1. Managing the Risk of an Options Portfolio

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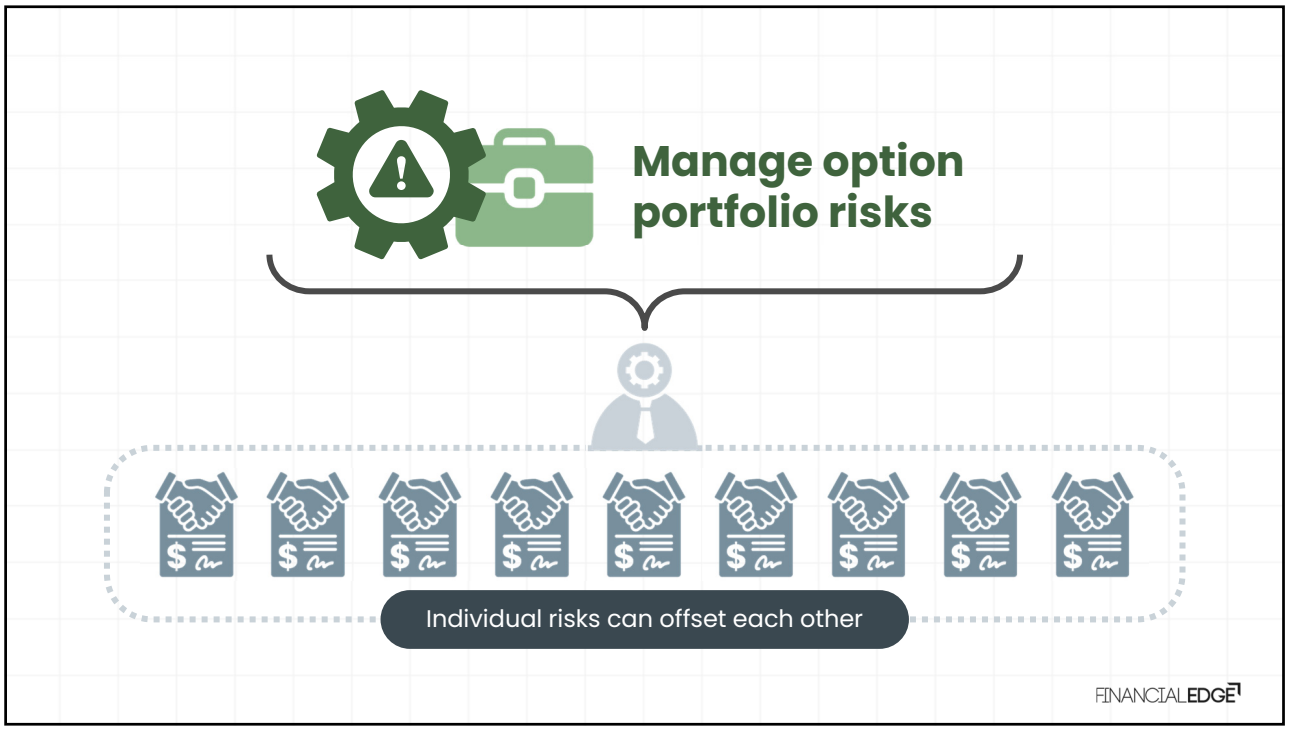

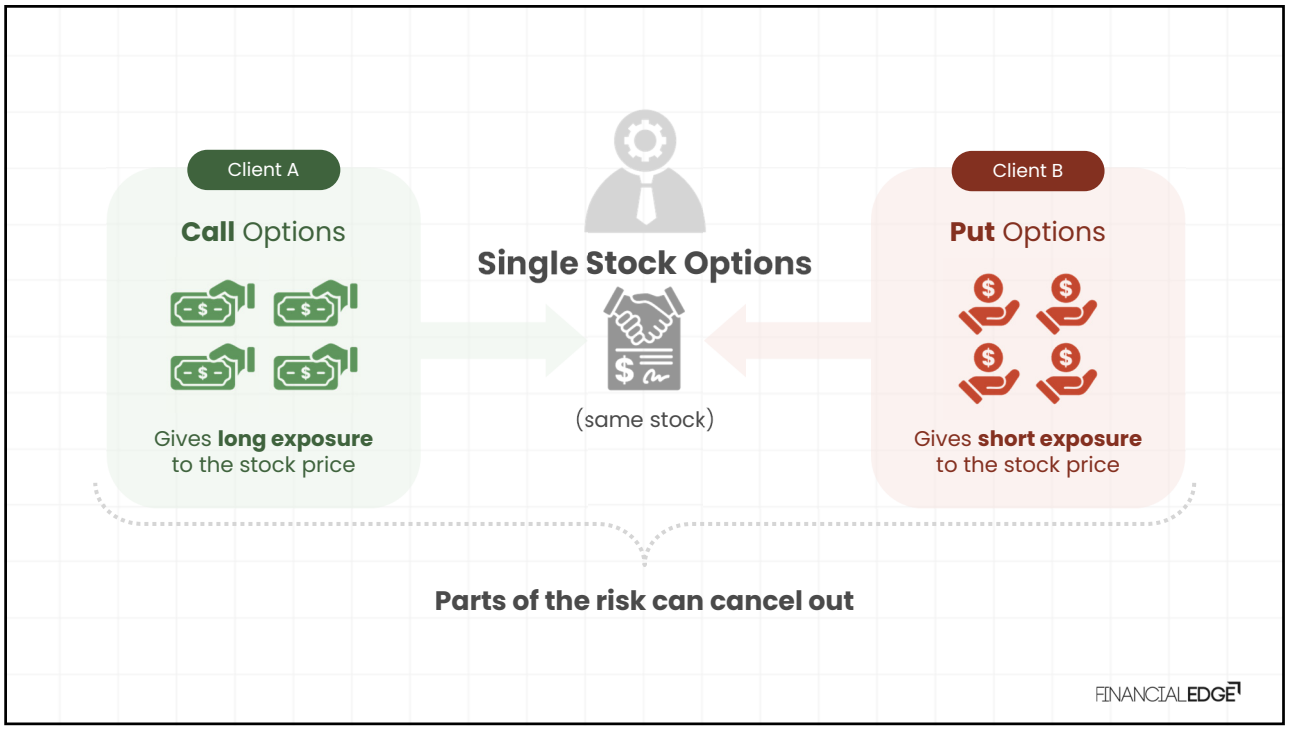

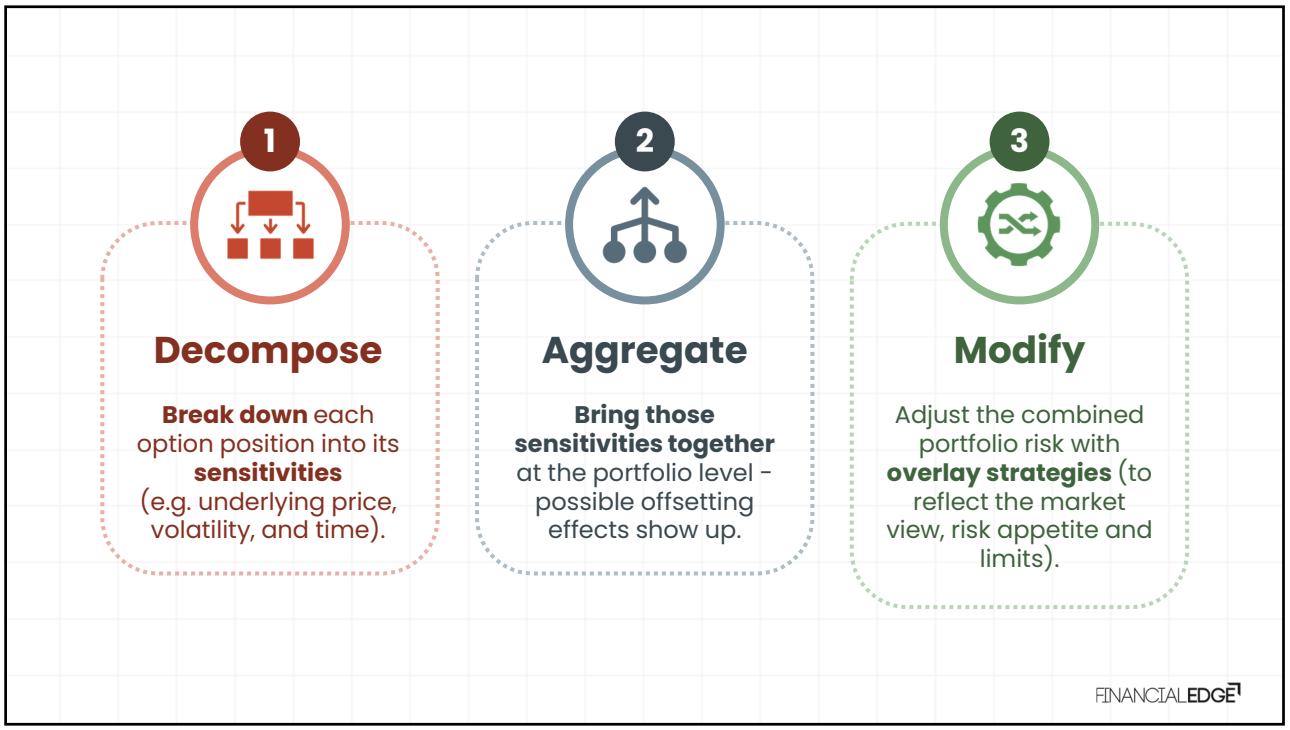

2. The Greeks – An Overview

How different market factors affect the value of options

Sensitivity measures - the Greeks

Most reliable for small moves (stress and scenario test for larger shocks)

Increased variable	Effect on call price:	Effect on put price:	Sensitivity:
Spot price	↑	↓	Delta (Δ)
Strike price	↓	↑	N/A
Time to expiry	↑	↑	Theta (θ)
Volatility	↑	↑	Vega (ν) / Kappa (κ)
Interest rates	↑	↓	Rho (ρ)
Underlying asset yield	↓	↑	Phi (Φ) / Rho-2

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Spot price	↑	↓	Delta (Δ)
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Interest rates	↑	↓	Rho (ρ)
Underlying asset yield	↓	↑	Phi (Φ) / Rho-2

Second-order (or Higher-order) Greeks

Don't measure how the option premium itself changes, but how a first-order sensitivity changes when market factors move

- Gamma (γ)
- Vanna
- Vomma

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3. Delta (Δ)

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Δ Delta

Indicates **the sensitivity of the option premium** to changes in the **underlying asset price**

Usually expressed **between 0 and 1** or between **0% and 100%**

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Often called a **participation ratio** or **likeness factor**

50% **Δ Delta** = If the underlying price increases by **$1**, the option premium will rise by about **50 cents**.

