

# Options

Reference: Bodie et al, Ch 20

Econ 457

Week 13-a

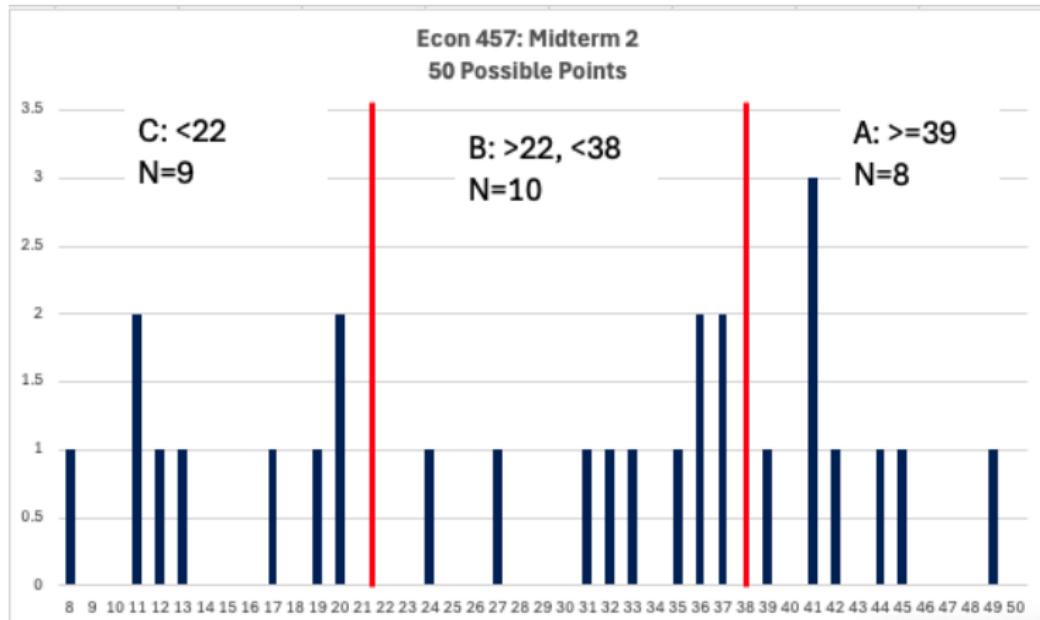
# Outline

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1. Put and Call Options
2. Options v. Stock Investments
3. Common Option Strategies
4. Other Options

# Midterm

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# Grades for Econ 457

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Table: Grades for Econ 457

Item	Percent of Total
Homework	25%
Mid-term 1	20%
Mid-term 2	20%
Final	35%

## 2. Economics 457

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### Material Covered

Subject	Book Chapters	Sub-topics
Intro	5	Measuring Returns, Distribution of Returns, Evaluating Returns
Portfolio Construction	6, 7, 8	Capital Allocation, Diversification, Index Model
Market Equilibrium	9, 10, 11, 12	CAPM, Fama-French Factors, Efficient Market Hypothesis
Fixed Income	14, 15, 16	Prices, Yields, Yield Curve, Duration and Convexity
Equity	18	Dividend Discount Models, Price-Earnings Ratios
Derivatives	20, 21, 22, 23	Futures, Swaps, Options

Note, this is subject to change throughout the semester.

# 1. Put and Call Options

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Definitions

## Call Option

- Gives its holder the right to **buy** an security at a specified price on or before some expiration date.
- Holder will exercise only if the price of the security is **above** the specified price.

## Put Option

- Gives its holder the right to **sell** an security at a specified price on or before some expiration date.
- Holder will exercise only if the price of the security is **below** the specified price.

# 1. Put and Call Options

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Standard Notation

## Standard Notation:

- **Strike Price (K):** The price at which the option can be exercised
- **Current Price (S):** Current market price of the underlying security
- **Expiration Date (T):** Last date the option can be exercised
- **Time to Expiration ( $\tau$ ):** Time remaining until expiration  
 $(\tau = T - t)$
- **Premium (C, P):** Price paid to purchase the option
  - $C$  = Call option premium
  - $P$  = Put option premium

# 1. Put and Call Options

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## Terminology

At the current price, an option is said to be...

- *In the money* when exercising the option would produce a positive cash flow
  - For a call option, security price is *above* the exercise price ( $S - K > 0$ )
  - For a put option, security price is *below* the exercise price. ( $S - K < 0$ )
- *Out of the money* when exercising the option would produce a negative cash flow
- *At the money* the current price is equal to the exercise price.

