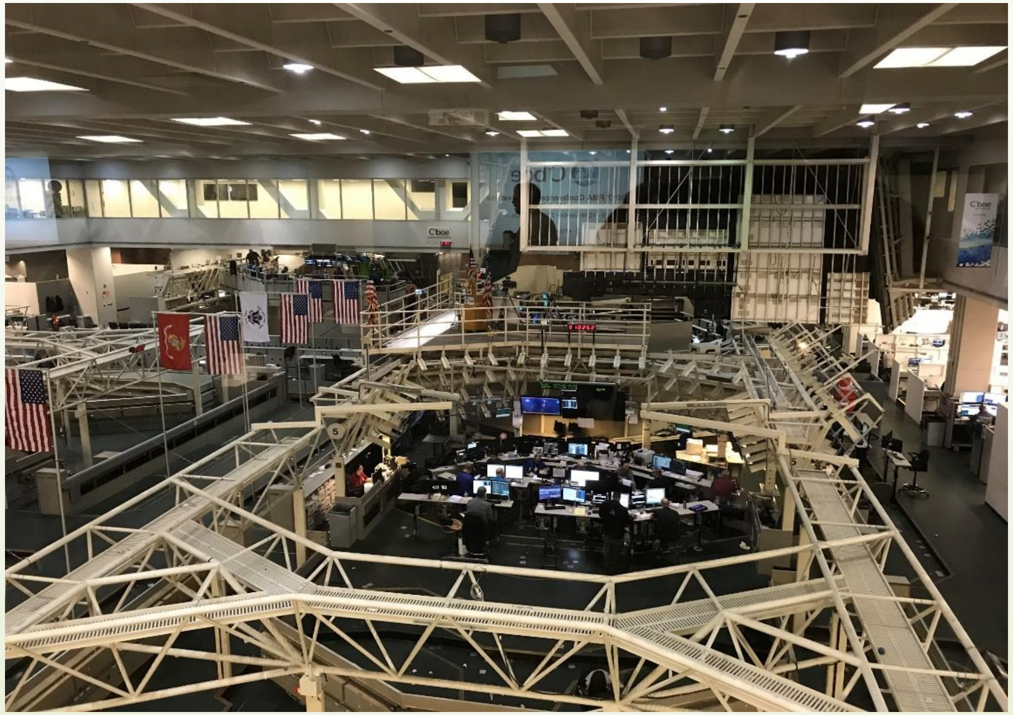
AAII San Diego Options Trading

What to make of models?

https://aaiisandiego.com/sub-groups/options-trading/



Please note:

- Keep microphones on mute
- Unmute to ask a question during the presentation
- Submit written questions via the chat facility
- We are recording the session; please turn off your camera if you prefer privacy

Agenda:

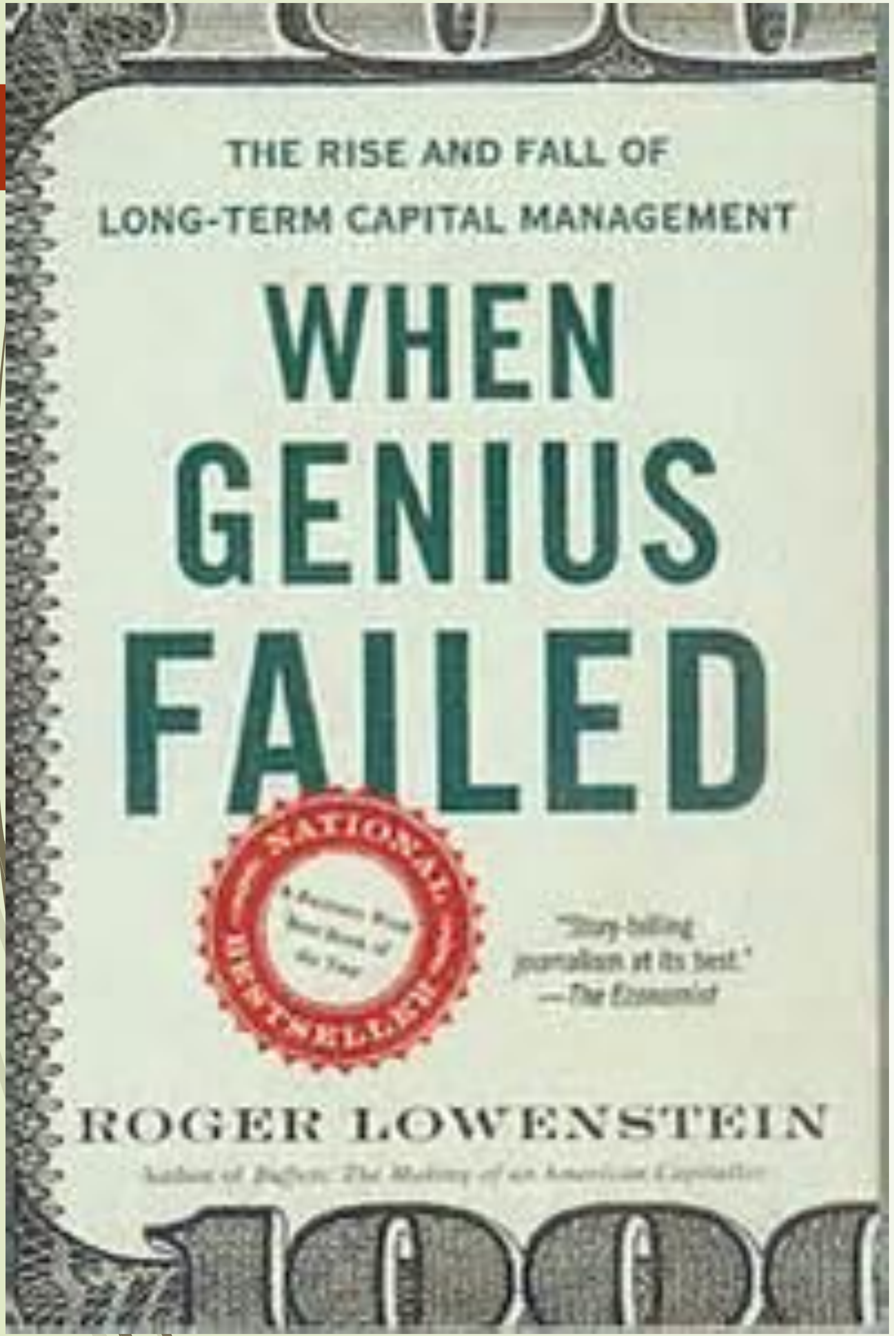
- Why should we care about pricing models? Do they have any relation to practice?
- Brief history of options pricing models
- Examples: Black-Scholes-Merton, Binomial, Bjerksund-Stensland
- Applications:
  - Implied volatility
  - P/L forecasting
  - Option Greeks
  - Limitations of research

