Option Valuation

February 6th, 2018

Interactive Questions

- Phone: Text JOSHUAWEST406 to 22333
  - You will then be able to answer each question by typing in the answer (all will be multiple choice)
  - Please silence your phones
  - Standard message rates apply

- Laptop/Tablet: PollEV.com/joshuawest406
  - Questions will appear on webpage
  - You'll need cellular data

Option Valuation

- Why study the valuation of options?
  - Value = Risk
  - Proper valuation of transactions
  - More than vanilla options have “option value”

Option Examples

Vanilla options

- Call
- Put
- Straddle
- Swaptions

Physical Options

- Thermal power assets
- Hydro assets
- Transmission
- Gas storage and transport
- Others?

Why study option valuation?

To properly value an option position

To better understand the derivation of risk

To properly value physical asset positions

Good times

All of the above

Overview and Terminology

Options - Overview

- Option: An option is an instrument that gives the holder the right, *but not the obligation*, to buy or sell the underlying at a specific price
- Components of an option:
  - Strike price
  - Underlying price
  - Volatility
  - Time to expiration
  - Interest rate
  - Others

Options – Payout Functions

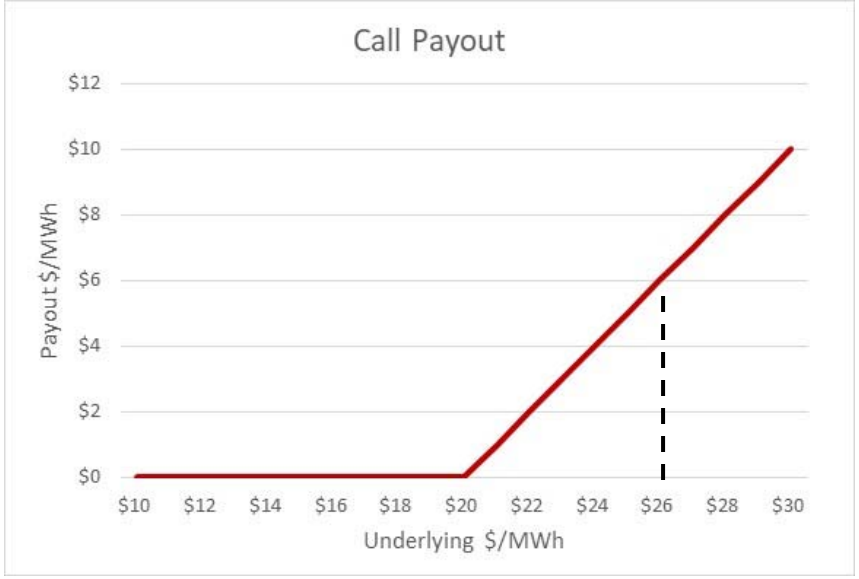
- Call: The *option* to buy the underlying at a specific price (strike price);

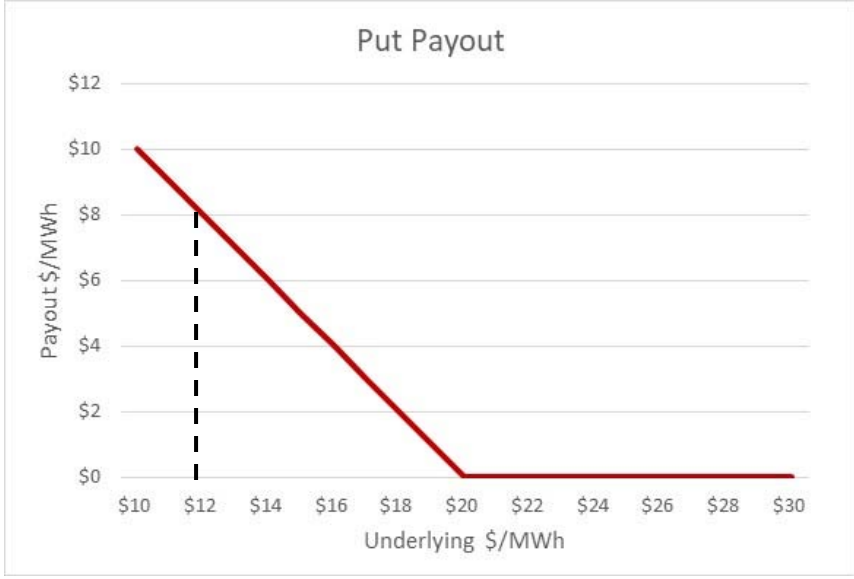
  Max(Underlying – Strike Price, 0)

