

# Financial Mathematics

MATH 5870/6870<sup>1</sup>  
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Le Chen

lzc0090@auburn.edu

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Auburn University  
Auburn AL

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<sup>1</sup>Based on Robert L. McDonald's *Derivatives Markets*, 3rd Ed, Pearson, 2013.

## Chapter 3. Insurance, Collars, and Other Strategies

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§ 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

§ 3.1 Basic insurance strategies

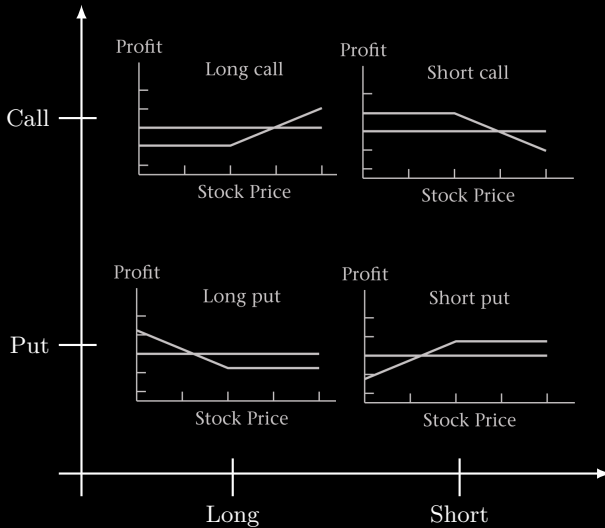
§ 3.2 Put-call parity

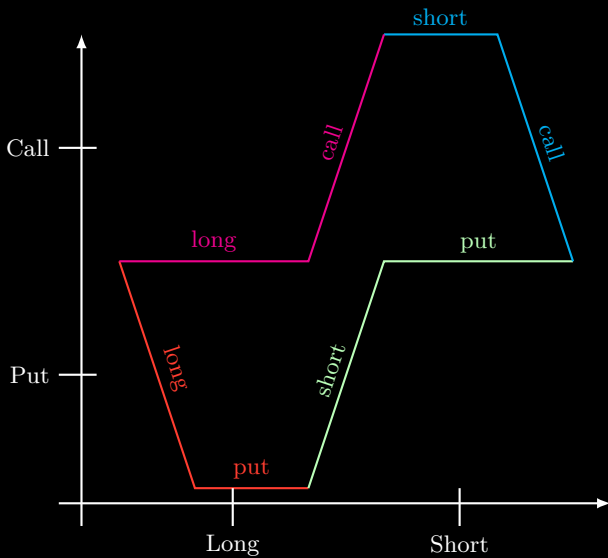
§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

By combining two or more options, we find many well-known strategies.





An **option spread** is a position consisting of only calls or only puts, in which some options are purchased and some written.

