Financial Mathematics

MATH 5870/6870[1]
Fall 2021

Le Chen

lzc0090@auburn.edu

Last updated on

September 1, 2021

Auburn University
Auburn AL

[1] Based on Robert L. McDonald's *Derivatives Markets*, 3rd Ed, Pearson, 2013.

Chapter 3. Insurance, Collars, and Other Strategies

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

Chapter 3. Insurance, Collars, and Other Strategies

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Directional positions

- Bull spread
- Bear spread
- Collars
- Box spreads

Nondirectional positions

- Straddles
- Strangle
- Butterfly spread

Investors who do not care whether the stock goes up or down, but only how much it moves.

Investors are speculating on

volatility

Example for this section

Black-Scholes option prices

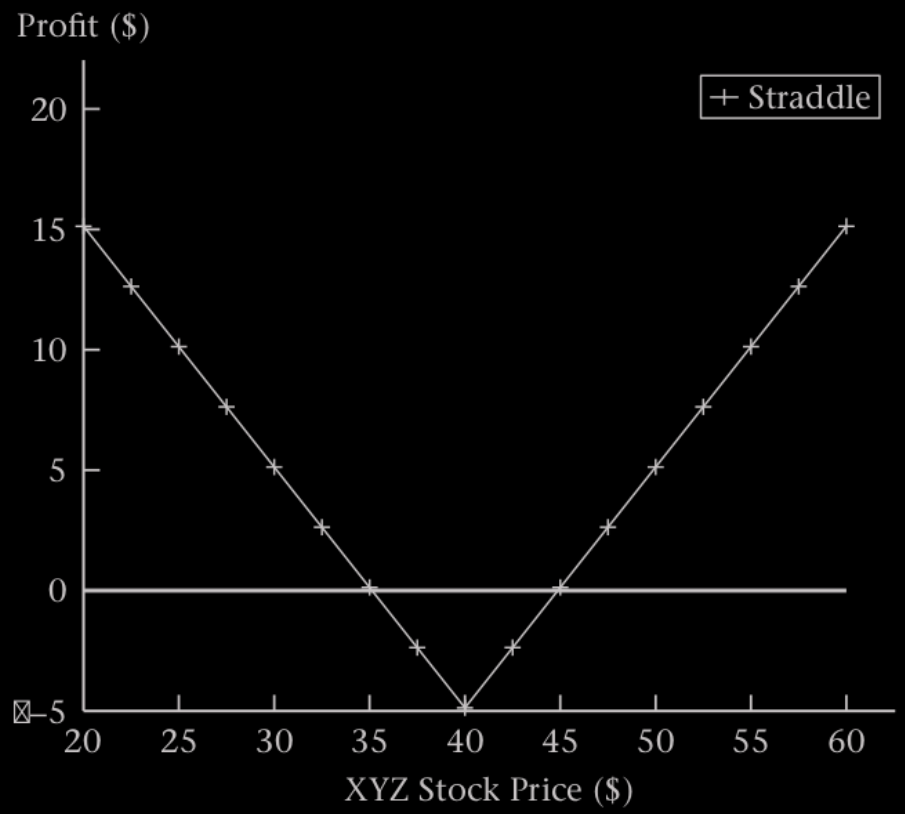
$$\begin{aligned}\text{Stock price} &= \$40\\ \text{Volatility} &= 30\%\\ \text{Effective annual risk-free rate} &= 8.33\%\\ \text{Dividend yield} &= \$0\\ \text{Expriation days} &= 91 \text{ days}\end{aligned}$$

Strike	Call	Put
35	6.13	0.44
40	2.78	1.99
45	0.97	5.08

Straddles

Straddle is the strategy of buying a call and a put with the same strike price and time to expiration.

A straddle is a bet that volatility will be high relative to the market's assessment

