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Chapter 9 Risk Measurement II

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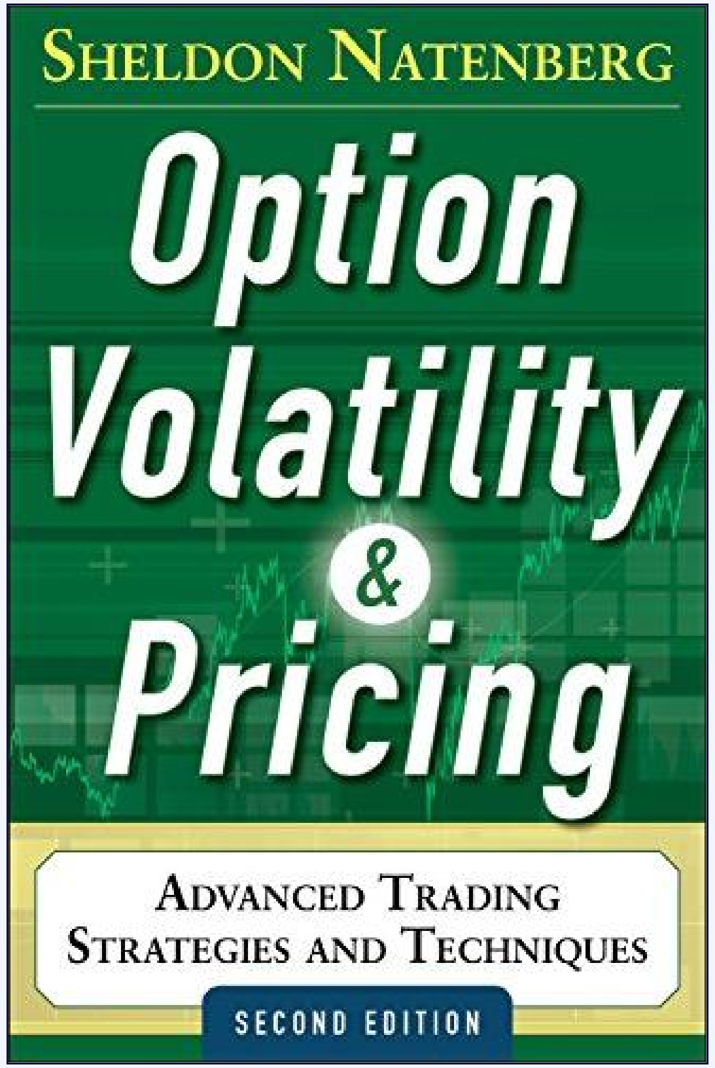
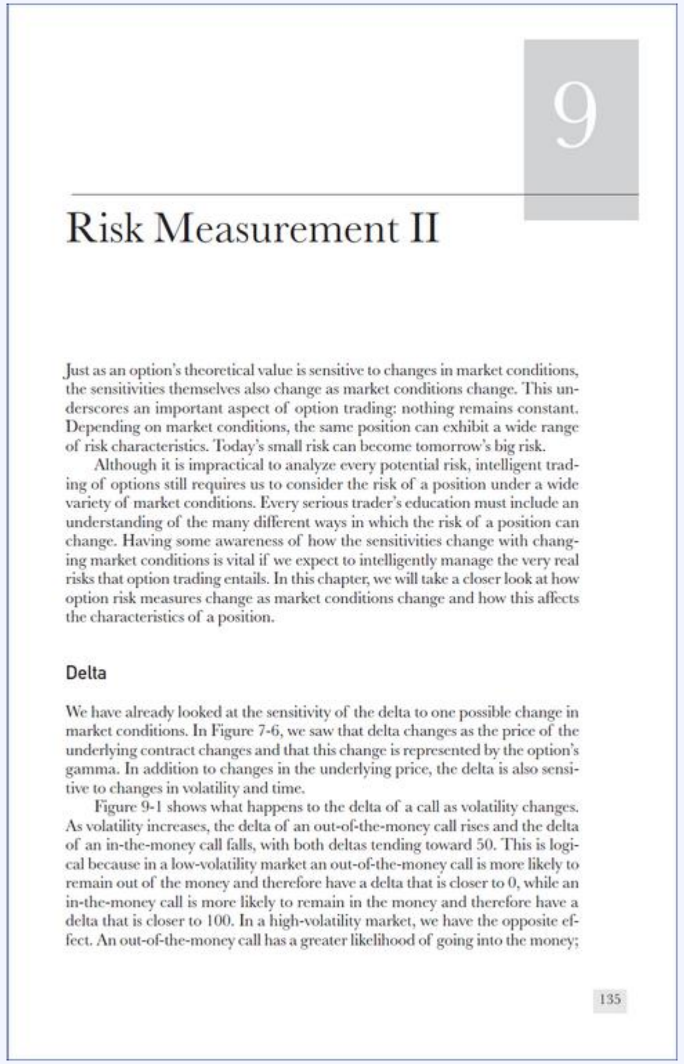
Chapter 9 — Risk Measurement II





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Risk Measurement II

Just as an option's theoretical value is sensitive to changes in market conditions, the sensitivities themselves also change as market conditions change. This underscores an important aspect of option trading: nothing remains constant. Depending on market conditions, the same position can exhibit a wide range of risk characteristics. Today's small risk can become tomorrow's big risk.

Although it is impractical to analyze every potential risk, intelligent trading of options still requires us to consider the risk of a position under a wide variety of market conditions. Every serious trader's education must include an understanding of the many different ways in which the risk of a position can change. Having some awareness of how the sensitivities change with changing market conditions is vital if we expect to intelligently manage the very real risks that option trading entails. In this chapter, we will take a closer look at how option risk measures change as market conditions change and how this affects the characteristics of a position.

Delta

We have already looked at the sensitivity of the delta to one possible change in market conditions. In Figure 7-6, we saw that delta changes as the price of the underlying contract changes and that this change is represented by the option's gamma. In addition to changes in the underlying price, the delta is also sensitive to changes in volatility and time.

Figure 9-1 shows what happens to the delta of a call as volatility changes. As volatility increases, the delta of an out-of-the-money call rises and the delta of an in-the-money call falls, with both deltas tending toward 50. This is logical because in a low-volatility market an out-of-the-money call is more likely to remain out of the money and therefore have a delta that is closer to 0, while an in-the-money call is more likely to remain in the money and therefore have a delta that is closer to 100. In a high-volatility market, we have the opposite effect. An out-of-the-money call has a greater likelihood of going into the money;

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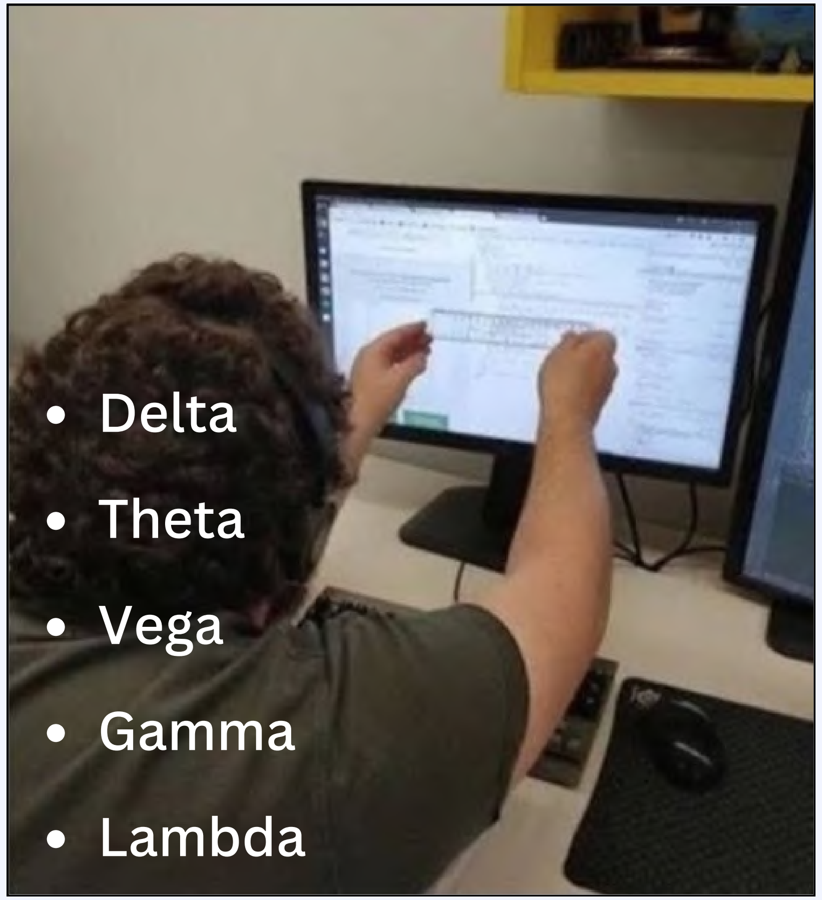
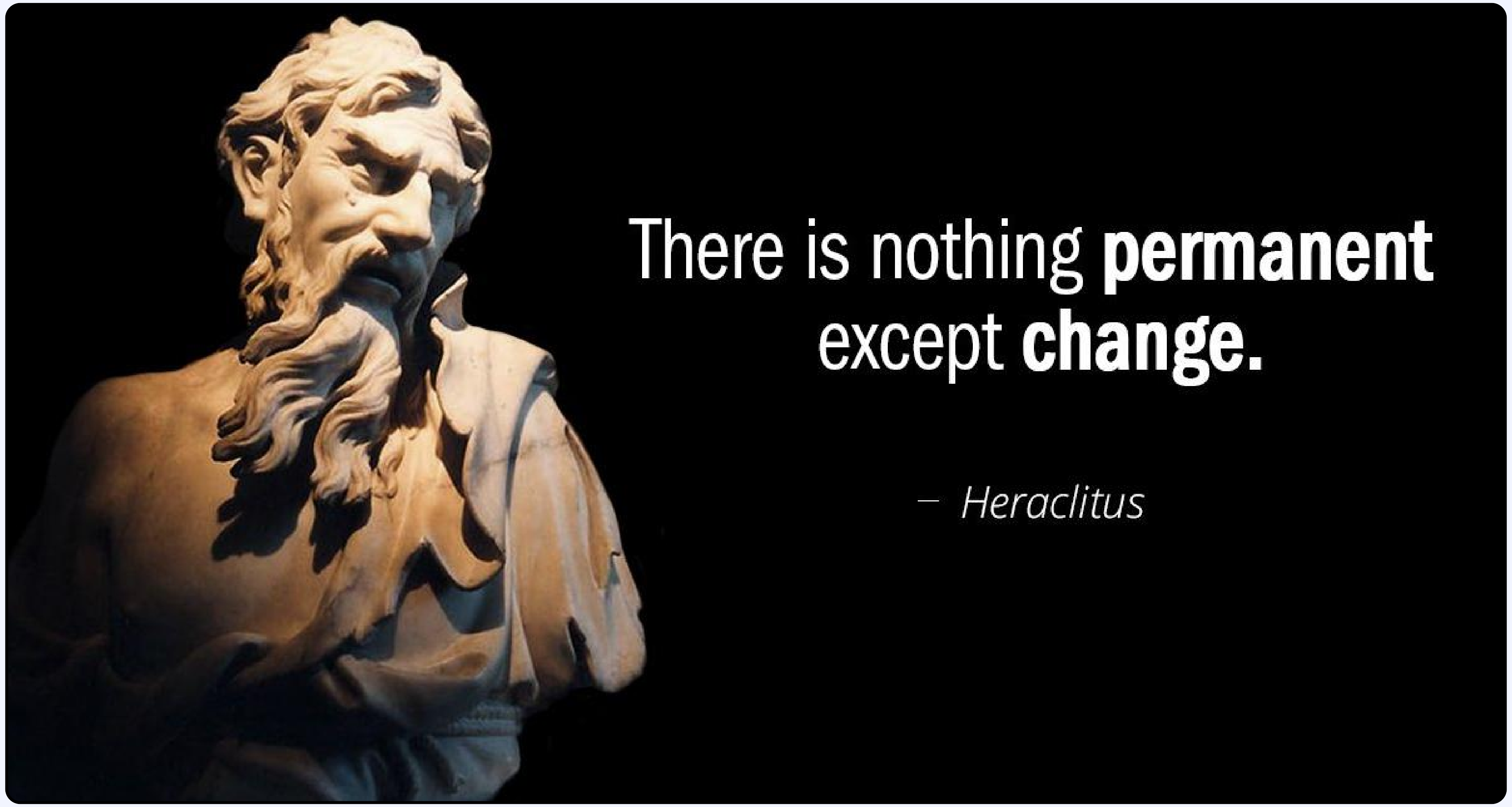


- Delta
- Theta
- Vega
- Gamma
- Lambda



*How do we quantify the change of... **change**?*

Sensitivities of Sensitivities… Greeks on Greeks = "Second Order"

Second order Greeks are CRITICAL for MMs & managers to understand.

Option values are dynamic… so are the Greeks!

- *Critical to understand your position's behavior*
- *Scenario analysis. Quantified.*
- *Fundamental to options trading*
- *Absolutely critical for position managers*

Delta

- *Previously we looked at delta's change with respect to underlying movement (Gamma)*
- *Delta is also sensitive to:*
    - *Implied Volatility*
    - *Passage of time*

Δ δ

delta

Call and Put Deltas change as *volatility* changes

Figure 9-1 Call delta values as volatility changes.

