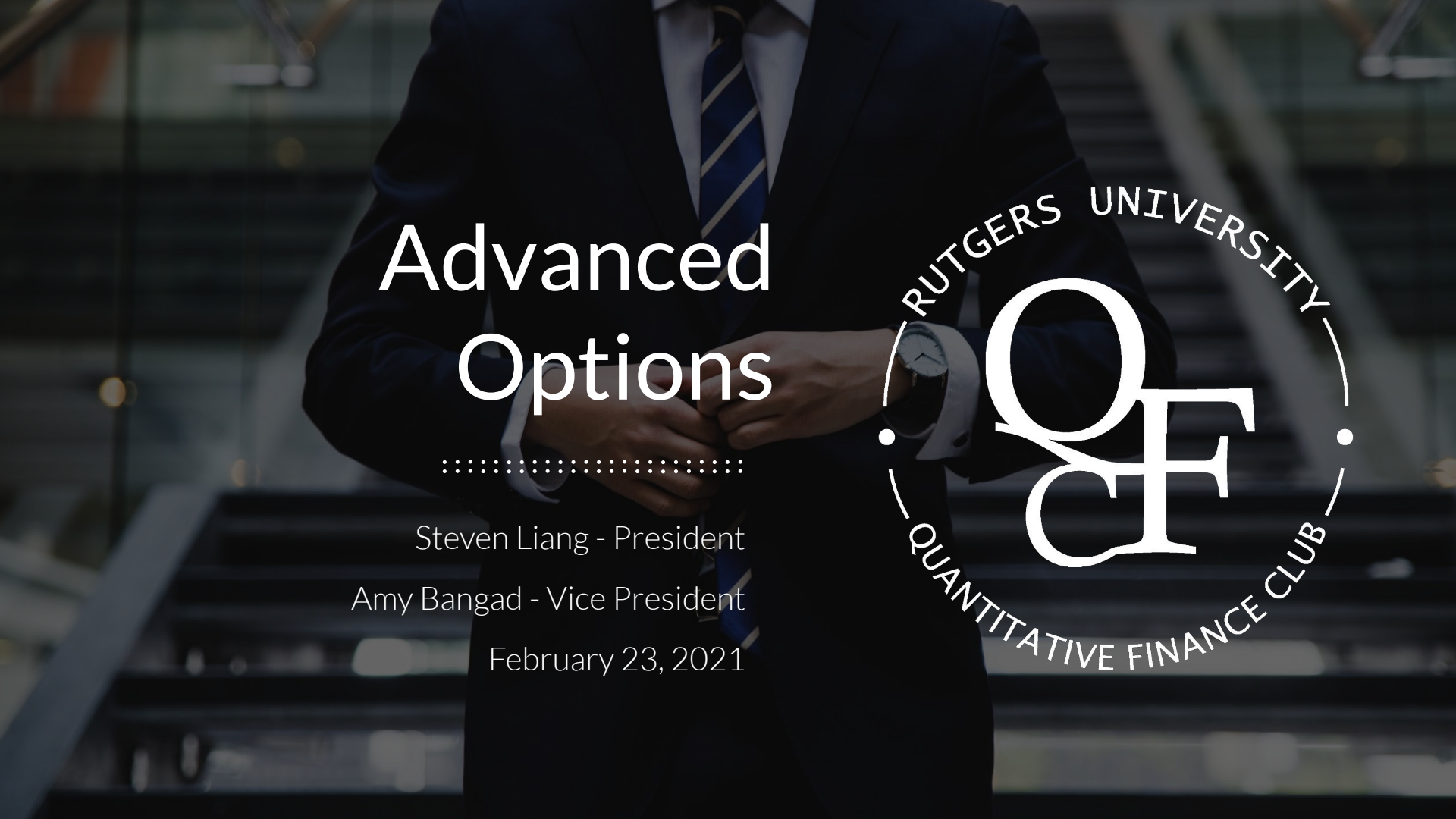


Advanced Options

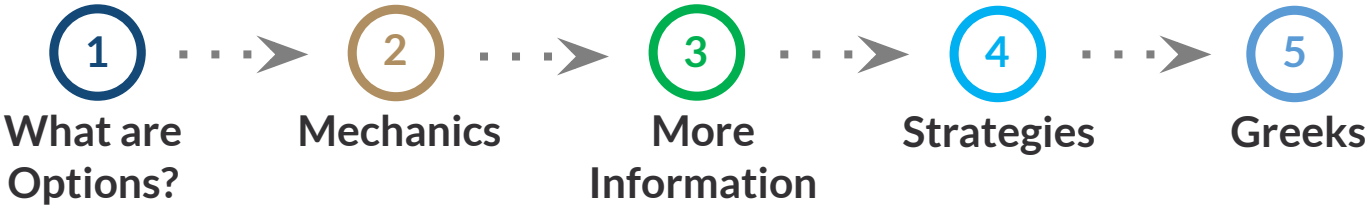
Steven Liang - President

Amy Bangad - Vice President

February 23, 2021

RUTGERS UNIVERSITY QUANTITATIVE FINANCE CLUB

Overview


1
What are Options?
2
Mechanics
3
More Information
4
Strategies
5
Greeks

What are Derivatives?

This isn't Calc 1

A derivative is a financial contract whose value depends on some underlying asset.

Yes, while it is a broad definition, keep this idea in mind as we proceed through this crash course.

Common Derivatives

1

Options

Contracts that gives the *right*, **but not the obligation**, to buy or sell an asset

2

Futures

Contract to buy or sell an asset on a future date at a specified price (occuring in a regulated exchange)

3

Forwards

Contract between any two parties to exchange an asset on a future date at a specified price

4

Swaps

Contract that allows two parties to swap cash flows on or before a specified date (interest rates and currencies)

Others

Swaptions, Options on Futures, Warrants, Convertible Bonds, CDO, CDS, headaches

Key Differentiators

Lock

- Include swaps, futures, and forwards
- Obligates agreeing parties to follow through on contract

Option

- Vanilla options, binary options, etc.
- Provides the participant the right, but **not the obligation**, to follow through on the contract

1 Options

CALL =  $ ⋯➤ *Right to buy*

PUT =  $ ⋯➤ *Right to sell*

Moneyness	Result
In-the-money	Gain
At-the-money	Break Even
Out-of-the-money	Loss

Strike Price

Describes the price at which the option can be exercised.