# 1. Put and Call Options

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## Call Options

The value of a **call** option at expiration equals:

$$\text{Call Payoff} = \begin{cases} S_T - K - C & \text{if } S_T > K \\ -C & \text{if } S_T \leq K \end{cases}$$

**Alternatively written as:**

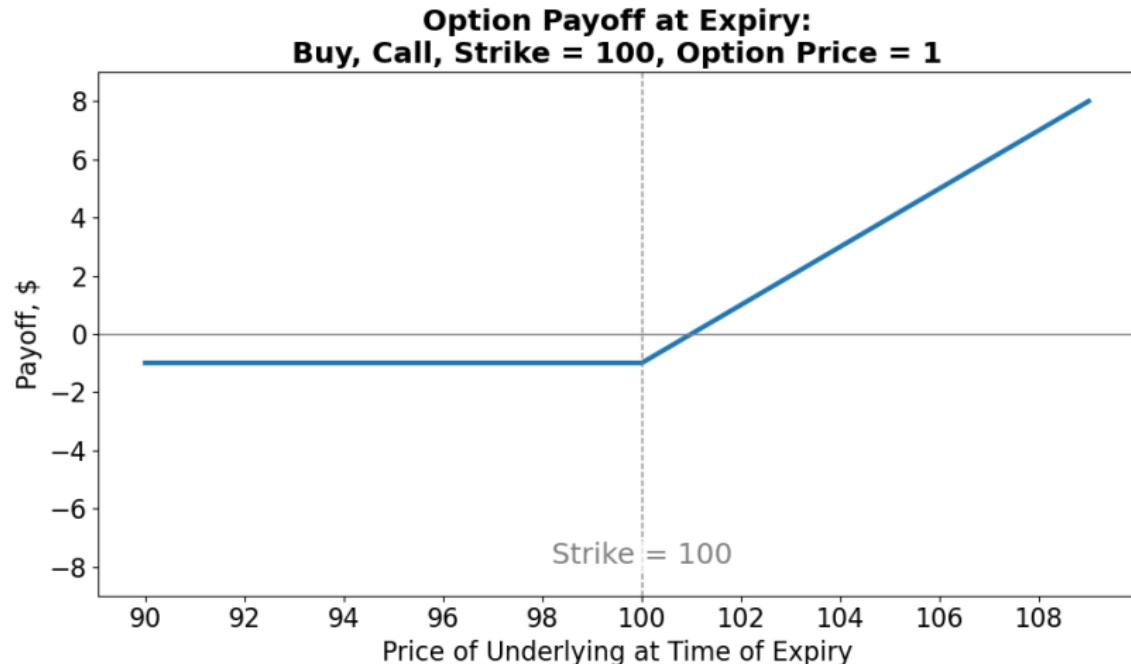
$$\text{Call Payoff} = \max(S_T - K, 0) - C$$

**Where:**

- $S_T$  = Stock price at expiration
- $K$  = Strike (exercise) price
- $C$  is the price paid for the call option

# 1. Put and Call Options

## Call Options



# 1. Put and Call Options

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## Call Options

Selling an option is sometimes referred to as 'writting' an option.

The payoff at expire for the seller of an option is the inverse of the payoff for the buyer of an option.

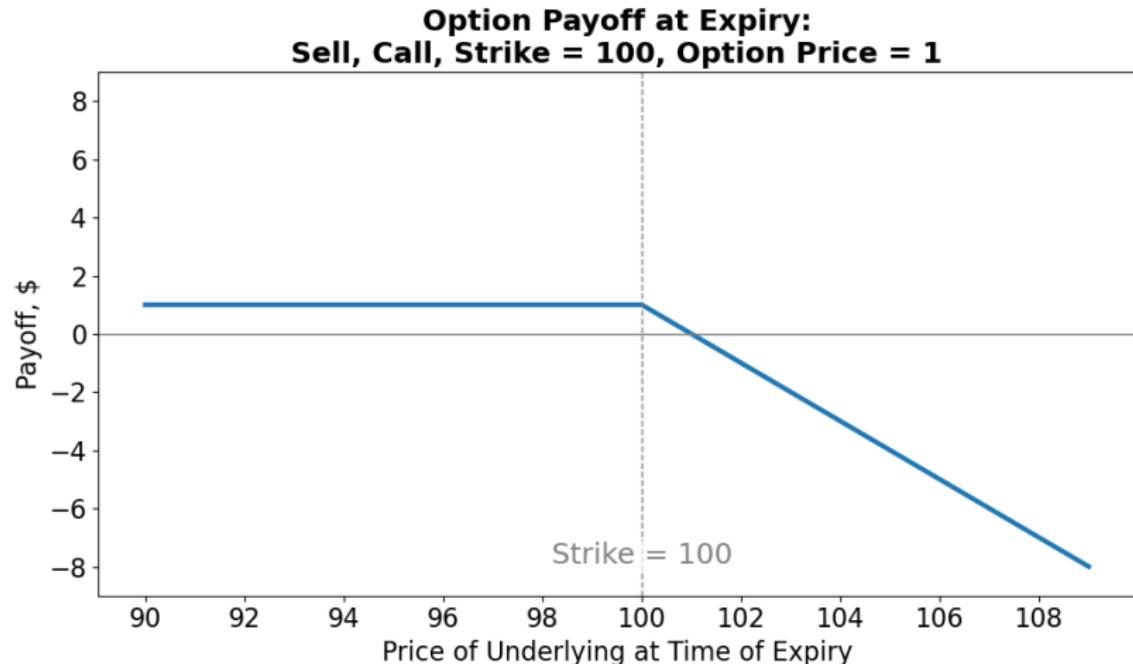
The value of a **writing a call** option at expiration equals:

$$\text{Call Writing Payoff} = \begin{cases} -(S_T - K) + C & \text{if } S_T > K \\ +C & \text{if } S_T \leq K \end{cases}$$