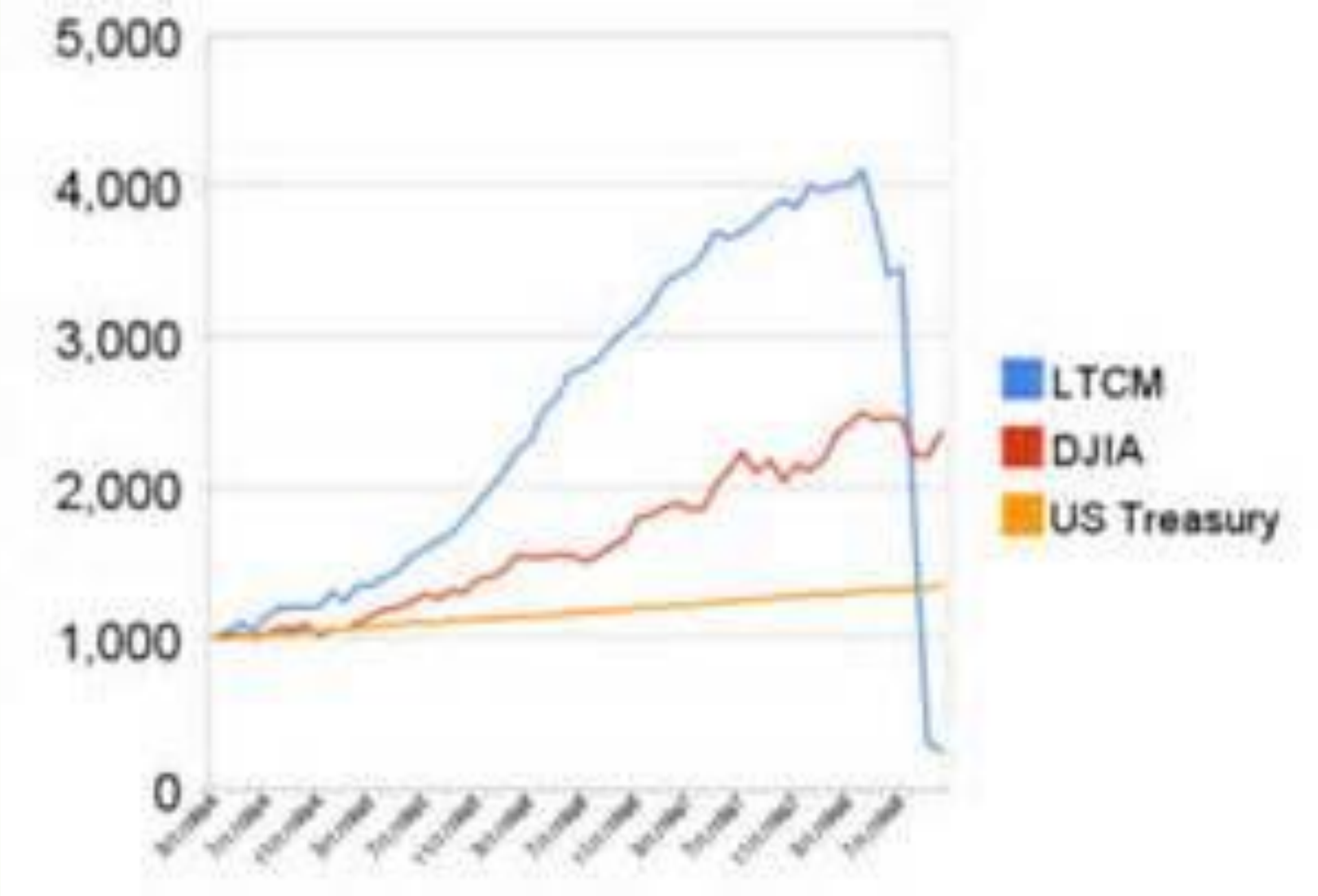
Why should we care about pricing models? Do they have any relation to practice?

- There's no way to avoid a model of some kind when doing any of the following:
  - Using implied volatility in any way
  - P/L forecasting for any trading strategy that you're not holding all the way to expiry
  - Using the option "Greeks" in any way
  - Understanding the limitations of any research you read on options trading

Brief history of option pricing models?

- 1900: Louis Bachelier uses the normal distribution and Brownian motion to model stock prices on the Paris stock exchange ("Random walk")
- 1960's: US economists, notably Nobel prize-winner Paul Samuelson, resurrect Bachelier's work and try apply it to the problem of pricing options and warrants.
- 1973: Myron Scholes, Fischer Black and Robert Merton provide the final breakthrough with **"risk-neutral" pricing**. They rely on work by Japanese mathematician Kiyosi Ito to solve their equation.
- Scholes and Merton were awarded the Nobel prize in economics in 1996, which was followed soon afterwards by …