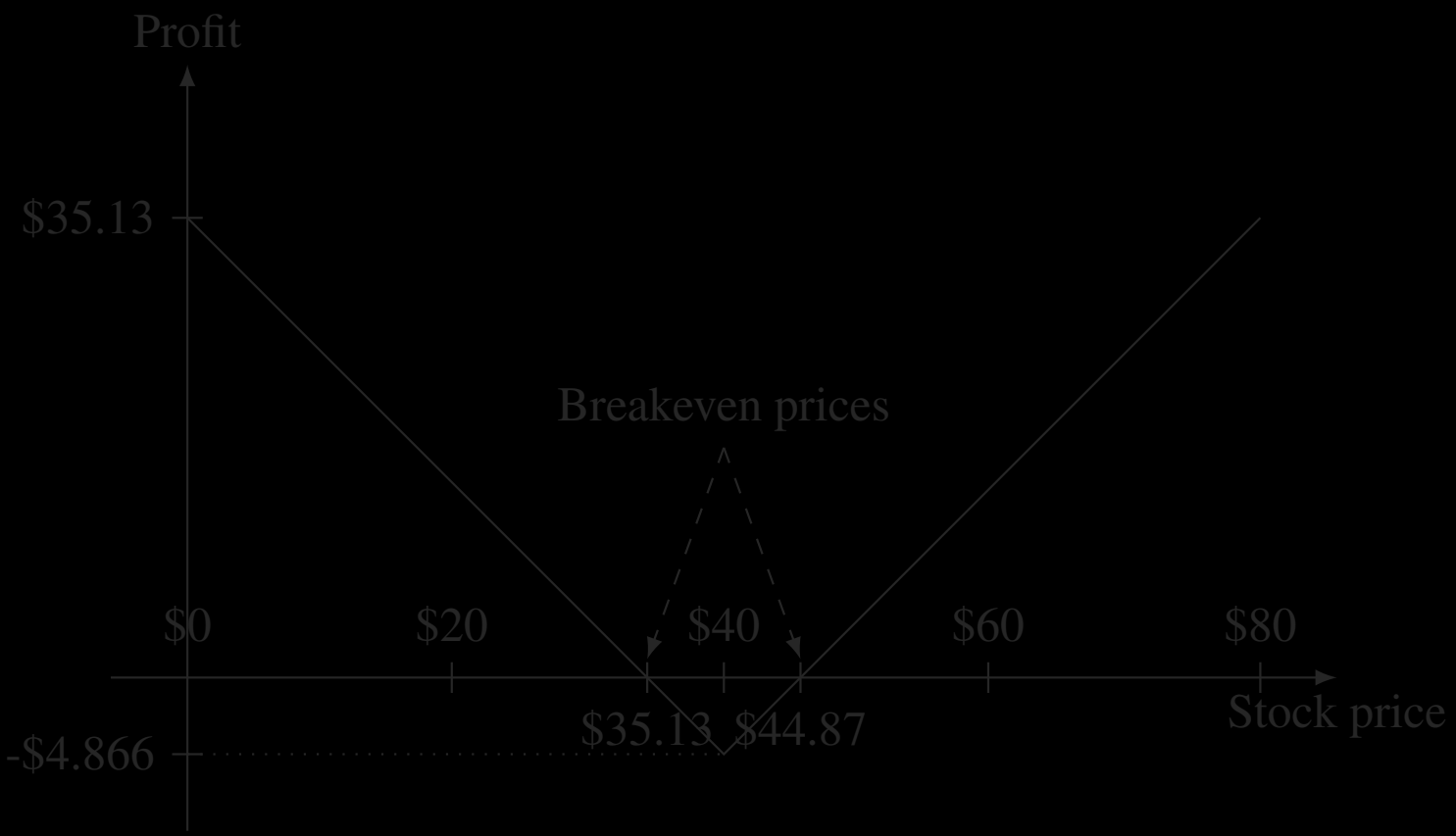


Example 3.4-1 Draw the profit graph for a \$40=strike straddle.

Solution. We only need to determine the tip of the graph:

$$-(2.78 + 1.99) \times (1 + 0.083)^{1/4} = -\$4.8660.$$

Hence,



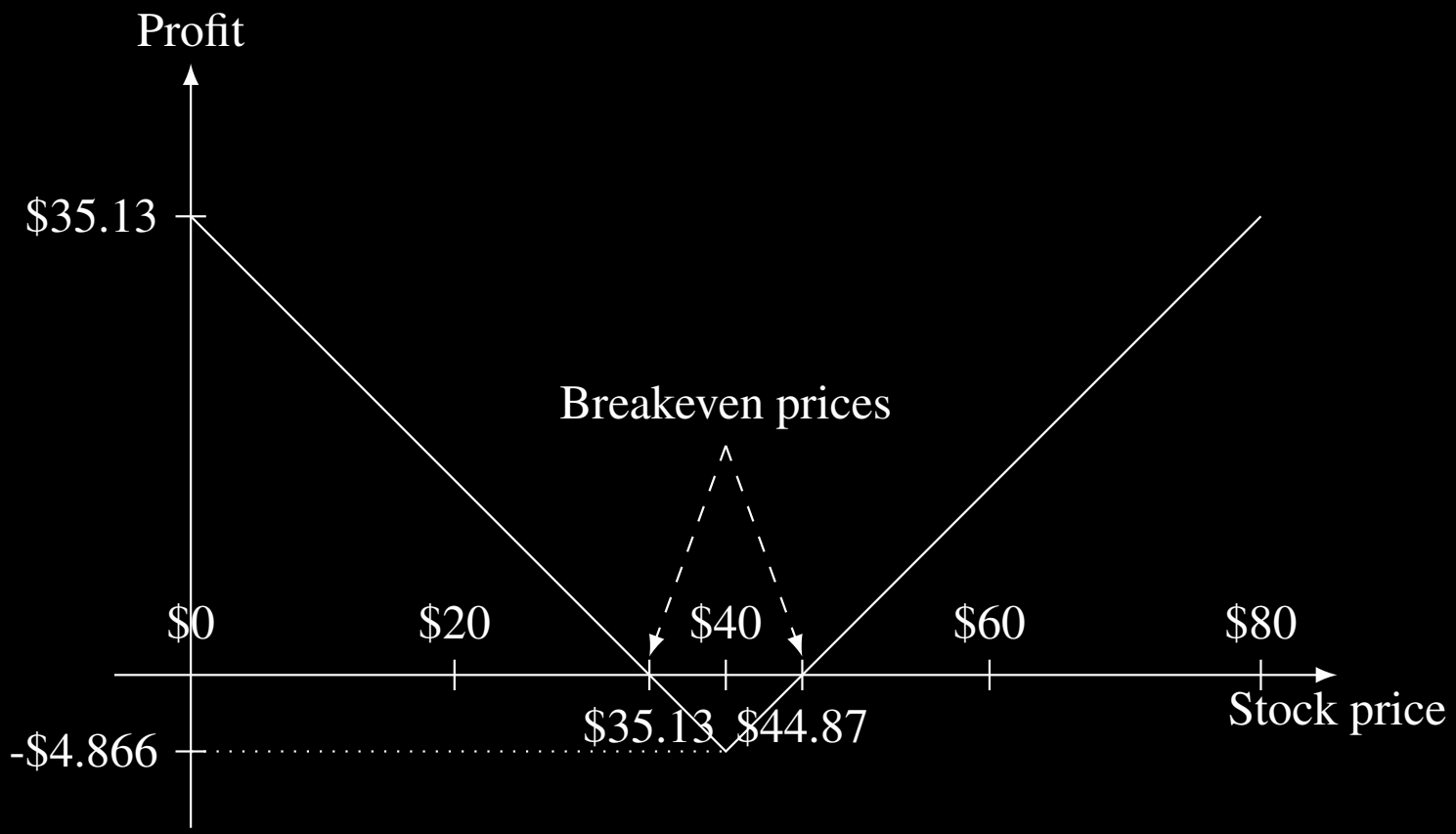
□

Example 3.4-1 Draw the profit graph for a \$40=strike straddle.

Solution. We only need to determine the tip of the graph:

$$-(2.78 + 1.99) \times (1 + 0.083)^{1/4} = -\$4.8660.$$

Hence,



□

Strangle

Strangle is the strategy of buying an out-of-the-money call and put with the same time to expiration.

A strangle can be used to reduce the high premium cost, associated with a straddle.

	Buying call at a strike price	Buying put at a strike price
Straddle	Same	Same
Strangle	High	Low

Example 3.4-2 Draw profit diagram for 40-strike straddle and strangle composed of

35-strike put + 45-strike call.

Solution. We know the shape of the graph and need only to determine the level of the flat part. Hence, suppose the stock price is \$40. Then the profit is

$$-(0.44 + 0.97) \times (1 + 0.083)^{1/4} = -\$1.4384.$$

The breakeven prices are

$$45 + 1.4384 = \$46.4384 \quad \text{and} \quad 35 - 1.4384 = \$33.562.$$

Example 3.4-2 Draw profit diagram for 40-strike straddle and strangle composed of

