The Greeks measure the sensitivity of options to their determinants.

– These measurements are accurate for small changes only!

– The Greeks are partial derivatives, not total derivatives. Each measures the sensitivity of option’s value to one determinant, holding all others constant!
Delta ($\Delta$) is the rate of change of the option price with respect to the underlying.
Delta ($\Delta$)

$$\Delta = \frac{\partial V}{\partial S}$$

- **Call:** $\Delta_c = N(d_1)$
- **Put:** $\Delta_p = N(d_1) - 1$
- $\Delta_c > 0$, $\Delta_p < 0$
**Delta \((\Delta)\)**

**Delta \([\Delta]\):**
Measures the change in the option price for a change in the underlying price. Graphically, delta is the slope of the option as shown on the graphs below.

<table>
<thead>
<tr>
<th>Delta for a European call</th>
<th>Delta for a European put</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c)</td>
<td>(p)</td>
</tr>
<tr>
<td>(\Delta_c)</td>
<td>(\Delta_p)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>-1</td>
</tr>
</tbody>
</table>

![Graphs showing Delta for European Call and Put options](image)
Gamma ($\Gamma$): Gamma ($\Gamma$) measures the change in the option delta ($\Delta$) as the underlying price changes.

Gamma is greatest for options that are at-the-money.
**Theta (Ω)**

**Theta [Ω]:**
Theta measures the change in the option price as the expiration date approaches. It is usually negative since an option becomes less valuable as time passes.

**Θ as a function of underlying price (S)**

**Θ as a function of time to maturity (T)**
**Vega**

**Vega** \([v]\) :  
Vega measures the change in the option price with respect to a change in the volatility of the underlying asset. It is positive since an option on more volatile assets is more valuable.
**Rho \[\rho\]:**

Measures the change in the option price with respect to a change in the interest rate. It is positive for calls and negative for puts.

![Diagram showing Rho for calls and puts](image)