11.2 Strategies Involving A Single Option and A Stock

- In Figure 11.1a, the portfolio consists of a long position in a stock plus a short position in a European call option → writing a covered call
    - The long stock position protects or 'covers' the investor from the payoff on the short call that become necessary if there is a sharp rise in the stock price.
- In Figure 11.1b, a short position in a stock is combined with a long position in a call option → Reversed of writing a covered call
- In Figure 11.1c, the investment strategy involves buying a European put option in a stock and the stock itself → protective put strategy
- In figure 11.1d, a short position in a put option is combined with a short position in the stock → reverse of protective put

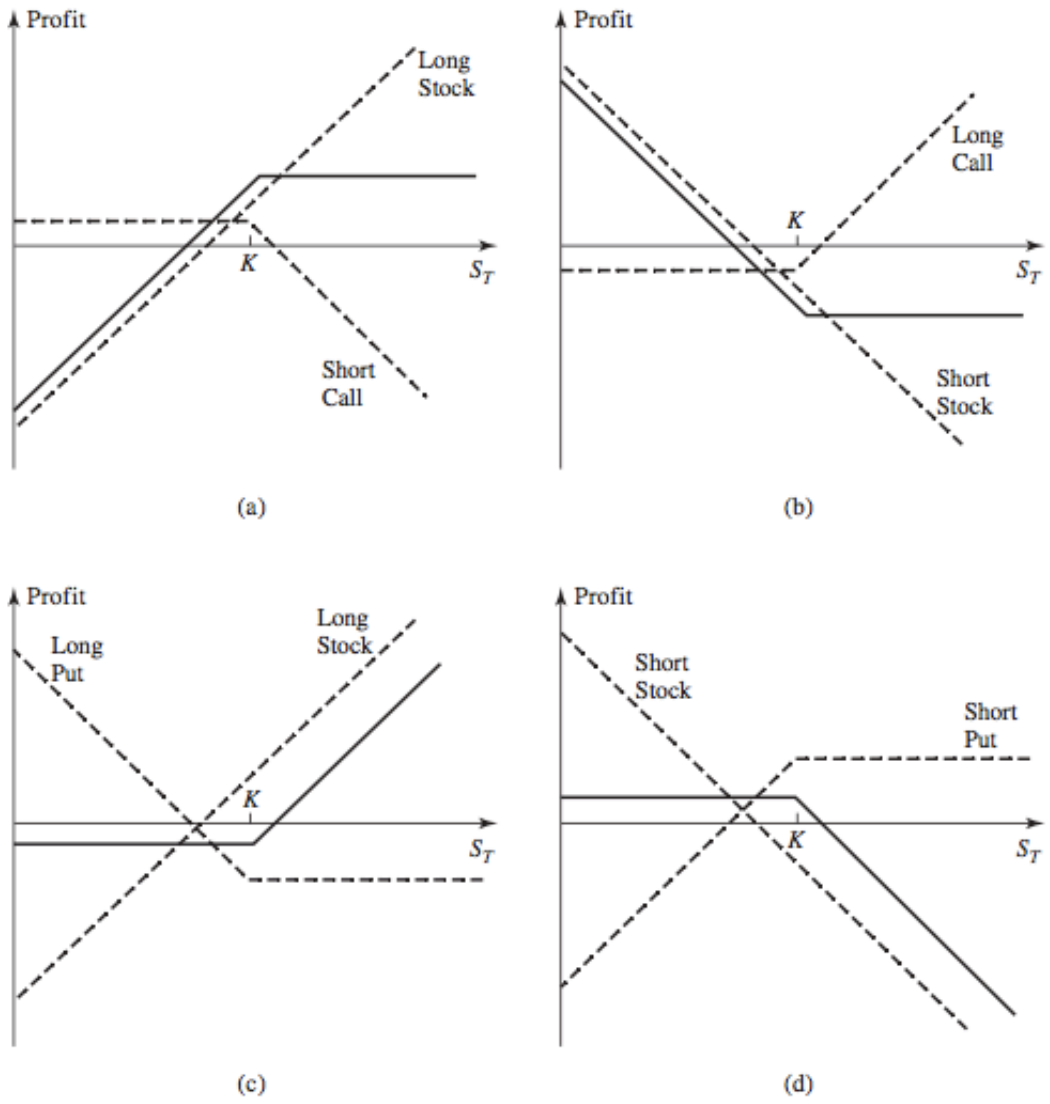

Figure 11.1 Profit patterns (a) long position in a stock combined with short position in a call; (b) short position in a stock combined with long position in a call; (c) long position in a put combined with long position in a stock; (d) short position in a put combined with short position in a stock

- Put-call parity provides a way of understanding why the profit patterns above have the same general shape as the profit patterns for basic short put, long put, long call, and short call, respectively.
- The put-call parity relationship is $p + S_0 = c + Ke^{-rT} + D$, where p is the price of a European put, So is the stock price, c is the price of a European call, K is the strike price of both call and put, and D is the present value of the dividends anticipated during the life of the options
    - The equation shows a long position in a European put combined with a long position in the stock is equivalent to a long European call position plus a certain amount $(= Ke^{-rT} + D)$ of cash.