With the standard notation for  $S_T$ ,  $K$ , and  $C$

# 1. Put and Call Options

## Call Options



# 1. Put and Call Options

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## Put Options

The value of a **put** option at expiration equals:

$$\text{Put Payoff} = \begin{cases} -P & \text{if } S_T > K \\ (K - S_T) - P & \text{if } S_T \leq K \end{cases}$$

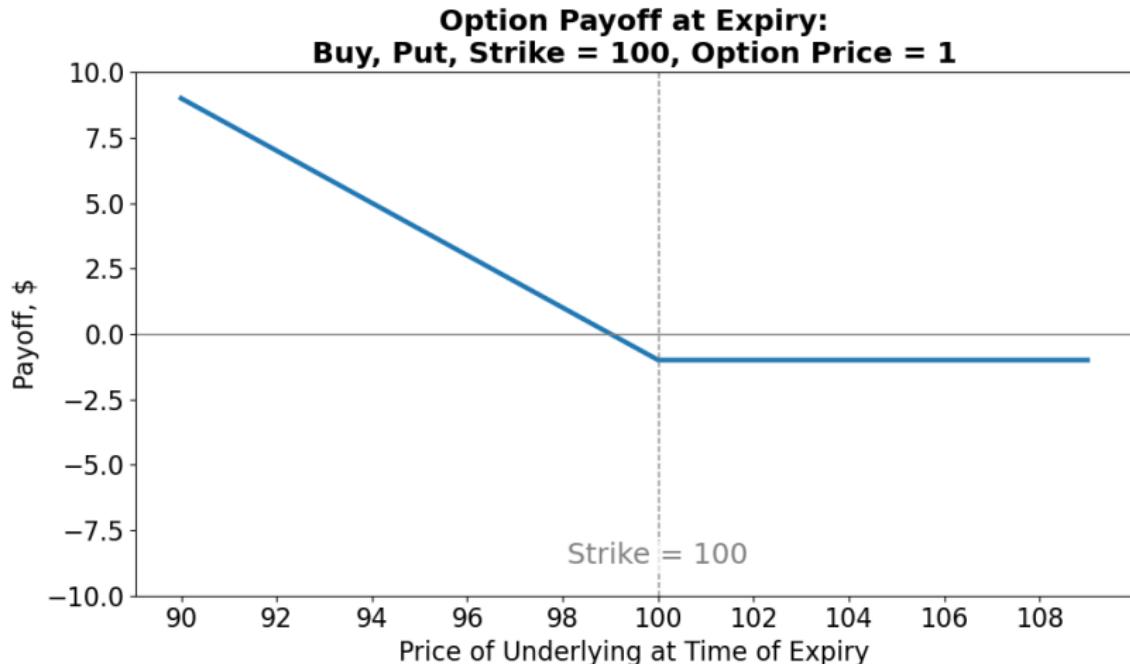
**Alternatively written as:**

$$\text{Put Payoff} = \max((K - S_T), 0) - P$$

Where  $S_T$  = Stock price at expiration,  $K$  = Strike (exercise) price, and  $P$  is the price paid for the put option

# 1. Put and Call Options

## Put Options



# 1. Put and Call Options

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## Put Options

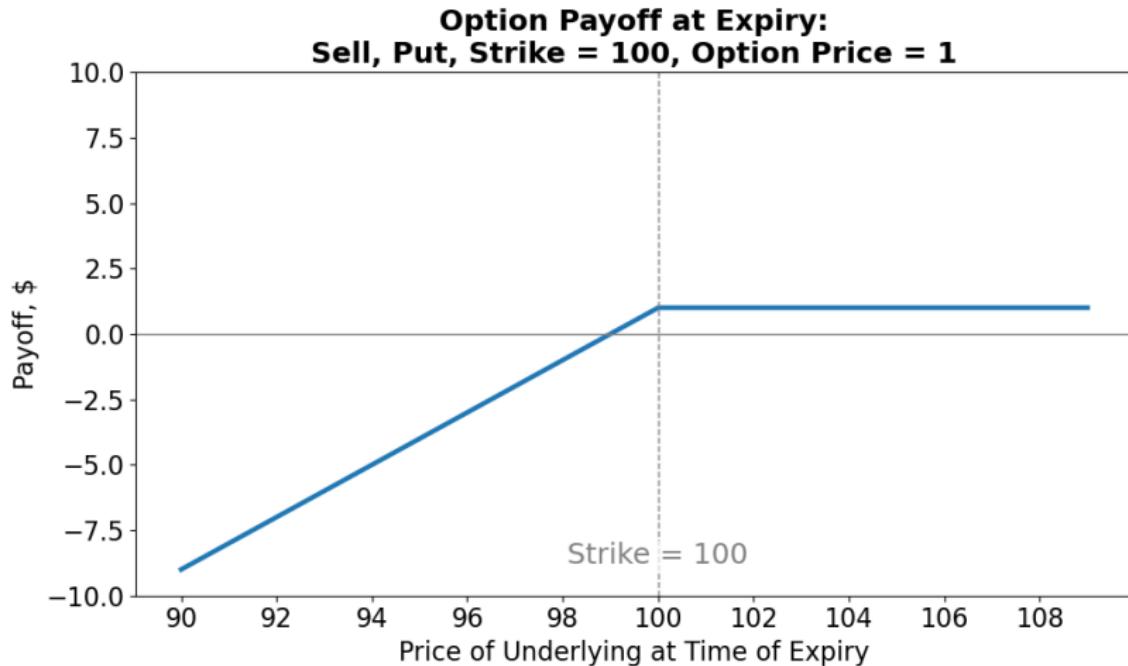
The value of a **writing a put** option at expiration equals:

$$\text{Put Writing Payoff} = \begin{cases} P & \text{if } S_T > K \\ -(K - S_T) + P & \text{if } S_T \leq K \end{cases}$$

With the standard notation for  $S_T$ ,  $K$ , and  $P$

# 1. Put and Call Options

## Put Options



## 2. Options v. Stock Investments

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When would you purchase a call option rather than buy shares of stock directly?

Example:

- Suppose you think a stock, currently selling for \$100, will appreciate
- A 1-year maturity call option with an exercise price of \$100 currently sells for \$10 and the interest rate is 3%
- You have \$10,000 to invest

## 2. Options v. Stock Investments

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Strategies:

- A. Invest entirely in stock
  - o Buy 100 shares, each selling for \$100
- B. Invest entirely in at-the-money- call options
  - o Buy 1,000 calls, each selling for \$10
- C. Invest in call options and T-Bills
  - o Buy 100 call options, paying a total of \$1,000
  - o Invest your remaining \$9,000 in 1-year T-Bills to earn 3% interest

## 2. Options v. Stock Investments

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Table: Portfolio Value by Portfolio Strategy

Portfolio	Stock Price					
	\$95	\$100	\$105	\$110	\$115	\$120
Portfolio A: All stock	\$9.5k	\$10k	\$10.5k	\$11k	\$11.5k	\$12k
Portfolio B: All options	0	0	5k	10k	15k	20k
Portfolio C: Call + T-bills	9.27k	9.27k	9.77k	10.27k	10.77k	11.27k

## 2. Options v. Stock Investments

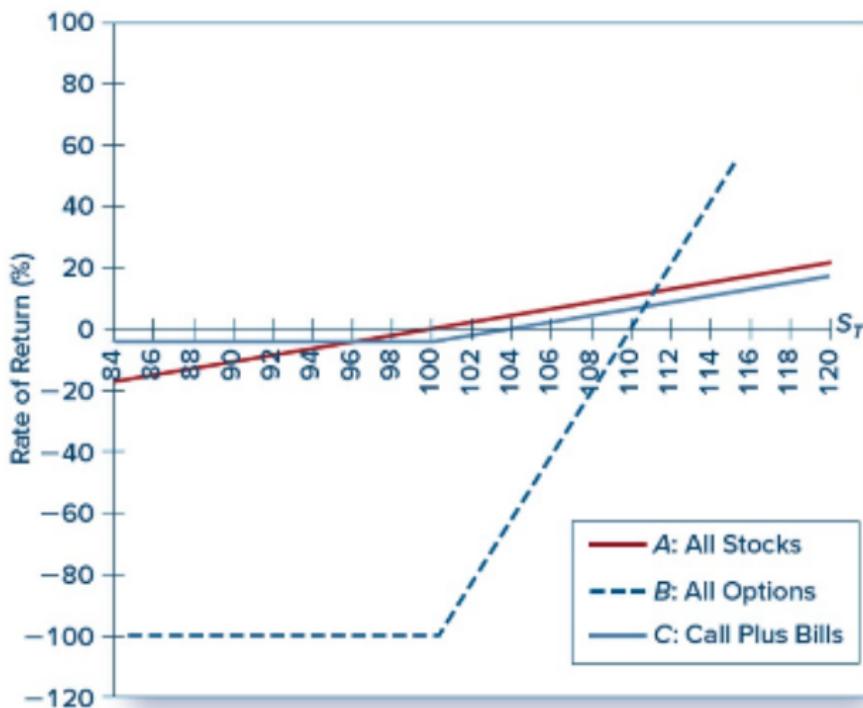
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Table: Rate of Return by Portfolio Strategy

Portfolio	Stock Price					
	\$95	\$100	\$105	\$110	\$115	\$120
Portfolio A: All stock	-5%	0%	5%	10%	15%	20%
Portfolio B: All options	-100%	-100%	-50%	0.0%	50%	100%
Portfolio C: Call + T-bills	-7.3%	-7.3%	-2.3%	2.7%	7.7%	12.7%

### 3. Common Option Strategies

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### 3. Common Option Strategies

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Options provide **leverage**. Portfolio B, which gets its exposure through options, performs more than proportionally to changes in the stock price. This can mean large upside, but it can also result in losing all the investment.

Options can also provide **insurance**. Portfolio C, which has options and T-bills, can never lose more than 9.2% (limited downside). However, some return is necessarily sacrificed for the insurance. Portfolio C underperforms an all stock portfolio when the stock rises.