- ▶ Bull and bear spreads

- ▶ Box spreads

- ▶ Ratio spreads

- ▶ Collars

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## Example for this section

Black-Scholes option prices

Stock price = \$40

Volatility = 30%

Effective annual risk-free rate = 8.33%

Dividend yield = \$0

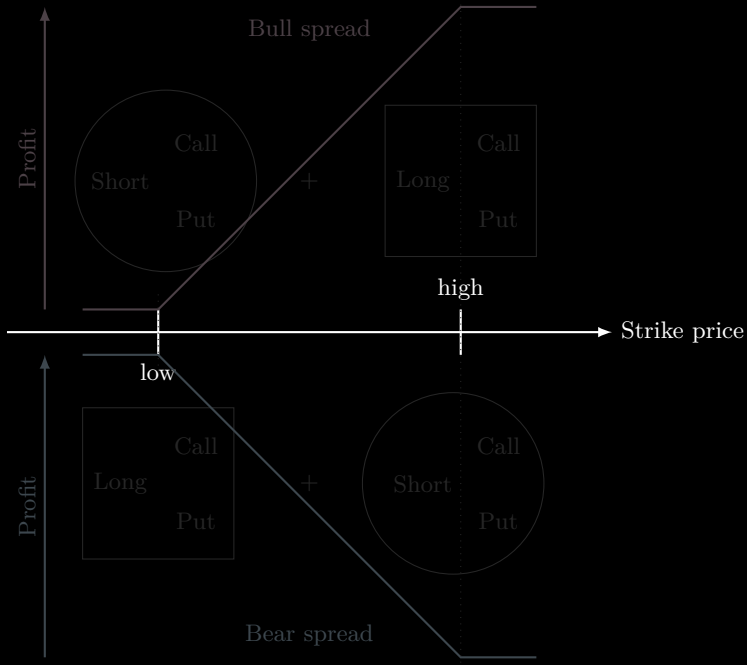
Expiration days = 91 days

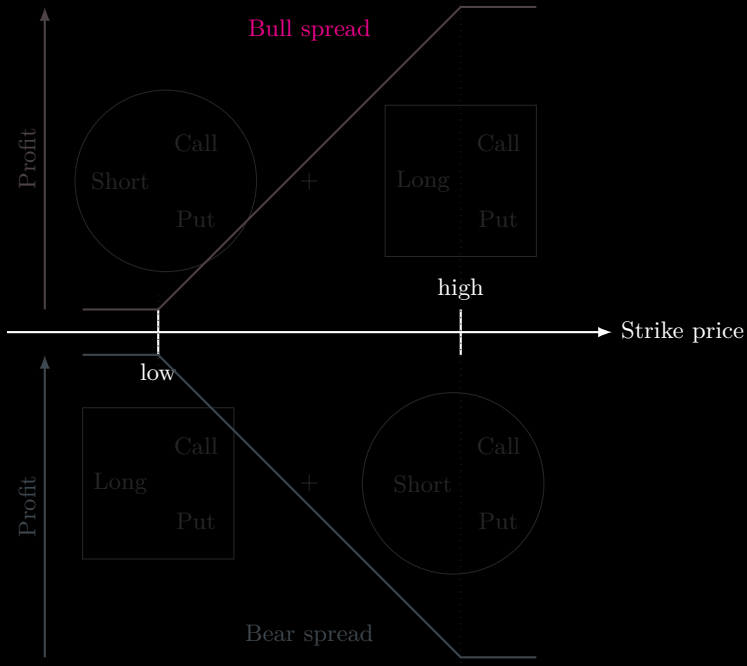
Strike	Call	Put
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45	0.97	5.08