- Put: The *option* to sell the underlying at a specific price (strike price);

  Max(Strike Price – Underlying, 0)

Options – Payout Functions





Example: Underlying price = $26 and Strike Price = $20
Payout at expiry = Max($26 - $20, 0) = $6

Example: Underlying price = $12 and Strike Price = $20
Payout at expiry = Max($20 - $12, 0) = $8

Options - Combinations

- Straddle: Simultaneously long/short a call and put with the same strike and expiration
- Why might straddle pricing be useful?

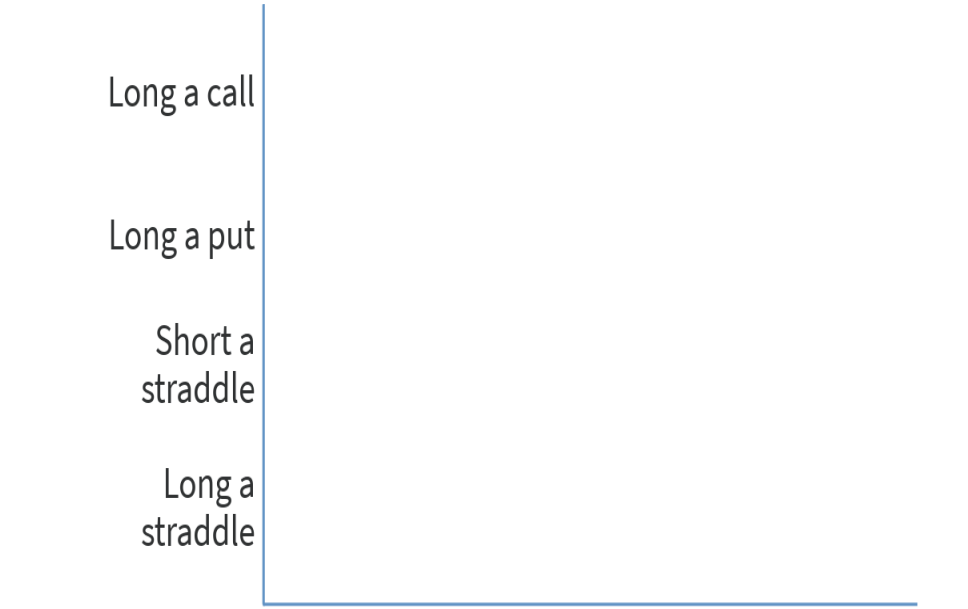
Options – Spread Options

- Other examples of combinations
  - *Cross-commodity spread*: Long an option in one commodity, short an option in another. Examples include spark-spread option or crack-spread option
  - *Locational spread*: Long in one area, short in another. Examples include gas transport and transmission
  - *Calendar spread*: Long in one time period, short in another. Example is gas storage.

Options - Terminology

- *European Option*: Option that can only be struck at the time of expiry
- *American Option*: An option that can be struck anytime *before* time of expiry
- *Volatility*: Standard deviation of the returns of prices
- *Implied Volatility*: Markets assessment of volatility (solve for volatility of a traded option price)
- *Correlation*: Correlation of the returns on two (or more) different underlying instruments

If you wanted to take a position PJM-W that benefited from a large move in the underlying, regardless of the direction, what would be an appropriate option position?



Modeling

Options – Inputs

- What inputs/data do we need?

Option Type: Call or Put	Prices: Strike and Underlying	Volatility and Correlation
Time to Expiration (Expiry)	Interest Rate	Others?

Options – Inputs

Volatility

- Historical
- Daily or monthly? Or both?
- Market implied volatility
- Is there a “market”

