CHAPTER 7

OPTIONS ON FUTURES CONTRACTS

INTRODUCTION

Trade in options on agricultural commodity futures began in the fall of 1984, and that development made a major contribution to the risk management tools at the disposal of the producer, holder, and user of agricultural commodities. The financial community has known about and traded options for some time. However, options on commodity futures contracts have had a more jaded and political history. Trading in options on U.S. agricultural commodities had been banned in the U.S. since 1936. In 1933, an attempt to manipulate the wheat futures market using options resulted in political pressure that brought on the 1936 ban. Much later, in the 1970s, trading of options tied to London commodity futures contracts became popular. Two scandals involving options led the Commodity Futures Trading Commission (CFTC) to suspend most trade in options in June 1978. Then, in September 1981, the CFTC approved a three-year pilot program for selected commodities. The program was deemed a success and option trade was expanded in 1984.

Options on futures contracts can remove two related and major barriers to the use of commodity futures in the forward-pricing of agricultural commodities. The first is the producer's constant fear that forward prices of future sales have been set too low or that forward prices (i.e., costs) of future purchases have been set too high. The opportunity cost of pricing lower or higher than would be possible at a later date has been discussed in earlier chapters. Producers often equate *bad outcomes*, in terms of opportunity costs, with *bad decisions*. Even if the forward price established is profitable, there is a tendency for producers to view the hedge set early at relatively low prices (or at relatively high costs) to be a bad decision. If the futures side of the hedge loses money, the tendency is to view the hedge as a mistake and to talk about losing money with the hedge.

A second and related barrier to direct use of the futures markets is the need to manage a margin account and answer margin calls as the market rallies against a short position in the futures. Neither producers nor their lenders have always understood the need for a special and additional credit line to answer margin calls. There are countless examples of producers being forced to offset short hedges due to the inability or lack of a willing creditor to provide the needed margin funds. Often, the market turns lower after the upward price move that forced the producer to offset the short hedges. A loss is incurred in the futures account and then the producer is without price protection as the market turns and trends lower.

A vivid example of the problems that can develop was the Chernobyl nuclear scare incident in the Soviet Union and Europe in the spring of 1986. Corn, wheat, and soybean prices soared, forcing many producers who had short hedges in place out of the market via margin liquidation. Prices then trended sharply lower for the rest of the year after the anxiety had subsided. This example is dated and extravagant, but this type of scenario is played out time and time again over the years. Frequently, over the course of a growing season or a feeding period, news about possible changing supply and demand conditions push commodity futures prices sharply higher only to be revealed later that the change was temporary or the news not as dramatic as was initially thought. Incidents such as Chernobyl are rare but the reactions by commodity futures prices to catastrophic events are not. Producers' and lenders' fears are not irrational, however. The summer of 1996 is a case in point. Grain and oilseed markets rallied strongly with continuing news about poor growing weather, strong demand by a recovering world and domestic economy, and downward revisions of grain stocks. Producers who forward-priced at very high prices early in the season then watched the market rally another 10 to 30 percent. Margin calls accompany these rallies, and they often prove difficult to manage and finance.

Purchasing options eliminates the need for a margin account and leaves open the potential of higher prices to the producer. They also leave open the potential of lower costs to the user who is interested in protection against rising raw materials costs. Options thus open up important new possibilities in marketing and price-risk management. *However, this opportunity comes at a cost.* To obtain an option, the producer or the commodity user must purchase it. The premiums are, in a realistic sense, the cost of the protection and flexibility that the options offer.

BASIC OPTIONS TRADING

This section will introduce you to the basics of options, options trading, and the use of options in forward-pricing. It is our experience that students and other beginners find options confusing. The main problem is the jargon. There is a lot of terminology specific to options. Table 7.1 lists and defines some terms. There is also a lot of flexibility in designing and executing options strategies. Cash and futures markets are relatively straightforward. Assets can be bought and/or sold in both. Things are not so simple in the options market. This section introduces you to the terminology and the basic components of options trade. Later sections in this chapter will elaborate on the different components and strategies.

An option gives the *right* to a position in the underlying futures contract but not an *obligation*. A purchaser of the option buys the right and the options seller sells the right. The idea is simple. Like an option on anything, the right granted by the option can be exercised, or the option can be abandoned. The cost of the option is incurred up front. It is the same whether the option is exercised or abandoned. It is important that you understand this distinguishing feature of options on futures before proceeding. We often treat options as contracts or as financial instruments. But what the con-

TABLE 7.1
Options on Futures Contracts: Terms and Definitions

Term	Definition
Option	A contract that gives the buyer the right but not the obligation to hold a futures contract at a specified price within a specified time period.
Call Option	The right to buy a futures contract at a specified price (strike price).
Put Option	The right to sell a futures contract at a specified price (strike price).
Strike Price	The price at which the option buyer can establish a futures position.
Premium	The cost an option buyer pays to an option seller for the option contract.
Write/Writer	Sell an option. Option seller.
Exercise	Covert the option contract to a futures contract.
Intrinsic Value	The value of an option if it is exercised immediately.
Time Value	The difference between the option price and intrinsic value.
In-the-Money	The market price for underlying futures contract is above the call strike price or below the put strike price. The option has intrinsic value.
Out-of-the-Money	The market price for underlying futures contract is below the call strike price or above the put strike price. The option has no intrinsic value.
At-the-Money	The market price for underlying futures contract is equal to the strike price.

tract does is implied in its name. An option is a *right* but not an *obligation* to take a position in the futures market.

A *put* option gives the buyer the right to a short position in the futures market. The seller, or *writer*, of a put option is assigned a long position if the option is *exercised*. A *call* option gives the buyer the right to a long position in the futures markets. The writer of a call option is assigned a short position if the option is exercised. Suppose a feeder cattle producer buys an $80.00 put option for November feeder cattle futures. The producer has purchased the right to a short position in November feeder cattle futures at $80.00/cwt. Intuitively, if the November feeder cattle futures trade below $80.00, the $80.00 put option will take on value because it could be used to acquire a short position in the November contract at $80.00. In practice, the feeder cattle producer will seldom actually exercise the option and take a short position in futures. Like the fact that delivery on futures contracts rarely occurs, options are rarely exercised. Rather, the market in that option will continue to trade so an offsetting position is taken. If the trader has bought a put option, selling a put option will net the options market position to zero. The same is true for call options. If a trader has bought a call option and then sells a call option at a later date, the net options market position is zero.

If the November feeder cattle futures trade down to $76.00, the right to a short position at $80.00 will be worth about $4. In this case the $80.00 put option could be sold for $4.00/cwt. and the producer can use these gains to offset the decrease in cash feeder cattle prices. However, if the November feeder cattle futures market increases to $83.50/cwt., then the right to a short position at $80.00 is worthless. The option is allowed to expire. The producer has bought price insurance. In a declining market the option covers some of the losses, and in an increasing market the option was price insurance that was not needed.

Cattle feedlot operators who need the feeder cattle might buy an $80.00 call option on the same November feeder cattle futures contract. They have the right to a long position at $80.00/cwt. If the November futures trade up to $83.50, the $80.00 call option takes on value, and the cattle feeders have the desired protection against higher feeder cattle costs. Conversely, if the November futures trade down to $76.00, then the right to a long position in the November futures at $80.00 will be worthless. The cattle feeders have bought cost insurance they do not need, and they are in a position to benefit from lower prices if feeder cattle can be bought below $80.00. However, they received the benefit of having protection against a sharp and unexpected increase in feeder cattle costs.

The returns to the two preceding options examples are shown in Figure 7.1 This figure is a returns diagram for the two options strategies. Returns diagrams are used frequently in discussions of options strategies. Futures prices are on the horizontal axis and returns to the options trader are on the vertical axis. We see that the $80.00 put has no value if the market price climbs above $80.00/cwt. The right to sell at $80.00 is worthless if the market is higher than $80.00. The $80.00 put has value if the market price falls below $80.00. The right to sell at $80.00 is worth $4.00 if the market price is $76.00. The put return line is kinked at $80.00. The $80.00 call has no value if the market price falls below $80.00/cwt. The right to buy at $80.00 is worthless if the market is lower than $80.00. The $80.00 call has value if the market price climbs above $80.00. The right to buy at $80.00 is worth $3.50 if the market price is $83.50. The call return line is also kinked at $80.

Because returns to options depend on the direction in which the market moves, they are easier to explain in a diagram than in discussion. Returns diagrams will therefore be used frequently in this chapter. As suggested above, the first exposure a person has to options is often confusing. The source of confusion with options stems from two things. First, the returns line is kinked. It isn't kinked with futures or cash positions because you either make money or you don't on a position. And second, you can buy both a right to a short position and a right to a long position. In futures and cash markets, buying is synonymous with a long position, but this is not the case with options. *You should review all returns diagrams and be comfortable with what each one is attempting to communicate before continuing*. Each diagram is as important as the related text.

The returns shown in Figure 7.1 are incomplete. To obtain the right to a short position, a put, or the right to a long position, a call, the trader must pay a *premium*. The premium is what the purchaser of an option pays for the right to enter into a futures position. Options are traded at various strike prices, in the process of trading puts and calls. The *strike price* is the futures contract price for which the option purchaser has a right. The strike price for the example in Figure 7.1 is $80. Exchanges set the strike-price intervals. At the CME, the exchange trades options at three strike prices above and below the current futures price in even-dollar units. The strike prices are thus in $1.00/cwt. intervals. The option premiums for each designated strike price, of a particular commodity futures contract and a given expiration month, are discovered in an open outcry auction on the exchange floor. The price discovery process is much like that for futures contracts themselves. Table 7.2 records the premiums for puts and calls at various strike prices for options on the October 1997, November 1997, and January 1998 feeder cattle futures. These prices were the closing premiums on October 2, 1997.

Look carefully at the premiums reported in Table 7.2. The premiums differ significantly depending on the underlying strike price and the amount of time between

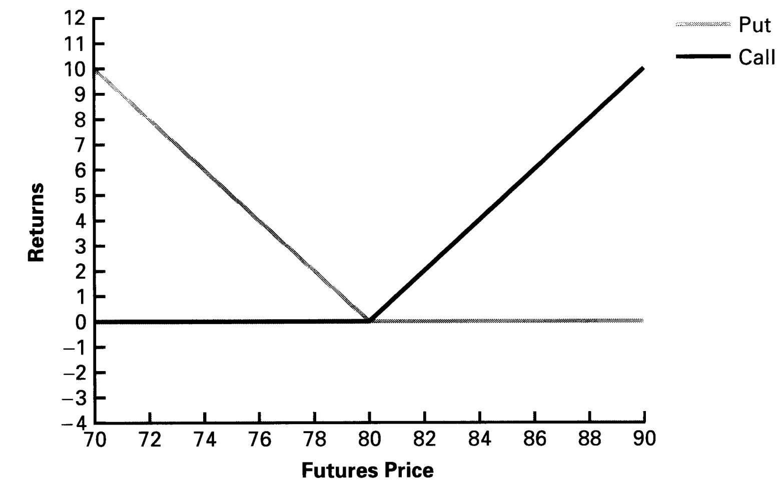


FIGURE 7.1
Returns Diagram from Purchase of an $80 Put and an $80 Call without Considering the Premium

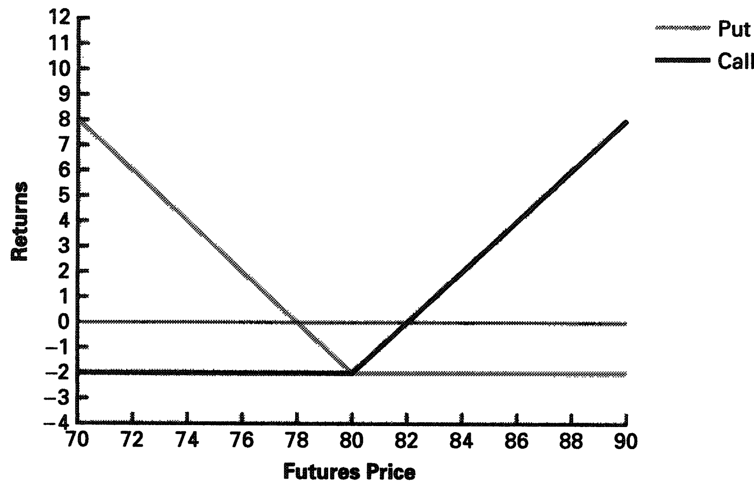
the current date and the date the option expires. Options expire on the last day of the month prior to the delivery month for contracts with physical delivery. Options expire early in the delivery month for contracts that are cash settled. The feeder cattle contract is for 50,000 pounds or 500 hundredweight. Buying a $78.00 put would cost the trader $650 ($1.30/cwt. × 500 cwt.). Notice that the underlying futures contract, the November contract, closed at $77.85. The January contract closed at $79.27, so the $80.00 put on the January contract is more comparable. Buying an $80.00 put on the January contract would cost the trader $1,125 ($2.25/cwt. × 500 cwt.).

It is time to correct the returns diagram in Figure 7.1. Figure 7.2 incorporates the premium paid into the option returns diagram. In this example, we have constructed the returns to a put and a call both with an $80 strike price. To purchase either of these two options, assume we must pay a $2/cwt. premium. The $80 put has no value if the market price climbs above $80/cwt.. and the $80 put has value if the market price falls below $80/cwt. The right to sell at $80 is still worth $4 if the market price is $76 and the put return line is still kinked at $80.

TABLE 7.2
Premiums for Put and Call Options on the October 1997, November 1997, and January 1998 Feeder Cattle Futures Contracts Discovered on October 2, 1997

	October 1997 Close @ $77.40		November 1997 Close @ $77.85		January 1998 Close @ $79.27	
	Premiums		Premiums		Premiums	
Strike Price	Calls	Puts	Calls	Puts	Calls	Puts
75	—	—	—	—	—	—
76	1.65	0.25	2.37	0.55	—	0.80
77	—	0.57	—	—	—	—
78	0.45	1.05	1.15	1.30	—	1.40
79	0.20	1.80	—	—	—	—
80	0.10	2.70	0.45	2.57	1.52	2.25

FIGURE 7.2
Returns Diagram from Purchase of Put and Call Options with Premiums Included



However, the return line is shifted down by the amount of the premium. The put strategy will give the trader a positive return if the market price falls below $80.00, but it will not be profitable until the market falls more than $2.00 below $80.00. The same idea holds for purchasing the call. The $80.00 call has no value if the market price falls below $80.00/cwt. and the $80.00 call has value if the market price climbs above $80.00. The right to buy at $80.00 is still worth $3.50 if the market price is $83.50 and the call return line is still kinked at $80.00. Again, the return line is shifted down the amount of the premium. The call strategy will give the trader a positive return if the market price climbs above $80.00, but it will not be profitable until the market climbs more than $2.00 above $80.00.

Much of the science to understanding options is in understanding the factors that determine the level of the premium. But before discussing these factors, more basic terms need to be introduced, some simple calculations need to be made, and some basic concepts need to be discussed. As mentioned earlier, the exchanges set strike prices in constant increments. For livestock and meat product futures, the CME uses $1.00/cwt. increments. The CBOT uses $.10/bu. for corn and wheat, and $.25/bu. for soybeans. If the December live hog futures contract, for example, is trading near $70.50/cwt., options will be listed with strike prices from $68.00 to $73.00 in $1.00 increments. Options for November soybeans that are trading near $6.50 per bushel would be offered in $.25 per bushel intervals above and below the $6.50 level.

Strike prices can be added to the trading set as needed. If the $80.00 strike price is the highest being traded for options on November feeder cattle futures contracts, the CME will add an $81.00 strike price if the futures start to trade above $78.00 and show potential for higher prices. There will always be strike prices that extend both above and below the trading level of the underlying futures contracts that are of interest to traders. In Table 7.2, strike prices from $75.00 to $80.00 were shown when the underlying October feeder cattle futures contract was at $77.40. Note that no trade occurred on that particular day in the $75.00 and $77.00 calls or the $75.00 puts.

An option strike price is *at-the-money* if the strike price is equal to the trading level of the underlying futures prices. An option is *in-the-money* if the strike price is at a level that would generate immediate return opportunities from the futures position if the purchaser exercised the option, took a position in the futures market, and then offset the futures position. A put option is in-the-money when the strike price is above the trading level of the underlying futures contract. For example, a $70.00 put option for the June live cattle futures contract is in-the-money if the underlying futures contract is trading at $67.50. The option, once purchased, could be exercised. The trader then holds a short position at $70.00 which they could then offset at the market price of $67.50. The returns from doing so would be $2.50, so the right to a short position has immediate value. Thus, the $70.00 put is in-the-money. Continuing with this example, a $65.00 put on the June contract would be *out-of-the-money*. If the underlying futures contract was trading at $67.50, there would be no immediate return possibilities if a short position was taken at $65.00, not when the futures would have to be bought back at $67.50. Intuitively, the premium on a $70.00 put will be much higher than the premium on the $65.00 put when the market is trading at $67.50.

Let's work another example referring to Table 7.2. The November contract closed at $77.85. Thus, the $78.00 put is in-the-money $.15 and the $80.00 put is in-the-money $2.15. The January contract closed at $79.27, so the $78.00 put on the January contract is well out-of-the-money and the $80.00 put is in-the-money by $.73.

Continuing with the live cattle example from earlier, the right to be short at $70.00 *has intrinsic* value when the underlying futures contract is $67.50. The right to be short at $65.00 has no intrinsic value. There will be a significant premium attached to the $65.00 put under these conditions only if we are dealing with a futures contract month that has a significant amount of time left before it expires. After all, if several months are left before expiration, the economic situation could change so that the futures contract could drop to $65.00 or lower. The $65.00 put has *time value* for that reason. This additional time value is also built into the $70.00 put premium as well. If the market drops to $65.00 or less, then a $70.00 put will have more intrinsic value. However, if the futures market stays around $70.00, the value of the $65.00 put option will decline to zero as the last trading day for the option approaches.

An option thus has *intrinsic value* and *time value*. The intrinsic value is determined by the strike price relative to the trading level of the underlying futures contract. A $70.00 put option has intrinsic value of $2.50 if the underlying futures contract is trading at $67.50. This is the case because the option could be exercised, the trader assigned a short position at $70.00, and then the position could be closed out by buying the futures position back at $67.50. A $65.00 put option would have zero intrinsic value if the underlying futures contract is at $67.50.

The time value is, of course, *a function of how much time is remaining before the option expires*. It is a reflection of the fact that the option is worth more the more time that is left to maturity. With more time, there is a greater chance that the futures market will move such that the option is in-the-money. *The time value component diminishes as the maturity data for the option approaches.*

You can see the decay in time value by looking at the premiums for feeder cattle options in Table 7.2. All of the feeder cattle futures prices are well above $76.00, so the premiums on all of the $76.00 puts reflect only time value, not intrinsic value. Notice that the premium for the January $76.00 put is $.80, the premium for the November $76.00 put is $.55, and the premium for the October $76.00 put is $.25. The October contract will expire in less than 30 days, the November in less than 60, and the January in less than 120. The premiums largely reflect the decay in time value due to the differences in how close the options are to expiration. However, the January futures contract is also $2.00 higher than the October or November contracts. If it were trading between $77.00 and $78.00, the premium on the January $76.00 put would be higher. But at $79.27, it has a smaller chance of falling below $76.00 and making the $76.00 put take on intrinsic value. A similar comparison can be made across the $78.00 puts. However, we need to remove the intrinsic value from the October and November $78.00 puts. The premium for the January $78.00 put is $1.40, the time value of the November $78.00 put is $1.15, and the time value of the October $78.00 put is $.45. Again, the time value decays for options closer to expiration. However, they are much larger for October and November $78.00 put options because the strike price is closer to being in-the-money. Here we have also observed something that will be discussed in later sections when we look at option premiums in more detail: in-the-money and out-of-the-money options are inexpensive relative to at-the-money options.

