CHAPTER 10

Trading Strategies Involving Options

We discussed the profit pattern from an investment in a single stock option in Chapter 8. In this chapter we cover more fully the range of profit patterns obtainable using options. We assume that the underlying asset is a stock. Similar results can be obtained for other underlying assets, such as foreign currencies, stock indices, and futures contracts. The options used in the strategies we discuss are European. American options may lead to slightly different outcomes because of the possibility of early exercise.

In the first section we consider what happens when a position in a stock option is combined with a position in the stock itself. We then move on to examine the profit patterns obtained when an investment is made in two or more different options on the same stock. One of the attractions of options is that they can be used to create a wide range of different payoff functions. (A payoff function is the payoff as a function of the stock price.) If European options were available with every single possible strike price, any payoff function could in theory be created.

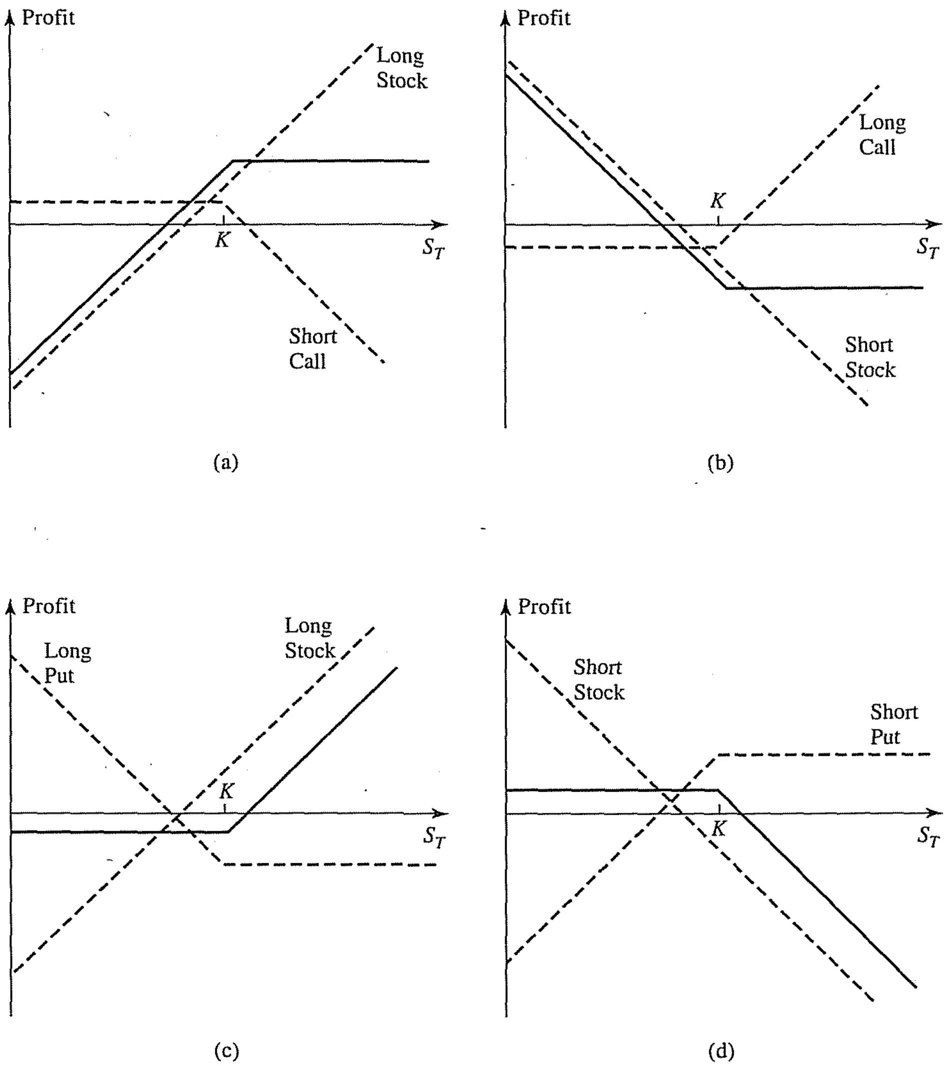
For ease of exposition the figures and tables showing the profit from a trading strategy will ignore the time value of money. The profit will be shown as the final payoff minus the initial cost. (In theory, it should be calculated as the present value of the final payoff minus the initial cost.)

10.1 STRATEGIES INVOLVING A SINGLE OPTION AND A STOCK

There are a number of different trading strategies involving a single option on a stock and the stock itself. The profits from these are illustrated in Figure 10.1. In this figure and in other figures throughout this chapter, the dashed line shows the relationship between profit and the stock price for the individual securities constituting the portfolio, whereas the solid line shows the relationship between profit and the stock price for the whole portfolio.

In Figure 10.1(a), the portfolio consists of a long position in a stock plus a short position in a call option. This is known as *writing a covered call.* The long stock ~~position~~ "covers" or protects the investor from the payoff on the short call that becomes necessary if there is a sharp rise in the stock price. In Figure 10.1(b), a short position in a stock is combined with a long position in a call option. This is the reverse of writing

Figure 10.1 Profit patterns (a) long position in a stock combined with short position in a call; (b) short position in a stock combined with long position in a call; (c) long position in a put combined with long position in a stock; (d) short position in a put combined with short position in a stock.



a covered call. In Figure 10.1(c), the investment strategy involves buying a put option on a stock and the stock itself. The approach is sometimes referred to as a *protective put* strategy. In Figure 10.1(d), a short position in a put option is combined with a short position in the stock. This is the reverse of a protective put.