    - This explains why the profit pattern in Figure 11.1c is similar to the profit pattern from a long call position. The position in Figure 11.1d is the reverse of that in Figure 11.1c and therefore leads to a profit pattern similar to that from a short call position
- Put-call parity equation can be rearranged to become $S_0 - c = Ke^{-rT} + D - p$
    - This shows that a long position in a stock combined with a short position in a European call is equivalent to a short European put position plus a certain amount $(= Ke^{-rT} + D)$ of cash.
    - This explains why the profit pattern in Figure 11.1a is similar to that from a short put position

11.3 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 (Debit Spread)

- This can be created by buying a European call option on a stock with a certain strike price and selling a European call option on the same stock with a higher strike price
- Both options have the same expiration date
- Due to the fact that 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

Table 11.1 Payoff from a bull spread created using calls

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

- 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

- If the stock price does well and is greater than the higher strike price, the payoff is the difference between the two strike prices, $K_2 - K_1$
- 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

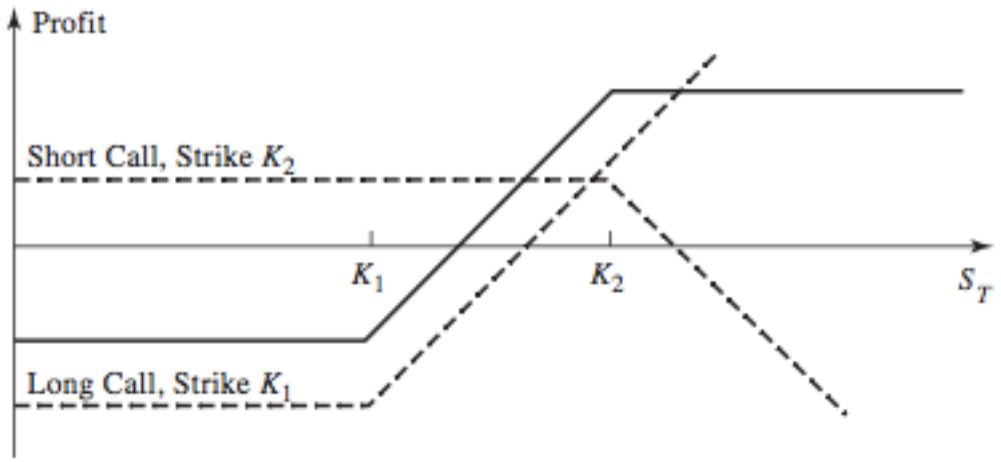

Figure 11.2 Profit from bull spread created using call options

Example 11.2 Bull spread using call options

An investor buys for \$3 a three-month call with a strike price of \$30 and sells for \$1 a three-month 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