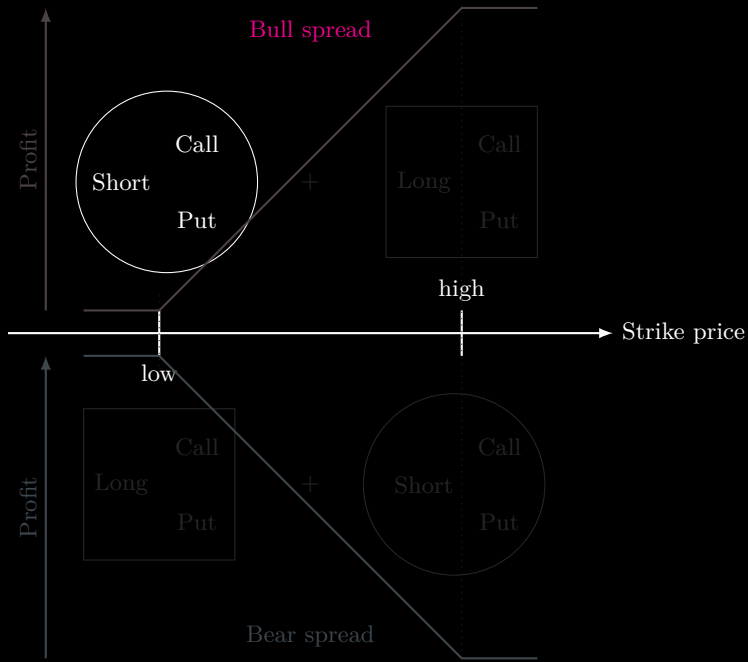
## Bull and bear spreads

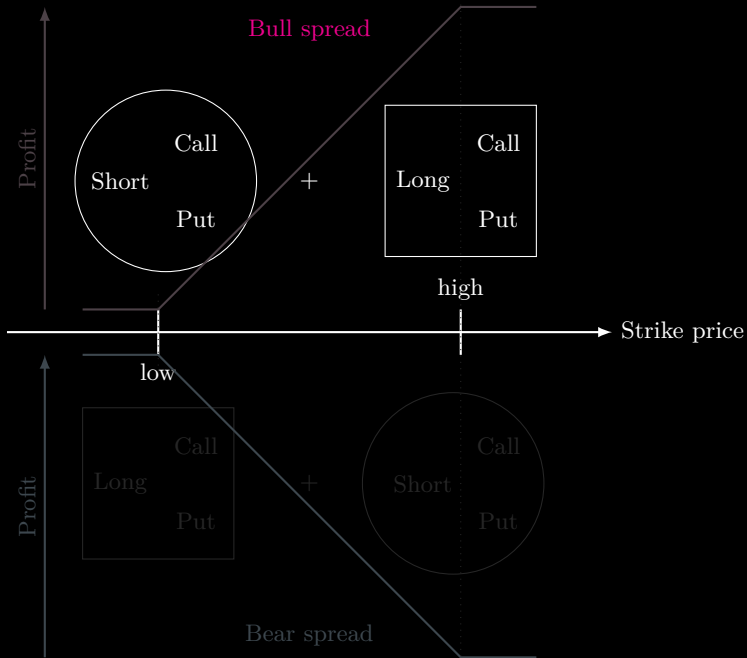
A position in which you buy a call and sell an otherwise identical call with a higher strike price is an example of a **bull spread**. Bull spreads can also be constructed using puts.

The opposite of a bull spread is a **bear spread**.

