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March 24, 2022

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Demystifying the Greeks

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OIC The Options Industry Council℠

Demystifying the Greeks

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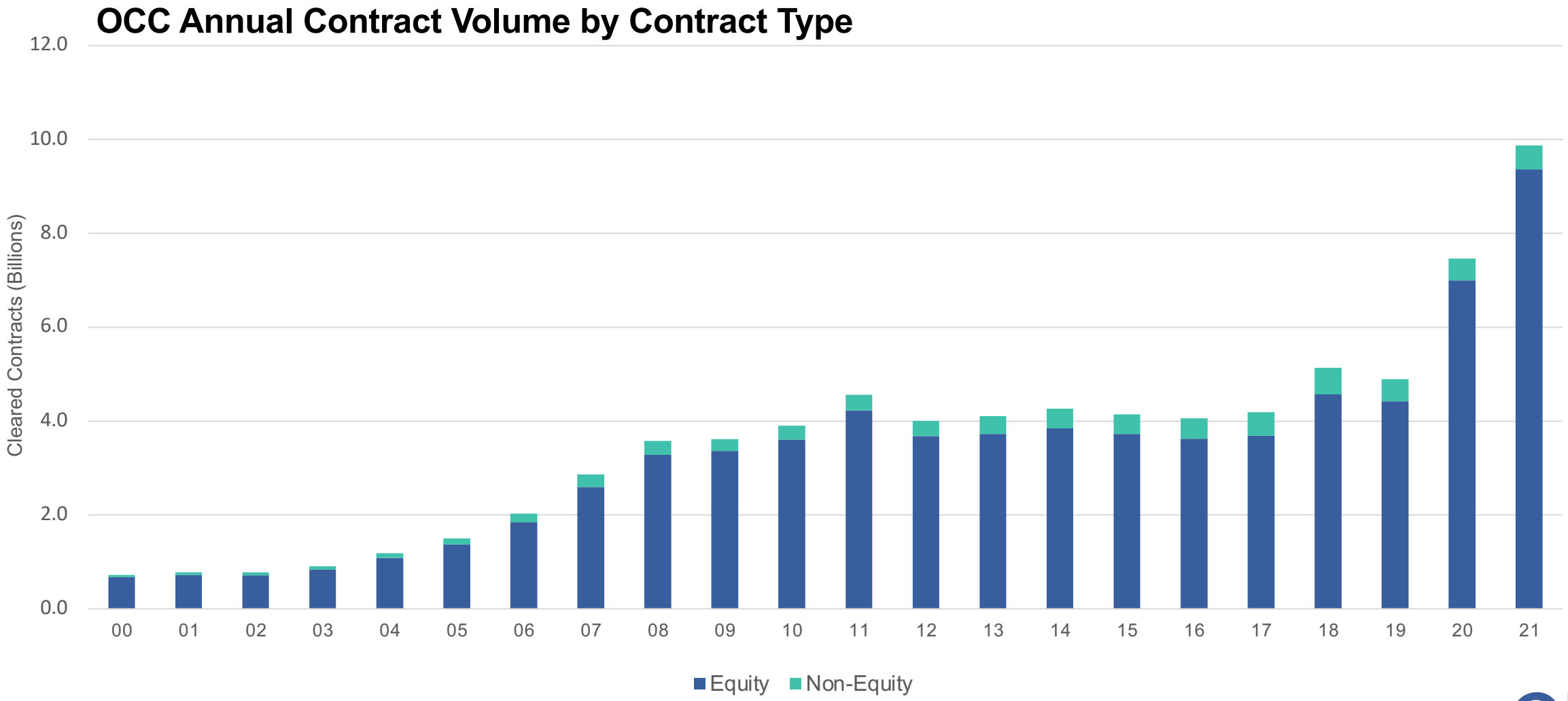
Annual Options Volume 2000-2021



Presentation Outline

- Greeks Overview
- Delta
- Gamma
- Theta
- Vega
- Rho
- Q & A

Introduction to the Greeks

Δ	**Delta**	*Expected change in option value with respect to changing underlying stock price*
Γ	**Gamma**	*Expected change in option **delta** with respect to changing underlying stock price*
Θ	**Theta**	*Expected change in option value through the passage of time (**time decay**)*
K	**Vega**	*Expected change in option value with respect to changing implied volatility*
P	**Rho**	*Expected change in option value with respect to changing risk-free interest rate*

