



Chapter 19

Futures and Options

LEARNING OBJECTIVES

L01	L02	L03	L04	L05	L06
Understand the basics of forward contracts.	Understand futures contracts, how futures are traded, and the payoffs to futures contracts.	Describe how futures are used to hedge price risk.	Understand option contracts and how options are traded.	Understand the payoffs to options contracts.	Understand intrinsic value and time value.

Introduction



Futures and **options** are **derivative contracts**. The term “derivative” is used because the price of a future or option is *derived* from the price (level) of an underlying asset (variable). The Explain It video presents an overview of the derivatives, markets, and some of the assets (variables) underlying Chicago Mercantile Exchange futures and options contracts.

In this chapter, we introduce derivatives as tools that companies use to reduce **price risk**. An action that reduces price risk is called a hedge. We will focus on hedging with derivatives. An action that increases price risk is called speculating. Speculators accept price risk in the hope of making a profit. The derivatives markets are a place where hedgers pass their price risk off to speculators. *Tip



The Explain It video provides a simple example of a business using a derivative (a futures contract) to hedge a price risk. Also in this chapter, we will provide the detail that you need to fully understand the profits of a futures transaction. Watch the video with the goal of understanding the price risk experienced by a company and the way that a derivative contract can offset it.

History of Futures and Options

Commodities have been traded for money since at least the fifth century BC in ancient Greece. **Forward contracts** are known to have been used in rice markets in seventeenth-century Japan and may have been used even earlier. *Tip

In North America, the first organized futures exchange was the **Chicago Board of Trade (CBOT)** created in 1848. In 1851, there are records of a forward contract for 3,000 bushels of corn. The forward contract provided a guarantee of price and quantity, which made it easier for eastern merchants to arrange financing for bulk purchases of Midwestern grains.

In 1865, the CBOT formalized grain trading by developing standardized agreements called **futures contracts**. Futures contracts were identical in terms of quantity, quality, delivery month, and terms. The only thing left to negotiate was price. The contracts could be traded at the CBOT during designated trading hours. The exchange publicized the bids and offers as well as negotiated prices of the trades. Unlike forward contracts, an active secondary market for standardized futures contracts grew quickly.

In the first section of this chapter, we describe first the forward contract (since it is the simpler precursor), and then, focus on futures, which are much more common.

L01 Forward Contracts



A **spot contract** is an agreement between a buyer and a seller to exchange a commodity (security or currency) immediately. In a spot market exchange, the terms of the exchange are agreed upon and the goods and money are exchanged immediately. The agreed-upon price in a spot contract is called the **spot price**.

A forward contract differs from a spot contract in regard to the timing of the physical exchange of goods for money. With a forward contract, the terms of the exchange are agreed upon now, but the exchange of goods for money occurs at a specified date in the future—the **maturity date**. Like a spot contract, a forward is a contract between two parties: the **buyer** and the **seller**. The buyer agrees to buy the asset on the maturity date and the seller agrees to deliver the asset on that date. The price or, **forward price** and quantity are agreed to when the contract is struck. The asset and payment are exchanged on the maturity date. The rights and obligations of the buyer and seller are summarized in Table 19.1.

TABLE 19.1 Rights and Obligations of Buyers and Sellers in a Forward Contract

BUYER (Long position)	SELLER (Short position)
<u>Pays price</u> and Has OBLIGATION to BUY an underlying asset on the maturity date.	<u>Receives price</u> and Has OBLIGATION to SELL

Forward contracts are privately negotiated. The contract terms are customized to satisfy the needs of the counterparties. There is no central exchange for forward contracts—contracts are negotiated through an international network of large banks and brokers who communicate electronically and by telephone. There is no secondary market for forward contracts. The only way to complete a forward contract is to follow through with the purchase/sale.

It's Time to Do a Self-Test

1. Domino's Pizza offers a medium pepperoni pizza for \$10 delivered in 30 minutes. Little Caesars Pizza sells a medium pepperoni pizza for \$9 that is hot and ready for immediate pickup. If you order from Domino's, what type of contract are you in and what is your position? **Answer**
2. Who has the short position in the pizza forward contract? **Answer**
3. What is the forward price for pizza? **Answer**
4. What is the spot price for pizza? **Answer**

1.1 Forward Contract Example: Foreign Currency

The most common type of forward contract is a currency contract. Consider the problem potentially faced by a large multinational, such as the Ford Motor Company. It generates sizable Canadian dollar profits from its sale of cars and trucks in Canada and it needs to convert those to its home currency, US dollars. Assume that Ford anticipates having CDN\$10,000,000 of profit from sales at the end of the next quarter, in three months' time. Ford has two choices: It can wait until the end of the quarter and exchange the Canadian dollars for US dollars at the then-prevailing spot exchange rate, or it can lock in the exchange rate now with a forward contract.

If it chooses to enter a forward agreement, then it will approach a bank, the typical counterparty in a currency forward contract, to sell the Canadian dollars and buy US dollars. For example, Ford might contract to give the bank CDN\$10,000,000 in exchange for USD\$10,500,000 in three months' time. The forward exchange rate is 1.05 \$USD/\$CDN.

1.2 Hedging and Speculating

Ford will enter the forward contract rather than wait and use the spot market because it fears that the spot rate will be lower than 1.05 \$USD/\$CDN at the end of the quarter. This strategy is called a **hedge** transaction. A hedge is a transaction that reduces the risk (harm) associated with an adverse price movement in a commodity (security or currency). The alternative to hedging is **speculation**. A speculative transaction accepts the risk of adverse price changes in exchange for the opportunity to profit. Speculators trade an asset in the hope of profiting from anticipated price changes.



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LO2

Futures Contracts

A futures contract is similar to a forward contract. Two important differences are that futures contracts are traded on an exchange and the terms of the contract are not privately negotiated. The terms of the futures contract (quantity, type of asset, and maturity date) are set by the exchange and cannot be changed by the counterparties. The only element negotiated by the counterparties is the price.



For example, the **Chicago Mercantile Exchange's (CME)** wheat contract calls for the delivery of 5,000 bushels of wheat. The short side of the contract (seller) has an option as to which type of wheat to **deliver**. The price is quoted in cents and quarter-cents per bushel with a **minimum tick size** of a quarter-cent per bushel (see the Explain It box for a description of the pricing convention).

There are five fixed maturity dates through the year: July, September, December, March, and May. The last trading day for each contract is the business day prior to the fifteenth calendar day of the month. The last delivery day (for the short side) is the seventh business day following the last trading day of the delivery month. Delivery is completed when the seller gets the wheat to an approved warehouse in the **Chicago Switching District**.

Figure 19.1 presents a screen shot from the CME website showing prices for wheat futures.