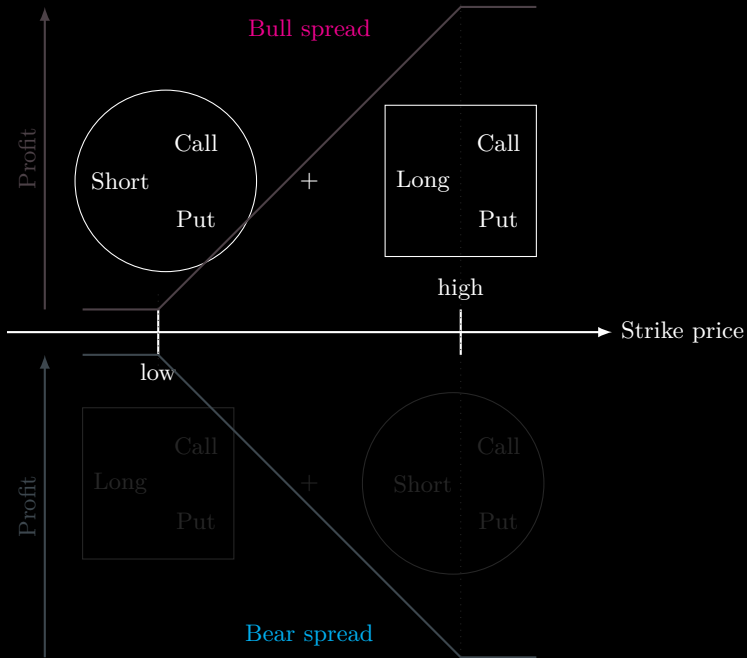


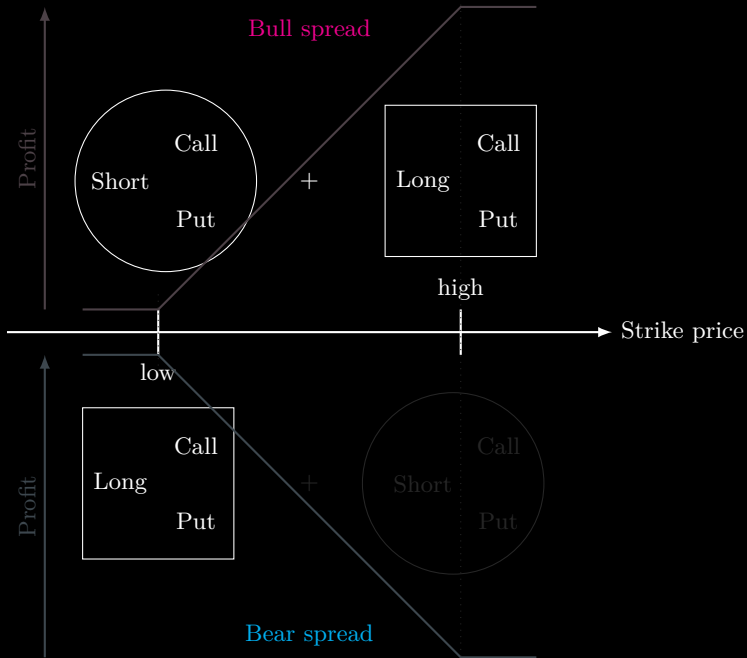


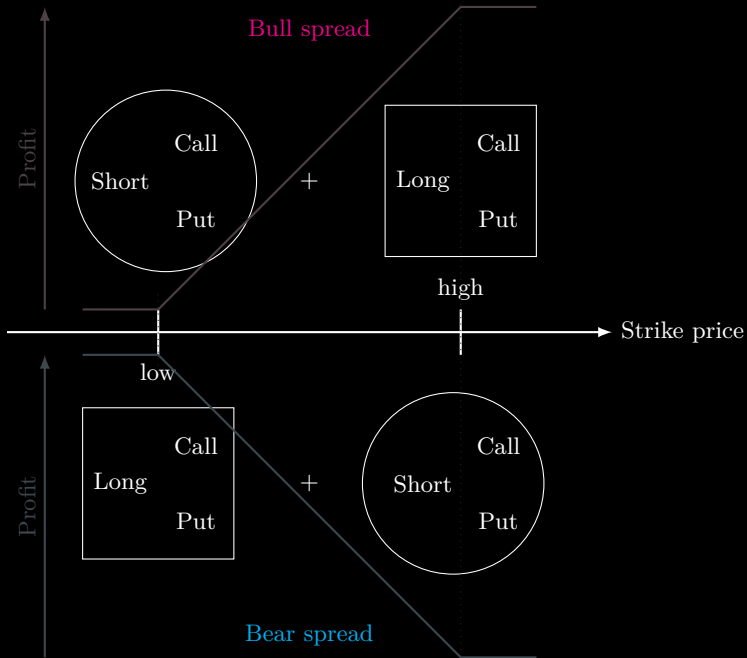


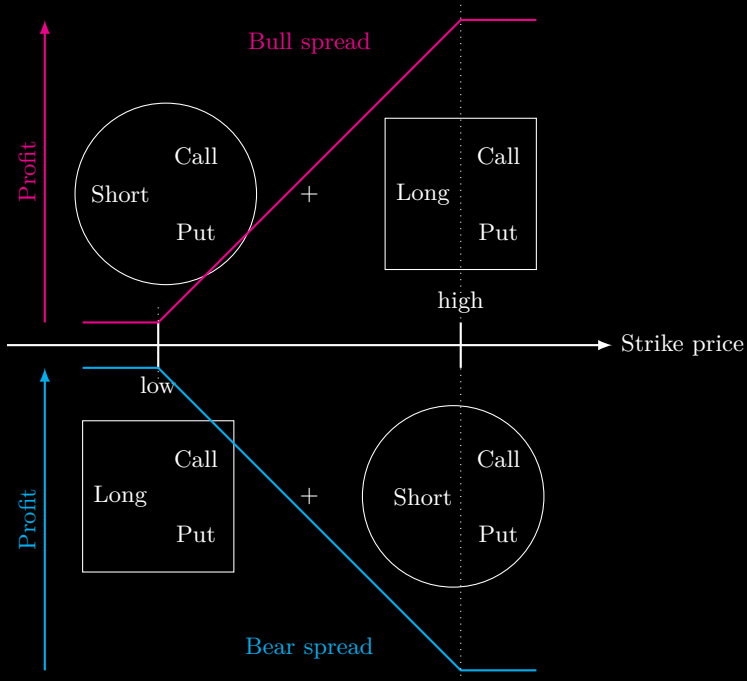












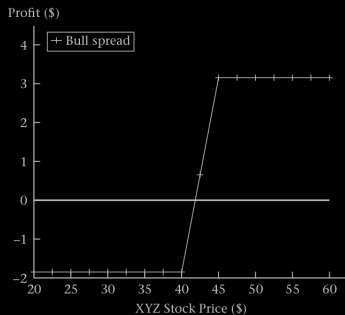
**Example 3.3-1** Draw profit diagram for a 40-45 bull spread, namely, buying a 40-strike call and selling a 45-strike call.

Solution.



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**Solution.**



## Box spreads

A **box spread** is accomplished by using options to create a **synthetic long forward** at one price and a **synthetic short forward** at a different price.

This strategy guarantees a cash flow in the future.

Hence, it is an option spread that is purely a means of borrowing or lending money. It is costly but has no stock price risk.

**Example 3.3-2** Suppose we simultaneously enter into the following two transactions:

1. Buy a 40-strike call and sell a 40-strike put.
2. Sell a 45-strike call and buy a 45-strike put.

Explain why there is no free lunch. Draw the profit diagram.

Solution. Check book 74.





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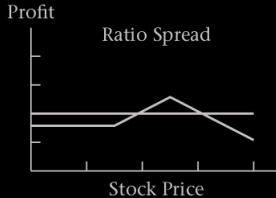
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**Solution.** Check book 74.



## Ratio spreads

A **ratio spread** is constructed by buying  $m$  options at one strike and selling  $n$  options at a different strike, with all options having the same type (call or put), same time to maturity, and same underlying asset.



**Example 3.3-3 (Problem 3.15)** Compute profit diagrams for the following ratio spreads:

- a Buy 950-strike call, sell two 1050-strike calls.
- b Buy two 950-strike calls, sell three 1050-strike calls.