Nature of the Greeks

Meaningful only during an option's lifetime

- At expiration they disappear / become irrelevant

Greeks may affect each other

- e.g., change in an options theta (time decay) may affect its delta

Impact of changes in Greeks differ for each option contract

- ITM vs. ATM vs. OTM
- Near-term vs. Long-term

Delta and Direction

Option Delta – A definition

Delta: Option Value's sensitivity to stock price

The ***expected*** change in an option's price (up or down) for each $1.00 move in underlying stock price

Deep in-the-money options

- High deltas approaching 100% (or 1.00)

At-the-money options

- Deltas around 50% (or .50)

Far out-of-the-money options

- Low deltas approaching 0% (or 0)

Delta Characteristics

Calls have positive (long) deltas

- Positive correlation to underlying stock price change
- Stock price ↑ → call price ↑
- Stock price ↓ → call price ↓
- Call deltas range from 0 to +1.00

Puts have negative (short) deltas

- Negative correlation to underlying stock price change
- Stock price ↑ → put price ↓
- Stock price ↓ → put price ↑
- Put deltas range from 0 to –1.00

Delta as ITM Probability

Another way investors might use delta is to determine **probability of an option finishing ITM**

- Buying a 70-delta call could indicate a 70% chance of the option finishing **ITM**, and
- Selling a 30-delta call could indicate a 70% chance of the option finishing **OTM**

ITM/OTM does not equal **PROFITABILITY!**

Knowledge Check

Shares trading $100 45-days until expiration

Strike	Call Delta	Put Delta
80	1.00	.00
90	.85	.15
100	.50	.50
110	.20	.80
120	.05	.95

- ❑ If an investor buys the 110 calls for $1, what is the expected option value if shares increase to $105 ? **$2.00***
- ❑ If an investor sells two of the 90 strike puts, what is the estimated probability that the contracts will finish OTM? **85% chance**
- ❑ If an investor buys the 100/110 call spread for $3.20, what is the expected value of the spread if shares increase to $105 ? **$4.70***

***Estimated value assumes all other factors constant**

Gamma

Option Gamma – A definition

Gamma: Delta's sensitivity to stock price

The anticipated change in the delta value for a $1.00 move in the underlying stock

- All other pricing factors constant
- In decimal form (e.g., .002)
- **Adjustment to Delta**

Only options have gamma

Gamma Characteristics

Gamma amount is the same for calls and puts on the same strike

- Gamma for calls
  - Stock price ↑ → delta ↑ by gamma amount
  - Stock price ↓ → delta ↓ by gamma amount
- Gamma for puts
  - Stock price ↑ → delta ↓ by gamma amount
  - Stock price ↓ → delta ↑ by gamma amount

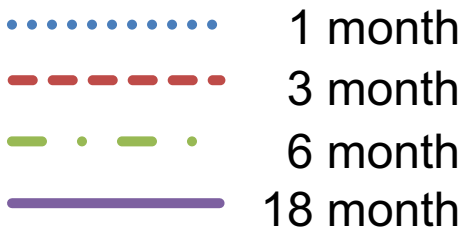
Gamma is what option buyers are paying for

