

# OPTIONS 201 WORKSHOP

Spring '18

# BRAINTEASER

There are 10 bags with 100 identical coins in each one. In all bags except one, the coins each weight 10 grams. However, in the one counterfeit bag, the coins all weigh 9 gram or all weigh 11 grams. You have a digital scale that tells you exact weight, how many uses do you need to find the counterfeit bag?

# SOLUTION

Take 1 coin from first bag, 2 from second, 3 from third, etc...

In perfect world, the 55 coins weight 550 grams total.

There's a unique weight if any bag x contains the fake coins.

542 -> 8 underweight coins -> 8<sup>th</sup> bag has 9's

551 -> 1 overweight coin -> 1<sup>st</sup> bag has 11's



**RISK PARITY**

**FINANCIAL JOURNALISTS  
AND ACTIVE  
MANAGERS LOOKING  
FOR SOMEONE TO BLAME**

**THE LEGION OF REGULAR  
OLD SCHOOL INVESTORS  
AND TRADERS  
WHO SOLD A BUNCH  
AND CAUSED A REGULAR  
OLD SCHOOL CORRECTION**



# People Fear What They Don't Understand

## Don't Blame The Quants - Forbes

[https://www.forbes.com/2008/10/07/securities-quants-models-oped-cx\\_ss\\_1008shre](https://www.forbes.com/2008/10/07/securities-quants-models-oped-cx_ss_1008shre)  
Oct 8, 2008 - Financial markets are a mess, and the excesses of the finance industry are dragging the whole economy. In recent years, safe investments delivered unusually low returns, and ho investors seeking to be above average (as Garrison Keillor would say) bought extremely complex instruments.

## Do Blame The Quants - Forbes

[https://www.forbes.com/2008/12/.../shreve-quants-derivatives-oped-cx\\_ptp\\_1209port](https://www.forbes.com/2008/12/.../shreve-quants-derivatives-oped-cx_ptp_1209port)  
Dec 9, 2008 - So it is with an enhanced sense of humility and an acute concern for appropriateness to reply to his Forbes.com column of Oct. 10, "Don't **Blame The Quants**." Professor Shreve's column, certainly, contains plenty of valuable insights. But I strongly believe that it is necessary (and imperative) to ...



## Don't **blame the quants** for market turbulence

[Irish Times](#) - 8 hours ago

Are the robots to **blame** for the current market turbulence? A lot of commentators, including US treasury secretary Steve Mnuchin, seem to think so, much to the disgruntlement of pugnacious hedge fund manager and quant Cliff Asness. "Here's an idea," tweeted Asness. "Stop saying silly accusatorial things ..."



## Quant-**Blame** Game and 'Crack Analysis' Behind the Flash Crash

[Bloomberg](#) - Feb 6, 2018

Cliff Asness, the co-founder of AQR Capital Asset Management, tweeted that some of the **blame on quants** is just "crack analysis" and said that "people who say such things may be idiots trying to get attention." Simply put, most of the strategies getting blamed are too small to have such a large impact.



## **Quants** Embrace Recent Selloff Even as Everyone Blames Them For It

[Wall Street Journal](#) - Feb 6, 2018

A day after the stock market plummeted more than 1,100 points, quantitative traders were made the scapegoat by many investors and even the treasury secretary. But within these high-powered "quant" funds, few see themselves as the problem. Some are even saying the selloff presents their best ...

*“So far, I’d say this is small potatoes...”*

*New York Federal Reserve President William Dudley, February 8, 2018*

*“All that said, given the fundamental factors in place that should support the demand for housing, we believe the effect of the troubles in the subprime sector on the broader housing market will likely be limited, and we do not expect significant spillovers from the subprime market to the rest of the economy or to the financial system.”*

*Federal Reserve Chairman Ben Bernanke, May 17, 2007*

# WELCOME!

Options 201

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Let's jump right in...

# With a review!

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Bear with us if you still remember everything. (Good on you!)



# EXPECTATIONS

1

## INTELLECTUAL HONESTY

Ask questions about anything you want to know more about or need explained a different way! Asking questions looks smart!

1

## Typos / Misspeak

Please correct me if you know I misspoke or accidentally put wrong information on the slides. I appreciate the help.

2

## TAKE NOTES

If you are a learn-by-writing type, this can help.

2

## Purposeful Approximation

Experts in every field come up with fancy terms with pretty simple definitions. Let's just stick with the simple definitions.

3

## PARTICIPATION

I will be sprinkling some questions between the slides. Give us your best guesses. That's all we ask. Correctness not required.

3

## Less Math / More Intuition

J: What is math? I did poorly in Linear Algebra  
S: Alright, let's just stick to qualitative points  
J: (See Sashank afterwards for options math)

# THIS WEEK

PUT CALL  
PARITY



Wait, isn't this just a  
stock now?

TIME AND  
VOL PRICING



But what is it worth?

BLACK  
SCHOLES



Life is not normally  
distributed.

OPTION  
GREEKS



Bro, the top frat  
everywhere is Delta  
Gamma Vega Theta  
Rho Vanna Volga.  
Don't you know?

SKEW



It's honestly a  
volatility smirk

OPTIONS  
PITCH



Look! It works!

# Definition of an Option

## Option Definition:

An option is a contract which gives the buyer (the owner or holder of the option) the right, but not the obligation, to buy or sell an underlying asset or instrument at a specified strike price on a specified date.



## BUY CALL

The right to buy underlying at a specific strike price for a specified time.



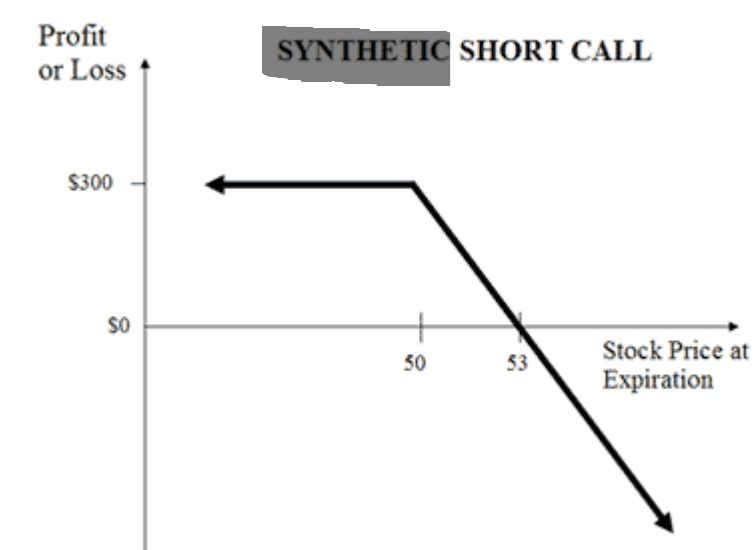
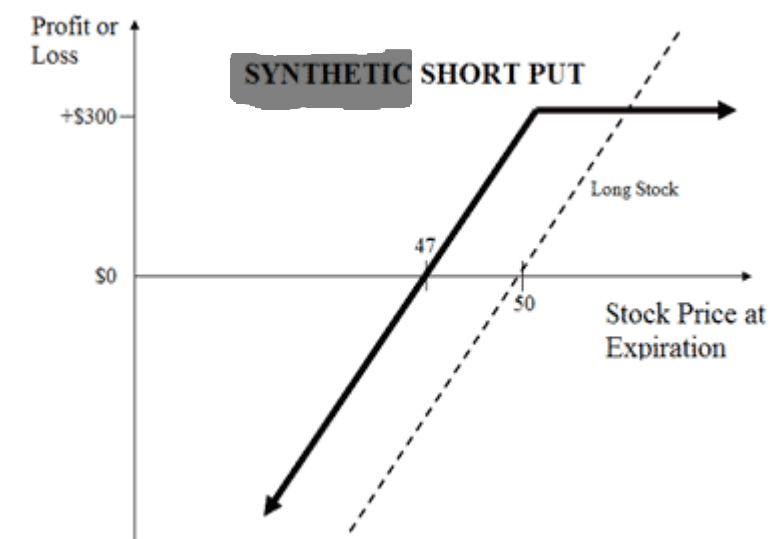
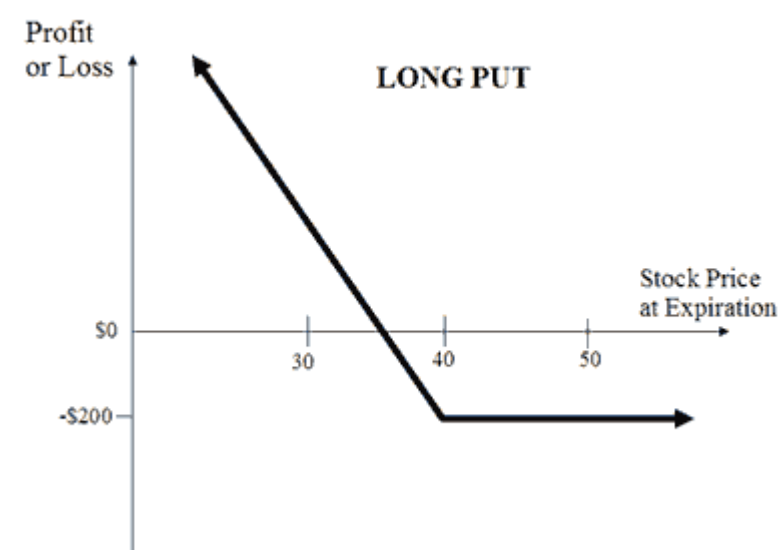
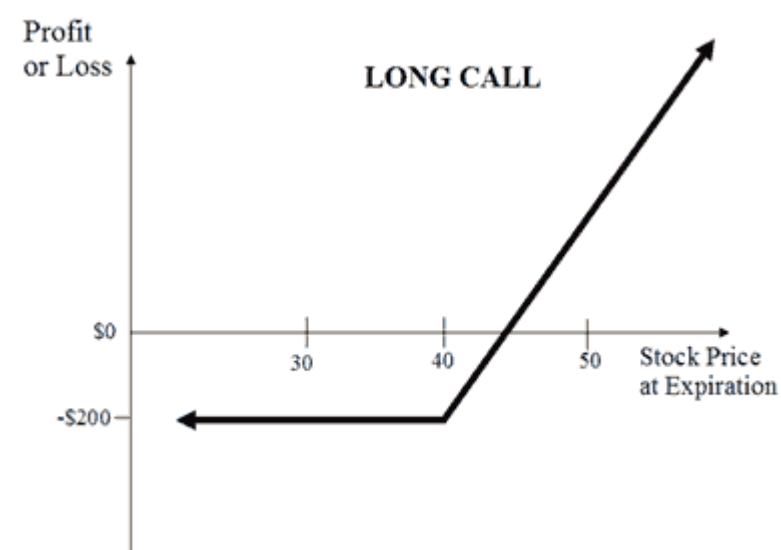
## BUY PUT