The profit patterns in Figures 10.1 have the same general shape as the profit patterns discussed in Chapter 8 for short put, long put, long call, and short call, respectively. Put–call parity provides a way of understanding why this is so. From Chapter 9, the put–call parity relationship is

$$p + S_0 = c + Ke^{-rT} + D \tag{10.1}$$

where p is the price of a European put, S_0 is the stock price, c is the price of a European call, K is the strike price of both call and put, r is the risk-free interest rate, T is the time to maturity of both call and put, and D is the present value of the dividends anticipated during the life of the options.

Equation (10.1) shows that a long position in a put combined with a long position in the stock is equivalent to a long call position plus a certain amount ($= Ke^{-rT} + D$) of cash. This explains why the profit pattern in Figure 10.1(c) is similar to the profit pattern from a long call position. The position in Figure 10.1(d) is the reverse of that in Figure 10.1(c) and therefore leads to a profit pattern similar to that from a short call position.

Equation (10.1) can be rearranged to become

$$S_0 - c = Ke^{-rT} + D - p$$

In other words, a long position in a stock combined with a short position in a call is equivalent to a short put position plus a certain amount ($= Ke^{-rT} + D$) of cash. This equality explains why the profit pattern in Figure 10.1(a) is similar to the profit pattern from a short put position. The position in Figure 10.1(b) is the reverse of that in Figure 10.1(a) and therefore leads to a profit pattern similar to that from a long put position.

10.2 SPREADS

A spread trading strategy involves taking a position in two or more options of the same type (i.e., two or more calls or two or more puts).

Bull Spreads

One of the most popular types of spreads is a *bull spread*. This can be created by buying a call option on a stock with a certain strike price and selling a call option on the same

Figure 10.2 Profit from bull spread created using call options.

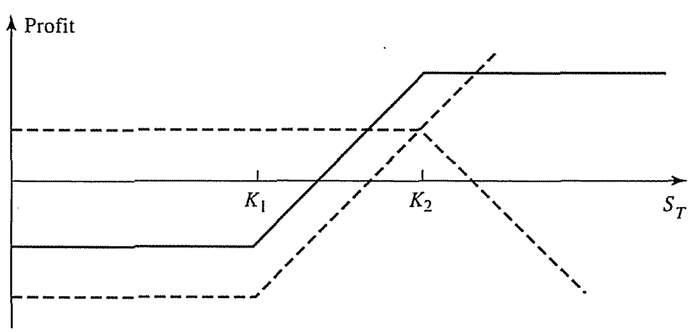


Table 10.1 Payoff from a bull spread created using calls.

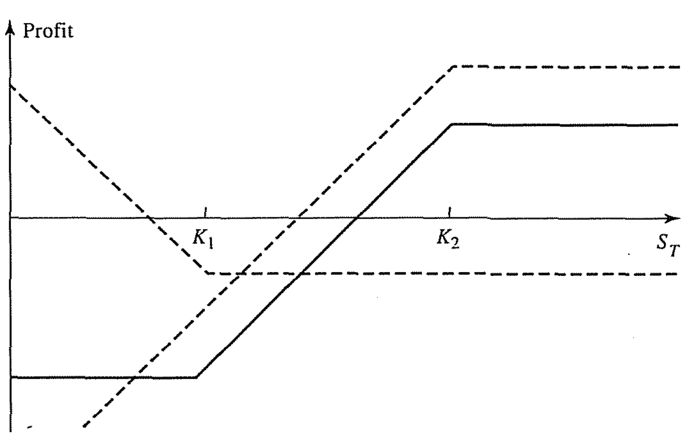
Stock price range	*Payoff from long call option*	*Payoff from short call option*	*Total payoff*
$S_T \geqslant K_2$	$S_T - K_1$	$-(S_T - K_2)$	$K_2 - K_1$
$K_1 < S_T < K_2$	$S_T - K_1$	0	$S_T - K_1$
$S_T \leqslant K_1$	0	0	0

stock with a higher strike price. Both options have the same expiration date. The strategy is illustrated in Figure 10.2. The profits from the two option positions taken separately are shown by the dashed lines. The profit from the whole strategy is the sum of the profits given by the dashed lines and is indicated by the solid line. Because a call price always decreases as the strike price increases, the value of the option sold is always less than the value of the option bought. A bull spread, when created from calls, therefore requires an initial investment.

Suppose that K_1 is the strike price of the call option bought, K_2 is the strike price of the call option sold, and S_T is the stock price on the expiration date of the options. Table 10.1 shows the total payoff that will be realized from a bull spread in different circumstances. If the stock price does well and is greater than the higher strike price, the payoff is the difference between the two strike prices, or $K_2 - K_1$. If the stock price on the expiration date lies between the two strike prices, the payoff is $S_T - K_1$. If the stock price on the expiration date is below the lower strike price, the payoff is zero. The profit in Figure 10.2 is calculated by subtracting the initial investment from the payoff.

A bull spread strategy limits the investor's upside as well as downside risk. The strategy can be described by saying that the investor has a call option with a strike price equal to K_1 and has chosen to give up some upside potential by selling a call option with strike price K_2 ($K_2 > K_1$). In return for giving up the upside potential, the investor gets the

Figure 10.3 Profit from bull spread created using put options.



price of the option with strike price K_2. Three types of bull spreads can be distinguished:

1. Both calls are initially out of the money.
2. One call is initially in the money; the other call is initially out of the money.
3. Both calls are initially in the money.