- 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 price of the option with the strike price K_2
- Bull spread can also be created by buying European put with a low strike price and selling a European put with a high strike price, see figure 11.3 below
    - Bull spreads created from puts involve a positive cash flow to the investor up front and a payoff that is either negative or zero

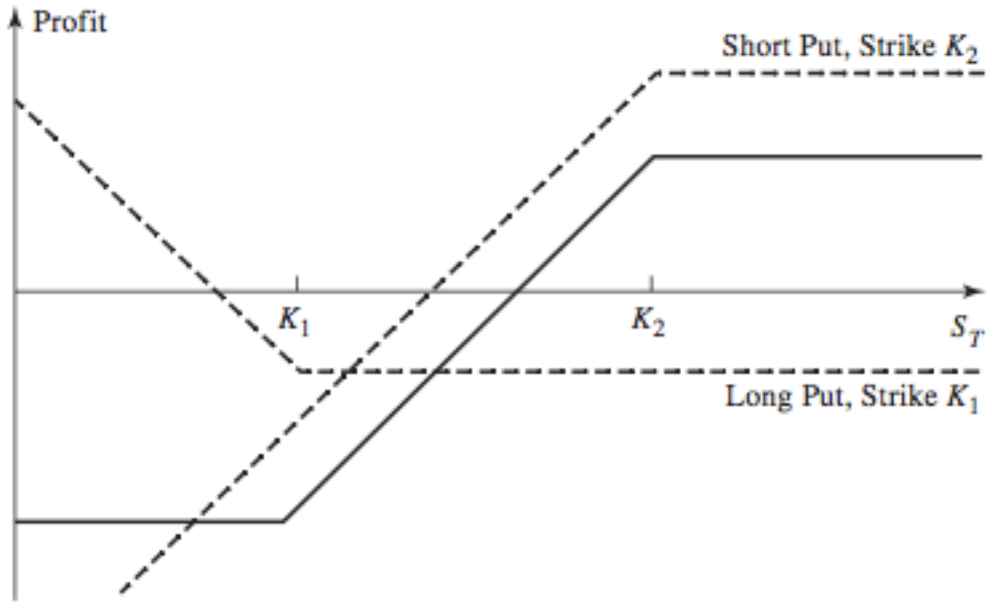

Figure 11.3 Profit from bull spread created using put options

Bear Spreads (Credit Spread)

- Investor who enters into a bear spread is hoping that the stock price will decline
- Bear spreads can be created by buying a European put with one strike price and selling a European put with another strike price
    - The strike price of the option purchased is greater than the strike price of the option sold (in contrast to a bull spread where the strike price of the option purchased is always less than the strike price of the option sold)

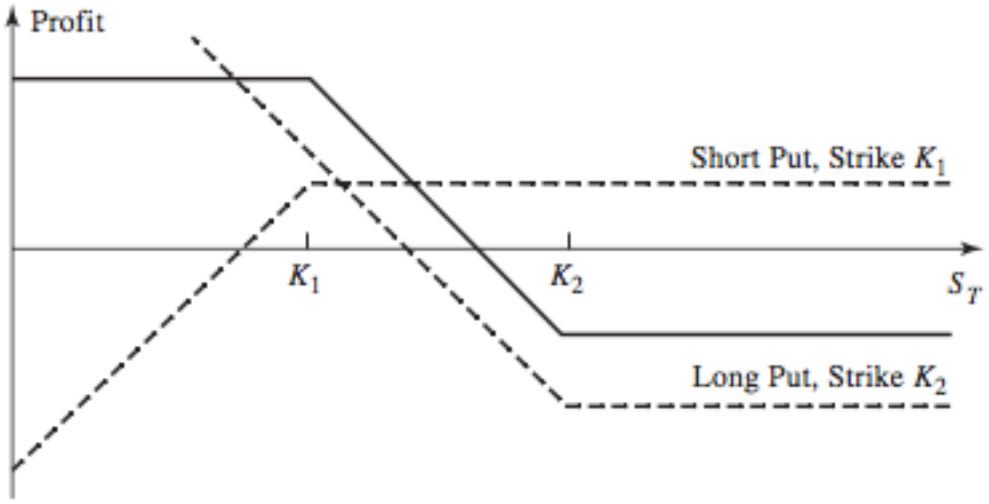

Figure 11.4 Profit from bear spread created using put options

- 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 potentially 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