- c Consider buying  $n$  950-strike calls and selling  $m$  1050-strike calls so that the premium of the position is zero. Considering your analysis in (a) and (b), what can you say about  $n/m$ ? What exact ratio gives you a zero premium?

Solution. Homework.



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Solution. Homework.



## Collars

A **collar** is the purchase of a put option and the sale of a call option with a higher strike price, with both options having the same underlying asset and having the same expiration date.

If the position is reversed, i.e., sale of a put and purchase of a call, the collar is written.

The **collar width** is the difference between the call and put strikes.

**Example 3.3-4** Draw the profit diagram for a purchased collar:

selling a 45-strike call + buying a 40-strike put.

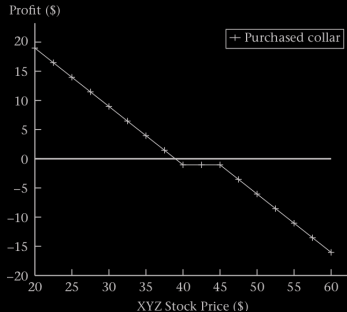
Solution.



Example 3.3-4 Draw the profit diagram for a purchased collar:

selling a 45-strike call + buying a 40-strike put.

Solution.



It is possible to find strike prices for the put and call such that the two premiums exactly offset one another. This position is called a **zero-cost collar**.

Example 3.3-5 Consider XYZ:

Strike	Call	Put
35	6.13	0.44
40	2.78	1.99
41.72	1.99	—
45	0.97	5.08

Show that the following gives a zero-cost collar

buying XYZ at \$40 + buying a 40-strike put + selling a 41.72-strike call

Draw the profit diagram.

Solution. Check book p. 77.



Example 3.3-5 Consider XYZ:

Strike	Call	Put
35	6.13	0.44
40	2.78	1.99
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Show that the following gives a zero-cost collar

buying XYZ at \$40 + buying a 40-strike put + selling a 41.72-strike call

Draw the profit diagram.

Solution. Check book p. 77.