For a given strike price and time value, the *volatility* in the underlying futures contract becomes the most important determinant of the premium level. Highly volatile markets are risky markets, and the premium has to be large enough to entice traders to write or offer the option for sale. Someone has to be willing to offer or sell the $70 put on live cattle futures, to illustrate, before cattle feeders can buy a $70 put. The more volatile the market, the more premium that will have to be paid to get traders, usually speculators, to offer the $70 put options.

Volatility is particularly important and observable in options on grain futures contracts. If the summer growing weather is moderate and there is adequate rainfall for corn and soybean production, the premiums for options on the harvest corn and soybean contracts will reflect the normal time-value decay across the summer. However, if weather is unpredictable and it is questionable as to whether rainfall amounts were adequate, the time value in option premiums will increase with increased volatility in the futures market. Remember, this is an increase in the time value and not just the premium. We are netting out the level of the futures price relative to the strike price. The premium on puts will also be increasing because the futures prices will be increasing relative to the fixed strike price.

The producer who buys a put option to get protection against lower prices has to open an account with a commodity broker and pay the premium at the time the put option is bought. The commodity user who buys a call option to get protection against rising costs likewise has to pay the premium when the call option is acquired. *Thus, the buyer of a put or call option only has to pay the premium and is not subject to margin calls if the underlying futures contract move against the position.* Buyers of the $70 put in live cattle futures have a right to a $70 short position, for example, but if the futures go to $80, they can just let the $70 put option expire worthless. *There is no position in futures and no margin calls.* In a similar fashion, the buyer of an $86 call option in feeder cattle futures pays no margin calls when the market drops to $80 at the time of maturity for the option. The option can be allowed to expire worthless. Thus, the option premium is similar to an insurance premium. If the protection is not needed, the premium is forfeited and no action is required.

The rationale for this can be seen in Figure 7.2. The trader who purchases options has a known and limited loss. The maximum that you can lose from the option position is the premium. And the premium is paid up front. Thus, there is no need for margin requirements and margin calls.

While the buyer of options does not need to worry about margin calls, the seller, or writer, of options is exposed to an unknown amount of risk at the time the option is sold, and *must post margin requirements and answer margin calls*. For example, the trader who sells or writes a $70 put in live cattle futures is agreeing to guarantee some other trader, a put option buyer, a short position at $70. Selling a $70 put carries an obligation to take the other side, the long side of the $70 futures contract, so that

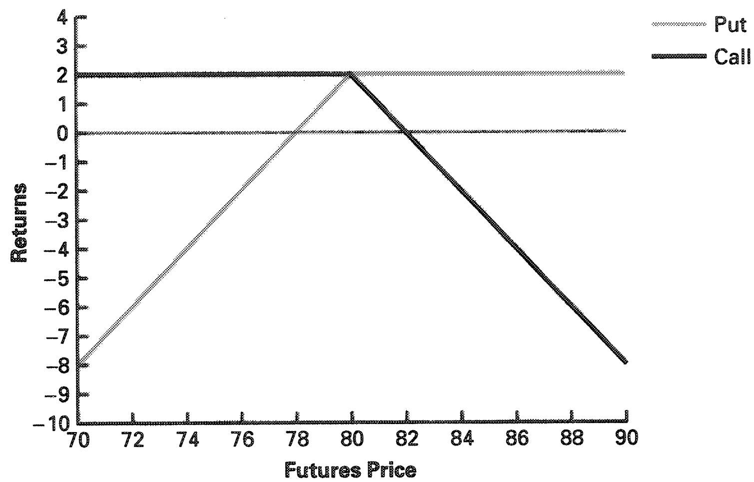


FIGURE 7.3
Returns Diagram from the Sale of Put and Call Options with Premiums Included

the buyer of the $70 put can be ensured a short position is available. Thus, selling a $70 put is comparable, in a sense, to being long in the live cattle futures market at $70.

If the market drops below $70, the buyer of the put can sell the option as the premium on the $70 put increases and registers the value of the right to a short position at $70. Alternatively, the buyer of the $70 put can exercise his or her option and ask for the short position at $70. A seller of the $70 put option, if the option is exercised, is then assigned a long position in the futures at $70.[1] It is apparent, then, that the seller of the $70 put will have to answer margin calls as the market drops below $70. In an account balance context, the sellers of $70 put options are treated essentially as if they had a long position in futures at $70. The margin requirements are often adjusted, but only if the put or call option is written or sold well out-of-the-money. *The key point here is that the buyer of options is not exposed to margin calls, but the seller of options is exposed to margin calls.*

We will return to the feeder cattle example used in Figure 7.2 and illustrate the returns diagram for options writers. In the example, we examined returns to a put and a call strategy with an $80 strike price. Let's look at the strategy from the viewpoint of the option writer. This is illustrated in Figure 7.3. The writer receives the $2 premium. The $80 put has no value if the market price climbs above $80/cwt. so the writer keeps the premium and has a $2 profit. The $80 put has value if the market price falls below $80. The right to sell at $80 is worth $4 if the market price is $76. The writer must pay this to get out of the obligation and has a $2 loss. The return line to the put writer is flat at the level of the premium when futures are above the strike price, the line is kinked at the strike price, and decreases one-to-one with changes in futures prices below the strike price. Selling the put will be profitable if the market price is above the strike price, will lose returns as the market price drops below the strike price, and will generate a loss when the market falls more than $2 below $80.

[1]If the buyer of a put does decide to exercise the option and take a short position in the underlying futures contract, the responsibility to take the opposite position will be assigned to the seller of the oldest put with the same strike price, determined by the date and time of trade.

The same idea holds for selling the call. The writer receives the $2.00 premium. The $80.00 call has no value if the market price falls below $80.00/cwt. so the writer keeps the premium and has a $2.00 profit before commissions. The $80.00 call has value if the market price climbs above $80.00. The right to buy at $80.00 is worth $3.50 if the market price is $83.50. The writer must pay this to get out of the obligation and has a $1.50 loss. The return line to the call writer is flat at the level of the premium when futures are below the strike price, is kinked at the strike price, and decreases one-to-one with changes in the futures price above the strike price. Selling the call will be profitable if the market price is below the strike price, will lose returns as the market price increases above the strike price, and will result in a loss when the market rises more than $2.00 above $80.00.

The buyer of a put option has two alternatives if the underlying futures contract price drops below the strike price for which the option purchased. First, the put option can be sold at the increased option premium that will accumulate as the futures market moves below the strike price. ***The option does not have to be exercised and a position in the futures acquired for the price protection to work.*** The option is simply sold as the end of the production or storage period approaches, and the net from the option buy–sell actions offset losses in the cash position.

The second alternative is to exercise the option and take a short position in the underlying futures contract. Occasional circumstances dictate that you should exercise the option and accept a position in the futures market.

One such set of circumstances can emerge for commodities that do not have a cash settlement delivery provision for futures contracts. The exchanges specify an expiration date for the options that is several weeks before the expiration date of the underlying futures to allow time for all the logistics that can be involved in the delivery process. For example, the June live cattle futures contract expires in the third week of June, but the options on the June contract expire in late May. To contrast, the options on the feeder cattle contract, which is cash settled, expire the same month that the futures contracts expire. If a cattle feeder has animals that are slower to finish than expected and therefore will not be sold until early June, he or she may well decide to exercise the option on a $70 put and ask for a short position at $70 in the June contract. This would be a good decision if fundamental and technical analysis suggest that the market is going lower in late May and early June. Protection is then extended into June when the cattle finish and are ready to be sold in the cash market.

A second but less likely reason for exercising the option occurs when the option is in-the-money and approaching its expiration date, but fails to show the premium appreciation expected given the decline in the underlying futures contract. By exercising the option and taking a short position in the futures, at the strike price, the full value of the decline in futures can be realized. The short position in futures can then be bought back. However, this action will not typically be needed. ***Professional traders looking for arbitrage opportunities will ensure that the option value moves with the underlying futures as the maturity date of the option approaches.***

To illustrate, assume that the option premium for a $70.00 put option in live cattle has increased to $2.00/cwt. when the underlying futures are trading at $67.75/cwt. A knowledgeable trader could buy the $70.00 put for $2.00, exercise the option, take a short position at $70.00, and then immediately buy the contract back for $67.75. The gross return is $2.25/cwt. for an outlay of $2.00/cwt. which would net $.25/cwt. for each contract traded. The trader must also pay commissions but the $100/contract ($.25/cwt. × 400 cwt. / contract) of profit per contract traded would quickly be exploited by opportunistic floor traders. This process of arbitrage will push the put premium and the futures contract price up. Rational traders would do this until the profit does not cover commission costs.

One main reason for a trader not to choose to exercise an option is the associated increase in commission costs. Commissions on futures trades are assessed on the round-turn. For example, let's say a brokerage house charges retail customers commissions of $50 per contract. A trader who executes a trade will pay no commission until the trade is offset. But options are different. They may expire worthless. So our example brokerage house will charge something like $25 per contract when an option is bought and $25 per contract if the option is offset. Thus, if the option has intrinsic value at expiration, the trader's commission cost will be $50. If the options expire worthless, the commission is $25.[2] Now, instead of offsetting the option, suppose the trader exercises the option, takes a futures position, and then offsets the futures position. The commission costs will be $75, $25 from initiating the options position and $50 from offsetting the futures position. Generally, then, nonfloor traders do not worry about exercising options.

Options give important flexibility to users of futures markets. Concern over opportunity costs of entering futures hedges too soon at prices that turn out to be too low for a short hedge or too high for a long hedge is mitigated. Since the put option sets a price floor for the producer and the call option a cost ceiling for the user, the advantages of favorable prices or costs are still available to the buyer of options. In addition, the possibility of margins calls are eliminated. However, the purchase of an option requires payment of a premium, and the size of the premium is not inconsequential. The buyer of options can later sell them or allow them to expire worthless and no position in the futures market is required.

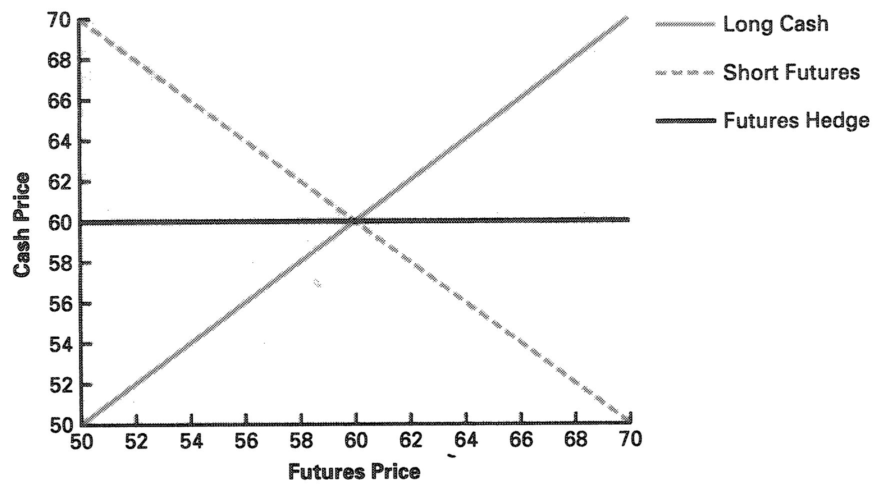
COMBINING CASH WITH FUTURES AND OPTIONS POSITIONS

This section examines the combination of cash, futures, and options positions. The results will typically be shown using a returns diagram. We will do this repeatedly through the remainder of the chapter, and it is useful to review the fundamentals of putting these diagrams together.

The purpose of the returns diagram is to communicate a lot of information in one place. The T-accounts in earlier chapters are useful for outlining and communicating the basic mechanics and ideas of a hedge. The mechanics are to sell in one market and buy in the other, and the concept is to offset losses in one market with gains in the other. However, we are now going to have to evaluate several potential strategies, not just compare a cash strategy to futures. We now have to add options to the mix and, potentially, options positions at different strike prices.

[2]Some brokerage houses charge the trader the second commission when the options expire worthless. It depends on the brokerage house.

FIGURE 7.4
Long Cash, Short Futures, and the Hedge Forward Price



First, as in the earlier section, futures prices are denoted on the horizontal axis and cash prices on the vertical. You may notice that in other texts profits are listed on the vertical axis. This is the case here as well. The profits are profits from options or futures positions. They are profits after offsetting the futures or options position, ***not profits that include costs from the production or storage of commodities***. Thus, the vertical axis can be viewed as cash prices or what we have been calling ***net prices***. The upward-sloping 45-degree line on Figure 7.4 represents the value of a cash position. It also captures the relationship between the cash and futures market. As futures prices increase, cash prices also increases. The price levels denoted on the horizontal and vertical axes are important. The difference in the two prices reflects expected or average basis between cash and futures markets. If the basis for a commodity and location is zero, the two axes will match identical prices. The main information that the line in the figure communicates is the value of the cash position. As the futures market increases, the cash market also increases, and the value of the cash position increases.

A short futures position is also included in Figure 7.4. The short futures position is a downward-sloped 45-degree line. If the trader takes a short position in the futures market and the futures prices increase, the value of the futures position will decrease. Combining the cash and the futures position through a hedge results in an asset position that holds its value regardless of changes in market prices. ***Losses in the cash market are offset by gains in futures and gains in the cash market are offset by losses in futures. The value of the hedge position is constant at the forward price chosen by the hedger.*** The hedge is thus a horizontal line on Figure 7.4 at $60.00/cwt. To combine the returns from different positions, the lines on the returns diagram are summed vertically. For example, when the cash position has a low value, the futures position has a high value and vice versa. A weakness of the diagram is that it does not communicate basis risk. The net price will be different from the forward price by the amount of basis error. We ignore basis error in all of the return diagrams.

Next, let's combine a long put option position (you have bought a put) and a long cash position to Figure 7.4. The new diagram is Figure 7.5. Purchasing a put option is similar to taking a short position in futures. As the futures price falls below the strike price, the value of the option position increases. As the futures price rises above the strike price, the option has no value. However, the premium paid must be considered.

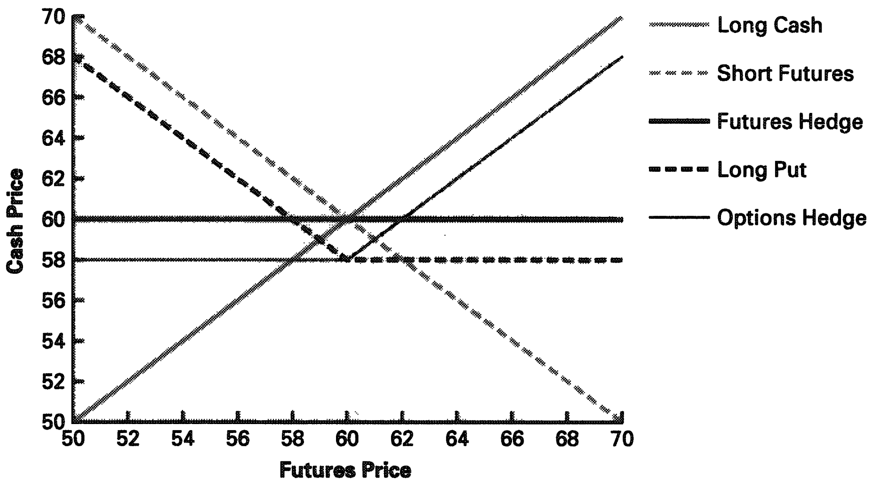


FIGURE 7.5
Long Cash, Long Put Option, and the Forward-Price Floor

Below the strike price, the combined cash and option position is similar to the hedge. However, it is below the hedge by the amount of the premium. Above the strike price, the combined cash and option position is similar to the cash market. The combined return is below the cash market by the amount of the premium. Purchasing a put option is similar to taking a short position in futures, but traders are limited in the amount of money they can lose in their brokerage accounts. They incur the maximum loss up front with the purchase of the option. The upside potential, it should be remembered, is greater than the premium cost.

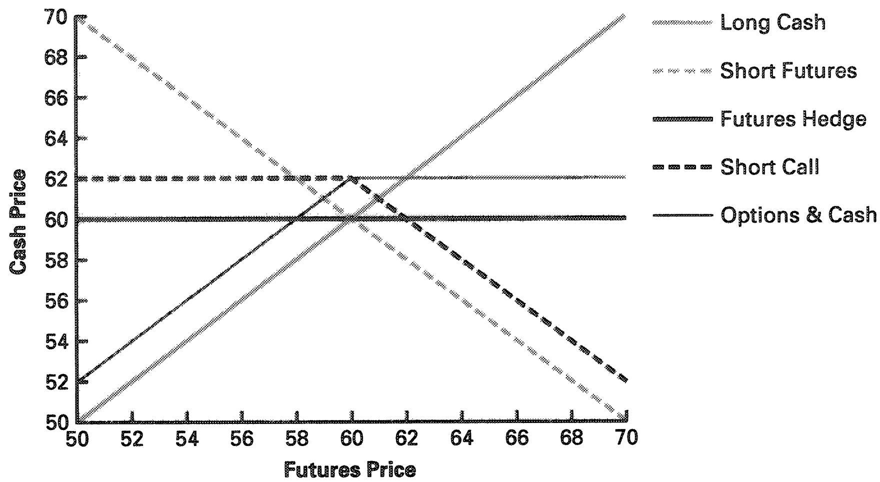
Look closely at the diagram. It illustrates the strengths and weaknesses of cash positions, positions hedged with futures, and positions hedged with options. *In a falling market, the position hedged with futures has the best outcome. In a rising market, the cash position has the best outcome.* But this is the problem. *We cannot know the outcome before we make the price-risk management decision.* This is risk. So we do the best we can by knowing the production costs of our business, and incorporating fundamental and technical analysis into our decision making. *But one of the two positions is going to result in a poor outcome.*

Options change this result. Options blend a cash and a futures position. *The options position is second best in both cases. Options never result in the best outcome.* But if markets change significantly up or down, they will also not result in the worst outcome. And this is a big "if." Examine the diagram. Do options ever result in the worst outcome? Yes, if market prices do not change. The options position results in the poorest outcome when the final market price is close to the strike price.

As a final example, let's combine a short call option position and a long cash position in Figure 7.6. Selling a call is similar to taking a short position in futures. As the futures price rises above the strike price, the value of the option position decreases. As the futures price falls below the strike price, the option has no value. However, in this latter case the trader receives the premium.

Above the strike price, the combined cash and option position is similar to the hedge. However, *it is above the hedge by the amount of the premium from selling the call option*. Below the strike price, the combined cash and option position is similar to the cash market. However, *the combined return is above the cash market by the amount of the premium*. Selling a call option is similar to taking a short position in futures, but the traders are limited in the amount of money they can gain. They

FIGURE 7.6
Long Cash, Short Call, and the Net Price



incur the maximum gain up front with the sale of the option. The downside potential is greater than the premium received. *This is not a hedge.*

Look closely at this diagram and compare it to the previous figure. Again, in a falling market, the position hedged with futures has the best outcome. In a rising market, the cash position has the best outcome. Options blend a cash and a futures position and are second best in both cases. But, now the options position has the best outcome if market prices do not change and the market price is close to the strike price. But, to achieve this good outcome, *the trader has no price floor. This strategy does not appear to be risk reducing.*

Return diagrams are important tools. We are vertically summing the lines that denote different asset positions. The picture then communicates the different returns to the trader under different market conditions—falling prices, rising prices, and scenarios in which price changes little. With a diagram, you can then start to think about picking the strategy that best fits your particular circumstances.