Premium

Price paid for the contract itself.

Expiration Date

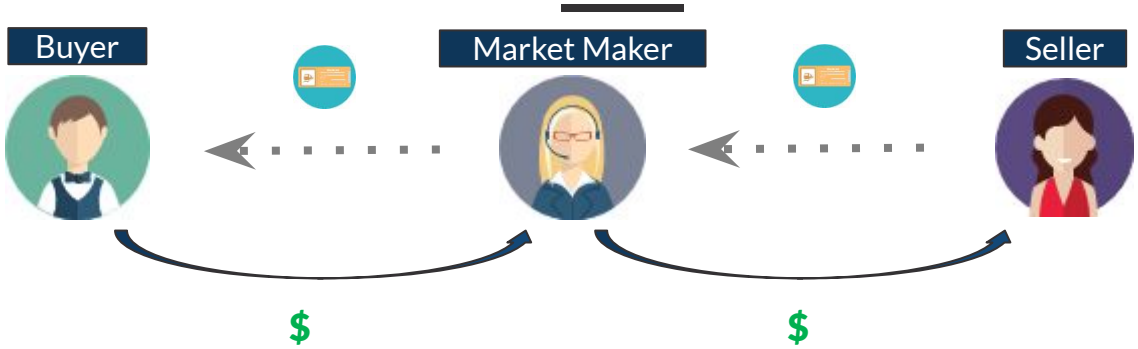
Date at which contract expires, and can no longer be used after.

Intrinsic Value: Value of the option if exercised right now; ITM option at expiration is worth its intrinsic value!

1 Options

- Options commonly exist on the following assets:
  - Stocks
  - Indexes
  - Bonds
  - Interest Rates
  - Currencies
- Options on Futures
- Options on Commodities

Mechanics of an Option



Volume	Number of contracts that have been exchanged in the day
Open Interest	Number of contracts held by market participants which have not been closed out, expired, or exercised

Options on Futures

Definition	The right to enter into a futures contract at a specified price by a certain date

Call Futures Option: Right to enter into a long future (bullish)

Put Futures Option: Right to enter into a short future (bearish)

Generally traded on commodities: corn, soybean, cotton, oil, etc.

Facts

- Normally closed out before delivery
- May be cheaper, more liquid, and more convenient
- Exercise results in contract position and cash settlement

Call Options

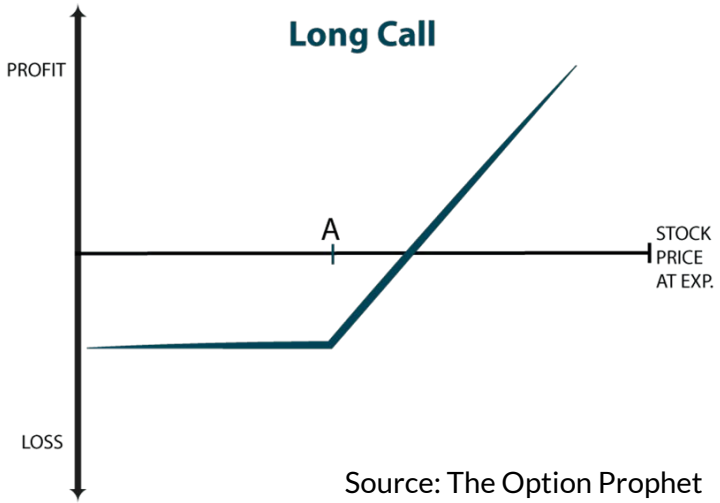
Example

Company	Strike Price	Expiration	Premium
NVIDIA	$570	2/26/21	$1665

What are you betting by “going long” on a call?

What happens when you exercise this option?

Is this a good trade?



Source: The Option Prophet

Put Options

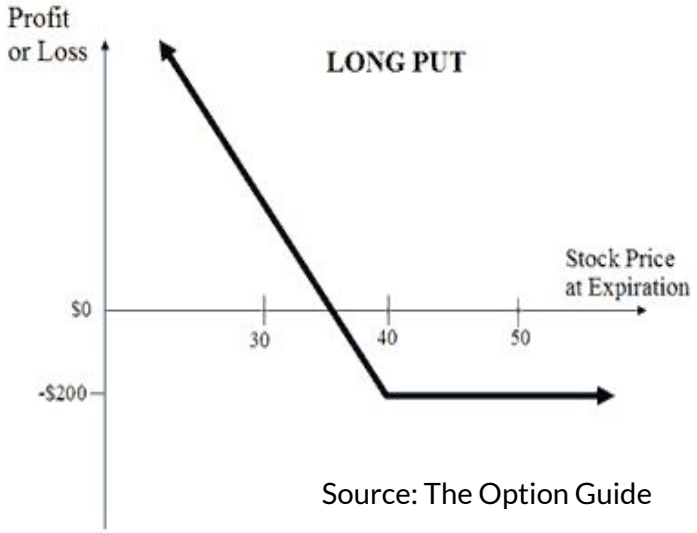
Example

Company	Strike Price	Expiration	Premium
AMD	$90	3/5/21	$590

What are you betting by “going long” on a put?

What happens when you exercise this option?

Is this a good trade?



Source: The Option Guide

Option Sentiments

Bullish

1. Rising stock price with increasing open interest
2. Large purchases of calls on a stock

Bearish

1. Rising stock price with decreasing open interest
2. Falling stock price with rising open interest
3. Falling stock price with decreasing open interest indicates a nearing bottom
4. Large purchases of puts on a stock

Weekly, Monthly, and LEAPS

Weekly

- The highest-volume, popular names tend to have weekly options that expire every Friday
- Provide the most profit potential but very high risk exposure
- **Very** easy way to lose money

Monthly

- Many stocks that are less popular have options on a monthly cycle
- More conservative trading strategy that is more likely to succeed
- Can be dangerous if the trader is not aware of theta decay

LEAPS

- Long Term Equity Anticipation Securities are known as LEAPS
- Expiry dates up to 39 months in the future (always in January)
- Trade on roughly 800 stocks

American and European Options

Can only be exercised on the expiration date

Can be exercised any time up to the expiration date

- In most cases, this will not matter to the average trader since options are generally not exercised anyway
- This distinction is still very important because many pricing theories and models assume the option is European
  - One less variable to worry about!
- This is also a common interview question...so know this distinction!

