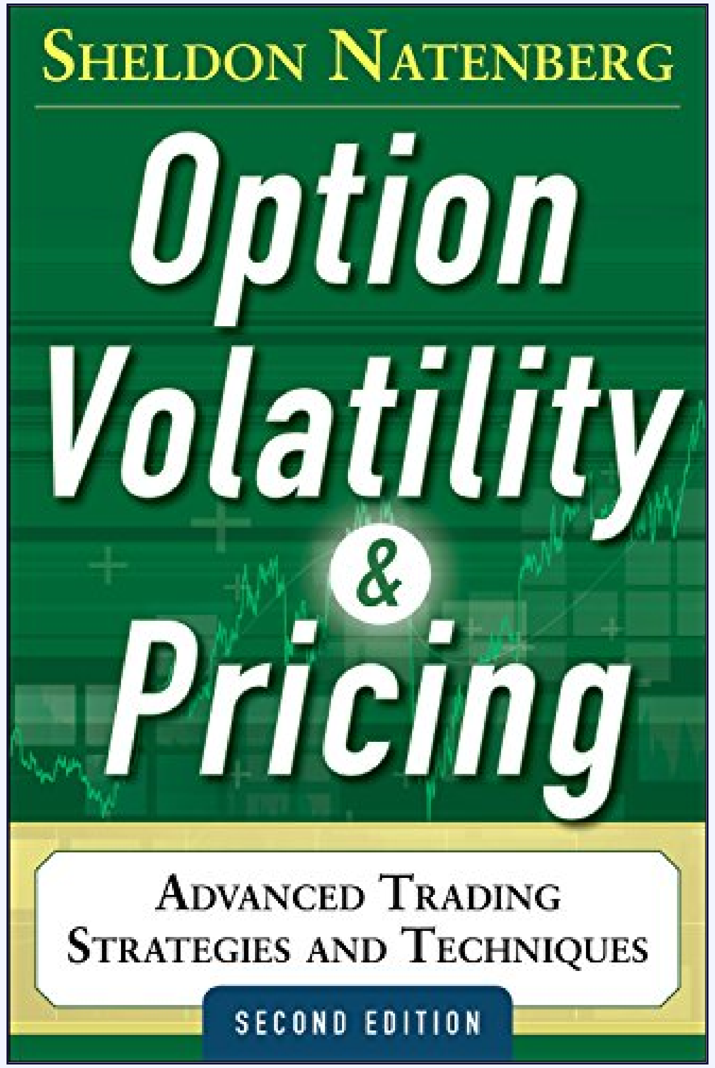
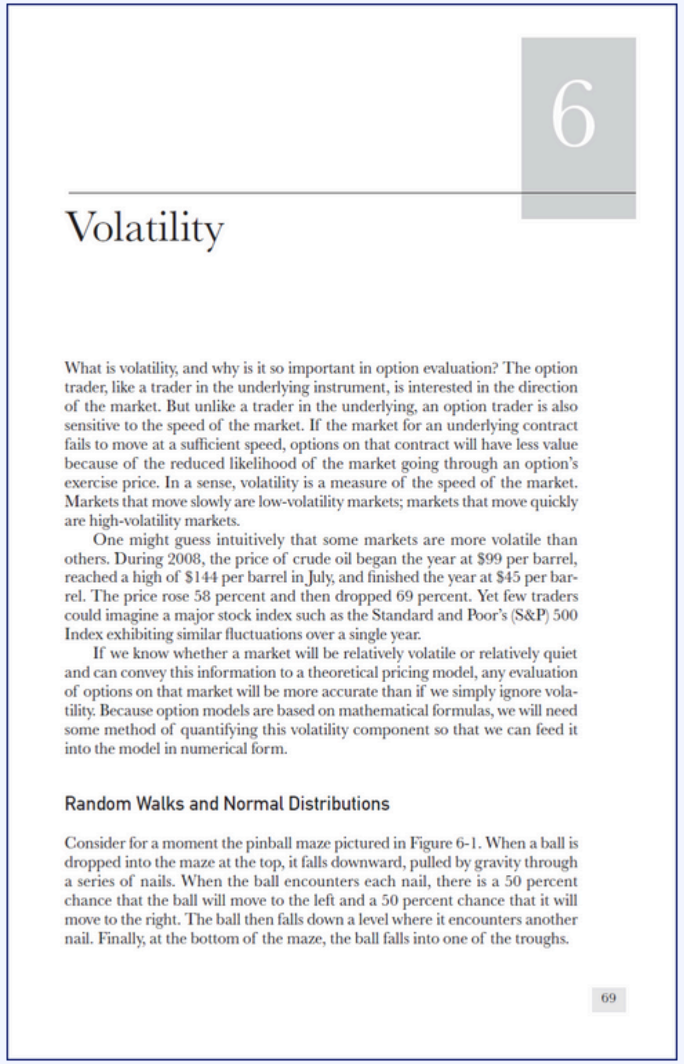
VolSignals

VolStudies

VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility





6

Volatility

What is volatility, and why is it so important in option evaluation? The option trader, like a trader in the underlying instrument, is interested in the direction of the market. But unlike a trader in the underlying, an option trader is also sensitive to the speed of the market. If the market for an underlying contract fails to move at a sufficient speed, options on that contract will have less value because of the reduced likelihood of the market going through an option's exercise price. In a sense, volatility is a measure of the speed of the market. Markets that move slowly are low-volatility markets; markets that move quickly are high-volatility markets.