### 3. Common Option Strategies

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Five common option strategies:

1. Selling a Covered Call
2. Buying a Protective Put
3. Call or put spreads
4. Straddle
5. Strangle

### 3. Common Option Strategies

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#### Selling a Covered Call

Selling a covered call:

- Own the underlying security
- Sell a call

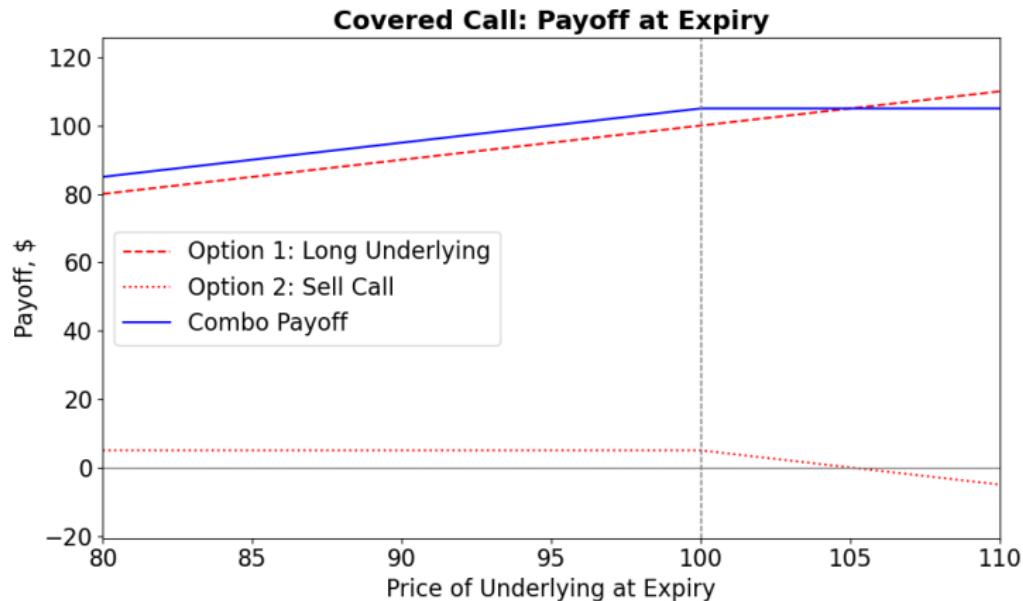
Considerations:

- Typically the call strike is out of the money at time of sale.
- Income from  $C$  improves returns around and below strike price
- Returns are capped (sell away large gains)
- Loss unlimited, although slightly better than outright long, due to  $C$

### 3. Common Option Strategies

Selling a Covered Call

Payoff at Expiry from **Selling a Covered Call**



### 3. Common Option Strategies

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Buying a Protective Put

Buying a protective put:

- Own the underlying security
- Buy a put

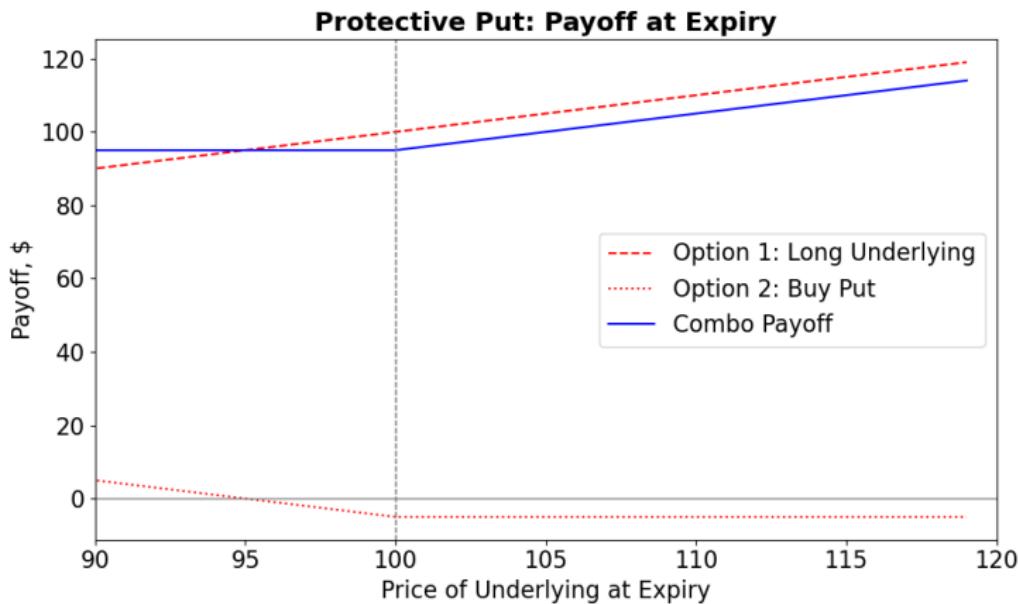
Considerations:

- Typically the put strike is out of the money at time of purchase.
- Cost of  $P$  detracts from returns around and below strike price
- Losses are limited (bought insurance against large losses)