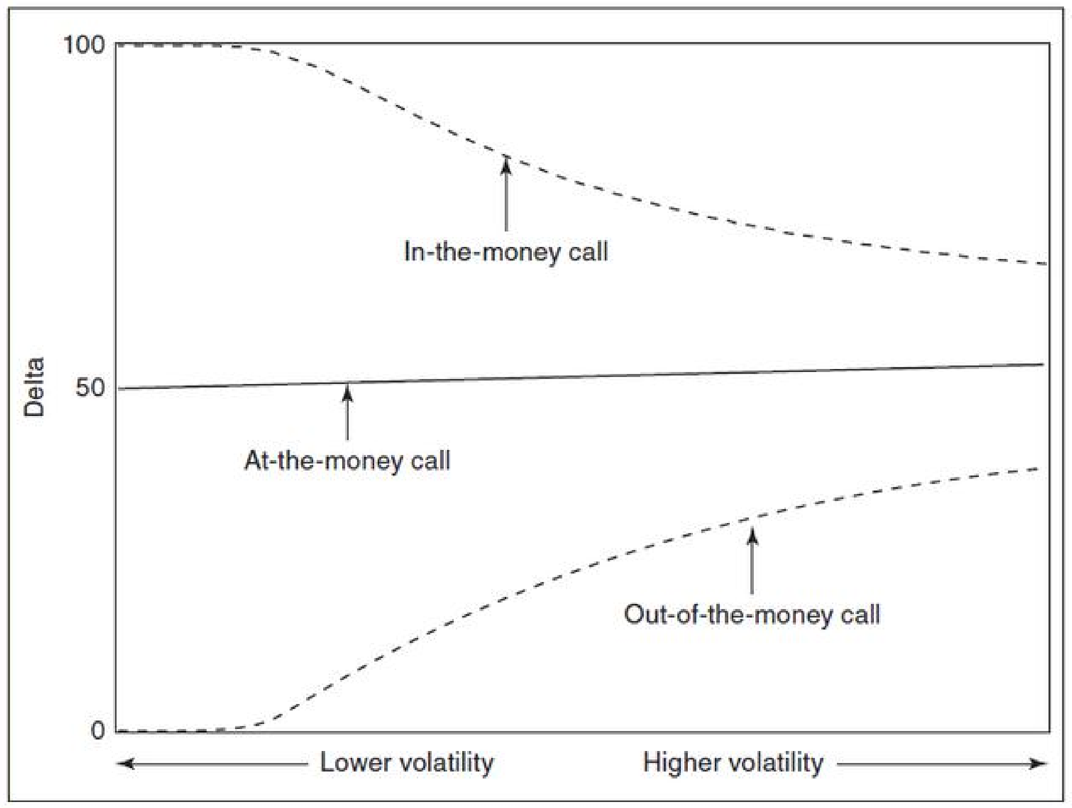
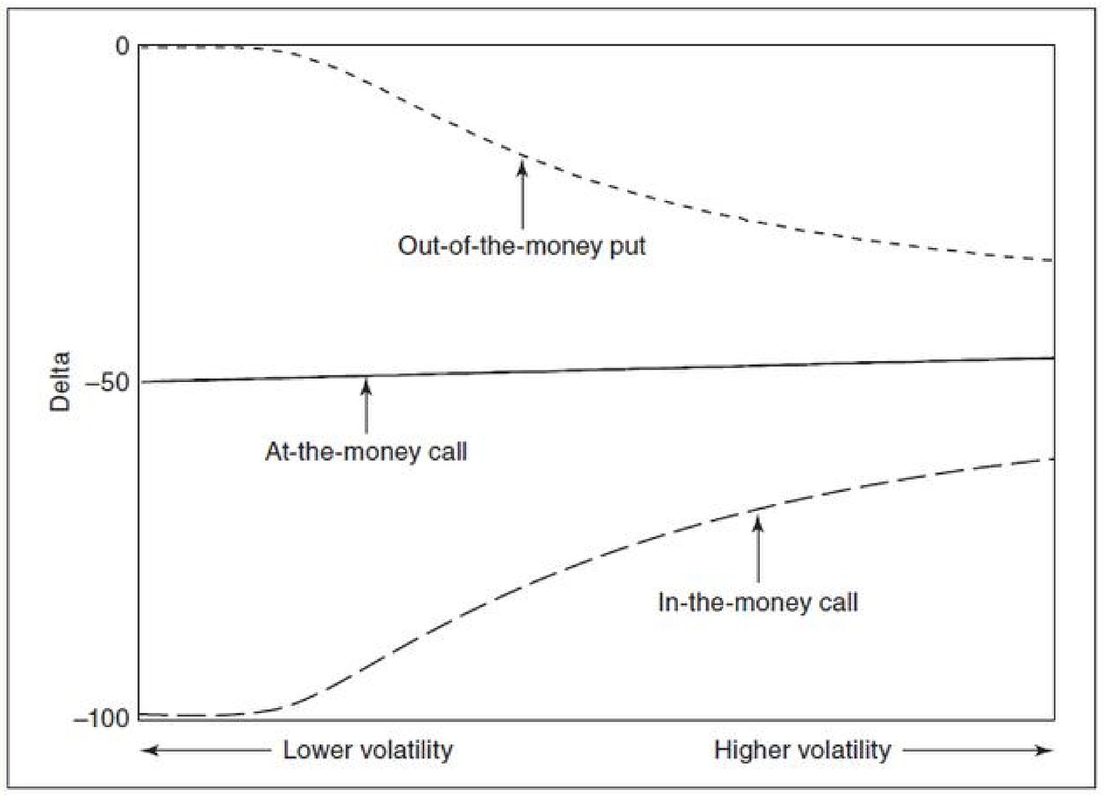


Figure 9-3 Put delta values as volatility changes.



$\Delta \; \delta$

delta

...and as *time passes*

Figure 9-2 Call delta values as time passes.

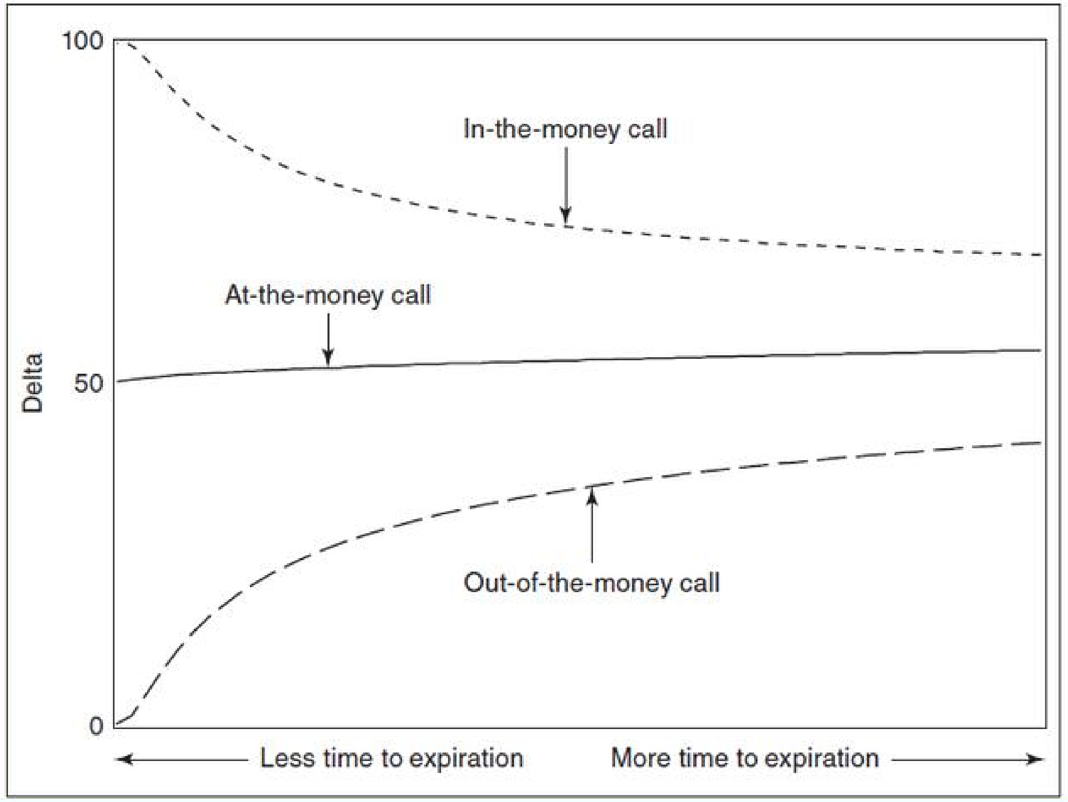
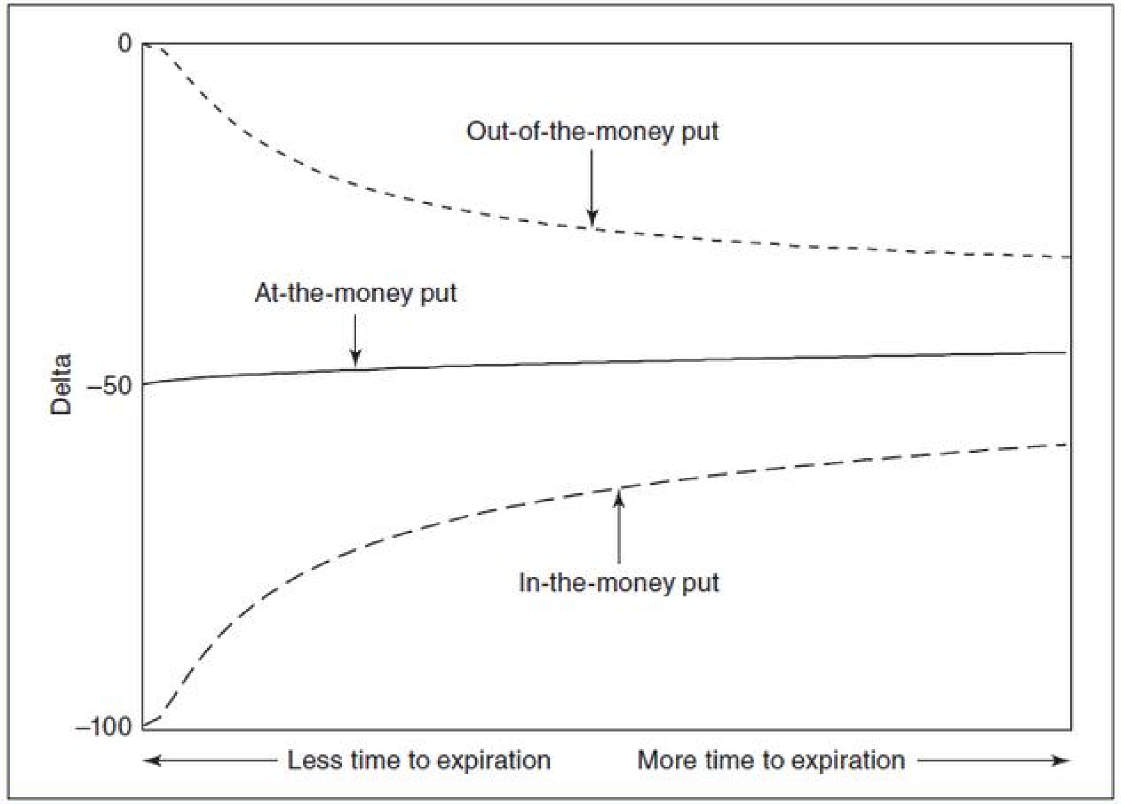


Figure 9-4 Put delta values as time passes.



Δ δ

delta

Delta

- *Whether you vary time or volatility… "looks similar!"*
- *Concepts are often best remembered by thinking through their extremes:*
  - *"If I fast-forward to expiration, is the option in-the-money (100d) or out-of-the-money (0d)?"*
  - *"If Vol went up so much that everything was like a straddle… (50d / -50d)"*