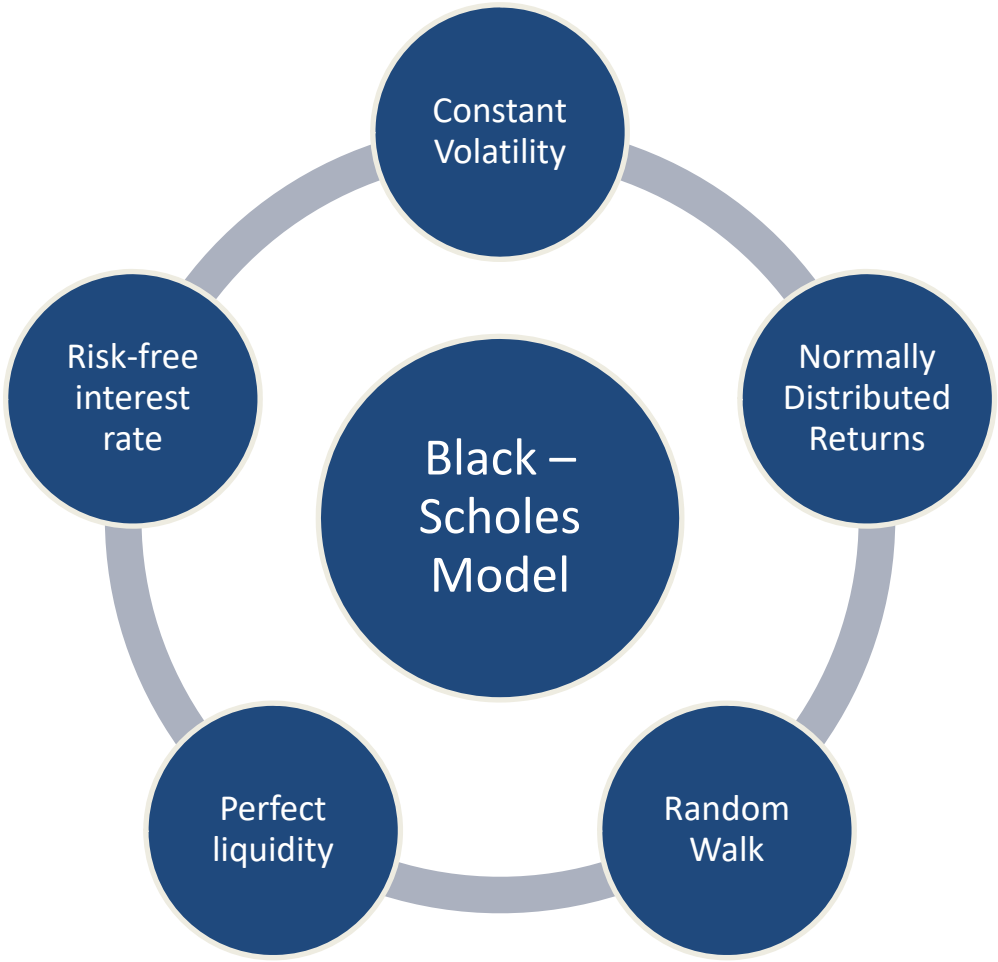
Correlation

- Historical
- Implied?
- Long lever, *be careful*
- More art then science

Options – Modeling

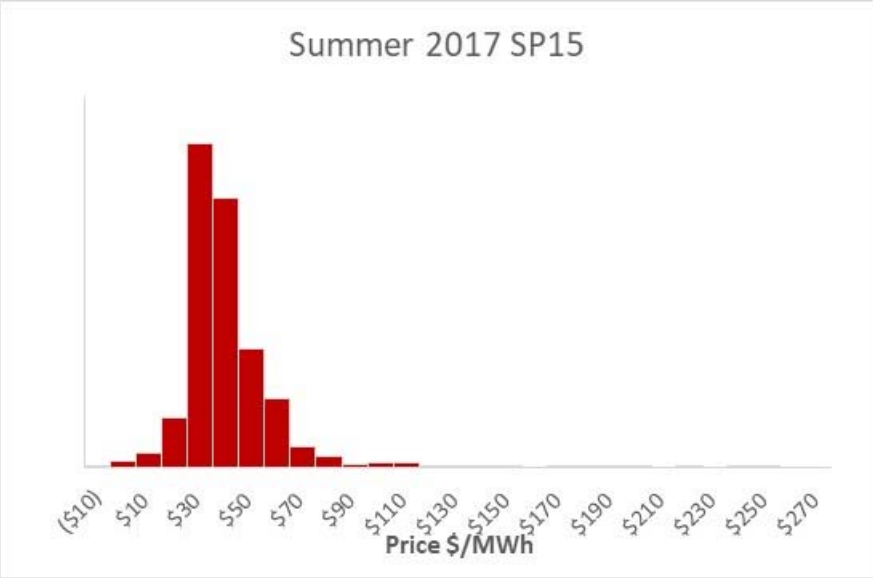
- Two primary methods for valuation
  1. Black-Scholes model
     a) Generally associated with “closed-form” modeling
     b) Analytical solution, not numerical
     c) Different form exist, notably for spread-option modeling
  2. Simulation
     a) Often referred to as “Monte Carlo”
     b) Generic terminology that has numerous different applications, and more importantly, techniques

Black-Scholes Assumptions



Black-Scholes Assumptions

Normally Distributed Returns?