The right to sell underlying at a specific strike price for a specified time.



## WRITE OPTION

You are selling the right to someone – which means you **MUST** take obligation. You can sell both a put and call.



Volatility

More on this later (quant guys use options for vol)

REASON 3

LEVERAGE

Cheaper to buy calls/puts than stock

REASON 2

PROTECTION AND  
HEDGING

Used to protect downside (think of payoff)

REASON 1

USE OF AN  
OPTION

There are many reasons to buy an option instead of stock.

# MONEYNESS

## Out of the Money

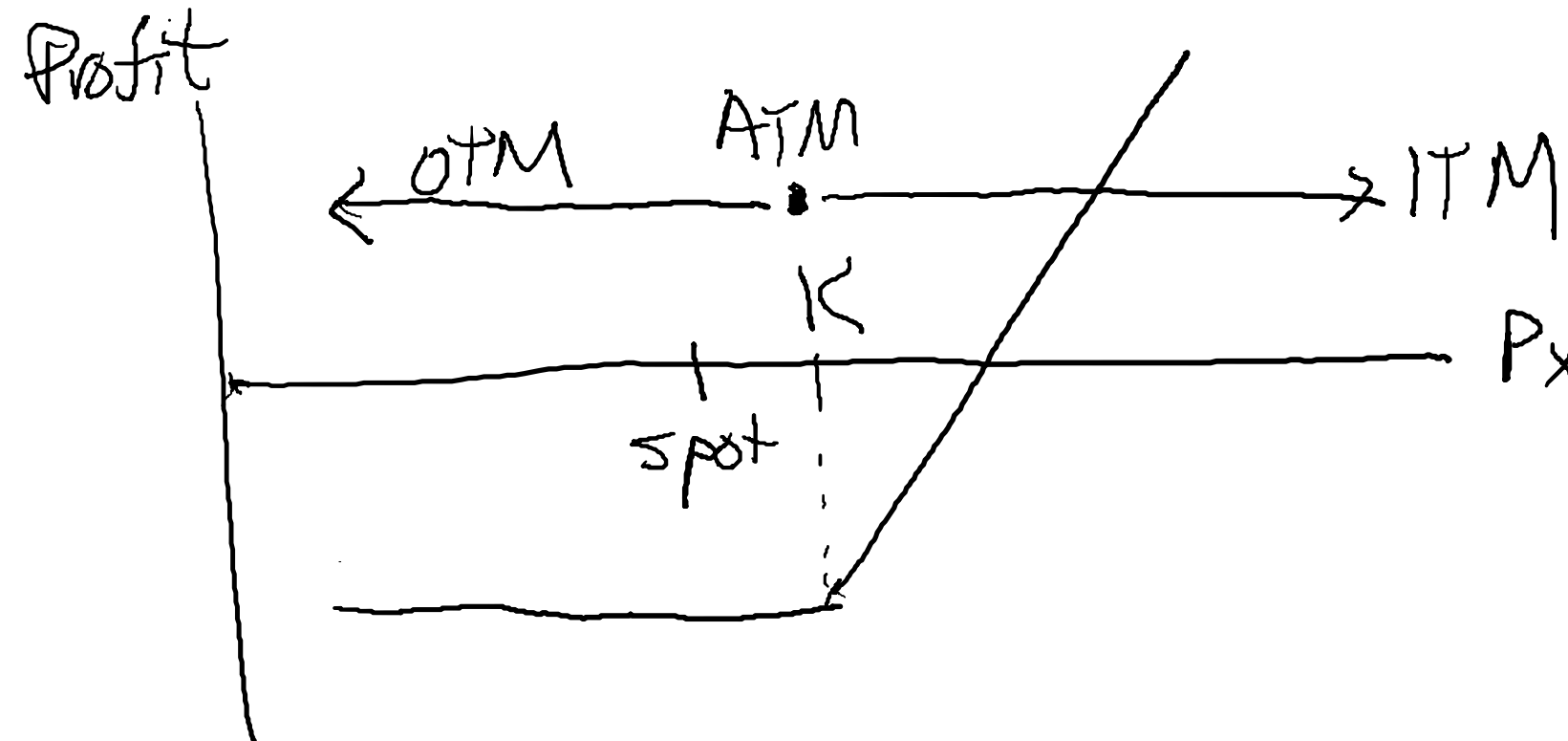
**Out of the money** (OTM) is term used to describe a call option with a strike price that is higher than the market price of the underlying asset, or a put option with a strike price that is lower than the market price of the underlying asset.

## At the money

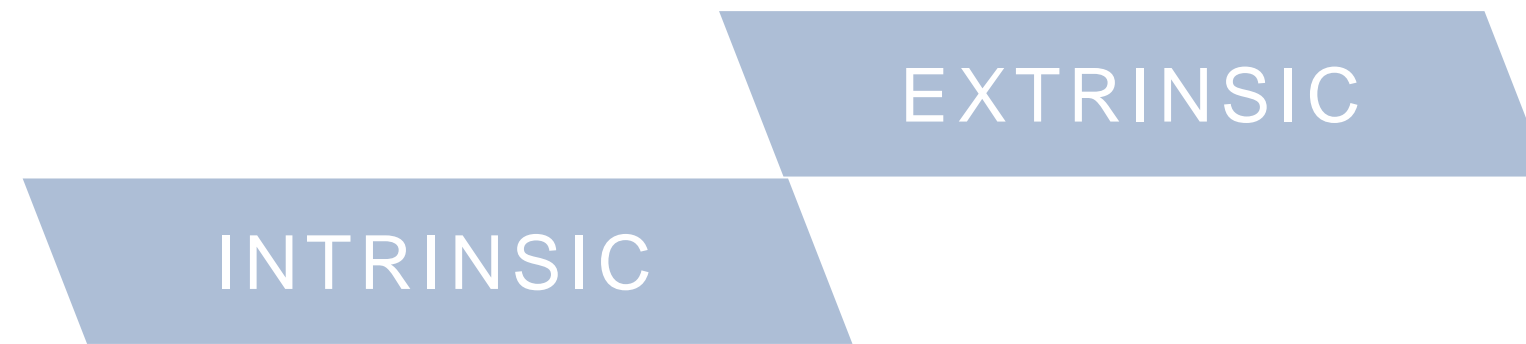
**At the money** (ATM) is a situation where an option's strike price is identical to the price of the underlying security. Both call and put options are simultaneously at the **money**. For example, if XYZ stock is trading at 75, then the XYZ 75 call option is at the money and so is the XYZ 75 put option.