Figure 19.1 Wheat Futures Price Quote

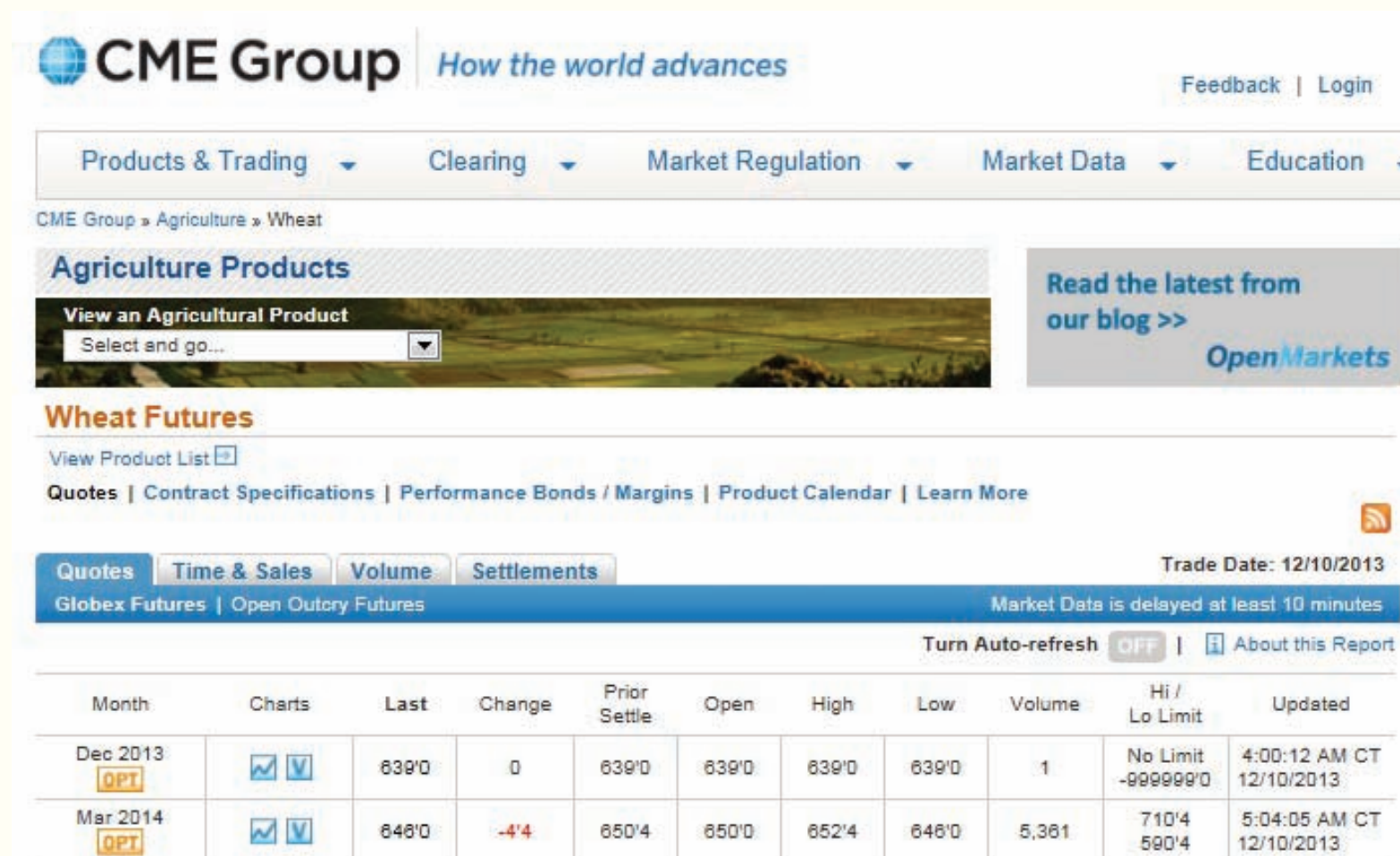


Figure 19.1 (Continued)

May 2014 OPT	 	651'2	-4'2	655'4	655'4	658'6	651'2	1,102	715'4 595'4	5:03:41 AM CT 12/10/2013
Jul 2014 OPT	 	648'6	-4'2	653'0	652'6	653'6	648'4	415	713'0 593'0	5:03:19 AM CT 12/10/2013
Sep 2014 OPT	 	661'0	-0'6	661'6	661'0	661'0	661'0	28	721'6 601'6	4:51:53 AM CT 12/10/2013
Dec 2014 OPT	 	669'6	-3'6	673'4	673'4	673'4	669'6	61	733'4 613'4	5:02:51 AM CT 12/10/2013
Mar 2015 OPT	 	-	-	679'4	-	-	-	0	739'4 619'4	1:09:38 AM CT 12/10/2013
May 2015 OPT	 	-	-	680'2	-	-	-	0	740'2 620'2	1:09:38 AM CT 12/10/2013
Jul 2015 OPT	 	673'6	-2'4	676'2	673'6	673'6	673'6	2	736'2 616'2	4:05:00 AM CT 12/10/2013
Sep 2015 OPT	 	-	-	680'2	-	-	-	0	740'2 620'2	1:09:38 AM CT 12/10/2013
Dec 2015 OPT	 	686'2	-2'6	689'0	686'2	686'2	686'2	2	749'0 629'0	4:05:00 AM CT 12/10/2013
Mar 2016 OPT	 	-	-	693'2	-	-	-	0	753'2 633'2	1:09:38 AM CT 12/10/2013
May 2016 OPT	 	-	-	693'2	-	-	-	0	753'2 633'2	7:00:00 PM CT 12/9/2013
Jul 2016 OPT	 	-	-	678'2	-	-	-	0	738'2 618'2	1:09:38 AM CT 12/10/2013

Icon Key: OPT Options  Price Chart  Volume Chart

[Market data explanation/disclaimer](#)

2.1 Futures Trading



Most derivative contracts are traded on computer trading platforms, but some exchanges, like the CME, still operate a trading floor. At the time of writing, about 10% of the CME's volume occurs on the floor and 90% occurs on their Globex computer trading system. The trading system used on the floor is called **open outcry**. It is fascinating to watch and is described in more detail in the Explain It video.