Table 11.2 Payoff from a bear spread created with put options

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

Example 11.3 Bear spread using put options

An investor buys for \$3 a three-month put with a strike price of \$35 and sells for \$1 a three-month 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

- Assume that the strike prices are K_1 and K_2, with $K_1 < K_2$
  - If the stock price is greater than K_2, the payoff is 0
  - If the stock price less than K_2, the payoff is $K_2 - K_1$
  - If the stock price is between $K_1 and\ K_2$, the payoff is $K_2 - S_T$
  - Profit is calculated by subtracting the initial cost from the payoff
- 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. Investor buys a call with a high strike price and sells a call with a low strike price. Bear spreads created with calls involve an initial cash inflow

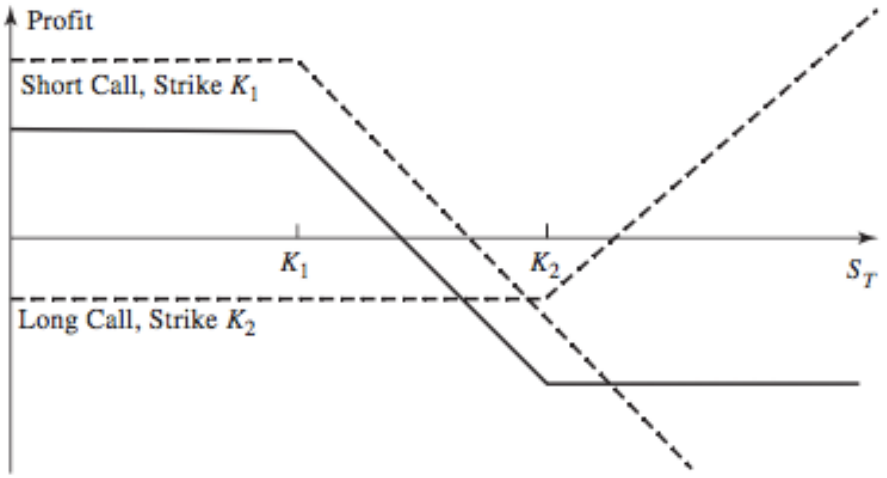

Figure 11.5 Profit from bear spread created using call options

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 the bull call, K_1 and K_2

Table 11.3 Payoff from a box spread

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

- The payoff from the 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 other value, there is an arbitrage opportunity
- If the market price of the box spread is too low, it is profitable to 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 realise that a box spread arbitrage only works with European options

Butterfly Spread

- Butterfly spread involves positions in options with three different strike prices
- It can be created by buying a European call option with a relatively low strike price, K_1, buying a European call option with a relatively high strike price, K_3, and selling two European 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. A butterfly spread leads to a profit if the stock price stays close to K_2, but gives rise to a small loss f there is a significant stock price move in either direction.
- Therefore, butterfly spread is appropriate for investors who feels that large stock price moves are unlikely
- Suppose that a certain stock is currently worth $61. Consider an investor who feels that a significant price move in the next six months is unlikely

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

- The investor could create a butterfly spread by buying one call with a strike price of 55, buying one call with a strike price of 65, and selling two calls with a 60 strike price → this cost an initial outflow of $10 + 5 - (2\times 7) = 1$ to create the spread