## In the money

**In the money** (ITM) is term used to describe a call option with a strike price that is lower than the market price of the underlying asset, or a put option with a strike price that is higher than the market price of the underlying asset.





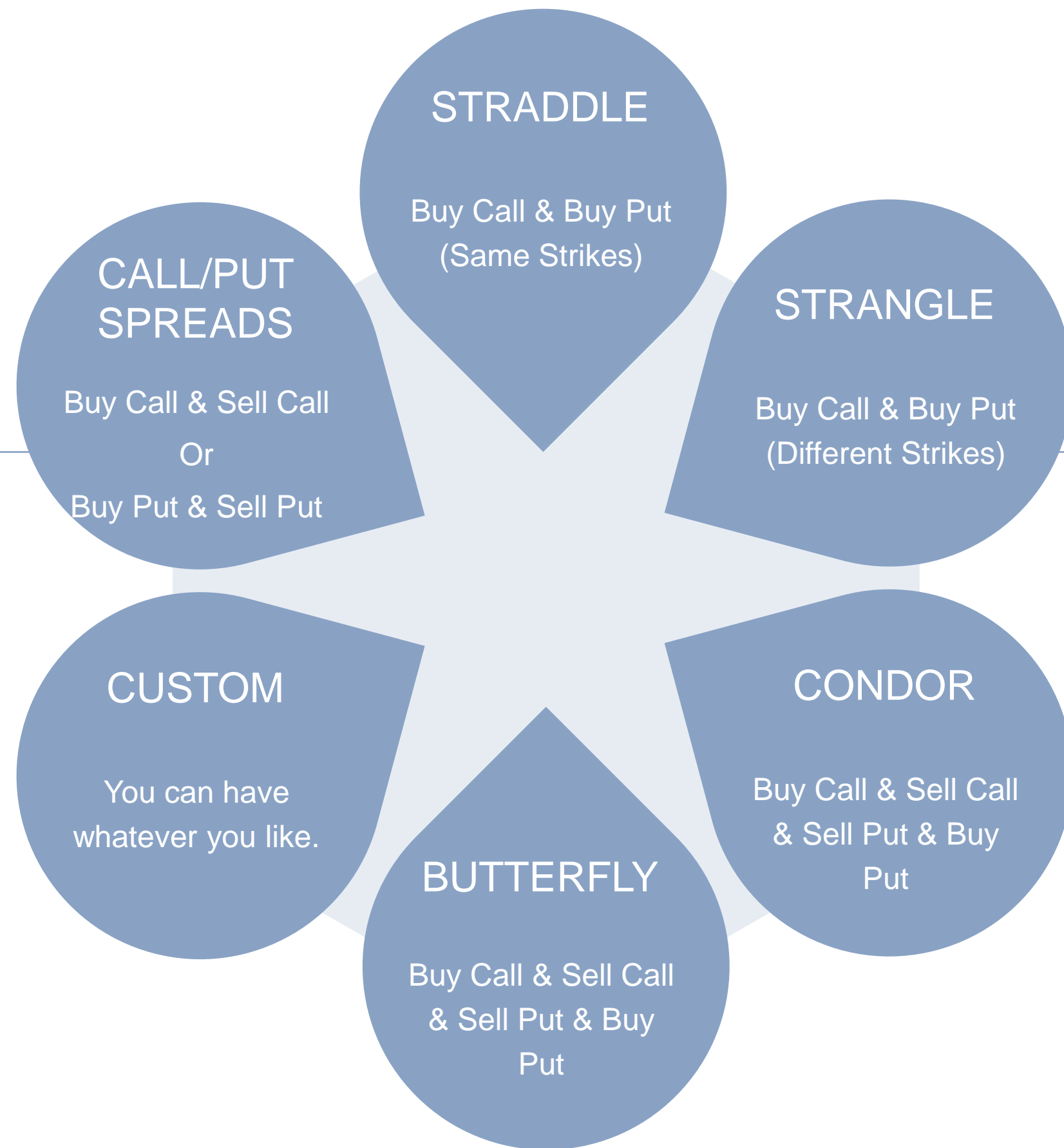


Intrinsic Value: What is your profit from exercising the option?  
Extrinsic Value: The rest of option's value

## Value of an Option

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There is something called the Black-Scholes options pricing model, but before we get there, let's understand this simpler extrinsic/intrinsic pricing model.



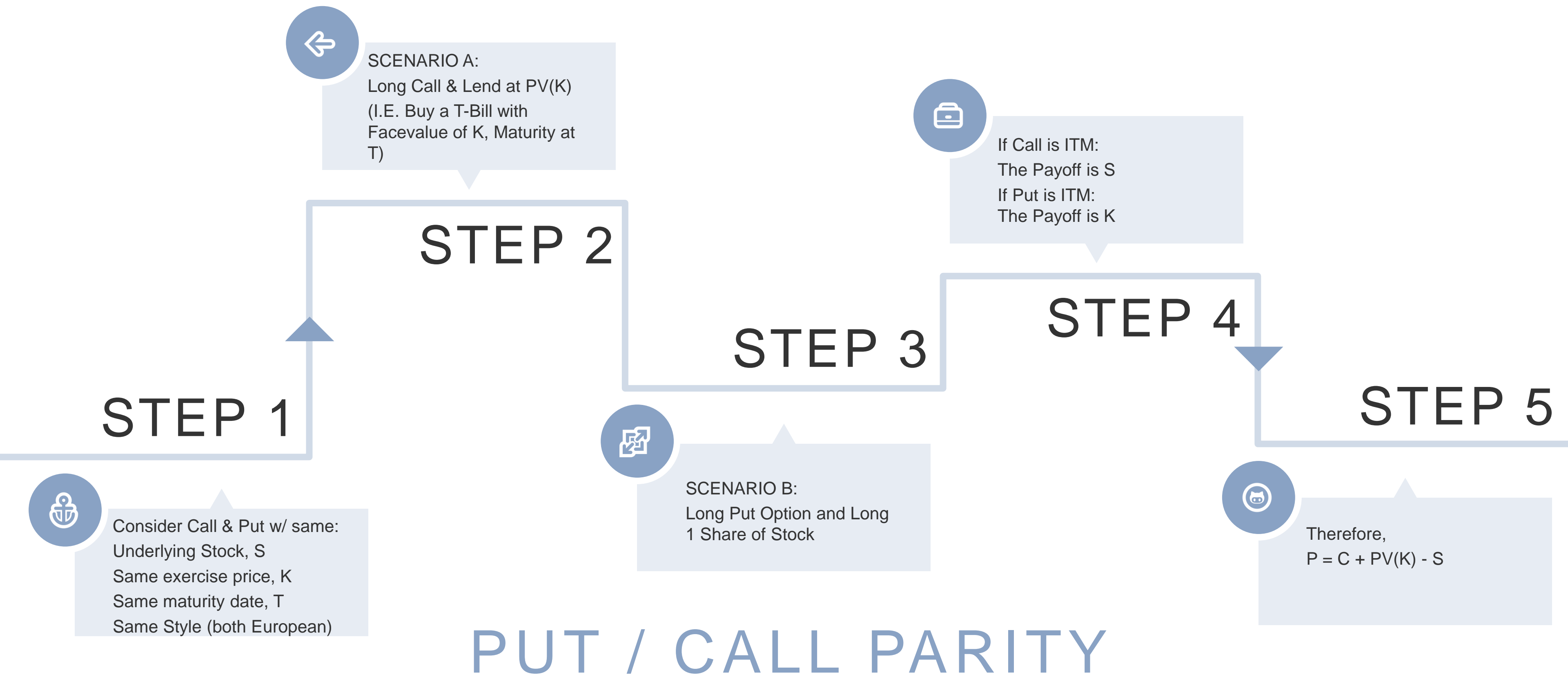
# 6 OPTIONS STRATEGIES

## ► VARIETY OF EXPRESSIONS

Have a view on any asset class? There's an options strategy for that!

## ► WHAT RISKS DO YOU WANT?

Forget bespoke suits. How about bespoke risks? Strategies have varying degrees of risk. We will go into risk sensitivities next lecture.



The payoff becomes equal to just owning the stock. This no-arbitrage-pricing model theorizes that appropriately priced puts and calls should result in that happening.

# AMERICAN EXERCISE

CALL NO DIVS

$$\text{Call} = [S - K] + [K - \text{PV OF } K] + \text{INS}$$

Would you exercise? What do you gain / lose?

CALL WITH  
DIVS

$$\text{Call} = [S - K] + [K - \text{PV OF } K] - \text{PV OF } D + \text{INS}$$

Would you exercise? What do you gain / lose?

PUT NO DIVS

$$\text{Put} = [K - S] + [\text{PV OF } K - K] + \text{INS}$$

Would you exercise? What do you gain / lose?