BASIC STRATEGIES FOR FORWARD-PRICING WITH OPTIONS

Using options to establish a forward price floor for producers and holders of commodities and a forward price ceiling for users of commodities is the objective of this section. More complex strategies are discussed in later sections. We will make use of returns diagrams to summarize the options strategies, but we now must be careful in numerically labeling the axes.

In simple terms, the buyer of a put option is looking for protection against falling prices and the flexibility of benefiting from higher prices. Assume a hog producer buys a $60.00 put option with a premium cost of $1.50/cwt. with the underlying October futures contract trading at $62.75/cwt. For ease in illustration, assume the expected basis is zero or that the producer sells hogs typically at a cash price that is very close to or the same as the futures price. Figure 7.7 shows the net price after

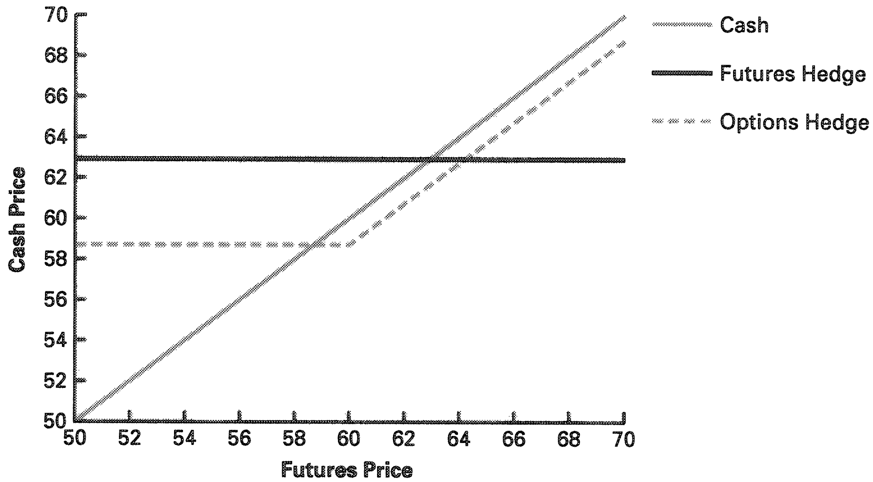


FIGURE 7.7
Net Price from Purchasing a $60.00 Put Option on Hog Futures Where Basis Is Zero and the Put Premium Is $1.50

accounting for the premium. The range of price chosen for the figure is from $50.00 to $70.00.

Note, in the figure, that the net price never goes below $58.50 as the market price, cash, and futures, move toward the $50 level. The price floor is at $58.50, or the $60.00 strike price plus basis of zero less the $1.50 option cost. The forward price floor (*FPF*) is calculated as follows:

$$FPF = SP + Basis - Premium$$

where

SP = strike price
Basis = expected cash-futures basis, and
Premium = option premium paid.

In this example, *FPF* = $60.00 + 0 − 1.50 = $58.50/cwt. If the expected cash-futures basis were not zero but −$1.00, then the forward price floor would have been $60.00 − 1.00 − 1.50 = $57.50.

The net price (*NP*) from the price floor strategy is the cash price received, less the premium paid, plus any premium or value that the option holds when the cash commodity is sold.

$$NP = Cash - Premium\ Paid + Premium\ Received$$

If prices fall, the $60.00 put takes on value. If the cash and futures market are trading at $54.00, the put will be worth $6.00. Thus, the net price is the cash price, $54.00, less the premium paid when the price protection was bought, $1.50, plus the current value of the option, $6.00, or $58.50. *The hog producer sells the hogs in the cash market and sells the $60.00 put option.*

If the cash and futures market rise above $60.00, the $60.00 put will be worthless at maturity. The net price received is the cash price less the premium paid. There is no premium received in this case. Suppose the markets rally to $68.00. The producer sells the hogs in the cash market for $68.00 and the $60.00 put expires worthless. No

TABLE 7.3
Net Prices from Selected Hog Marketing Strategies

Futures Price	Pure Cash	Hedge	Put Option Price Floor
$52.00	$52.00	$62.75	$58.50
54.00	54.00	62.75	58.50
56.00	56.00	62.75	58.50
58.00	58.00	62.75	58.50
60.00	60.00	62.75	58.50
62.00	62.00	62.75	60.50
64.00	64.00	62.75	62.50
66.00	66.00	62.75	64.50
68.00	68.00	62.75	66.50

Hedge and options were initiated when futures equals $62.75 and the $60.00 put premium equals $1.50. Expected basis equals $0.

price protection was needed and the option premium is much like the insurance premium on your health or your automobile. There are no positions in the futures market. However, the premium does reduce the net price. The net price received is the cash price, $68.00, less the option premium paid, $1.50, or $66.50.

Table 7.3 shows a simple comparison of strategies involving a hedge, a $60.00 put option, and a pure cash position. Figure 7.7 shows the hedge and the cash strategies along with the $60.00 put-option strategy. Above $60.00 the option strategy is superior to the hedge which forward-prices at $62.75. Below $60.00 the option strategy is superior to the cash position which falls with decreases in futures prices. However, the option strategy has the worst outcome if the market price is close to the strike price.

The same concepts and similar calculations are used to establish price ceilings for commodity users. The buyer of a call option is looking for protection against rising input prices and the flexibility of benefiting from purchasing at lower prices. Assume a cattle feeder buys a $2.80 call option with a premium of $.25/bu. on the underlying March futures contract trading which is at $2.80/bu. Expected basis is +$.20/bu. Figure 7.8 shows the net price (i.e., the cost) after accounting for the premium. The range of prices chosen for the figure is from $2.50 to $3.50. Notice the relationship between the futures price level and the cash price level. We have to be careful here to show the proper expected basis.

The price ceiling is at $3.25, or $2.80 plus +$.20 basis plus the $.25 option cost. The forward price ceiling (FPC) is calculated as follows:

$$FPC = SP + Basis + Premium$$

where

SP = strike price
Basis = expected cash-futures basis, and
Premium = option premium paid.

Note that the premium paid is added to get the price ceiling for a commodity to be purchased. The price floor is for a commodity to be sold. In this example,

$$FPC = \$2.80 + \$.20 + \$.25 = \$3.25/\text{bu.}$$

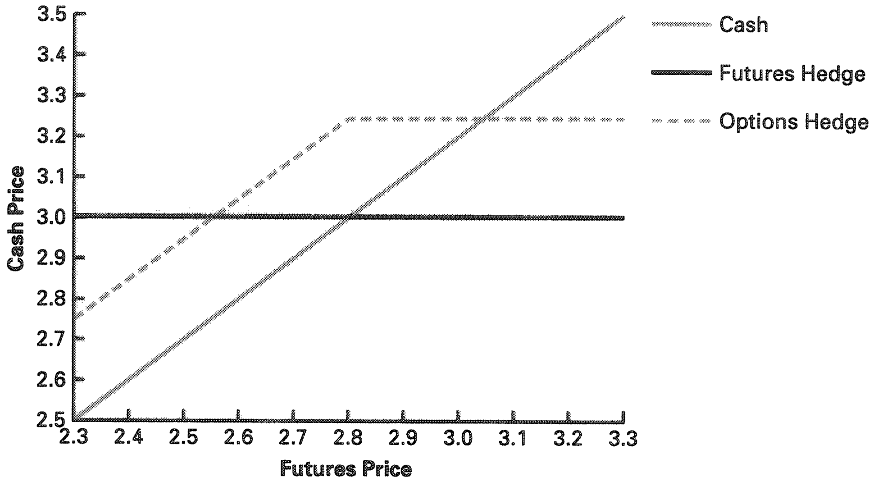


FIGURE 7.8
Net Price from Purchasing a $2.80 Call Option on Corn Futures Where Basis Is +$.20/bu. and the Call Premium Is $.25/bu.

The net price from the price ceiling strategy is the cash price paid, plus the premium paid, less any premium or value that the call option holds when the cash commodity is sold.

NP = Cash + Premium Paid – Premium Received

If prices rise, the $2.80 call takes on value. If the futures market is trading at $3.35, the call will be worth $.55. Thus, the net price or net cost is the cash price, $3.55, plus the premium paid when the price protection was bought, $.25, less the current value of the option, $.55, or $3.25. The cattle feeder buys the corn in the cash market and sells the $2.80 call option.

If the futures market falls below $2.80, the $2.80 call will be worthless at maturity. The net price paid is the cash price plus the premium paid. There is no premium received in this case. Suppose the futures market falls to $2.25. The cattle feeder buys corn in the cash market for $2.45 ($2.25 + .20) and the $2.80 call expires worthless. There are no positions in the futures market, but the premium does increase the net price. The net price paid is the cash price, $2.45, plus the option premium paid, $.25, or $2.70.

Later, we will examine more sophisticated options strategies that combine the use of both puts and calls in a single strategy. Go back through the examples if you are not ready to move ahead.

The forward price floor and the forward price ceiling are the most basic options strategies. To establish a price floor, the hedger purchases put options. The price floor is equal to the strike price of the put bought, plus basis, less the premium. A price ceiling is established by purchasing call options. The price ceiling is equal to the strike price of the call bought, plus basis, plus the premium. The net price for price floors or ceilings is the cash price received or paid net of the premium paid to purchase the options and any option premium received when offsetting the position.

COMPARING PRICE FLOORS, OR, WHAT OPTION TO CHOOSE?

The previous section went carefully through the steps of calculating the price floor, or price/cost ceiling, available via an option with a particular strike price, and then compared the returns to that option strategy with a cash or futures position. This section will examine price floors from several strike prices. Here, the usefulness of the returns diagram will become more apparent. Options are flexible and they offer many choices. The returns diagram is useful for evaluating the different choices.

Let's examine the price floor alternatives that a feeder cattle producer would have from the example in the beginning of the chapter. This feeder cattle producer has 700-pound calves coming off fall pasture in mid-November—it is early October now. The producer is worried about the fed-cattle market turning down and the corn market turning up. Both of these events will pressure feeder cattle prices lower. The futures and options markets are trading at prices reported earlier in Table 7.2. The expected basis for 700-pound feeder cattle is –$4.00/cwt. in mid-November. The hedge forward price is as follows:

Hedge Forward Price = $77.85 – 4 = $73.85/cwt.

Remember that the forward price floor for put options is calculated as follows:

Forward Price Floor = Strike Price + Basis – Premium Paid

The forward price floors for $76.00, $78.00, and $80.00 puts are therefore

FPF $76.00 Put = $76 – 4 – 0.55 = $71.45/cwt.
FPF $78.00 Put = $78 – 4 – 1.30 = $72.70/cwt.
FPF $80.00 Put = $80 – 4 – 2.57 = $73.43/cwt.

The $76.00 put offers less downside risk protection than the $78.00 or $80.00 puts, but we need to remember that because the strike prices and premiums are different, the upside potential is different as well. The $76.00 put has no value if the market price is above $76.00 at expiration. This means that the returns to this option strategy will follow the cash market more closely than the other two options if the market is above $76.00. Observe the returns diagram in Figure 7.9. The price floor for each option is the strike price plus basis less the premium. The price floor is in effect when futures are less than the strike price, the option has value, and gains in the option value offset losses in the cash position value. Above the strike price the put option has no value at expiration, and the option strategy return equals the cash market price less the premium.

The returns diagram facilitates easy comparison of different strategies and strike prices. While it is easy to observe and compare the returns, it is not easy to choose among the strategies. *There is no clear best option choice based on any objective measure*. "Best" depends on the individual producer's willingness to accept risk. *The puts with different strike prices offer different degrees of downside risk protection and different upside profit potential, but there is definitely an inverse relationship between risk protection and profit potential*. The option with the most downside protection, the $80.00 put, has the least upside potential. Likewise, the option with

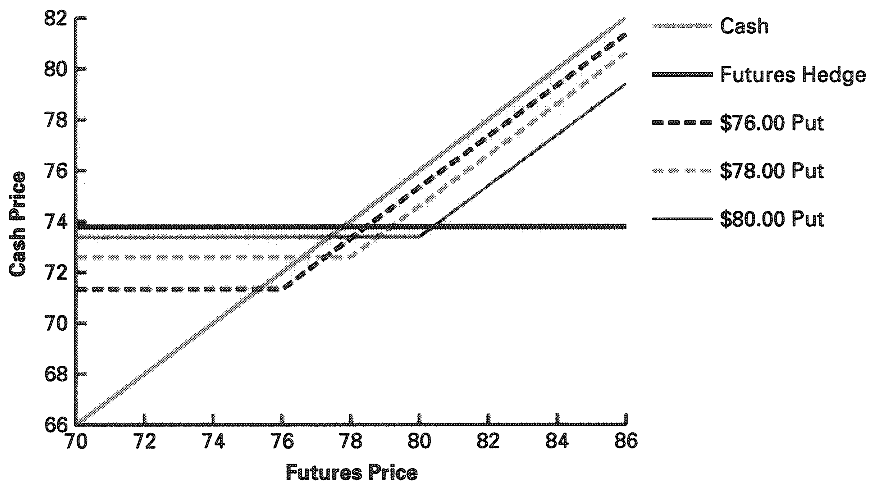


FIGURE 7.9
Feeder Cattle Price Floors with Different Put Option Strike Price Levels

the least downside protection, the $76.00 put, has the most upside potential. The $78.00 put offers an intermediate choice.

Options blend elements of cash positions and futures hedges and they offer flexibility. But there is no free lunch. Strategies with high price floors involve purchasing options that are well in-the-money. These strategies offer little upside potential and are relatively expensive. Strategies that offer good upside potential involve purchasing options that are well out-of-the-money. These options are relatively inexpensive but the price floor offers less protection. We also see the usefulness of the returns diagram. Five strategies were considered in an example, three put options, hedging with futures, and a pure cash position. The diagram shows the different returns under different final market prices, and the five strategies are easily compared.

WHEN TO USE OPTIONS

There is no question that options add attractive dimensions and flexibility to a producer's pricing program. Eliminating margin call problems and minimizing the opportunity costs of pricing too soon are attractive attributes. But it is important to recognize that a cost comes with this added flexibility. The buyer of the option pays the premium up front and that premium must be sufficient to attract a seller or writer to the market. *The option buyer is paying someone else to accept the exposure to market moves and margin calls that the option buyer is trying to avoid.* It follows, therefore, that options could be a relatively expensive way to price over time compared to other approaches.

The previous section explained rather clearly that there is no best option strike price to choose when establishing a forward price floor. The same thing holds for forward price ceilings. There is no best choice among the options using an objective measurement. This section discusses a framework for choosing among different options strategies. *There are logical economic factors to consider that will help you evaluate different options.* Just don't look for "the one right" answer. This section will also discuss when to choose hedging with options compared to hedging with futures contracts. This is a very common and practical question. There are basic procedures that can be used to help make this decision.

A "best" option strategy may emerge if you add other information to the question, or you place the different returns possibilities within the context of additional information. The most important factor to consider is your willingness to accept risk and your evaluation of the risk versus reward tradeoffs. A livestock and grain producer who is older, has well-established production and marketing systems, has little debt, has saved for retirement, and whose money is not tied up in the farming operation may rarely hedge through either futures or options. There is little need. Such a producer is used to accepting the risk associated with production agriculture and his or her financial situation, long-term or short-term, will not be hurt much if the current year is a bad outcome.

On the other hand, a young producer who is adopting new technology, has taken on large amounts of debt, and who has basically all of the family's resources tied up in the farming operation should seriously consider hedging. In fact, the bank that has loaned the producer most of the farm's capital may encourage or even require that the producer follow a hedging program. One or two bad price outcomes may create a financially insolvent operation. The producer may need to choose to live with many years of small positive returns and specifically avoid the large negative returns.

The first producer will want to participate mainly in the cash market. Think back to the returns diagrams presented earlier in this chapter, especially Figures 7.5, 7.6, and 7.7. This older producer can live with low prices, as long as there is also the possibility of high prices. The producer may also trade futures or options—or forward-price through cash contracts—but this will be done to exploit obvious profit opportunities. Futures and options trading, or cash contracting, is not something the producer will do every year or production cycle.

The second, younger producer will want to consider hedging aggressively. The younger producer will need to establish forward prices on much of the operation's production. This will be done mainly through the use of futures. Options price floors are always lower and this producer is interested in hedging much of the operation's production. The younger producer cannot wait for excellent pricing opportunities. Options may be purchased periodically when the price floor covers costs of production and an upside opportunity is present.

An entire spectrum of operations exists between the two example producers. And in that context, the rationale emerges for hedging a portion of production and marketing or hedging with more flexible pricing instruments, such as options. Producers with more intermediate financial conditions, debt, and willingness to accept risk will be the ones that find options attractive. Options offer downside price protection, but not as good as that of a hedge with futures contracts, while offering upside potential, but not as good as the cash market. Options are a tool that allows the producer to make forward-pricing decisions without guaranteeing that the decision will result in the best or worst outcome. If the price market moves away from the strike price, options will result in the second best outcome. Options are never the worst outcome, unless the market price trades close to the strike price level.

The discussion started out focused on risk and reward preferences. What is the producer's willingness to accept different levels of price flexibility? This influences whether he or she hedges at all, hedges aggressively, or chooses some intermediate ground. But the latter part of the discussion has taken on an element of price direction. ***What is the likely future direction of changes in market prices?*** The choice among cash, futures, and options for the producer with intermediate willingness to accept risk becomes clearer if you have an informed opinion about market direction. How do you become informed about likely future movements in price? The tools we used in previous chapters were fundamental and technical price analysis.

Whether the costs of an options-based program will exceed the costs of a futures-based program will depend on the characteristics of the underlying futures market. *In a choppy and sideways market, the options approach will tend to be more costly.* In a market with major and sustained price trends, in which significant margin calls can be involved, the futures-based program will typically be more costly on a per-unit basis in terms of actual cost outlays and/or opportunity costs.

Fundamental analysis can contribute to making informed choices among futures and options. The grain balance sheet is an important tool used to summarize supply and demand conditions in any grain market. Suppose an assessment of the corn balance sheet reveals that the grain stocks-to-use ratio is at its lowest level in 15 years. This was the situation in 1995 and 1996. At the same time, corn prices were trading at average levels. A small crop or strong demand could cause this market to move up significantly over the crop year. However, an excellent crop and weak demand could push prices down significantly below average. *This situation appears to favor the use of options over futures for hedging.*

Let's contrast this with the corn market situation that occurred in the mid-1980s. At that time, the stocks-to-use ratio was very high, approaching a ratio of 1.0 for some of the years. There is almost no upside potential in this type of market. Purchasing options would seem to be an expensive risk management choice. *The downside potential is far greater than the upside*, and it is actually much more likely that corn prices will stay at low levels. The best price-risk management strategy would then be to time forward sales on any rally and sell futures or use cash forward contracts.

Livestock producers can follow a similar decision-making process. The key is assessing the upside potential and the downside risk. A cattle feeder examines the most recent USDA *Cattle on Feed* report and finds that past placements into feedlots and the current inventory of cattle on feed were both above that of the previous year. It is likely, then, that future marketings will be large. But the feeder also reads that substitute meat prices are high, prices of pork and chicken, and that demand is strong. Further, feedlots are doing a good job of marketing cattle before they reach excessively heavy weights. While future cattle numbers will be up, the weight of those cattle are down compared to the previous year. How would you assess this market situation? The market appears to have upside potential *and* downside risk. *Thus, the cattle feeder would want to consider options.* Hedges with futures contracts would be a good choice if the market situation changes in that cattle feeders start holding finished animals to heavier weights. In this case, the market loses its upside potential.