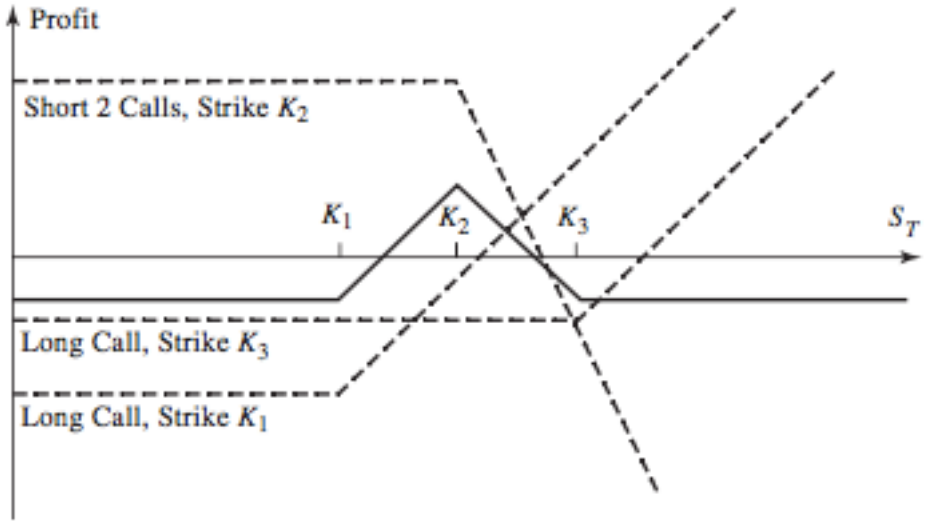

Figure 11.6 Profit from butterfly spread using call options

Table 11.4 Payoff from a butterfly spread

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

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

- If the stock price in six months is greater than 65 is 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 six months is 60
- Note that butterfly spreads can also be created using put options
    - Investor buys two European puts, one with a low strike price and one with a high strike price, and sells two European puts with an intermediate strike price
    - Put-call parity can be used to show that the initial investment is the same in both cases

Calendar Spreads

- Up to now we have assumed that the options used to create a spread all expire at the same time. For Calendar spreads, the options have the same strike price and different expiration dates.
- A calendar spread can be created by selling a European call option with a certain price and buying a longer maturity European call option with the same strike price.
    - **Usually**, The longer the maturity of an option, the more expensive it usually is
    - A calendar spread therefore 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 position is closed out at that time

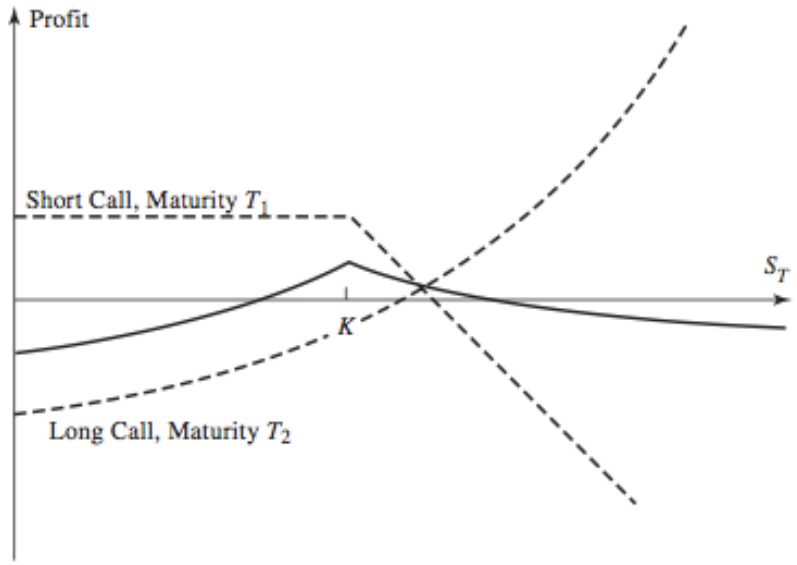

Figure 11.8 Profit from calendar spread created using two calls when $T_2 > T_1$, calculated at the time when the short maturity call expires

- 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
- A loss is incurred when the stock price is significantly above or significantly below the 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
- Next, consider 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 a little more than $S_T - K$ where K is the strike price of the options

  - The investor, therefore, 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 choses
- Bullish calendar spread → high strike price
- Bearish calendar spread → low strike price
- Calendar spreads can also be created with put options
  - The investor buys a long-maturity put option and sells a short-maturity put option

