration. Said another way, as volatility rises, the more likely the stock will trade substantially above the call option's strike price. As a result, the option premium is a function of an option's intrinsic value and a volatility premium is what the option writer demands for taking what is theoretically unlimited risk from selling a call. (The risk of selling a naked put is limited, as the asset price can only fall to zero.) This volatility premium will be discussed in greater detail below.

From an accounting standpoint, the premium paid by a purchaser of an option is known as a **net debt**. This is the amount the buyer places at risk when entering into a long option trade. If in the case of a call option, the price of the underlying stock rises, the premium will increase, resulting in a gain. Likewise, if the price of the underlying stock falls, the option premium will fall, resulting in a loss. In the case of a put option, if the price of the underlying stock falls, the premium will rise, resulting in a gain. Likewise, if the price of the underlying stock increases, the option premium will fall, resulting in a loss. In either case, if the price of the underlying security does not change as the option ages, the time premium of the option will fall, leaving the option buyer with a loss. When selling an option, the initial premium is subtracted from the proceeds of the sale to determine the profit earned, if any. On the flip side of the coin, the option writer collects the premium paid by the option buyer. This premium is compensation the option writer demands for providing an asymmetric return pattern enjoyed by the option buyer. Sellers of options take a significant risk that the price of the underlying security will move sharply against them and that under these circumstances, they would be required to fulfill their promise and perform on the contract.

From an accounting standpoint, the amount the option writer collects is known as a **net credit** as funds are deposited (credited) to the writer's account upon settlement of the trade. The option writer keeps these funds so long as the option sold remains outstanding. If the writer decides to cover the short position before the option expires, he must pay the current premium to buy back the option he previously sold. The writer's gain or loss is a function of the price that must be paid to buy back the option. If he can buy it back at a price lower than where it was originally sold, then he will capture a gain. If he has to pay a higher price, he suffers a loss. At the expiration date, one of two scenarios will occur. If the option is in the money, the owner of the option will exercise his right. The seller of a call option will have to deliver the underlying asset. Now that the seller is short that asset, she will have to buy it in the marketplace to make delivery. (Alternatively, she could maintain a short position. This would require the option seller to borrow the underlying asset and deliver it to the call buyer.) The amount of money it costs the writer to execute these transactions is equal to the intrinsic value of the option (plus commission). If the intrinsic value of the option is greater than the premium collected, the option writer suffers a loss. Naturally, if the option is out of the money at expiration, the option will expire worthless and the writer keeps the entire premium, which is equal to the profit on the trade.

Option Premium

Premium is another way to describe the price paid for an option. Like all financial instruments, the premium the buyer pays and the writer collects changes constantly over the life on an option. The direction and degree of change depends on a number of factors. As seen in the discussion above, when the price of the underlying changes, so will the intrinsic value of in-the-money put and call options referencing that underlying instrument. The price of the underlying security relative to an option's strike price is the primary determinant of the option premium. This is particularly true for options that are in the money. The expected volatility of returns on the underlying stock is a primary determinant of an option's value as well. The more volatile the returns on the underlying instrument are expected to be, the higher the value of both the associated puts and calls. As volatility rises, so does the potential for an extreme event. If the extreme event is a rise in price, the value of a call will enjoy a huge gain. Since options provide leveraged returns with respect to the price action of the underlying security, it is not uncommon for buyers of call options to capture returns that are hundreds of percent in magnitude. In such a scenario, the put will fall drastically in value and the owner can lose up to 100 percent of their investment should it expire worthless. If, on the other hand, the extreme event turns out to be a drop in price, the value of the put option will rise in value, possibly by multiples of the buyer's original premium. The value of the call option will go the other way and the owner can lose up to 100 percent of the premium paid.