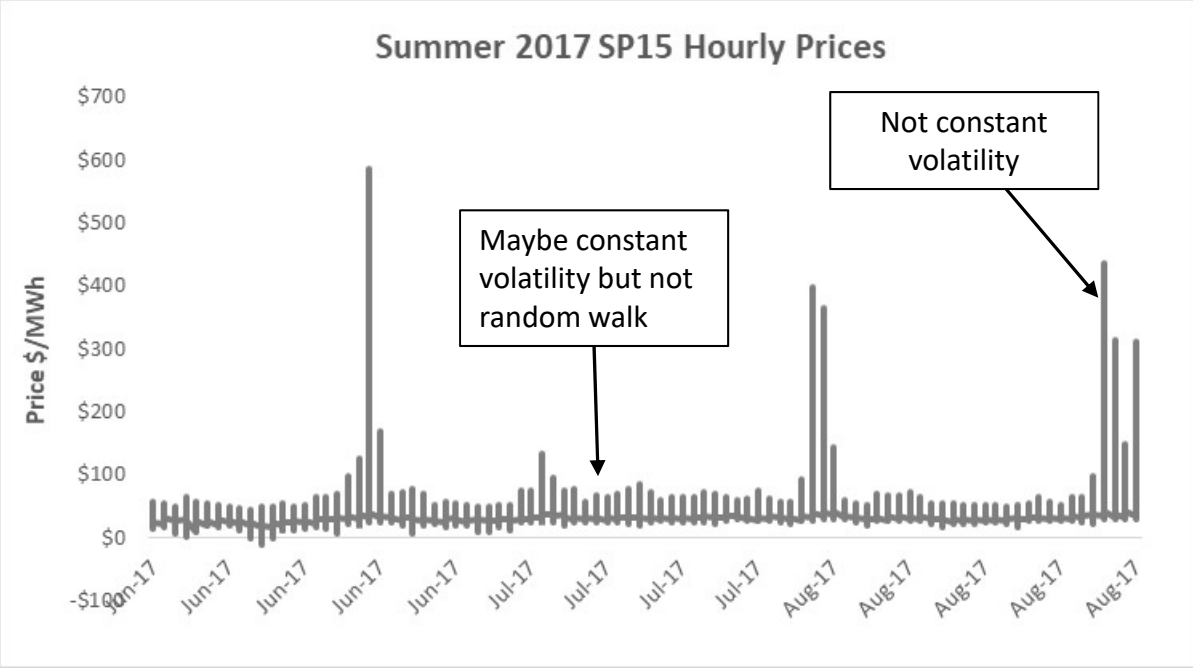


No.

No.

Black-Scholes - Assumptions

Random Walk? Constant Volatility?



Black-Scholes Model

Strengths

- It can be a powerful tool, if used properly
- Easy
  - Computationally
  - Implementation
  - Anyone can run it
  - Low cost
  - Integrated into ETRM, booking

Weaknesses

- Valuations can be grossly inaccurate, if not used properly
  - Inputs need to be carefully calculated
  - Inputs usually need to be massaged, accounting for underlying assumptions
  - The more complex the product, the less realistic the valuation

Simulation (Monte Carlo) Models

- Monte Carlo based models are computational algorithms that model uncertainty using random number generation (sampling)
- There are numerous simulation based techniques for modeling risk, valuing options, and physical assets
- These models allow you to:
  - Capture path dependent nature of commodity prices, i.e. *not random walk*
  - Capture *mean reversion* tendency of commodity prices
  - Random jump or diversions, i.e. *non-constant volatility*
  - More easily model physical idiosyncrasies of commodity assets or highly complex options

Simulation (Monte Carlo) Models

- Simulations can be used to value almost anything, example models include:
  - Mean-reversion models
    - Options with daily strikes
  - Mean-reversion with jump diffusion
    - Options with daily strikes, underlying has random jump/diversions
    - Examples include anything with hourly price paths
  - Multiple price paths with embedded correlations
    - Cross-commodity spread options, e.g. power and gas correlated
    - Full-requirements load transactions, load and price correlated
    - Hydro optimization (with embedded linear optimization techniques), hydro and price correlated