Usually expressed **between 0 and 1** or between **0% and 100%**

Do the **option's value** and the **underlying price** move in the **same direction**, or **opposite directions**?

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Do the **option's value** and the **underlying price** move in the **same direction**, or **opposite directions**?

Long Call

Option's value **increases** when the underlying **increases**.

Long Put

Option's value **decreases** when the underlying **increases**.

Positive delta (long delta)

Negative delta (short delta)

Short Put

Option's value **decreases** when the underlying **increases**.

Short Call

Option's value **increases** when the underlying **increases**.

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Hedge Ratio

How many units of the underlying asset need to be bought or sold to neutralize the directional risk of the option.

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4. Delta Hedging & Option Delta vs. Position Delta

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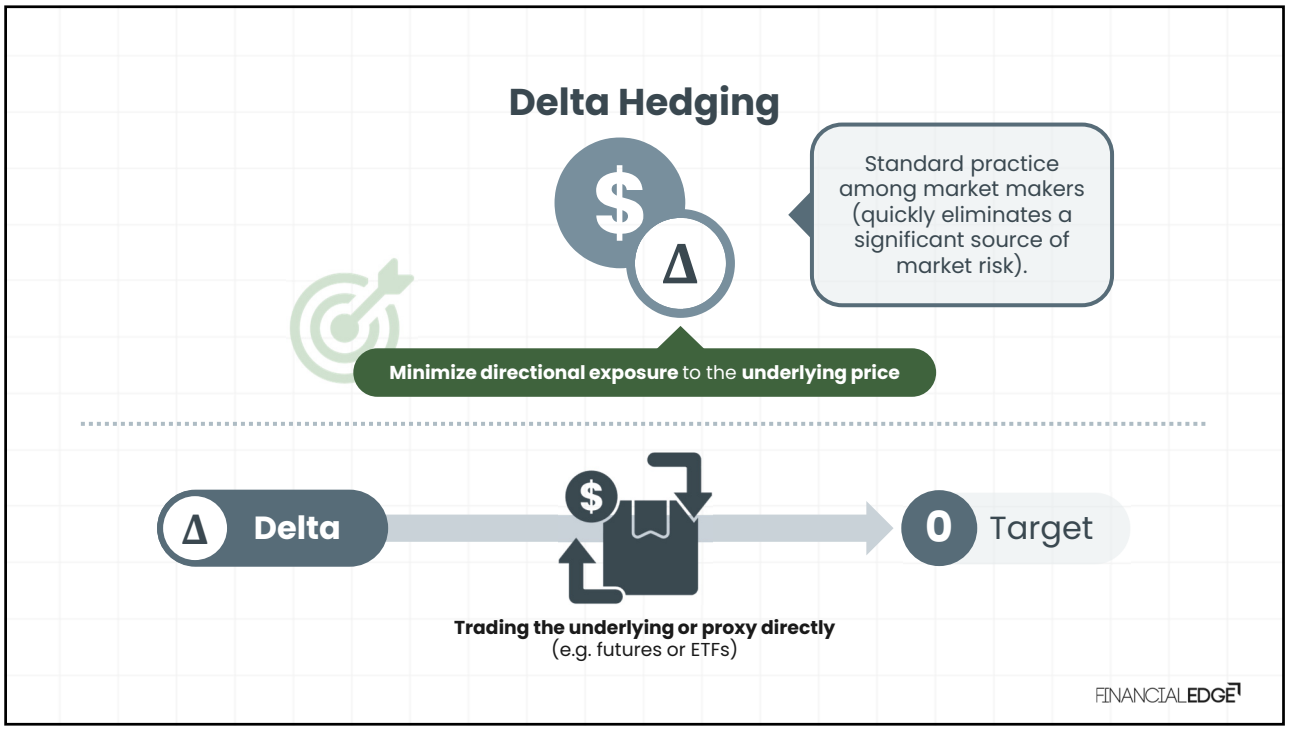

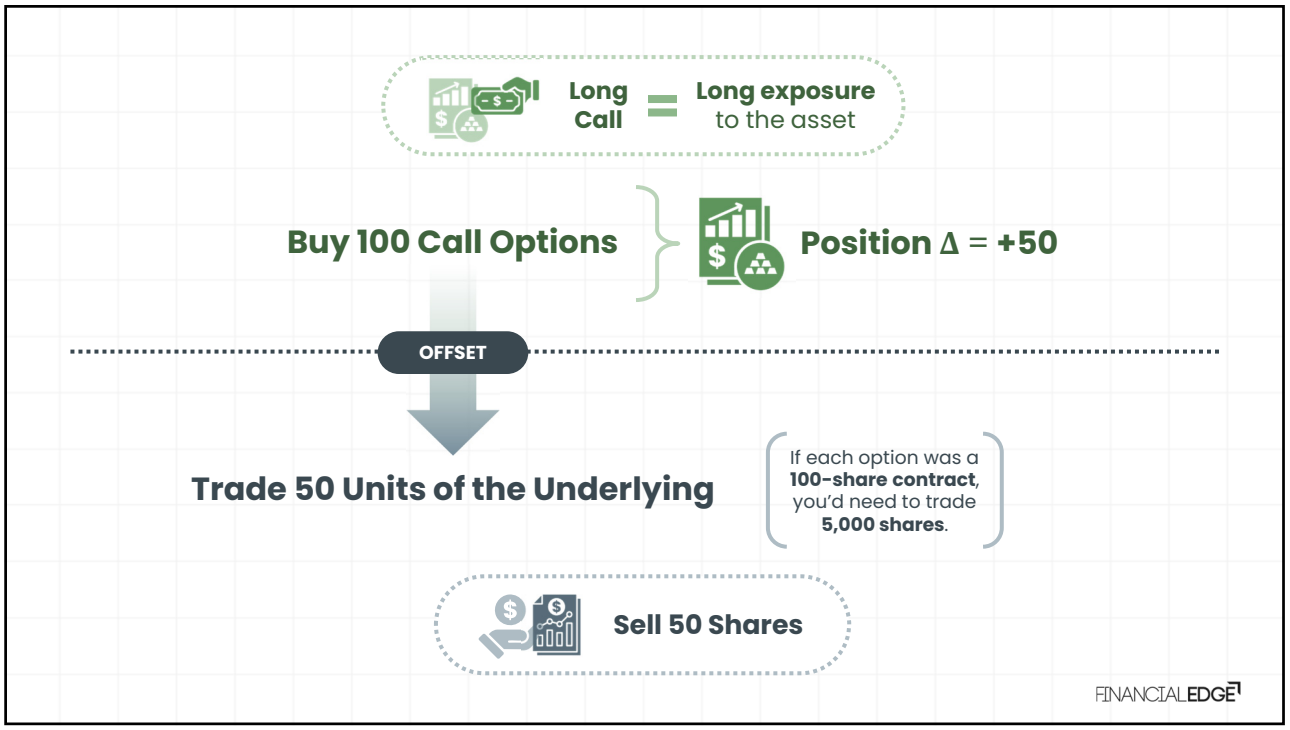

	Stock price drops by $1
Buy 100 Call Options	Option premium falls by 50 cents per contract: **$50 Loss** ($0.5 x 100)
Sell 50 Shares	50 shares sold short now trade $1 lower: **$50 Gain** ($1 x 50)

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	Stock price drops by $1	
Buy 100 Call Options	Option premium falls by 50 cents per contract: **$50 Loss** ($0.5 x 100)	**Net effect ≈ 0**
Sell 50 Shares	50 shares sold short now trade $1 lower: **$50 Gain** ($1 x 50)	After the move, Delta will change (typically need to re-hedge)

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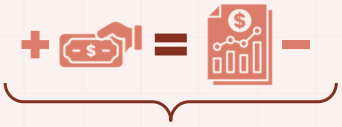
Practical Considerations

Ensure that hedge amounts do not exceed a tradable size

With 100,000 calls, hedging requires selling 50,000 shares.



Can you execute this trade quickly, without moving the market? (Liquidity is a key consideration).

Sometimes both counterparties want to hedge their Delta

Call seller has a short Delta position and may hedge by buying stock.

Both sides can agree to a Delta exchange (they provide the hedge directly to each other).

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3 Levels of Delta

Option Delta

The **sensitivity of the option premium** to underlying asset price changes.

Option Position Delta

The **profit and loss (P&L) impact** of the total position in a single option.

= **Option Delta** × **Contract size** × **# of contracts**

Total Position Delta

The **Delta of the whole portfolio** (including all option positions and hedges).

Shows the **net sensitivity to moves** in the underlying.

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Short 1,000 at-the-money (ATM) **call options** on **100 shares each**.

Delta ≈ +0.5

Bought 45,000 shares as a **delta hedge**.