With these dynamics in mind, it is easy to understand that as the uncertainty concerning the performance of the underlying instrument rises, we would prefer the asymmetric payoff pattern of an option vis-à-vis the underlying instrument. Volatility of returns on any asset continuously changes over time, as do investors' expectations concerning future volatility. To be effective at trading options, both buyers and sellers must develop a view on volatility over the life of the option they wish to trade. If market participants expect volatility to be high, option buyers bid up the price of options until they are indifferent between owning a call and owning the underlying stock, or owning a put versus taking a short position in the underlying stock. This applies to option writers as well. If option writers expect the volatility of asset price returns to be high, they will not sell any options until the premium rises to the point where they believe they are getting compensated for the risk they are taking. In short, volatility expectations drive option premiums. Only after these two parties agree on a premium will a transaction actually take place.

How we translate volatility estimates into option premiums across the strip of available strike prices and expiration dates is a matter of mathematics. Fortunately, academics have worked for decades on the question of option pricing. As a result, the theory of how to determine a fair price for an option is well developed and traders use models to price and value options. The most important of these models is the Black–Scholes–Merton option-pricing model, which was developed in the early 1970s. In Chapter 2, we delve into the mathematics of option pricing so anyone can become an expert in pricing options. Equally as important, the reader will gain an understanding of how the price of an option behaves as it ages and the investment environment changes from a mathematical perspective. Until then it is very important to develop some intuition about how market participants price options, and how those prices change as market conditions and investor expectations change. To build that intuition, we will focus on call options once again for a moment. Exhibit 1.2 shows an example of what the premium might look like for a three-month call option compared to a similar one at expiration. Notice that the buyer has to pay more than the intrinsic value of the option to the seller as payment for the asymmetric nature of an option's payoff pattern. For the most part, the market price of an option will be greater than the intrinsic value of an option. (There are rare circumstances when this is not the case for European options and we discuss those situations in later chapters.) The difference between the market price of an option and its intrinsic value is equal to the time value of an option. The time

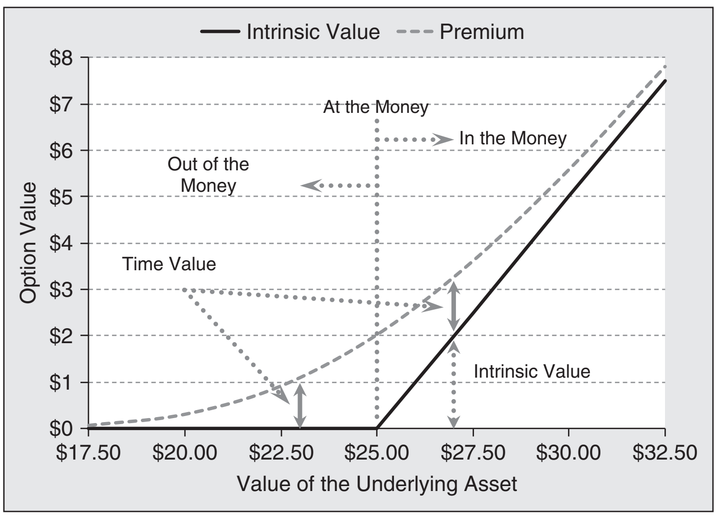

Exhibit 1.2 Premium = Intrinsic Value + Time Value

value of an option captures the investor's expectation of future volatility of returns on the underlying instrument. Naturally, time to expiration is a factor in time value as well. As the time to expiration increases, so does the time value of an option. This should be intuitively obvious because there is more time for the option to trade in the money sometime during its life.

An important concept in option valuation is the likelihood that an option will be exercised. This is determined, in part, by the relationship between the market price of the underlying instrument and the strike price. A call option is said to be **in the money** if the price of the underlying asset is greater than the strike price of the option. This is depicted by the area on the right-hand side of Exhibit 1.2. A put option is said to be in the money if the price of the underlying asset is less than the strike price. The value of an option increases as it moves further and further into the money simply because the intrinsic value of the option increases. If an option is far enough in the money, its price action will closely mimic the price action of the underlying asset. In other words, its price will move virtually dollar for dollar with the price of the underlying instrument. Now that the call option's price action closely follows that of the underlying instrument, it loses its asymmetric payoff pattern. The option no longer protects the owner from a large drop in the price of the underlying stock. As a result, the time value of the option falls as an option moves in the money. Exhibit 1.2 reveals this phenomenon, as the slope of the gray dotted line representing option premium is virtually the same as the slope of the intrinsic value line and the distance between these two lines narrows.