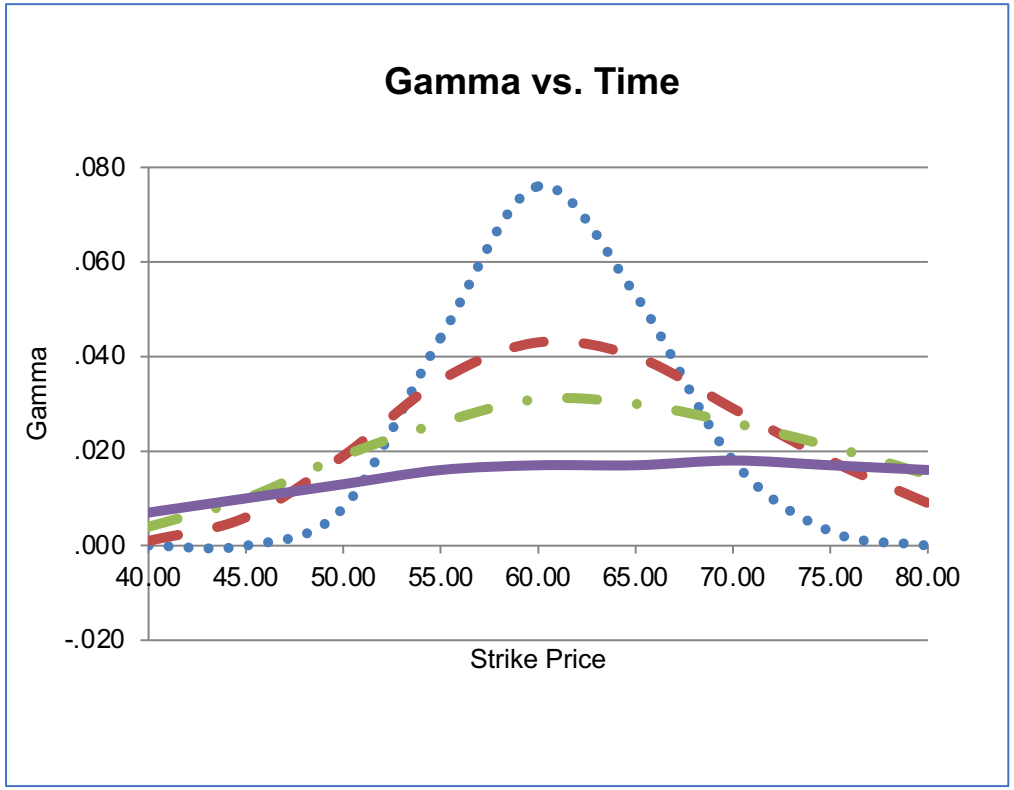
- Acceleration of delta
- "Delta of the delta"

Gamma over Time

As expiration nears:

- Gamma of ATM calls and puts ***increases***
- Gamma of both ITM and OTM calls and puts ***decreases***





XYZ $60.00 30% vol. 2% int.

Knowledge Check

Shares trading $50 10-days 'til expiration

- If an investor were to buy the 50 calls and shares increased $2, what is the new expected delta? **.75**
- If an investor was short the 50 calls with stock trading $50, would a share price increase to $52 result in an increase or decrease in gamma? **Decrease**

Strike	Call Delta	Call Gamma
48	.74	.09
49	.63	.11
50	.51	.12
51	.39	.11
52	.29	.10

- If a trader was long 10 of the 52 calls (delta neutral) and shares increased from $50 to $51, how many shares would they need to buy/sell in order remain delta neutral? **Short an additional 100 shares (390 total short shares)**

Theta (Time Decay)

Option Theta (Time Decay) – A definition

Theta: Option value's sensitivity to time

Expected time decay in option value

- With the passage of 1 day
- Expressed in decimal form (-.080)
- Decay is per **calendar day**, not per trading day
- Represents cash amount per option
- All other pricing factors constant

Calls and puts both have negative theta amounts

Theta

An Example of Theta (Time Decay)