The technical picture should also be included with fundamental analysis. Technical analysis often gives buy and sell signals before the information needed for fundamental analysis is released. Further, trend lines, support planes, and resistance planes often provide very basic and useful information about anticipated market directions. For example, it makes little sense to purchase an option price floor when the market is trading at a high level and is close to resistance at life-of-contract highs. There is little upside potential and the likely market move is down. This recommendation assumes there is no new fundamental information suggesting that new higher prices are warranted. It makes more sense to purchase a price floor when the market is trading at low levels yet is above support. Purchasing an option here may offer the producer peace of mind. The market is trending down and pressuring support. The producer missed the sell signals that occurred at higher prices before the downtrend began. The producer is also concerned about the market breaking through the support plane, perhaps a life-of-contract low support plane, and moving lower. It has broken minor support several times following the down-trend, and the price dropped quickly and significantly following each break.

Trends can also be worked into the decision of choosing between futures and options. Suppose the market price is trending up and then stalls. It has not broken the trend line but the producer is not convinced that the fundamentals warrant higher prices. The current market price (less the option premium) will cover production costs, so an option is purchased. The producer secures a price floor but if the technical up trend continues, the producer gains. Futures make more sense in a down-trending market. Upside potential requires a change in the technical picture. A good strategy is to hedge as the market price rallies to test the trend line. *One important thing to notice is that in all of the examples, there is always a blending of attitude toward risk and expected future price movements.* If the expected movements relative to the downside risk favor options, use options. Otherwise, use futures.

Advocates of selective hedging would argue that the producer does not have to endure substantial margin calls if the futures are used for hedging. When the market starts to rally, the short positions can be lifted. But a selective hedging strategy is not always easy to manage in practice. The producer has to be a good technical and fundamental analyst and must have the discipline to manage the selective hedging program effectively. Many producers will not be that effective in managing such programs. If that is the case, there are lots of reasons to argue in favor of an options-based program. If the market shows a sustained price rally, there are no difficult decisions to make. The put option expires worthless, and the producer benefits from any price rally that exceeds the option premium.

Pulling the points together, a general set of guidelines about the decision to use futures or options is as follows:

1. *Use options in markets likely to be characterized by large and sustained price moves.* If ending stocks are being reduced to a level that might force prices to rally significantly to ration usage, for example, options might be the preferred instrument in a price-risk management program. In livestock, the major price moves are often cyclical in nature. If prices are so low that some producers are liquidating breeding herds, any pricing for later in the year or the following year might be done with options in anticipation of a possible major price rally.
2. *Use options when there will be problems in arranging and financing a margin line.* The futures markets should *never* be used by decision makers who would have major problems financing margin calls.
3. Use options when the ability to manage a selective hedging program directly in the futures is questionable.

When do you use options instead of futures or cash marketing strategies? First, it depends on your willingness to accept risk and your evaluation of the risk and return. You must know your costs of production and marketing. Hedges with futures are the low-risk, and low-return, alternative. Risk and returns are both highest with cash strategies. Options are an intermediate choice, but hedging just a percent of expected marketings can also be an "intermediate" choice. Second, whether or not options are the "best" strategy also depends on

expected future price moves. Incorporate your futures-or-options choice with fundamental and technical analysis. Use options when the market offers upside potential or is expected to be volatile. Use futures when the downside looks most likely or there is little volatility. And remember, options are usually the second best outcome.

MORE ADVANCED OPTIONS TRADING

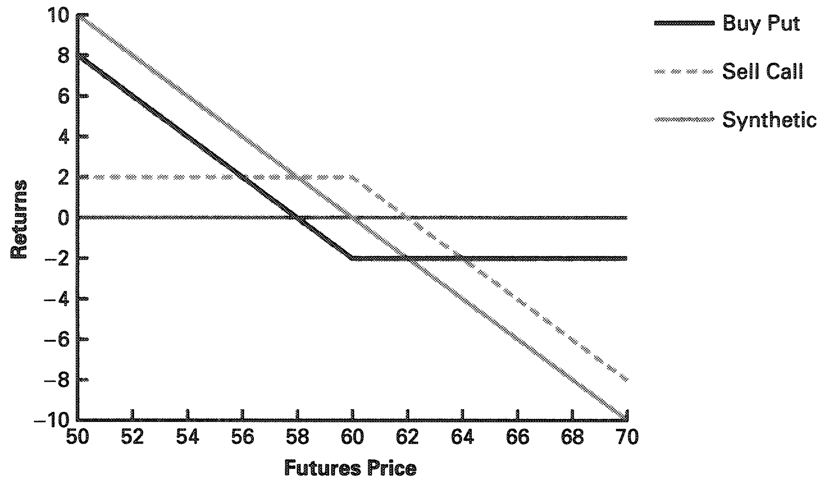
Three sections prior to this one, we introduced the returns diagram and illustrated the returns to purchasing puts and calls, and selling puts and calls. The options trading strategies were kept simple. We purchased either a put or a call, or we sold a put or a call. Later in the section, we combined these simple options strategies with a cash position. We will examine the returns to more advanced options trading strategies in this section and look at the returns from combining different options positions.

The point to this section is to illustrate basic options trading strategies. If you have any exposure to options or have read popular press articles on marketing strategies and outlook, you have no doubt seen a lot of fancy options strategies and terminology. These strategies include fences, windows, butterflies, straddles, strangles—the list is almost endless. People who write about options like to use jargon—words that don't really communicate. This section will present some of the most basic of these strategies and call them by their most common names. More complex strategies are usually variations of these. Some of the strategies are useful for hedging and the remainder are speculative. All strategies use puts and calls as building blocks. If you are going to trade options you need to be comfortable with their components. In addition, it is important to recognize the difference between strategies that are useful for hedging and those that are useful for speculation. If you understand the basic strategies, you will not fall into the trap that has caught producers who thought they were hedging but were actually speculating.

The first strategy involves purchasing a put and selling a call. The strike price is the same for both options ($60.00) and we assume the premium is the same at $2.00. Most of the time, this is a very reasonable assumption. Thus, the trader uses the premium received from the sale of the call to pay the premium on the put. At expiration, if the futures price is below the strike price, the call has no value and the put is in-the-money. If the futures price is above the strike price, the put has no value and the call is in-the-money. *This strategy is equivalent to taking a short position in the futures market and is often called a synthetic short hedge.* When combined with a long cash position, purchasing a put and selling a call creates a hedged position for the trader. However, without a cash position, the trader has a short position in the options market. If the futures price falls, the trader stands to make money, and if the futures price rises, the trader stands to lose. Figure 7.10 shows the results of this strategy for final futures prices from $50.00 to $70.00.

The trader can also create a synthetic long hedge in the options market. In this case, he or she purchases a call and sells a put. This is done at the same strike price ($60.00), and the put premium ($2.00) received is used to purchase the call. At expiration, if the futures price is above the strike price, the put has no value and the call is in-the-money. If the futures price is below the strike price, the call has no value and the put is in-the-money. This strategy is equivalent to a long position in the futures market. If the futures price rises, the trader will make money, and if the futures price falls, the

FIGURE 7.10
Synthetic Short Position Using Put and Call Options

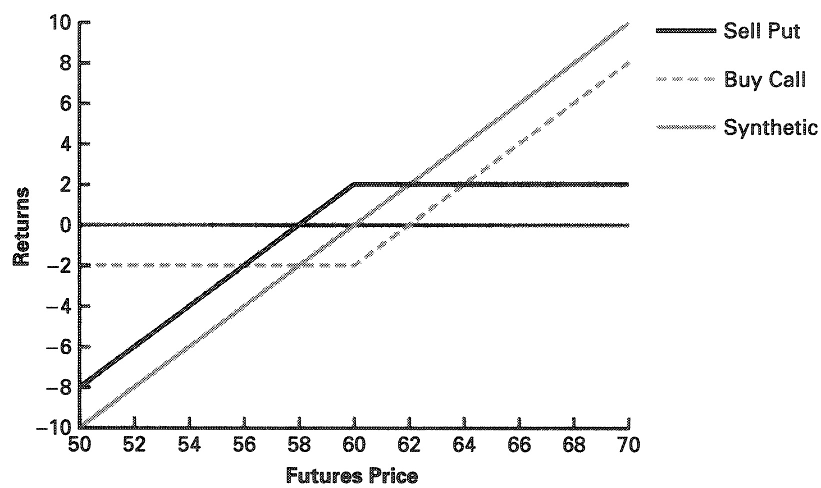


trader will lose money. However, when combined with a short cash position, purchasing a call and selling a put creates a hedged position. Figure 7.11 shows the results.

The main point that synthetic hedges illustrate is that options can be used as building blocks. They are more basic than futures positions and can be used to create a position that looks like a futures position. However, they are more flexible than futures positions. The following strategies illustrate this.

How important is it that the trader uses options with the same strike price in a synthetic position? It is easy to answer the question by looking at the returns diagram. Assume the trader wants to construct a short position with options and that he or she purchases a put with a lower strike price than the call being sold. Assume both of the options are out-of-the-money. This assumption is not important but it makes the discussion easier. If the futures market is between the two strike prices, then both options are out-of-the-money and the trader does not have a short position. The trader only has a short position if the market falls below the put strike price ($56.00) or rises above the call strike price ($64.00). This is illustrated in Figure 7.12.

FIGURE 7.11
Synthetic Long Position Using Put and Call Options



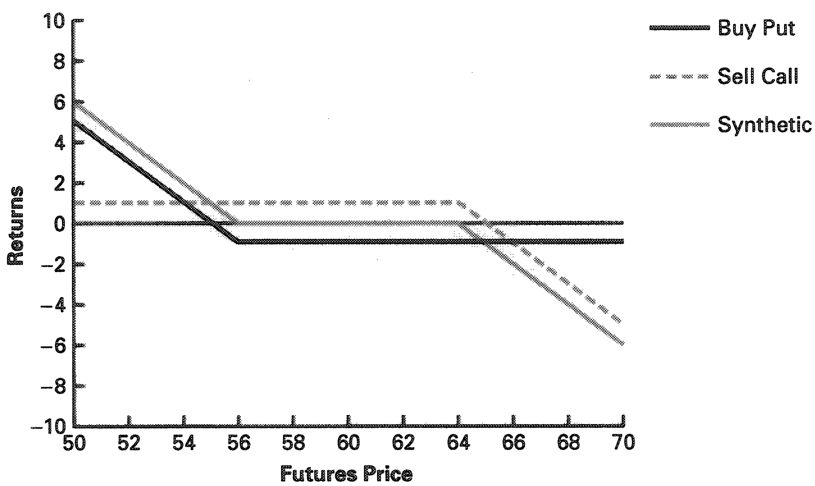


FIGURE 7.12
Synthetic Short Position with Different Strike Prices

The same thing occurs in the synthetic long position if the trader buys a call when the strike price is above the strike price of the put sold. The trader has a long position when the market is outside of either strike price and no position when the market is between the strike prices. This is illustrated in Figure 7.13.

What happens if the trader who is interested in a synthetic short position purchases a put with a strike price that is above the strike price of the call being sold? In this case, both of the options are in-the-money. In this case, the trader is essentially doubling the short position when the market is between the two strike prices. The trader has one short position if the market is below the call strike price and one position if the market is above the put strike price, ***but he or she has two short positions if the market is between the two strike prices.*** This case is confusing and would not be useful for risk management. None of the further discussion assumes that the trader uses options with strike prices that result in the position being doubled.

The next two types of strategies are useful primarily to speculators. The two strategies are called ***spreads*** and ***straddles***. The details and mechanics of these two strategies are not very important for traders interested in risk management. However,

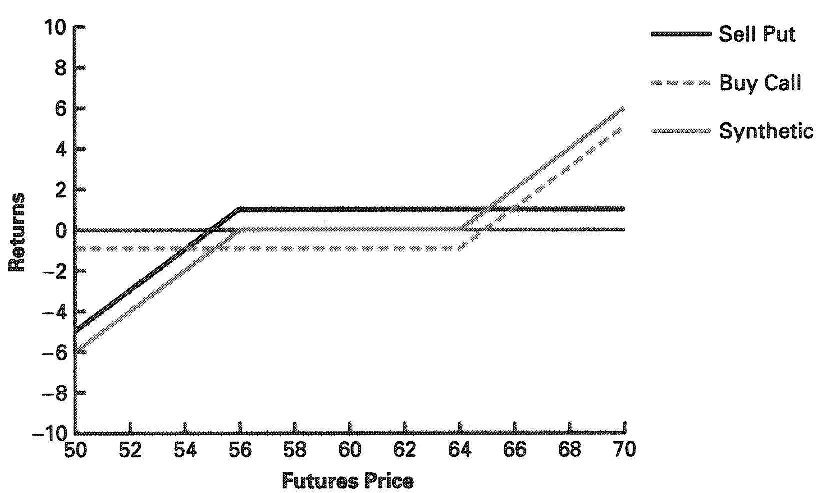
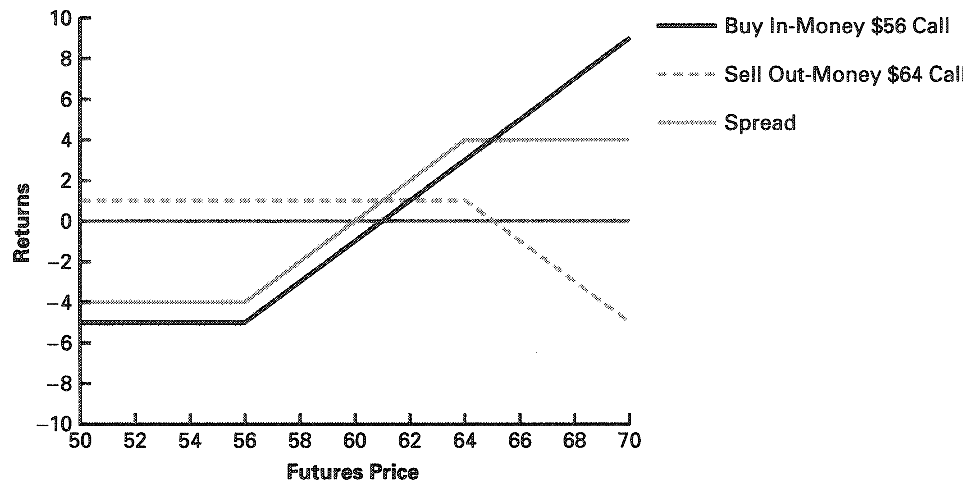


FIGURE 7.13
Synthetic Long Position with Different Strike Prices

FIGURE 7.14
Long Spread with Calls



they are useful for illustrating how options positions can be pieced together to construct a larger strategy. They are similar in construction to the synthetic hedges and provide alternative examples. You should read the examples with this in mind.

The first strategy discussed is a spread. Spreads can be long or short. These are often called bull or bear spreads. In a long spread, the trader purchases an in-the-money call at a low strike price and sells an out-of-the-money call at a high strike price. The two options positions and the combined position are shown in Figure 7.14. At expiration, if the futures price is below the low strike price, the trader loses money because the premium paid for the in-the-money call is greater than the premium received for the out-of-the-money call. If the futures price is above the low strike price but below the high strike price, the trader will make money as the intrinsic value of the long call and the premium received from the short call are greater than the premium paid for the long call. If the futures price is above the high strike price, the trader will make money if the intrinsic value of the long call and the premium received from the short call are greater than the premium paid for the long call and the obligation to pay the intrinsic value of the short call. An important thing to see with a spread is that ***the trader has a long position but the returns and losses are limited.*** If the market moves up, the trader will make money and if the market falls, the trader will lose money. But losses are limited to the net of the two premiums. To achieve limited losses the traders have limited gains as well.

The trader can also construct a long spread through purchasing put options. The strategy involves purchasing an out-of-the-money put at a low strike price and selling an in-the-money put at a high strike price. The two options positions and the combined position are shown in Figure 7.15. If the futures price is above the high strike price, the trader makes money because the premium received for the in-the-money put is greater than the premium paid for the out-of-the-money put. If the futures price is below the high strike price but above the low strike price, the trader will make money if the premium received from the short put is greater than the premium paid for the long put and the obligation to pay the intrinsic value of the short put. If the futures price is below the low strike price, the trader will lose money because the intrinsic value received from the short put will be less than the premium paid for the long put and the obligation to pay the intrinsic value of the short put. Again, the important thing to see with this spread is that ***the trader has a long position but the returns***

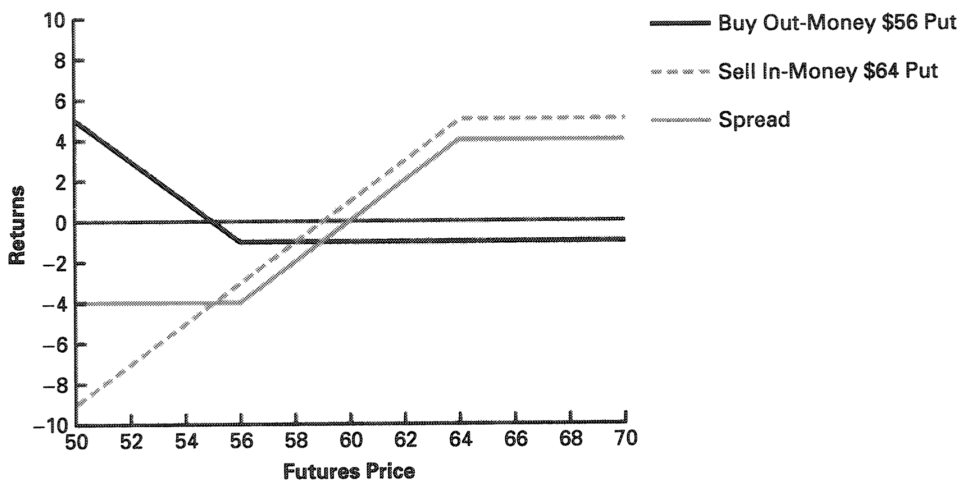


FIGURE 7.15
Long Spread with Puts

and losses are limited. If the market moves up, the trader will make money and if the market falls, the trader will lose money. But losses are limited to a net of the two premiums. Again, to achieve limited losses, the traders have limited gains as well.