Similarly, a call option is said to be **out of the money** if the price of the underlying asset is less than the option's strike price. The area on the left-hand side of Exhibit 1.2 depicts this situation. A put option is said to be out of the money when the price of the underlying asset is greater than the strike price of the option. An option that is out of the money does not have any intrinsic value. Its value simply comes from the probability that it might trade in the money by the time it expires. As a result, as an option drifts out the money, it becomes less and less sensitive to the price of the underlying asset. Furthermore, it becomes less likely that the option will trade in the money by the time it expires. As a result, time value falls. This phenomenon is revealed in Exhibit 1.2 as well. If the option is far enough out of the money, the slope of the gray dotted line, representing the option price, approaches zero. This tells us that it has very little sensitivity to the price of the underlying asset. The price of the option approaches zero as well, as the probability the option will expire worthless becomes more certain.

When the price of the underlying asset is trading at the strike price of a put or call option, it is said to be **at the money**. Like out-of-the-money options, at-the-money options do not have any intrinsic value, either. It gets its value simply from the fact that there is roughly a 50:50 chance it will trade in the money at the expiration date. Since it falls in between in-the-money and out-of-the-money options, it shares characteristics of both. Its price action will move with the underlying security but will do so at a rate less than an in-the-money option and more than an out-of-the-money option. At-the-money options provide the greatest asymmetric payoff pattern. The option buyer risks little relative to the value of the underlying security, just 8 percent in this case. But there is the potential for the price of the underlying to rise far, far more. If the stock rises 20 percent, the option buyers will almost triple their money. If it falls by 20 percent, they will simply lose their premium. Since at-the-money options provide the greatest asymmetric return profile, they have the highest time premium.

Moneyness

Option traders use shorthand terminology for the differential between the market price of the underlying security and an option's strike price. That word is **moneyness,** which is a numerical figure that is normalized to the price of the underlying security. An option that is at the money is said to have moneyness of 100, or 100 percent. If the strike price of the option is less than the market price of the underlying asset, it has moneyness less than 100. When moneyness is less than 100, a put option is out of the money and a call is in the money. The following is a numerical example for the computation of simple moneyness, which tells us how much an option is in or out of the money on a percentage basis.

Simple Moneyness

$$\text{Strike price } (K) = \$25.00$$
$$\text{Asset spot price } (S) = \$20.00$$
$$\text{Simple moneyness} = \frac{K}{S} \times 100$$
$$\text{Simple moneyness} = \$25.00/\$20.00 \times 100 = 125$$

Simple moneyness of 125 tells us that a call option is 25 percent out of the money relative to the price of the underlying asset. In the case of an equivalent put option, it tells us that it is 25 percent in the money. Moneyness is an important aspect of an option as it makes analyzing options between differing assets with differing prices more easily comparable. Just remember, when discussing options with moneyness less than 100, you are discussing options with a strike price less than the market price of the underlying asset. When discussing options with moneyness greater than 100, you are discussing options with a strike price more than the market price of the underlying asset.

While the concept of simple moneyness is relatively straightforward, there is a nuance to the analysis that sophisticated options traders take into consideration. In theory, investors should use the forward price of an asset, not the current spot price to determine an option's moneyness. The difference between the spot price and forward price of an asset is its cost of carry. The cost of carry is a function of the current rate of interest; the dividend yield of the underlying stock, index, or ETF pays a dividend; and the time to expiration of the option. This is an important component to the valuation of options. The following is an example of how to compute the forward price of an asset.