Scenarios

Variable	*European call*	*European put*	*American call*	*American put*
Current stock price	+	−	+	−
Strike price	−	+	−	+
Time to expiration	?	?	+	+
Volatility	+	+	+	+
Risk-free rate	+	−	+	−
Amount of future dividends	−	+	−	+

* + indicates that an increase in the variable causes the option price to increase; − indicates that an increase in the variable causes the option price to decrease; ? indicates that the relationship is uncertain.

[1]Diagram derived from page 215 of Options, Futures, and other Derivatives 8th Edition by Hull

Black-Scholes-Merton Model

$$C(S,t) = N(d_1)S - N(d_2)Ke^{-r\,T}$$

$$d_1 = \frac{ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$C(S,t)$	(call option price)
$N(\,)$	(cumulative distribution function)
$T = (T_1 - t)$	(time left til maturity (in years))
S	(stock price)
K	(strike price)
r	(risk free rate)
σ	(volatility)

Inputs

- Current Price
- Interest Rate
- Expected dividend
- Volatility
- Strike Price
- Time to Expiration

Output

Fair Price

Assumptions

- European option
- No dividends during life of option
- Markets are efficient
- Risk-free rate and volatility known/constant
- Normally distributed returns
- No transaction costs

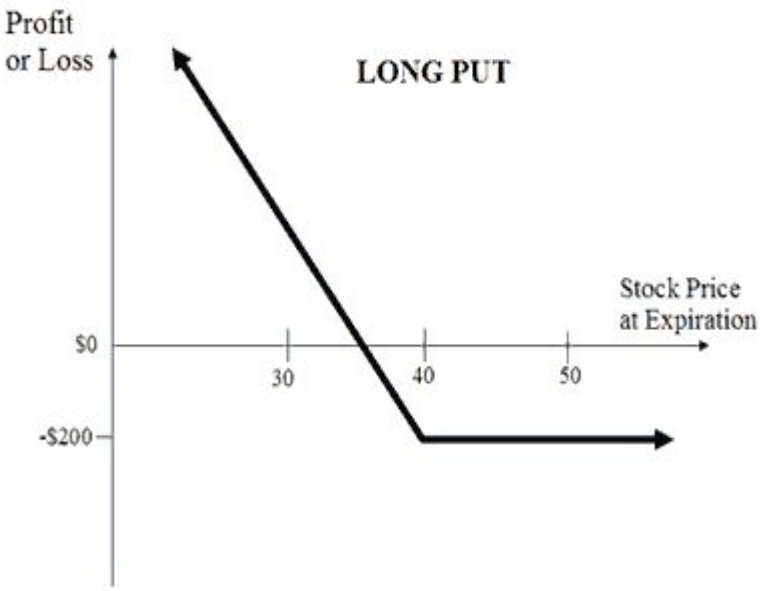
P&L Diagrams

A.K.A. The Risk Graph

What's the point of these graphs?

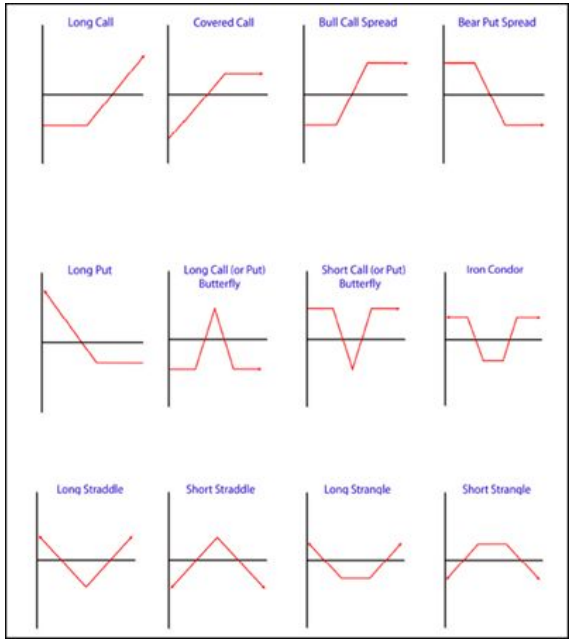
- Visual evaluation at a glance
- Differentiate between strategies
- X axis is the underlying price; Y axis is the profit or loss
- Combinations of calls and puts result in different graphs
- Ascertain risk exposure and profit potential

Example:



Source: The Options Guide

Putting it all together:



Source: Investopedia

Putting Together Strategies Using Options

You can do some wicked things with options because different options have different risk profiles and outcomes.

By combining options with different strikes, expiry dates, and moneyness, you can create very niche scenarios and probabilities.

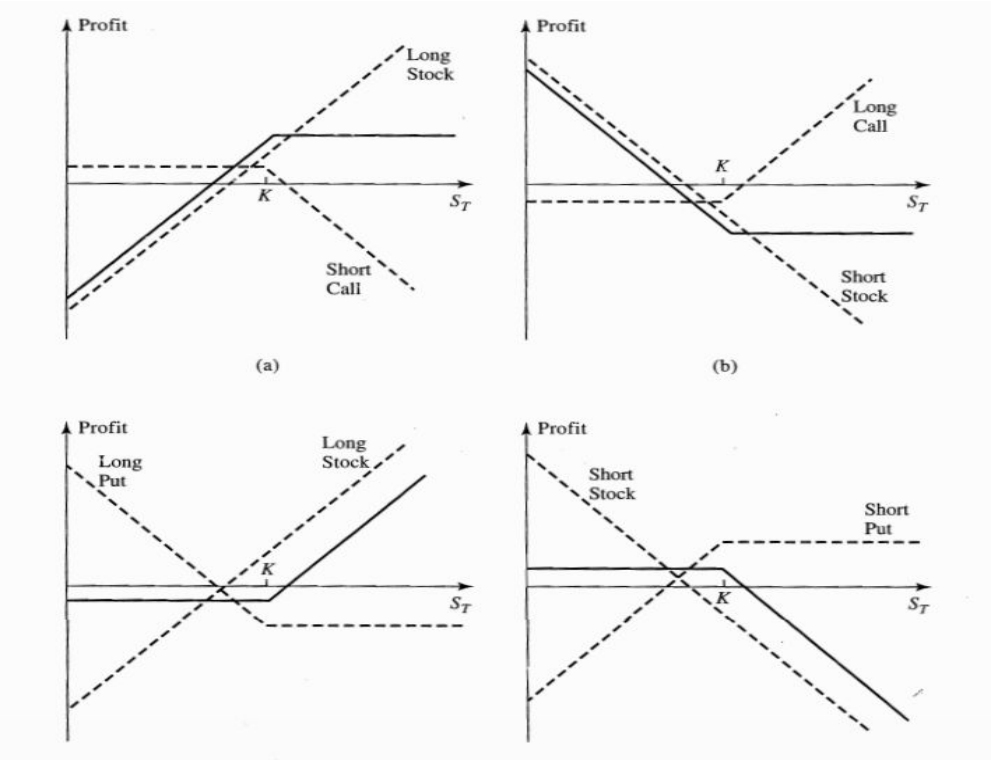
- Options are great evidence of applied probability and statistics knowledge in finance
- Options strategies involve combining different P&L diagrams