2.2 Initiating a Futures Trade: Margin/Performance Bond

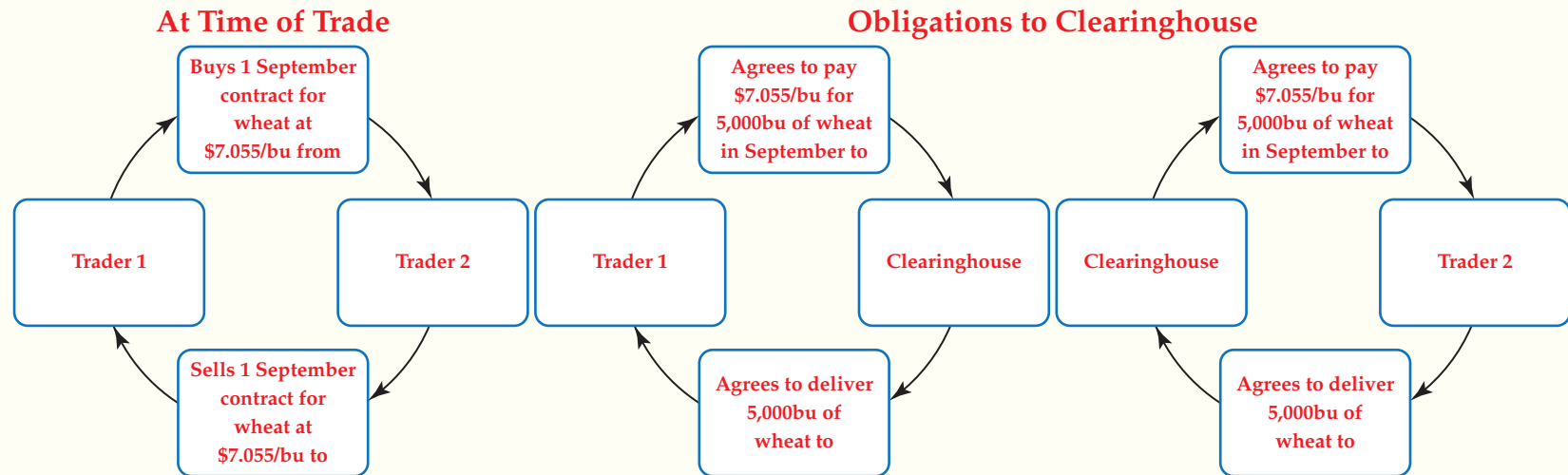
Assume that you think wheat prices are going to rise and you want to speculate on that expectation. You place an order with your **broker** to buy one wheat contract at the market. Each contract is for 5,000 bushels, or 5,000bu. Let's say the order goes through on May 3 and one September contract is purchased at a price of **705³/₄**/bu. You are now obliged to buy 5,000bu of wheat in mid-September for a total cost of $\$7.055 \times 5,000 = \$35,275$.

You do not have to have that much money when you place the order. Your broker will require you to create an account and to deposit in that account a performance bond (aka initial margin) equal to between 5% and 10% of the value of the position. For the wheat contract, the performance bond (initial margin) is \$3,240. In turn, your broker maintains an account with the exchange's clearinghouse.

2.3 The Clearinghouse

An important feature of exchange traded futures contracts is the **clearinghouse**. After a trade is consummated on the exchange floor (or electronically), both counterparties deal only with the clearinghouse. It interposes itself in each trade. The clearinghouse becomes the counterparty to each trader, as shown in Figure 19.2. The left-hand panel shows the trade, and the right-hand panel shows each trader's relationship with the clearinghouse after the trade.

Figure 19.2 The Role of the Clearinghouse in Futures Markets



The clearinghouse serves as a guarantor, ensuring that the obligations of all traders are met and that no trader is hurt by a counterparty that reneges on an obligation. Since each trade starts with one buyer and one seller, there are as many buyers as there are sellers and the clearinghouse has no net exposure.

Let's assume that the wheat futures trade discussed above is the first trade for each trader. Each trader posts a performance bond with his or her broker. Each day after the trade, the clearinghouse tracks the details of each trade and calculates daily profits and losses. The clearinghouse credits the accounts of those who profit and debits the accounts of losers. Again, since futures trading is zero sum, the clearinghouse has no net exposure. In turn, the brokers credit and debit their clients' accounts. This process is called **marking-to-market** (or **daily resettlement**) and is described in the next section.

At maturity, if traders want to take or make delivery then buyers pay the clearinghouse and sellers bring their warehouse receipts (proof of delivery) to the clearinghouse (see **Figure 19.2**).

2.4 Daily Marking-to-Market

Each day, the clearinghouse credits gains and debits losses to each traders' account. This process is called marking-to-market.

Think about our wheat example. At the end of the first day of trading, assume that the **settlement price** for the wheat futures contract is \$7.10. You have a long position, so you profit from the increase. Your gain is the difference between the settlement price and your

purchase price (\$7.055) multiplied by the number of bushels. The gain is calculated as if you have closed the position and sold the wheat at the settlement price. In a long position, the forward price when the contract is initiated is your purchase price.

$$\text{Day 1 Profit} = (P_1 - P_0) \times 5,000 = (7.10 - 7.055) \times 5,000 = \$225 \quad \text{Eq. 19.1}$$

This gain is added to the balance in your margin account (the performance bond), so the account rises to **\$3,465**.

Where did the money come from? Futures are zero sum. The short side of your contract lost \$225, and that amount was subtracted from his margin account and transferred to yours through the clearinghouse.

On Day 2, the futures price falls to \$6.8075. Your profit (loss) relative to the end of Day 1 is given by:

$$\text{Day 2 Profit} = (P_2 - P_1) \times 5,000 = (6.8075 - 7.10) \times 5,000 = -\$1,462.50 \quad \text{Eq. 19.2}$$

This profit (loss) is added to the balance in your margin account, which reduces it to **\$2,002.50**. Your cumulative profit is the sum of the two daily profits:



$$\text{Cumulative Profit Day 2} = (P_2 - P_0) \times 5,000 = (6.8075 - 7.055) \times 5,000 = -\$1,237.50 \quad \text{Eq. 19.3}$$

It's Time to Do a Self-Test

5. You went long one wheat futures contract yesterday at a futures price of \$5 per bushel. At the end of trading today the settlement price for wheat futures is \$6/bu. What is your profit for the day? Answer
6. Last week you went long one wheat futures contract at a futures price of \$5 per bushel. At the end of trading today the settlement price for wheat futures is \$5.50/bu. What is your cumulative profit for the week? Answer
7. You went short one wheat futures contract yesterday at a futures price of \$5 per bushel. At the end of trading today the settlement price for wheat futures is \$3.50/bu. What is your profit for the day? Answer
8. Last week you went short one wheat futures contract at a futures price of \$5 per bushel. At the end of trading today the settlement price for wheat futures is \$4/bu. What is your cumulative profit for the week? Answer

2.5 Maintenance Margin



Your account balance has fallen through a critical threshold called the **maintenance margin** level. The maintenance margin level for your wheat futures contracts is \$2,400. When your account balance falls below the maintenance margin level, you are given a **margin call**. After a margin call, the trader must contribute more money to the margin account. The amount

deposited must bring the balance back to the initial margin level. In this case, the trader must contribute **\$1,237.50**. If the margin call is not heeded, then the broker will close out the position. The margin call, in conjunction with the initial margin requirement and daily marking-to-market, protects brokers from losses in the event a client reneges on a futures position after an adverse price change.



The Explore It provides you with an opportunity to calculate daily profit and cumulative profit and to understand margin calls.

2.6 Completing a Futures Trade

The most obvious way to complete a futures trade is to make or take delivery of the underlying asset. However, the clearinghouse provides a second way to complete a futures trade: through an **offset (reversing) trade**. It may surprise you to learn that fewer than 1% of all contracts are completed with physical delivery.

Consider our wheat example. In May, you took a long position in one wheat contract for September delivery. The futures price when you initiated the long position was \$7.055/bu. Let's say that the futures price of wheat for September delivery rises to \$7.25/bu by August 25th and you want to close out the position and take your gains. Your cumulative profit on the long position is **\$925**. The balance in your margin account will be the sum of your margin contributions and this profit.

How do you get out of the contract in the middle of its life? The answer is with an offset trade. Since you are long one September contract, you do the opposite: you sell one

September contract. Afterwards, the clearinghouse ignores you and you have no delivery obligations. Your position is closed and you get to keep the accumulated gain in the account. This is equivalent to selling a share after you have gone long.