Δ δ

delta

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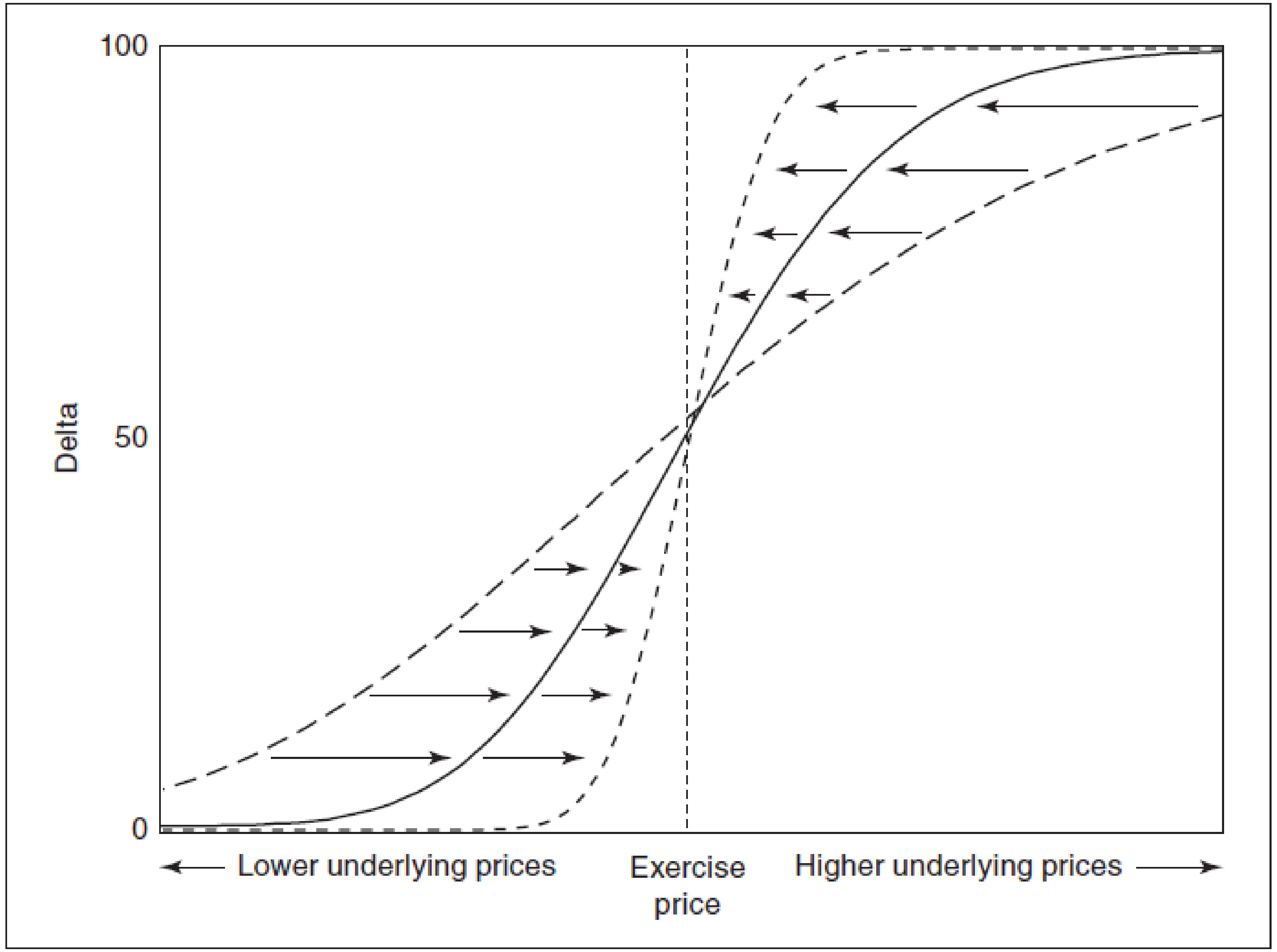
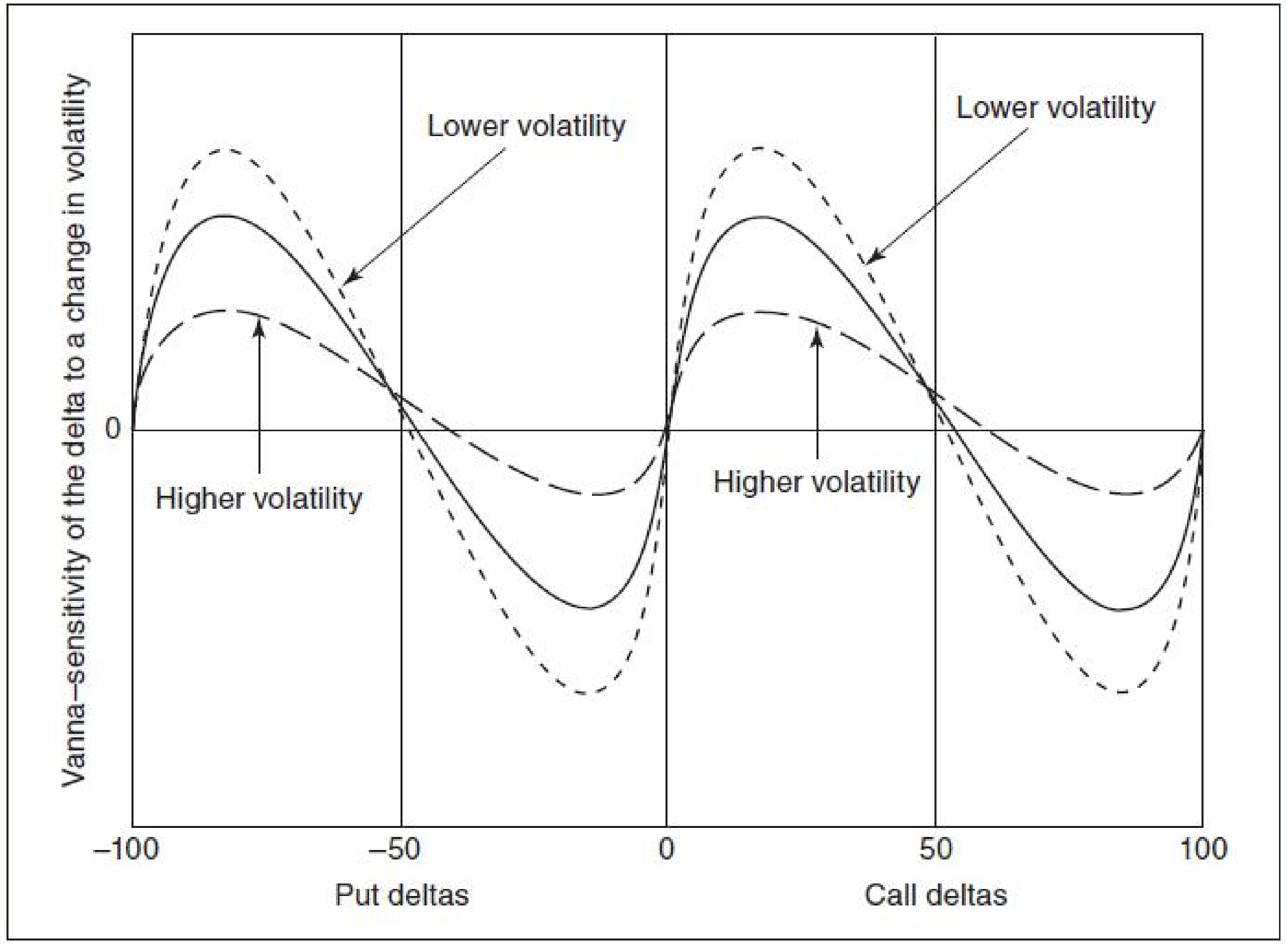
Figure 9-5 Call delta values as time passes or volatility declines.



Vanna describes the sensitivity of the option's Delta to changes in Volatility

Figure 9-6 Vanna of an option.

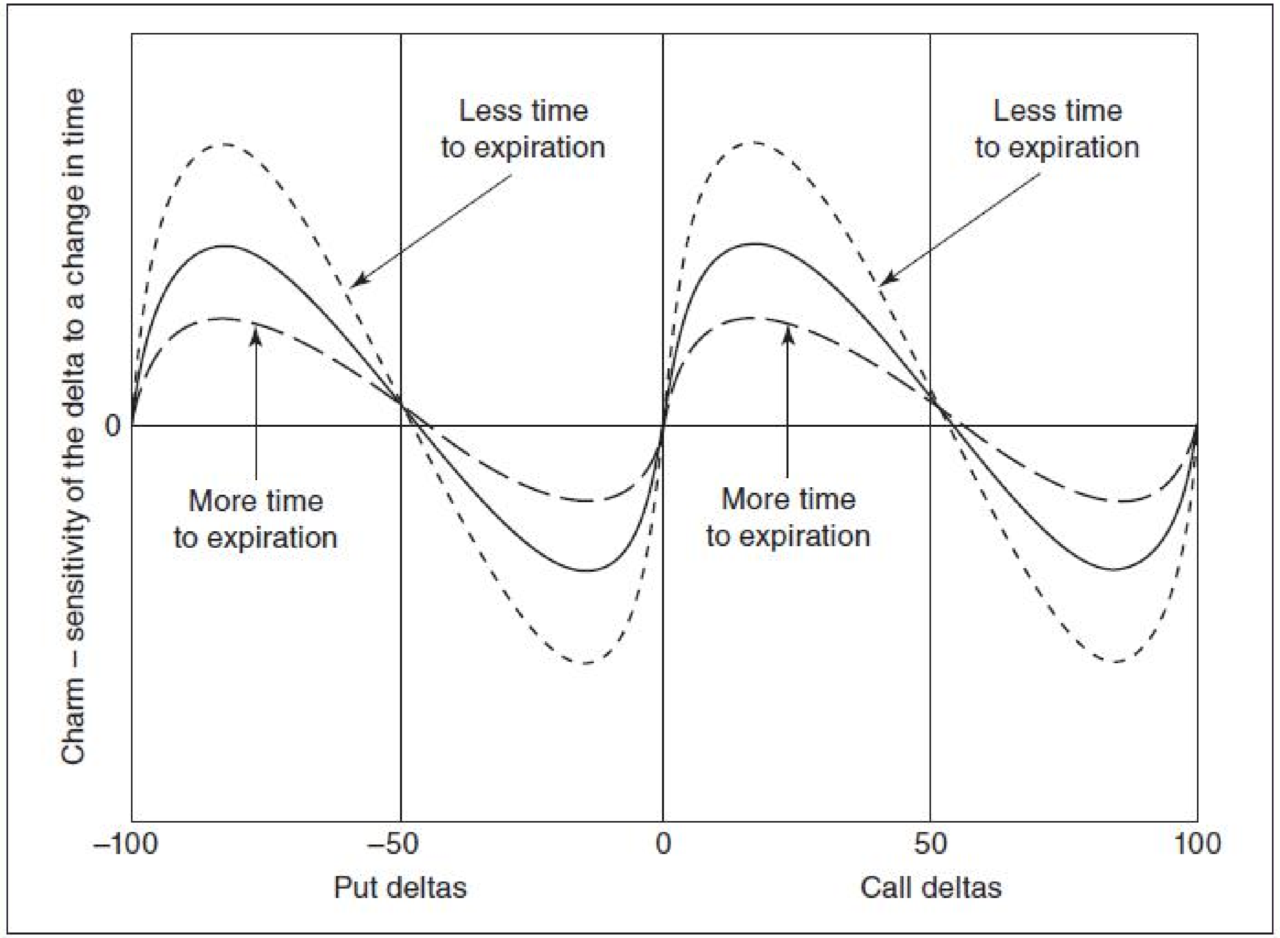


Δ δ

delta

Charm (*Delta decay*) describes the sensitivity of the option's Delta to the passage of Time

Figure 9-7 Charm of an option.



Vanna & Charm

- *Greeks are virtually identical with 0 values around options of 0, 50 or 100 delta*
- *Vanna and Charm are greatest at +/- 20 (or 80) delta*
- *Options with these deltas will move most quickly *towards* 50 delta if we raise volatility or *away from* 50 if we lower volatility* ***or*** *advance time.*

Δ δ

delta

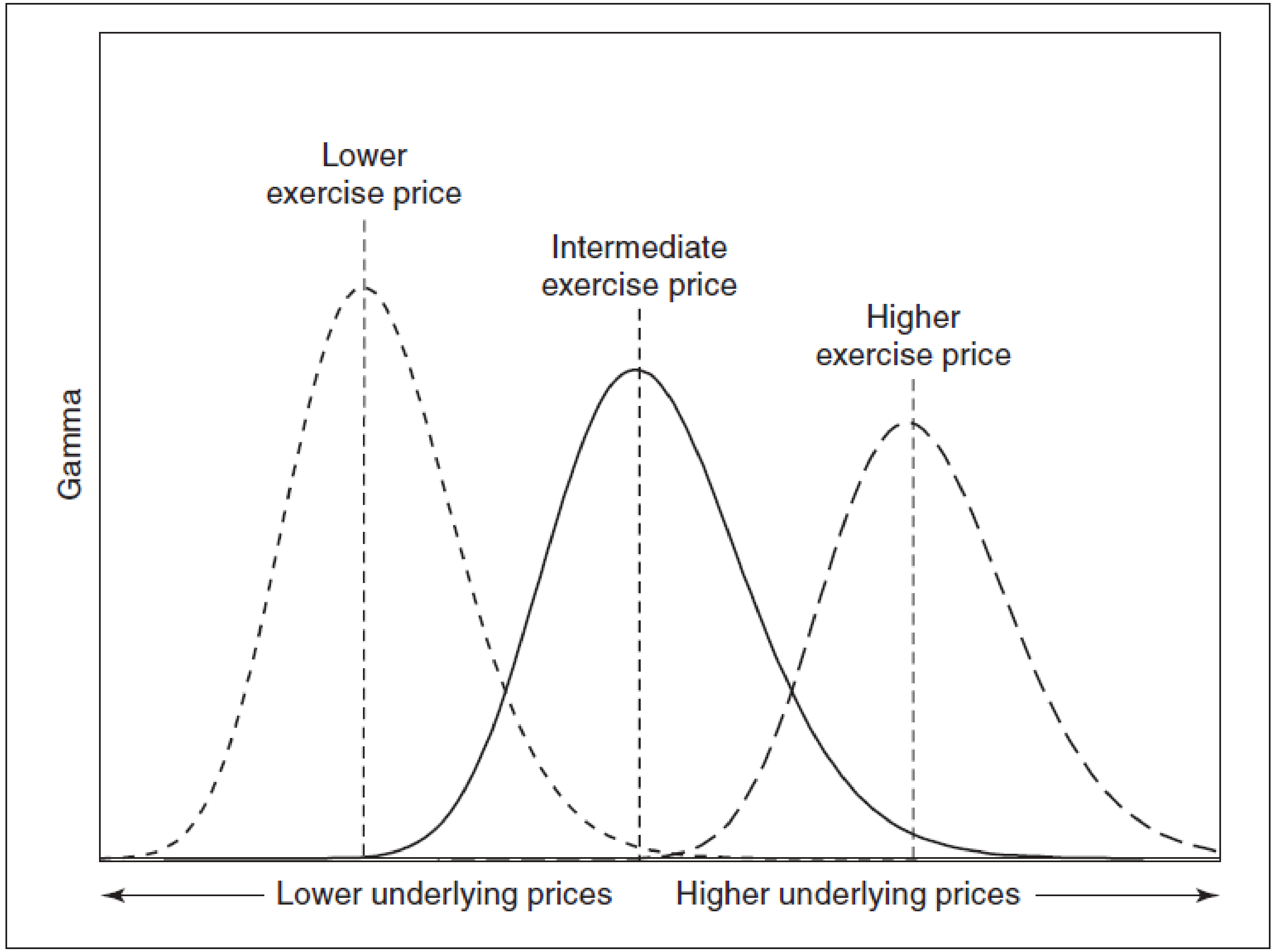
Gamma

- *Measures the sensitivity of the delta to changes in the underlying price*
- *But Gamma itself is sensitive to changes in market conditions:*
    - *Underlying price*
    - *Time to expiration*
    - *Volatility*

$\Gamma \ \gamma$

gamma

Figure 9-18 Gamma of an option as the underlying price changes.