PUT WITH  
DIVS

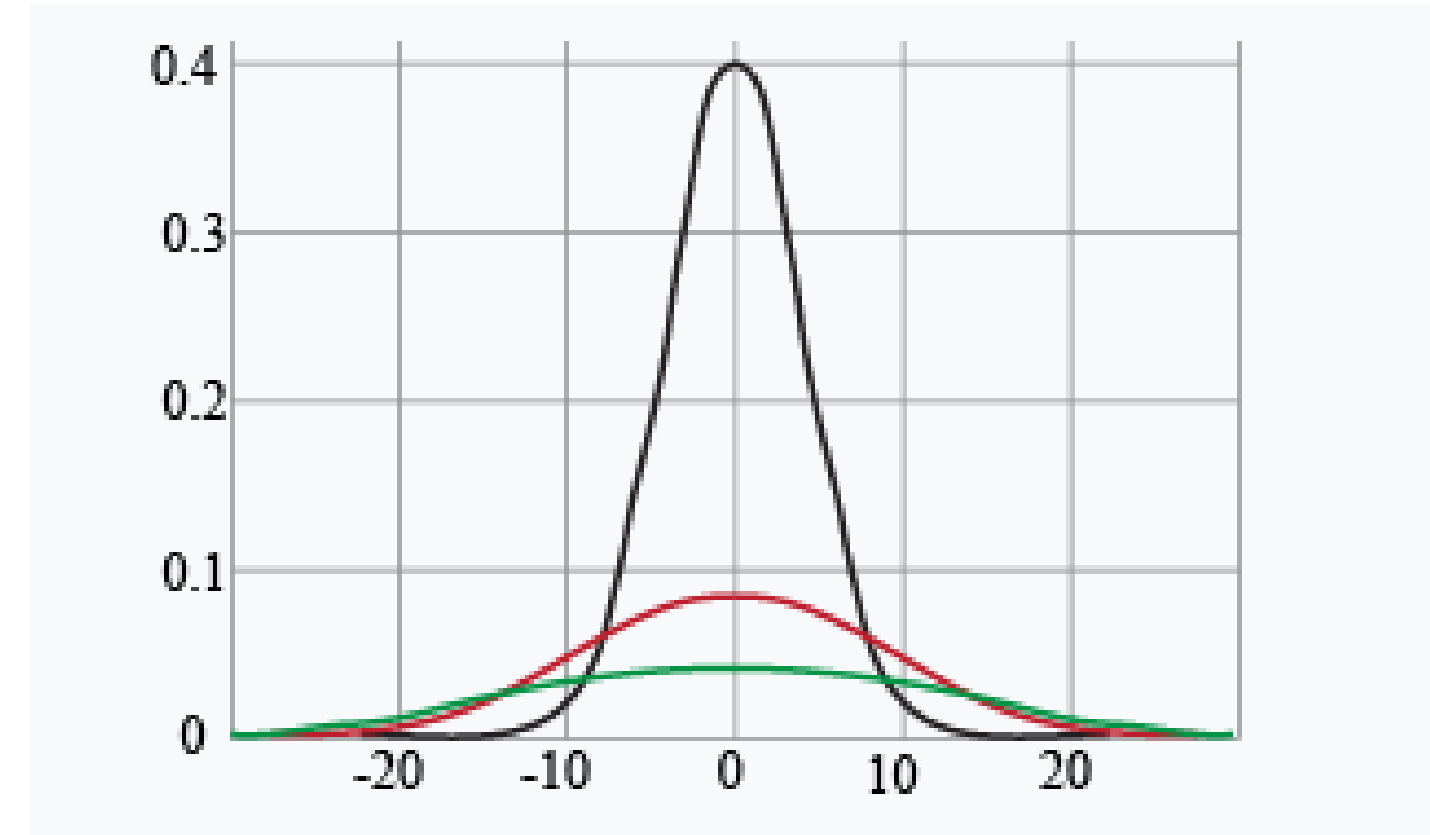
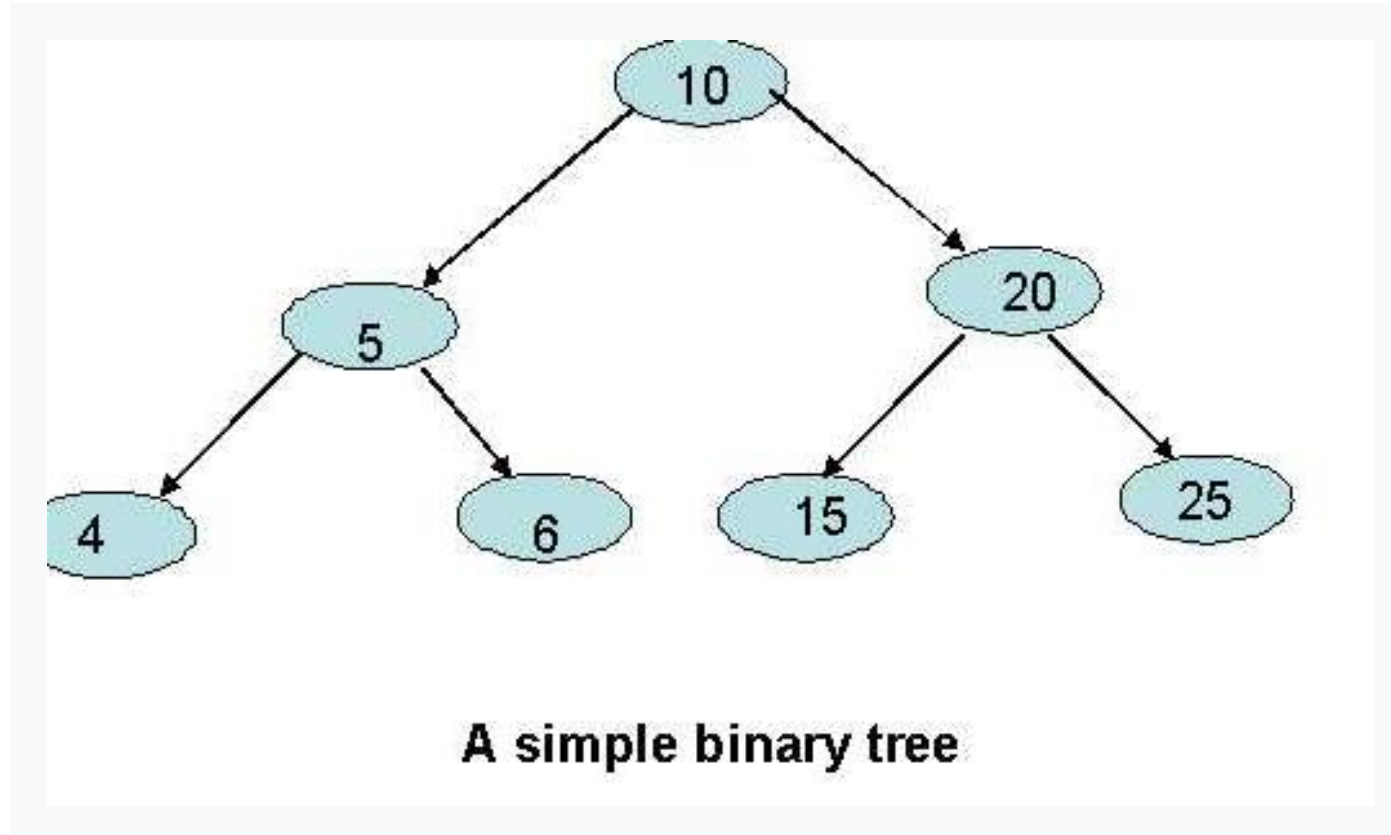
$$\text{Put} = [K - S] + [\text{PV OF } K - K] + \text{PV OF } D + \text{INS}$$

Would you exercise? What do you gain / lose?

CONCLUSION

Early exercise is dependent on change in interest rates (time value) & change in dividends.

# TIME & VOL EFFECTS



## INCREASE DAYS TO EXPIRY

If you increase the number of days, you increase the number of nodes and levels in the binary tree.

Is greater time good for the value of a put / call?

What if you sold an options contract to a counterparty?

## INCREASE VOLATILITY

**Volatility** is defined as the standard deviation of returns of the underlying asset. Think about it as how intensely the price swings.

Is greater volatility good for longing a put / call?





# LETS DO THIS!

(Who picked that picture?!)