Trading with Stocks and Options

Being long on a call is similar to being short on a put | Being short on a call is similar to being long on a put

Stock and Option Combinations

These strategies can be used to hedge against unfavorable movements, or speculate on movements without risking too much

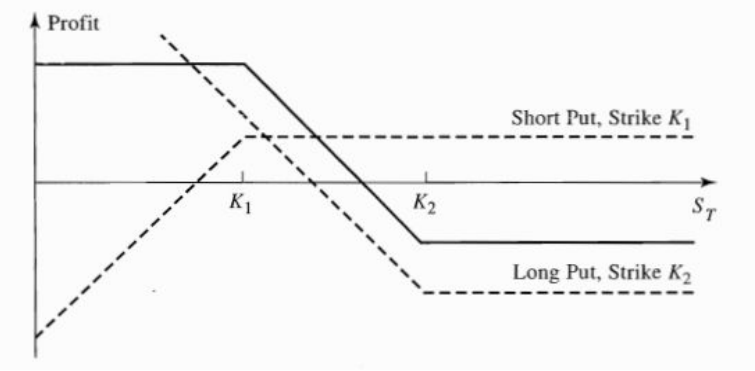


Some Options Strategies: Spreads

Being long on a call is similar to being short on a put | Being short on a call is similar to being long on a put

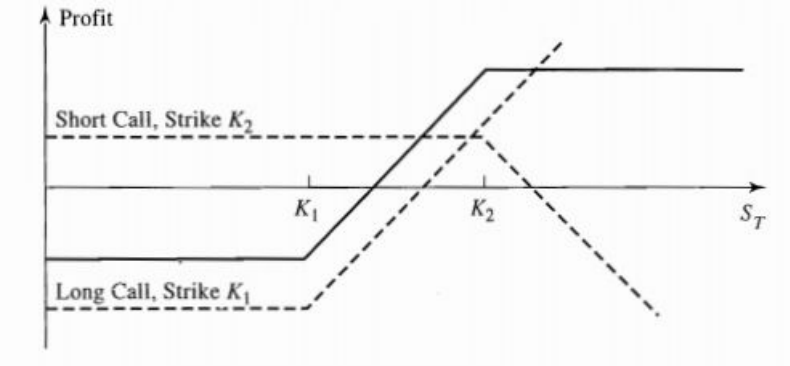
Bear Spread

- Short put and long put (with a higher strike) combination for a bearish outlook
- Short call and long call (with a higher strike) for a bearish outlook



Bull Spread

- Short call and long call (with lower strike) combination for bullish outlook
- Short put and long put (with a lower strike) for a bullish outlook

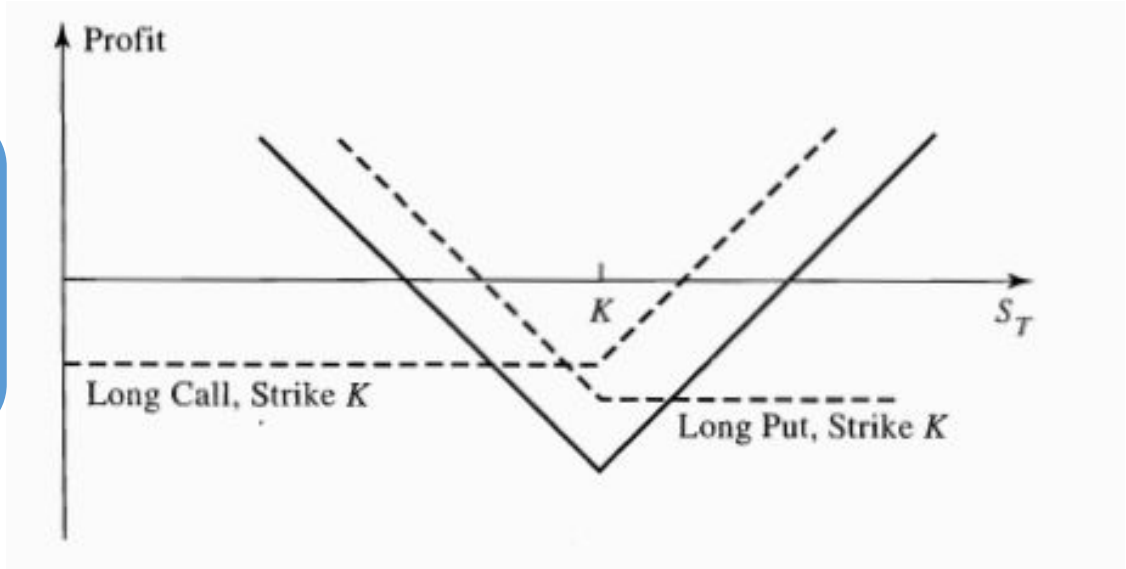


Some Options Strategies: Straddles

Being long on a call is similar to being short on a put | Being short on a call is similar to being long on a put