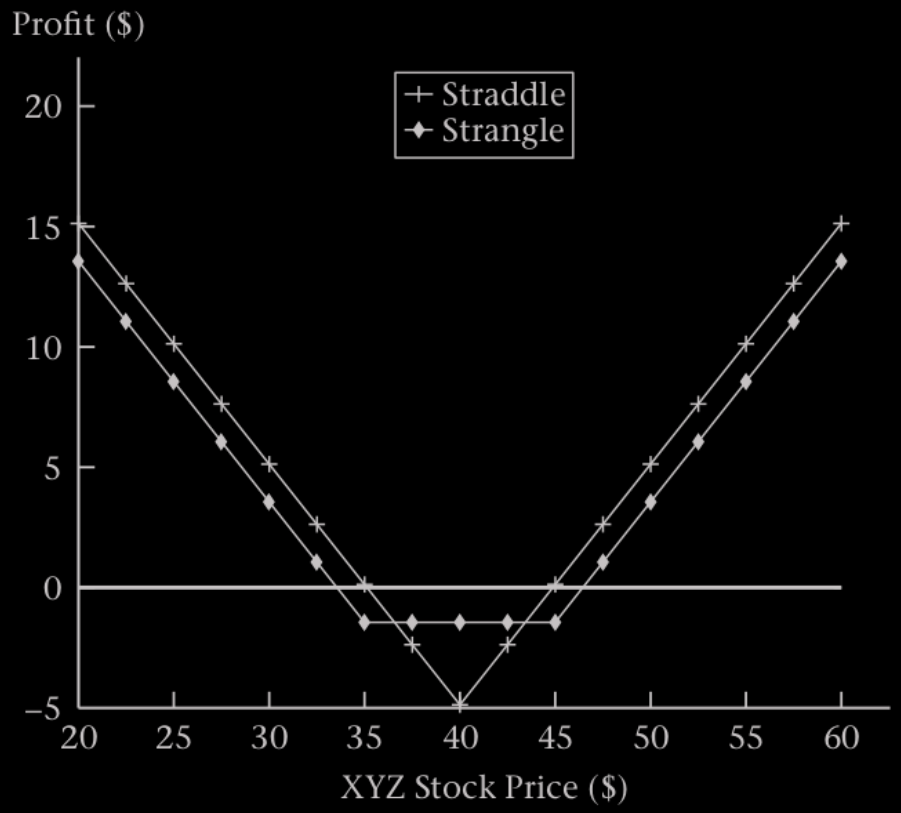
$$\text{35-strike put} + \text{45-strike call}.$$

Solution. We know the shape of the graph and need only to determine the level of the flat part. Hence, suppose the stock price is \$40. Then the profit is

$$-(0.44 + 0.97) \times (1 + 0.083)^{1/4} = -\$1.4384.$$

The breakeven prices are

$$45 + 1.4384 = \$46.4384 \quad \text{and} \quad 35 - 1.4384 = \$33.562.$$


Profit ($)
Straddle
Strangle
20
15
10
5
0
−5
20
25
30
35
40
45
50
55
60
XYZ Stock Price ($)

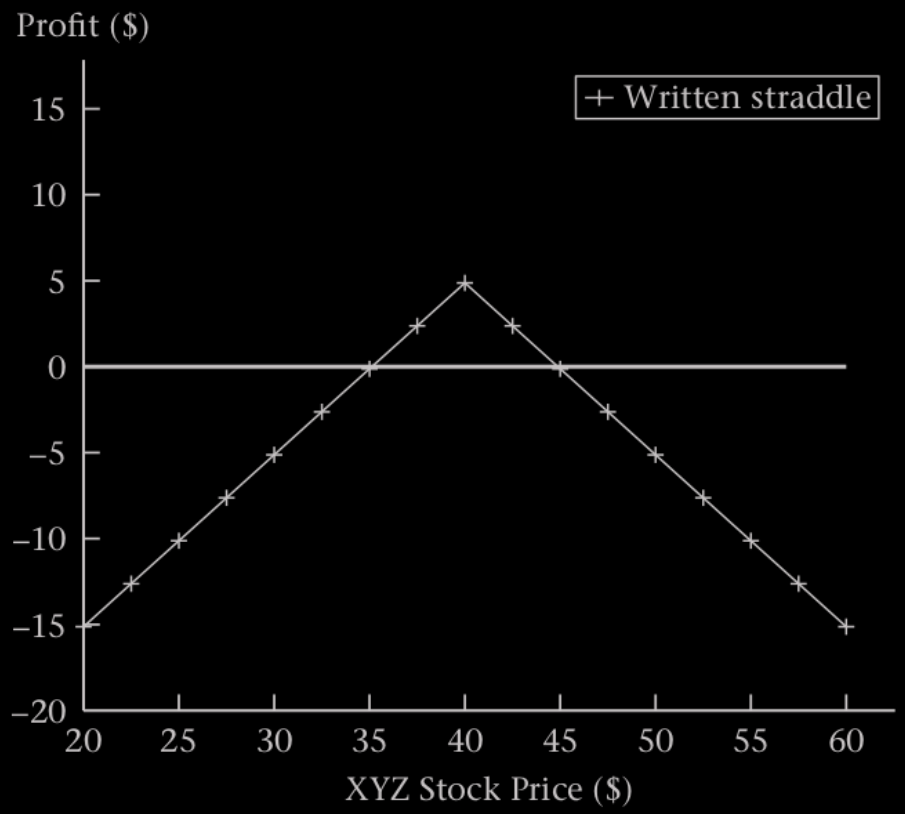
Written straddles

Written straddle is the strategy of selling a call and put with the same strike price and time to maturity.