To understand why the clearinghouse ignores you, think about its obligations vis-à-vis each trader, as shown in Table 19.2. In your first trade you went long wheat futures and agreed to take delivery in September. Let's call the short side of that contract Trader 2. Trader 2 agreed to deliver wheat in September. These obligations are shown in the middle column. In August you entered a new contract on the short side; you agreed to deliver wheat in September. Let's assume that you traded with a new counterparty, Trader 3.

Table 19.2 Obligations of Futures Traders to Clearinghouse

	Obligation to Clearinghouse	Clearinghouse's Action
Trader 1	1. Take delivery of 5,000bu of wheat in September. 2. Deliver 5,000bu of wheat in September.	Nothing
Trader 2	Deliver 5,000bu of wheat in September.	Pair Trader 2 with Trader 3
Trader 3	Take delivery of 5,000bu of wheat in September.	

You have an obligation to deliver wheat to the clearinghouse under your short position, but you have an obligation to take delivery of wheat from the clearinghouse under your long position. That is a lot of work for nothing. Thus, the clearinghouse waives your obligations. As shown in the right-hand column, it takes no action with you; you are irrelevant. Trader 2 still has an open obligation to deliver wheat to the clearinghouse and Trader 3 still has an open obligation to take delivery of wheat. The clearinghouse will simply give Trader 2's wheat to Trader 3. The clearinghouse has no net exposure at the end of the matching process.

2.7 The Differences between Forwards and Futures Contracts

1. Forward contracts are customized. Futures contracts are standardized.
2. Forward contracts are traded in a dealer (over-the-counter) market. Futures contracts are exchange traded.
3. Forward contracts can only be completed by making or taking delivery. Futures contracts can also be completed through an offset (reversing) trade.
4. Forward contracts are settled on the maturity date. Futures contracts have daily marking-to-market.

It's Time to Do a Self-Test

9. The initial margin is \$5,000. The maintenance margin is \$3,000. The balance in your margin account is \$2,000. You receive a margin call. How much must you deposit in your margin account? [Answer](#)
10. What are the two ways to complete a futures trade? [Answer](#)
11. You are short one gold contract with a December maturity. You want to close out the position. What is the offset trade? [Answer](#)
12. If you agreed to sell one September wheat futures contract at \$7.055/bu on May 3 and the September contract has a settlement price of \$6.90 on May 10, what is your cumulative profit? [Answer](#)



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L03

Hedging with Futures Contracts

To explain how companies hedge with futures, we first need to explain two concepts: (1) basis and (2) convergence.

3.1 Basis

Basis is the spot price minus the futures price for the same asset.

$$\text{Basis} = \text{Spot Price} - \text{Futures Price} \quad \text{Eq. 19.4}$$



The spot price varies by location, and so does the basis. For example, the price of No. 2 soft red wheat is probably not the same in Toledo as it is in Chicago. The basis also varies across different futures contract maturity dates. For simplicity, think of one location and one futures contract. For commodities like wheat that are costly to store, the basis is negative.¹ That is, the futures price is bigger than the spot price.

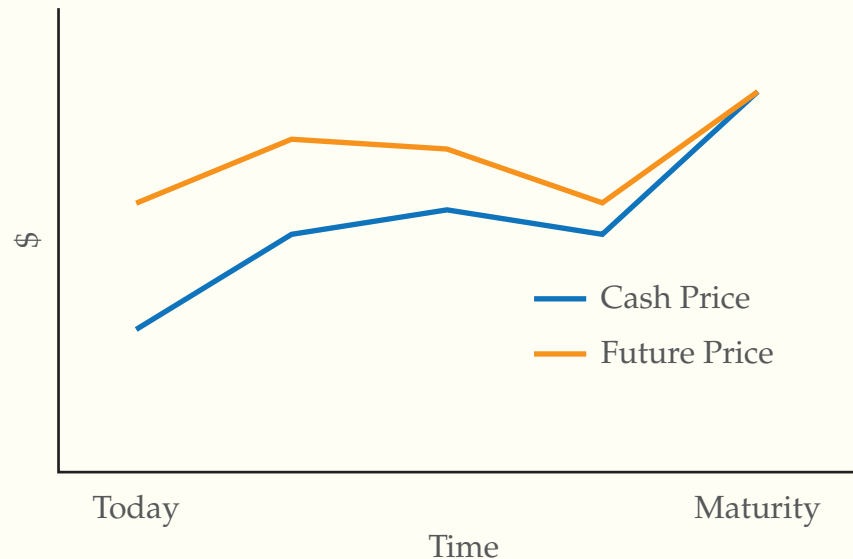
3.2 Convergence

Figure 19.3 graphs the spot and futures prices for a wheat futures contract over time. The basis is the difference between the two lines. Notice that the basis declines as the maturity date nears. This is a property of futures called **convergence**. The futures price gets closer and

¹You will learn the reason for positive or negative basis in an elective course on futures and options.

closer to the spot price as the maturity date approaches. The reason for this is simple: If a trader buys a futures contract on the maturity date and does not offset, then she will take delivery of the underlying asset almost immediately. In respect of the delivery time, the futures contract (on its maturity date) is equivalent to a spot contract. By the law of one price, the futures price must equal the spot price (the basis is zero) on the maturity date.

Figure 19.3 Convergence





3.3 A Short Hedge

A short hedge is a short position taken by a hedger. Think of a wheat farmer who plants her crops in May. She plants enough seed to harvest 100,000 bushels. Assume that the December contract is trading at 400¢/bu (\$4.00/bu). If the farmer likes the \$4 price and is worried that the price of wheat might fall by harvest (in late October), then she could sell 20 December wheat futures contracts in May for \$4/bu.

Assume that late October arrives and the growing season was excellent—plenty of rain and hot weather. The farmer harvests her 100,000bu, but the spot price of wheat has dropped to \$3.50/bu because of the excess supply. The farmer could simply wait for the middle of December and then transport her wheat to Chicago to fulfill the delivery requirements of her 20 short contracts. She would then, obviously, receive \$4/bu for her wheat despite the drop in the spot price. She has locked-in the price and “hedged” the price risk with the futures contract.

However, the transportation costs associated with this completion method are very high, especially if her farm is any distance from Chicago. If that is the case, then she might prefer to sell her wheat to her local grain elevator operator. She would receive the spot price of \$3.50/bu for total proceeds of $100,000\text{bu} \times \$3.50 = \$350,000$.

Of course, she still has the short futures position. To get out of those contracts she would execute an offset trade. She would buy 20 December contracts. Let's assume that

convergence is complete and the futures price equals the spot price. The equation to determine the cumulative profit is:

$$\text{Cumulative Profit} = (P_0 - P_t) \times 100,000 \quad \text{Eq. 19.5}$$

The futures settlement price is \$3.50/bu, so the cumulative profit is

$$(\$4.00 - \$3.50) \times 100,000 = \$50,000.$$

The farmer has sold high and bought low. When the futures trading profit is combined with the revenues from the sale of the wheat to the elevator, we see that the farmer has total receipts of \$400,000, which is the same as if she had delivered the wheat to complete the contracts (ignoring transportation costs). Futures contracts are effective hedging tools even if you do not make or take delivery.