THE RISE AND FALL OF
LONG-TERM CAPITAL MANAGEMENT
WHEN GENIUS FAILED
NATIONAL BESTSELLER
"Story-telling journalism at its best."
—The Economist
ROGER LOWENSTEIN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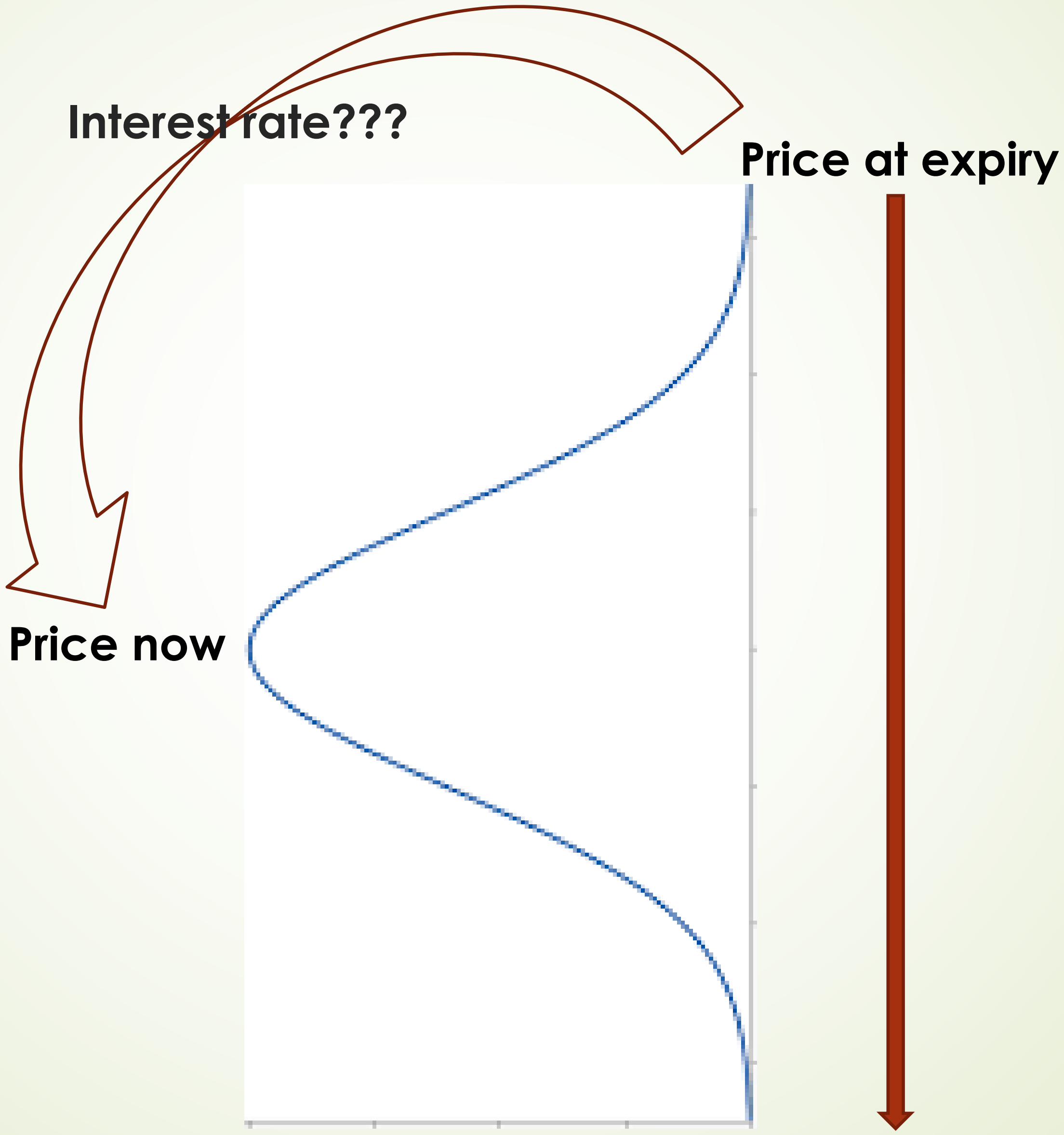
LTCM
DJIA
US Treasury

State of affairs at the end of the 1960's



The Black-Scholes-Merton solution

- Don't price the option directly, price hedged portfolio of option and stock.
- Infer option price by subtracting out the price of the stock.
- Procedure does NOT require us to know the rate of return on the option. We can use the T-bill rate for pricing.
- Cost: makes it harder to infer the probabilities of stock price being above a particular level in the future

In other words … replace this:

$$Price = \frac{p_1 V_1 + p_2 V_2 + \cdots + p_N V_N}{Option\ return}$$

… with this:

$$Price = \frac{p_1^* V_1 + p_2^* V_2 + \cdots + p_N^* V_N}{T - bill\ rate}$$

Black-Scholes-Merton

$$Call = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

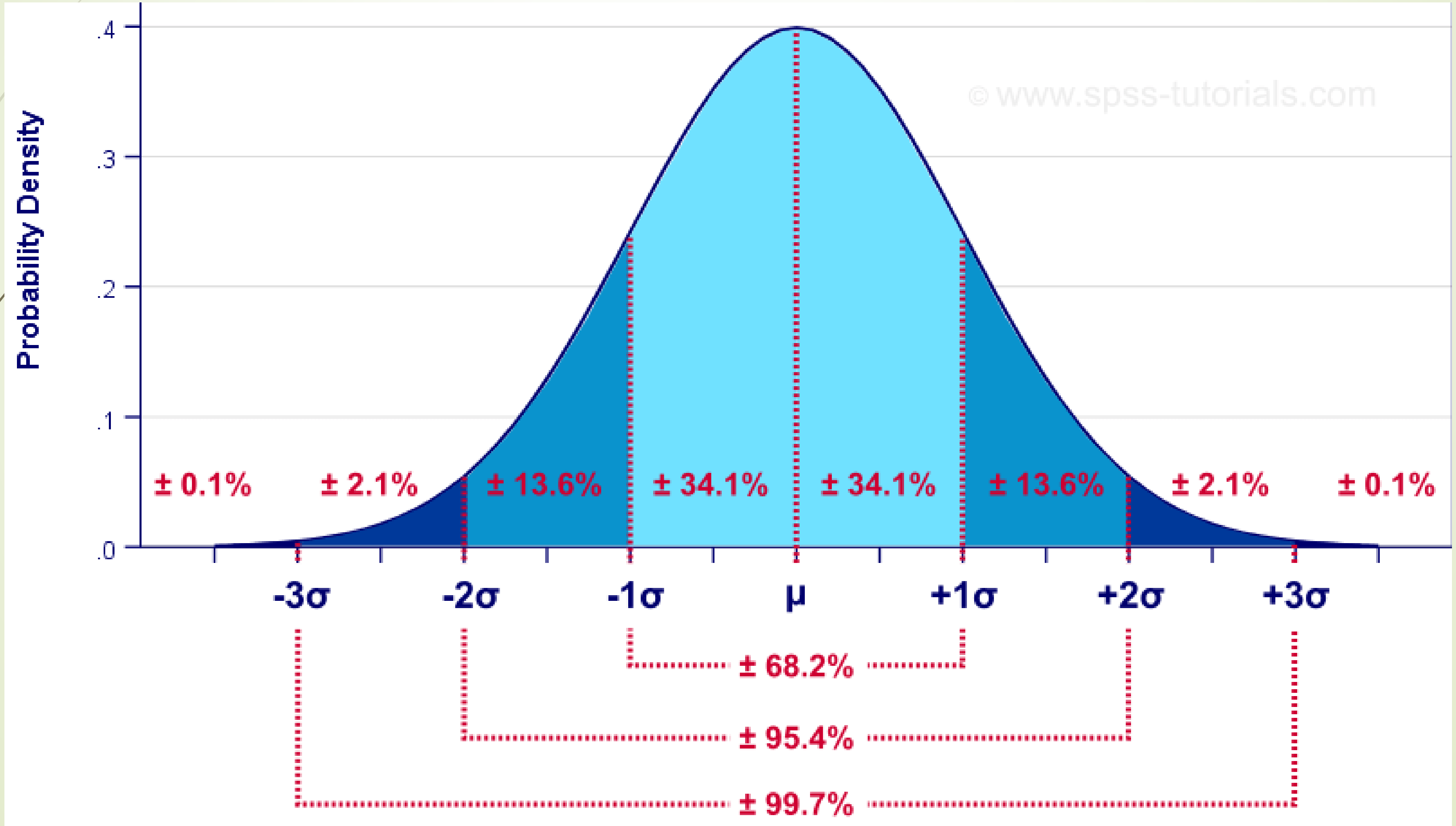
$$Put = Ke^{-rT} N(-d_2) - S_0 N(-d_1)$$