Short spreads can also be constructed through trading two call options or trading two put options. Figures 7.16 and 7.17 illustrate the strategies. The strategies are very similar to the long spread. The difference is that the strategy reverses purchases and sales of in-the-money and out-of-the-money options. You should examine the return to each option and to the total strategy when the market price falls below the low strike price, is between the two strike prices, or is above the high strike price. You should examine both cases when either calls or puts are used. *The main point of the strategy is that a short position can be established and that this short position has limited loss potential.*

The second, and last, advanced trading strategy is the straddle and there can be long and short straddles. Spreads involve buying a put and selling a put, or buying a call and selling a call. Straddles involve buying a put and a call, or selling a put and a

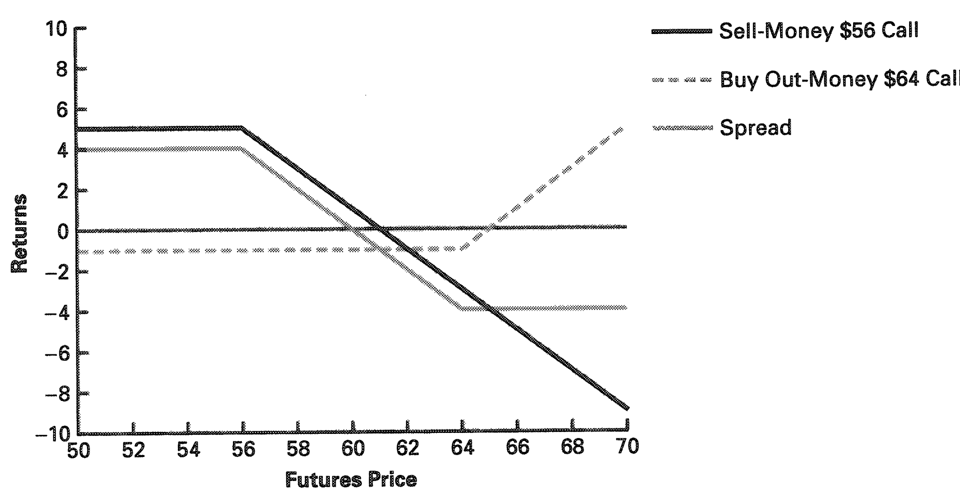
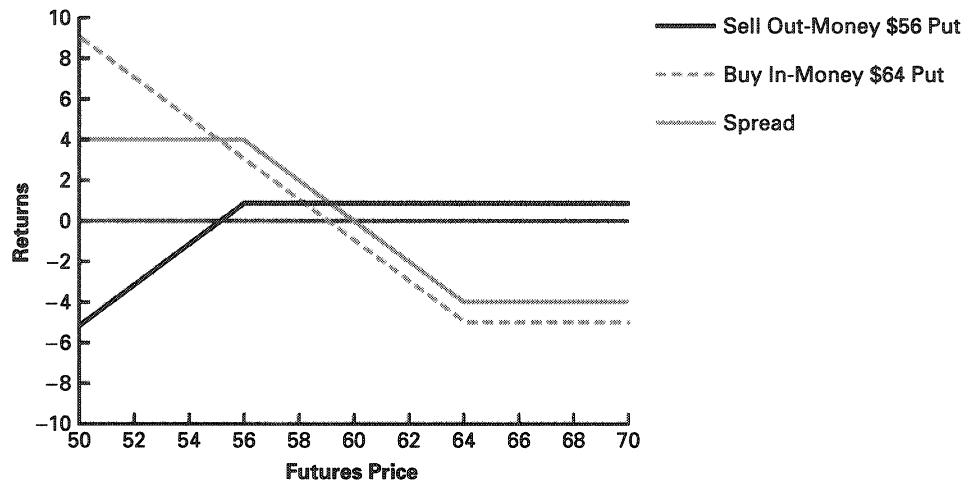


FIGURE 7.16
Short Spread with Calls

FIGURE 7.17
Short Spread with Puts

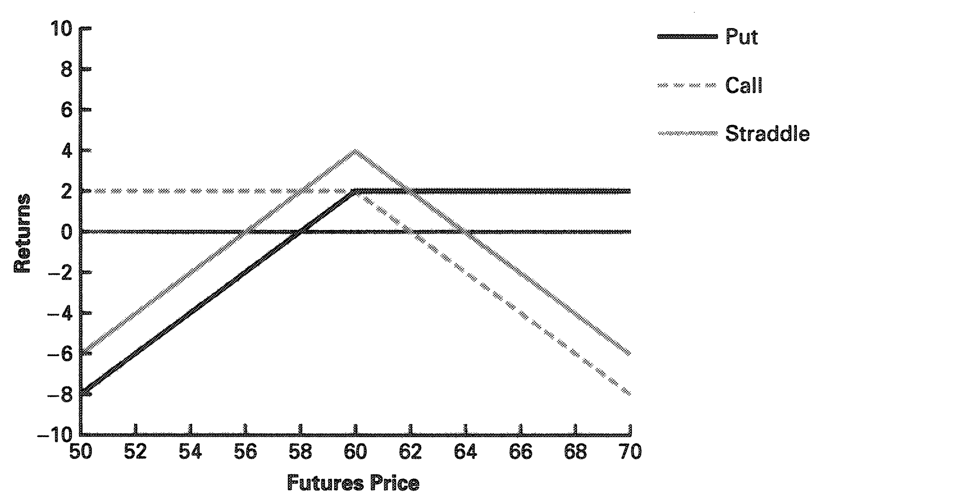


call. In a short straddle, the trader sells a put option and a call option. This strategy is illustrated in Figure 7.18. The put and call used both have the same $60.00 strike price. The trader obtains both premiums. If the market price at expiration is around the strike price, the trader makes money. If the market price falls or rises, the trader may lose. ***The market price must be different from the strike price by the amount of the combined premium before the position loses.***

The long straddle, illustrated in Figure 7.19, is just the opposite of the short $60.00 straddle. The trader buys a put and a call. The put and call used both have the same strike price. The trader pays both premiums. If the market price at expiration is around the strike price, the trader loses money. If the market price falls or rises, the trader may make money. ***The market price must be different from the strike price by the amount of the combined premium before the position makes money.***

The straddle strategy is attractive if the trader thinks the market will not move (short straddle) or will move sharply in either direction (long straddle). Further, the trader must perceive that these changes are likely relative to the level of the premium.

FIGURE 7.18
Short Straddle with the Same Put and Call Strike Price



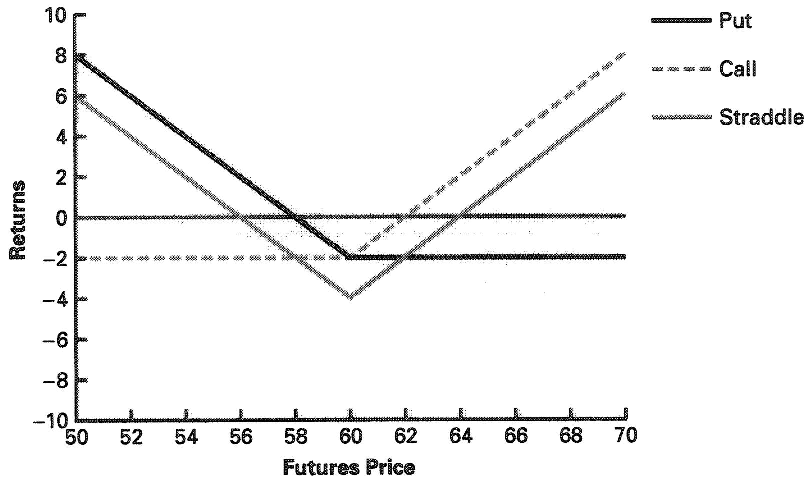


FIGURE 7.19
Long Straddle with the Same Put and Call Strike Price

In the short straddle, the trader perceives that both options are overpriced. The trader perceives that both options are underpriced in the long straddle.

How would the use of different strike prices change the straddle strategy? Again, we will place the call strike price above the put strike price to avoid doubling up the position. With the short straddle, the trader sells options which are both out-of-the-money. The trader receives a smaller total premium, but creates a larger range of futures prices where the strategy will be profitable. The same conditions hold for the long straddle. The trader pays a smaller total premium, but creates a larger range of futures prices where the strategy will not be profitable. Figures 7.20 and 7.21 illustrate these two straddles in which the strike prices are not equal.

The main point to learn from this section is the flexibility of options in putting together a position that will take advantage of different futures price movements, and consequently be exposed to different risks. Options can be used to construct positions similar to futures positions.

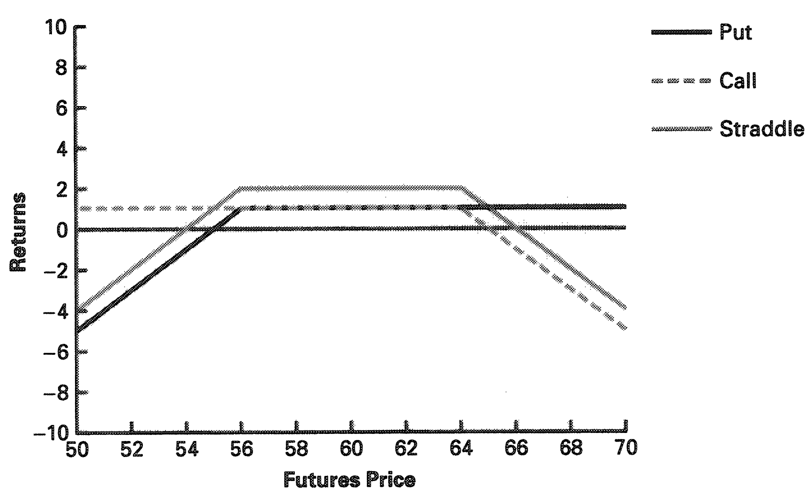
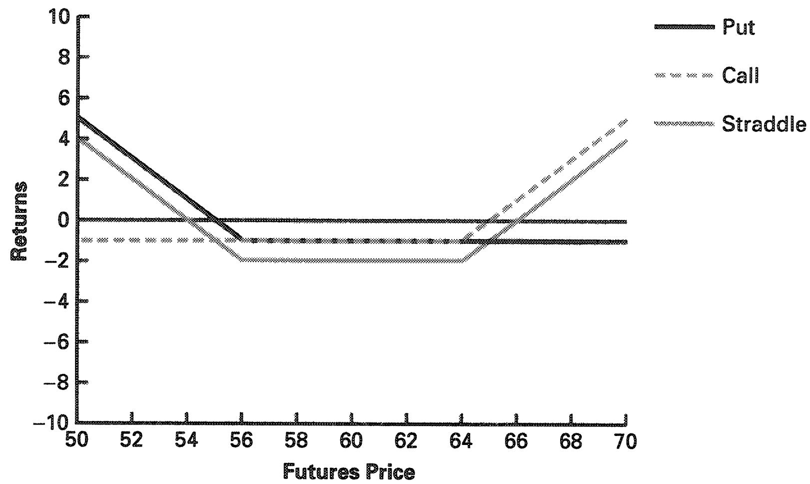


FIGURE 7.20
Short Straddle with Different Put and Call Strike Prices

FIGURE 7.21
Long Straddle with Different Put and Call Strike Prices



We can take long and short positions with different options. But unlike futures positions, an options position is not limited to a long or short position.

ADVANCED STRATEGIES FOR FORWARD-PRICING WITH OPTIONS

This section will introduce you to combining more complex options trading strategies with a cash position. However, our perspective is that of forward-pricing and risk management. *The combined cash and options strategy should provide protection against downward movements in price to owners of the cash commodity and should provide protection against upward movements in price to users that must purchase the cash commodity in the future.* Strategies that do not do this should be classified as speculative. We will present common strategies that are of this speculative nature.

In order for an options position or strategy to provide protection against adverse price movements, that strategy cannot result in limited gains or unlimited losses. The term *unlimited loss* is perhaps too strong, but the point is that large losses are possible within the probable range of prices. The most common combined cash and options strategy that has this characteristic is the *covered call*. In this example, the trader has a long cash position and sells a call option. The sale of the call, which is a short position, is thus "covered" by the long cash position. The trader receives the call premium and this premium is added to the cash price to determine the net price. The strategy is captured in Figure 7.22. The strategy is price enhancing if the futures price is close to the strike price at the option's expiration. Further, the strategy enhances the cash price if the futures market falls below the strike price. The call is worthless at expiration so the return to the option position is the premium received. *However, as a producer, you have no price protection. The net price is above the cash price, but the downward potential of the strategy has no floor.* Further, the upward potential of the combined position is limited. If the futures price rises above the strike price, the call writer has an obligation to pay the difference. This obligation places a ceiling on the net price.

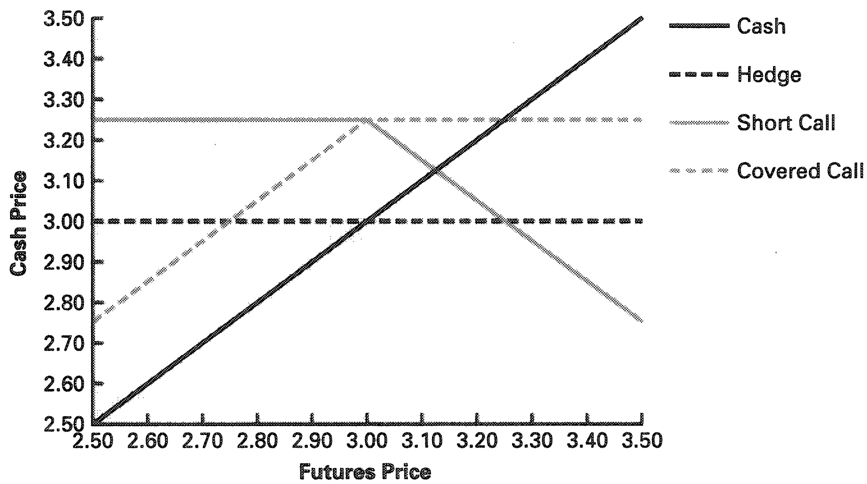


FIGURE 7.22
Long Cash, Long Call Option, and the Covered Call Net Price

Using a covered call strategy is not unreasonable. It is especially effective if the futures market is close to the strike price at expiration. Suppose the trader sells a \$3.00 corn call for \$.25 per bushel. Assume this option is at-the-money so the underlying contract is trading at \$3.00. If the market does not change between the sale and expiration, the producer adds the premium to the cash price received for the corn. Many years, the harvest period corn futures contract goes off the board at the price discovered in late August. ***You just need to recognize that it is difficult if not impossible to argue that this is a risk management strategy***. It is a ***return-enhancing strategy*** under some market conditions, but you are not protected from downside price risk. If the futures price falls to \$2.50, you will receive \$2.50 plus basis, plus the premium for the call. Likewise, if the futures price falls to \$2.00, you will receive \$2.00 plus basis plus the \$.25 premium. ***There is no floor other than the lowest price that can be discovered in the corn market.***

The limited upside potential of this strategy was part of the problem with the hedge-to-arrive (HTA) contract ordeal in the summer of 1996. The 1996 crop year saw corn prices rise to very high levels early in the spring, and in some areas of the country many producers entered into price-enhancing HTA contracts. After falling briefly off these record high prices, the markets then rallied higher on the news of poor growing weather, poorer than expected harvests, and strong demand. The call positions underlying these HTA contracts were losing money. The grain merchants that wrote the HTA contracts and offset them by selling call options received more and more margin calls. In many cases, they attempted to pass the margin calls on to the growers, and in any case, they required delivery of the grain to extract themselves from the strategy. Upon receipt of the grain, they could sell it at the high cash market price and pay the losses on the purchased calls. The remainder would be returned to the producer (less the grain merchant's margin) as per the contract. The producers had already received their premium from the calls.

Two problems emerged. First, ***many grain merchants could not meet the margin calls***. In some cases, banks forced several grain merchants into bankruptcy after covering the margin calls. Second, ***many producers could not, due to poor harvests, or would not, due to the low net price they would have received, deliver the grain required by the HTA contracts***. Producers complained in popular press articles that as the corn market approached \$4 per bushel, they were receiving less than \$3 for their corn under the HTA contract. All of the discussions of HTA contracts revealed that *a lot of producers do not understand the returns that come with a covered call strategy*. It is too bad that they had to learn the basic concepts the hard way.

In addition to the covered call, several options strategies discussed in the previous section have returns that are not useful from a risk management perspective. The short straddle is the most obvious choice. *The gains to this position are limited and the losses are unlimited.*

The long straddle is similar to a price floor and a price ceiling. For the producer or holder of a commodity, the purchase of a put provides downside price protection. Likewise, for the user of a commodity, the purchase of a call provides upside price protection. The second option in the position doubles up the returns to the cash position. For example, the call in a long straddle adds to the value of a long cash position. Similarly, the put in a long straddle adds to the value of a short cash position. The strategy may be useful from this doubling perspective, but it would be simpler to just purchase the type of protection desired.

Spreads, long or short, have little value for risk management. The gains to any spread are limited, as are the losses. It is good that the losses are limited, but we need the gains from the option position to offset the losses from a cash position. Thus, spreads are poor risk management tools.

The advanced options trading strategy that is the most useful, and the one we have only briefly discussed so far, is the synthetic futures position. The synthetic future position in which both options have the same strike price is not interesting. This position, long or short, can be obtained by selling one futures contract instead of two options, usually with lower commissions costs. The interesting strategy, and the strategy that cannot be obtained with a futures position, is the synthetic in which the strike prices are different. *This strategy is often called a fence or a window.*

The fence is a combination of a price floor and a covered call. You purchase an out-of-the-money put for downside price protection. You also sell an out-of-the-money call. *The call premium is used to offset a portion of the premium paid for the put.* While the call premium reduces the total cost of the floor price protection, it limits the upside potential of the combined cash and options position. A fence is contrasted with a price floor and a hedge in Figure 7.23. The feeder cattle futures contract price and premiums for options on feeder cattle futures contracts reported in Table 7.2 are used for the example.

The fence contains a price floor which is the put strike price, plus basis, minus the premium paid for the put, plus the premium received for the call. Assume the expected basis for 700-pound feeder cattle is –$4.00/cwt. in mid-November. The price floor is calculated as follows:

Fence Price Floor = *Put Strike Price* + *Basis* – *Put Premium* + *Call Premium*

The price floor for a fence with a $76.00 put and an $80.00 call is

Fence Price Floor = $76.00 – 4 – 0.55 + 0.45 = $71.90/cwt.

The fence price ceiling is the call strike price plus basis, minus the premium paid for the put, plus the premium received for the call. The price ceiling is calculated as follows

Fence Price Ceiling = *Call Strike Price* + *Basis* – *Put Premium* + *Call Premium*

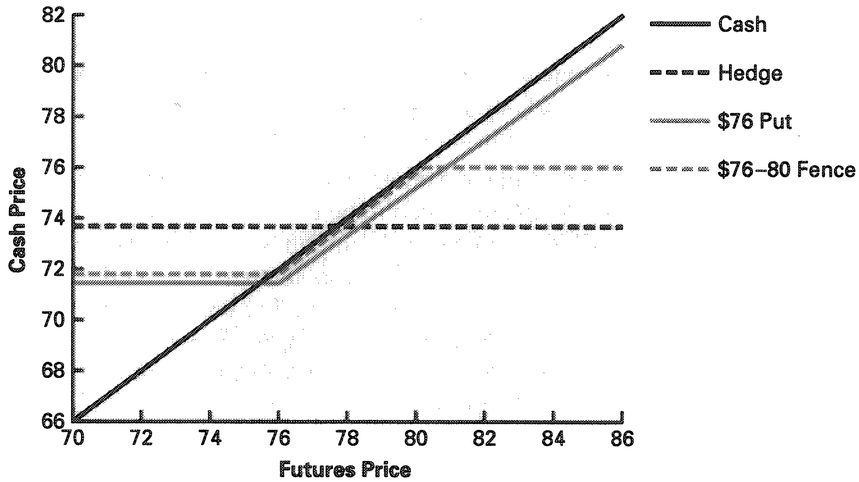


FIGURE 7.23
Fence, Price Floor, and Hedge Net Price Comparisons

The price ceiling for a fence with a $76.00 put and an $80.00 call is

Fence Price Ceiling = $80 – 4 – 0.55 + 0.45 = $75.90/cwt.

At expiration, the net price of the fence is the cash price, or the futures price plus basis, plus any premium that could be received by selling back the put, minus any premium paid buying back the call obligation.

Net Price = Futures Price + Basis + Net Put Premium + Net Call Premium

If the futures price falls below the put strike price, the put has intrinsic value and the call will be worthless. For example, if the futures falls to $72.00 then the $76.00 put will be worth $4.00 and the $80.00 call will be worthless.