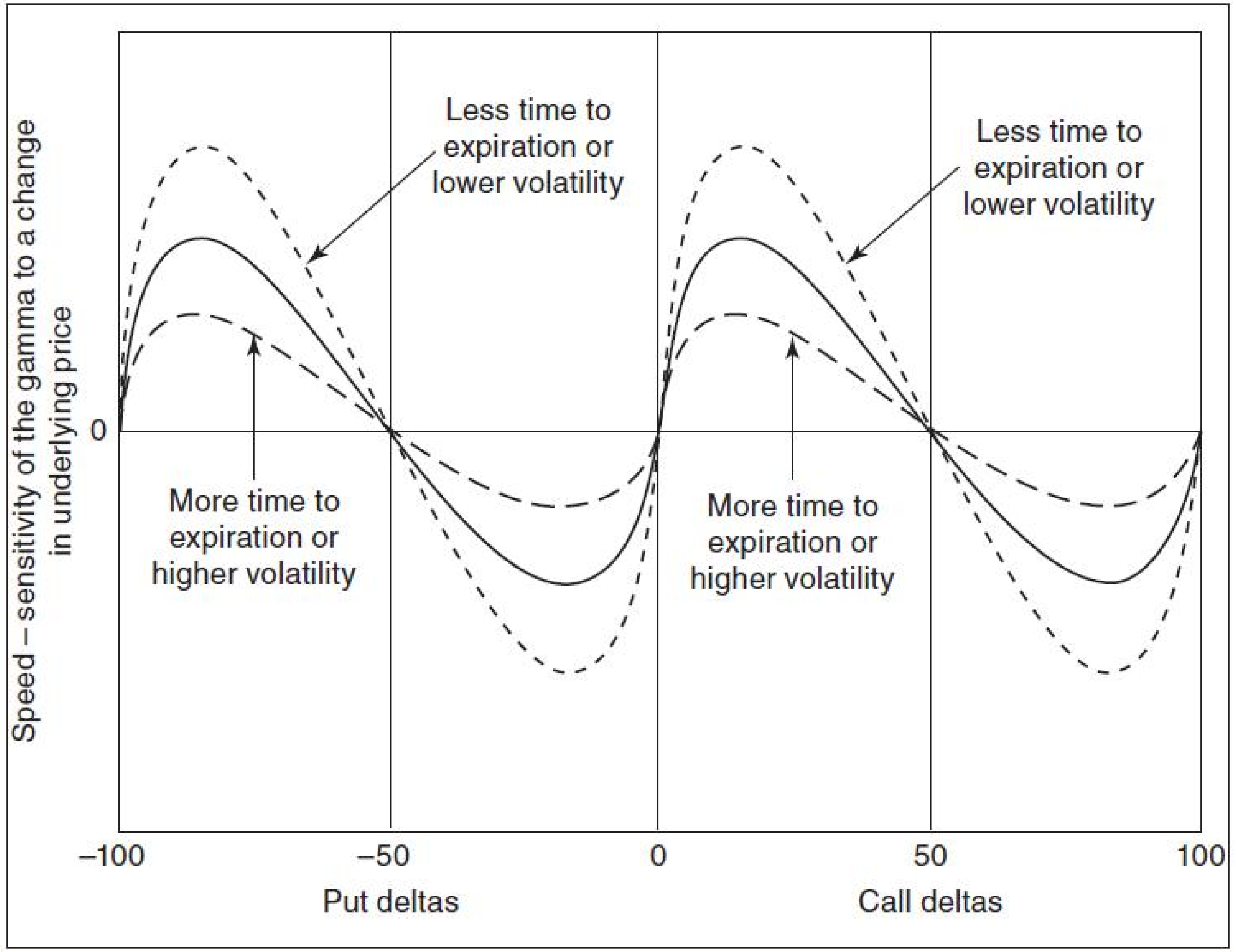
Γ γ

gamma

Speed describes how an option's gamma changes as the *underlying* changes

Speed is greatest for options at +/-15 (85) delta

Figure 9-19 Speed of an option.



While Gamma peaks when an option is at-the-money (50d), the option's speed at that moment approaches 0

Gamma changes as *time passes* (Color) or *volatility* changes (Zomma)

Figure 9-20 Gamma of an option as time passes or volatility changes.

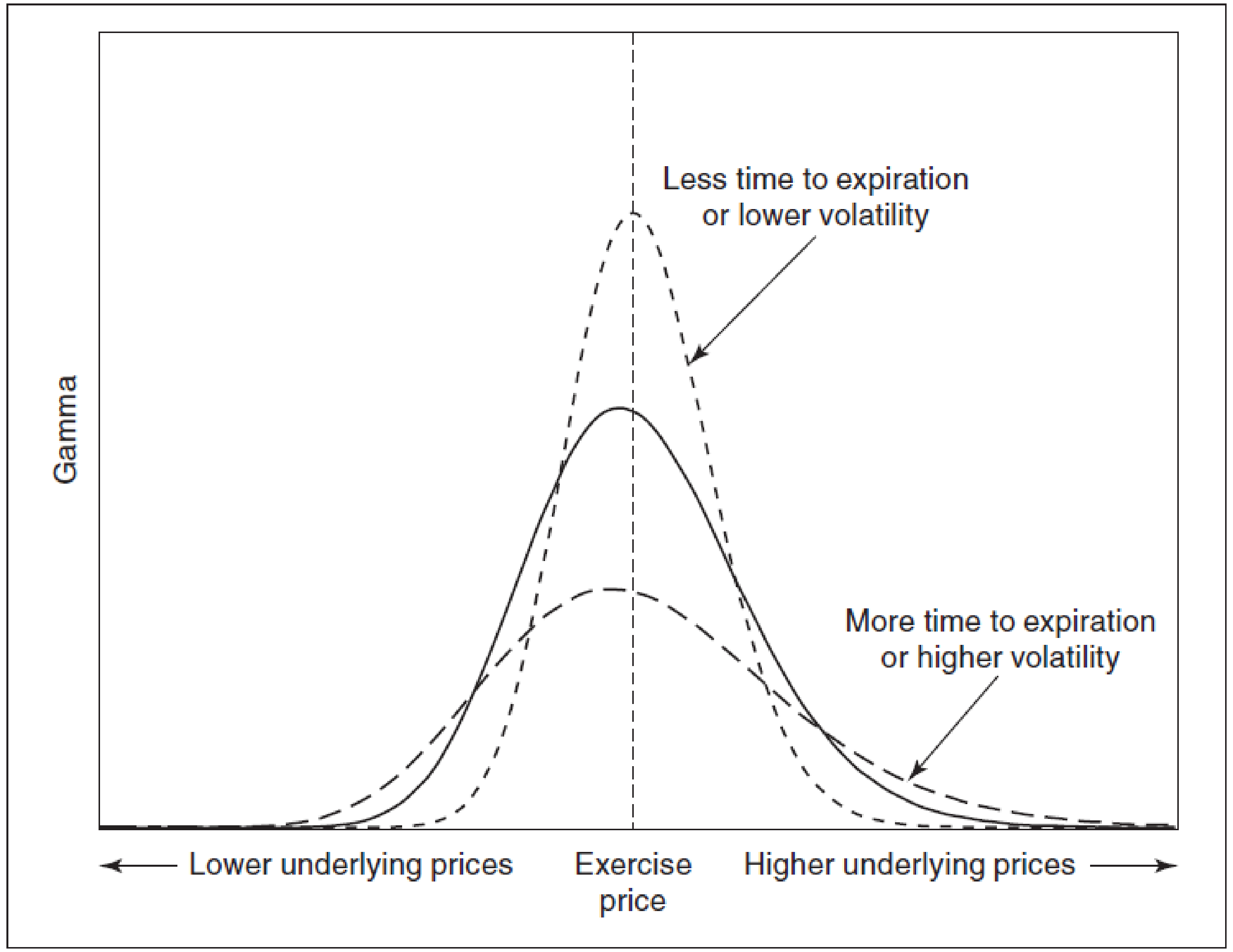


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Figure 9-21 Color of an option.

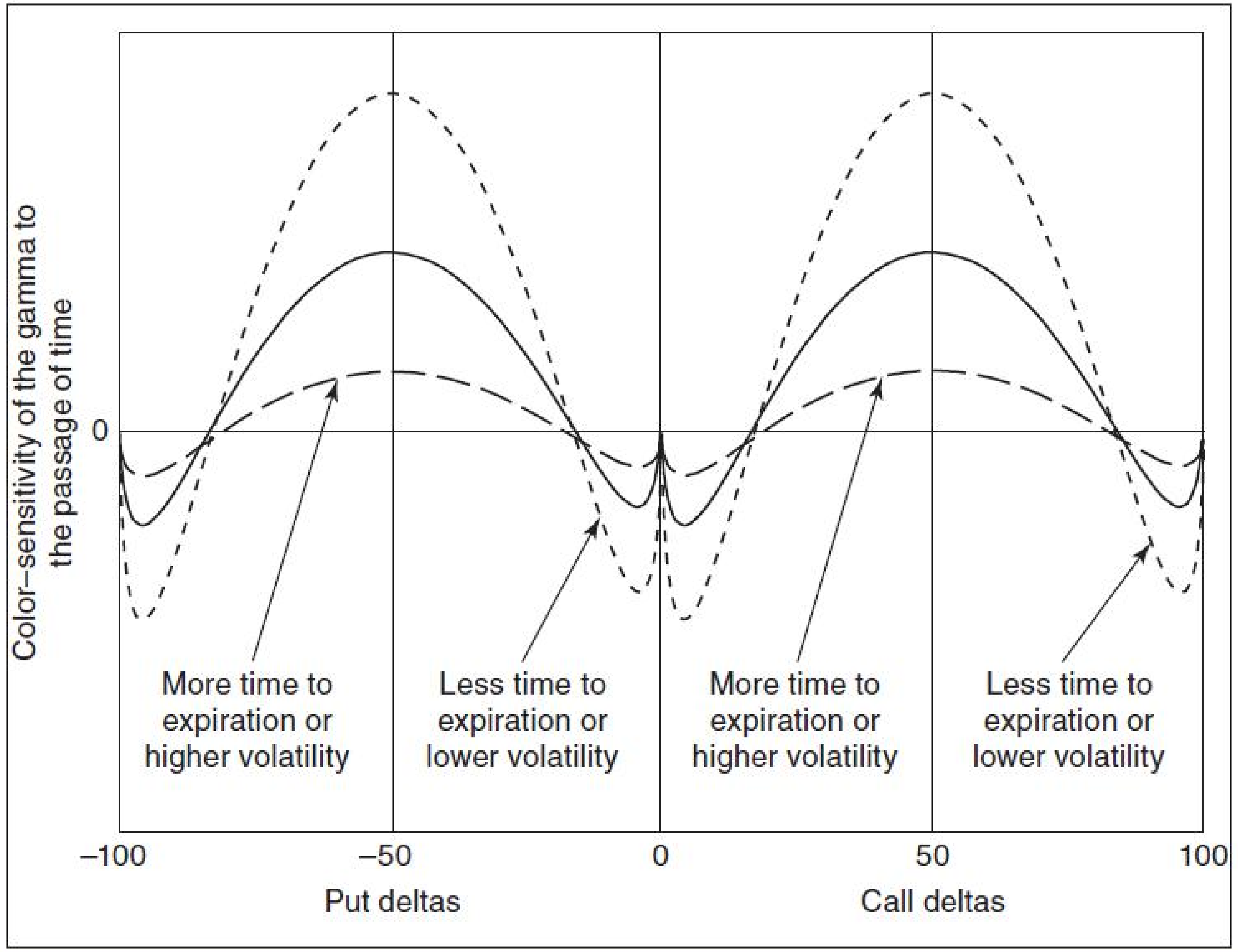
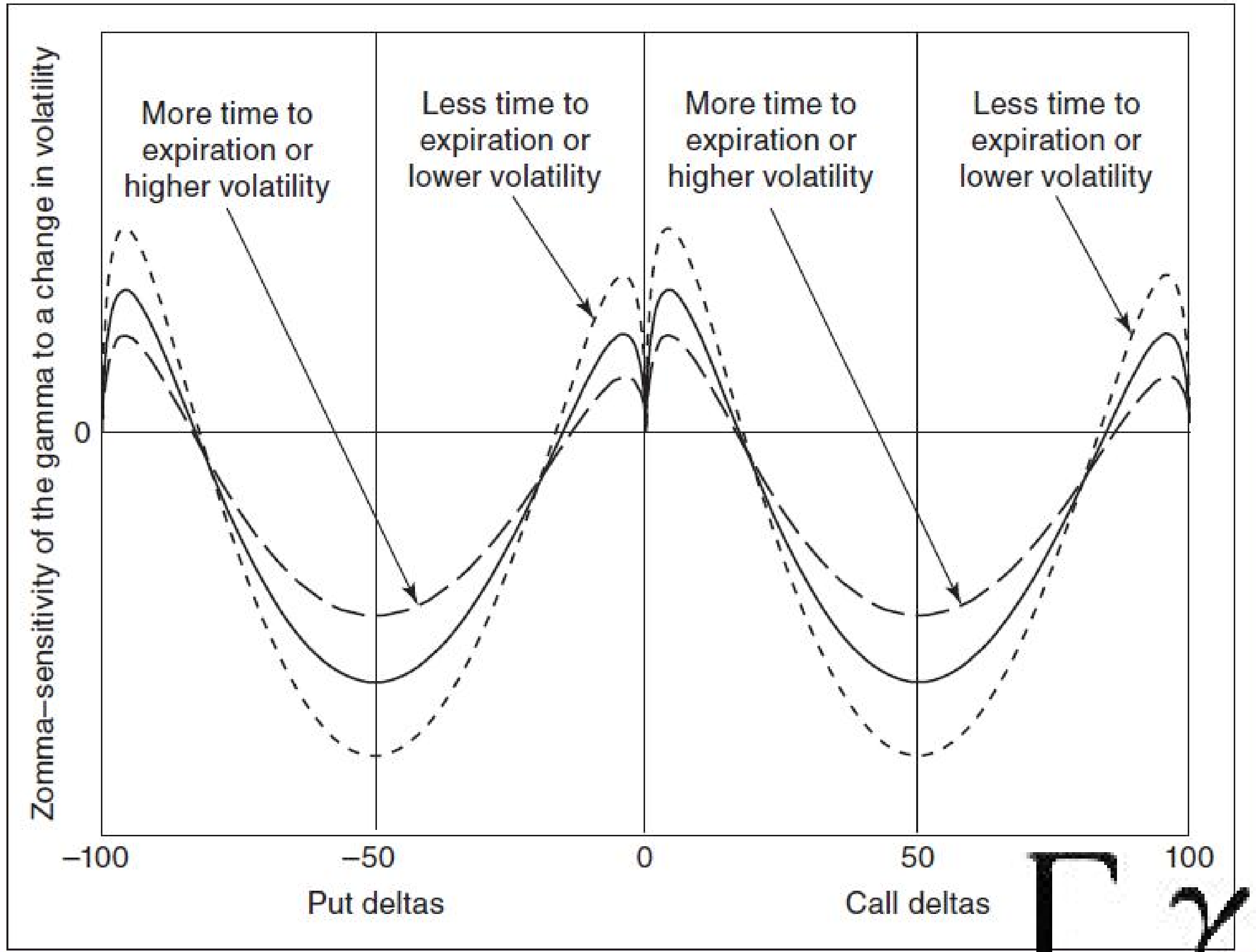
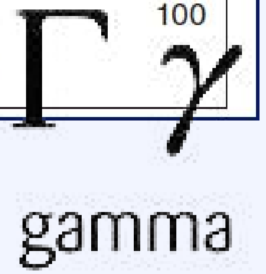


Figure 9-22 Zomma of an option.