The most aggressive bull spreads are those of type 1. They cost very little to set up and have a small probability of giving a relatively high payoff ($= K_2 - K_1$). As we move from type 1 to type 2 and from type 2 to type 3, the spreads become more conservative.

Example 10.1

An investor buys for \$3 a call with a strike price of \$30 and sells for \$1 a call with a strike price of \$35. The payoff from this bull spread strategy is \$5 if the stock price is above \$35, and zero if it is below \$30. If the stock price is between \$30 and \$35, the payoff is the amount by which the stock price exceeds \$30. The cost of the strategy is \$3 − \$1 = \$2. The profit is therefore as follows:

Stock price range	*Profit*
$S_T \leqslant 30$	-2
$30 < S_T < 35$	$S_T - 32$
$S_T \geqslant 35$	3

Bull spreads can also be created by buying a put with a low strike price and selling a put with a high strike price, as illustrated in Figure 10.3. Unlike the bull spread created from calls, bull spreads created from puts involve a positive up-front cash flow to the investor (ignoring margin requirements) and a payoff that is either negative or zero.

Bear Spreads

An investor who enters into a bull spread is hoping that the stock price will increase. By contrast, an investor who enters into a *bear spread* is hoping that the stock price will decline. Bear spreads can be created by buying a put with one strike price and selling a put with another strike price. The strike price of the option purchased is greater than the strike price of the option sold. (This is in contrast to a bull spread, where the strike

Figure 10.4 Profit from bear spread created using put options.

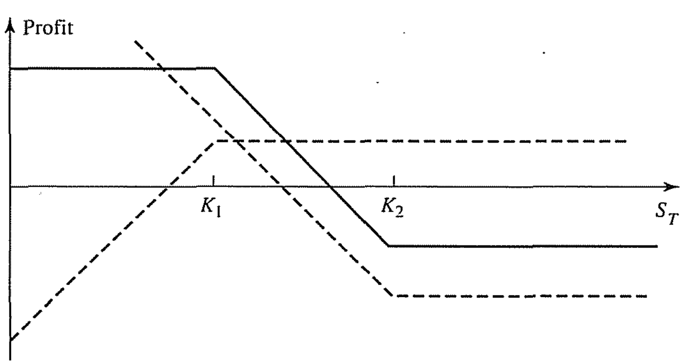


Table 10.2 Payoff from a bear spread created with put options.

Stock price range	*Payoff from long put option*	*Payoff from short put option*	*Total payoff*
$S_T \geqslant K_2$	0	0	0
$K_1 < S_T < K_2$	$K_2 - S_T$	0	$K_2 - S_T$
$S_T \leqslant K_1$	$K_2 - S_T$	$-(K_1 - S_T)$	$K_2 - K_1$

price of the option purchased is always less than the strike price of the option sold.) In Figure 10.4, the profit from the spread is shown by the solid line. A bear spread created from puts involves an initial cash outflow because the price of the put sold is less than the price of the put purchased. In essence, the investor has bought a put with a certain strike price and chosen to give up some of the profit potential by selling a put with a lower strike price. In return for the profit given up, the investor gets the price of the option sold.

Assume that the strike prices are K_1 and K_2, with $K_1 < K_2$. Table 10.2 shows the payoff that will be realized from a bear spread in different circumstances. If the stock price is greater than K_2, the payoff is zero. If the stock price is less than K_1, the payoff is $K_2 - K_1$. If the stock price is between K_1 and K_2, the payoff is $K_2 - S_T$. The profit is calculated by subtracting the initial cost from the payoff.

Example 10.2

An investor buys for \$3 a put with a strike price of \$35 and sells for \$1 a put with a strike price of \$30. The payoff from this bear spread strategy is zero if the stock price is above \$35, and \$5 if it is below \$30. If the stock price is between \$30 and \$35, the payoff is $35 - S_T$. The options cost $\$3 - \$1 = \$2$ up front. The profit is therefore as follows:

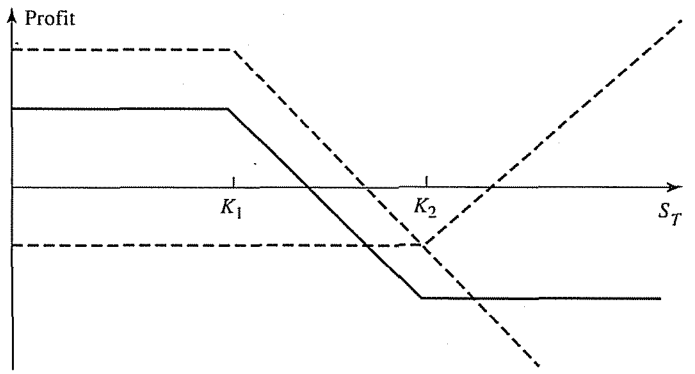
Stock price range	*Profit*
$S_T \leqslant 30$	$+3$
$30 < S_T < 35$	$33 - S_T$
$S_T \geqslant 35$	-2

Like bull spreads, bear spreads limit both the upside profit potential and the downside risk. Bear spreads can be created using calls instead of puts. The investor buys a call with a high strike price and sells a call with a low strike price, as illustrated in Figure 10.5. Bear spreads created with calls involve an initial cash inflow (ignoring margin requirements).

Box Spreads

A box spread is a combination of a bull call spread with strike prices K_1 and K_2 and a bear put spread with the same two strike prices. As shown in Table 10.3 the payoff from a box spread is always $K_2 - K_1$. The value of a box spread is therefore always the present value of this payoff or $(K_2 - K_1)e^{-rT}$. If it has a different value there is an arbitrage opportunity. If the market price of the box spread is too low, it is profitable to

Figure 10.5 Profit from bear spread created using call options.



buy the box. This involves buying a call with strike price K_1, buying a put with strike price K_2, selling a call with strike price K_2, and selling a put with strike price K_1. If the market price of the box spread is too high, it is profitable to sell the box. This involves buying a call with strike price K_2, buying a put with strike price K_1, selling a call with strike price K_1, and selling a put with strike price K_2.