Option Delta	Option Position Delta	Total Position Delta
		
= -0.5	= 1,000 x 100 x -0.5	= -50,000 + 45,000
	= -50,000	= -5,000

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5. Delta (Δ) – Behaviour

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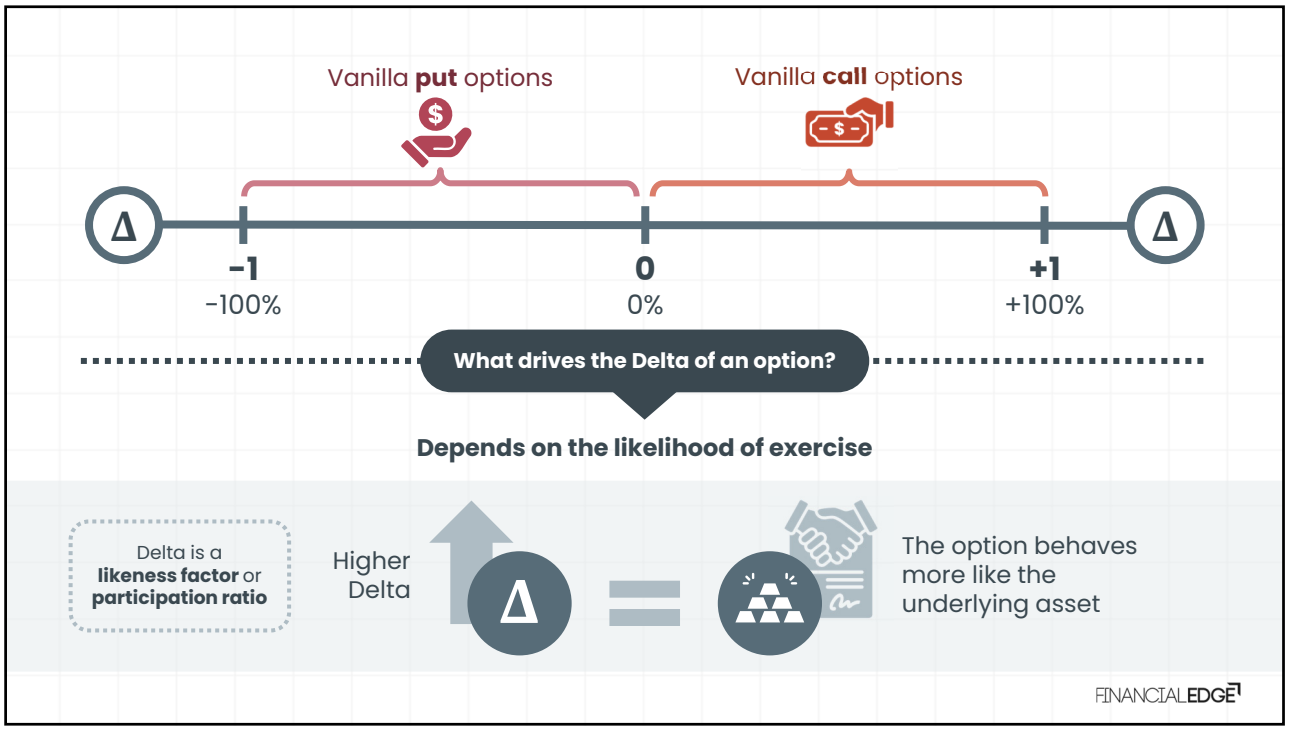