# BLACK SCHOLES MODEL

PREVIOUS CLOSE  
24.81  
TOTAL VOLUME  
823.149

24.84  
24.14  
25.85  
25.16  
24.66  
24.14

# Assumptions of Model

- Option Assumptions
  - Describes European options
    - Europe -> hates freedom -> can only exercise at expiry
- Market Assumptions
  - Efficient markets/no forecasting moves
  - No transaction costs and perfect liquidity
- Underlying Risky Asset Assumptions
  - No dividends
  - **Returns are Normally Distributed**
  - **Volatility is constant**
- Cash Assumptions
  - Risk-free and volatility are constant

# The Black-Scholes Formulas

$$c = S_0 N(d_1) - K e^{-rT} N(d_2)$$

$$p = K e^{-rT} N(-d_2) - S_0 N(-d_1)$$

$$\text{where } d_1 = \frac{\ln(S_0 / K) + (r + \sigma^2 / 2)T}{\sigma \sqrt{T}}$$

$$d_2 = \frac{\ln(S_0 / K) + (r - \sigma^2 / 2)T}{\sigma \sqrt{T}} = d_1 - \sigma \sqrt{T}$$

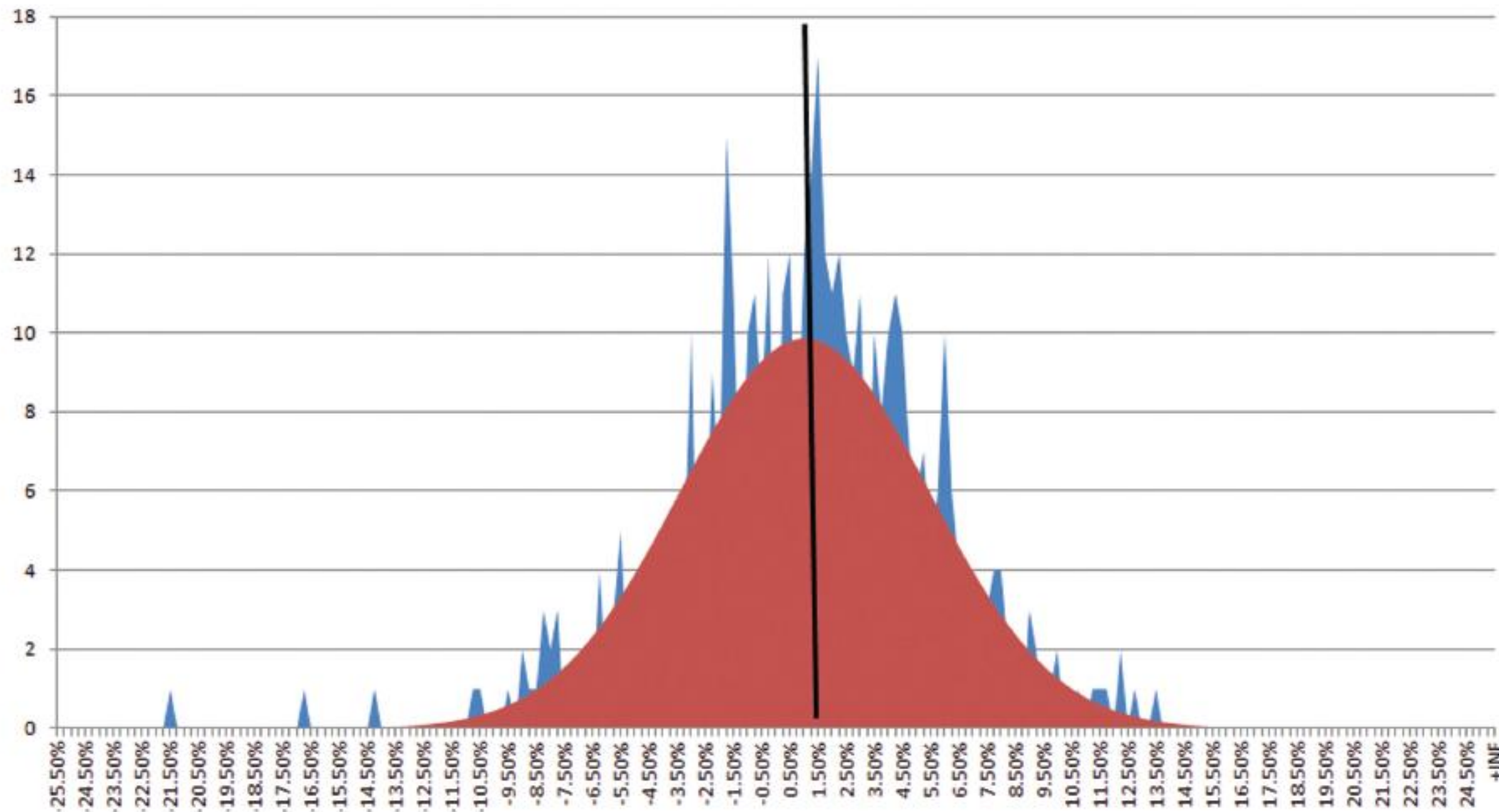
*LTCM was merely a setback*



Merton, Scholes, & Black

# Limitations of Normal Distribution

Figure 5: Distribution of Monthly Returns for the S&P 500





# BLACK SCHOLES

There are **five** inputs to the B-S Model



## Stock Price

Part of Intrinsic Value



## Strike Price

Part of Intrinsic Value



## Time

More Time = More Extrinsic Value



## Interest Rates

More IR = Affects Puts and Calls differently



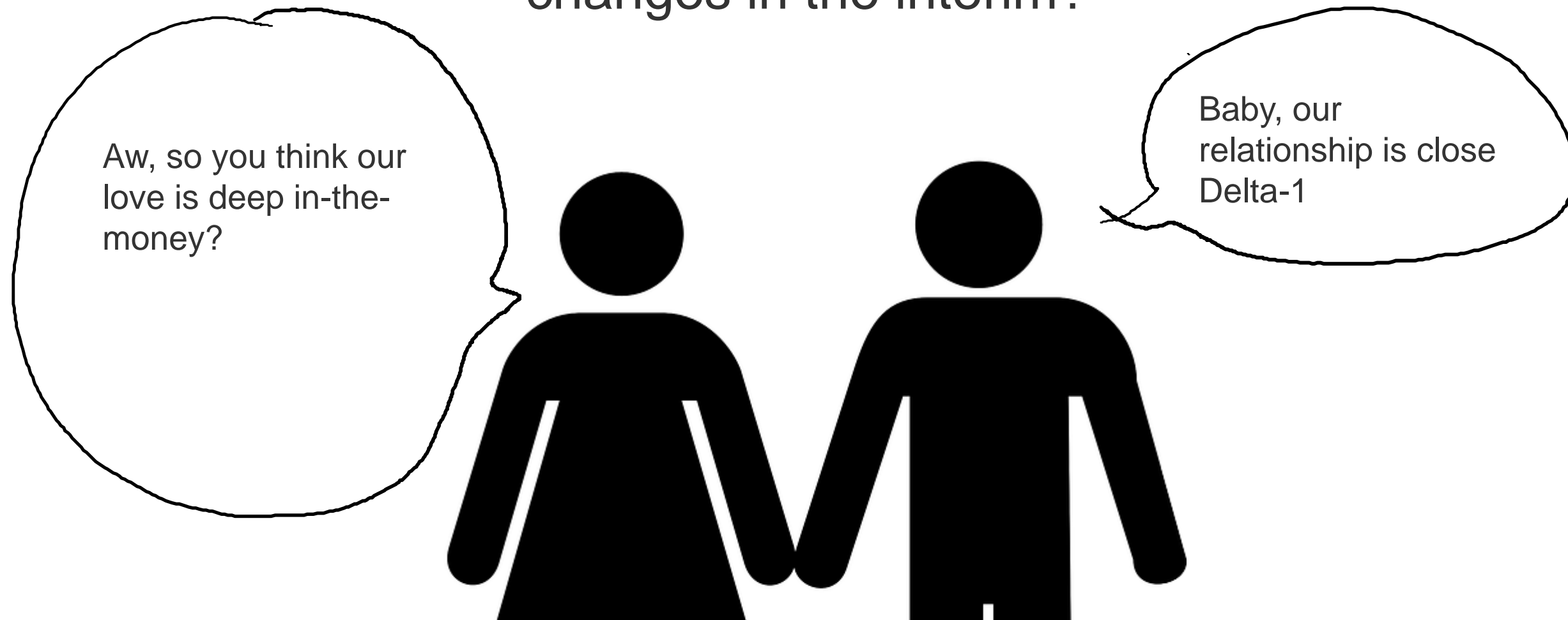
## Implied Volatility

Volatility is good. But what does implied mean?