It is important to realize that a box-spread arbitrage only works with European options. Most of the options that trade on exchanges are American. As shown in Business Snapshot 10.1, inexperienced traders who treat American options as European are liable to lose money.

Butterfly Spreads

A *butterfly spread* involves positions in options with three different strike prices. It can be created by buying a call option with a relatively low strike price, K_1, buying a call option with a relatively high strike price, K_3, and selling two call options with a strike price, K_2, halfway between K_1 and K_3. Generally K_2 is close to the current stock price. The pattern of profits from the strategy is shown in Figure 10.6. A butterfly spread leads to a profit if the stock price stays close to K_2, but gives rise to a small loss if there is a significant stock price move in either direction. It is therefore an appropriate strategy for an investor who feels that large stock price moves are unlikely. The strategy requires a small investment initially. The payoff from a butterfly spread is shown in Table 10.5.

Table 10.3 Payoff from a box spread.

Stock price range	*Payoff from bull call spread*	*Payoff from bear put spread*	*Total payoff*
$S_T \geqslant K_2$	$K_2 - K_1$	0	$K_2 - K_1$
$K_1 < S_T < K_2$	$S_T - K_1$	$K_2 - S_T$	$K_2 - K_1$
$S_T \leqslant K_1$	0	$K_2 - K_1$	$K_2 - K_1$

Business Snapshot 10.1 Losing Money with Box Spreads

Suppose that a stock has a price of \$50 and a volatility of 30%. No dividends are expected and the risk-free rate is 8%. A trader offers you the chance to sell on the CBOE a 2-month box spread where the strike prices are \$55 and \$60 for \$5.10. Should you do the trade?

The trade certainly sounds attractive. In this case $K_1 = 55$, $K_2 = 60$, and the payoff is certain to be \$5 in 2 months. By selling the box spread for \$5.10 and investing the funds for 2 months you would have more than enough funds to meet the \$5 payoff in 2 months. The theoretical value of the box spread today is $5 \times e^{-0.08\times 2/12} = \$4.93$.

Unfortunately there is a snag. CBOE stock options are American and the \$5 payoff from the box spread is calculated on the assumption that the options comprising the box are European. Option prices for this example (calculated using DerivaGem) are shown in Table 10.4. A bull call spread where the strike prices are \$55 and \$60 costs $0.96 - 0.26 = \$0.70$. (This is the same for both European and American options because, as we saw in Chapter 9, the price of a European call is the same as the price of an American call when there are no dividends.) A bear put spread with the same strike prices costs $9.46 - 5.23 = \$4.23$ if the options are European and $10.00 - 5.44 = \$4.56$ if they are American. The combined value of both spreads if they are created with European options is $0.70 + 4.23 = \$4.93$. This is the theoretical box spread price calculated above. The combined value of buying both spreads if they are American is $0.70 + 4.56 = \$5.26$. Selling a box spread created with American options for \$5.10 would not be a good trade. You would realize this almost immediately as the trade involves selling a \$60 strike put and this would be exercised against you almost as soon as you sold it!

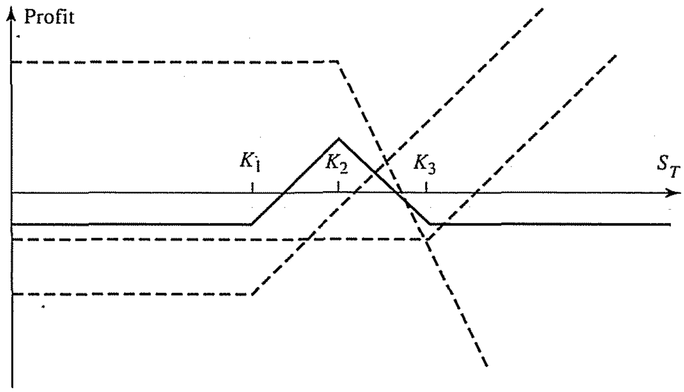
Suppose that a certain stock is currently worth \$61. Consider an investor who feels that a significant price move in the next 6 months is unlikely. Suppose that the market prices of 6-month calls are as follows:

Strike price (\$)	Call price (\$)
55	10
60	7
65	5

Table 10.4 Values of 2-month European and American options on a non-dividend-paying stock. Stock price = \$50; interest rate = 8% per annum; and volatility = 30% per annum.

Option type	*Strike price*	*European option price*	*American option price*
Call	60	0.26	0.26
Call	55	0.96	0.96
Put	60	9.46	10.00
Put	55	5.23	5.44

Figure 10.6 Profit from butterfly spread using call options.



The investor could create a butterfly spread by buying one call with a \$55 strike price, buying one call with a \$65 strike price, and selling two calls with a \$60 strike price. It costs $\$10 + \$5 - (2 \times \$7) = \$1$ to create the spread. If the stock price in 6 months is greater than \$65 or less than \$55, the total payoff is zero, and the investor incurs a net loss of \$1. If the stock price is between \$56 and \$64, a profit is made. The maximum profit, \$4, occurs when the stock price in 6 months is \$60.