Straddle

- Long call and long put with same strike for betting outside of a range

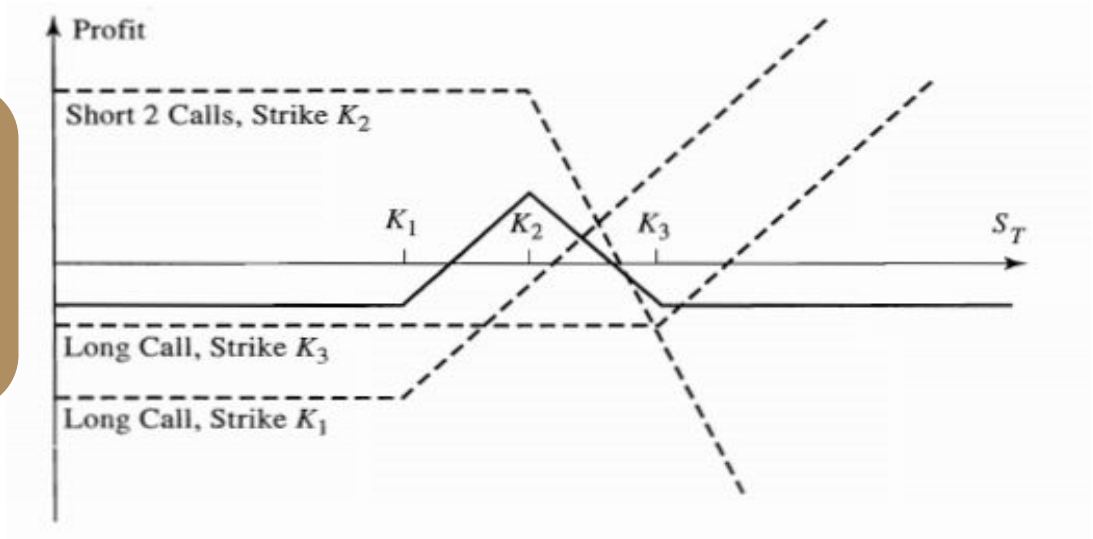


Something More Complex: Butterflies

Being long on a call is similar to being short on a put | Being short on a call is similar to being long on a put

Long Call Butterfly

- Two long calls with different strikes and shorting two calls with a strike mid-range (betting in a range)



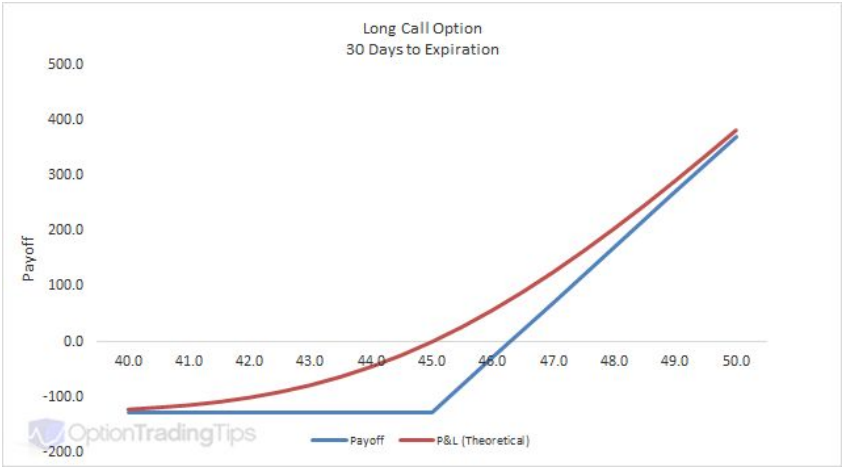
Time to Learn Some Greek

Multiple factors are considered to create the "fair value" for an option in the market. If any one of these factors changes, so does the value of the option. The Greeks quantify these factors into easy-to-understand, normalized values.

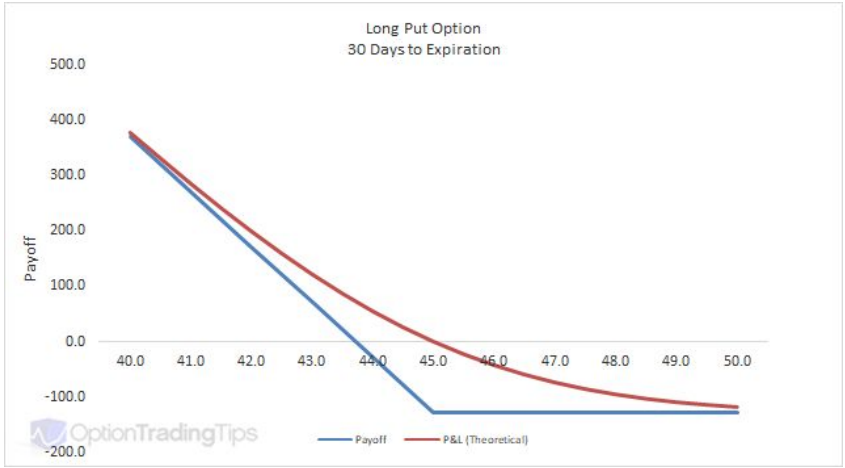
Delta	Change in contract value based on change in underlying
Gamma	Derivative of delta; delta's rate of change
Theta	Effect of time decay on price
Vega	Measure of implied volatility (IV) effects on contract price
Rho	Effect of interest rate on on the contract value