Net Price = $72 – 4 + (-0.55 + 4) + (+0.45 – 0) = $71.90

Basis error will complicate this result. If the futures price rises above the call strike price, the call has intrinsic value that is an obligation and the put will be worthless. For example, if the futures rises to $86.00 then the $76.00 put will be worthless and the $80.00 call will be worth $6.00.

Net Price = $86 – 4 + (–0.55 + 0) + (+0.45 – 6) = $75.90

If the futures price is between the strike prices, both options will be worthless.

Net Price = $78 – 4 + (–0.55 – 0) + (+0.45 – 0) = $73.90.

We ignore basis error in these calculations. The producer is able to buy price protection below $71.90 for $.55, and $.45 of that can be deferred through selling a call. However, in addition to deferring $.45, the producer sacrifices price potential above $75.90.

These results are in contrast with the forward price offered by the futures hedge. The market is offering

Hedge Forward Price = \$77.85 – 4 = \$73.85/cwt.

This is the floor *and* the ceiling. Fences offer a lot of flexibility in terms of forward-pricing but there are trade-offs that need to be evaluated. A fence is similar to a price floor with a put option. The net price will not fall below a certain price. This allows the producer to manage risk. The fence is also similar to the hedge in that the producer gives up some of the upside potential. And the fence follows the cash market at more intermediate price levels. *There are no right or wrong choices with respect to choosing among the price floor, hedging with futures, and the fence. You need to assess perceived risks and opportunities, and make an informed choice among the alternatives.*

The concept of a fence is interesting because many agribusinesses use it in writing marketing contracts. The best example is with the hog industry. Over the late 1990s, almost all of the expansion in the hog industry has been through integrated operations. The most well-known of these are the firms that have built new production capacity in North Carolina and Oklahoma. These firms own the sow farrowing and meatpacking operations, and contract the feeding portion of the enterprise to other more geographically dispersed firms. The large integrated firm will then purchase the market hogs using a "fence" type pricing arrangement. The purchase price is tied to the futures price or some central cash market price. However, there is a price floor and a price ceiling. *These marketing contracts are essentially a combination of put and call options.*

Of the several good forward-pricing strategies that are more advanced than simple price floors or ceilings, the most useful is the fence. A fence involves the purchase of puts and sale of calls. The put establishes a price floor and the call sets a price ceiling. The premium received from the calls are used to reduce the cost of the puts. The key feature of a fence is that it provides downside price protection while allowing the hedger to capture benefits of price moves up to the call strike price.

OPTION PRICING WITH BLACK'S FORMULA

Mathematics is a powerful language, but it's not a language we use every day, and there are mathematical tools that most of us never use. However, a set of basic tools and formulas can be very useful for understanding why puts and calls are priced at the levels we see. For example, why is a \$78.00 put on November feeder cattle priced at \$1.30 per hundredweight in October? Why not \$1.00, or why not \$2.00? Is \$1.30 a good buy because it's too low, or should one sell it because it's too high?

A thorough understanding of the material covered in this section is not essential for making use of options in forward-pricing strategies. But the material is useful. The objective of this section is very similar to that of the chapters on fundamental and technical analysis. Fundamental and technical analysis are not essential for using futures to hedge. All you really need to understand is how to forward-price and basis. Rather, fundamental and technical analysis are important for understanding *why* we see the price levels and changes that we do. These analyses facilitate decision making. Likewise, this section is not absolutely essential for using options to hedge. It is helpful though, *in understanding the level and changes in options prices*. Technical analysis is relatively easy with its visual tools, and we used those tools mainly. It is harder with more mathematical tools, and much of technical analysis can be computerized. Fundamental analysis is relatively easy at some level. For example, it is straightforward to assess supply conditions from grain balance sheets and livestock reports. And, anyone with elementary training in economics can tell us the expected direction of price. If supply increases, then the price will fall. But the hard question is how much. This section asks the same question about options prices. Why do we see the premium levels and changes that we do? Answering the question "how much?" requires mathematics.

The simplest tool for calculating an option price is Black's Option Pricing Formula. The formula itself is written below. The user inputs a number of data variables and the formula returns a put or a call price. For example, we enter the strike price, the underlying futures contract price, a variable measuring volatility in the futures market, and the number of days before expiration, and the formula calculates an estimate of the premium. Before we consider the nuts and bolts of the formula, let's consider the concepts behind it. The mathematics look tough but they are actually summarizing a pretty simple idea.

Consider the following simple option example. You offer to sell to a buyer the right to receive $100 after observing the flip of a coin. The buyer must pay the premium for this right before the coin is flipped and if the coin lands heads-up, you will pay the buyer $100. If the coin lands tails-up, the buyer receives nothing. You keep the premium regardless of the outcome. For what value would you be willing to sell this option? First, we can bracket the answer. You would not offer the option for free, a zero premium. You will run out of money after a reasonably small number of coin flips. And you will not find anyone willing to pay $100 or more for such an option.

If you follow our thinking so far, you see that a fair price for the option is something close to $50. With a $50 premium, both sides can play the game without either side going broke in the long run. If you continue to follow our thinking, you would say, "I am not interested in being fair but in making money." So, you would want to sell the option at something above $50. However, you are in a room full of people trying to sell the same option to a large number of possible buyers. The pressure of competing for business brings your price down to something close to $50. *You would have to price the option at the expected value of its long-run payout*. There is a 50% chance of observing a head and having to pay $100, and a 50% chance of observing a tail and having to pay nothing. The expected value of the cost of obligation you are offering to pay in the option is thus $50. In a competitive market, the option price will roughly converge to this $50 premium.

The Black option pricing formula is basically the same thing. The real world of commodity prices is not as simple as the coin flip so the mathematics must be more complex to capture more of what is happening. In the real world, futures prices are the coin and there are more than two prices. What else is captured, and thus is important, in Black's Formula?

Four essential pieces of information go into Black's Formula.

1. The relationship of strike price to underlying futures contract price;
2. The amount of time before the option expires;

3. The volatility of the price of the underlying futures contract; and
4. The level of market interest rates.

We will consider each of these in turn after presenting the formula. We will discuss why each component is important and show through examples how each affects the option price.

Black's Option Pricing Formula for a call option premium is

$$C = e^{(-r \cdot t)} \cdot [FP \cdot cdfN(x_1) - SP \cdot cdfN(x_2)]$$

and Black's Formula for a put option premium is

$$P = e^{(-r \cdot t)} \cdot [FP \cdot cdfN(-x_1) - SP \cdot cdfN(-x_2)]$$

where

$$x_1 = \left[\ln(FP/SP) + (v^2 \cdot t)/2\right] / \left(v \cdot \sqrt{t}\right)$$

$$x_2 = \left[\ln(FP/SP) - (v^2 \cdot t)/2\right] / \left(v \cdot \sqrt{t}\right)$$

and

$cdfN(x_1)$ = standard normal cumulative density function evaluated at x_1
$cdfN(x_2)$ = standard normal cumulative density function evaluated at x_2
$e^{(\cdot)}$ = exponential function
$\ln(\cdot)$ = natural logarithm function

and

FP = price of underlying futures contract
SP = option strike price
v = volatility measure (%)
t = time to expiration (days/365)
r = risk-free interest rate (%).

We plug in values for FP, SP, v, t and r, and the formula returns an estimate of the premium.

Logarithmic and exponential functions are basic analysis tools and are programmed into all spreadsheets. Likewise, the cumulative density function is also programmed into commercial spreadsheet software. The normal distribution is characterized by two parameters, the mean and variance. The standard normal distribution has a mean of zero and a variance of one. The $cdfN(x)$ is the standard normal density function evaluated at the number x, which is

$$cdfN(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} \exp\left[-\frac{s^2}{2\sigma^2}\right] ds.$$

If we set $x = 0$, then $cdfN(x) = 0.5$. Find the function in a spreadsheet you have access to and test this. Likewise, if we set $x = 1$, then $cdfN(x) = 0.8413$ and if $x = -1$, then $cdfN(x) = 0.3413$.

Let's work an example of Black's Formula and generate option prices. Assume we are interested in the premium of a soybean put. The strike price is \$7.00 per bushel. and the underlying futures price is \$6.90 per bushel. Volatility is 25 percent, there are 90 days until expiration, and the interest rate is 6.5 percent. We will use cents per bushel instead of dollars per bushel for the strike price and the futures price, so

$$FP = 690,\ SP = 700,\ v = 0.25,\ t = (90/365) = 0.2466,\ r = 0.065,$$

thus,

$$x_1 = \left[\ln(690/700) + (0.25^2 \cdot 0.2466)/2\right] / \left(0.25 \cdot \sqrt{0.2466}\right) = -0.0538$$

$$x_2 = \left[\ln(690/700) - (0.25^2 \cdot 0.2466)/2\right] / \left(0.25 \cdot \sqrt{0.2466}\right) = -0.1780$$

$cdfN(-x_1) = cdfN(0.0538) = 0.5215$
$cdfN(-x_2) = cdfN(0.1780) = 0.5706$

so that

$$P = -e^{(-0.065 \cdot 0.2466)} \cdot [690 \cdot 0.5215 - 700 \cdot 0.5706] = 38.998 = 39.$$

Black's formula estimates that the \$7.00 put premium will be \$.39 per bushel. Notice that the strike price and the futures price were expressed in cents per bushel so the premium will also be in cents per bushel. The premium is expressed in the same units as the strike and futures price used in the formula.

Let's work a second example for a call option. We are interested in the premium of a soybean call. The strike price is \$7.00/bu. and the underlying futures price is \$6.90 per bushel. Volatility is 25 percent, there are 90 days until expiration, and the interest rate is 6.5 percent. So, the inputs are the same

$$FP = 690,\ SP = 700,\ v = 0.25,\ t = (90/365) = 0.2466,\ r = 0.065,$$

and x_1 and x_2 are the same

$$x_1 = \left[\ln(690/700) + (0.25^2 \cdot 0.2466)/2\right] / \left(0.25 \cdot \sqrt{0.2466}\right) = -0.0538$$

$$x_2 = \left[\ln(690/700) - (0.25^2 \cdot 0.2466)/2\right] / \left(0.25 \cdot \sqrt{0.2466}\right) = -0.1780$$

but the cumulative densities are evaluated at different points

$cdfN(x_1) = cdfN(-0.0538) = 0.4785$
$cdfN(x_2) = cdfN(-0.1780) = 0.4294$

and the premium formula is

$$C = e^{(-0.065 \cdot 0.2466)} \cdot [690 \cdot 0.4785 - 700 \cdot 0.4294] = 29.115 = 29.1.$$

Black's formula estimates that the \$7.00 call premium will be \$.291 per bushel.

Black's Formula is reasonably accurate and is used fairly often by commercial option trading firms. There is a large body of new research that has been devoted to generalizing Black's Formula to more accurately capture the observed options premium levels seen in commodity markets. This body of research is growing. All of this research has led to more mathematically complex equations for the pricing formula. Many of these formulas are not expressions like the above equations—it is not always possible in these cases to plug in numbers for the variables and calculate the premium. The premium must be solved for via numerical techniques and computer simulation. Our point in mentioning this is that the Black Formula is the simplest to use. You are encouraged to work through the mathematics. All other formulas are much more work.

The main use of Black's Formula is to evaluate what price to bid or offer for different options, or to evaluate the premiums bid and offered in the options market. For example, our earlier calculations suggest that a $7 put on soybeans should have a premium of $.39, if the underlying futures price is $6.90, volatility is 25 percent, the time to expiration is 90 days, and the interest rate is 6.5 percent. If a trader observes that the market for this put is trading at $.35 then the option is underpriced, and the trader should purchase the option. Likewise, if a trader observes that the market is pricing this put at $.45, then the option is overpriced, and the trader should sell the option. This would be a speculative strategy. ***It could also be used by producers or users of commodities to evaluate whether the options market is offering a good forward-pricing opportunity.***

A second use of Black's Formula would be to change various inputs and examine how these elements result in different premiums. These points have been discussed earlier in this chapter section, but only from an intuitive perspective. The formula will give us actual premiums and changes in premiums as we change the inputs. Thus, Black's Formula can be used from a learning perspective.

Refer back to the list of inputs that are used to calculate an option price. In addition to knowing whether we are pricing a put or a call, we need the strike price, the underlying futures price, time to expiration, volatility, and interest rate. The relationship between the strike price and futures price has been much discussed earlier in the chapter, so let's turn to the other factors.

Understanding the time decay of options premiums is important for successful use of options in forward-pricing strategies. Figure 7.24 shows the decay of the $7 soybean option with which we have been working. The put is $.10 in-the-money and the call is $.10 out-of-the-money. The lines represent premiums over the last year of the option and are calculated by holding the strike price at $7, futures at $6.90, and volatility and interest rate are held constant. The $7 put is $.70 at 365 days from expiration, $.35 at 70 days, and is $.14 at 5 days from expiration. The time decay is relatively smooth at first and then falls off more sharply as the option approaches expiration. Many beginning options traders learn the hard way that an option loses its value quickly as it approaches expiration.

The effects of increases in the volatility of the underlying futures contract are shown in Figure 7.25. Details about volatility and calculation of volatility are provided in the next section. It is an important topic in that volatility can have a major impact on the premium. So the volatility input that is used to estimate the premium is very important. The volatility that is used in Black's Formula is the standard deviation of the percent change in the price around its mean value. For example, in the soybean option example, a volatility measure of 25 percent was used. This is interpreted as follows. Two-thirds of the time, the underlying soybean futures price will change by 25 percent of its mean over the course of a year. If an average soybean price is $6.50,

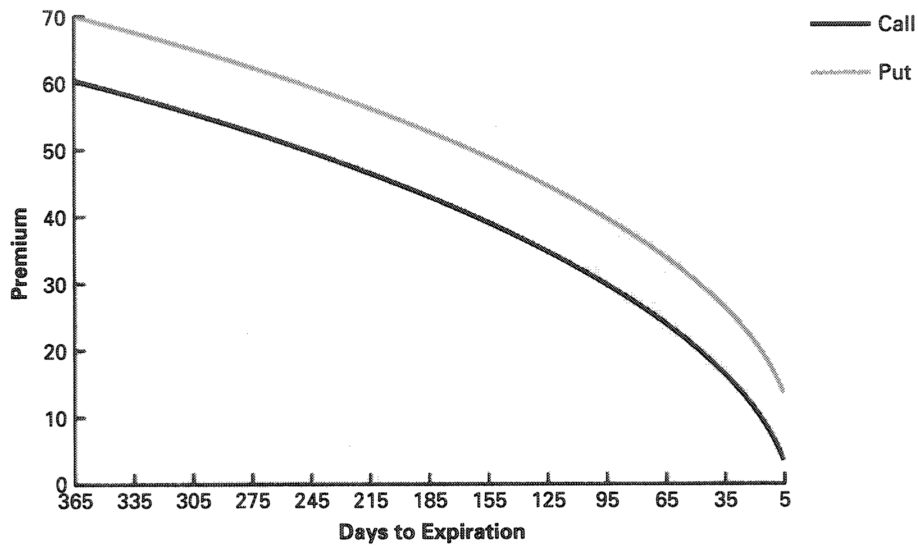


FIGURE 7.24
Time Decay of Options Prices

within a given year there is a two-thirds chance that the price will change by $1.625 or less. We see from Figure 7.25 that a doubling of volatility will double the premium, all else being constant.

Figure 7.26 illustrates the effects of changing interest rates on the premium. Interest rate has the smallest impact. The interest rate effect is an opportunity cost effect. The seller of an option receives the premium and this premium could be invested in an interest bearing account. The higher the interest rate, the more the seller makes from investing the premium. Sellers are able to offer options with lower premiums when interest rates are higher. We see in Figure 7.26 that as the interest rate increases from 7.5 percent to 10 percent, the put premium falls from just under $.39 to just over $.385. The impact is small, but the example is for an option that expires in 90 days. The impact is a little larger for options that are held longer.

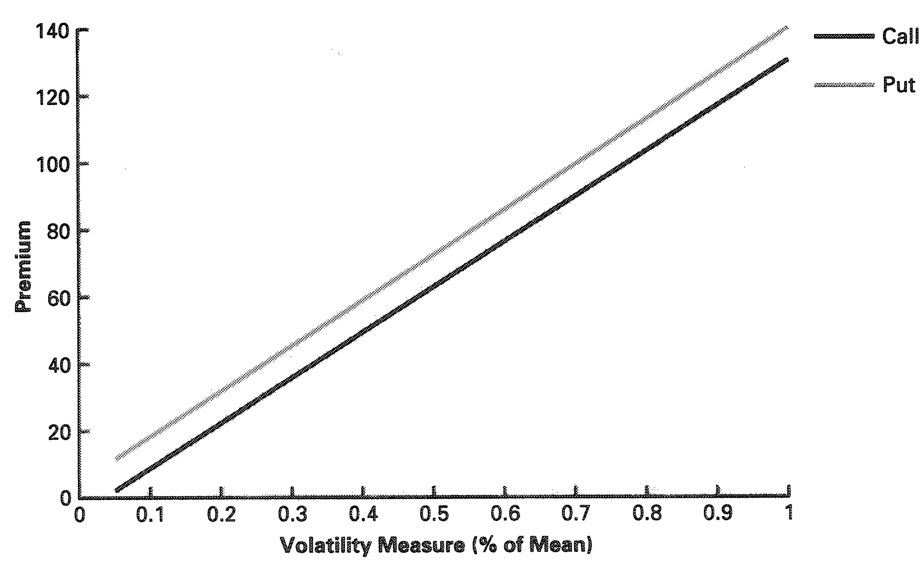


FIGURE 7.25
Effects of Futures Price Volatility on Options Prices

FIGURE 7.26
Effects of Changing Interest Rates on Options Prices

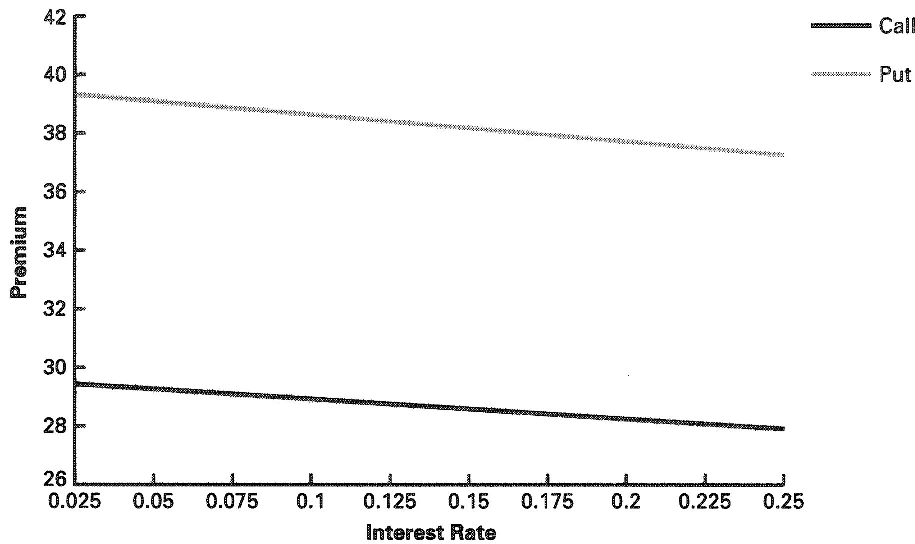
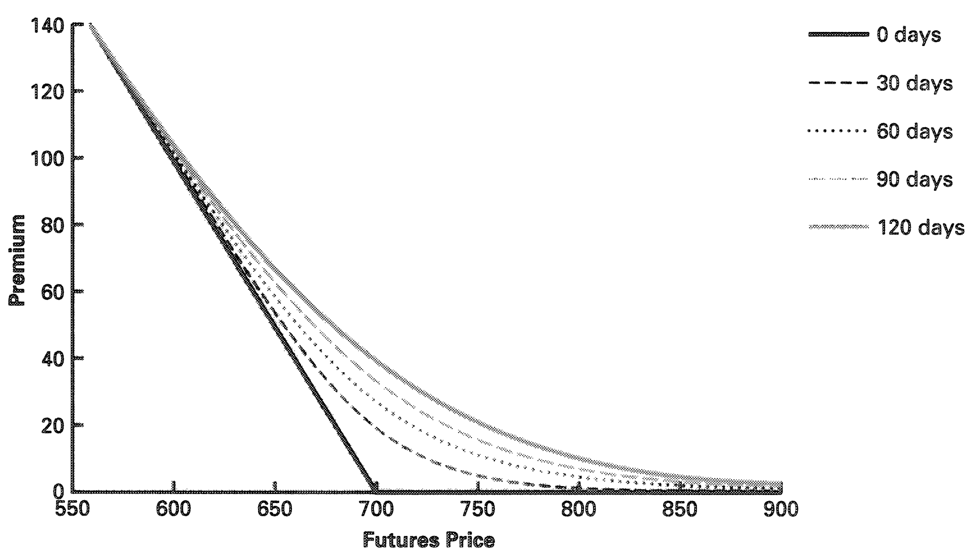


Figure 7.27 is one of the most important figures in the section. The figure is one of our familiar returns diagrams. It shows premiums for a $7 soybean put with different levels of the underlying futures price. It also shows the premiums for this put when futures prices take on different levels at different times to expiration. For example, when the put is at-the-money, remembering we are examining the premium of a $7 put, the put is worthless at expiration, the premium is 20¢ at 30 days from expiration, 28¢ at 60 days, 34¢ at 90 days, and 39¢ at 120 days. When the futures price is $8, the put is out-of-the-money and worthless at expiration, the premium is $.06 at 30 days from expiration, 3¢ at 60 days, 6.5¢ at 90 days, and 10¢ at 120 days. When the futures price is $6.50, the option is in-the-money and the premium is $.50 at expiration, 53.5¢ at 30 days from expiration, 59¢ at 60 days, 63¢ at 90 days, and 67¢ at 120 days. The figure summarizes a lot of the information about premiums, and how they

FIGURE 7.27
Options Returns Diagram with Different Days to Option Expiration



change as the futures price changes and how they change over time. You should spend some time on it.