Butterfly spreads can be created using put options. The investor buys a put with a low strike price, buys a put with a high strike price, and sells two puts with an intermediate strike price, as illustrated in Figure 10.7. The butterfly spread in the example just considered would be created by buying a put with a strike price of \$55, buying a put with a strike price of \$65, and selling two puts with a strike price of \$60. If all options are European, the use of put options results in exactly the same spread as the use of call options. Put–call parity can be used to show that the initial investment is the same in both cases.

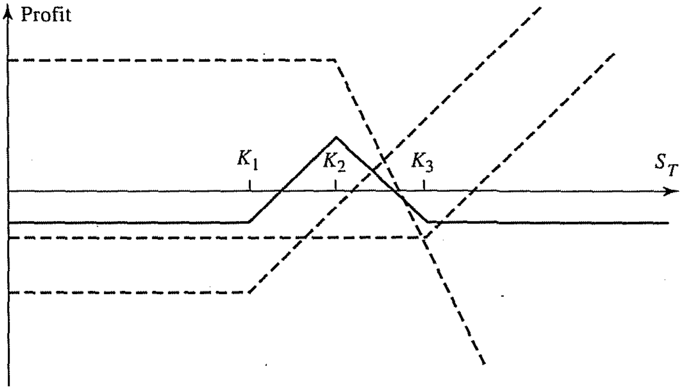
A butterfly spread can be sold or shorted by following the reverse strategy. Options are sold with strike prices of K_1 and K_3, and two options with the middle strike price K_2 are purchased. This strategy produces a modest profit if there is a significant movement in the stock price.

Table 10.5 Payoff from a butterfly spread.

Stock price range	*Payoff from first long call*	*Payoff from second long call*	*Payoff from short calls*	*Total payoff**
$S_T < K_1$	0	0	0	0
$K_1 < S_T < K_2$	$S_T - K_1$	0	0	$S_T - K_1$
$K_2 < S_T < K_3$	$S_T - K_1$	0	$-2(S_T - K_2)$	$K_3 - S_T$
$S_T > K_3$	$S_T - K_1$	$S_T - K_3$	$-2(S_T - K_2)$	0

* These payoffs are calculated using the relationship $K_2 = 0.5(K_1 + K_3)$.

Figure 10.7 Profit from butterfly spread using put options.



Calendar Spreads

Up to now we have assumed that the options used to create a spread all expire at the same time. We now move on to *calendar spreads* in which the options have the same strike price and different expiration dates.

A calendar spread can be created by selling a call option with a certain strike price and buying a longer-maturity call option with the same strike price. The longer the maturity of an option, the more expensive it usually is. A calendar spread therefore usually requires an initial investment. Profit diagrams for calendar spreads are usually produced so that they show the profit when the short-maturity option expires on the assumption that the long-maturity option is sold at that time. The profit pattern for a calendar spread produced from call options is shown in Figure 10.8. The pattern is

Figure 10.8 Profit from calendar spread created using two calls.

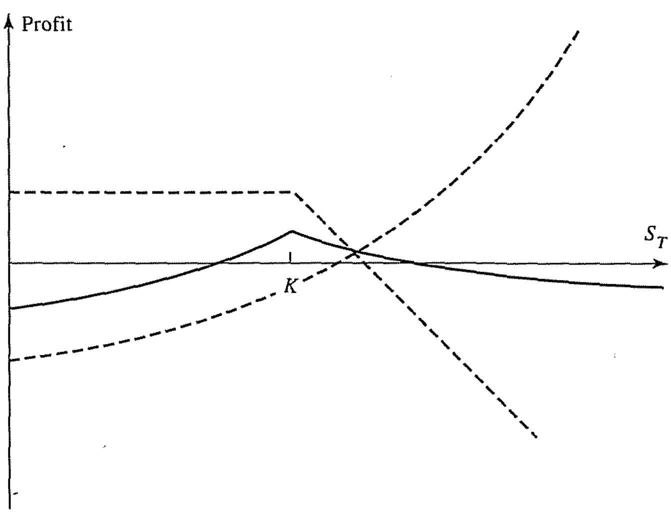
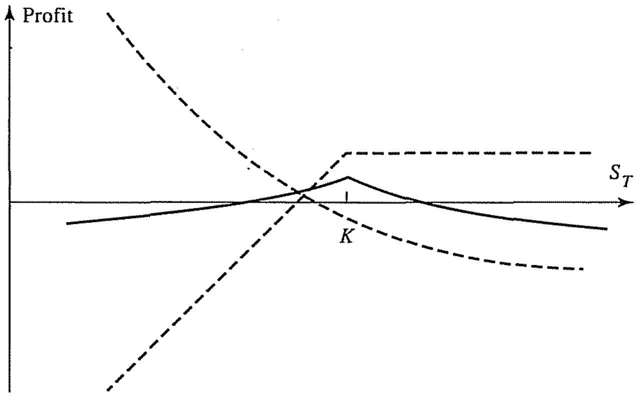


Figure 10.9 Profit from a calendar spread created using two puts.



similar to the profit from the butterfly spread in Figure 10.6. The investor makes a profit if the stock price at the expiration of the short-maturity option is close to the strike price of the short-maturity option. However, a loss is incurred when the stock price is significantly above or significantly below this strike price.

To understand the profit pattern from a calendar spread, first consider what happens if the stock price is very low when the short-maturity option expires. The short-maturity option is worthless and the value of the long-maturity option is close to zero. The investor therefore incurs a loss that is close to the cost of setting up the spread initially. Consider next what happens if the stock price, S_T, is very high when the short-maturity option expires. The short-maturity option costs the investor $S_T - K$, and the long-maturity option is worth close to $S_T - K$, where K is the strike price of the options. Again, the investor makes a net loss that is close to the cost of setting up the spread initially. If S_T is close to K, the short-maturity option costs the investor either a small amount or nothing at all. However, the long-maturity option is still quite valuable. In this case a significant net profit is made.