It's Time to Do a Self-Test

- 13.** Bakers use wheat as an input to make flour. A bakery anticipates needing 100,000bu of wheat in three months. It is worried that the price of wheat might rise. What position should it take in the wheat futures contract to hedge the price risk? **Answer**



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L04

Option Contracts



Options are contracts between two counterparties. There are two kinds of options: **calls** and **puts**. Calls give the **owner** the right to buy, and puts give the owner the right to sell. The buyer of a call option pays a **premium** (price) and has a choice to buy an underlying asset before a specified date (**expiration date**) at a fixed price (**strike price** or **exercise price**). The seller of a call option receives the premium and must be ready to sell the asset (if the owner chooses to buy) before a specified date at the strike price.

The owner of a put option pays a premium and has the right to sell an underlying asset at a strike price before expiration. The **writer** of a put option receives the premium and must stand ready to buy the underlying asset (if the owner chooses to sell) at the strike price.

There are four things that you should notice about options:

1. They are contracts, like futures, and not securities.
2. There are two cash flows: the premium and the strike price.
3. Buyers, not sellers, have the option.
4. Buyers pay (the premium) for the option and the sellers receive the premium.

Table 19.3 summarizes the rights and responsibilities of buyers and sellers of call and put options.

Table 19.3 Rights and Obligations of Buyers and Sellers in Option Contracts

	BUYER	SELLER
CALL	<u>Pays</u> a premium and has the <u>right</u> to BUY an underlying asset at the specified strike price before the expiration date.	<u>Receives</u> a premium and has an <u>obligation</u> to SELL
PUT	<u>Pays</u> a premium and has the <u>right</u> to SELL an underlying asset at the specified strike price before the expiration date.	<u>Receives</u> a premium and has an <u>obligation</u> to BUY

The premium of the option contract is the price that is negotiated between the buyer and seller. All other elements of the contract—strike price, expiration, quantity, and quality of the underlying asset—are fixed by the exchange.

If the owner of an option decides to buy (sell), then they are **exercising** their option.



Call owners make money when the price of the underlying asset rises above the strike price, then they can buy the asset cheap (by exercising their option) and sell it for a higher price in the spot market. Call sellers want the price of the underlying asset to stay steady or fall so that the option owner lets the contract expire. Then the option seller gets to keep the premium. The highest profit that an option seller can earn is the premium. There is no further upside for them.



Put owners profit when the price of the underlying asset falls below the strike price. Then, the put owners can buy the asset cheap in the spot market and sell it for a higher price (by exercising their option). Like all option writers, put option writers want the owner to walk away without exercising so that they keep the premium.

The preceding two paragraphs convey the essential nature of the “bets” represented by options. We suggested that option contracts are completed through exercise. As with futures, options can also be completed through an **offset trade**. Offsetting is almost always better than exercising the contract. We’ll prove this point with an example in a little while.

There are two varieties of options: **American** and **European**. The labels have nothing to do with where they are traded. American options can be exercised at any time prior to expiration. European options can only be exercised at expiration. At first, European options seem to contradict their very nature: They restrict the flexibility of the option. But if you recall what we asserted in the previous paragraph, it is (almost) never optimal to complete an option by exercising it, so the restriction on exercise is not that significant.

4.1 Stock Options



There are many underlying assets for options contracts, some of which were listed in an earlier Explain It video (reproduced here again for your viewing convenience). Throughout this chapter we will focus on one type of option: stock options. With a stock option, the underlying asset is 100 shares of a particular stock but, in most of our examples, we will act like there is only one share to keep the numbers simple.

For example, consider the stock options on Big Heartless Corp. (BHC), a multinational conglomerate, which are traded on the NASDAQ OMX PHLX trading system (the PHLX used to be the Philadelphia Stock Exchange). The ticker for the option contract is BHO, and the ticker for the stock is BIG (listed on NASDAQ). The contract calls for the delivery of 100 of BHC's common shares. The option contract has a fixed schedule of dates on which the contracts expire throughout the year (September, October, December, January, and March). The contracts always expire on the third Friday of the month. There are a variety of strike prices.

4.2 Stock Option Price Quote

A typical stock option quote is shown in Table 19.4. The table shows that the shares of BHC closed at \$54. Below the stock price information is information on prices and volumes for various call options with different strike prices and expiry dates. The October contract with a strike price of \$50 last traded at a price (premium) of \$4.60. If you had wanted to buy the option, you would have paid $\$4.60 \times 100 = \460 (stock option price quotes are expressed per share even though the contract is for 100 shares). This would have entitled you to buy 100 shares of BHC for \$50.

Table 19.4 Option Price Quotes for Big Heartless Corp. Call Options

3 BIG				54.00	
Date				Vol 4,155,199	
Expiry	Strike	Last Sale	Net	Vol	Open Int
Oct. 20XX	\$50	4.60	−0.30	6	1866
Oct. 20XX	\$55	0.05	−0.15	704	5611
Oct. 20XX	\$60	0.05	pc	0	9997
Nov. 20XX	\$50	5.40	−0.30	9	1400
Nov. 20XX	\$55	2.45	+0.20	472	3440
Nov. 20XX	\$60	0.70	−	19	6502

4.3 Initiating an Options Trade

To initiate an options trade, a trader must deposit an initial amount (cash or securities) into an account with a broker. The amount of the initial deposit depends on the account type (cash or margin), whether the contract is a put or a call, whether the trader is long or short, and the type of underlying asset. For long positions in both puts and calls on stock options, the trader only needs to deposit the option premium in their account. Each exchange publishes initial deposit requirements on their websites. As with futures, the account is marked-to-market daily and there are maintenance margin levels that, if breached, require the trader to invest more funds in the account.

4.4 Completing an Option Trade: Exercise or Offset

Consider buying the October call option with the \$50 strike price shown in Table 19.4. The stock price is \$54 and you pay \$4.60 for the option. Let's assume that the price of BHC stock climbs to \$55 before your option expires and the premium rises to \$5.50. Now you think that it is time to get out of the option and take your profits.

You have two choices in completing this option position:

1. You can exercise your option (assuming that it is an American option) and buy the underlying BHC stock for \$50 a share for a total cost of \$5,000. At the same time, you would sell the shares on the stock market for **\$5,500**, yielding a payoff of \$500. Since you had to invest \$460 to pay the option premium, this represents a profit of $\$500 - \$460 = \$40$.
2. You can execute an offset trade by writing (selling) a BHO Oct 50 call option for \$5.50 per share (or a total of \$550). Your net profit is the difference between the premium received (\$550) and paid (\$460)—\$90.

The return is higher when you offset because when you exercise you give up the time value. (We will explain the time value later.) This is why it is almost always better to complete an options position with an offset trade rather than by exercising an option.