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

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

Normal distribution

$$Z - score = \frac{x - \mu}{\sigma}$$



Black-Scholes-Merton

Z-score

$$Call = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

$$Put = Ke^{-rT} N(-d_2) - S_0 N(-d_1)$$

X

μ

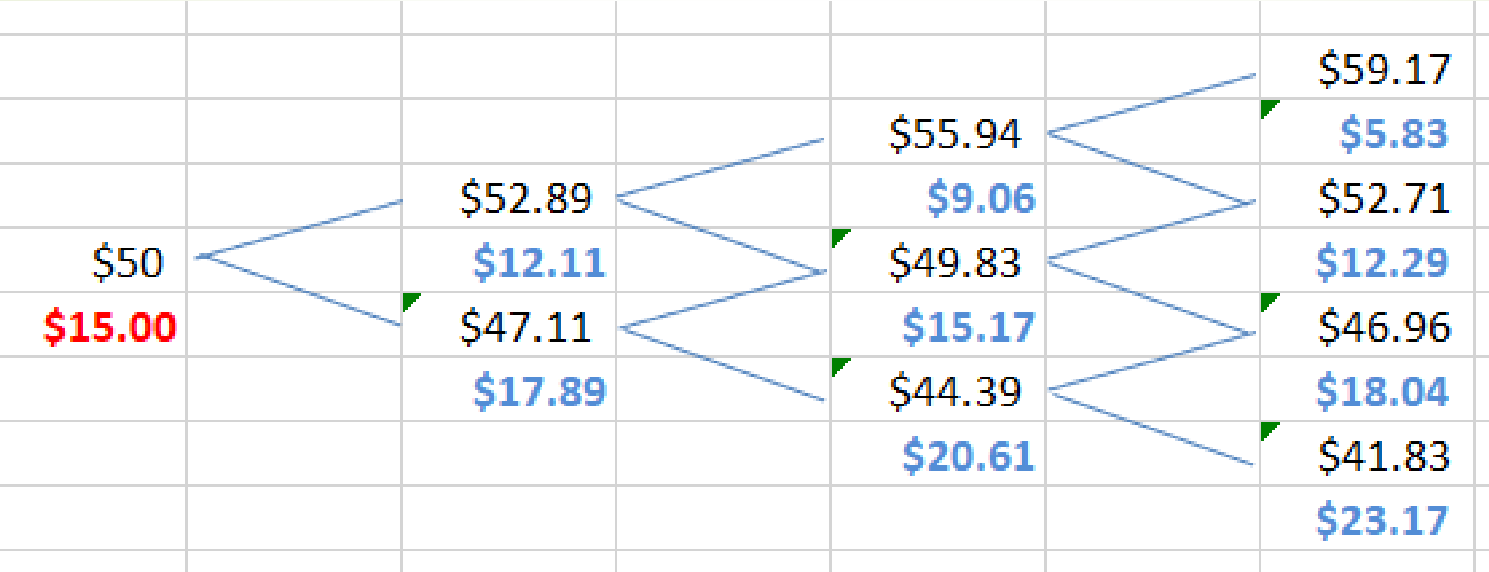
$$d_1 = \frac{In(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

σ

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

Binomial

- Use of branches, tree structure to map out future stock prices.
- Same assumptions as Black-Scholes-Merton, but easier to see. Discrete model, not continuous like BSM.
- Easier to “tweak” the model to include non-standard provisions.
- Gives the same answer as BSM if you use a large number of ‘steps’ in the setup.



Bjerksund-Stensland

- Simulates early exercise of options.
- For example, value of exercising a call option before a dividend payment.