### 3. Common Option Strategies

Buying a Protective Put

Payoff at Expiry from **Buying a Protective Put**



### 3. Common Option Strategies

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#### Call or Put Spreads

##### Buying a Call Spread:

- Buy an out of the money call:  $K_1 = S_0 + x_1$
- Sell a call further out of the money  $K_2 = S_0 + x_2$
- Selling the second call reduces the cost:  $C_1 - C_2 < C_1$

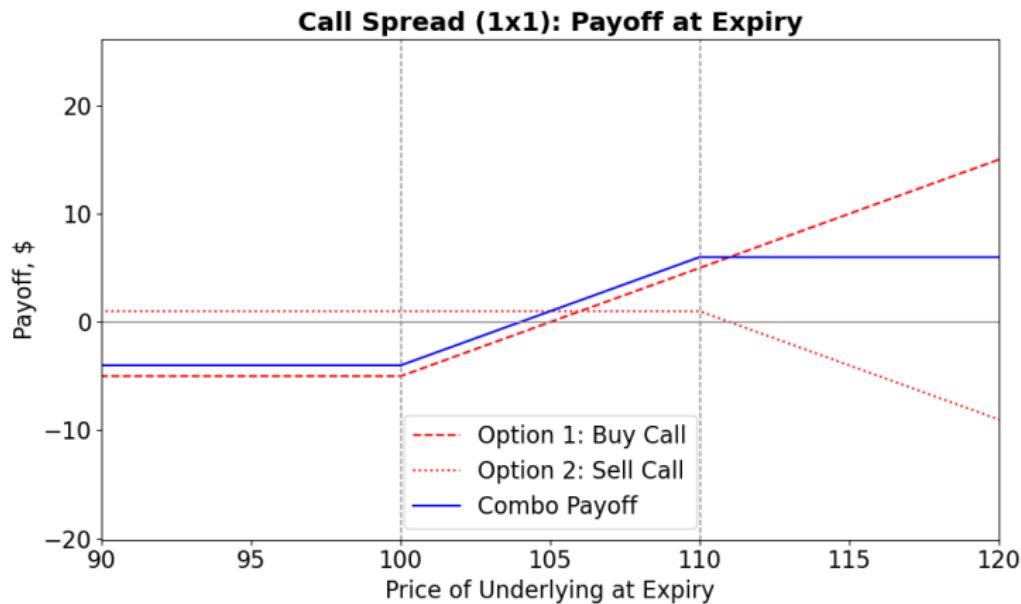
##### Considerations:

- Purchasing options can be expensive, spreads are less expensive.
- Often executed as a 1x2: Buy one option, sell two options
- Losses are limited (bought insurance against large losses)

### 3. Common Option Strategies

Call Spread (1x1)

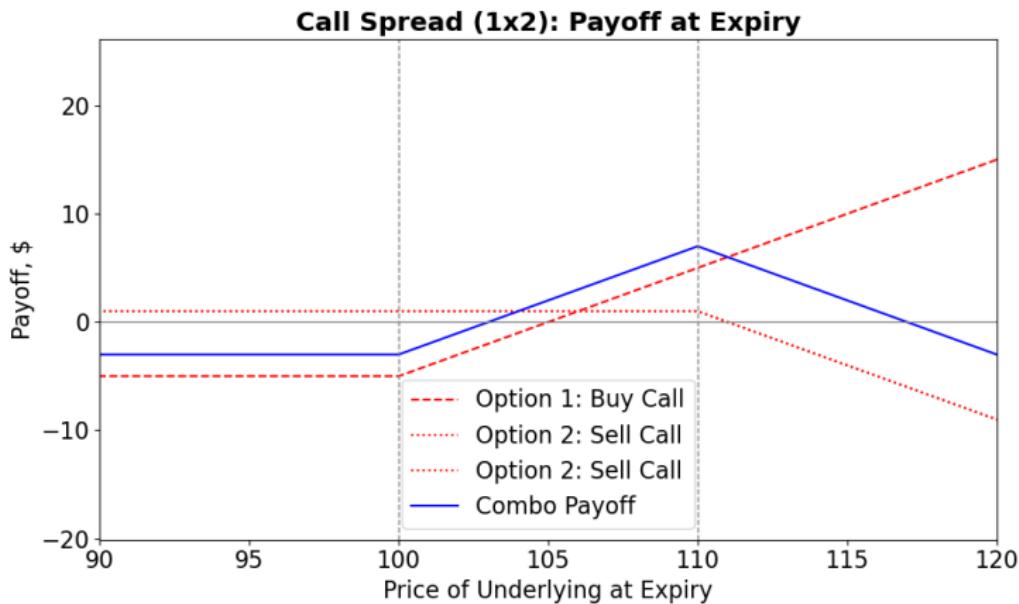
Payoff at Expiry from **Call Spread (1x1)**



### 3. Common Option Strategies

Call Spread (1x2)

Payoff at Expiry from **Call Spread (1x2)**



### 3. Common Option Strategies

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#### Straddles

Buying a Straddle:

- Buy a call option at the money:  $K = S_0$
- Buy a put option at the money:  $K = S_0$  (same strike price)
- Both options have the same expiration date
- Total cost:  $C + P$