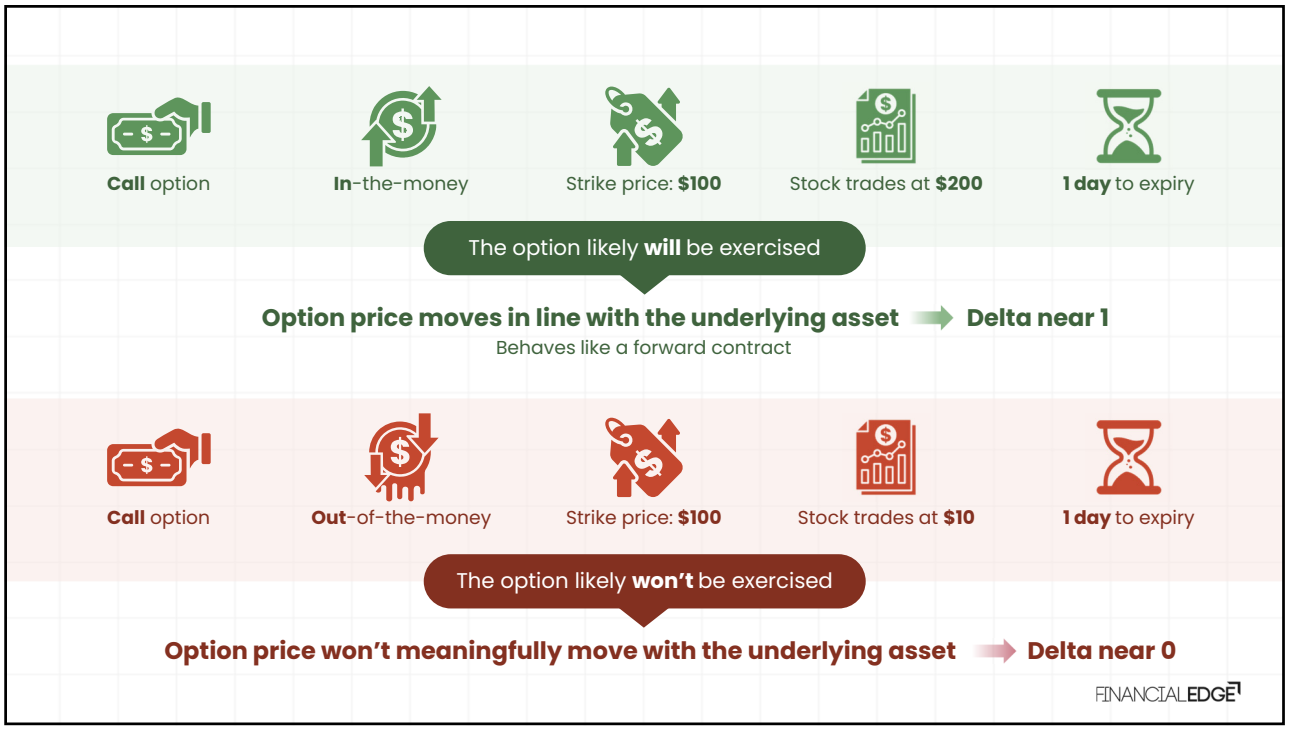

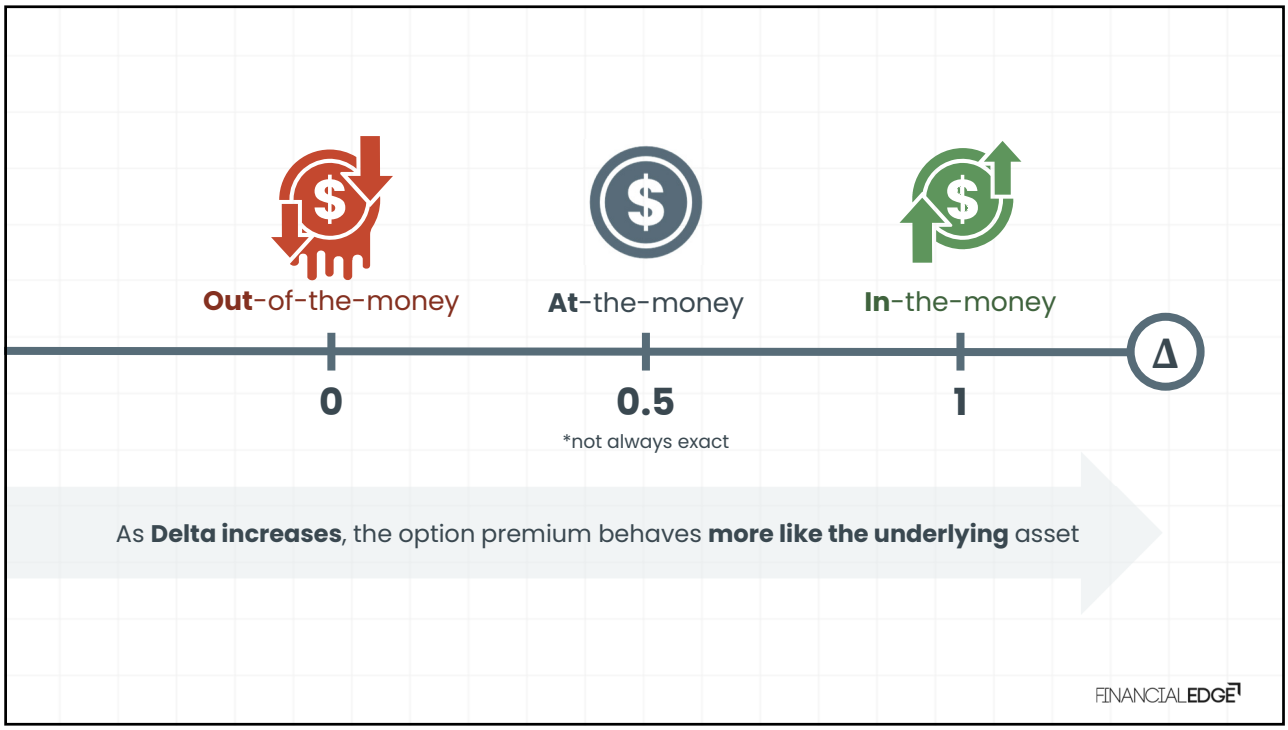

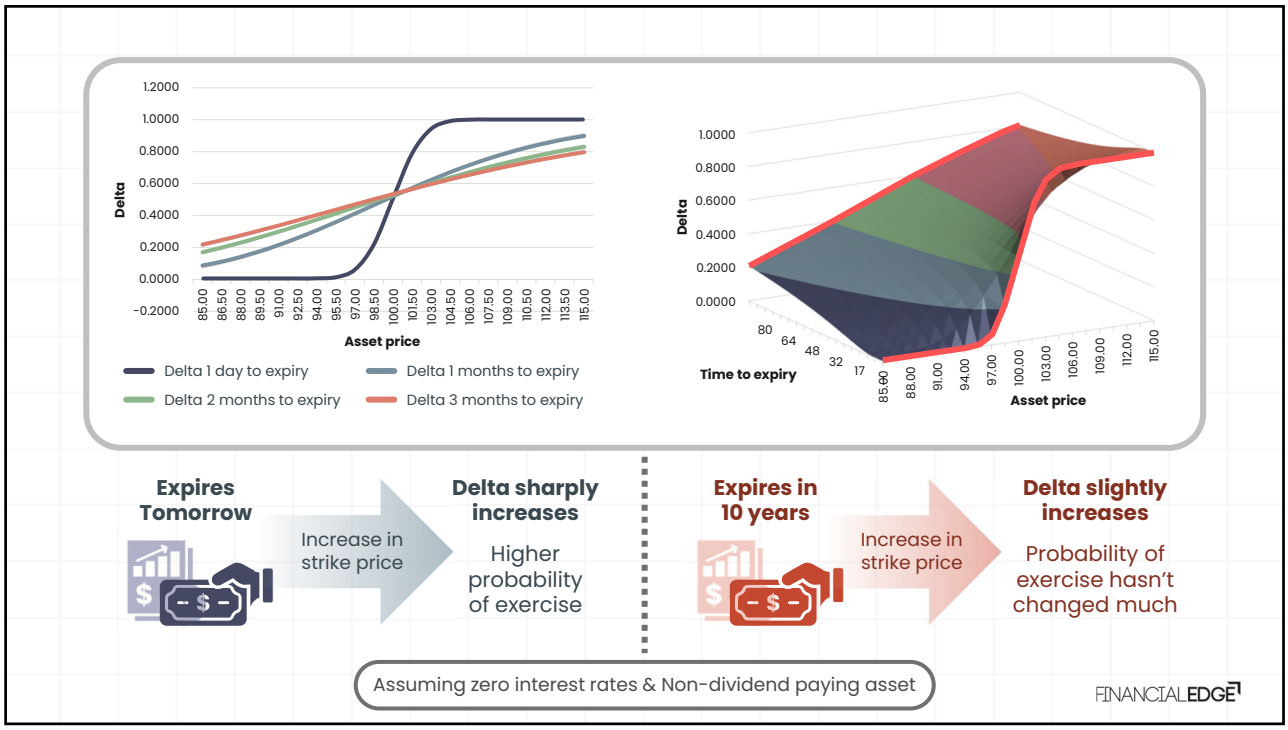

6. Gamma (γ)

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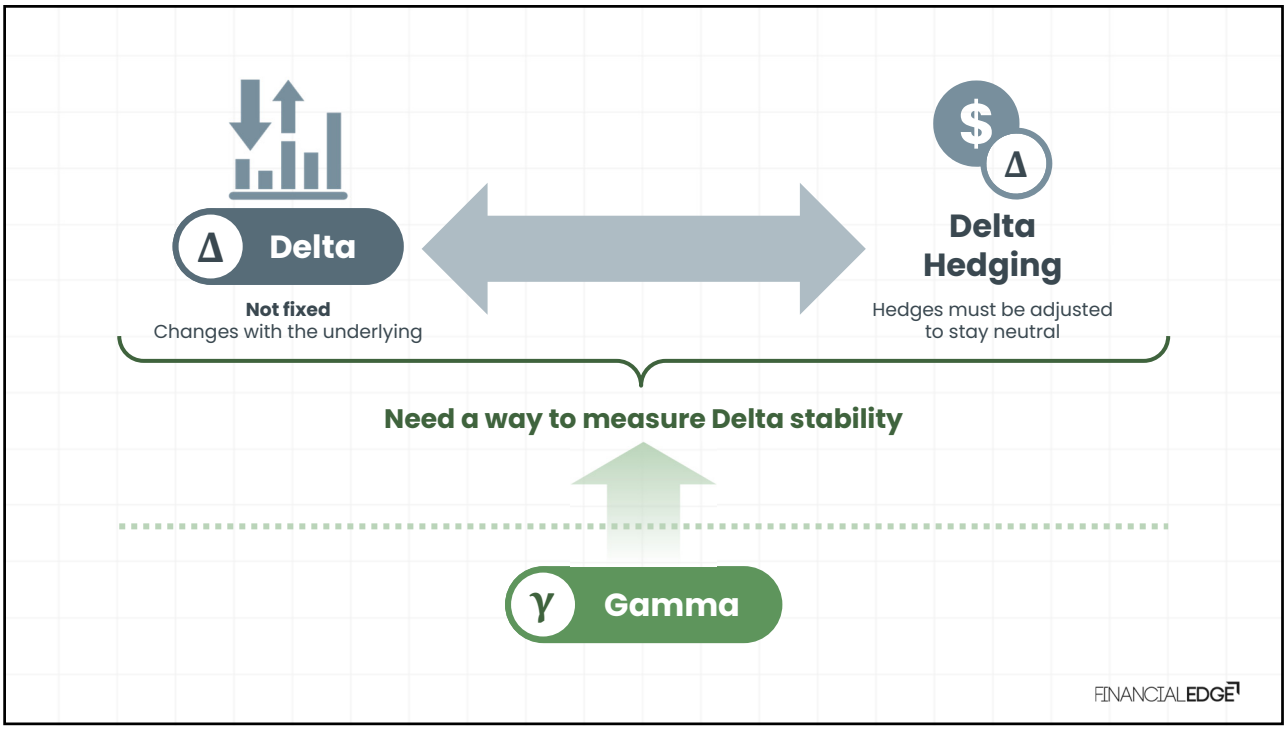

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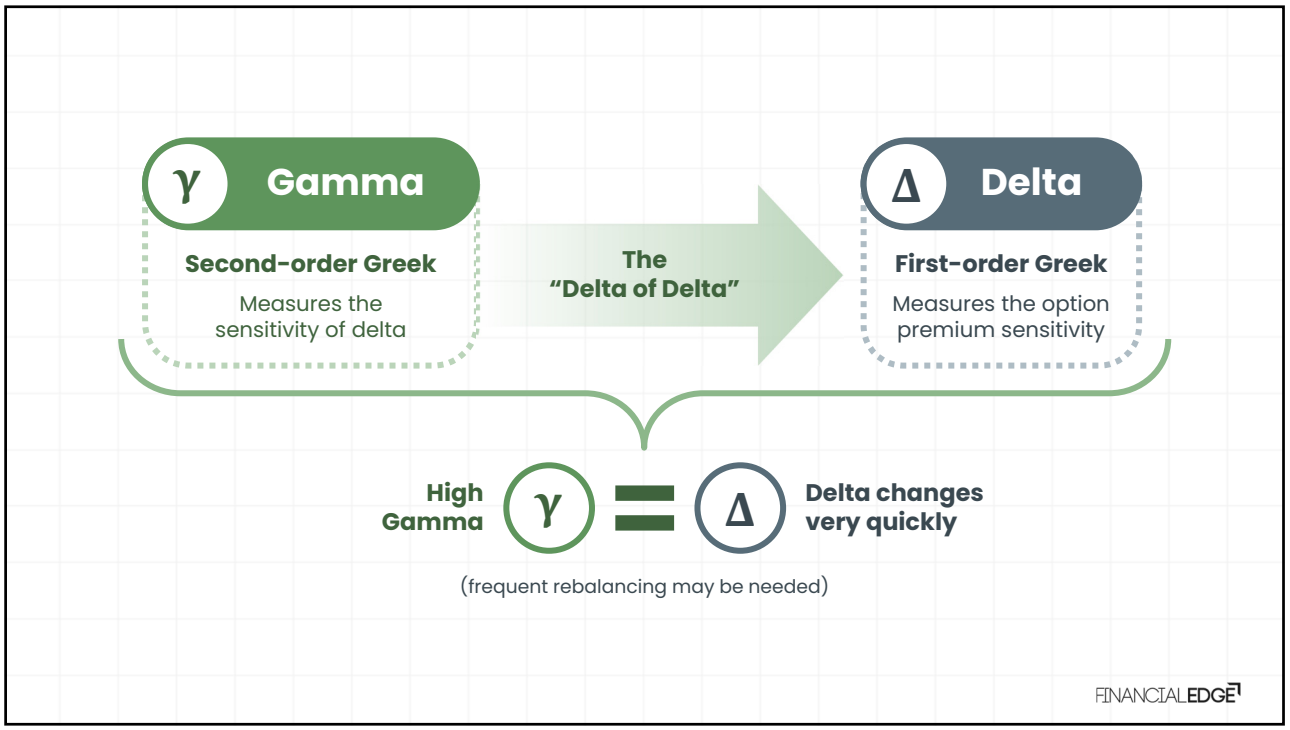