Simulation (Monte Carlo) Models

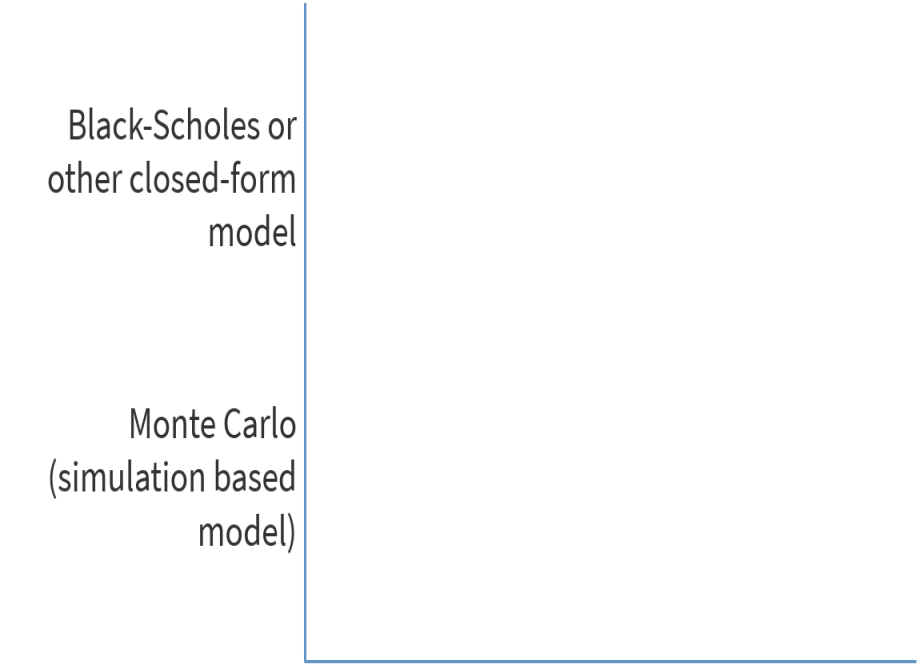
Strengths

- Model pretty much anything
- Accounts for many of Black-Scholes shortfalls
- Much easier to account for physical nature of commodity assets
- Works well with optimization techniques

Weaknesses

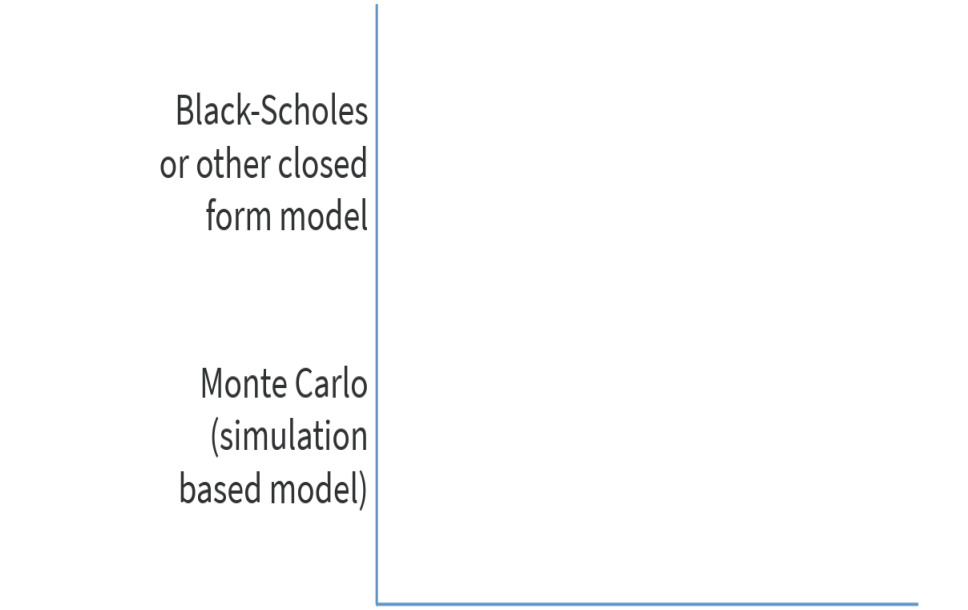
- Computationally expensive
- Need the appropriate human capital
- Not easily integrated into ETRM, booking
- Complex, not easily explained

Which model would you use to value a March 2018 NYMEX call option? Assume its at-the-money and monthly strike.



