Chapter 14
Option Market – Part II

Call Options Payoffs and Profits at Expiration

- Payoff to call holder (buyer)
  $\max \{S_T - X, 0\}$
- Payoff to call writer (seller)
  $- \max \{S_T - X, 0\}$

- Profit to call holder
  $\max \{S_T - X, 0\} - \text{Premium}$
- Profit to Call Writer
  $\text{Premium} - \max \{S_T - X, 0\}$
Payoff Profiles for Calls

Profit/Loss Profiles for Calls
Put Options Payoffs and Profits at Expiration

- Payoff to put holder (buyer)
  \[ \text{max} \{X - S_T, 0\} \]

- Payoff to put writer (seller)
  \[-\text{max} \{X - S_T, 0\} \]

- Profit to put holder
  \[ \text{max} \{X - S_T, 0\} - \text{Premium} \]

- Profit to put Writer
  \[ \text{Premium} - \text{max} \{X - S_T, 0\} \]

Payoff Profiles for Puts

- Put Holder
- Put Writer

Stock Price at time T

ITM

OTM
Profit/Loss Profiles for Puts

<table>
<thead>
<tr>
<th>Stock Price at time T</th>
<th>ITM</th>
<th>OTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit for Put Writer</td>
<td>0</td>
<td>-P</td>
</tr>
<tr>
<td>Profit for Put Holder</td>
<td>X</td>
<td>0</td>
</tr>
</tbody>
</table>

Put-Call Parity Relationship

<table>
<thead>
<tr>
<th></th>
<th>$S_T \leq X$</th>
<th>$S_T &gt; X$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payoff for Holding a Call</td>
<td>0</td>
<td>$S_T - X$</td>
</tr>
<tr>
<td>Payoff for Writing A Put</td>
<td>- ($X - S_T$)</td>
<td>0</td>
</tr>
<tr>
<td>Total Payoff</td>
<td>$S_T - X$</td>
<td>$S_T - X$</td>
</tr>
</tbody>
</table>

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Payoff of a Long Call and A Short Put

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>Payoff</th>
<th>Combined Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>-X</td>
<td>-X</td>
<td>Short Put</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Long Call</td>
</tr>
</tbody>
</table>

Payoff of a Leverage Equity

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>Payoff</th>
<th>Combined Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>-X</td>
<td>-X</td>
<td>Short Bond</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Long Stock</td>
</tr>
</tbody>
</table>

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Put-Call Parity

- We can replicate the payoff from a long call and a short put by:
  - Long 1 share of stock today and hold it to $T$;
  - Borrow a margin loan in the amount of $\frac{X}{(1 + r_f)^T}$
- Since the payoff on a long call and a short put are equivalent to leveraged equity, the prices must be equal today:
  \[ C - P = S_0 - \frac{X}{(1 + r_f)^T} \]
- If the prices are not equal, arbitrage will be possible

An Example – Put Call Parity Arbitrage

Q: Stock Price = 110  Call Price = 17
   Risk Free = 5%   Put Price = 5
   Maturity = 1 yr  Strike Price = 105

Is there any arbitrage opportunity?

A: $C - P > S_0 - \frac{X}{(1 + r_f)^T}$
   17 - 5 > 110 - (105/1.05)
   12 > 10

Arbitrage opportunity:
- The leveraged equity is less expensive
- Buy (long) the low cost portfolio and sell (short) the high cost alternative
### An Example – Put-Call Parity Arbitrage

<table>
<thead>
<tr>
<th>Position</th>
<th>Immediate Cashflow</th>
<th>Cashflow in Six Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy Stock</td>
<td>-110</td>
<td>$S_T$  $S_T$</td>
</tr>
<tr>
<td>Borrow</td>
<td>$\frac{X}{(1+r)^T} = 100$</td>
<td>-105  -105</td>
</tr>
<tr>
<td>Sell Call</td>
<td>$+17$</td>
<td>0  $-(S_T - 105)$</td>
</tr>
<tr>
<td>Buy Put</td>
<td>$-5$</td>
<td>$105 - S_T$  0</td>
</tr>
</tbody>
</table>

Total: 2  0  0

### Option Strategy I – Protective Put

- **Long stock + Long (ATM) put**
  - Pay put premium for downside protection

![Diagram of Payoff from Long a stock, Long a put, and protective put](attachment:diagram.png)
Option Strategy II – Covered Call

- Long stock + short (sell / write) call
  - Sacrifice upside potential for call premium

Payoff at T

Payoff at T

Long a stock

Write a call

Covered Call

Payoff at T

Profit

Option Strategy III - Straddle

- Long call and put with same strike price
  - Benefit from big jumps in stock prices
Wrap-up

- Payout and P/L for holders and sellers of put or call options
- Put-call parity
- Three option strategies
  - Protective put
  - Covered call
  - Straddle