Forward Price

$$
\begin{aligned}
\text{Spot price } (S) &= \$20.00 \\
\text{Risk-free rate } (r) &= 2\% \\
\text{Dividend yield } (d) &= 1\% \\
\text{Time to expiration } (t) &= 0.25 \text{ years} \\
\text{Forward price} = F &= Se^{(r-d)t} \\
F = \$20.00 \times e^{(0.02-0.01)0.25} &= \$20.05
\end{aligned}
$$

In an environment of low interest rates or when we are estimating the forward price for a near-dated option, the forward price is not much different than the spot price. In this example, the difference is just \$0.05. Under these circumstances, it is perfectly acceptable to use the spot price of the asset when computing moneyness. This is not the case for estimating moneyness in a high-interest-rate environment for a long-dated option. If the risk-free rate was 10 percent and the dividend yield was 1 percent, the forward price of a one-year option would be \$21.88, which is \$1.88 or 9.4 percent higher than the spot price. In this example of a \$25.00 strike call, the correct estimate of the option's moneyness is 114 percent, not the moneyness of 125 estimated by simply referencing the current spot price of the asset. Given the current low-interest-rate environment, and the fact that most traders work with short-dated options, we do not have to pay too much attention to this distinction most of the time.

Simple moneyness is an absolute measure of how much an option is in or out of the money. This measure is a good shorthand method to understanding the behavior of a particular option under consideration. It is not the best measure of moneyness, however. Underlying this absolute measure of moneyness is the assumption that the volatility of returns on the underlying asset is constant over time. Anyone who trades the markets knows firsthand that markets go through periods of low and high volatility. Indeed professional volatility traders and market makers attempt to profit from fluctuations in volatility as a core element of their business model. When volatility is low, so is the time premium of an option. When volatility is high, option premiums are high as well. Volatility traders attempt to buy volatility when it is low and expected to rise, or sell it high when it is high and expected to fall, while managing other attributes such as sensitivity to the price of the underlying asset and time decay in the process.

An option that is out of the money is more likely to trade in the money when volatility is high versus in an environment when volatility is low. Therefore, measuring moneyness on an absolute basis is insufficient when comparing options on assets with distinctly different volatilities or options on the same asset during differing volatility regimes. To deal with this, sophisticated option traders use a standardized measure of moneyness. **Standardized moneyness** modifies absolute moneyness by dividing simple moneyness by the volatility of returns on the underlying instrument. With this measure, we are measuring moneyness in volatility terms. This measure is very similar to a *t*-stat, used in statistical analysis. The following is an example of the computation of standardized moneyness continued from the example started above.

Standardized Moneyness

$$\text{Standard deviation of returns} = 35\%$$
$$\text{Standardized moneyness} = \frac{\ln\left({}^{K}\!/\!{}_{F}\right)}{\sigma\sqrt{t}}$$
$$\text{Standardized moneyness} = \frac{\ln\left({}^{\$25.00}\!/\!{}_{\$20.05}\right)}{0.35\sqrt{0.25}} = 1.26$$

In this example, the standardized moneyness tells us that a call is 1.26 standard deviations out of the money. In other words, the underlying stock would have to produce a return greater than 1.26 standard deviations for a call to get in the money and a put with the same strike price to fall out of the money.

Consider for a moment that the stock is trading in a low-volatility environment. If volatility falls to 20 percent, the standardized moneyness estimate jumps to 2.19. This tells us that moneyness is 1.76 times as high as in the first case, making it far less likely the option will ever trade in the money. This is a very important way of thinking of moneyness in an environment where volatility is changing and testing various options strategies with historical data. Since options are complicated enough, we will explain concepts throughout this book using simple moneyness where possible. Bear in mind that you can sharpen your pencil and replace it with standardized moneyness in research and trading activities if you choose to do so.