Price of an Option

Call Option



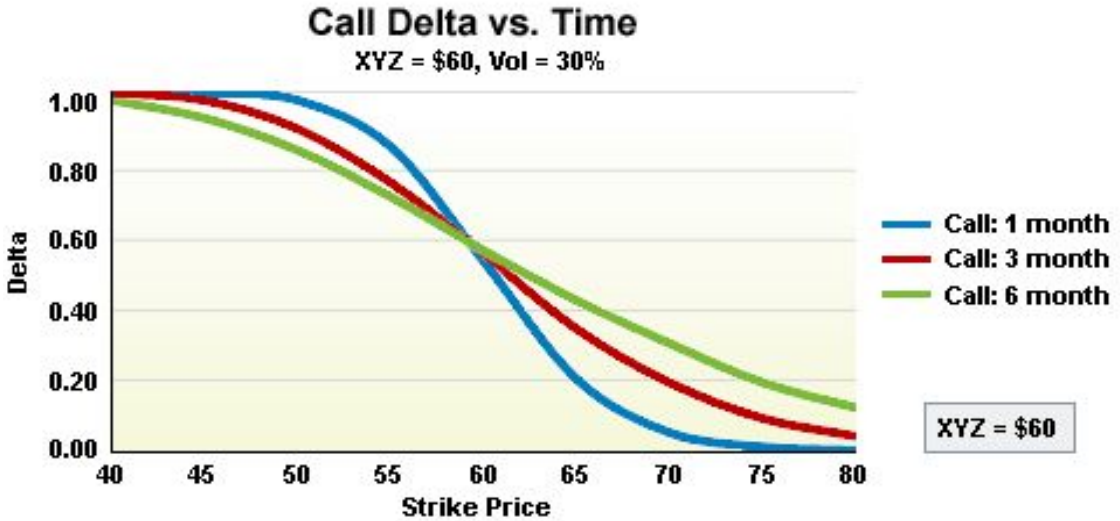
Put Option



Delta

- Call options have *positive* deltas and put options have *negative* ones
- As you go more out of the money, delta approaches 0
- As you go more in the money, delta approaches 1 (calls) or -1 (puts)
- Delta **is not constant** as the price moves, because of gamma
    - Recall Calc 1!!!

For every $1 that the underlying changes, how much will the option contract value change?

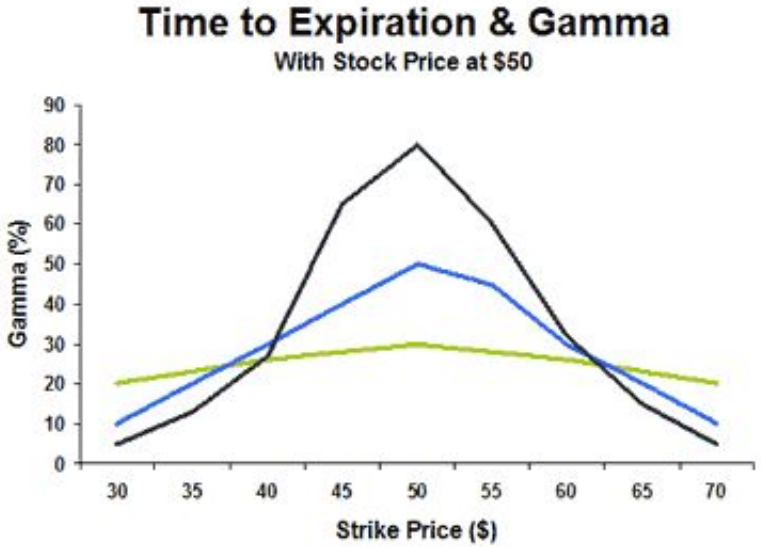


Source: Options Industry Council (OIC)

Gamma

- Gamma is simply the derivative of delta
  - When the price moves $1, add the value of gamma to the existing delta to obtain an approximation of the “new” delta
- Put-Call Parity: gamma of a put and call is the same ceteris paribus
- Option at the money will have the highest gamma, as moving in or out of the money has the largest effect on delta

For every $1 that the underlying changes, how much does the value of delta change?



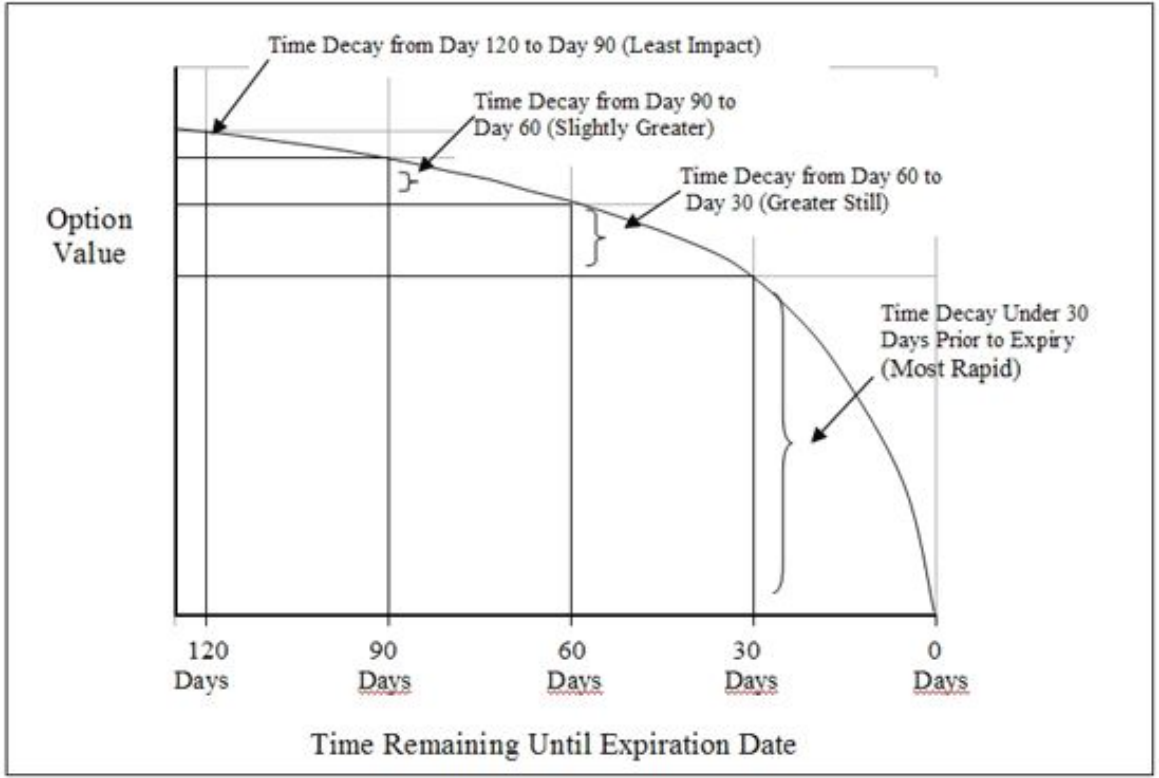
Source: The Options Guide

Theta

- As expiry gets closer, the contract is worth less
- Daily “decay” value is theta
  - You can expect to lose the value of theta from your contract daily
- Yes, it happens on the weekends too: theta never sleeps

What would you pay for milk that expires tomorrow versus two months from now?