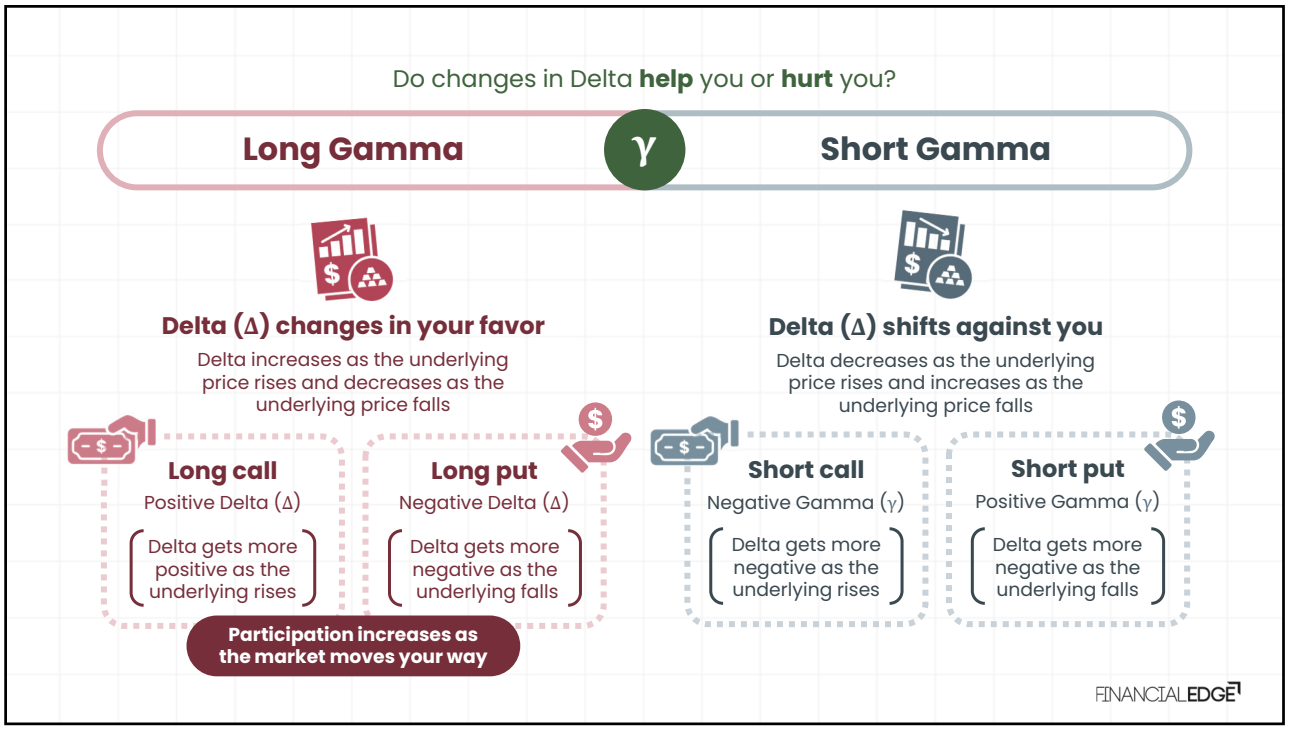

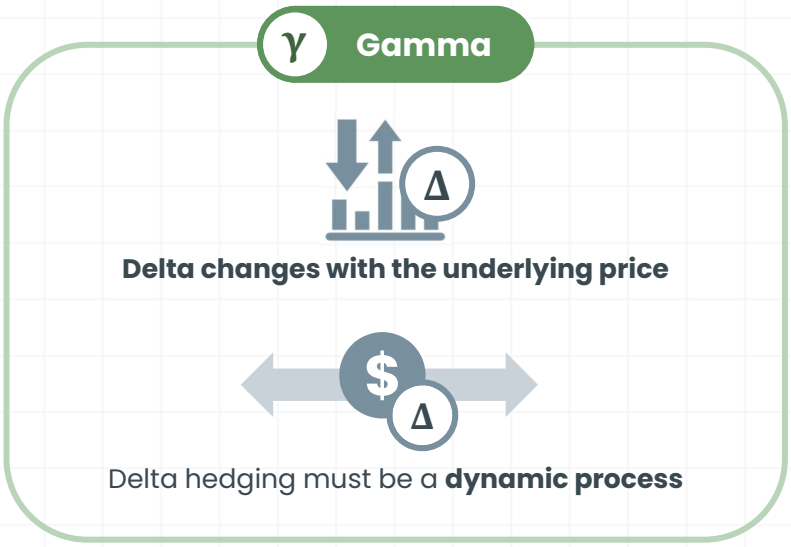

7. Gamma (γ) – Behaviour

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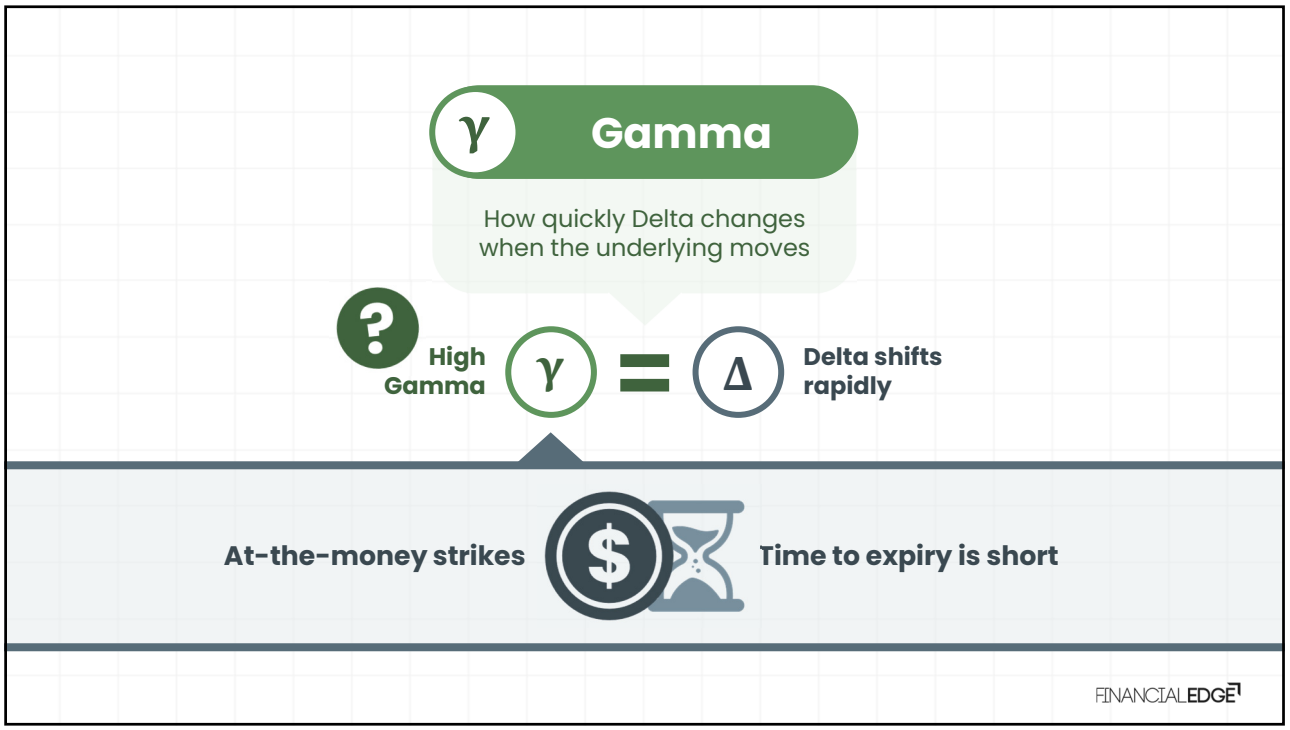