The Relationship between Puts, Calls, and the Underlying Asset

While puts and calls on the same underlying instrument have different payoff patterns, they represent two sides of the same coin. Both contracts derive their value from the same underlying asset and the volatility of returns on that asset. When the price of the underlying rises, so does the price of a call, while the price of a put falls. When the price of the underlying asset falls, the price of a put increases while the price of a call declines. In short, calls move in the same direction as the price of the underlying instrument, while the price of a put moves in the opposite direction. Both puts and calls produce asymmetric payoff patterns. Both will increase in price when uncertainty rises and both will fall when volatility does the same. Since puts and calls are dependent, at least in part, on the value of the underlying security and the volatility of returns on the underlying instrument, their value must be related in some way. That relationship is known as **put–call parity**. Put–call parity defines an arbitrage condition between European put and call options with the same defining characteristic. More specifically, the two options must reference the same underlying security, have the same strike price, and expire on the same date. Those that trade and make markets in equity options are very familiar with the concept. The following is the mathematical relationship.

$$\text{Cash} + \text{Call option} = \text{Stock} + \text{Put option}$$
$$\text{Cash} = Ke^{-rt}$$

This equation is the standard formulation of put–call parity. It states that with cash and a call option, we can identically replicate the return performance of the underlying security (stock in this case) and a put option. The amount of cash required is equal to the present value of the strike price associated with the put and call options. Looking at the relationship more deeply, the intuition behind put–call parity becomes clear. An investor can buy a call option on a stock and hold cash equal to the strike price of the option. If the stock price is above the strike price, the investor exercises the option and gives up his or her cash and takes ownership of the company's stock. If the stock price is below the exercise price at expiration, the investor keeps their cash and the option expires worthless. The second half of the equation replicates that investment performance by purchasing shares in the company's stock and simultaneously purchasing a married put option. If the price of the stock is above the strike price at expiration, the investor keeps the shares and lets the option expire worthless. If the price of the stock falls below the strike price, the investor sells the shares to the seller of the put option, and now has cash equal to the strike price of the put option. The end result of following the strategy on the left-hand side of the equation is identical to the result of the right-hand side of the equation.

With this formulation, we can easily see why volatility moves the price of a puts and calls in the same direction. If implied volatility rises, pushing the price of a call higher, the price of a put must rise as well. If this were not the case, it would be cheaper to buy stock and sell a put than to hold cash and a call option. The individual investor will rarely see arbitrage opportunities like this as volatility traders, market makers, and computers run by high-frequency trading firms look for these opportunities. Once identified these sophisticated investors will sell calls and buy puts and stock until the discrepancy disappears. Small discrepancies exist all the time, but after paying a bid/offer spread to a market maker on the options and underlying stock plus commission to a broker, the advantage is eaten up by transaction costs.

Another way to look at put–call parity is to rearrange the equation and look at it from the perspective of holding stock outright.

$$\text{Stock} = \text{Call} - \text{Put} + Ke^{-rt}$$

By rearranging the general formula of put–call parity it becomes easy to see that we can replicate stock by purchasing a call, selling a put, and holding the present value of the option's strike price in cash. If at expiration, the call is in the money, the investor exercises the call, lets the put expire, and uses the cash on hand to purchase the underlying stock. If at expiration the put is in the money, the call will expire worthless and the stock will be put to the investor, who will pay for it with cash. Remember, put–call parity holds, if and only if the two options have the same strike price. If in the extraordinary circumstance the stock price is equal to the strike price of the put and call options, the investor can either exercise the call and take stock or let both options expire and hold cash with the same value. Alternatively, the investor can still buy stock by actively purchasing it in the marketplace. In all three scenarios, the investor ends up in the same place as simply buying the stock outright.

Put–call parity is a very important concept when formulating option strategies. There are situations when investors might want to synthetically create stock, puts, or calls, as it may be slightly cheaper than buying the securities outright. There are times when investors might want to create *cash* synthetically as well. Institutions do this all the time. In Chapter 9, the subject of synthetics based on put–call parity and other relationships is discussed in detail.