In a *neutral calendar spread*, a strike price close to the current stock price is chosen. A *bullish calendar spread* involves a higher strike price, whereas a *bearish calendar spread* involves a lower strike price.

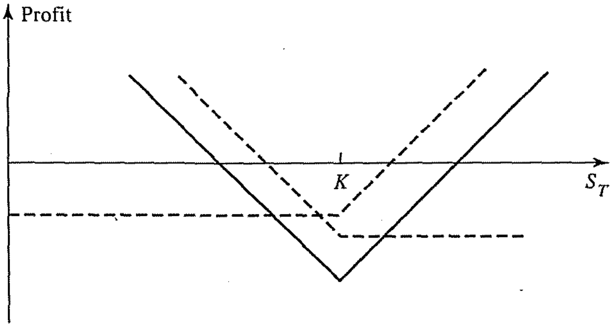
Calendar spreads can be created with put options as well as call options. The investor buys a long-maturity put option and sells a short-maturity put option. As shown in Figure 10.9, the profit pattern is similar to that obtained from using calls.

A *reverse calendar spread* is the opposite to that in Figures 10.8 and 10.9. The investor buys a short-maturity option and sells a long-maturity option. A small profit arises if the stock price at the expiration of the short-maturity option is well above or well below the strike price of the short-maturity option. However, a significant loss results if it is close to the strike price.

Diagonal Spreads

Bull, bear, and calendar spreads can all be created from a long position in one call and a short position in another call. In the case of bull and bear spreads, the calls have

Figure 10.10 Profit from a straddle.



different strike prices and the same expiration date. In the case of calendar spreads, the calls have the same strike price and different expiration dates.

In a *diagonal spread* both the expiration date and the strike price of the calls are different. This increases the range of profit patterns that are possible.

10.3 COMBINATIONS

A *combination* is an option trading strategy that involves taking a position in both calls and puts on the same stock. We will consider straddles, strips, straps, and strangles.

Straddle

One popular combination is a *straddle*, which involves buying a call and put with the same strike price and expiration date. The profit pattern is shown in Figure 10.10. The strike price is denoted by K. If the stock price is close to this strike price at expiration of the options, the straddle leads to a loss. However, if there is a sufficiently large move in either direction, a significant profit will result. The payoff from a straddle is calculated in Table 10.6.

A straddle is appropriate when an investor is expecting a large move in a stock price but does not know in which direction the move will be. Consider an investor who feels that the price of a certain stock, currently valued at \$69 by the market, will move significantly in the next 3 months. The investor could create a straddle by buying both a put and a call with a strike price of \$70 and an expiration date in 3 months. Suppose that the call costs \$4 and the put costs \$3. If the stock price stays at \$69, it is easy to see

Table 10.6 Payoff from a straddle.

Range of stock price	*Payoff from call*	*Payoff from put*	*Total payoff*
$S_T \leqslant K$	0	$K - S_T$	$K - S_T$
$S_T > K$	$S_T - K$	0	$S_T - K$

Business Snapshot 10.2 How to Make Money from Trading Straddles

Suppose that a big move is expected in a company's stock price because there is a takeover bid for the company or the outcome of a major lawsuit involving the company is about to be announced. Should you trade a straddle?

A straddle seems a natural trading strategy in this case. However, if your view of the company's situation is much the same as that of other market participants, this view will be reflected in the prices of options. Options on the stock will be significantly more expensive than options on a similar stock for which no jump is expected. The V-shaped profit pattern from the straddle in Figure 10.10 will have moved downward, so that a bigger move in the stock price is necessary for you to make a profit.

For a straddle to be an effective strategy, you must believe that there are likely to be big movements in the stock price and these beliefs must be different from those of most other investors. Market prices incorporate the beliefs of market participants. To make money from any investment strategy, you must take a view that is different from most of the rest of the market—and you must be right!

that the strategy costs the investor \$6. (An up-front investment of \$7 is required, the call expires worthless, and the put expires worth \$1.) If the stock price moves to \$70, a loss of \$7 is experienced. (This is the worst that can happen.) However, if the stock price jumps up to \$90, a profit of \$13 is made; if the stock moves down to \$55, a profit of \$8 is made; and so on. As discussed in Business Snapshot 10.2 an investor should carefully consider whether the jump that he or she anticipates is already reflected in option prices before putting on a straddle trade.

The straddle in Figure 10.10 is sometimes referred to as a *bottom straddle* or *straddle purchase*. A *top straddle* or *straddle write* is the reverse position. It is created by selling a call and a put with the same exercise price and expiration date. It is a highly risky strategy. If the stock price on the expiration date is close to the strike price, a significant profit results. However, the loss arising from a large move is unlimited.

Figure 10.11 Profit from a strip and a strap.