Figure 7.28 combines the option premiums in Figure 7.27 with those of a cash position. We are vertically adding the premiums in Figure 7.27 to a 45-degree line. Figure 7.28 communicates the same information as Figure 7.27, only the returns are in terms of net cash prices and not option premiums.

Again, look closely at Figure 7.27, our familiar returns diagram. The line labeled 0 days to expiration is the option premium during the last trading day. This is the kinked return line that we have used so often, but we must remember that this is the return only on the last day of trading. Rarely will a trader in a hedging or speculative program carry an option up to the expiration date, so the option will have value when the trader liquidates the position. The familiar kinked line communicates the intrinsic value of the option. The vertical distant between this kinked line and the curved lines denotes the time value of the option. This time value is determined by the number of days before the option expires and the price difference between the strike price and the futures price of the underlying contract.

This remaining time value is important, and the figure communicates two things. First, when a producer lifts forward-price protection, the put option will almost always have some value. This is true even if the option is out-of-the-money. The option will only be worthless if it is out-of-the-money on the expiration day. Thus, net price calculations will almost always have some premium that is returned to the hedger.

Second, the difference between the strike price and the futures price of the underlying futures contract will change frequently and considerably over the life of the options contract. Figure 7.27 communicates how this will change the option premium. Think about a futures position first. The value of the position in futures changes one-to-one with changes in the contract price. A $.25 increase in the futures price will result in a $.25 loss on a short position and a $.25 gain on a long position. This point seems trivial, but compare it to the change in value of an options position at expiration. A $.25 change in the futures price will result in a $.25 change in the value of the option position only if the option is in-the-money. Otherwise, there is no change in the value. We are describing the slope of the lines in the returns diagram in Figure

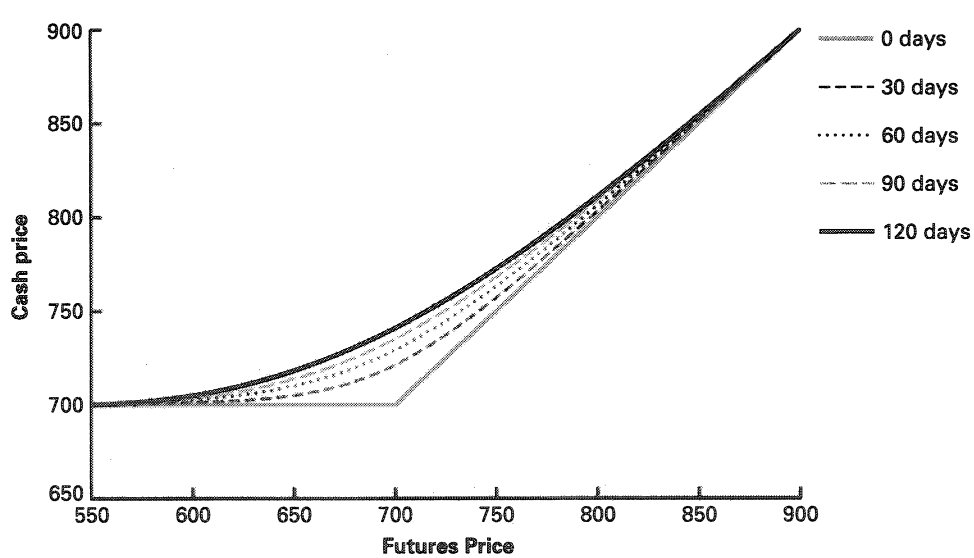


FIGURE 7.28
Returns Diagram for a Cash Position Which Includes an Option Position with Different Days to Options Expiration

7.27. The slope of the futures line is one (or minus one) and the slope of the option returns line at expiration is one (or minus one) or zero. However, we see from Figure 7.27 that if the option is not at the expiration date, the slope is usually not one, minus one, or zero. Rather, the slope is between the absolute value of one and zero, and *the option premium does not change one-to-one with changes in the underlying futures contract price*.

The concept of how options premiums change when the underlying futures price changes is called the *delta* by options trading professionals. Let's look closely at Figure 7.27 again. The option is a $7.00 put. Examine how the premium would change if the futures price, being well in-the-money, decreased from $6.00 to $5.75. Futures have decreased $.25 and the premium for this short position increases, depending on the time to expiration, by $.23 to $.24. The change in the premium could be the same if the futures price increased from $5.75 to $6.00. On the other hand, examine the change in the premium of an option well out-of-the-money, if the futures price increased from $8.75 to $9.00. Futures changes $.25 and the premium changed, again depending on the time to expiration, less than $.05. These are the extreme cases. The delta concept is more important for options that are closer to being at-the-money. If the futures price changes $.50 from $7.25 to $6.75, the option premium changes about $.25.

The practical implication of deltas being between one and zero is that option positions do not accumulate or lose value the way futures positions do. Options positions lose value more slowly and accumulate value more slowly. This can be an *advantage* or *disadvantage* to the hedger who uses options. The advantage will be discussed later in a strategy called "rolling up" price protection. The disadvantage is pretty straightforward. *If the producer has a long cash position and the cash and futures market prices are falling, the option position will not necessarily offset these losses one-for-one.* The only way to make sure that the option position offsets the cash position losses is to buy a put well in-the-money or buy a put that expires very close to when the cash position will be liquidated.

Black's Option Pricing Formula can be used to derive an equation for option deltas. Basically, the delta is the result of taking the derivative of the premium formula with respect to the futures price. The equations for the call delta (δ) and the put delta (δ) are as follows:

$$\textit{Call } \delta = cdfN(x_1)$$

$$\textit{Put } \delta = cdfN(-x_1)$$

whereas before

$$x_1 = \left[\ln(FP/SP) + (v^2 \cdot t)/2\right] / \left(v \cdot \sqrt{t}\right).$$

Using the $7 soybean put for an example, the volatility is 25 percent, there are 90 days until expiration, and the interest rate is 6.5 percent. We will choose three futures prices, one in-the-money, one at-the-money, and one out-of-the-money. The delta for this put when futures are at $6 is

$$x_1 = \left[\ln(600/700) + (0.25^2 \cdot 0.2466)/2\right] / (0.25 \cdot \sqrt{0.2466}) = -1.1797$$

$$\delta = cdfN(-x_1) = cdfN(1.1797) = 0.8809$$

or a 1¢ change in the futures price will result in a 0.88¢ change in the premium. When futures are at \$8, the delta is

$$x_1 = \left[\ln(800/700) + (0.25^2 \cdot 0.2466)/2\right]/(0.25 \cdot \sqrt{0.2466}) = 1.1377$$

$$\delta = cdfN(-x_1) = cdfN - (1.1377) = 0.1276$$

or a 1¢ change in the futures price will result in a 0.13¢ change in the premium. Last, when futures are at \$7, the delta is

$$x_1 = \left[\ln(700/700) + (0.25^2 \cdot 0.2466)/2\right]/(0.25 \cdot \sqrt{0.2466}) = 1.0621$$

$$\delta = cdfN(-x_1) = cdfN - (0.0621) = 0.4753.$$

A 1¢ change in the futures price results in a 0.48¢ change in the premium for this option when it is at-the-money.

We discussed the factors that influence option premiums in several of the previous sections of this chapter. This section provides more concrete information on how each factor and changes in each factor will impact price. Four essential pieces of information go into Black's Formula: (1) the relationship of strike price to underlying futures contract price, (2) the amount of time before the option expires, (3) the volatility of the price of the underlying futures contract, and (4) the level of market interest rates. With this information and Black's Formula, we can calculate the premium that should accompany any option. Further, we can change these pieces of information and examine the resulting changes in options premiums. Black's Formula provides a powerful and useful tool for pricing and understanding the pricing of options.

HISTORICAL VOLATILITY AND IMPLIED VOLATILITY

The volatility of futures contract prices is important in determining the proper price or premium for an option. The concept has a lot of intuitive appeal. *The more volatile a futures contract price is, the more likely the option will be to move into the money, and the higher the premium a writer or seller will want for that option.* Black's Option Pricing Formula clearly shows that as volatility increases or decreases, option premiums increase or decrease. Yet, we were not clear in the previous section on exactly how the volatility input used in Black's Formula was calculated. It will be covered in this section. The topic is reasonably difficult and subjective enough to warrant a separate section.

The treatment of volatility in options pricing is similar to the treatment of basis in hedging examples. In hedging examples, we used expected basis and actual basis. At the time the hedge is placed, the hedger forms a best guess at what the relationship will be between the cash and futures market on the date the hedge is lifted. It is usually calculated with historical data on cash and futures prices. However, the outcome of the hedge, whether or not the net price that was received equals the forward price chosen, depends on the actual basis at the time the hedge is lifted. A similar thing occurs with volatility.

We can use Black's Formula to calculate option premiums. We will need to put together an estimate of historical volatility. Data are gathered on past futures prices, and statistics are estimated that describe volatility. We use these statistics as best guesses about future volatility. Black's Formula will then tell us if current options premiums are too high, too low, or correct. Real world options prices may be quite different from that suggested by Black's Formula. This is because options premiums are discovered in a competitive open-outcry auction. Black's Formula is a model of the real world, and the model may not always describe how traders think. Also, different data can be used to calculate estimates of volatility. So instead of using historical volatility to calculate the premium, we could work backwards. We will use the actual premium and solve Black's Formula for the level of volatility implied by that premium. We can then compare the ***implied volatility*** to the ***historical volatility*** and see if the two measures are close in size or if the difference can be explained by supply and demand conditions.

The most common method of calculating historical volatility involves constructing a moving average of futures prices and calculating a standard deviation around that average. An example is presented in Table 7.4. A 21-observation sample of daily futures prices is used. A price ratio is constructed in which the price on the current day, day t, is expressed as a percent of the price on the previous day, day $t-1$. This is done for the whole sample and there are 20 ratios. The price ratio is then expressed in natural logarithm form. Look closely at the table. The natural logarithm function changes the price ratio to a series that shows the percent change from the previous

TABLE 7.4
Example Calculation for Historical Volatility in Corn Prices

Date	Price	Ratio	Percent Change (%Δ)	$(\%\Delta - \mu)^2$
9/1	$269.25			
9/2	272.25	1.0111	0.0048	0.000032
9/3	271.75	0.9982	−0.0008	0.000000
9/4	269.75	0.9926	−0.0032	0.000005
9/5	264.25	0.9796	−0.0089	0.000065
9/8	263.00	0.9953	−0.0021	0.000001
9/9	264.75	1.0067	0.0029	0.000014
9/10	267.75	1.0113	0.0049	0.000033
9/11	262.50	0.9804	−0.0086	0.000060
9/12	264.25	1.0067	0.0029	0.000014
9/15	365.75	1.0057	0.0025	0.000011
9/16	263.50	0.9915	−0.0037	0.000008
9/17	263.75	1.0009	0.0004	0.000002
9/18	264.50	1.0028	0.0012	0.000004
9/19	261.75	0.9896	−0.0045	0.000014
9/22	262.25	1.0019	0.0008	0.000003
9/23	262.25	1.0000	0.0000	0.000001
9/24	261.00	0.9952	−0.0021	0.000001
9/25	259.50	0.9943	−0.0025	0.000003
9/26	257.50	0.9923	−0.0034	0.000006
9/29	258.75	1.0049	0.0021	0.000009
Average/Sum			−0.0009	0.000287
Volatility				0.0606

day. This is a useful mathematical rule and trick. Next, we calculate the mean of the log ratio and use the mean to calculate the standard error of the 20-observation sample. The steps on this table are very easy to program into commercial spreadsheet software. The mean measures the average percent change in price between observations. For example, in Table 7.4 the average daily percent change in price is –0.09 percent. This is very close to zero so the market is not trending. Heuristically, the standard deviation measures the dispersion in the data. Sixty-eight percent of the percent price changes should be within the mean plus or minus one standard deviation. For example, 68 percent of the percent price changes should be within –0.0047 (–0.0009 – 0.0038) and 0.0029 (–0.0009 + 0.0038). The standard deviation of percent price changes is the measure of volatility in Black's Formula. However, the measure must be multiplied by 256, the number of business days in a year, to convert the daily measure to an annual measure. The formula for volatility is then as follows:

$$\sigma = \sqrt{\sum_{t=1}^{20} \frac{\left(\ln(P_t/P_{t-1}) - \mu\right)^2}{21 - 1} \times 256}.$$

The steps in Table 7.4 provide one measure for a 20-day period. A more complete data series on volatility would be constructed by dropping the last observation from the top of the table and adding a new observation to the bottom. This would be done for all prices in the life of the contract and would provide the trader with a history of volatility over the life of the contract. Likewise, the trader would need to calculate several series from different contracts. Traders need to develop this information or need to search out research that reports this information. It is essential and comparable to the hedger's need for basis information. With these estimates, the trader would then have a good database and knowledge about historical volatility. The trader is now prepared to use that information as inputs in Black's Formula.

A common alternative to the 20-observation moving average is a 30-observation sample. This illustrates the problem with historic volatility. There are a number of reasonable alternatives and there is no one right answer. Besides, if you are selling options, you would base your offers on expectations of future volatility, not just estimates of historic behavior. It *is* likely that the past will describe the future. For example, averages of past basis levels often do a very good job of predicting future basis levels. But practitioners should remember that this is what they are doing—using the past to make a best guess about the future.

Research and other reported information on futures price volatility are available but are not as voluminous as information on basis. But basis is different for every geographic region and season of the year, whereas volatility is measured on specific exchange traded futures contracts. Reasonable estimates of volatility are highly dependent on the commodity and season of the year. For example, soybean prices are much more volatile than corn prices. Wheat prices are more intermediate. Pork belly prices are very volatile, feeder cattle and hogs are next, and live cattle are the least volatile of the commonly traded livestock and meat contracts. Research on volatility tends to report average levels of volatility and then bounds. For example, corn volatility averages 20 percent, can fall as low as 10 percent, and can reach 30 percent to 40 percent in normal years. Drought years can increase volatility to 70 percent and 80 percent. The example time period used in Table 7.4 is not volatile, the measure is 6.1%.

Instead of calculating volatility measures using futures prices, some researchers use implied volatilities. Examine the inputs for Black's Formula in the previous section. All are well-known but one. The strike price is fixed for a given option, the futures price is reported, the time to expiration is known, and the proper interest rate level, while not very crucial to the problem, is easy to find. *The only thing that is tough is the volatility measure.* Instead of using historical futures price data, we could use the options price itself and solve Black's Formula backwards for volatility. This gives the level of volatility implied by the option price. We now have a large history of put and call premiums. This was not the case in the early to mid-1980s. This would be done for all premiums over the life of the option and would provide the trader with a history of implied volatility. Again, you would need to do this for options on many different futures contracts. With these estimates, you would then have a good database and knowledge from which to estimate future volatility and make options trades.

Calculating implied volatility is not as easy as calculating an option premium. Black's Formula cannot be inverted. We cannot solve for volatility as a function of the premium and the other factors. We have to use trial and error. Different volatility measures are used until the formula solves for a premium that is very close to that observed in the market. It is very easy to do this for a small number of observations on option premiums. Black's Formula usually needs to be evaluated four or five times. However, it is not a trivial exercise to do this for a large database. There are software programs which calculate implied volatility for large data sets and this data is also available from commercial data vendors.

Volatility to the options trader is as important as basis is to the hedger. And it is as hard to anticipate. We can use data to calculate historical volatility or use actual options prices to calculate implied volatility. Historical volatility is a moving-average calculation of the standard deviation of percent price changes from some previous number of days. It can then be used in Black's Formula to calculate options premiums. Implied volatility involves taking the option premium and solving Black's Formula backwards for the volatility measure. This is the volatility implied by the current price.

OTHER ADVANCED STRATEGIES FOR FORWARD-PRICING WITH OPTIONS

This last section in the chapter looks at combining options trading strategies with a cash position. The emphasis of this section is in making use of information gleaned from Black's Formula.