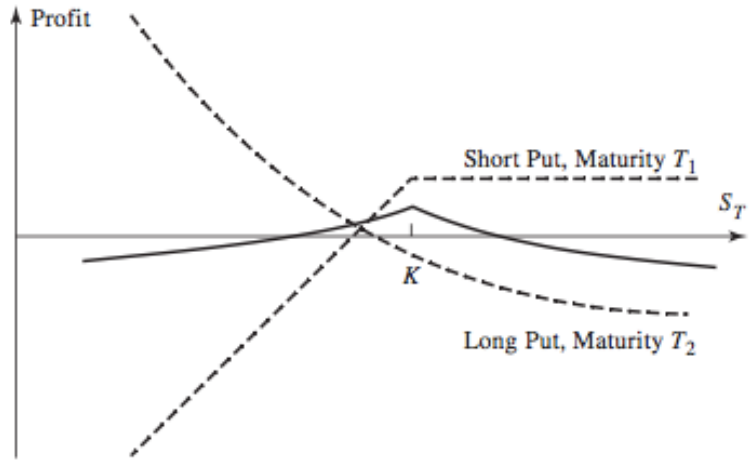

Figure 11.9 Profit from calendar spread created using two puts when $T_2 > T_1$, calculated at the time when the short maturity put expires

- Reverse calendar spread is the opposite to that in figure 11.8 and 11.9 above
  - 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.
  - Significant loss will be resulted if the stock price is close to the strike price

Diagonal Spread

- 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 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

11.4 Combinations

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

Straddle

- This involves buying a European call and put with the same strike price and expiration date
- 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.

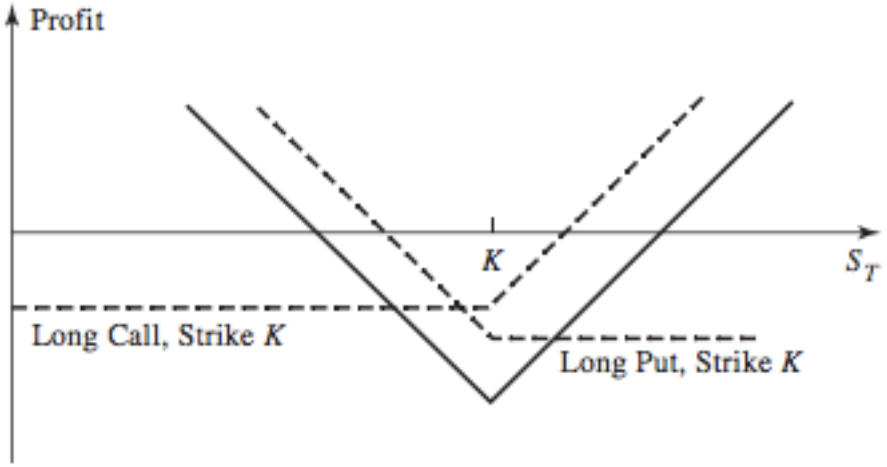

Figure 11.10 Profit from a straddle

Table 11.5 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	$S_T - K$

- 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 three 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 three months.
    - Suppose that the call costs $4 and the put costs $3. If the stock price stays at $69, it is easy to see 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 and this is the worst that can happen.
    - 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.
- The straddle in figure 11.10 above 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

Strips and Straps

- A strip consists of a long position in one European call and two European puts with the same strike price and expiration date.
- A strap consists of a long position in two European calls and one European put with the same strike price and expiration date