Leverage and Risk

Derivative products such as options, futures, and forwards, were developed as tools for risk transfer. Before the advent of derivatives, if someone had risk in their portfolio they did not want, their only choice was to sell the asset. Derivative products allow the investor to keep the investment and transfer some or all of the price risk to another market actor who is willing to take on that risk. A key attribute of derivatives products is leverage. It allows the investor to allocate just a fraction of the value of the investment they want to hedge to the hedging instrument.

Options, like most derivative financial products, provide a levered means of gaining exposure to a stock, market index, ETF, commodity, or other underlying asset. Option buyers pay a relatively small premium compared to the face value of the underlying instrument. In so doing, they experience a much larger gain or loss on the premium paid compared to the face value of the contract.

For example, assume an investor buys a three-month, at-the-money call when the underlying is trading at \$25.00. Exhibit 1.2 shows the investor will pay \$2.00 for this option contract. If the price of the underlying goes up \$5.00 to \$30.00, the rate of return on that asset is 20 percent (\$5/\$25). The option, on the other hand, will increase by \$3.60 to \$5.60, producing a return of 180 percent (\$3.60/\$2.00). This shows that the inherent leverage in an option gives the investor a big bang for the buck. While the investor sees a magnified return if price moves her way, she also suffers an outsized loss if price moves the wrong way. If the price of the underlying falls by \$5.00 to \$20.00, the loss is 20 percent. At the same time, the price of the option falls by \$1.70 to \$0.30, for an 85 percent loss. If the expected recovery in price does not materialize, the option will expire worthless resulting in a 100 percent loss.

One of the advantages of using options is that they limit risk relative to owning the underlying instrument outright. For example, instead of buying the underlying instrument at \$25.00, assume the investor puts \$23.00 in a money market account and spends \$2.00 to buy a call option. If the underlying increases 20 percent to \$30 a share, this strategy will produce a return of 14 percent ([\$23 + \$5.60]/\$25.00), for a 14 percent gain. If, on the other hand, the price falls 20 percent to \$20, this strategy suffers a 6.8 percent loss (1 − [\$23.00 + \$0.30]/\$25.00). In the worst-case scenario, the price of the underlying stock would fall to zero if the company filed for bankruptcy, and stockholders would lose 100 percent of their investment. However, option holders would only lose the option premium of \$2.00 or just 8 percent.

Leverage is a double-edged sword. If investors overleverage their portfolio by purchasing or selling options without holding the underlying security as a hedge or an adequate amount of cash, the results can be catastrophic. If they simply held the \$2.00 call discussed above without cash, their returns would be either heroic (+180%) or disastrous (−85%), depending on what direction the underlying security went. It is very important when trading options to understand and quantify the risk before the trade is made. In the following chapter, we discuss option pricing, return dynamics, and risk metrics. This is the first step in effective risk management and strategy development for option traders. In later chapters, we build on this analysis and introduce various option strategies that maximize the potential for success by constructing strategies with moderate levels of leverage in some cases and/or self-hedging in others.

Effectively used, options can limit an investor's downside risk. The characteristic of limited risk comes with a cost, however. If the price of the underlying does not change over the life of an option, it will expire worthless. In the example of the \$2.00 call option, the option buyer will lose 100 percent of the option premium and 8 percent on the combination of cash and call. If one bought the stock instead, they would have neither enjoyed a gained nor suffered a lost. Just like buying insurance, hedging and limiting risk often comes with a cost. One does not earn quite as much if price moves in the intended direction, but one can lose most or their entire option premium if price stagnates or moves in the wrong direction. The loss in value of an option as time passes is known as **time decay**. Managing time decay is a very important aspect of risk management in the context of both speculation and hedging. In our discussion of option strategies, we will uncover ways for investors to minimize loss due to time decay—and even profit by it, in some cases.