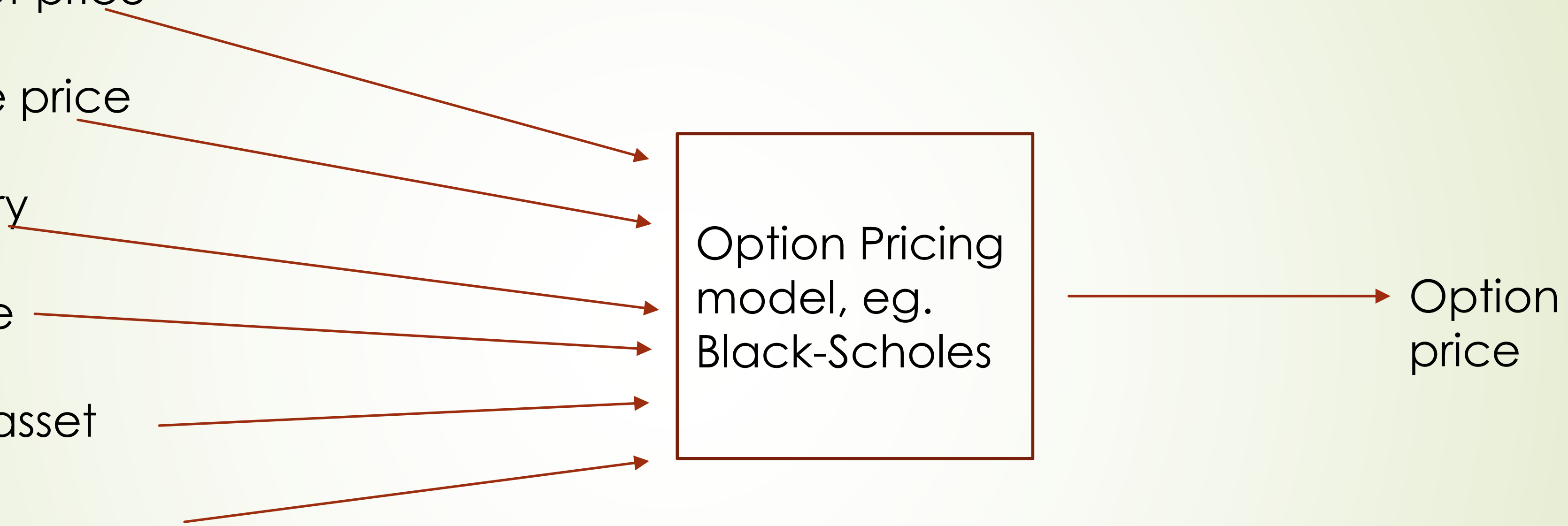
Summary of models

- They all assume a normal distribution of returns in the underlying asset
  - This is very rarely true in reality
- You can't actually infer the probability of any price level directly from the models, although some things are reasonable approximations
- You can't actually replicate the trading strategy used to derive the models (although this was never the intention of the research!)
- All models require an estimate of future volatility. This is unobservable! (and the answers from the models are only as good as your estimate of volatility)

Applications

- Implied volatility
  - This is obtained from running the market price of the option back through a model
  - In other words, it's the level of volatility which makes the model price match the market price
  - Model relies on assumption of normal distribution and symmetry in the returns of the stock/index. The market does not.
  - This is why we get volatility smiles/skew

- Current asset price
- Option strike price
- Option expiry
- Risk-free rate
- Volatility of asset price
- Income (dividends etc.)



- ☺ Current asset price
- ☺ Option strike price
- ☺ Option expiry
- ☺ Risk-free rate
- ☹ Volatility of asset price
- ? Income (dividends etc.)

→ Option Pricing model, eg. Black-Scholes → Option price

- ☺ Current asset price
- ☺ Option strike price
- ☺ Option expiry
- ☺ Risk-free rate
- ☺ Option price
- ? Income (dividends etc.)

→ Option Pricing model, eg. Black-Scholes

→ Volatility of asset price

S&P 500 index implied volatility for 16th October

33.02%

15.22%

These can't both be true!

Applications

- P/L forecasting
  - Charts for P/L on the expiry date are relatively well known…
  - …but, how do we know how the trade will unfold before the expiry date
  - We have to use a model to project the possible future values

(See analysis on ThinkOrSwim, for example)

Applications

- Option Greeks
  - Greeks are all derived from option pricing models
  - Be careful with interpretation:
    - Many of the Greeks are non-linear
    - The Greeks are static, assume nothing else changes
    - Some are used incorrectly in practice:
      - Example: use of delta as an indication of how likely the option is to finish in-the-money (over-estimates the likelihood significantly for OTM calls)
      - Two problems:
        - this is a model value (i.e. an estimate)
        - In BSM, delta is *not* actually the probability of the option finishing in-the-money

Option Greeks

ategy... | Trade | Get Quote | P&L Calc | Clear Selections | Expand all | Collapse all