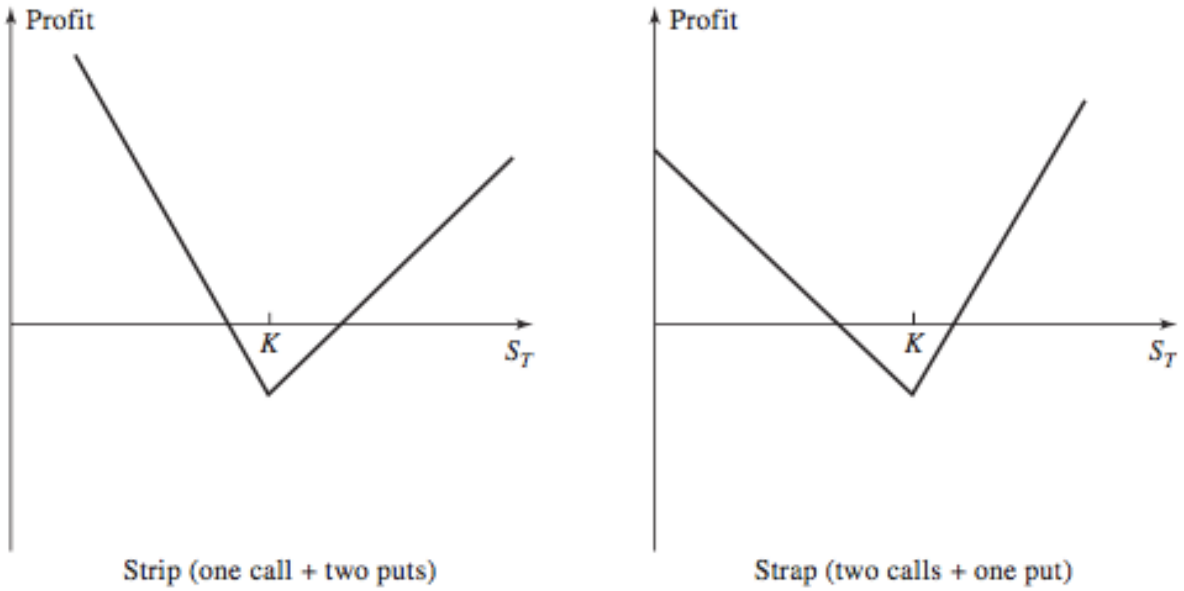

Figure 11.11 Profit from a strip and a strap

- 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 European put and a European call with the same expiration date and different strike prices.
- The call strike price is higher than the put strike price

- The investor is betting that there will be a large price movement, but is uncertain whether it will be an increase or a decrease

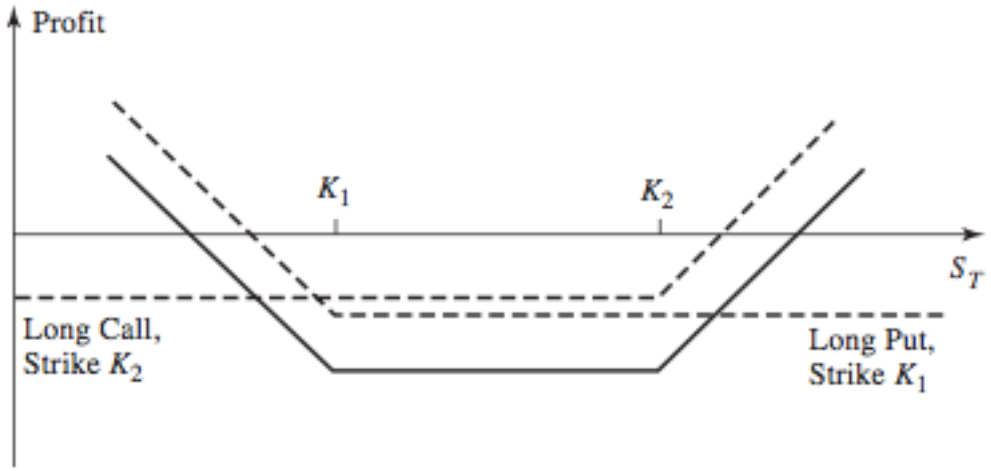

Figure 11.12 Profit from a strangle

Table 11.6 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	$S_T - K_2$

- Comparing Figure 11.12 and 11.10, we see that the stock price has to move farther in s strangle than in a straddle for the investor to make 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.
- The sale of a strangle (short call and short put) 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.