It's Time to Do a Self-Test

- 14.** You have a long position in the December put option on the shares of Heartless Enterprises Inc. with a strike price of \$40. It is an American option. Today Heartless shares are trading for \$30 and you want to close your position. What do you do? [Answer](#)
- 15.** You have a short position in the December put option on the shares of Heartless Enterprises Inc. with a strike price of \$40. It is an American option. Today Heartless shares are trading for \$30 and you want to close your position. What do you do? [Answer](#)



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L05 Option Payoffs and Profits

A good way to understand options is to draw profit diagrams. A profit diagram shows the profit from holding an option position at expiration for hypothetical values of the stock price. It is a “what if” exercise: What if you held the option to maturity, and what if the stock price was at various levels? Of course, you don’t have to hold to maturity—you can close a position at any time with an offset trade.

5.1 Long Call



***Tip** Reconsider the example from the previous section. You purchase the BHO Oct 50 call option for a premium of \$4.60. Let’s fast forward to expiration on the third Friday of October. Let’s say that the stock price on that Friday is \$60. If you sell the shares after exercise, then what is your profit from the option? We calculate profit in two steps. First, we calculate the payoff of the option. Second, we subtract the premium (you pay the premium in a long position).



***Tip** Payoff is the amount earned from buying the share for \$X by exercising the option and selling the share at the market price of \$S_t (on date t). The payoff can be represented with the following function:

$$\text{Payoff}_t = \text{MAX}(0, S_t - X) \quad \text{Eq. 19.6}$$

In this example, if you exercise the option then you buy the share for \$50 and sell it at the market price for \$60. The payoff is **\$10**.

The payoff cannot be negative, because the **holder** will not exercise the call option when the stock price is below the strike price. If there is time until the expiration date, then the holder will wait. If it is the expiration day, then the holder will abandon the option.

The profit is the payoff less the premium:

$$\text{Profit} = \text{Payoff} - \text{Premium} \quad \text{Eq. 19.7}$$

$$\text{Profit} = \$10 - \$4.60 = \$5.40$$

Remember, this is on a per-share basis. Your profit for the whole contract is \$540.

Table 19.5 presents payoffs and profits for a variety of hypothetical closing prices on the expiration date. One interesting example is if the stock price is \$50 at expiration. In this case, it is not worth exercising your option. The payoff is zero and the profit is $-\$4.60$ per share. Indeed, for all prices under \$50, that is the profit.



Table 19.5 Call Option Payoffs and Profits

Stock Price	Payoff	Profit
\$0	\$0	−\$4.60
\$40	\$0	−\$4.60
\$50	\$0	−\$4.60
\$60	\$10	\$5.40
\$70	\$20	\$15.40
\$80	\$30	\$25.40

Figure 19.4 presents a graph of the values in Table 19.5. The graph shows both the payoff and profit from the call option.

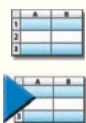
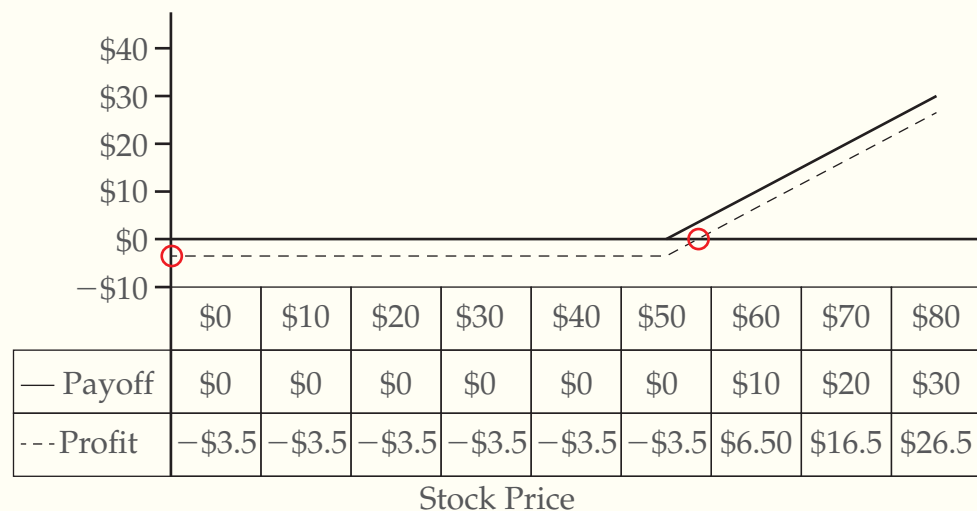


Figure 19.4 Profit (Payoff) Diagram for One Long Call Option



It's Time to Do a Self-Test

16. Practise calculating the profit to a long position in a call option. Answer

17. What is the maximum loss to a call owner? Answer

5.2 Short Call

To understand the payoff and profit to an option writer, it is best to think of what the owner of the option will do in each situation and then consider the impact on the writer. Let's say that you wrote the call in the previous example—the BHO Oct 50 call option for a premium of \$4.60. If the option holder does not exercise, then you get to keep the \$4.60. As we saw above, this happens for all stock prices at or below \$50. At prices above \$50, the writer starts to get in trouble. Consider a price of \$60. The option holder will exercise and the writer is obliged to sell shares to the holder for \$50—the option's strike price. This represents a loss to the writer of \$10. The writer's payoff is the opposite of the holder's payoff. The writer gets to keep the premium, which partially offsets the negative payoff.

Example 19.1 Profit to a Call Writer

You wrote the BHO Oct 50 call option for a premium of \$4.60. The expiration day is today and the stock is trading for \$60. What is your profit?

SOLUTION

The payoff for the writer is equal to -1 times the payoff to the holder.

$$\text{Payoff} = -\text{MAX}(0, S_T - X)$$

$$\text{Payoff} = -\text{MAX}(0, \$60 - \$50) = -\$10$$

The premium is added to the payoff because the option writer receives the premium.

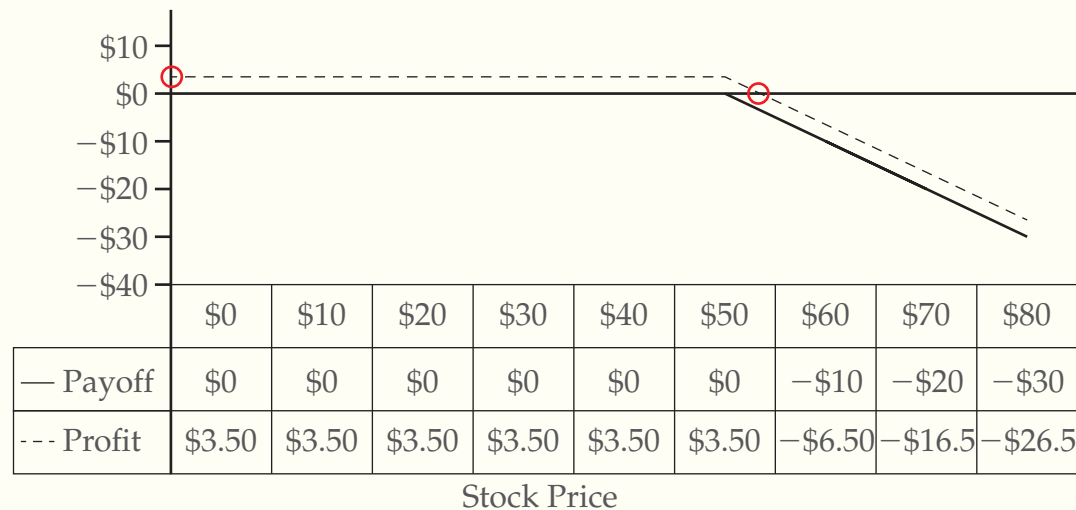
$$\text{Profit} = \text{Payoff} + \text{Premium}$$

$$\text{Profit} = -\$10 + \$4.60 = -\$5.40.$$

Figure 19.5 presents a graph of the payoffs and profits to a call writer.