Poll Everywhere — Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app

Which model would you use to value a calendar 2020 daily heat rate call option? Assume ERCOT North Zone power, HSC gas, 8 heat rate, and all hours.



Poll Everywhere — Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app

Greeks and Square Root of Time

Option Greeks

- Option Greeks measure an options sensitivity given changes in certain factors.
- Most commonly these include delta, gamma, theta, vega, and rho.

Hint: Not these Greeks

Option Greeks

- Delta: The sensitivity in the price of an option given a change in the underlying
- Gamma: The sensitivity in the delta of an option given a change in the underlying
- Theta: Sensitivity to the price of an option given a change in time
- Vega: Sensitivity to the price of an option given a change in volatility
- Rho: Sensitivity to the price of an option given a change in the interest rate

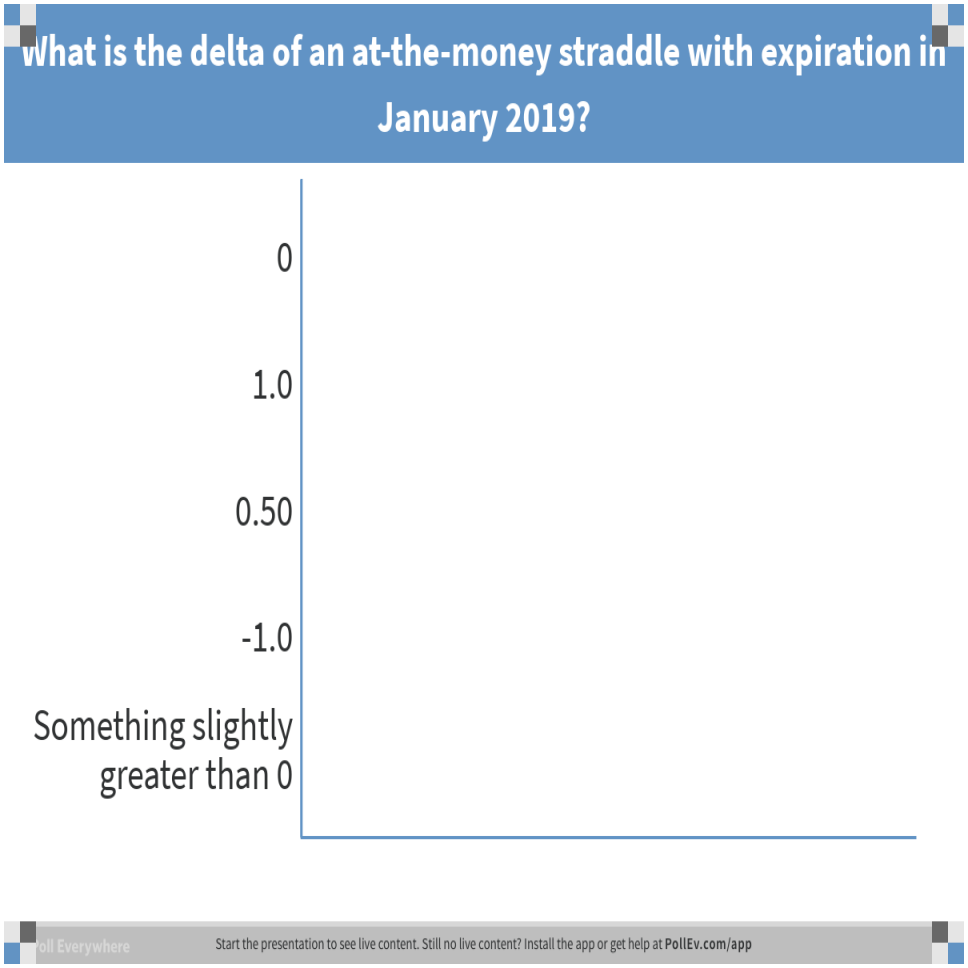
Option Greeks - Delta

- What can delta be used for?
  - Provides quantity of the underlying you *may* want to hedge to be "risk neutral"
  - Gives you your net position in an underlying, can be netted across multiple positions
- Calculated as a number between 0-1
  - Close, but not quite the probability of the option being in-the-money at expiry