# MARK TO MARKET CHANGES

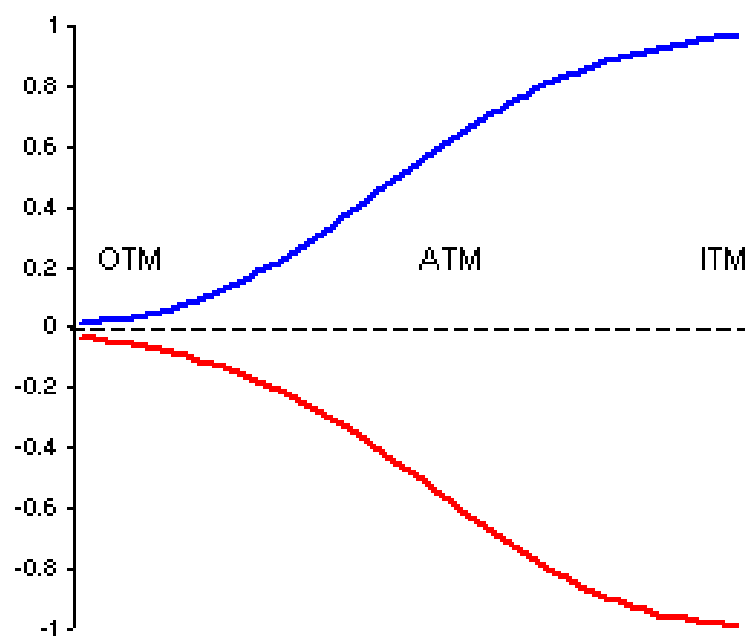
We can use these aforementioned pricing models to determine a fair value when we buy or sell an option.

But we keep these contracts on our books until expiry! How do we determine price changes in the interim?





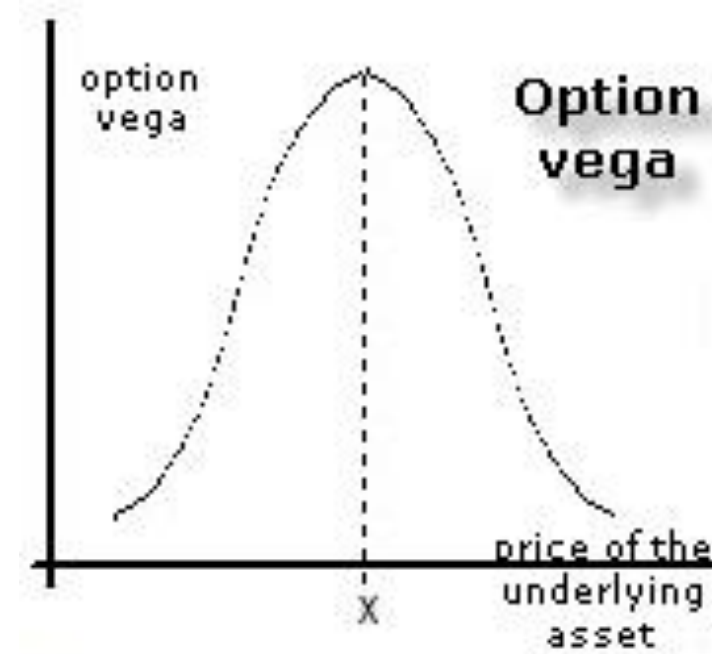
M E E T   T H E   G R E E K S



## Gamma

$$\frac{\Delta \text{Delta}}{\Delta S}$$

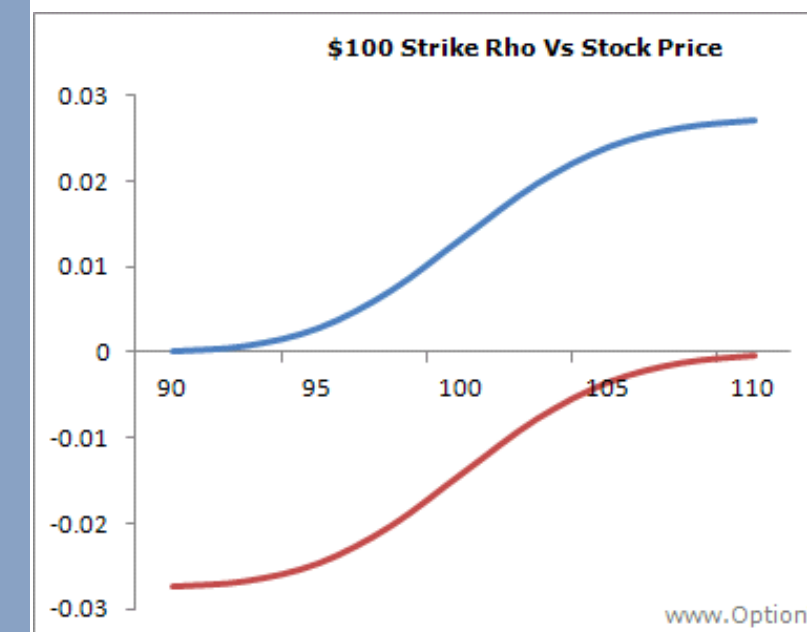
Derivative of Delta



## Theta

$$\frac{\Delta V}{\Delta T}$$

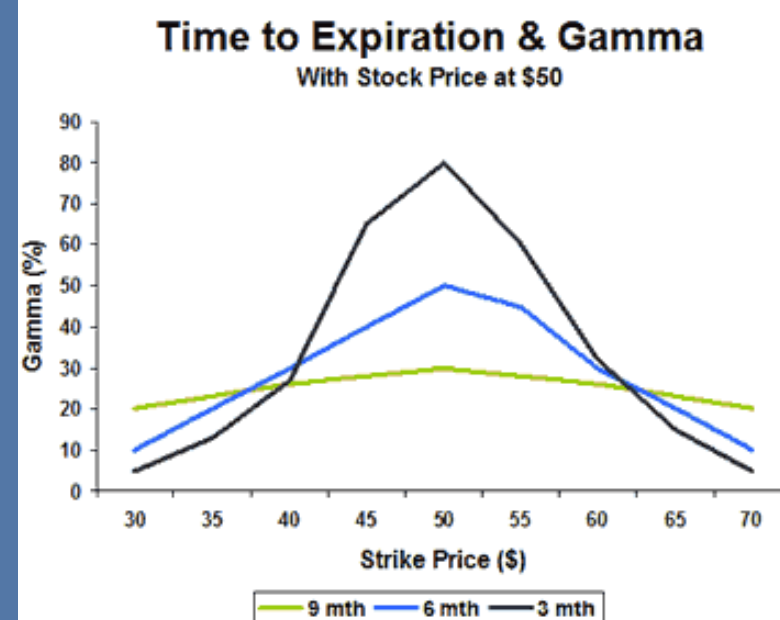
where V = Value of Option  
and where  
T = Time (in days)



## Delta

$$\frac{\Delta V}{\Delta S}$$

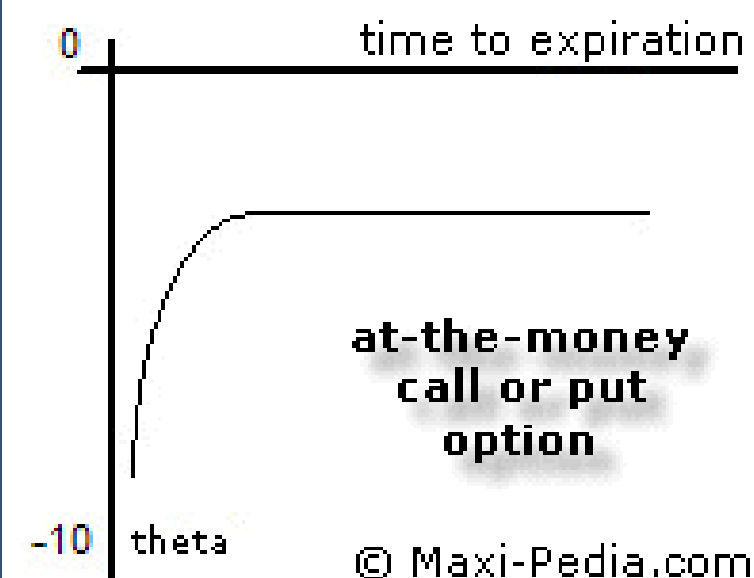
where V = Value of Option  
and where  
S = Spot Price