Figure 19.5 Profit (Payoff) Diagram for One Short Call Option



It's Time to Do a Self-Test

18. Practise calculating the profit to a short position in a call option. [Answer](#)
19. What is the maximum loss to a call writer? [Answer](#)
20. What is the maximum profit to a call writer? [Answer](#)

5.3 Long Put

Now consider owning a put option on BHC shares. Assume that you bought the BHO Oct 50 put option for a premium of \$3.00. The put option gives you the right to sell 100 shares of BHC common shares for a price of \$50 per share at any time before the option expires in October. The right to sell the shares at a fixed price becomes more valuable as the price of the underlying shares drops. Ideally, the stock goes bankrupt. In that case, you can acquire 100 shares for nothing and then exercise your put. When you exercise the put, you sell the shares to the put writer at the strike price. Your payoff is the strike price, since the purchase price is zero. In general, we can express the payoff as:

$$\text{Payoff}_t = \text{MAX}(0, X - S_t) \quad \text{Eq. 19.8}$$

The payoff to a put owner is the greater of zero or the difference between the strike price and the stock price. The minimum payoff is zero because you cannot be forced to exercise the option if it is disadvantageous to you. That is, you cannot be forced to sell at the strike price if the market price is higher. If the market price is lower than the strike price, then your payoff is equal to the amount of money you would earn if you bought the shares today at a price of $\$S_t$ and sold them for $\$X$ by exercising the put.

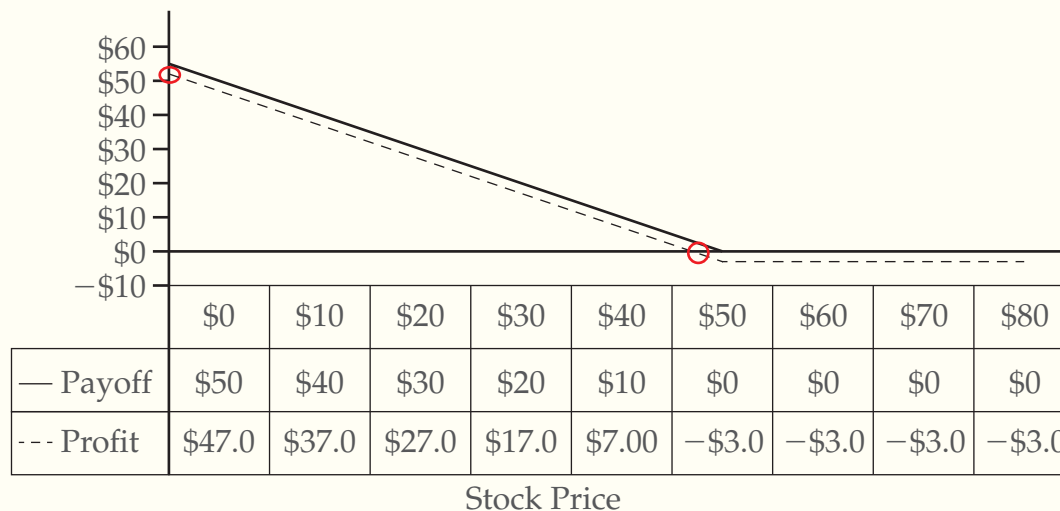
The profit is the payoff minus the premium, since the owner of an option pays the premium.

$$\text{Profit} = \text{Payoff} - \text{Premium} \quad \text{Eq. 19.9}$$

Figure 19.6 presents a graph of the payoffs and profits to a put owner.



Figure 19.6 Profit (Payoff) Diagram for One Long Put Option



It's Time to Do a Self-Test

21. Practise calculating the profit to a long position in a put option. [Answer](#)
22. What is the maximum loss to a put owner? [Answer](#)
23. What is the maximum profit to a put owner? [Answer](#)

5.4 Short Put

Now consider writing the BHO Oct 50 put option for a premium of \$3.00. The put option obliges you to buy 100 shares of BHC common shares for a price of \$50 per share if the owner exercises. You receive the premium of \$3.00.

The writer of the option wants the holder to walk away—to not exercise their option. In that case, the writer keeps the premium, which is his profit. The put owner will walk away if the share price is above the strike price at expiration. Consider a situation where the owner does not walk away. Consider a final share price of \$40. The put owner, as we demonstrated in the last example, exercises at this price. She sells the shares for \$50 to the put writer. The put writer is therefore buying shares that are overpriced by \$10, since they only trade for \$40 on the stock market. The put writer's payoff is the opposite of the put owner's: $-\$10$. The put writer receives the premium, which partially offsets this negative payoff.

Example 19.2 Profit to a Put Writer

You wrote the BHO Oct 50 put option for a premium of \$3.00. The expiration day is today and the stock is trading for \$40. What is your profit?

SOLUTION

The payoff for the writer is equal to -1 times the payoff to the holder.

$$\text{Payoff} = -\text{MAX}(0, X - S_T)$$

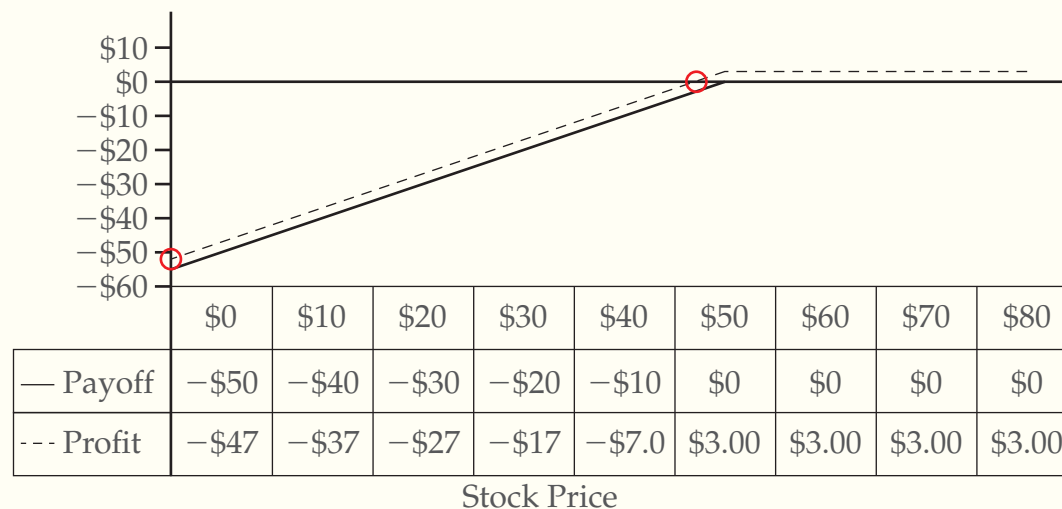
$$\text{Payoff} = -\text{MAX}(0, \$50 - \$40) = -\$10$$

The premium is added to the payoff because the option writer receives the premium.

$$\text{Profit} = \text{Payoff} + \text{Premium}$$

$$\text{Profit} = -\$10 + \$3 = -\$7$$

Figure 19.7 presents a graph of the payoffs and profits to a put writer.