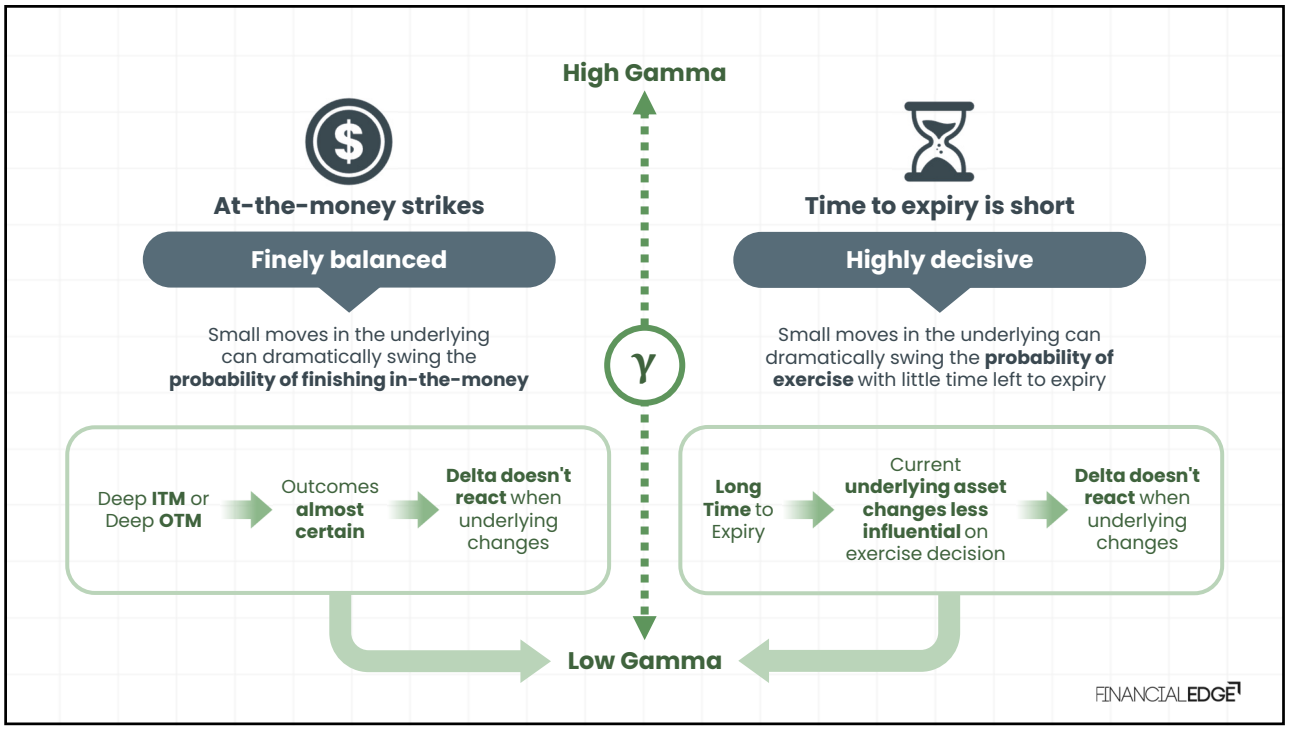
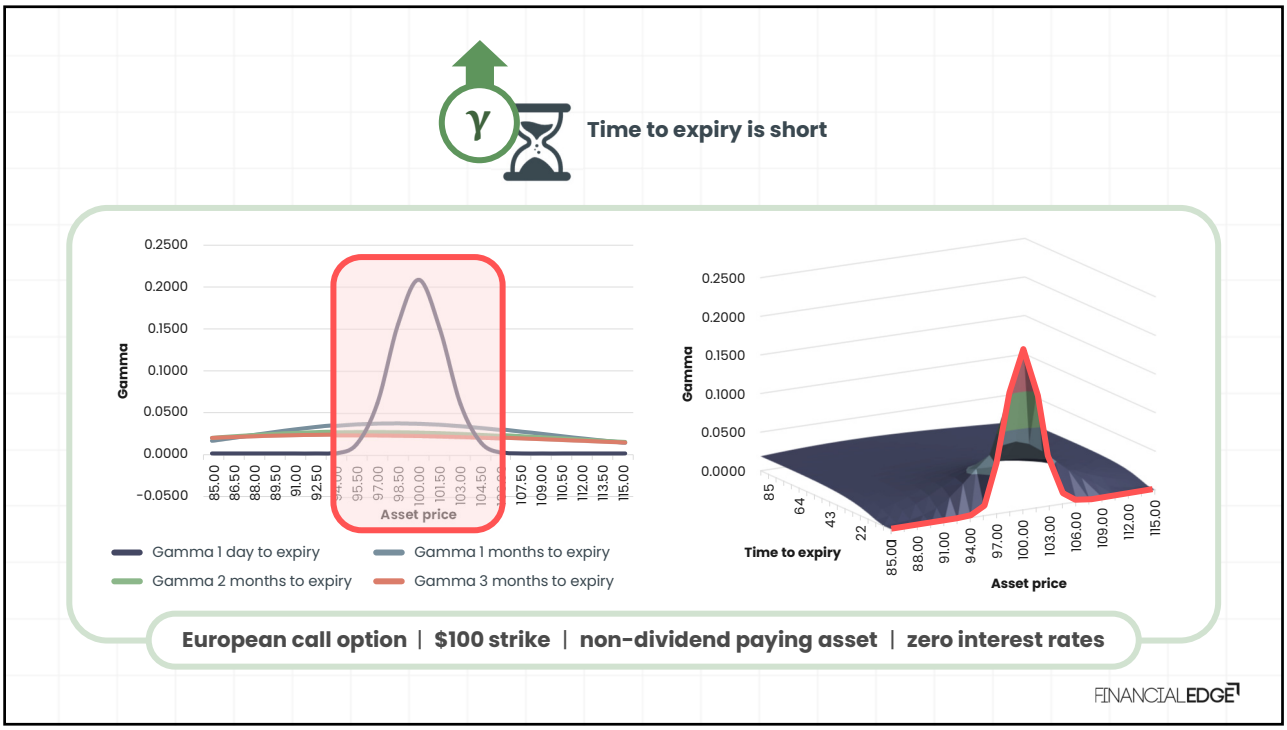
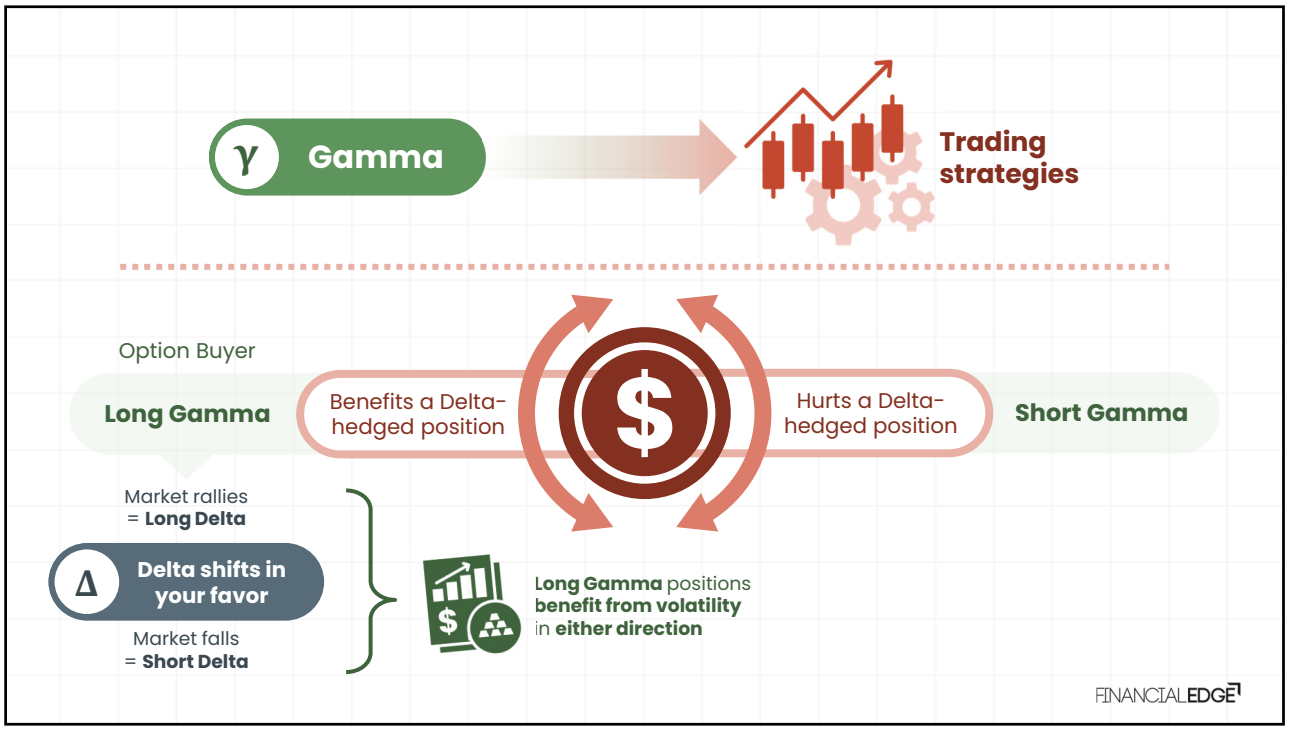
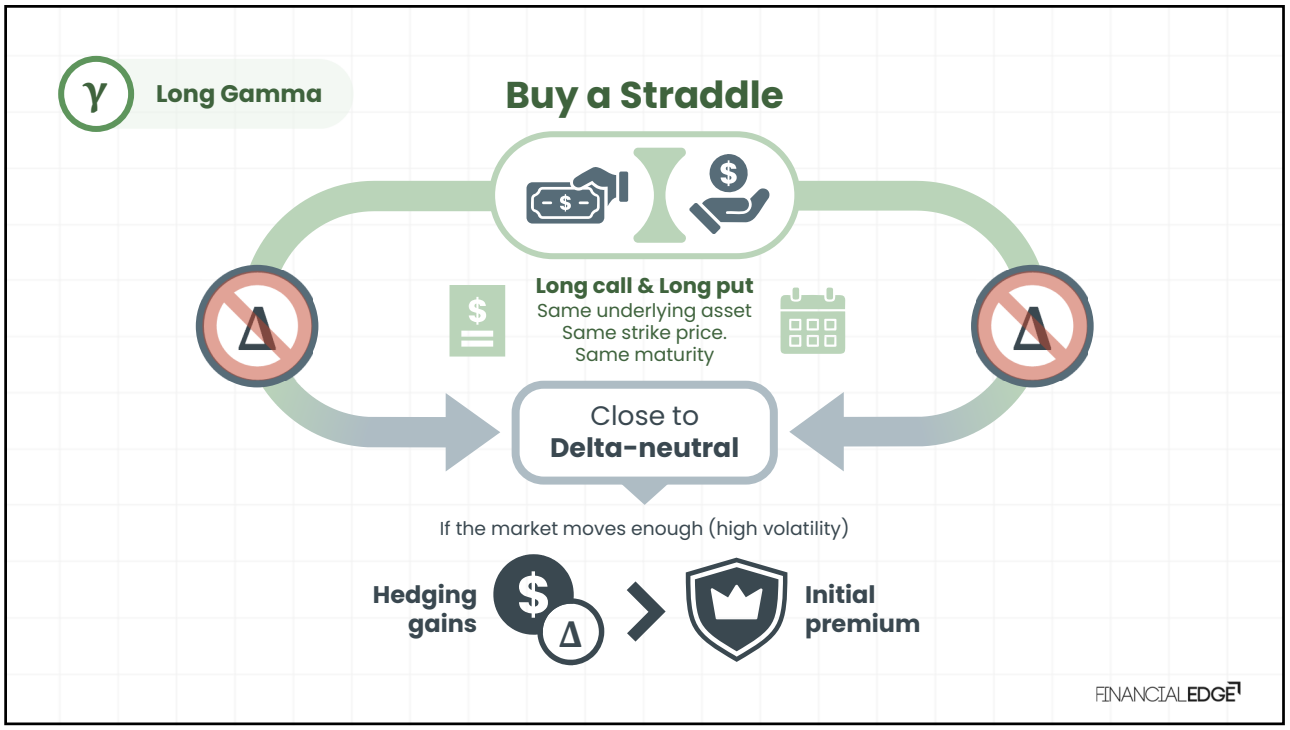