Gamma changes as *time passes* (Color) or *volatility* changes (Zomma)

- *The passage of time (Color) or the lowering of volatility (Zomma) increase an ATM option's Gamma*
- *Maximum Color / Zomma ATM ~50 delta*
- *Minimum (Negative) Color / Zomma ~ +/-5 delta (or +/-95d)*
- *Near +/-15 delta (or +/-85d)... Color / Zomma are 0*

Γ γ

gamma

Theta describes the rate at which an option decays

- *Theta is greatest for at-the-money (ATM) options*
- *Declines as options move into or out of the money*
- *Theta is a function of an option’s time value (extrinsic value)*
    - *Higher underlyings = higher Theta values*

Θ θ

theta

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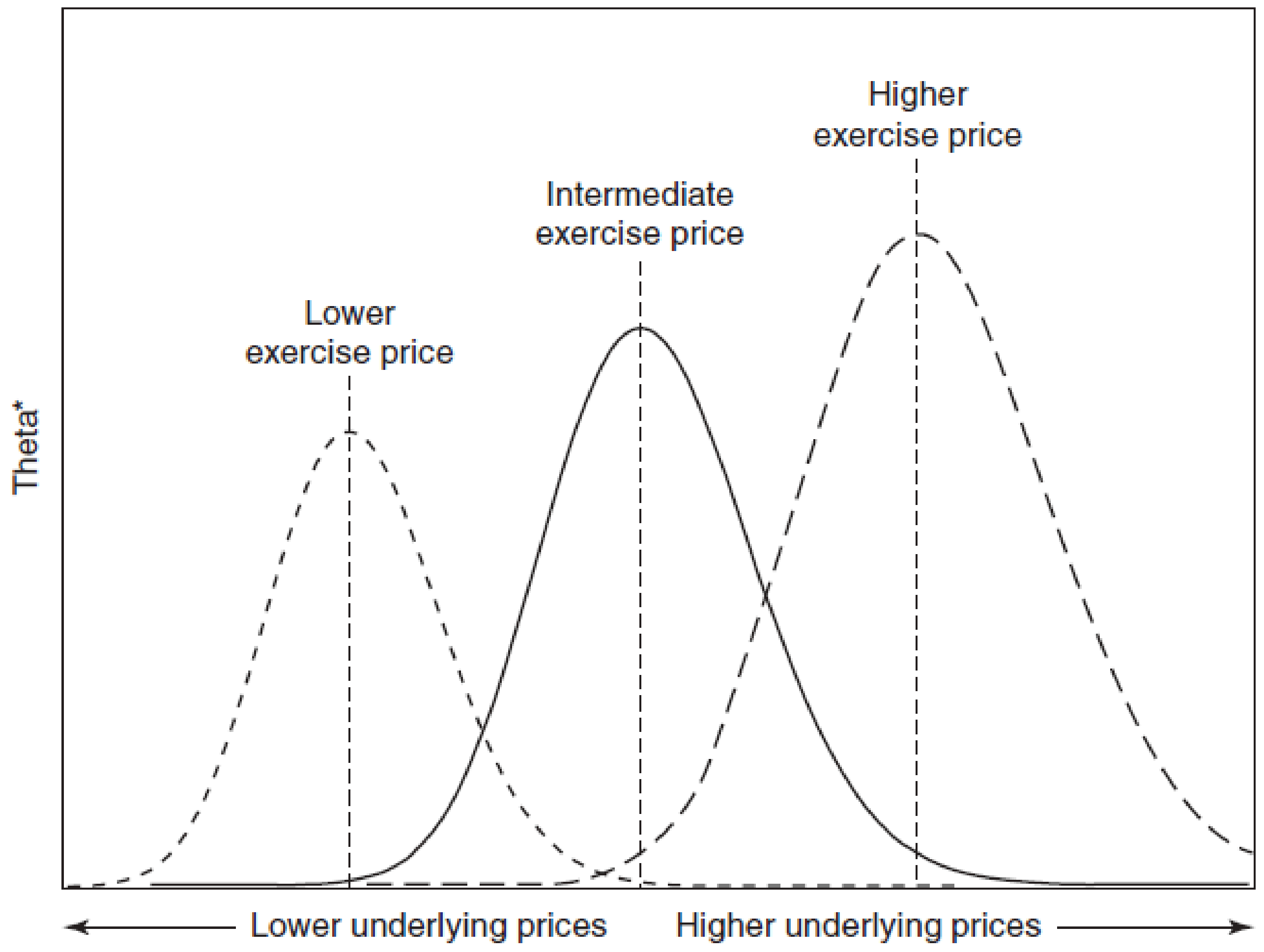
Figure 9-8 Theta of an option as the underlying price changes.



*Although it is common to express theta as a negative number, the theta values in Figures 9-8, 9-10, and 9-11 are expressed in terms of absolute value.

Θ θ

theta

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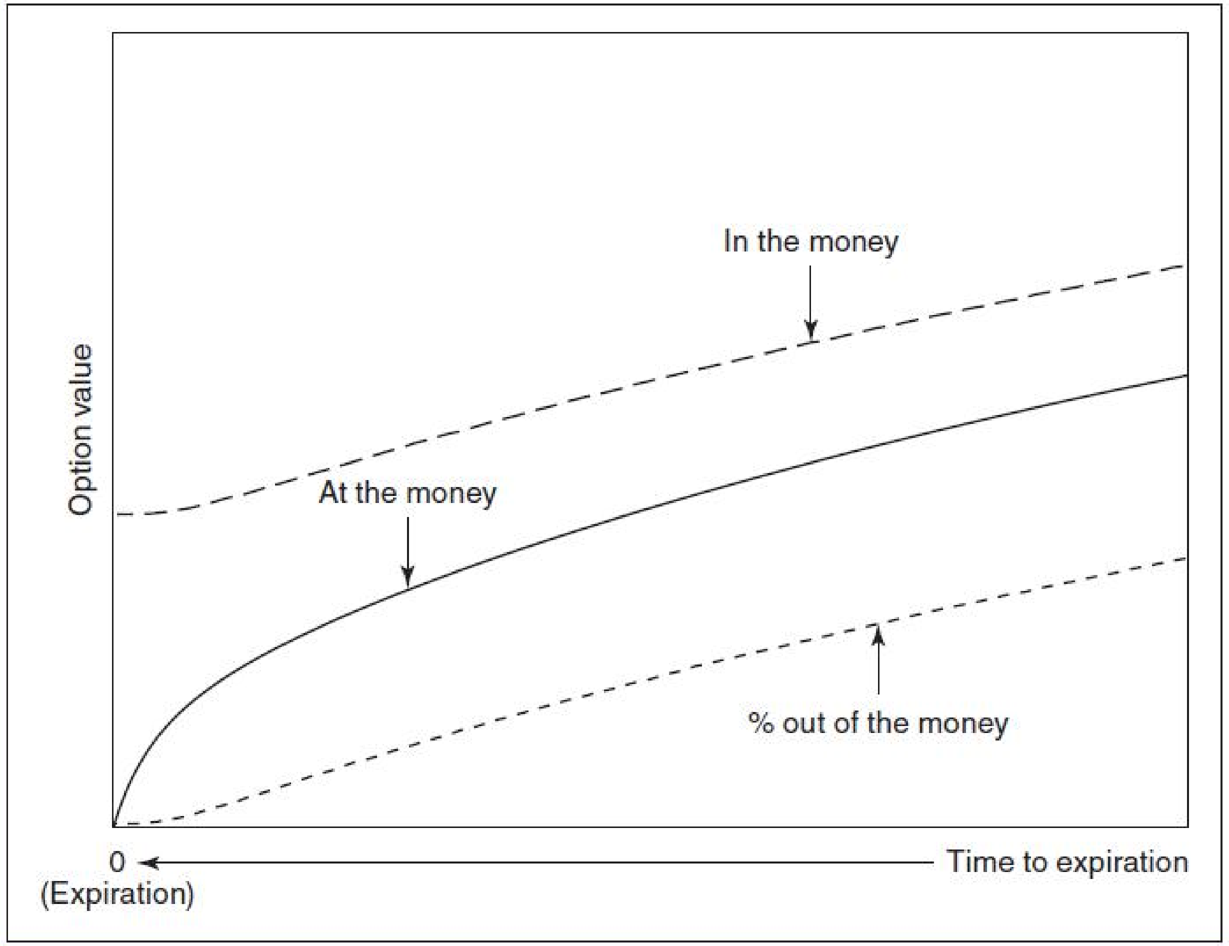
Figure 9-9 Theoretical value of an option as time passes.



Θ θ

theta

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Figure 9-9 Theoretical value of an option as time passes.

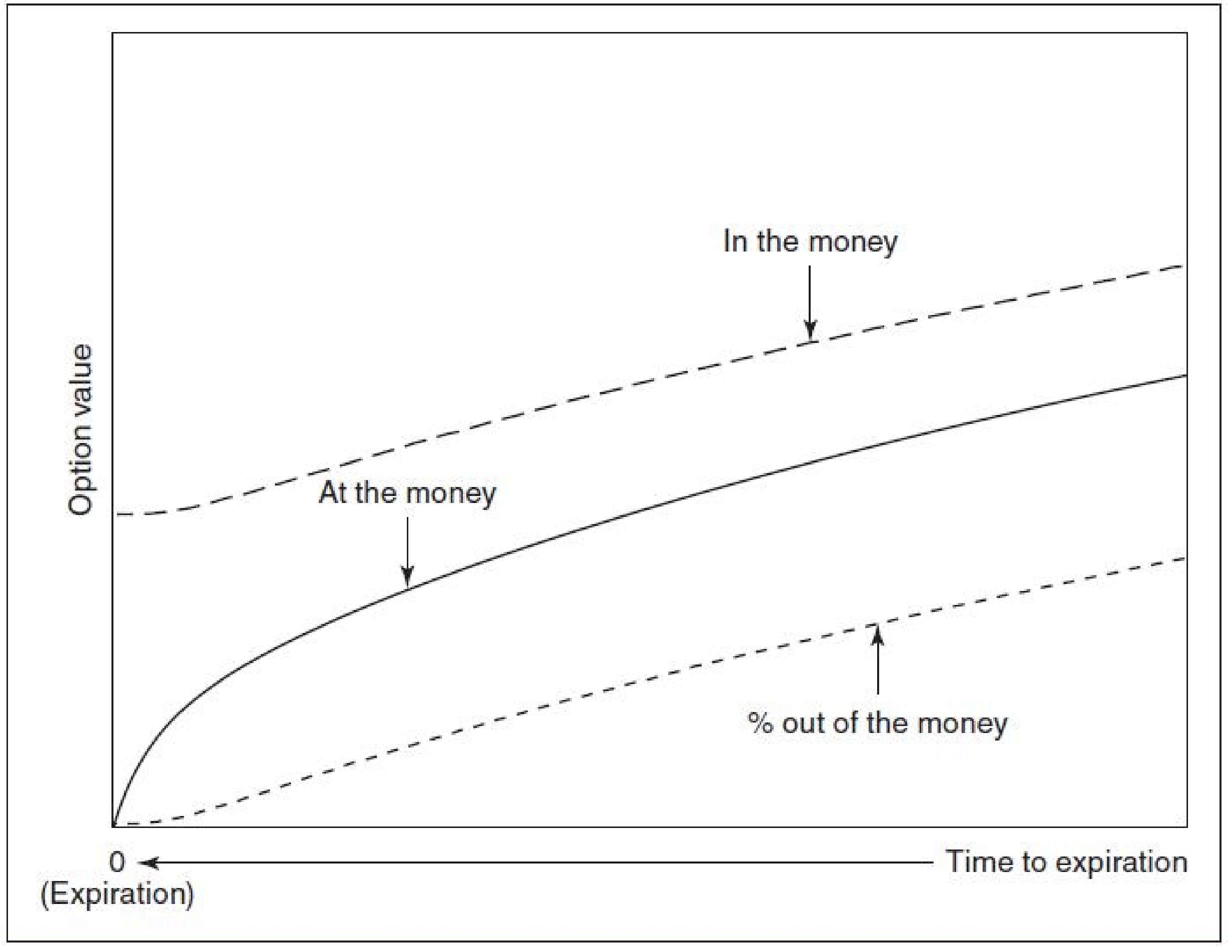
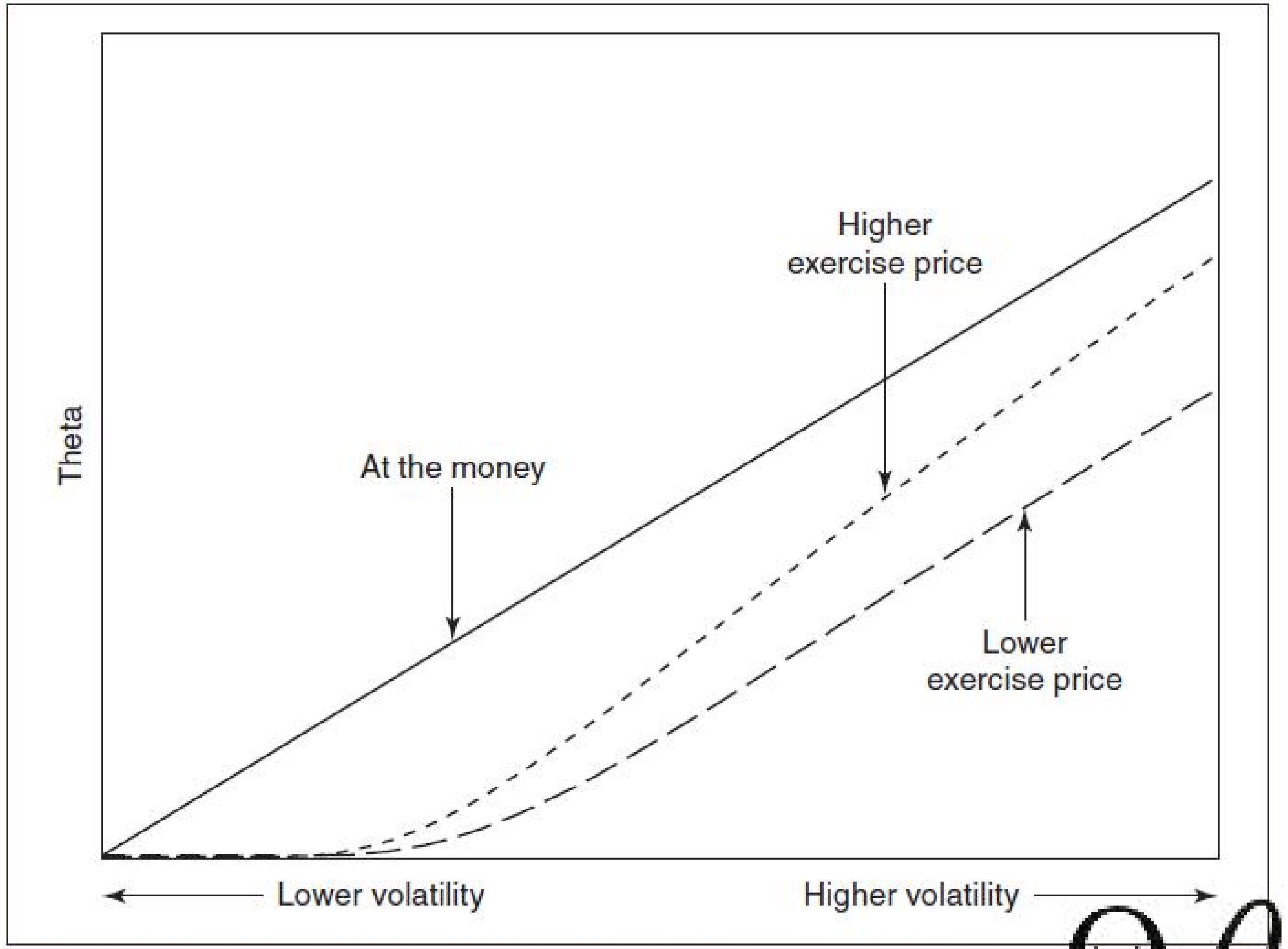