Probably not the same price.



Source: StackExchange Quantitative Finance

Vega

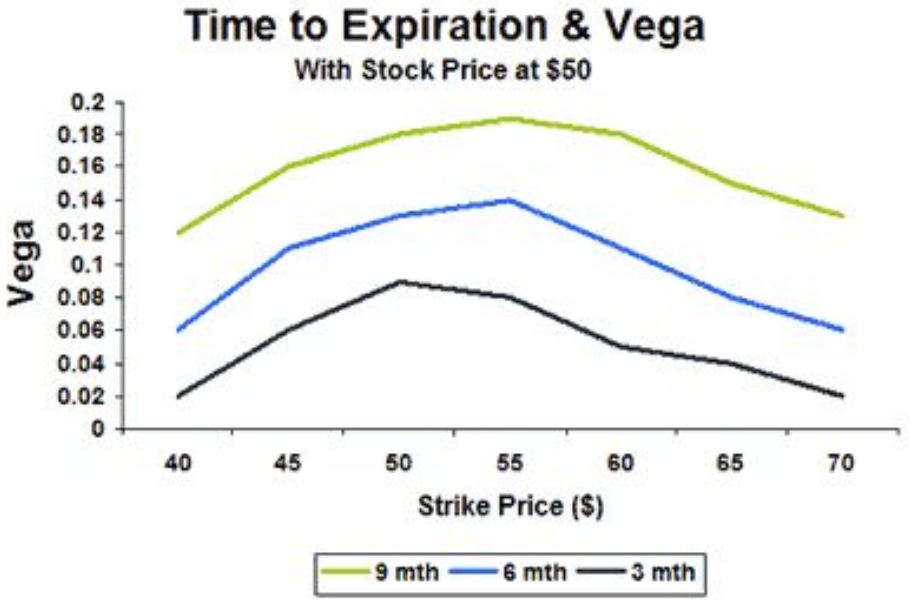
What is Implied Volatility?

- Approximated volatility of the price of a security
- Bearish market? More IV!
- Check out the VIX

Every security has its own implied volatility.

- When this value changes, the value of the option changes

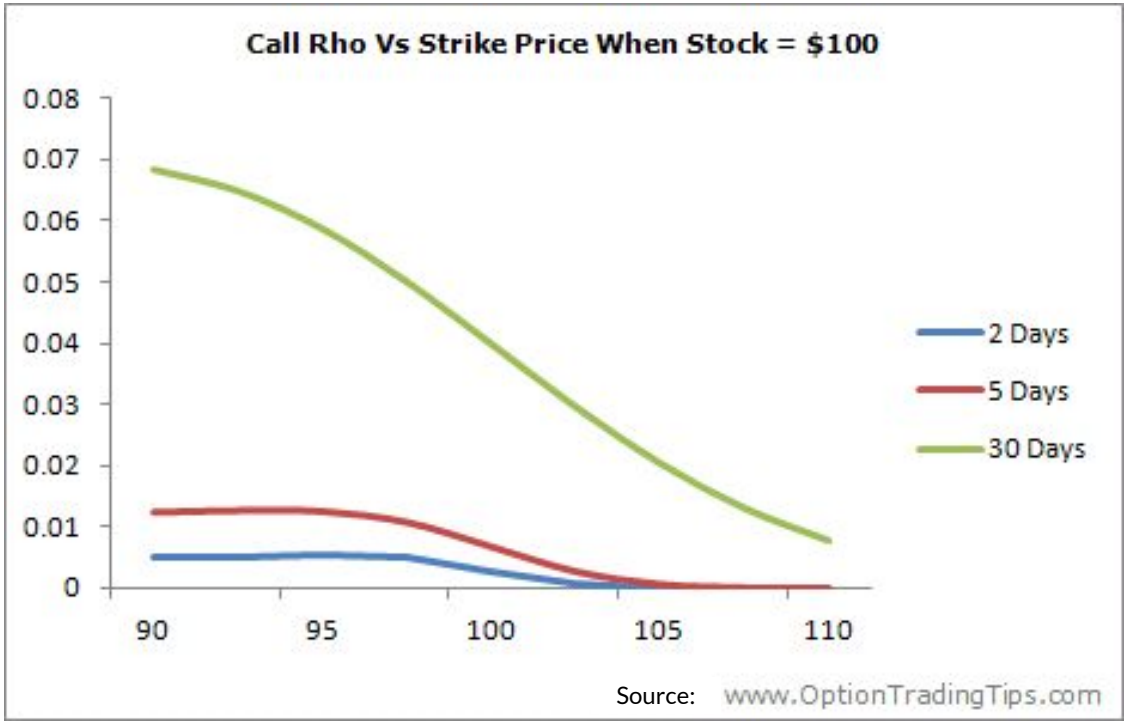
Have you ever used options to bet on a company's quarterly earnings results?



Source: The Options Guide

Rho

- Contract price will change by the value *rho* for every 100 basis point change in the U.S. Treasury bill risk-free rate
- Just as how stocks react to market-wide changes in interest rates, options will do so as well
- Larger for in the money options
- Longer options have larger rho
- LEAPs have the largest rho
- Rho is the least important of the Greeks