We learned about the delta factor in the section on Black's Formula. The delta measures the change in the option price given a change in the underlying futures contract price. Delta factors are somewhere between zero and one, but never reach zero or one except at the option expiration. An option that is well out-of-the-money will have a delta close to zero. Any change in the underlying futures contract price will result in almost no change in the option price. Because the option is so far out-of-the-money, there is little chance that the futures price will change enough that the option will move in-the-money. An option that is well in-the-money will have a delta close to one. Any change in the underlying futures contract price will result in essentially a one-to-one change in the option price. Any change in the futures price results in a change in the option's intrinsic value and this will be reflected in price. A delta less

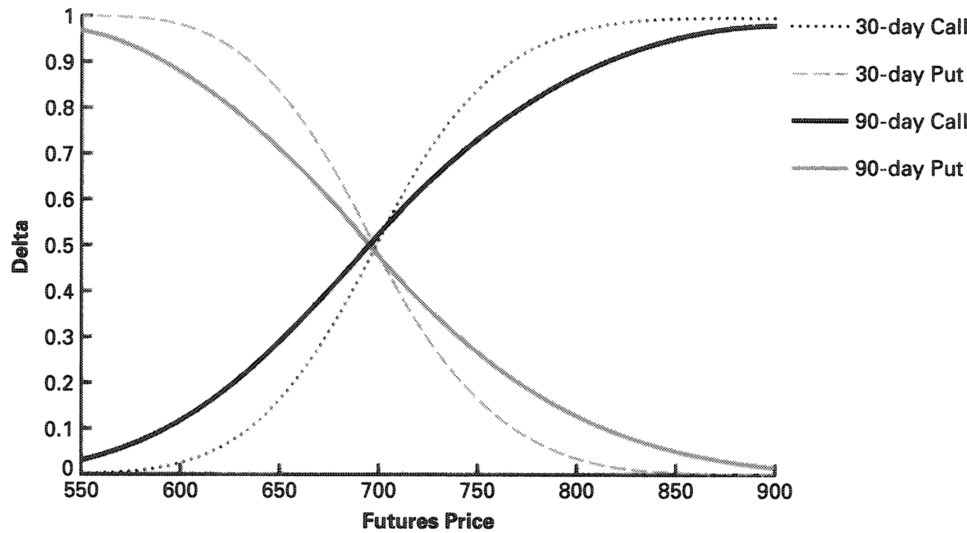


FIGURE 7.29
Deltas for Options That Are In-the-Money and Out-of-the-Money Different Amounts and Different Numbers of Days from Expiration

than one is a unique feature of options and is in contrast to that of futures. Figure 7.29 illustrates these relationships.

The "delta" for a futures contract is one. Any change in the futures contract price results in a direct change in the value of that position. The change in the value of an option position is less than one-to-one, however. As a hedger, you can use this to your advantage.

To illustrate, suppose a corn producer forward-prices his or her crop on the futures market. The December contract is trading at \$3.00, and assume the local basis is zero for ease in discussion. If the futures contract increases to \$3.20, the producer cannot lock in this new higher price. If the producer liquidates the hedge, the market must increase another \$.20 to \$3.40 before the producer can cover the \$.20 "loss," replace the hedge, and forward-price the crop at a net realized price of \$3.20. Even with fundamental and technical analysis, this is very difficult and it is certainly risky. To illustrate further, suppose the futures market increases to \$3.80. If the producer liquidates the hedge, the market must continue upward to \$4.60, enough to offset the \$.80 "loss," before the producer can replace the hedge with a net forward price of \$3.80. *Price protection from downside movements is also protection from upside movements when futures contracts are used*, and once the producer has pulled the pricing trigger, they have chosen a price. This is not the case with options.

Now, suppose as a corn producer you forward-price your crop with options. The December contract is again trading at \$3.00 and the local basis is zero. You buy a put option with a \$3.00 strike price for \$.40. The forward price floor is

$$FPF = \$3.00 + 0 - 0.40 = \$2.60.$$

If the futures contract increases to \$3.20, you or any other producer cannot lock in this new higher price exactly, but you can move the price floor up. The market has increased \$.20, but the options position will not have lost \$.20. The option started out with a delta close to one-half, and as the option moves out-of-the-money, the delta will decrease. The futures price changed \$.20 and the option premium will have fallen at least \$.09. This \$.09 change in the premium is due to the change in the futures price. However, time will have also passed so the put will lose time value. For this example, we will assume the put premium decreased \$.15. The hedger can sell back the \$3.00 put for \$.25 and purchase a \$3.20 put for \$.35.

The new price floor is the new strike price on the second put purchased. Refer to this as the new put, plus basis, plus the net premium of the first put which was offset, less the premium of the new put:

FPF = New Strike Price + Basis + (Net Premium Offset Put) – Premium New Put

or for the example

$$FPF = \$3.20 + 0 + (-0.40 + 0.25) - 0.35 = \$2.70.$$

The producer moved the price floor up \$.25 at a cost of \$.15, so the net increase in the price floor is \$.10. ***This is not possible with futures. To move the price floor up \$.20, it costs the hedger using futures \$.20.*** Let's continue with the example. Suppose the futures market increases further to \$3.80. The market price increases \$.60 but the put premium does not fall by that amount. In fact it cannot; the original premium was \$.35 and the maximum it can fall would be to zero. However, if the option has time value, it will not fall to zero. Assume the premium is \$.05. The producer can sell the put option back and again replace the hedge by purchasing another put option at a higher strike price. Suppose the hedger purchases a \$3.80 put for \$.20. The new forward-price floor is tied to the new strike price on the third put purchased. This is now the new put, plus basis, plus the net premium of the first and second puts both of which were offset, less the premium of the new put. For the example,

$$FPF = \$3.80 + 0 + (-0.40 + 0.25) + (-0.35 + 0.05) - 0.20 = \$3.15.$$

This options hedging strategy exploits the delta. The hedger is able to move the price floor because the loss to the options position is less than the gain in the futures market. The loss in the options market will equal the gain in the futures market only at expiration.

This strategy is called delta hedging, roll-up hedging, or rolling-up price protection. It requires the hedger to understand how delta and time decay impact the premium for options. These concepts are captured well by Black's Formula.

Black's Formula was also used to calculate the premiums in Figure 7.27 and the net cash prices in Figure 7.28. The formula can be used to anticipate changes in premiums and net prices from forward-pricing strategies.

The fact that options prices do not change one-for-one with changes in the underlying futures contract price can be used by the hedger to his or her advantage. Hedgers can replace lower price floors with higher price floors and the cost is not as great as the improvement in price protection. This is not possible in futures—the cost is equal to the improvement in price protection. This options strategy is called delta hedging and is revealed in Black's Formula.

DISTRIBUTION OF FUTURES PRICES AND RETURNS TO HEDGING

This final section of the chapter discusses a couple of points about probability distributions and their use. ***It is optional reading and is not essential to later chapters.*** Probability distributions are essential for options pricing. The example of the coin-flip option and the use of the standard normal cumulative density function should illustrate this. Black's Formula makes an assumption about the distribution of futures prices and futures price changes to derive the premium. It is important for you to recognize this. Generalizations of the assumption will change the formula and it is likely that future research will do this. In addition to their use in options pricing, probability distributions can be used to summarize the risk-reducing properties of hedges with futures contracts and options on futures contracts.

First, we will introduce and discuss the basics of distribution functions. Figure 7.30 illustrates the familiar bell-shaped curve of the normal distribution. The function we are graphing is the following:

$$pdfN(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right]$$

where we graph over different values of x. The normal distribution is summarized by the mean μ and standard deviation σ of the underlying random variable. For example, if price is the random variable, the distribution communicates that we will observe low values and high values of the price less frequently than intermediate values. The observations tend to be centered around the mean, which is another way of saying that the mean is the measure of central tendency. The standard deviation measures the dispersion in price around the mean. The larger the measure, the more variable price observations will be.

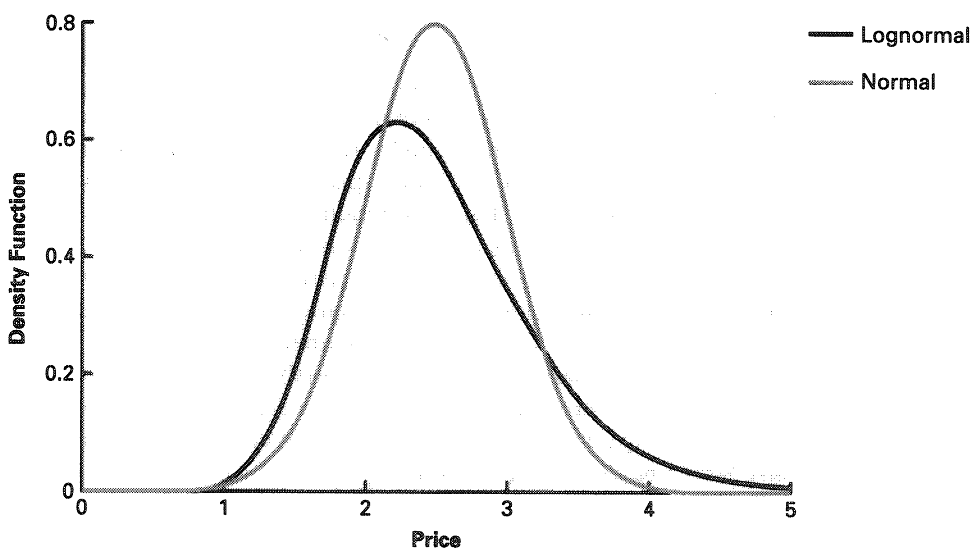


FIGURE 7.30
Normal and Lognormal Probability Density Functions

The density function has the appearance of a histogram. However, you should be careful in inferring probabilities from the function. They cannot simply be read off the vertical axis. The function must be examined over an interval. For example, the probability of observing a price less than the mean is

$$Prob(x \leq \mu) = \int_{-\infty}^{\mu} \frac{1}{\sigma\sqrt{2\pi}} \exp\left[\frac{(s - \mu)^2}{2\sigma^2}\right] ds.$$

This is the area under the curve to the left of the mean. Actually integrating this function is difficult. However, all commercial spreadsheet software have functions that will perform this task, given values of μ, σ, and the range for which you are interested.

While the bell-shaped normal distribution is used for many examples of random variables, this distribution does not describe futures prices satisfactorily. An alternative, which was used to develop Black's Formula, is the lognormal distribution. This distribution is also illustrated in Figure 7.30 to contrast it with the normal distribution. The function we are graphing is as follows:

$$pdfLN(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{\left(\ln(x) - \mu\right)^2}{2\sigma^2}\right]$$

where

$x > 0$.

The lognormal distribution is slightly skewed. The mode, the most likely value, is to the left of the mean. Low values are more likely than high values, but we are more likely to see very high values than very low values. Commodity prices fit this distribution better than the normal distribution. Think of corn prices as an example. The average price is around \$2.50. A reasonable but very low price would be \$2.00. A reasonable but very high price would be something larger than \$3.00, possibly \$3.50. Commodity prices tend to follow skewed distributions.

Black's Formula assumes commodity prices follow a lognormal distribution. However, the normal distribution is used in the premium equations. Why is this? The reason is that if commodity prices are assumed to follow a lognormal distribution then the logarithm of the price follows a normal distribution. To see this, examine the equations defining x_1 and x_2 in the section on the formula. The formula makes a more realistic assumption about the distribution of futures prices, yet is able to use the well-known standard normal cumulative density function.

Our final use of distribution functions in this section will be to describe the distribution of a producer trading commodities in the cash market, in the cash and futures market, and in the cash and options market. Figure 7.31 illustrates the three sets of returns. For simplicity, we use the familiar bell-shaped curve. The distribution of cash returns is our base for comparison. Read the zero on the horizontal axis as average returns and deviations from zero as above or below average returns. The cash distribution has a mean and experiences above- and below-average realizations. The producer may make large profits or experience large losses.

The combined cash and futures returns are much less disperse. The producer forgoes the opportunity of large profits in return for removing the downside poten-

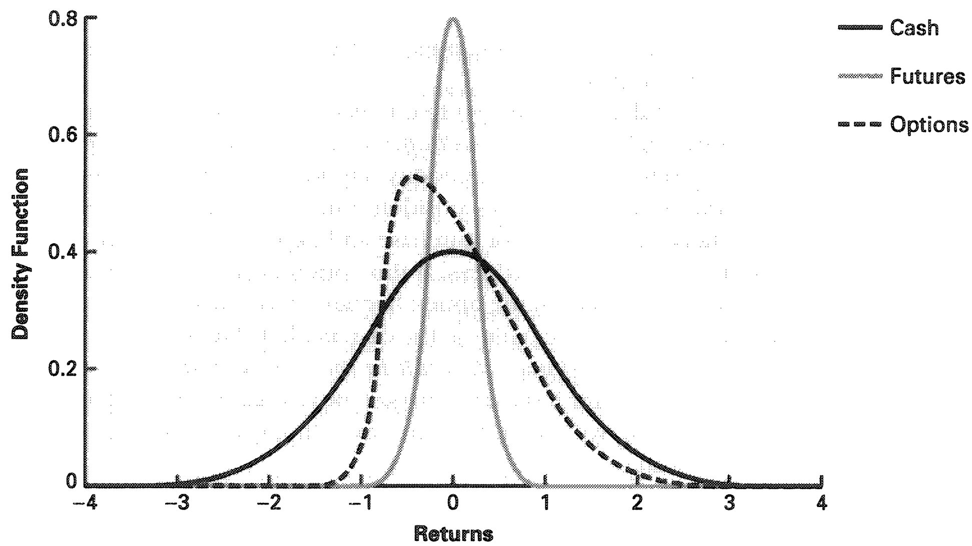


FIGURE 7.31
Cash, Futures Hedge, and Options Hedge Returns Distribution

tial. ***The removal of this downside potential is risk management for the producer or holder of the commodity.*** The hedger trades cash price risk for basis risk. By hedging, they remove cash price risk, but basis risk remains. If the remaining basis risk is as large as the underlying cash price risk, there is no point to hedging. The hedge is ineffective.

One thing that may be missing from the diagram is that the mean returns from the hedging distribution may be lower than returns from the cash distribution. Think back to the lognormal distribution. The most likely prices are lower than the mean because the mean is influenced by occasional run-ups in price. Thus, you need to mentally shift the hedge distribution slightly to the left. The amount of this shift depends on the commodity and location, and can only be answered by research.

The distribution of the combined cash and options strategy is itself a combination of the distribution from the cash strategy and the hedge strategy. When the producer purchases put options and realizes low prices, the producer is effectively hedging. The left side of the options distribution is similar to the futures distribution. This is the basis error and risk that we have been ignoring in the returns diagram. When high prices are realized, the producer is effectively in the cash market. Thus, the right side of the options distribution is similar to the cash distribution. However, the producer must pay premiums to purchase the options. This shifts the distribution to the left the amount of the average premium. The downside price protection is not as good as the hedge, but it is better than being unprotected in the cash market. The upside potential is not as great as the cash market, but it is better than no upside potential as is offered by the hedge. ***Options are not a panacea; they offer alternatives not found in cash or futures strategies.***

SUMMARY

Options add flexibility to hedging and trading programs. The risk of incurring significant ***opportunity costs*** is reduced, and the often troublesome need to manage margins and ***margin calls*** can be eliminated. Producers and other potential users of the futures market who worry about these issues will be more likely to use the options in simple strategies that are restricted to buying puts to protect against price declines or buying calls to protect against rising costs.

Purchasing put options allows the hedger to establish a *price floor* on future marketings of the commodity, and *purchasing call options* allows the hedger to place a *price ceiling* on future purchases of the commodity. Options give the purchaser the *right* to but not the *obligation* of a futures position. Purchase of options costs the hedger the *premium*. Between the time of purchase and expiration, the option may accumulate value or it may become worthless. If the option accumulates value, this gain offsets losses in the cash market. If the option becomes worthless, the purchaser has lost only the premium and captures gains in the cash market. Trading options may be a good decision, but, at best, *options will result in the second best outcome*. The outcome of the hedge will be better if the cash market moves against the hedger, and the outcome of cash marketing will be better if it moves in favor of the hedger. But this is difficult to know ahead of time.

In addition to the traditional use of the options, more sophisticated option strategies can be used to allow the decision maker to *select price ranges* across which the *option strategy is superior to hedging with futures* and to select price ranges across which *exposure to cash price risk* would be preferred. Such strategies may involve managing a margin account, however, when options are sold by the decision maker. Further, the decision maker must exercise caution. Many sophisticated looking options strategies are weak price-risk management strategies.

The *fence strategy* is the classic, more advanced strategy. In this strategy, the hedger establishes a price floor through the purchase of put options and offsets part of the cost of the put by selling call options. The call options also place a ceiling on the strategy. Returns are "fenced" between the floor and ceiling. The strategy is widely used and is a legitimate price risk management approach.

The *returns diagram* should be used to examine the potential outcomes of different cash, futures, and options strategies. The diagram communicates quickly and clearly the usefulness of different strategies in protecting the decision maker from risk and offering return potential. *Hedgers should always recognize that risk and return are in conflict in risk management strategies. Strategies that offer high returns are also exposed to high risk. Strategies that offer low risk generally must accept low returns.* High-risk-low-return strategies also exist. But the point is that high-return-low-risk strategies *don't* exist.

Options trading should be integrated with solid fundamental and technical analysis. Hedging with options is attractive relative to futures if sustained market price moves are likely. Identifying when this is likely is the realm of fundamental and technical analysis.

Black's Formula is a useful tool for evaluating option prices. Premiums for puts and calls can be calculated with information on the *futures price relative to the strike price, volatility, time to expiration, and interest rate*. The tool can be used to assess if options prices are relatively high or relatively low, given historic volatility. This is similar to the evaluation of market prices with fundamental and technical analysis. The tool can give you buy or sell signals on options. The tool is also very useful for communicating how volatility and time to expiration affect option prices. For example, it can be used to show the decline in options premiums as the option gets closer and closer to expiration.

Volatility is one of the most important determinants of option price. Options traders need data on historic price volatility to understand option price movements. This is similar to the need for basis information. Historical volatility can be calculated or can often be purchased from commercial data providers.

The concept denoted as *delta* is important for options trading. Delta is the measure of how the option price changes following a change in the underlying futures contract price. The fact that deltas are between zero and one makes options trading more flexible than futures trading. Given a price move in the underlying futures, the trader will lose more in the futures market than in the options market. The hedger can use this to his or her advantage. The level of price protection can be increased for less than the cost of the change. This is not possible with futures.

Since options on agricultural commodities are still relatively new, strategies are still being developed and potential users continue to gain familiarity with this tool. Models are still being refined to calculate the proper premium for options given the underlying volatility in futures prices. For some of the more distant contracts, trade in options is very thin. Given the difficulties many producers and users of agricultural commodities have experienced in using futures, however, *it is reasonable to expect that use of the options will increase in the future*.

KEY POINTS

- The *put option* gives the user the *right to a short position* in the futures. The *call option* gives the user the *right to a long position* in the futures.
- Options are traded for various *strike prices* established by the exchanges on which futures are traded.
- The option *purchaser pays* a *premium* for the option. The option *writer*, or seller, *receives* the *premium* for the option.
- In a hedging program, strategies that buy options have the potential to *avoid exposure to opportunity costs*, and buying options to protect against price moves *eliminates margin calls* and the related need to manage a margin account.
- Option hedging strategies can be designed to combine a producer's cash position with many different combinations of options. Puts and calls can be both bought and sold. These strategies open up the possibility of *results superior to straight cash marketing and hedging with futures across different price ranges*. However, producers must be cautious in that they will be *exposed to price risk* across other and related price ranges. Sophisticated options strategies may be weak price-risk management strategies. These strategies will also often involve managing margins.
- The *returns diagram* is a good tool for communicating the possible results of different options strategies. The trader can examine the different profit or losses that will accompany the price changes between the time the options are traded and the time the position is closed.
- *Black's Formula* is a useful tool for assessing option prices. With information on the *futures price relative to the strike price, volatility, time to expiration, and interest rate*, the premium for puts and calls can be *calculated*.
- *Volatility* is an important determinant of option price. Traders of options *need data on volatility* to understand option price movements.

- Options will typically be the *preferred approach* in markets that have the potential for *sustained price moves* and in circumstances in which the *analytical ability and financial capacity of the potential user are limited*.
- Options on agricultural commodities are *relatively new*. Given the attractive features of options in eliminating *opportunity costs* associated with positions directly in futures and the possibility of eliminating the need for *margin calls*, the use of options is likely to increase in the future.

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