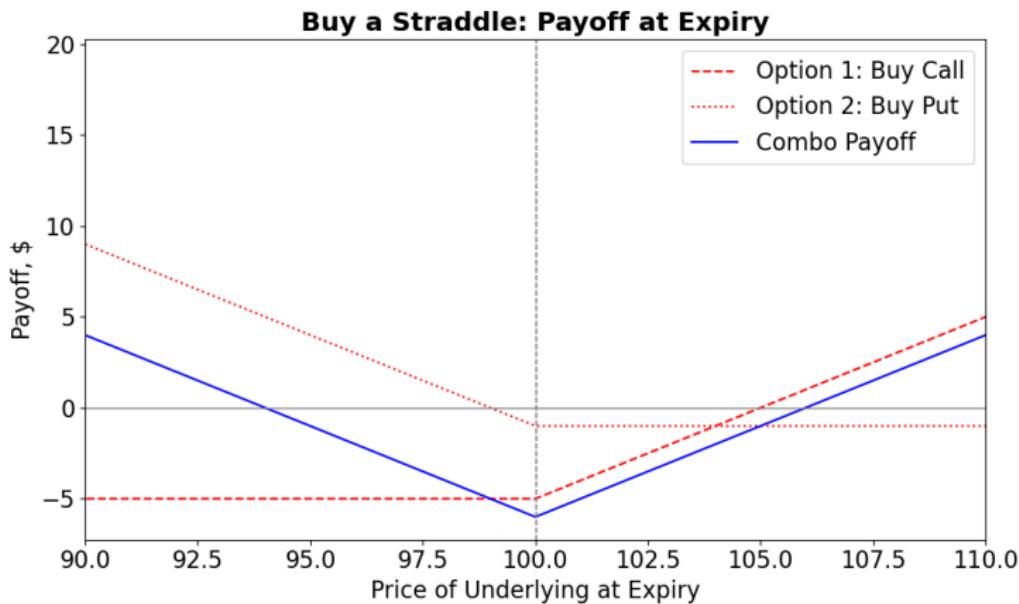
Considerations:

- Profits from large price movements in either direction
- Expensive strategy due to purchasing two at-the-money options
- Requires significant price movement to overcome premium costs
- Maximum loss is limited to total premiums paid ( $C + P$ )
- Used when expecting high volatility but uncertain about direction

### 3. Common Option Strategies

Buy Straddle

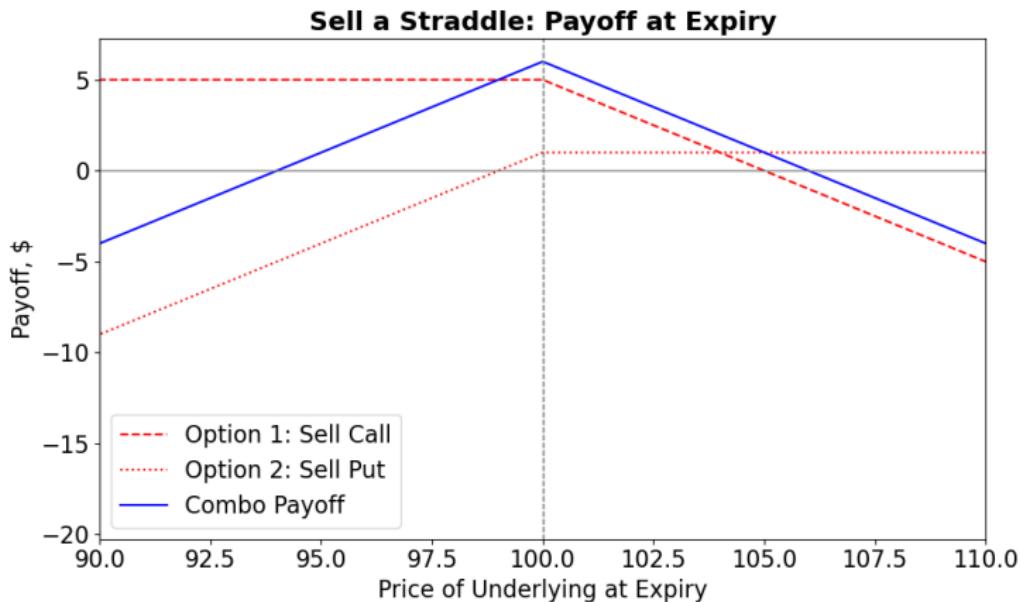
Payoff at Expiry from **Buy Straddle**



### 3. Common Option Strategies

Sell Straddle

Payoff at Expiry from **Sell Straddle**



### 3. Common Option Strategies

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#### Strangle

Buying a Strangle:

- Similar to Straddle, but separate the strikes – move the put strike down slightly and the call strike up slightly