Figure 19.7 Profit (Payoff) Diagram for One Short Put Option

It's Time to Do a Self-Test

- 24.** Practise calculating the profit to a short position in a put option. [Answer](#)
- 25.** What is the maximum profit to a put writer? [Answer](#)
- 26.** Click on this [link](#) to see four option profit diagrams. Identify the option and the position that each represents. [Answer](#)
- 27.** Pick a company that you like that has a stock option traded on it. Open a web browser and search for “[Company Name] stock option quote.” (Replace “Company Name” with your company’s name.) This should take you to a NASDAQ price quote for options on your company. Select the second-nearest expiration date. Pick one put and one call option. Write down the strike price and premiums for those options. Then use that data to draw four graphs like those shown in this section. Create a data table beneath the graph with payoffs and profits. Carefully label all x-axis and y-axis intercepts.



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L06

Option Pricing

6.1 Intrinsic Value

The **intrinsic value** of an option is simply the payoff to the option holder. For a call, it is the money the holder would receive today if they exercised the option and then sold the shares at the market price. The intrinsic value of a call is given by:

$$\text{Call Intrinsic Value}_t = \text{MAX}(0, S_t - X) \quad \text{Eq. 19.10}$$

For a put, the intrinsic value is the money the holder would receive if they bought the shares at the market price and sold the shares by exercising the put. The intrinsic value of a put is given by:

$$\text{Put Intrinsic Value}_t = \text{MAX}(0, X - S_t) \quad \text{Eq. 19.11}$$

The intrinsic value cannot be negative, since the option holder can choose not to exercise and, in a sense, walk away from the option.

6.2 Moneyness

An option with positive intrinsic value is said to be **in-the-money**. An option with an intrinsic value of 0 is said to be **out-of-the-money**. When the share price equals the strike price, then the option is said to be **at-the-money**. Table 19.6 relates the share price, the exercise price, and intrinsic value to **moneyness**.

Table 19.6 Moneyness for Puts and Calls

	$S_t > X$	$S_t < X$
CALL	In-the-money Intrinsic value > 0	Out-of-the-money Intrinsic value $= 0$
PUT	Out-of-the-money Intrinsic value $= 0$	In-the-money Intrinsic value > 0

6.3 Intrinsic Value and Price

An option premium is almost never less than the intrinsic value. If it is, then there can be an arbitrage opportunity—that is, an easy profit opportunity. As traders exploit the opportunity, the option price changes until the price is above the intrinsic value.

For example, consider the BHO Oct 50 call option. Assume that it is an American option, the price of the stock is currently \$55, and the premium is \$1. The intrinsic value of the option is **\$5**, which is greater than the premium of \$1. Could you structure a sequence of trades to take advantage of this situation? Yes. Buy the option for \$1, exercise it and buy the shares for \$50, then sell the shares on the stock market for \$55. Your profit is \$4. Traders would flock to such an opportunity and the premium would quickly be bid over \$5. At that level, there is no easy profit opportunity.

6.4 Time Value

Option premiums are usually higher than the intrinsic value. The difference is called the **time value** or **time premium** of the option:

$$\text{Time value} = \text{Option premium} - \text{Intrinsic value} \quad \text{Eq. 19.12}$$

The time value reflects the likelihood that the stock price will rise (for calls) or fall (for puts) between now and the expiration date.

The main factors that affect the time value are

1. time and
2. volatility.

With more time comes the increased likelihood of a change in the stock price. In the short run, the odds of something happening to a company are small. Over a longer time period, the odds rise. Time values rise as the time to expiration rises and fall as the time to expiration nears.

The second factor that affects the time value is volatility. The higher the volatility of the price of the underlying asset, the higher will be the time value, all other things being equal. More volatile assets are more likely to jump up (or down).

It's Time to Do a Self-Test

- 28.** Practise computing intrinsic and time values for call options. [Answer](#)
- 29.** Practise computing intrinsic and time values for put options. [Answer](#)
- 30.** What are the two most important determinants of the time value of an option? [Answer](#)
- 31.** If you exercise an American option before the expiration date, what do you give up?
[Answer](#)



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Chapter Summary

Concepts You Should Know	Key Terms and Equations	Solution Tools	Extra Practice MyFinanceLab
Introduction	futures, options, derivative contracts, price risk, forward contracts, Chicago Board of Trade (CBOT), futures contracts		
LO1 Understand the basics of forward contracts	spot contract, spot price, maturity date, buyer, seller, forward price, currency contract, hedge, speculation		Study Plan 19.L01
LO2 Understand futures contracts, how futures are traded, and the payoffs to futures contracts	minimum tick size, open outcry, clearinghouse, marking-to-market (daily resettlement), settlement price, maintenance margin, margin call, offset (reversing) trade		Study Plan 19.L02

Concepts You
Should Know

Key Terms and Equations

Solution Tools

Extra Practice
MyFinanceLab

	$Day\ 1\ Profit = (P_1 - P_0)$ Eq. 19.1		
	$Day\ 2\ Profit = (P_2 - P_1)$ Eq. 19.2		
	$Cumulative\ Profit\ Day\ 2 = (P_2 - P_0)$ Eq. 19.3		
LO3 Describe how futures are used to hedge price risk	convergence		Study Plan 19.LO3
	$Basis = Spot\ Price - Futures\ Price$ Eq. 19.4		
	$Cumulative\ Profit = (P_0 - P_t)$ Eq. 19.5		
LO4 Understand option contracts and how options are traded	calls, puts, owner, premium, expiration date, strike price (exercise price), writer, exercising, offset trade, American options, European options		Study Plan 19.LO4

Concepts You Should Know	Key Terms and Equations	Solution Tools	Extra Practice MyFinanceLab
LO5 Understand the payoffs to options contracts	holder		Study Plan 19.L05
	$Payoff_t = \text{MAX}(0, S_t - X)$ Eq. 19.6		
	$Profit = Payoff - Premium$ Eq. 19.7	Profit to a Call Writer	
	$Payoff_t = \text{MAX}(0, X - S_t)$ Eq. 19.8		
	$Profit = Payoff - Premium$ Eq. 19.9	Profit to a Put Writer	
LO6 Understand intrinsic value and time value	intrinsic value, in-the-money, out-of-the-money, at-the-money, moneyness, time value (time premium)		Study Plan 19.L06
	$\text{Call Intrinsic Value}_t = \text{MAX}(0, S_t - X)$ Eq. 19.10		
	$\text{Put Intrinsic Value}_t = \text{MAX}(0, X - S_t)$ Eq. 19.11		
	$\text{Time value} = \text{Option premium} - \text{Intrinsic value}$ Eq. 19.12		



**It's time to do your
chapter homework!**

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