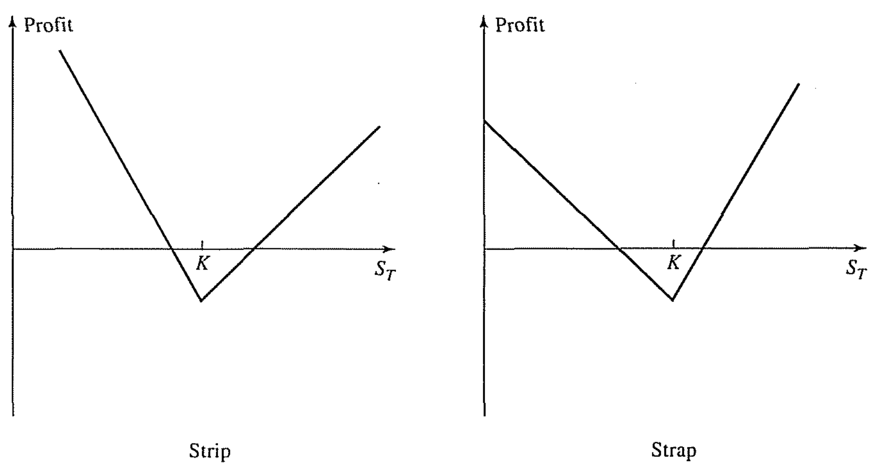
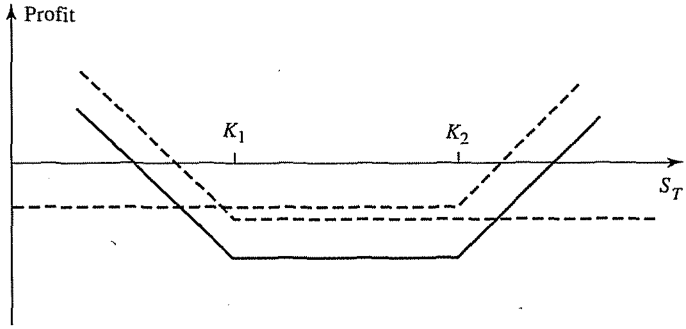


Figure 10.12 Profit from a strangle.



Strips and Straps

A *strip* consists of a long position in one call and two puts with the same strike price and expiration date. A *strap* consists of a long position in two calls and one put with the same strike price and expiration date. The profit patterns from strips and straps are shown in Figure 10.11. In a strip the investor is betting that there will be a big stock price move and considers a decrease in the stock price to be more likely than an increase. In a strap the investor is also betting that there will be a big stock price move. However, in this case, an increase in the stock price is considered to be more likely than a decrease.

Strangles

In a *strangle*, sometimes called a *bottom vertical combination*, an investor buys a put and a call with the same expiration date and different strike prices. The profit pattern that is obtained is shown in Figure 10.12. The call strike price, K_2, is higher than the put strike price, K_1. The payoff function for a strangle is calculated in Table 10.7.

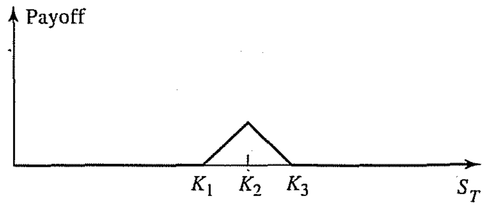
A strangle is a similar strategy to a straddle. The investor is betting that there will be a large price move, but is uncertain whether it will be an increase or a decrease. Comparing Figures 10.12 and 10.10, we see that the stock price has to move farther in a strangle than in a straddle for the investor to make a profit. However, the downside risk if the stock price ends up at a central value is less with a strangle.

The profit pattern obtained with a strangle depends on how close together the strike prices are. The farther they are apart, the less the downside risk and the farther the stock price has to move for a profit to be realized.

Table 10.7 Payoff from a strangle.

Range of stock price	*Payoff from call*	*Payoff from put*	*Total payoff*
$S_T \leqslant K_1$	0	$K_1 - S_T$	$K_1 - S_T$
$K_1 < S_T < K_2$	0	0	0
$S_T \geqslant K_2$	$S_T - K_2$	0	$S_T - K_2$

Figure 10.13 Payoff from a butterfly spread.



The sale of a strangle is sometimes referred to as a *top vertical combination*. It can be appropriate for an investor who feels that large stock price moves are unlikely. However, as with sale of a straddle, it is a risky strategy involving unlimited potential loss to the investor.

10.4 OTHER PAYOFFS

This chapter has demonstrated just a few of the ways in which options can be used to produce an interesting relationship between profit and stock price. If European options expiring at time T were available with every single possible strike price, any payoff function at time T could in theory be obtained. The easiest illustration of this involves a series of butterfly spreads. Recall that a butterfly spread is created by buying options with strike prices K_1 and K_3 and selling two options with strike price K_2, where $K_1 < K_2 < K_3$ and $K_3 - K_2 = K_2 - K_1$. Figure 10.13 shows the payoff from a butterfly spread. The pattern could be described as a spike. As K_1 and K_3 move closer together, the spike becomes smaller. Through the judicious combination of a large number of very small spikes, any payoff function can be approximated.

SUMMARY

A number of common trading strategies involve a single option and the underlying stock. For example, writing a covered call involves buying the stock and selling a call option on the stock; a protective put involves buying a put option and buying the stock. The former is similar to selling a put option; the latter is similar to buying a call option.

Spreads involve either taking a position in two or more calls or taking a position in two or more puts. A bull spread can be created by buying a call (put) with a low strike price and selling a put (call) with a high strike price. A bear spread can be created by buying a put (call) with a high strike price and selling a put (call) with a low strike price. A butterfly spread involves buying calls (puts) with a low and high strike price and selling two calls (puts) with some intermediate strike price. A calendar spread involves selling a call (put) with a short time to expiration and buying a call (put) with a longer time to expiration. A diagonal spread involves a long position in one option and a short position in another option such that both the strike price and the expiration date are different.