An option is trading today at $3.50

- Theta of -$.030 (-$.03)
- Contract is worth $3.50 x 100 shares = $350.00

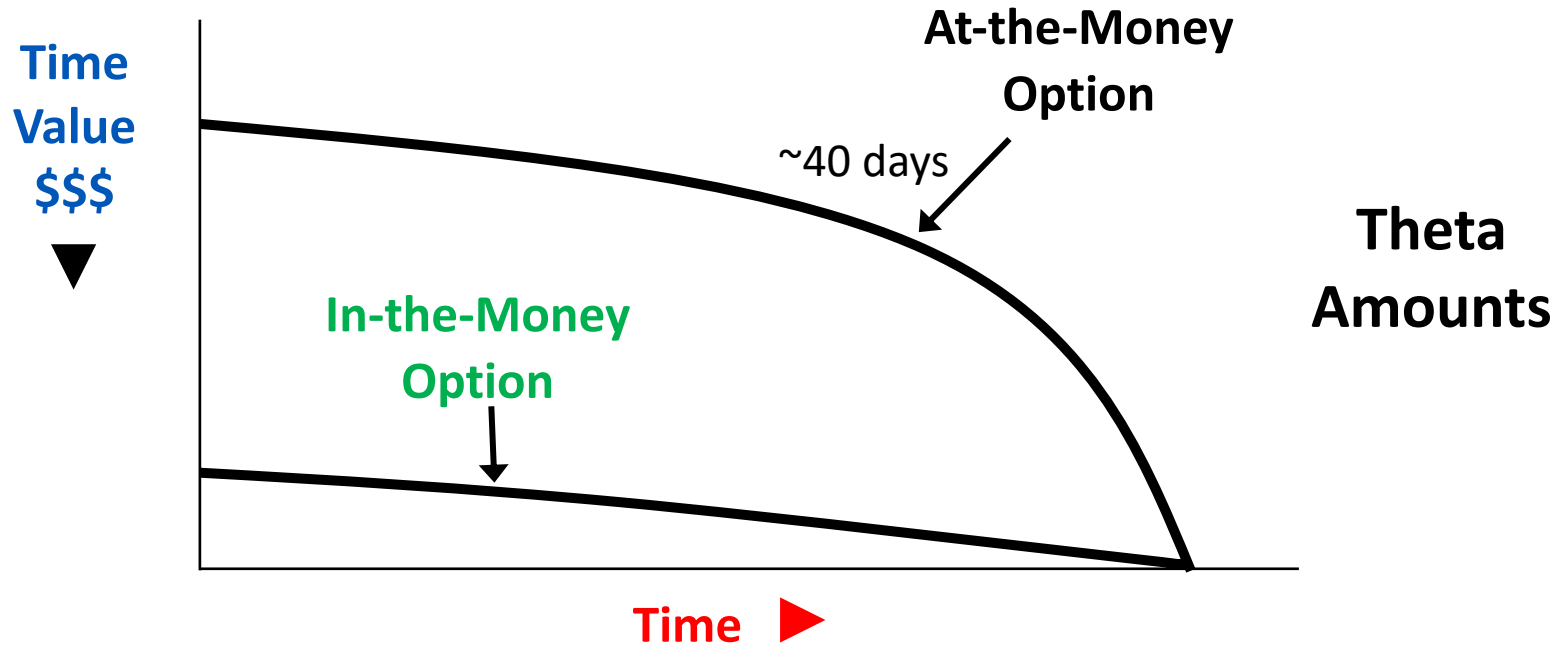
Expected value tomorrow = $3.50 - $.03 = $3.47

- Contract is worth $3.47 x 100 shares = $347.00
- Theta -$.03 → $3.00 loss per contract

Expected value 10 days from now = $3.20

Assuming other pricing factors constant

Time Decay is Not Always Linear



Overall rate of time decay is exponential (**accelerates** towards expiry)

Knowledge Check

Shares trading $100

Long the 95/90 put spread for $0.50. Does Theta help or hurt this position? **Hurt**

Long 80-strike calls for $20.25 or long 85-strike puts for $.40. Which is more affected by time decay? **85-strike puts**

Stock is trading $50 and you are long the April $50/March $50 calendar spread. Does theta help or hurt you? **Help**


Implied Volatility and Vega

Vega: The Volatility Greek – A definition

Vega: Option value's sensitivity to volatility

- Expected change in option value
  - With a 1%-point change in implied volatility (IV)
  - Expressed in decimal form (.080)
  - Represents cash amount per option
  - All other pricing factors constant