## Vega

$$\frac{\Delta V}{\Delta \sigma}$$

where V = Value of Option  
and where  $\sigma$  =  
Implied Volatility



## Rho

$$\frac{\Delta V}{\Delta R}$$

where V = Value of Option  
and where  
R = Interest Rate

## 2<sup>nd</sup> Derivative Vol Exposures

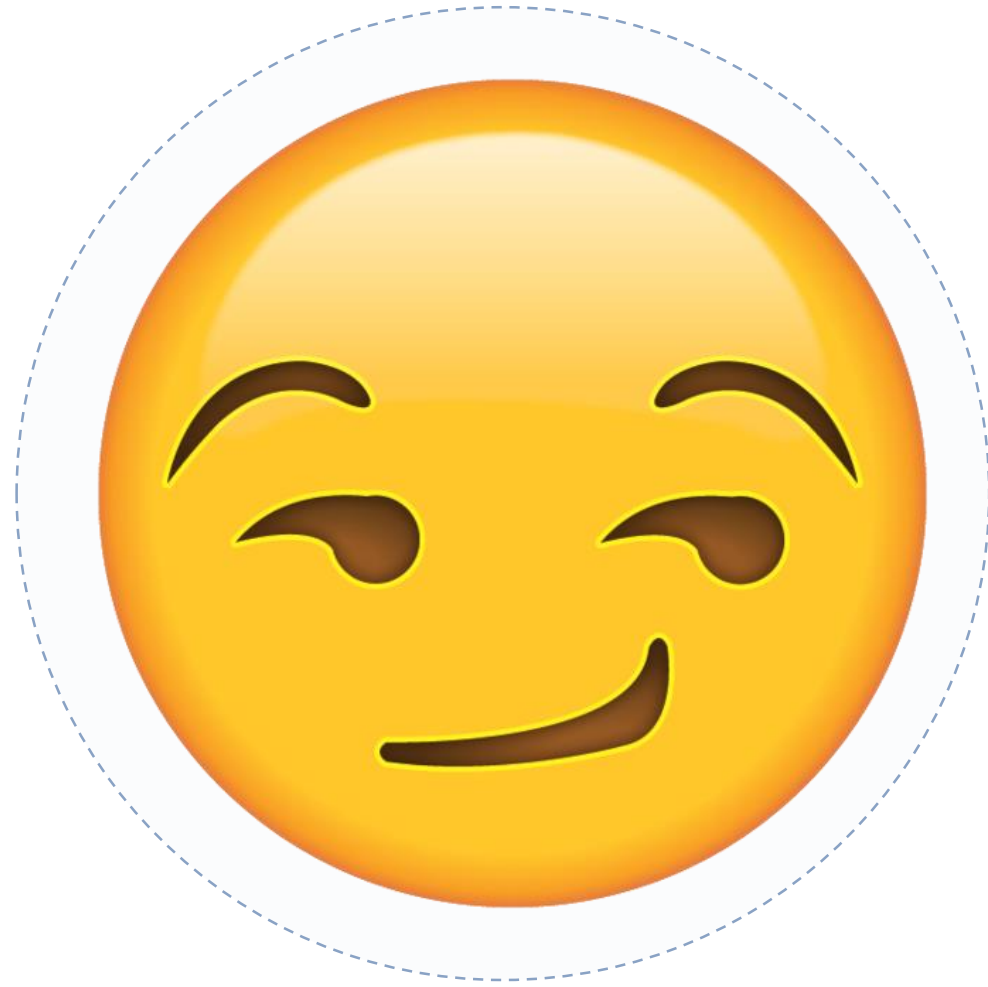
There are also two more important Greeks:

$$Volga = \frac{\delta Vega}{\delta Vol}$$

$$Vanna = \frac{\delta Vega}{\delta Spot}$$

This is going beyond the basics. They are here so you know they exist.

If you would like to know more about trading these exposures, please bother Sashank after the meeting.



# OPTION SMILE / SKEW

Implied Volatility vs. Moneyness

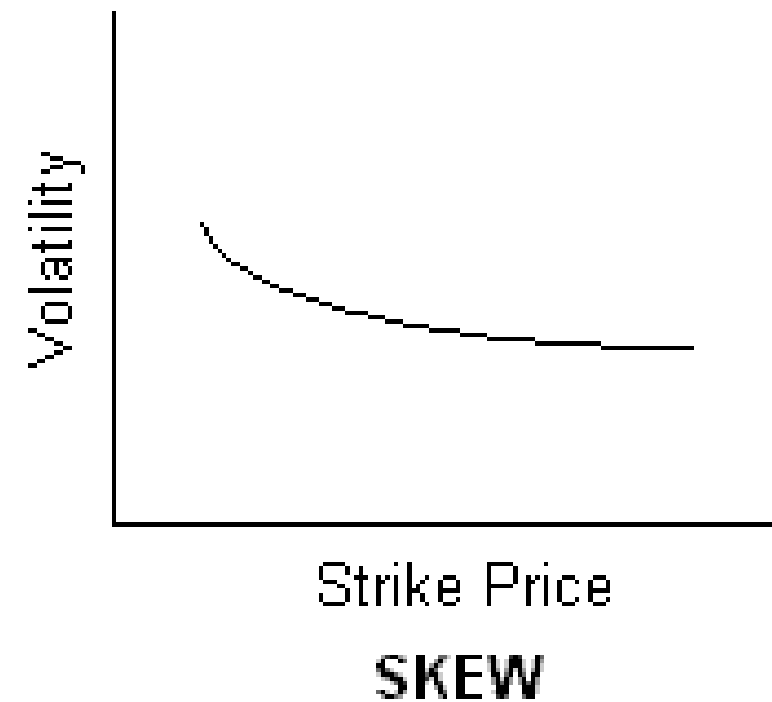
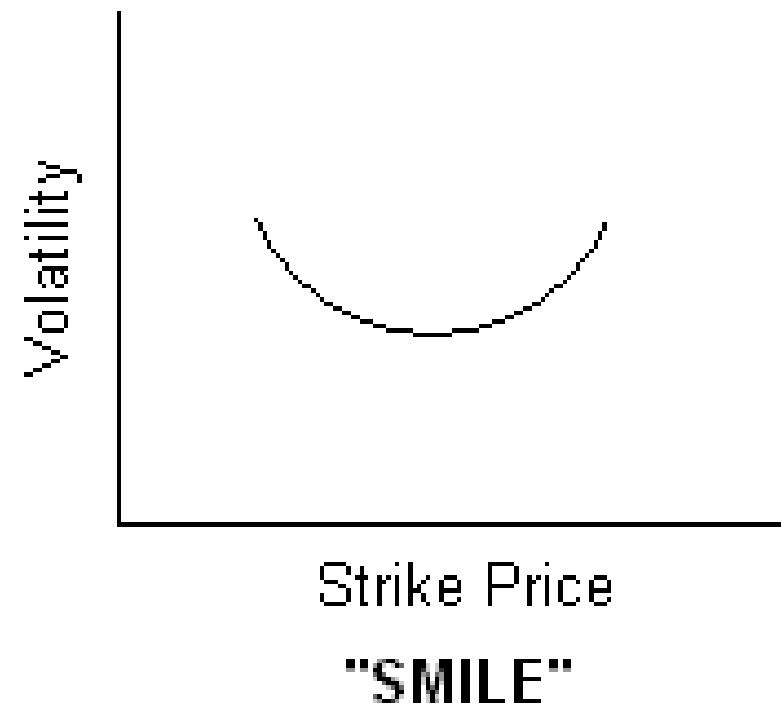
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Black Scholes assumes no skew across strike prices. This is wrong.

Log-normal distributions adjust for that.

# OPTION SKEW

What does it mean?



1

## Black-Scholes Failure

Returns are not normally distributed in real life!

2

## Define IV as Function of Price

Just means OTM Puts and Calls are relatively more expensive as they require greater IV to end ITM.

3

## Put Skew Persists in some Markets

Why are puts generally more expensive than calls?