Figure 9-11 Theta of an option as volatility changes.



$\Theta\ \theta$

theta

Theta of an at-the-money (ATM) option is proportional to the *square root of time*

Given an at-the-money (ATM) option…

Where TV_t *is the option's theoretical value at time t (in DTE)*

Then the theoretical value one day later, TV_{t-1} *is* $TV_{t-1} = TV_t \times \sqrt{(t-1)/t}$

$$\Theta = TV_t \times \left[1 - \sqrt{(t-1)/t}\right]$$

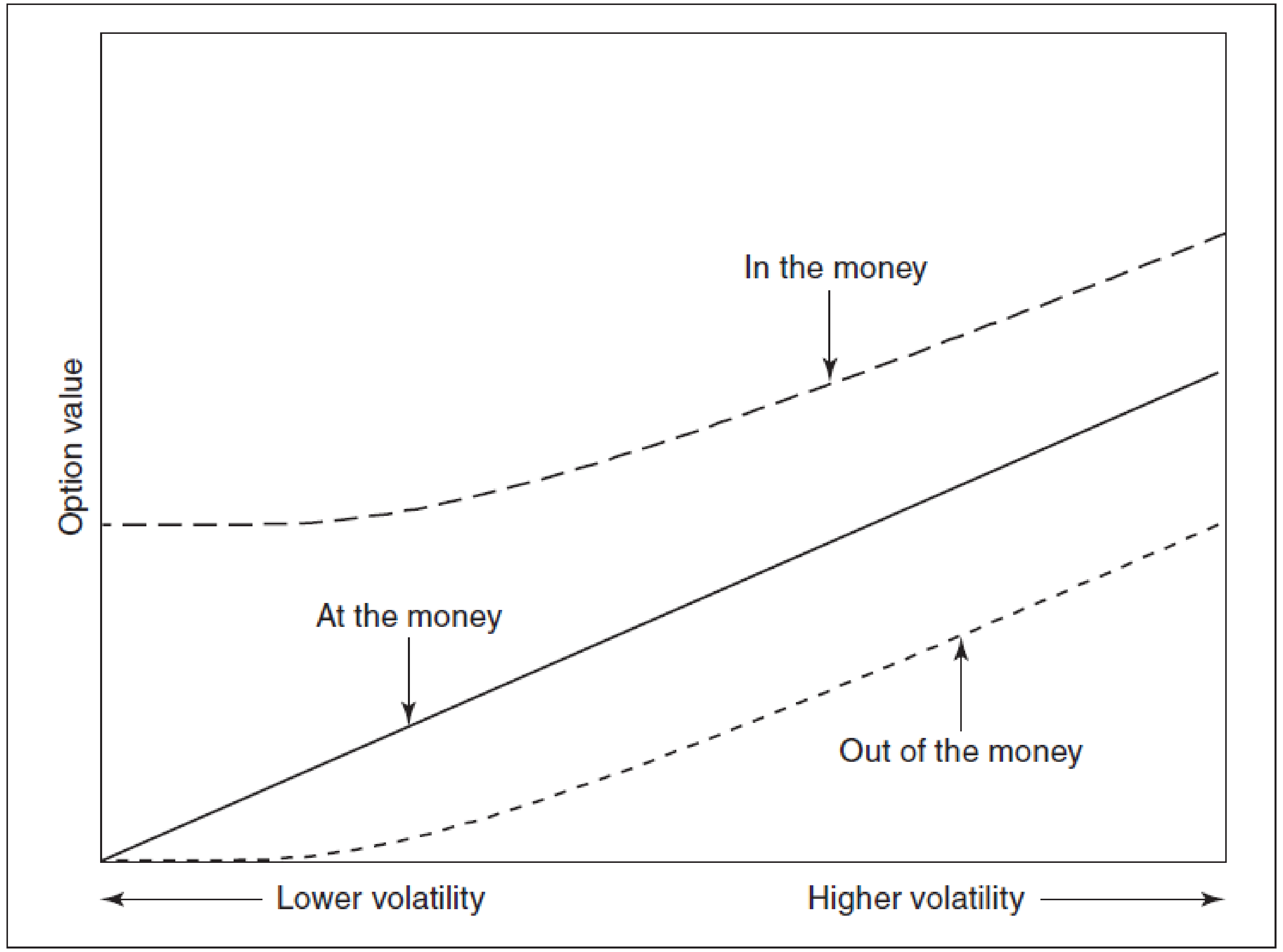
Θ θ

theta

Vega describes how an option's price changes as implied volatility changes

Vega of an ATM option is proportional to its exercise price

Figure 9-13 Theoretical value of an option as volatility changes.

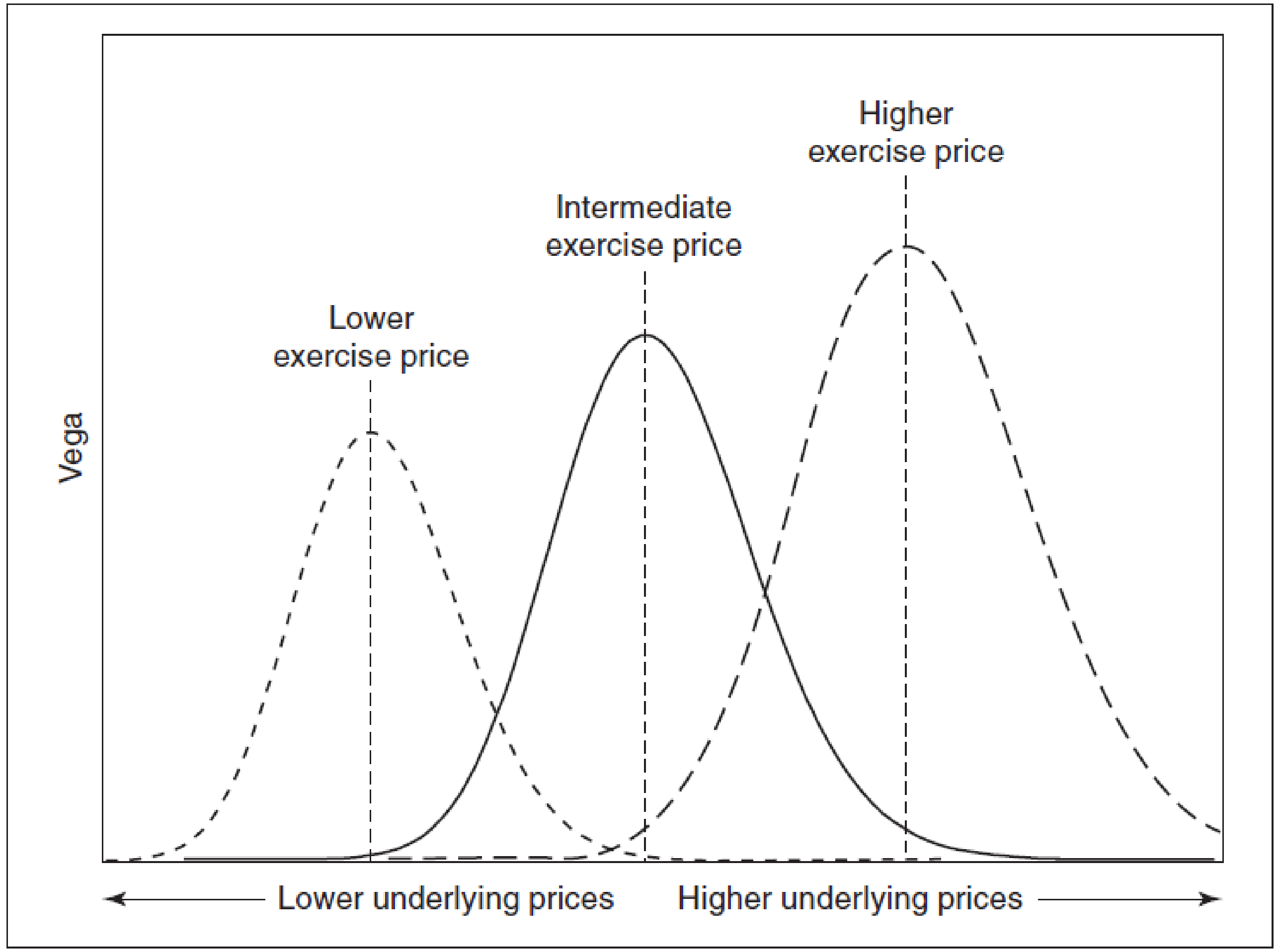


Vanna also describes the sensitivity of an option's Vega to changes in the underlying price

ν
vega

Vega is greatest for ATM options, and increases with the underlying

Figure 9-12 Vega of an option as the underlying price changes.



ν
vega

Volga (or Vomma) describes how Vega changes as *volatility* changes

Figure 9-14 Vega of an option as volatility changes.