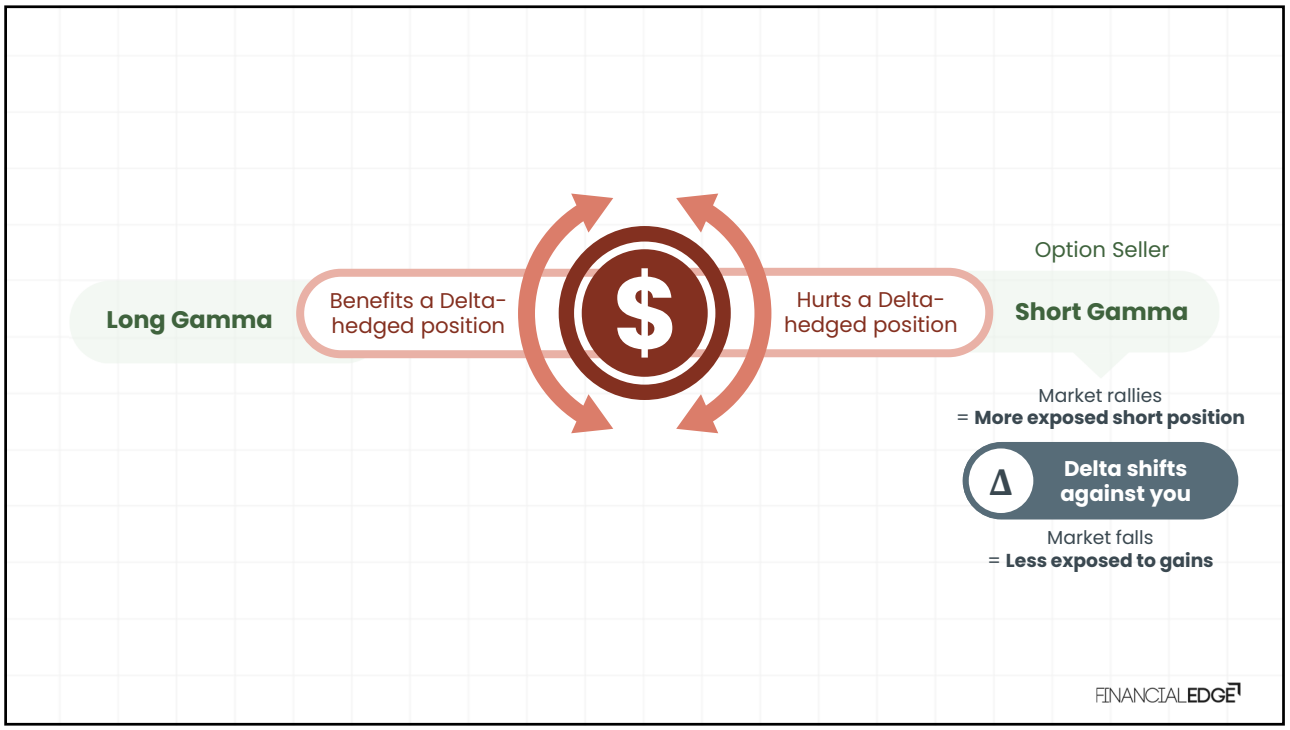


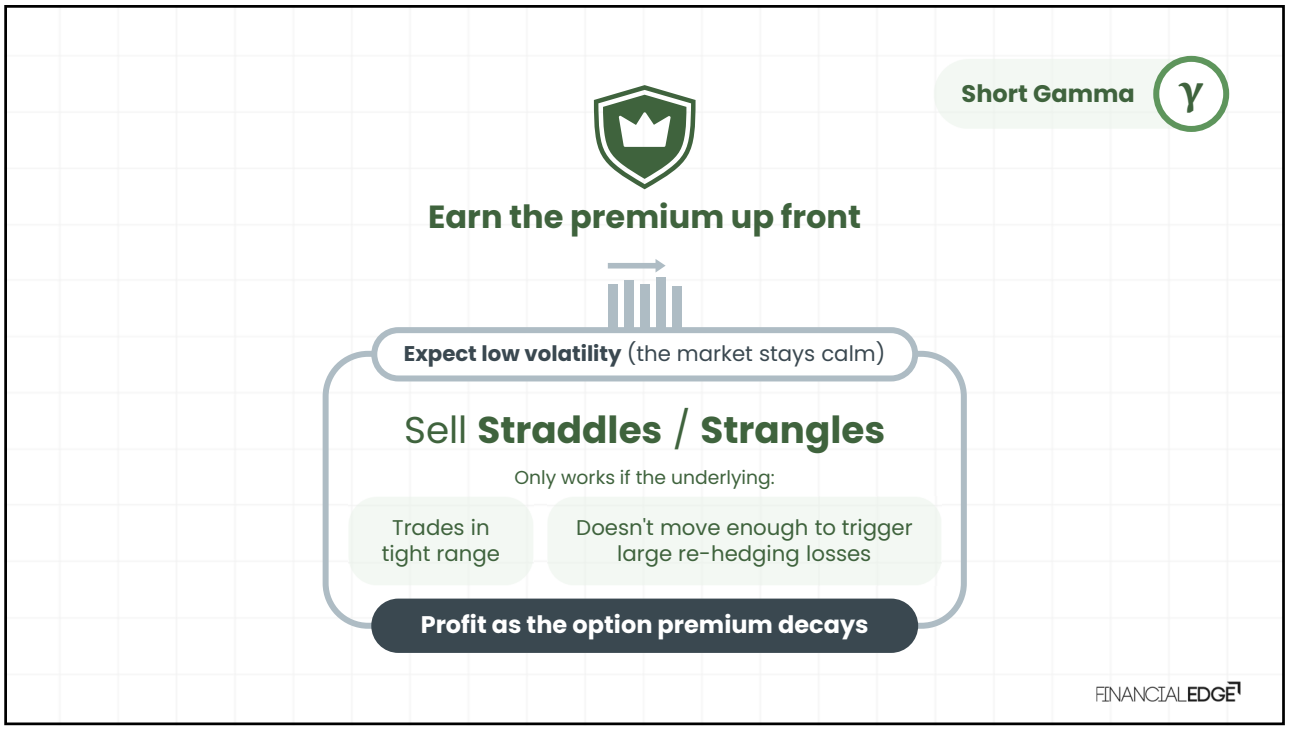


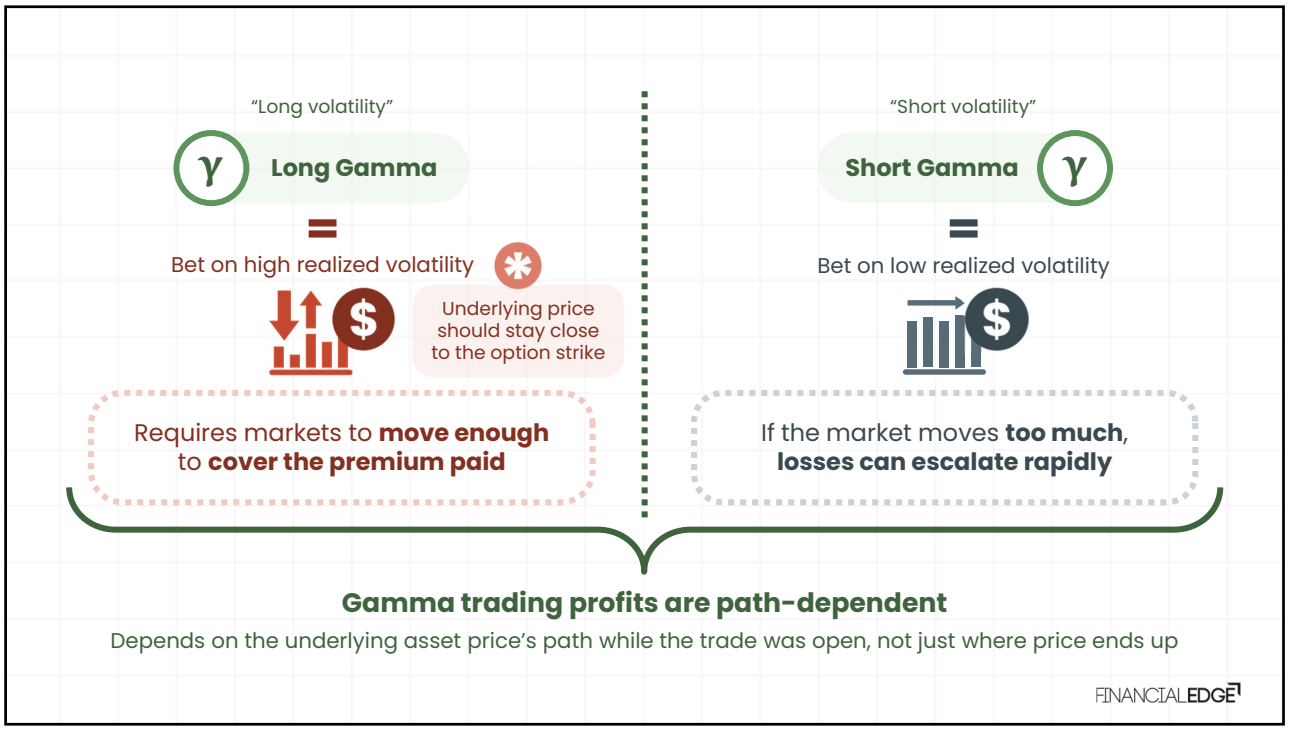
10. Gamma Trading











11. Theta (θ)

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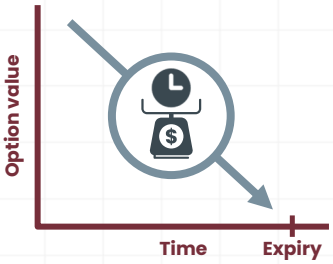
"Running yield" **θ Theta** "Carry"

Measures the **impact of time** on the option premium

Buyer

Long option position carries **negative Theta (θ)**

Option loses value over time. Drag on P&L



Seller

Long option position carries **positive Theta (θ)**

Reduced value of short position. Gain to P&L

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θ Theta

Owning options is like **renting insurance**

Buyer Pay "rent" every day you hold it (time decay)

Time

Seller Collects "rent" (income for providing protection)

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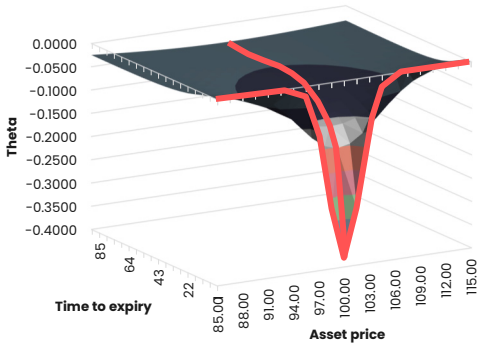
θ Theta



European call option | $100 strike | non-dividend paying asset | zero interest rates

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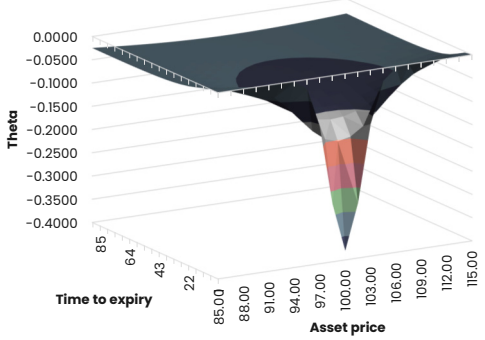
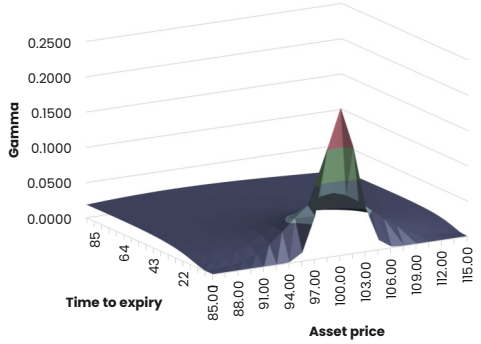
θ Theta



The cost of carrying Gamma
(buyers pay it and sellers earn it)

γ Gamma



Measures how sensitive and risky Delta is
(makes hedging more complex)

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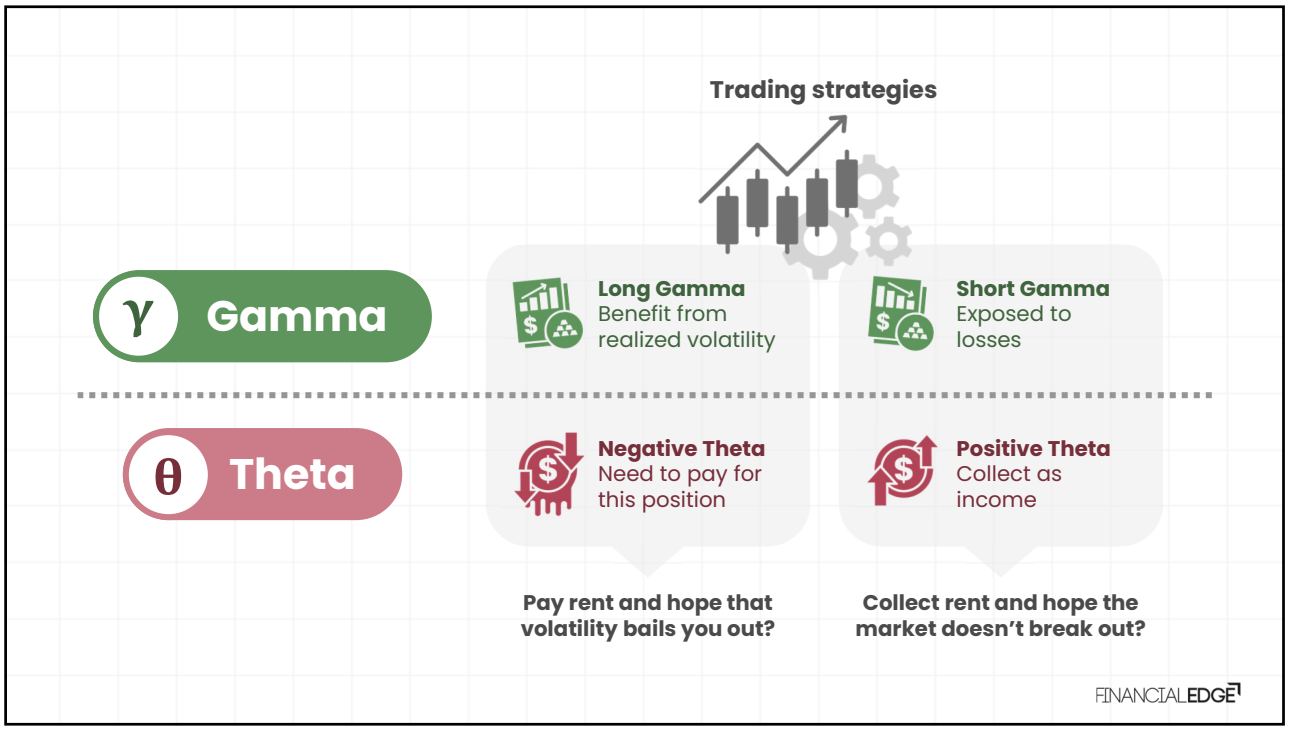