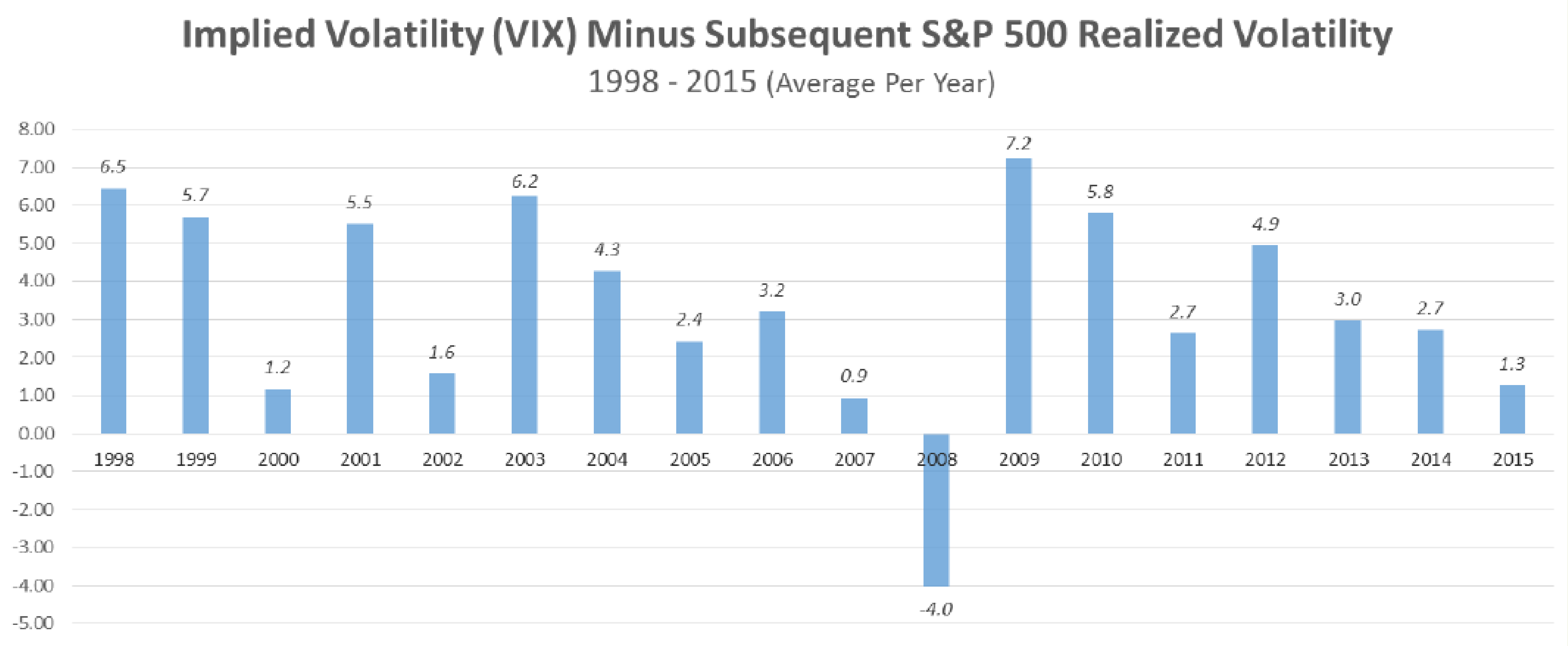
Symbol	Description	Qty	Price	Market Value	Implied Vol.	Delta	Gamma	Theta	Vega	Option Reqs.
AMZN	**Amazon.Com Inc**	—	**$3,401.80**	—	**Position Totals:**	**76.98**	**0.03**	**-111.12**	**638.54**	0
AMZN Call	AMZN Jan 15 2021 2860.00 Call	1	$703.30	$70,330.00	47.84%	76.98	0.03	-111.12	638.54	
NFLX	**Netflix Com Inc**	—	**$523.89**	—	**Position Totals:**	**288.72**	**-4.14**	**421.42**	**560.44**	0
NFLX Call	NFLX Sep 04 2020 550.00 Call	-9	$5.37	-$4,833.00	53.54%	-229.90	-7.87	866.42	-198.73	
NFLX Call	NFLX Oct 16 2020 530.00 Call	10	$39.11	$39,110.00	56.11%	518.62	3.73	-445.00	759.17	

Applications

- Limitations of research
  - Many simulations will assume options are priced by a particular model
  - In practice, many of the variables are unstable

- Volatility risk premium
  - What is the correct interpretation??
  - Does the market "over-price" volatility, or is this just model imprecision?

Volatility risk premium



Conclusion

- I certainly use datapoints such as implied volatility, the Greeks etc…
- …but, important to know where these numbers are coming from and therefore what the limitations are (based on the assumptions underlying them)