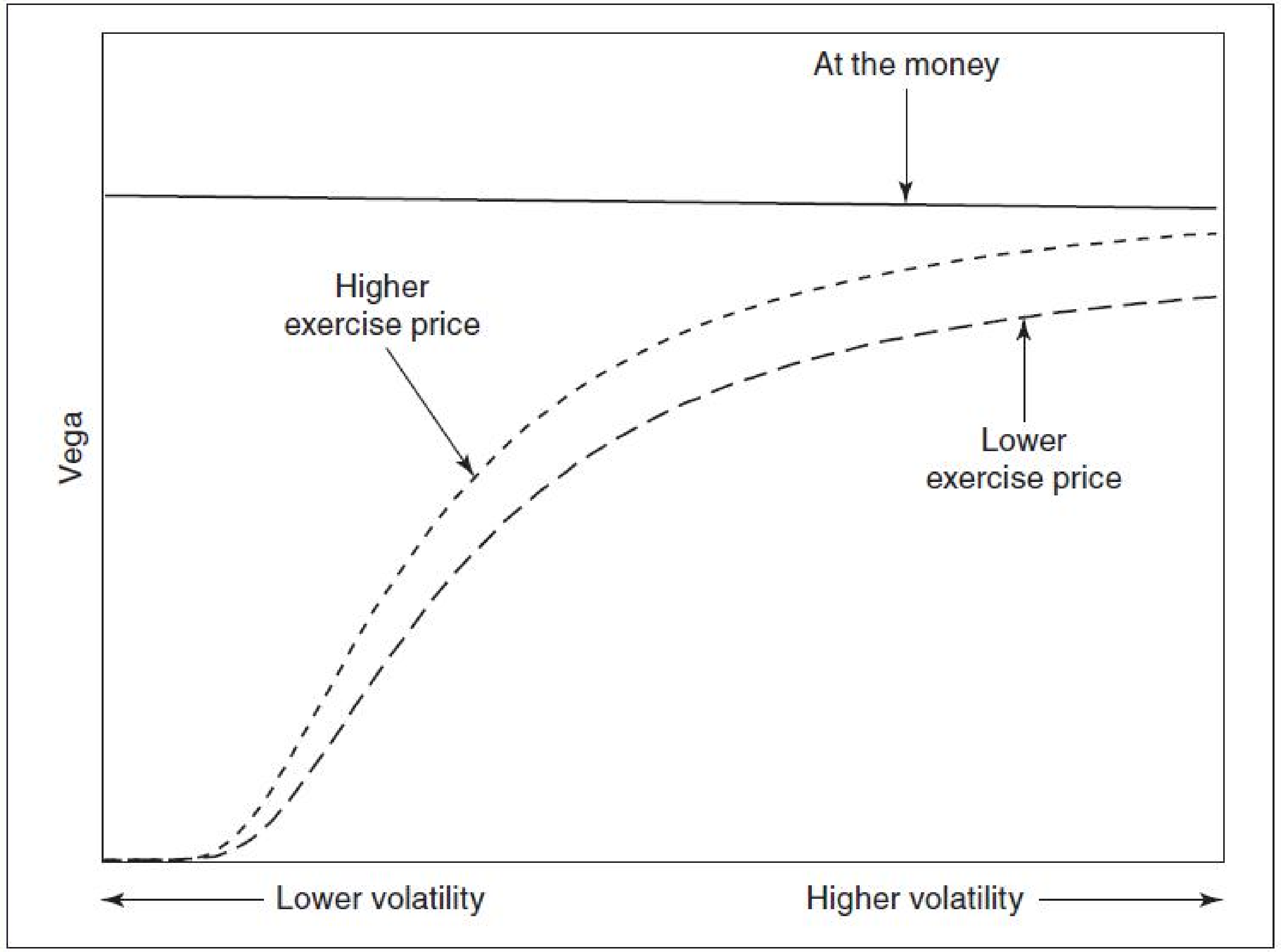
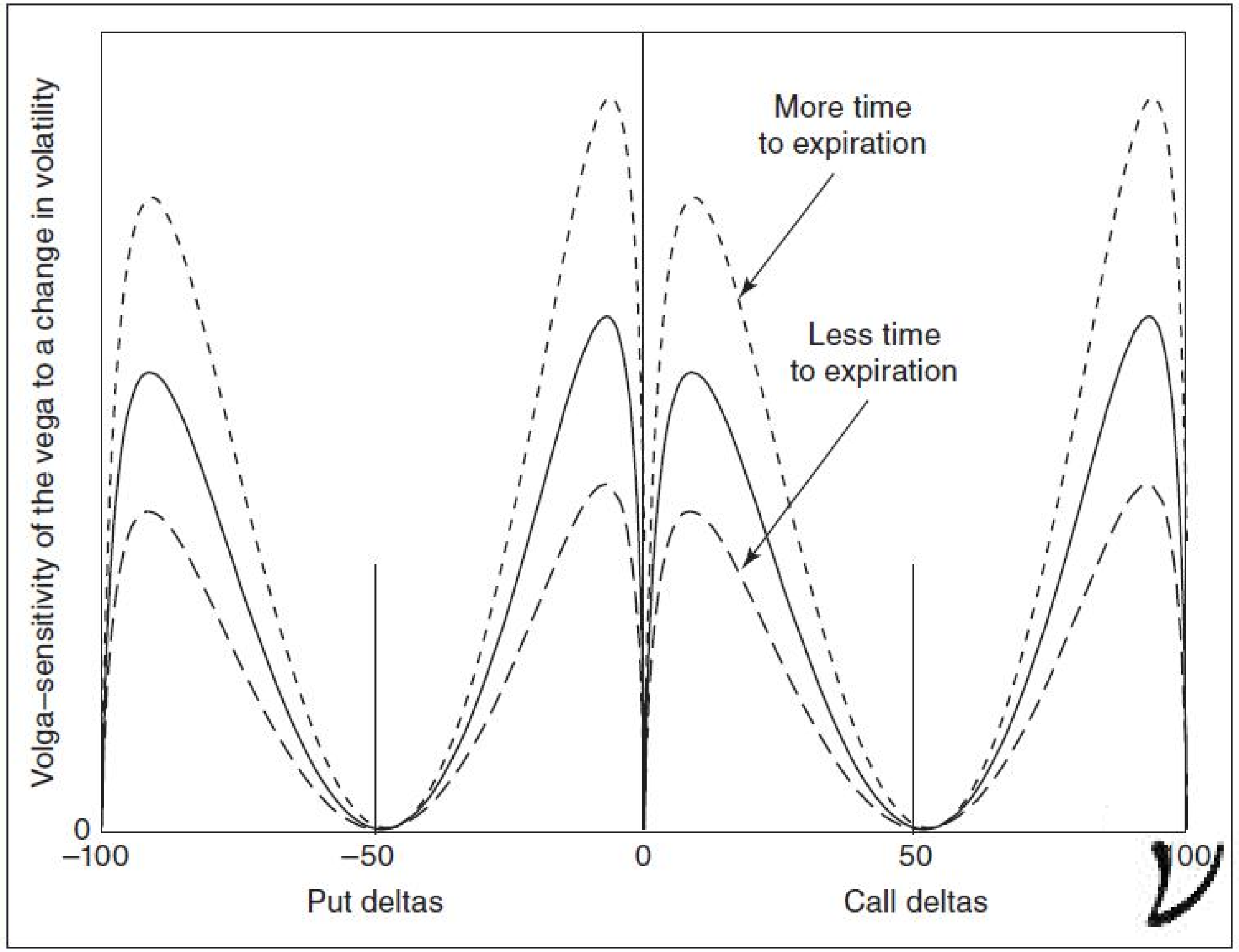


Figure 9-15 Volga (vomma) of an option.



vega

Vega decay (*DVega/Dtime*) describes how Vega changes as time passes

Figure 9-16 Vega of an option as time passes.

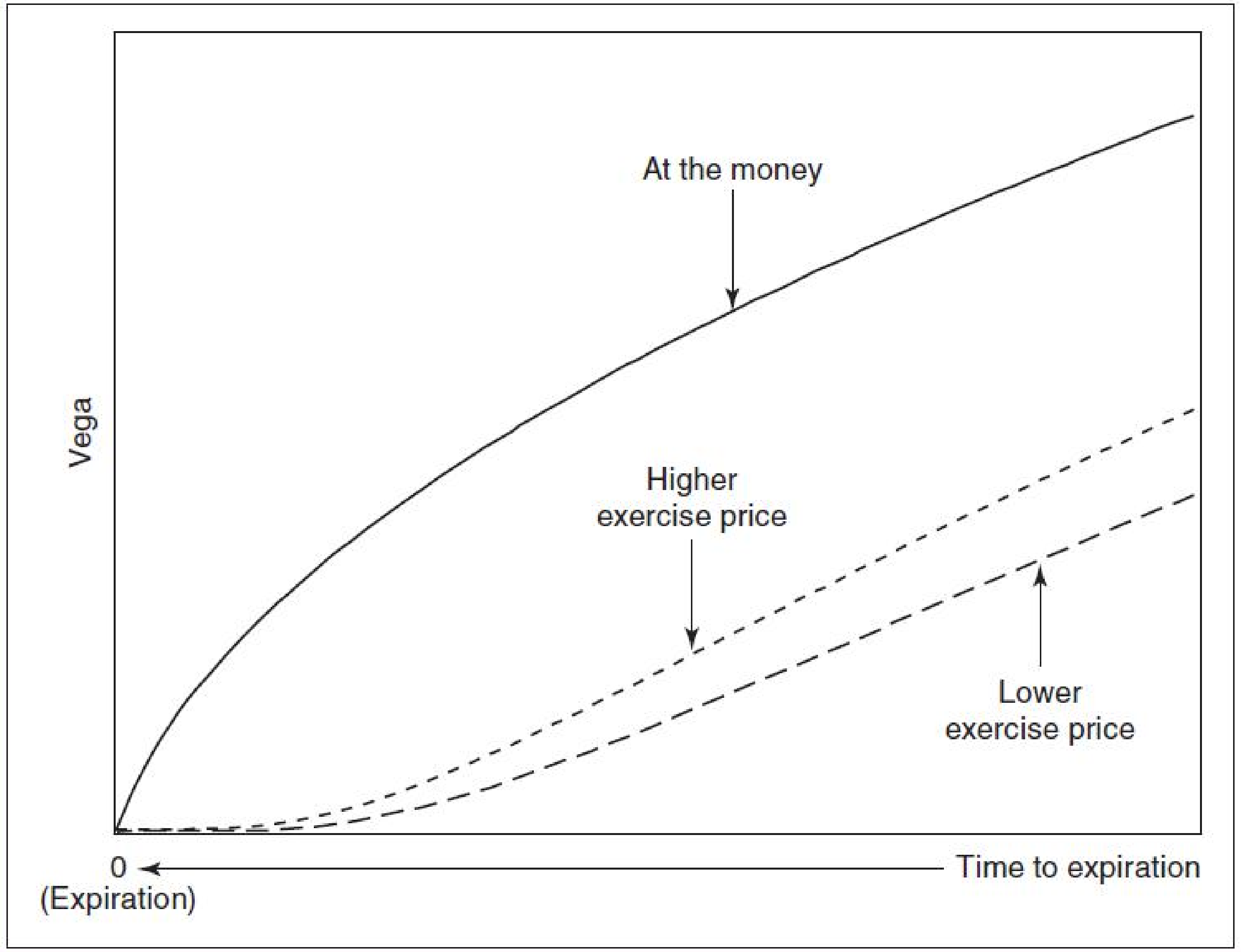
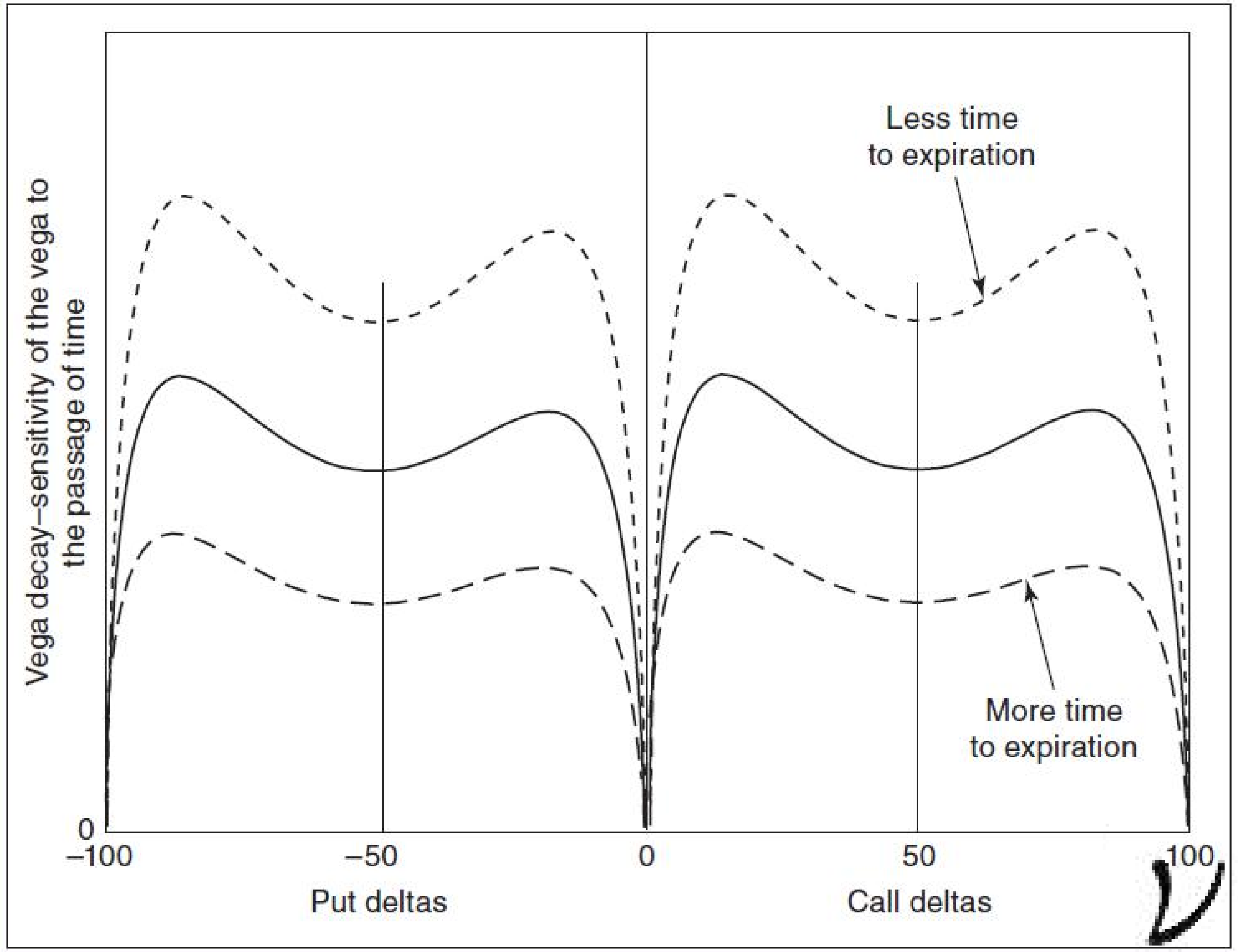


Figure 9-17 Vega decay of an option.



vega

Volga (Vomma) & Vega Decay (DVega/Dtime)

- *ATM Vega levels are relatively constant as Volatility changes*
- *Longer term options are always more sensitive to changes in Volatility*
- *Raising volatility forces all options to become “more like straddles”*
- *Volga (Vomma) and Vega Decay (DVega/Dtime) is greatest at +/- 10 (or 90) delta*
- *Volga (Vomma) is greater for longer-dated options (increases with time to maturity)*

ν
vega

Lambda is like Delta… but via *percentage change*

- *Lambda also called "elasticity", and is sometimes referred to as the option's "leverage value"*
- *Lambda = D * (S/TV), where D is the option's decimal delta, S is the underlying price & TV is the option's value*

Figure 9-23 Lambda of a call as time passes or volatility changes.