Unlike a purchased straddle, a written straddle is a bet that

volatility will be low

relative to the market's assessment.

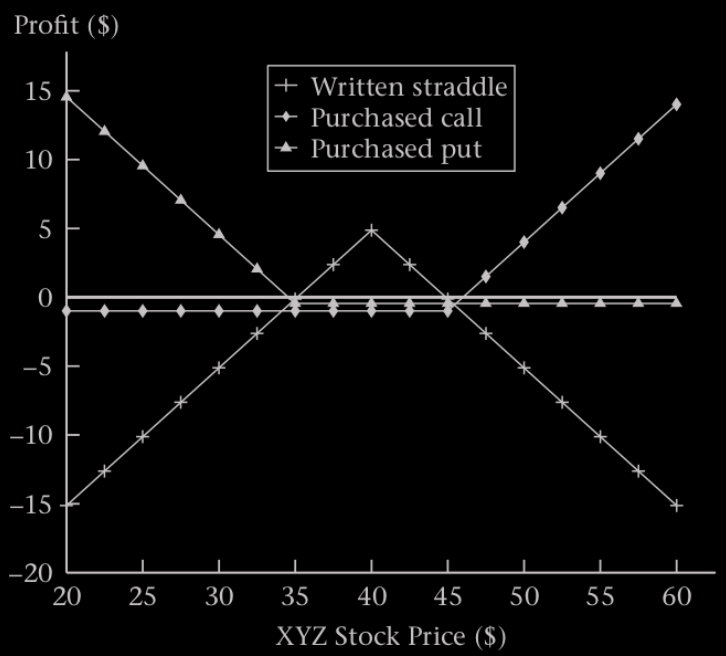


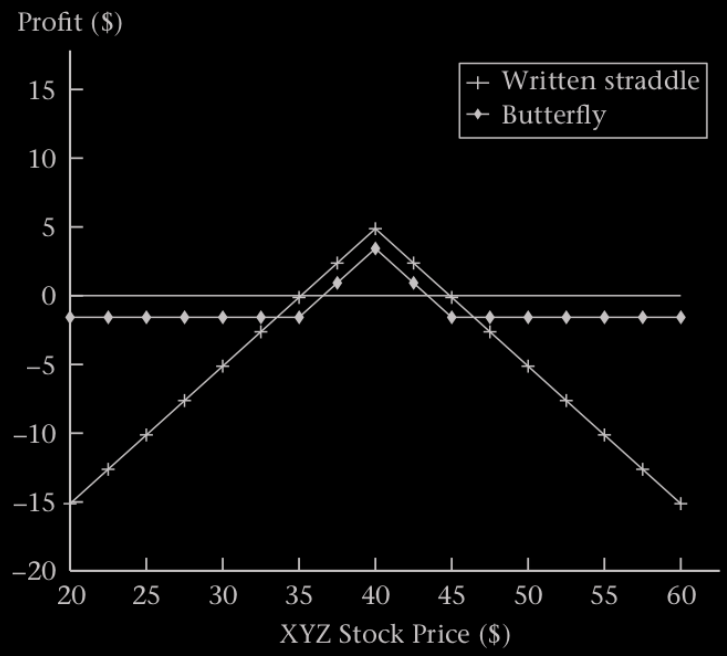
Butterfly spreads

Butterfly spreads = Insured wrien straddle

= Written straddle + purchased straggle

A butterfly spread insures against large losses on a straddle.





Example 3.4-3 Draw the profit graph for the butterfly spread:

Written \$40 straddle + purchased 35-45 straggle.