Option Greeks - Delta

- Long call makes you long delta
  - Long an at-the-money call is a ~0.50 delta
  - Short an at-the-money call is a ~-0.50 delta

- Long put makes you short delta
  - Long an at-the-money put is a ~-0.50 delta
  - Short an at-the-money put is a ~0.50 delta

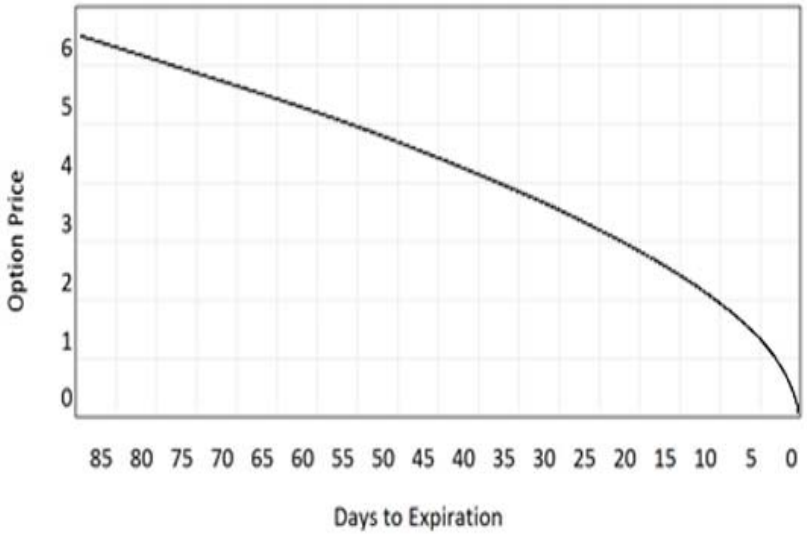

What is the delta of an at-the-money straddle with expiration in January 2019?
0
1.0
0.50
-1.0
Something slightly greater than 0
Poll Everywhere
Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app

Option Greeks - Gamma

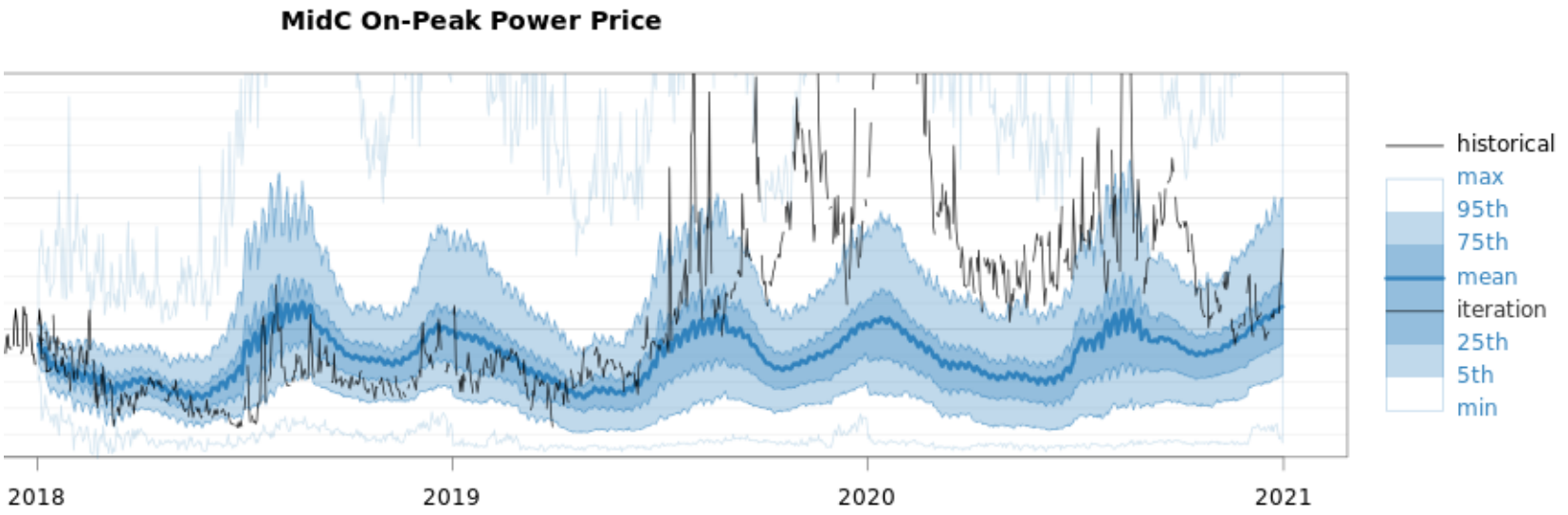
- Who cares?
  - Gamma tells you how fast (or not) your position can change
  - Long gamma, one benefits from a move in the underlying
  - Short gamma, one loses on a move in the underlying
  - The higher the gamma, the more option value to be extracted from delta hedging

