Introduction

- **Definition**
  - *Option* is the *right* to buy or sell an underlying asset at a specified price on or before a specified date.

- **Key elements of an option**
  - Specified price: Exercise price or Strike price (*X*)
  - Specified date: Expiration date (*T*)
    - Exercise only on expiration date: European option
    - Exercise on or before expiration: American option
  - Option premium: the price of the option

- **Call**: right to buy
- **Put**: right to sell
Example

- On 10/18/1999, IBM Dec155 Call trades at $8 3/8; IBM stock price is $159 3/8

- What does it tell us?
  - Style: American Call
  - Underlying Security: IBM Stock
  - Strike Price: $155 (X)
  - Expiration Month: Dec, 1999
  - Expiration Date: The 3rd Friday
  - Current asset price: $159 3/8 (S)
  - Call price (premium): $8 3/8

Option creation and exercise

- 10/18/1999: 1 contract of IBM Dec155 call created

- Pay Option Premium = $8 3/8 * 100
  - Option Buyer (Long position) → Option Seller (Short position)
  - IBM Dec. 155 Call

- 12/18/1999 or before: buyer exercises call

- Pay $155 * 100
  - Option Buyer (Long position) ← Option Seller (Short position)
  - 100 shares of IBM stock

- When to exercise?
  - Decision: exercise if $S_t > $155
  - Payoff per share: $S_t - $155
Moneyness of the Options

- **In-the-money (ITM):** positive payoff for immediate exercise
  - For call: \( S_t - X > 0 \)
  - For put: \( S_t - X < 0 \)
- **At-the-money (ATM):** zero payoff for immediate exercise
  - For both call and put: \( S_t - X = 0 \)
- **Out-of-the-money (OTM):** negative payoff for immediate exercise
  - For call: \( S_t - X < 0 \)
  - For put: \( S_t - X > 0 \)

Example of Moneyness of Options

- Current IBM stock price \( S = \$155 \)
  - Option 1: Dec150 IBM call
  - Option 2: Dec155 IBM call
  - Option 3: Dec160 IBM call
  - Option 4: Dec160 IBM put
Option Payoff versus Option Profit/Loss

- **Notation**
  - Security Price: \( S_t \)
  - Strike (Exercise) Price: \( X \)

- **Payoff per share at expiration for a call**
  - Payoff = \( \max(S_T - X, 0) \)
    - Payoff = \( S_T - X \) if \( S_T > X \), option is in-the-money
    - Payoff = 0 if \( S_T < X \), option is out-of-the-money

- **Profit or loss**
  - \( P/L = \) Payoff – Option Premium

An Example of Option Profit/Loss

- IBM Dec155 call trading at $8 3/8
- Decision Time: 12/18/1999

<table>
<thead>
<tr>
<th>Possible Price of IBM on 12/18/99 (( X = $155 ))</th>
<th>( ST - X )</th>
<th>Exercise</th>
<th>Option Decision</th>
<th>Option Payoff</th>
<th>Option P/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>$145</td>
<td>$145-$155 &lt; 0</td>
<td>No Exercise</td>
<td>0</td>
<td>-8.375</td>
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<tr>
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<tr>
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</table>
Payoff vs. P/L for Call Option

- Payoff Diagram of IBM Dec155 Call

Payoff of A Call Option

Value

- $8 3/8 (Premium)

IBM price at T

S_T

P/L

Leverage Effect of Call Option

- IBM price $150; IBM Dec150 ATM call price $15;
  Start with $15,000 in the account

- Strategy 1 (all equity): buy 100 share of IBM
- Strategy 2 (all option): buy 10 contract call

<table>
<thead>
<tr>
<th>S_T</th>
<th>Gain at T</th>
<th>Return</th>
<th>Gain at T</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>$180</td>
<td>100*30</td>
<td>20%</td>
<td>10<em>100</em>15</td>
<td>100%</td>
</tr>
<tr>
<td>$120</td>
<td>100*(-30)</td>
<td>-20%</td>
<td>10<em>100</em>(-15)</td>
<td>-100%</td>
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</tbody>
</table>

Options magnify both gains and losses
Payoff vs. Profit / Loss for Put Option

- **IBM Dec155 Put**

Payoff of Puts at \( T \):

\[
\text{Payoff} = \begin{cases} 
X - S_T & \text{if } S_T < X \\
0 & \text{if } S_T \geq X
\end{cases}
\]

Wrap-up

- Definition of Call and Put options
- Difference between American and European options
- ITM vs. OTM vs. ATM
- Option payoff vs. option profit/loss
- Payoff and P/L diagrams for call and put