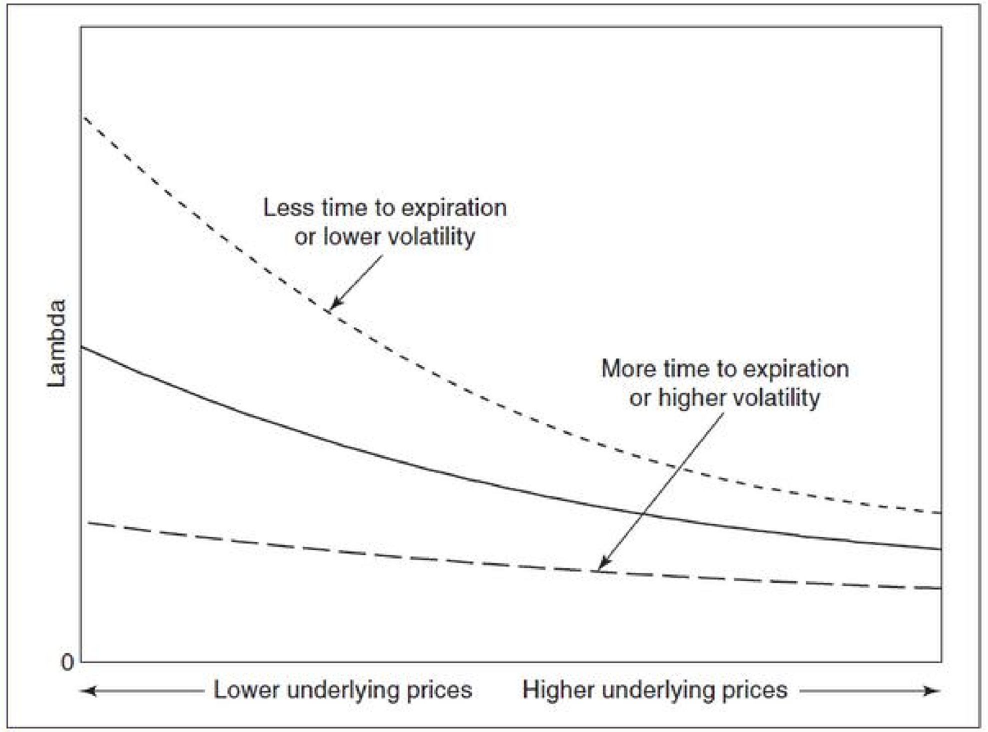
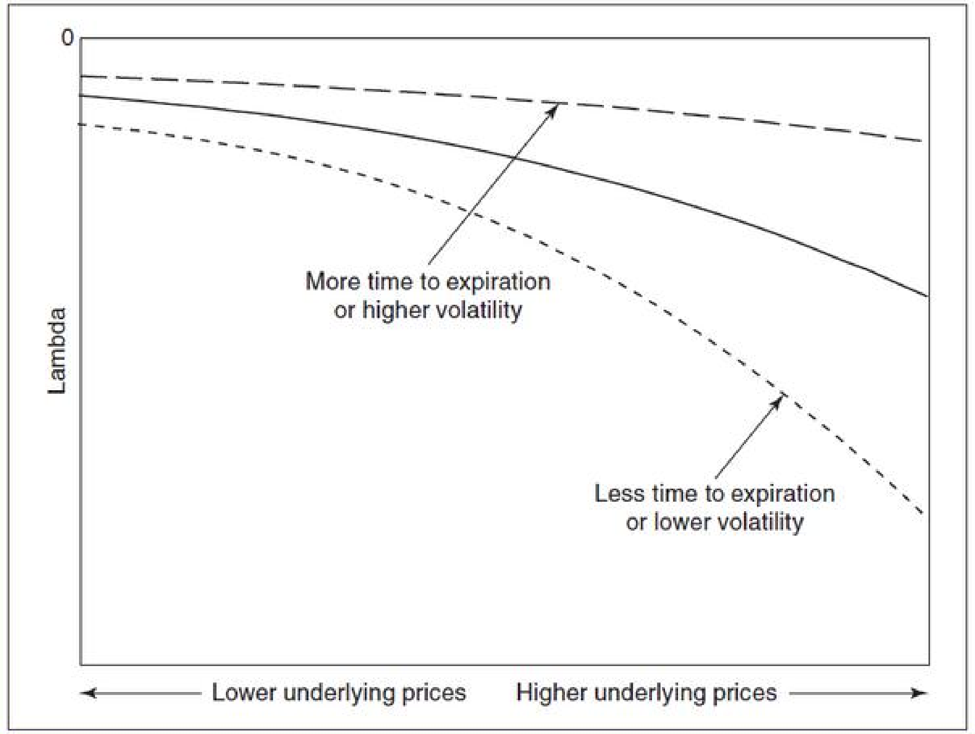


Figure 9-24 Lambda of a put as time passes or volatility changes.



Λλ
lambda

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First order risk measures...

C = call theoretical value P = put theoretical value S = underlying price or spot price
t = time to expiration σ = annual volatility r = domestic interest rate rf = foreign interest rate

Risk Name	Sensitivity of the	To a Change in	Math	Maximized
Delta (Δ)	Theoretical value (in points)	Underlying price (in points)	$\partial C/\partial S \approx \partial P/\partial S + 1$	Deeply in the money
Lambda (Λ) [omega (Ω)] elasticity	Theoretical value (in percent)	Underlying price (in percent)	$\Delta c^*(S/C)$ $\Delta p^*(S/P)$	Out of the money Close to expiration Low volatility
Gamma (Γ) curvature	Delta	Underlying price	$\partial^2C/\partial S^2 =$ $\partial^2P/\partial S^2$ $\partial\Delta/\partial S$	At the money Close to expiration Low volatility
Theta (Θ) time decay	Theoretical value	Time to expiration	$\partial C/\partial t$ $\partial P/\partial t$	At the money Close to expiration Low volatility
Vega	Theoretical value	Volatility	$\partial C/\partial\sigma = \partial P/\partial\sigma$	At the money Long term
Rho (Ρ)	Theoretical value	Interest rate	$\partial C/\partial r$ $\partial P/\partial r$	Deeply in the money Long term
Rhof or phi (Φ)	Theoretical value	Foreign interest rate or dividend yield	$\partial C/\partial rf$ $\partial P/\partial rf$	Deeply in the money Long term

Second order & beyond...

Risk Name	Sensitivity of the	To a Change in	Math	Maximized
Vanna	Delta Vega	Volatility Underlying price	$\partial^2C/\partial S\partial\sigma$ $\partial^2P/\partial S\partial\sigma$	15-20, 80-85 delta Low volatility
Charm delta decay	Delta Theta	Time Underlying price	$\partial^2C/\partial S\partial t$ $\partial^2P/\partial S\partial t$	15-20, 80-85 delta Close to expiration
Speed	Gamma	Underlying price	$\partial^3C/\partial S^3 = \partial^3P/\partial S$ $\partial^2\Delta/\partial S^2$ $\partial\Gamma/\partial S$	15-20, 80-85 delta Low volatility Close to expiration
Color gamma decay	Gamma Charm	Time to expiration Underlying price	$\partial^3C/\partial S^2\partial t$ $\partial^3P/\partial S^2\partial t$ $\partial\Gamma/\partial t$	At the money Close to expiration Low volatility
Volga (vomma)	Vega	Volatility	$\partial^2C/\partial\sigma^2 =$ $\partial^2P/\partial\sigma^2$	10, 90 delta Long term Low volatility
Vega decay	Vega	Time	$\partial^2C/\partial\sigma\partial t$ $\partial^2P/\partial\sigma\partial t$	20, 80 delta Close to expiration
Zomma	Gamma Vanna	Volatility Underlying price	$\partial^3C/\partial S^2\partial\sigma =$ $\partial^3P/\partial S^2\partial\sigma$ $\partial\Gamma/\partial\sigma$	At the money Close to expiration Low volatility

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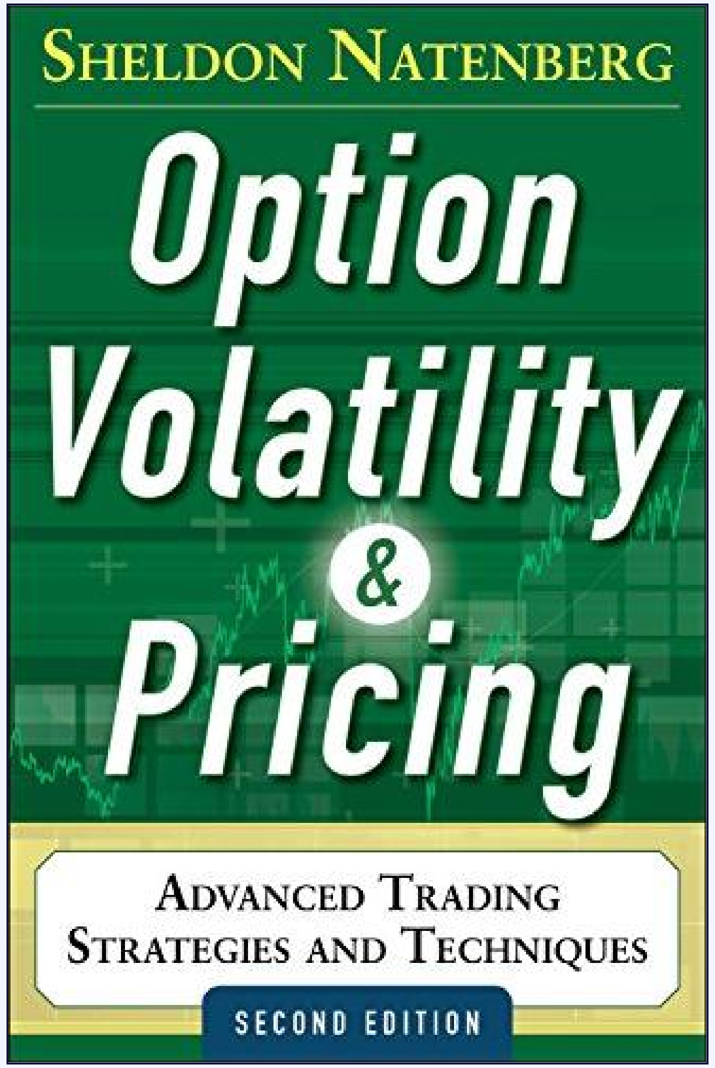
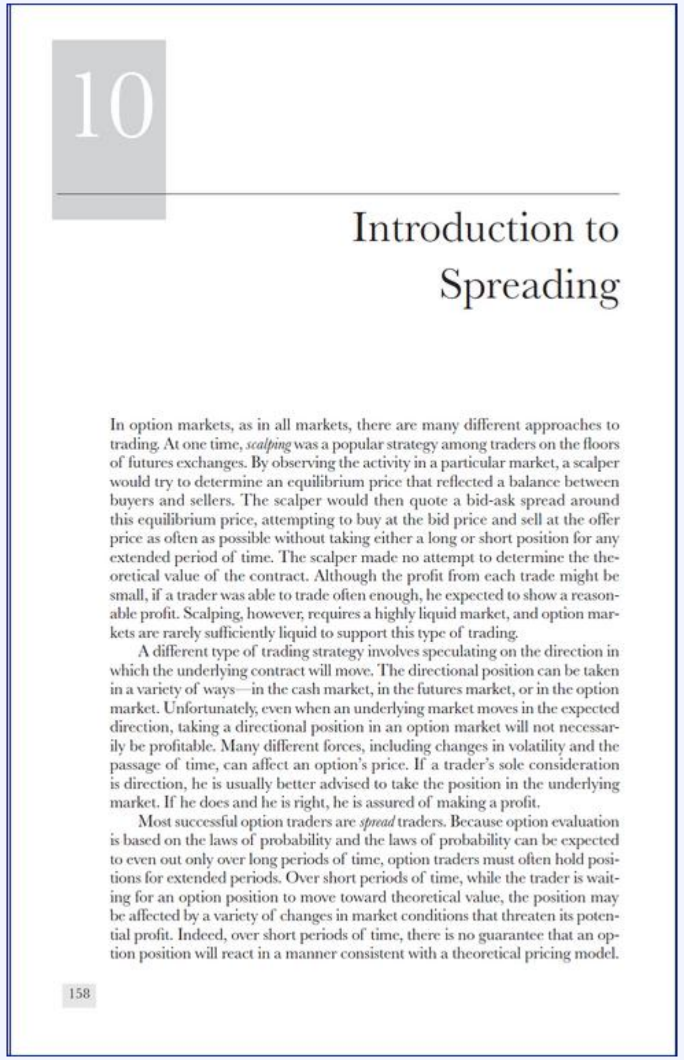
Next up...





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Introduction to Spreading

In option markets, as in all markets, there are many different approaches to trading. At one time, *scalping* was a popular strategy among traders on the floors of futures exchanges. By observing the activity in a particular market, a scalper would try to determine an equilibrium price that reflected a balance between buyers and sellers. The scalper would then quote a bid-ask spread around this equilibrium price, attempting to buy at the bid price and sell at the offer price as often as possible without taking either a long or short position for any extended period of time. The scalper made no attempt to determine the theoretical value of the contract. Although the profit from each trade might be small, if a trader was able to trade often enough, he expected to show a reasonable profit. Scalping, however, requires a highly liquid market, and option markets are rarely sufficiently liquid to support this type of trading.

A different type of trading strategy involves speculating on the direction in which the underlying contract will move. The directional position can be taken in a variety of ways—in the cash market, in the futures market, or in the option market. Unfortunately, even when an underlying market moves in the expected direction, taking a directional position in an option market will not necessarily be profitable. Many different forces, including changes in volatility and the passage of time, can affect an option's price. If a trader's sole consideration is direction, he is usually better advised to take the position in the underlying market. If he does and he is right, he is assured of making a profit.

Most successful option traders are *spread* traders. Because option evaluation is based on the laws of probability and the laws of probability can be expected to even out only over long periods of time, option traders must often hold positions for extended periods. Over short periods of time, while the trader is waiting for an option position to move toward theoretical value, the position may be affected by a variety of changes in market conditions that threaten its potential profit. Indeed, over short periods of time, there is no guarantee that an option position will react in a manner consistent with a theoretical pricing model.

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