And Finally...The Options Table

Calls

Strike	Last	Theoretical	IV	Delta	Gamma	Rho	Theta	Vega	Volume	Open Int	Vol/OI	Type	Last Trade
3,835.00	52.18	48.25	18.73%	89.00	0.00494	0.09332	-3.44445	0.38190	519	34	15.26	Call	02/23/21
3,840.00	45.10	43.95	18.90%	86.09	0.00577	0.09034	-4.12590	0.45020	1,693	152	11.14	Call	02/23/21
3,845.00	39.82	39.82	19.07%	82.75	0.00659	0.08691	-4.82239	0.51880	988	66	14.97	Call	02/23/21
3,850.00	35.69	35.69	18.91%	79.42	0.00741	0.08347	-5.35076	0.57854	3,093	359	8.62	Call	02/23/21
3,855.00	32.64	31.70	18.70%	75.72	0.00823	0.07965	-5.82968	0.63550	1,330	150	8.87	Call	02/23/21
3,860.00	28.84	27.80	18.36%	71.75	0.00906	0.07553	-6.19746	0.68682	2,638	983	2.68	Call	02/23/21
3,865.00	24.19	24.19	18.15%	67.21	0.00980	0.07080	-6.55772	0.73383	1,801	261	6.90	Call	02/23/21
3,870.00	20.76	20.76	17.87%	62.33	0.01046	0.06571	-6.79994	0.77142	2,137	692	3.09	Call	02/23/21
3,875.00	17.37	17.37	17.34%	57.19	0.01114	0.06034	-6.82632	0.79725	2,603	416	6.26	Call	02/23/21
3,880.00	14.55	14.55	17.19%	51.57	0.01141	0.05444	-6.88437	0.80983	4,526	414	10.93	Call	02/23/21
3,885.00	11.83	11.83	16.82%	45.77	0.01161	0.04835	-6.70838	0.80591	3,952	238	16.61	Call	02/23/21
3,890.00	9.50	9.50	16.56%	39.88	0.01148	0.04215	-6.43396	0.78427	6,665	522	12.77	Call	02/23/21
3,895.00	7.50	7.30	16.07%	33.83	0.01120	0.03578	-5.91980	0.74295	6,725	131	51.34	Call	02/23/21
3,900.00	5.70	5.70	15.99%	28.34	0.01043	0.02998	-5.45568	0.68788	12,277	1,367	8.98	Call	02/23/21
3,905.00	4.30	4.30	15.79%	23.12	0.00949	0.02447	-4.84922	0.61863	5,000	309	16.18	Call	02/23/21
3,910.00	3.20	3.20	15.66%	18.48	0.00838	0.01957	-4.21638	0.54197	6,179	421	14.68	Call	02/23/21
3,915.00	2.23	2.23	15.32%	14.09	0.00718	0.01492	-3.45835	0.45411	4,018	382	10.52	Call	02/23/21
3,920.00	1.55	1.55	15.14%	10.56	0.00593	0.01119	-2.79261	0.37091	6,651	724	9.19	Call	02/23/21
3,925.00	1.25	1.25	15.64%	8.59	0.00494	0.00910	-2.47904	0.31870	5,006	1,182	4.24	Call	02/23/21
3,930.00	0.92	0.92	15.78%	6.58	0.00399	0.00697	-2.04214	0.26004	5,374	848	6.34	Call	02/23/21

For reference:

- *Expiration date: 2/24/21*
- *Underlying price = $3,881.37*

Source: Barcharts

And Finally...The Options Table

Puts

Strike	Last	Theoretical	IV	Delta	Gamma	Rho	Theta	Vega	Volume	Open Int	Vol/OI	Type	Last Trade
3,835.00	4.07	4.07	23.33%	-16.18	0.00517	-0.01732	-5.83309	0.49793	4,052	1,139	3.56	Put	02/23/21
3,840.00	4.67	4.67	22.80%	-18.38	0.00574	-0.01968	-6.18414	0.54016	5,906	1,714	3.45	Put	02/23/21
3,845.00	5.60	5.60	22.66%	-21.29	0.00631	-0.02279	-6.71825	0.59018	3,105	747	4.16	Put	02/23/21
3,850.00	6.40	6.40	22.09%	-24.06	0.00694	-0.02576	-7.01962	0.63239	7,232	2,852	2.54	Put	02/23/21
3,855.00	7.13	7.40	21.63%	-27.28	0.00756	-0.02921	-7.34130	0.67513	1,528	1,066	1.43	Put	02/23/21
3,860.00	8.40	8.40	20.96%	-30.67	0.00825	-0.03284	-7.51997	0.71332	2,674	1,006	2.66	Put	02/23/21
3,865.00	9.50	9.85	20.68%	-34.74	0.00879	-0.03721	-7.81044	0.75042	1,481	421	3.52	Put	02/23/21
3,870.00	11.12	11.40	20.27%	-39.04	0.00932	-0.04183	-7.96000	0.77969	2,623	1,068	2.46	Put	02/23/21
3,875.00	12.43	13.15	19.84%	-43.66	0.00977	-0.04678	-8.00432	0.80020	2,606	1,323	1.97	Put	02/23/21
3,880.00	15.10	15.10	19.38%	-48.56	0.01013	-0.05205	-7.91992	0.80993	5,157	2,105	2.45	Put	02/23/21
3,885.00	17.44	17.44	19.09%	-53.68	0.01024	-0.05756	-7.78184	0.80701	1,880	466	4.03	Put	02/23/21
3,890.00	20.00	20.00	18.75%	-58.91	0.01021	-0.06320	-7.49323	0.79014	2,307	794	2.91	Put	02/23/21
3,895.00	22.35	22.35	17.77%	-64.67	0.01030	-0.06938	-6.80396	0.75503	1,215	247	4.92	Put	02/23/21
3,900.00	25.80	25.80	17.87%	-69.54	0.00964	-0.07466	-6.45844	0.71116	1,392	2,015	0.69	Put	02/23/21
3,905.00	25.44	29.95	18.69%	-73.22	0.00867	-0.07868	-6.35903	0.66892	261	190	1.37	Put	02/23/21
3,910.00	29.73	33.75	18.72%	-77.31	0.00792	-0.08313	-5.84415	0.61216	533	674	0.79	Put	02/23/21
3,915.00	33.68	38.00	19.21%	-80.41	0.00708	-0.08655	-5.51402	0.56154	212	187	1.13	Put	02/23/21
3,920.00	41.00	42.30	19.57%	-83.28	0.00630	-0.08971	-5.10157	0.50863	329	393	0.84	Put	02/23/21
3,925.00	45.43	46.80	20.12%	-85.53	0.00557	-0.09224	-4.77749	0.46223	231	1,092	0.21	Put	02/23/21
3,930.00	48.54	51.45	20.84%	-87.28	0.00492	-0.09422	-4.54024	0.42333	572	343	1.67	Put	02/23/21

QUANT FINANCE

For reference:

- *Expiration date: 2/24/21*
- *Underlying price = $3,881.37*

Source: Barcharts