12. Vega (or: Kappa (κ)) & Implied Volatility

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Vega ν κ Kappa

Measures the option premium's **sensitivity** to **changes in implied volatility**

Implied Volatility - Volatility currently implied in the option price

Current option price → Input into an option pricing model → Solve for volatility

- Forward-looking measure
- Impacted by option supply and demand

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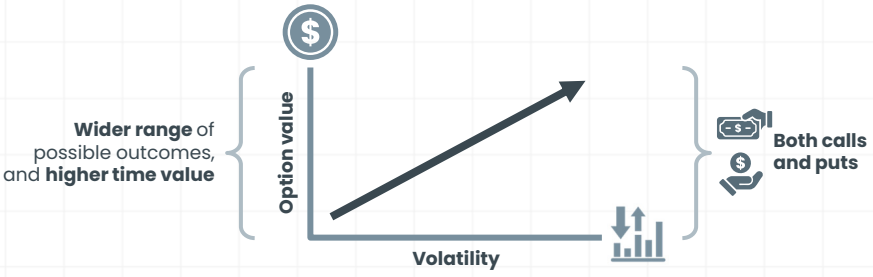
Vega ν κ Kappa



- Option **buyer** = **Long** Vega (ν)
- Option **seller** = **Short** Vega (ν)

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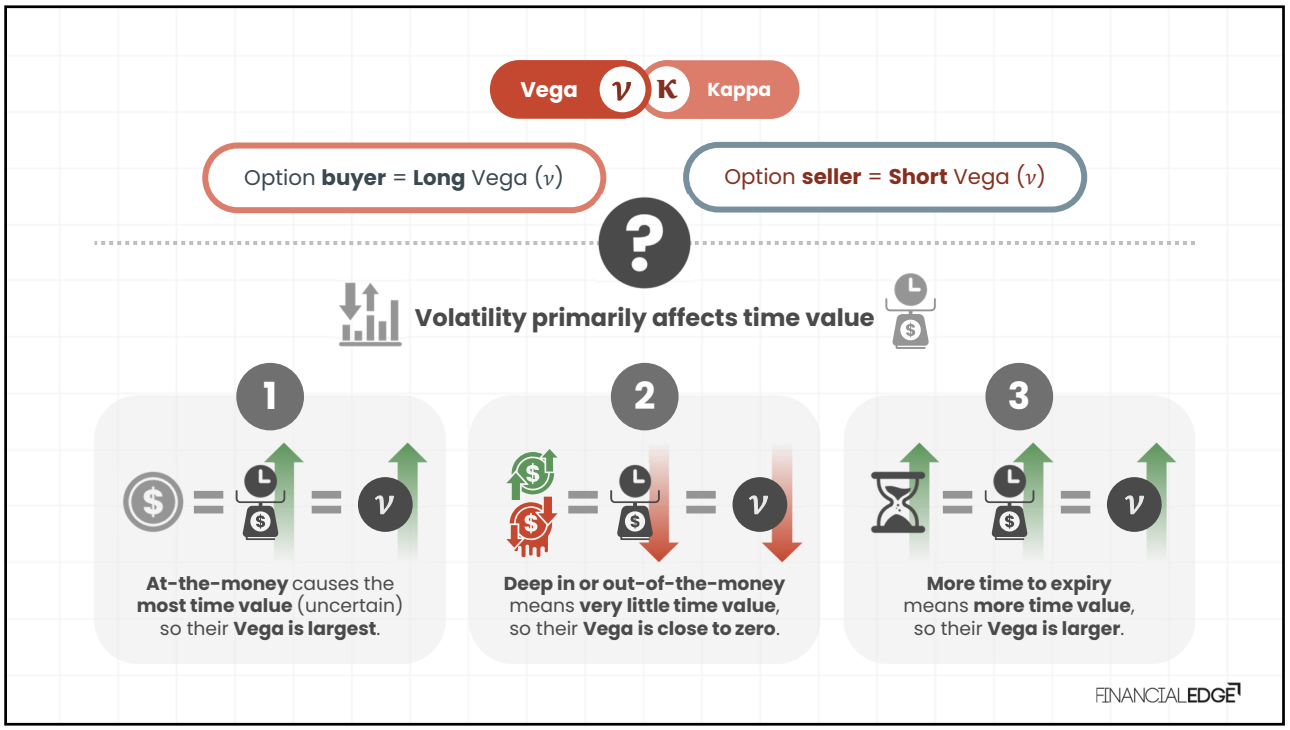
Vega ν
Kappa κ
Option buyer = Long Vega (ν)
Option seller = Short Vega (ν)
?
Volatility primarily affects time value
1
2
3
At-the-money causes the most time value (uncertain) so their Vega is largest.
Deep in or out-of-the-money means very little time value, so their Vega is close to zero.
More time to expiry means more time value, so their Vega is larger.
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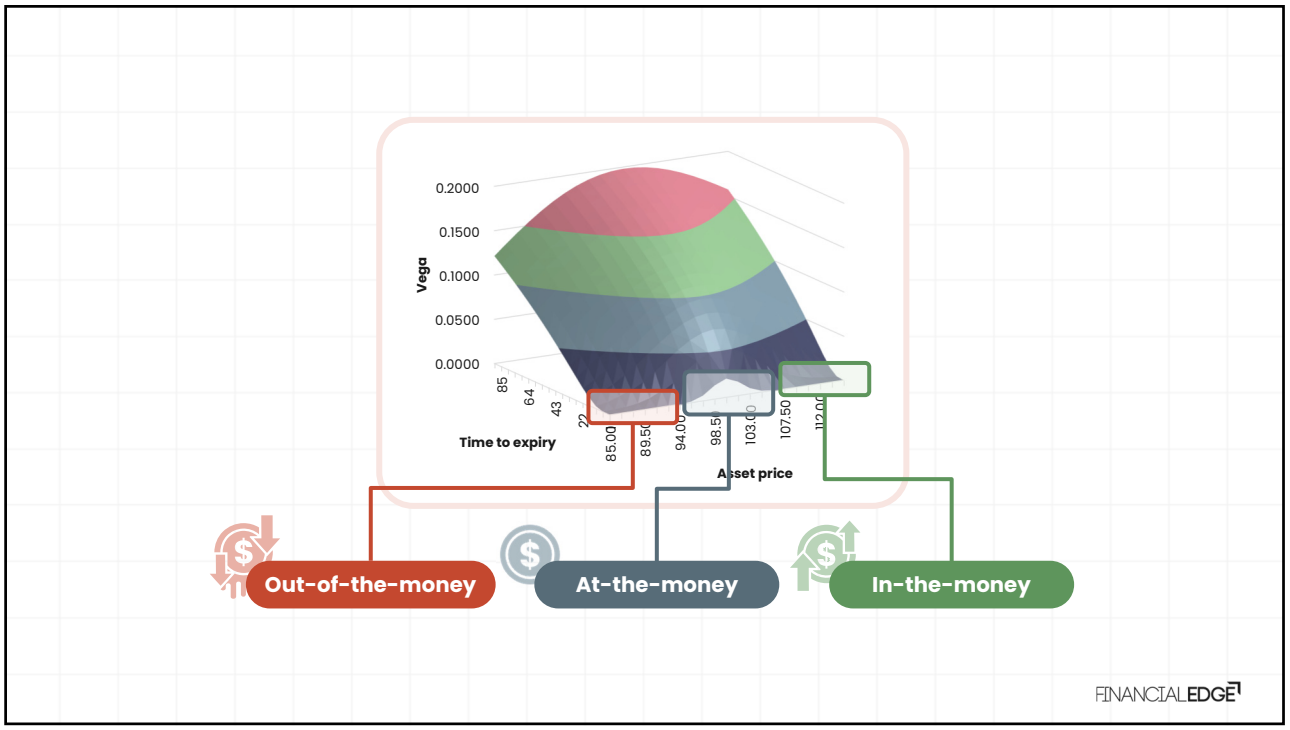
0.2000
0.1500
0.1000
0.0500
0.0000
Vega
85
64
43
22
Time to expiry
85.00
89.50
94.00
98.50
103.00
107.50
Asset price
Out-of-the-money
At-the-money
In-the-money
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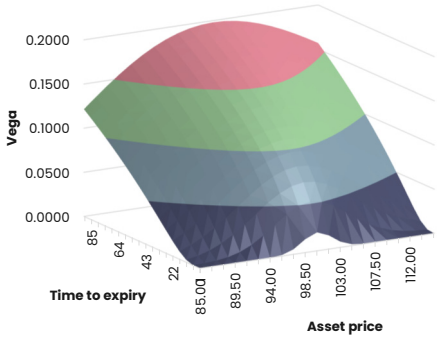
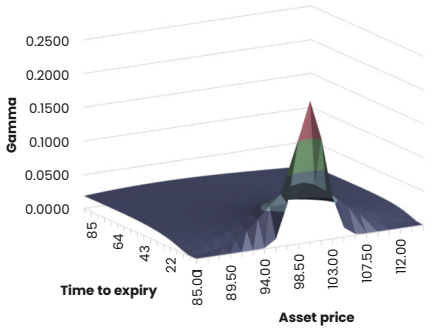
Vega ν



Exposure to implied volatility

How the market **expects** uncertainty to evolve, reflected in the option's premium.

γ Gamma



Exposure to realized volatility

How much the underlying **actually** moves, and how often you'll need to adjust your hedge.

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