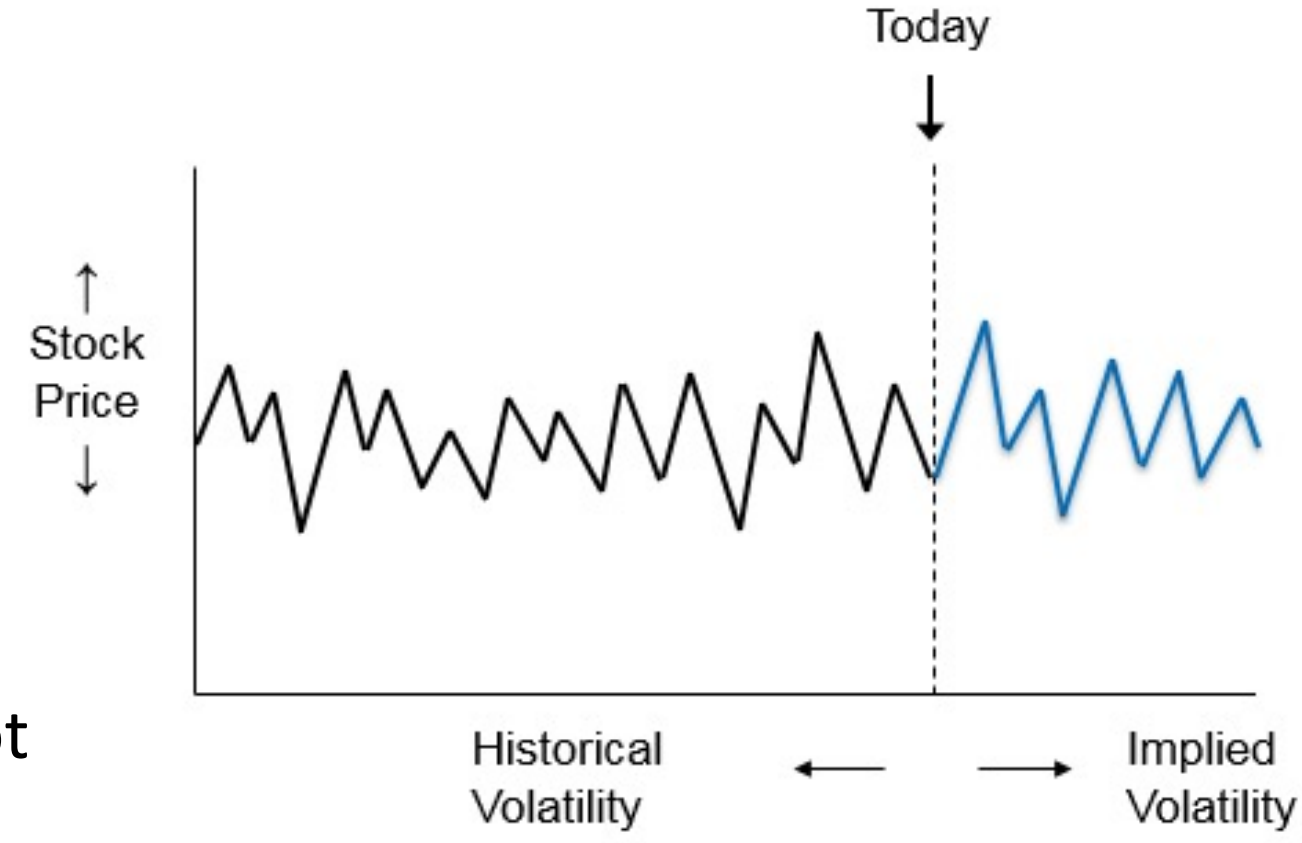
- Calls and puts both have positive Vega amounts
  - IV ⬆ option value ⬆ by Vega amount
  - IV ⬇ option value ⬇ by Vega amount

Vega

Historical (Delivered) Volatility (HV)

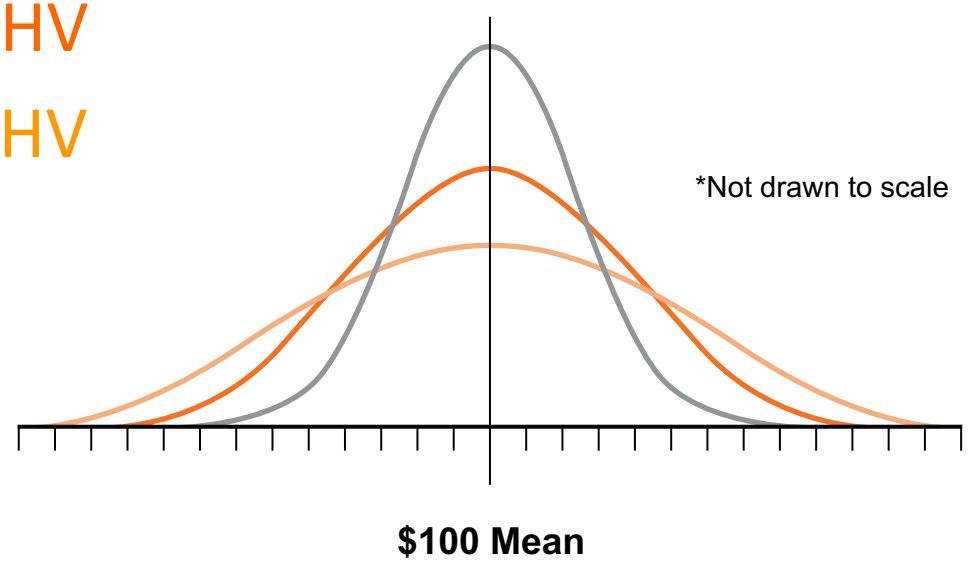
A stock's volatility in the past:

- Can be observed and quantified
- This is "historical" or "delivered" volatility
- A statistic, or a fact (backward looking) --not a prediction



Comparing Distributions

- Compare distributions of three stocks – each with different delivered volatility:
  - Stock A = 15% HV
  - Stock B = 25% HV
  - Stock C = 35% HV



Implied Volatility (IV)

- Option implied volatility:
  - Volatility level that influences an options price
  - Can be determined via option pricing models (calculator)
- Reflects underlying stock volatility expected by marketplace:
  - Forward Looking
  - Consensus of all market participants
- Who ultimately determines option market prices?
  - Everybody who makes a bid/ask price and trades an option
  - Professionals and individual investors alike

Implied Volatility: Effect on Option Prices

- A change in underlying stock historical volatility may or may not affect an option's market price. However…
- **Other pricing factors remaining constant, a change in implied volatility WILL affect option prices:**
- As implied volatility increases ↑
  - both call and put prices will increase ↑
- As implied volatility decreases ↓
  - both call and put prices will decrease ↓

Implied Volatility and Vega in Action

Pre-Earnings

- Stock: $100
- DTE: 13
- IV: 50%

	105 Call
Value	**$1.85**
Delta	**.30**
Gamma	**.05**
Theta	**.15**
Vega	**.10**
Rho	**.01**

Post-Earnings

- Stock: $105
- DTE: 6
- IV: 30%

	105 Call
Value	**$1.20**
Delta	**.50**
Gamma	**.15**
Theta	**.20**
Vega	**.05**
Rho	**.01**

Even with a $5 increase in share price, these calls lost value due to time decay and decreasing IV

Knowledge Check

With a 100-strike call, is Vega greater on a contract expiring in 5 days, 30 days, or 90 days? **90 days**

An investor puts on a Covered Call strategy. Do they have a long or short Vega position and will an increase in Vega help or hurt the trade? **Short/hurt**

If stock drops 15% as a result of unexpected company news, are long or short Vega positions likely to be positively impacted? **Long**

Rho & Interest Rates

Rho – A definition

P Rho: Option value's sensitivity to interest rates

Expected change in option value

- With a 1%-point change in the risk-free interest rate
- Expressed in decimal form (.080)
- Represents cash amount per option
- All other pricing factors constant

Considered the least significant of all pricing factors

- Component of "cost of carry"—time/LEAPS
- Small portion of any option's total premium

Rho Characteristics

- Rho amounts generated by pricing model
  - Calls have + rho/Puts -
- Rho is largest for in-the-money calls and puts
  - Decreases as options move out-of-the-money
  - Rho increases with higher priced underlying stocks
- Rho increases with more time until expiration
  - For shorter-term options → little impact
  - For longer-term options (**LEAPS**) → more significant

- Rates increase, calls increase/puts decrease
- Rates decrease, calls decrease/puts increase

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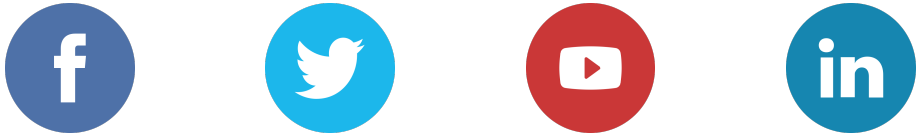

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