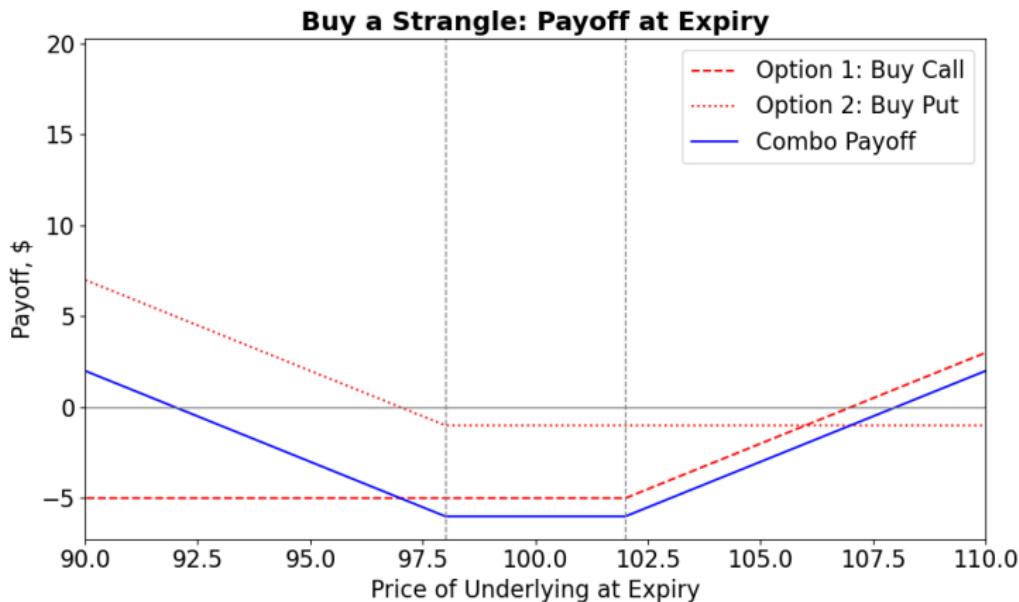
Considerations:

- Similar to straddle – profit from large price moves in either direction
- Less expensive than a straddle (because strikes are out of the money, premium is lower)
- Need a large move to profit

### 3. Common Option Strategies

Buy Strangle

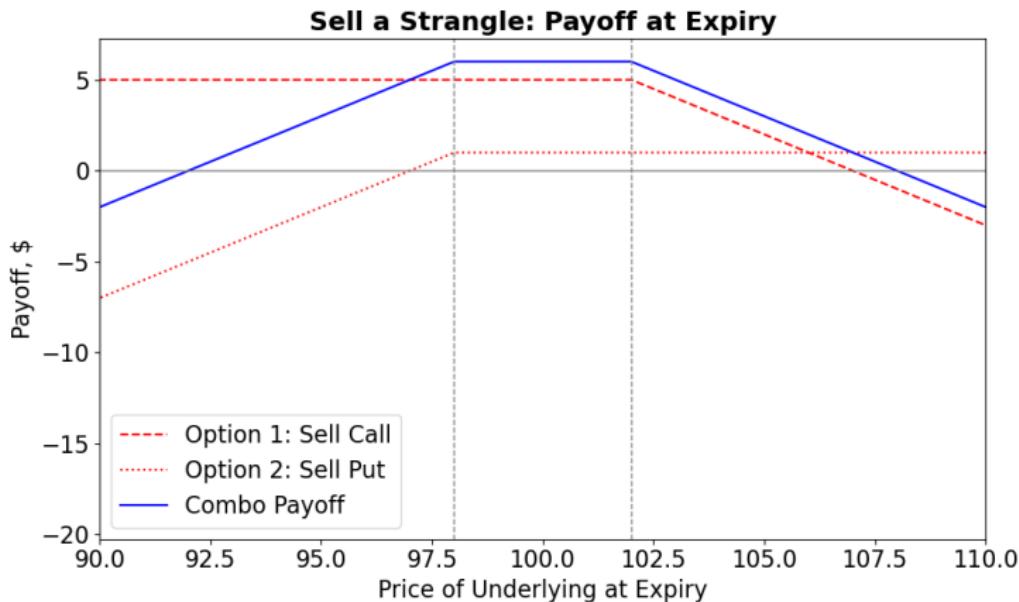
Payoff at Expiry from **Buy Strangle**



### 3. Common Option Strategies

#### Sell Strangle

##### Payoff at Expiry from **Sell Strangle**



## 5. Practice

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### Practice Questions

1. What are the trade-offs facing an investor who is considering buying a put option on an existing portfolio?
2. What are the trade-offs facing an investor who is considering writing a call option on an existing portfolio?
3. You expect that a stock will break out of its recent range. You don't know which direction. What is a simple options strategy to position for your view? Assuming that at-the-money puts and calls both cost \$1, how much does the stock need to move in order for your strategy to be profitable.
4. In what ways is owning a corporate bond similar to selling a put option?

## 5. Practice

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### Practice Questions

5. You sell a call option with  $X = 50$  and buy a call option with  $X = 60$ . The options are on the same stock and have the same expiration. One of the calls sells for \$3 and the other sells for \$9. Draw the payoff graph for this strategy at option expiration. What is the breakeven point for this strategy? Is the investor bullish or bearish on the stock?
6. An investor purchases a stock for \$28 and a put for \$0.50 with a strike price of \$35. The investor also sells a call for \$0.50 with a strike price of \$40. What are the maximum possible profit and loss for this position? Draw the profit and loss diagram for this strategy as a function of the stock price at expiration.