Solution. First notice that this spread corresponds:

Strike	Call	Put
35	6.13	0.44 (long)
40	2.78 (short)	1.99 (short)
45	0.97 (long)	5.08

We know the general shape of the profit graph and need only to determine the level when the graph is flat. For this, suppose that the stock price is \$ $x < 30$. In this case, only both puts are in the money and the profit is

$$(2.78 + 1.99 - 0.44 - 0.97) \times (1 + 0.083)^{1/4} + (35 - x) + (x - 40) = -\$1.5724.$$

Example 3.4-3 Draw the profit graph for the butterfly spread:

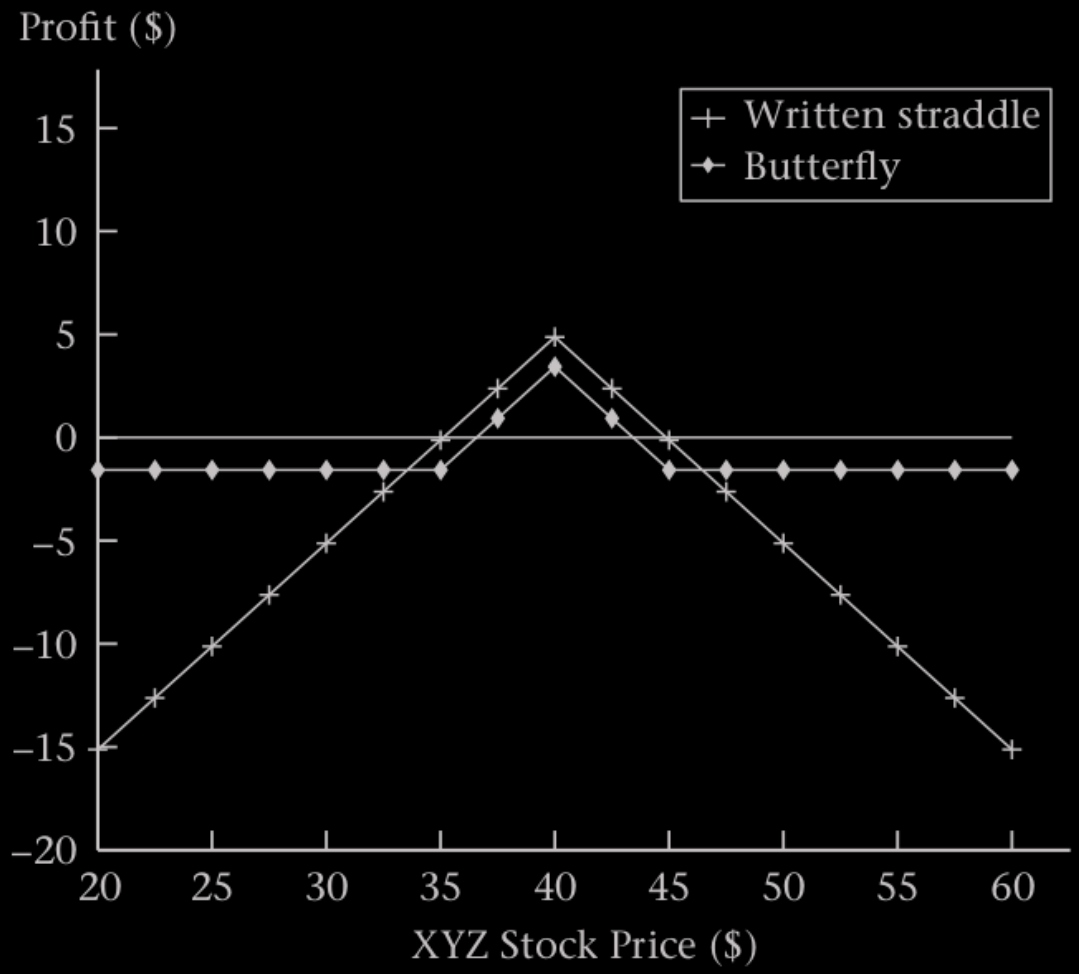
Written \$40 straddle + purchased 35-45 straggle.

Solution. First notice that this spread corresponds:

Strike	Call	Put
35	6.13	0.44 (long)
40	2.78 (short)	1.99 (short)
45	0.97 (long)	5.08

We know the general shape of the profit graph and need only to determine the level when the graph is flat. For this, suppose that the stock price is \$ $x < 30$. In this case, only both puts are in the money and the profit is

$$(2.78 + 1.99 - 0.44 - 0.97) \times (1 + 0.083)^{1/4} + (35 - x) + (x - 40) = -\$1.5724.$$


Profit ($)
15
10
5
0
−5
−10
−15
−20
20
25
30
35
40
45
50
55
60
XYZ Stock Price ($)
Written straddle
Butterfly

□