Combinations involve taking a position in both calls and puts on the same stock. A straddle combination involves taking a long position in a call and a long position in a put with the same strike price and expiration date. A strip consists of a long position in one call and two puts with the same strike price and expiration date. A strap consists of a long position in two calls and one put with the same strike price and expiration date. A strangle consists of a long position in a call and a put with different strike prices and the same expiration date. There are many other ways in which options can be used to produce interesting payoffs. It is not surprising that option trading has steadily increased in popularity and continues to fascinate investors.

FURTHER READING

Bharadwaj, A. and J. B. Wiggins. "Box Spread and Put–Call Parity Tests for the S&P Index LEAPS Markets," *Journal of Derivatives*, 8, 4 (Summer 2001): 62–71.

Chaput, J. S., and L. H. Ederington, "Option Spread and Combination Trading," *Journal of Derivatives*, 10, 4 (Summer 2003): 70–88.

McMillan, L. G. *Options as a Strategic Investment*. 4th edn., Upper Saddle River: Prentice-Hall, 2001.

Rendleman, R. J. "Covered Call Writing from an Expected Utility Perspective," *Journal of Derivatives*, 8, 3 (Spring 2001): 63–75.

Ronn, A. G. and E. I. Ronn. "The Box–Spread Arbitrage Conditions," *Review of Financial Studies*, 2, 1 (1989): 91–108.

Questions And Problems (Answers in Solutions Manual)

10.1. What is meant by a protective put? What position in call options is equivalent to a protective put?

10.2. Explain two ways in which a bear spread can be created.

10.3. When is it appropriate for an investor to purchase a butterfly spread?

10.4. Call options on a stock are available with strike prices of \$15, \$$17\frac{1}{2}$, and \$20, and expiration dates in 3 months. Their prices are \$4, \$2, and \$$\frac{1}{2}$, respectively. Explain how the options can be used to create a butterfly spread. Construct a table showing how profit varies with stock price for the butterfly spread.

10.5. What trading strategy creates a reverse calendar spread?

10.6. What is the difference between a strangle and a straddle?

10.7. A call option with a strike price of \$50 costs \$2. A put option with a strike price of \$45 costs \$3. Explain how a strangle can be created from these two options. What is the pattern of profits from the strangle?

10.8. Use put–call parity to relate the initial investment for a bull spread created using calls to the initial investment for a bull spread created using puts.

10.9. Explain how an aggressive bear spread can be created using put options.

10.10. Suppose that put options on a stock with strike prices \$30 and \$35 cost \$4 and \$7, respectively. How can the options be used to create (a) a bull spread and (b) a bear spread? Construct a table that shows the profit and payoff for both spreads.

10.11. Use put–call parity to show that the cost of a butterfly spread created from European puts is identical to the cost of a butterfly spread created from European calls.

10.12. A call with a strike price of \$60 costs \$6. A put with the same strike price and expiration date costs \$4. Construct a table that shows the profit from a straddle. For what range of stock prices would the straddle lead to a loss?

10.13. Construct a table showing the payoff from a bull spread when puts with strike prices K_1 and K_2, with $K_2 > K_1$, are used.

10.14. An investor believes that there will be a big jump in a stock price, but is uncertain as to the direction. Identify six different strategies the investor can follow and explain the differences among them.

10.15. How can a forward contract on a stock with a particular delivery price and delivery date be created from options?

10.16. "A box spread comprises four options. Two can be combined to create a long forward position and two can be combined to create a short forward position." Explain this statement.

10.17. What is the result if the strike price of the put is higher than the strike price of the call in a strangle?

10.18. One Australian dollar is currently worth \$0.64. A 1-year butterfly spread is set up using European call options with strike prices of \$0.60, \$0.65, and \$0.70. The risk-free interest rates in the United States and Australia are 5% and 4% respectively, and the volatility of the exchange rate is 15%. Use the DerivaGem software to calculate the cost of setting up the butterfly spread position. Show that the cost is the same if European put options are used instead of European call options.

Assignment Questions

10.19. Three put options on a stock have the same expiration date and strike prices of \$55, \$60, and \$65. The market prices are \$3, \$5, and \$8, respectively. Explain how a butterfly spread can be created. Construct a table showing the profit from the strategy. For what range of stock prices would the butterfly spread lead to a loss?

10.20. A diagonal spread is created by buying a call with strike price K_2 and exercise date T_2 and selling a call with strike price K_1 and exercise date T_1, where $T_2 > T_1$. Draw a diagram showing the profit when (a) $K_2 > K_1$ and (b) $K_2 < K_1$.

10.21. Draw a diagram showing the variation of an investor's profit and loss with the terminal stock price for a portfolio consisting of:
(a) One share and a short position in one call option
(b) Two shares and a short position in one call option
(c) One share and a short position in two call options
(d) One share and a short position in four call options
In each case, assume that the call option has an exercise price equal to the current stock price.

10.22. Suppose that the price of a non-dividend-paying stock is \$32, its volatility is 30%, and the risk-free rate for all maturities is 5% per annum. Use DerivaGem to calculate the cost of setting up the following positions:
(a) A bull spread using European call options with strike prices of \$25 and \$30 and a maturity of 6 months

(b) A bear spread using European put options with strike prices of \$25 and \$30 and a maturity of 6 months
(c) A butterfly spread using European call options with strike prices of \$25, \$30, and \$35 and a maturity of 1 year
(d) A butterfly spread using European put options with strike prices of \$25, \$30, and \$35 and a maturity of 1 year
(e) A straddle using options with a strike price of \$30 and a 6-month maturity
(f) A strangle using options with strike prices of \$25 and \$35 and a 6-month maturity

In each case provide a table showing the relationship between profit and final stock price. Ignore the impact of discounting.