4

## Spot-Vol Correlation

Market makes assumptions about volatility behavior



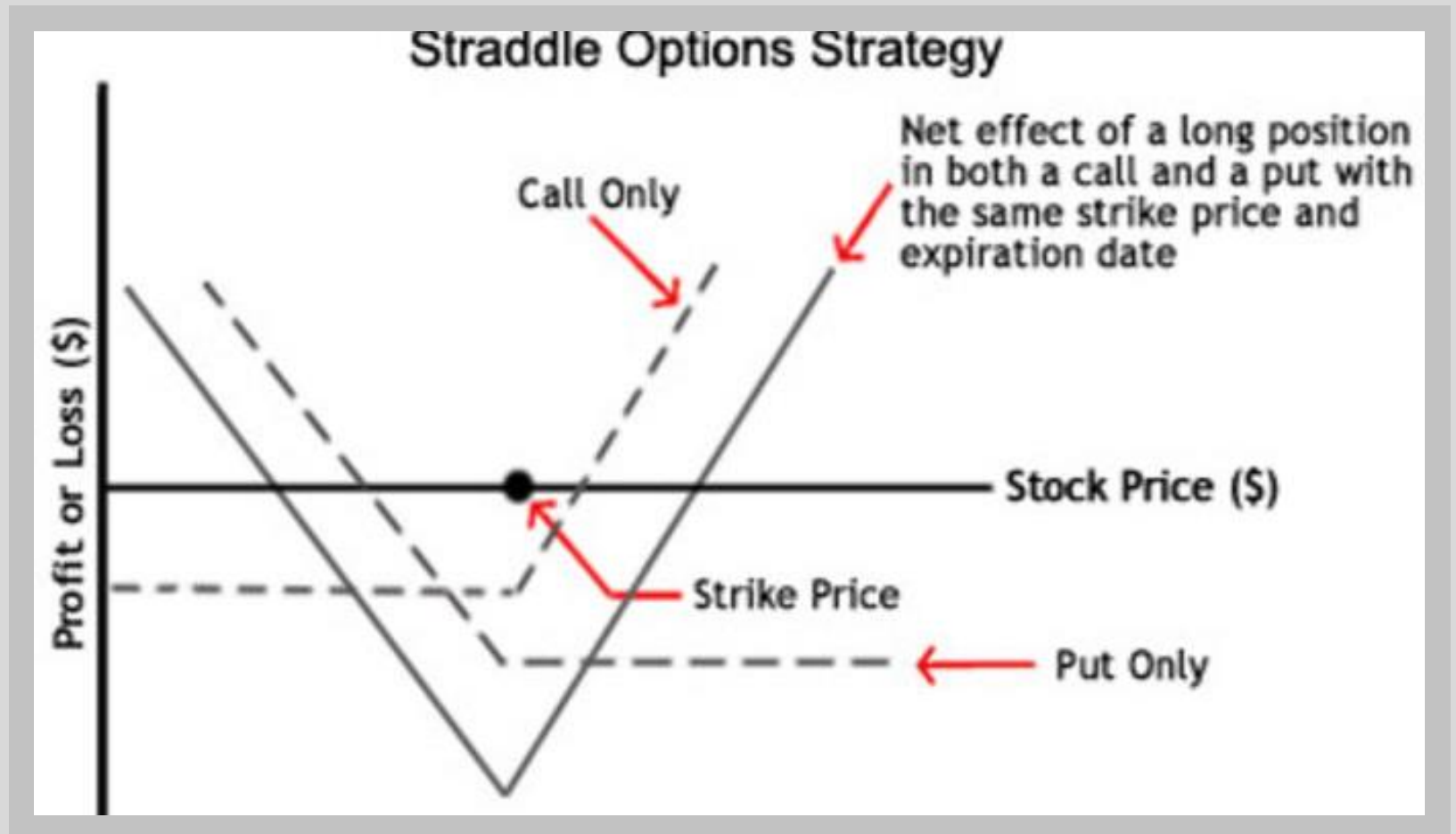
# OPTIONS PITCH... STRADDLE!

Long – Like straddling a fence. Don't pick a side. Instead, play the moves to either direction (gamma scalping)

Short – Moves to either side? What moves? I think the underlying is going to experience very low volatility (barring earthquakes which never happen in places like Japan)



# LONG STRADDLE



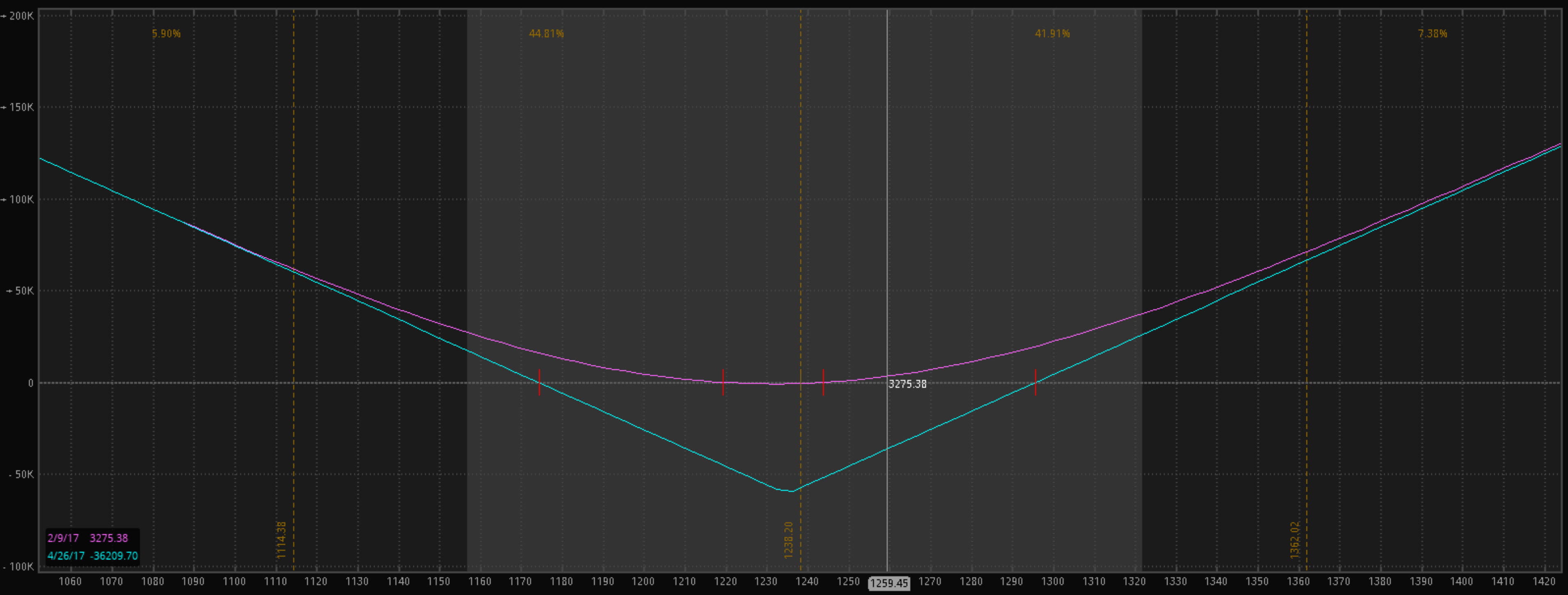
Buy ATM Call and ATM Put = Straddle

What is Delta Position? +, 0, or -

Gamma? +, 0, or -

Vega? +, 0, or -

Theta? +, 0, or -



Cost \$60 for the option:

Need Gold to go up 60 or down 60 (4.85%) in 70 days to breakeven.

Directionally Agnostic...but only at initiation. Why?

# DELTA CHANGES

## GAMMA IS POSITIVE

**Positive Gamma** because bought both calls and puts

As a result, Delta changes as spot moves...

## AS PRICES GOES UP

**Call Delta** increases from .5 to a higher level to  $>.5$

**Put Delta** increases from  $-.5$  to a higher level to  $>-.5$

**Net Delta** = Positive Delta (now you have long exposure)

## AS PRICES GOES DOWN

**Call Delta** decreases from .5 to a lower level to  $<.5$

**Put Delta** decreases from  $-.5$  to a lower level to  $<-.5$

**Net Delta** = Negative Delta (now you have long exposure)

# GAMMA SCALPING

## HEDGE DELTAS

**Gamma Scalping** is the idea of hedging your deltas so that you are directionally agnostic at all points in time.

Instantaneous hedging = costly and hard to do...so hedging is also an art.

## HEDGE WITH STOCK

As prices go up, Deltas go up, so hedge the Deltas by shorting the stock (negative deltas). As prices go down, Deltas go down, so hedge the Deltas by buying the stock (positive deltas)

## CONSTANT ADJUSTMENTS

As a result, you are buying stock as underlying moves down and selling stock as underlying moves up. Gamma Scalping always buys at lows and sells at highs.

# SCALPING – RISKLESS?

## GAMMA

**Gamma** is always good. As you are correct you accelerate your gains from the convexity and as you are incorrect you decelerate your losses.

## FREE MONEY?

**TINSTAFL.** You are paying with Theta (time). You want to look at Gamma/Theta to see risk rewards. As IV is low, Gamma/Theta looks more attractive.

## HOW TO LOSE

Burn more theta than you gain Gamma. Theta by definition is the amount of gamma you expect to scalp.  $\frac{\text{Gamma}}{\text{Theta}} \text{daily breakeven} = IV/\sqrt{252}$

**GOLD STRADDLE (GAMMA SCALPING) THESIS:** I think Gold volatility is cheap (options are pricing in a lower IV, meaning their prices are lower, thus making them cheap) given investors expect rate hikes to drive money away from interest-free assets like Gold. On the flipside, with such a long string of positive economic prints, the risk on inflation and other markets are to the downside. So, there are competing theses to be long or short gold.

As a result, uncertainty should drive Gold volatility higher. All I need to breakeven when Gamma Scalping =  $\frac{13\%}{\sqrt{252}}$  = .82% daily move in Gold. We would be Delta neutral, Long Gamma, Long Vega, Short Theta.