Options - Square Root of Time

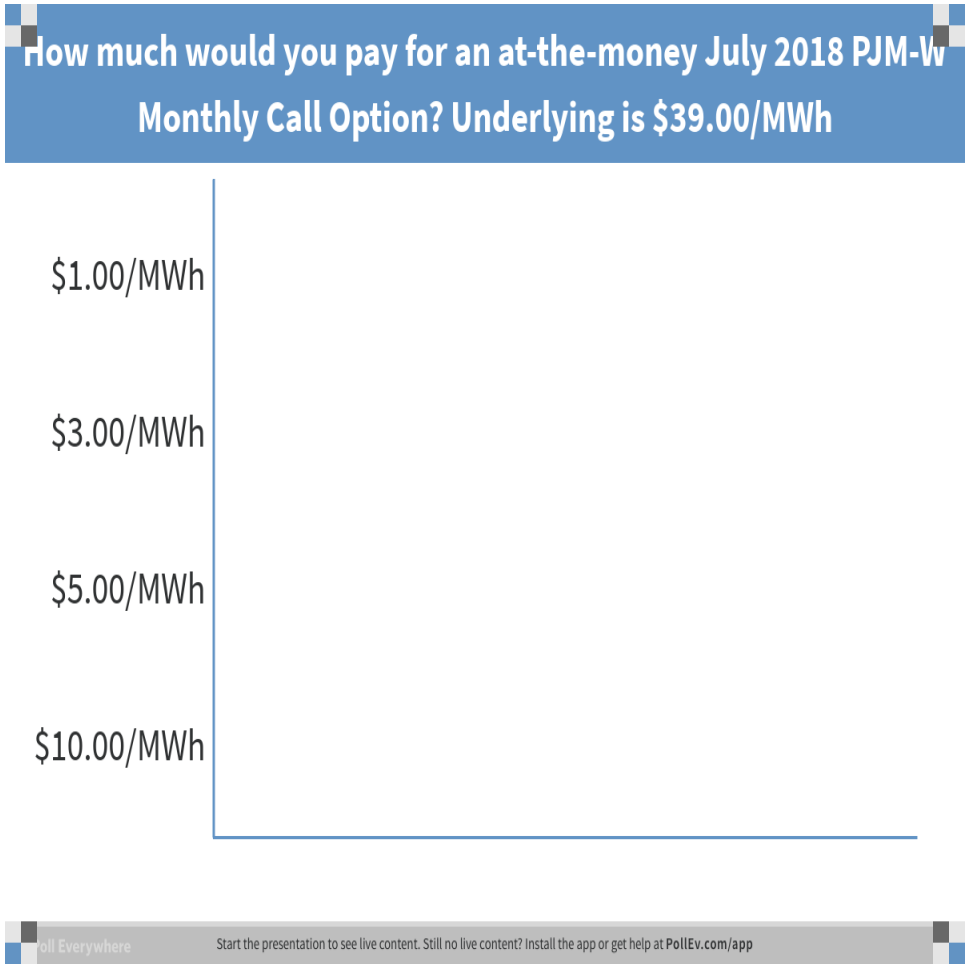
- Option prices are proportional to the square root of time
- This is a critical consideration when valuing options or assessing risk
- The more time until expiry, the more an option is worth
- Conversely, the longer dated a position the more risk as the more price can move



Options - Square Root of Time



Market Valuation


How much would you pay for an at-the-money July 2018 PJM-W Monthly Call Option? Underlying is $39.00/MWh
$1.00/MWh
$3.00/MWh
$5.00/MWh
$10.00/MWh
Poll Everywhere
Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app

Key Takeaways

- Understanding the key assumptions of modeling and distributions of underlying is critical
- There is option value embedded in much more than vanilla options
- Understanding option valuations and assessing risk are one and the same

Thank you!

Josh West
Manager, Analytics
The Energy Authority
jwest@teainc.org