One might guess intuitively that some markets are more volatile than others. During 2008, the price of crude oil began the year at $99 per barrel, reached a high of $144 per barrel in July, and finished the year at $45 per barrel. The price rose 58 percent and then dropped 69 percent. Yet few traders could imagine a major stock index such as the Standard and Poor's (S&P) 500 Index exhibiting similar fluctuations over a single year.

If we know whether a market will be relatively volatile or relatively quiet and can convey this information to a theoretical pricing model, any evaluation of options on that market will be more accurate than if we simply ignore volatility. Because option models are based on mathematical formulas, we will need some method of quantifying this volatility component so that we can feed it into the model in numerical form.

Random Walks and Normal Distributions

Consider for a moment the pinball maze pictured in Figure 6-1. When a ball is dropped into the maze at the top, it falls downward, pulled by gravity through a series of nails. When the ball encounters each nail, there is a 50 percent chance that the ball will move to the left and a 50 percent chance that it will move to the right. The ball then falls down a level where it encounters another nail. Finally, at the bottom of the maze, the ball falls into one of the troughs.

69

VolSignals

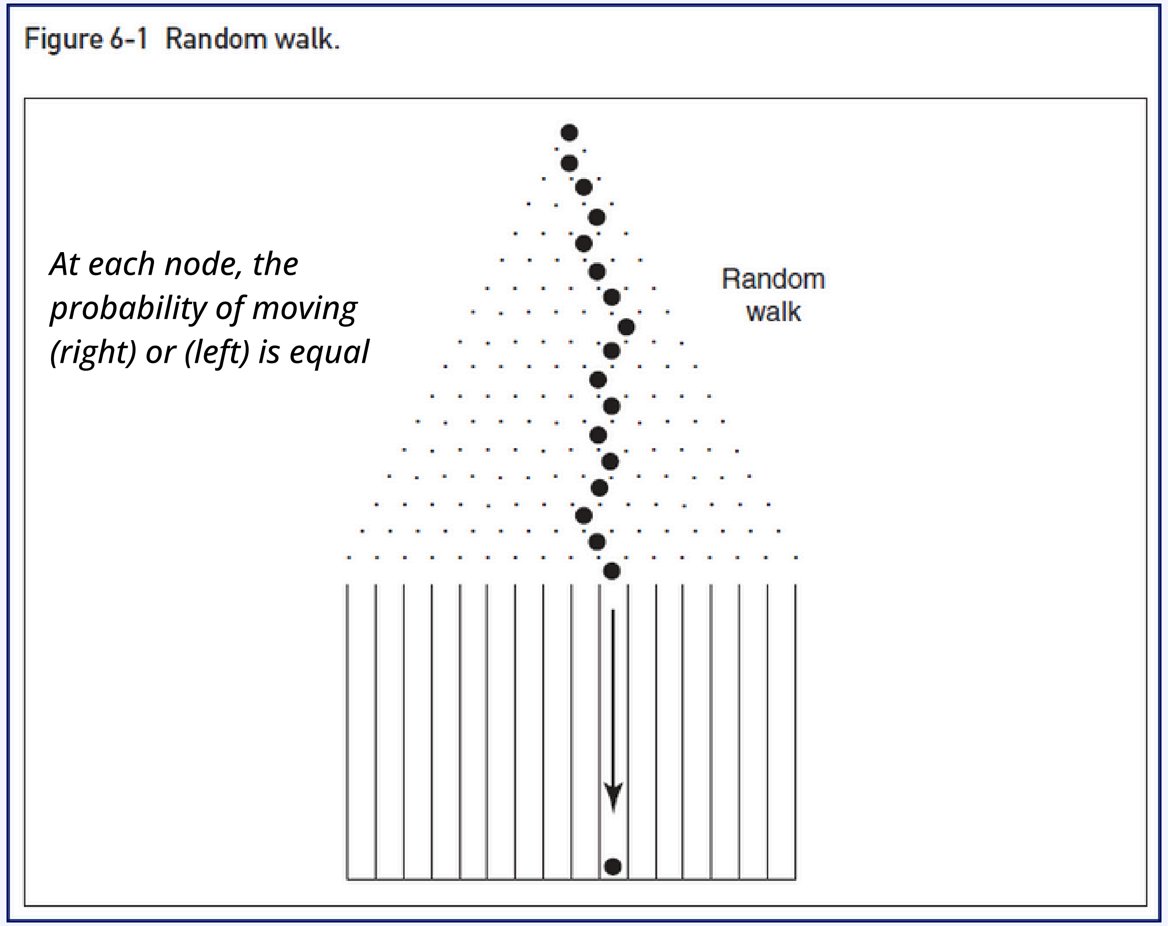
VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

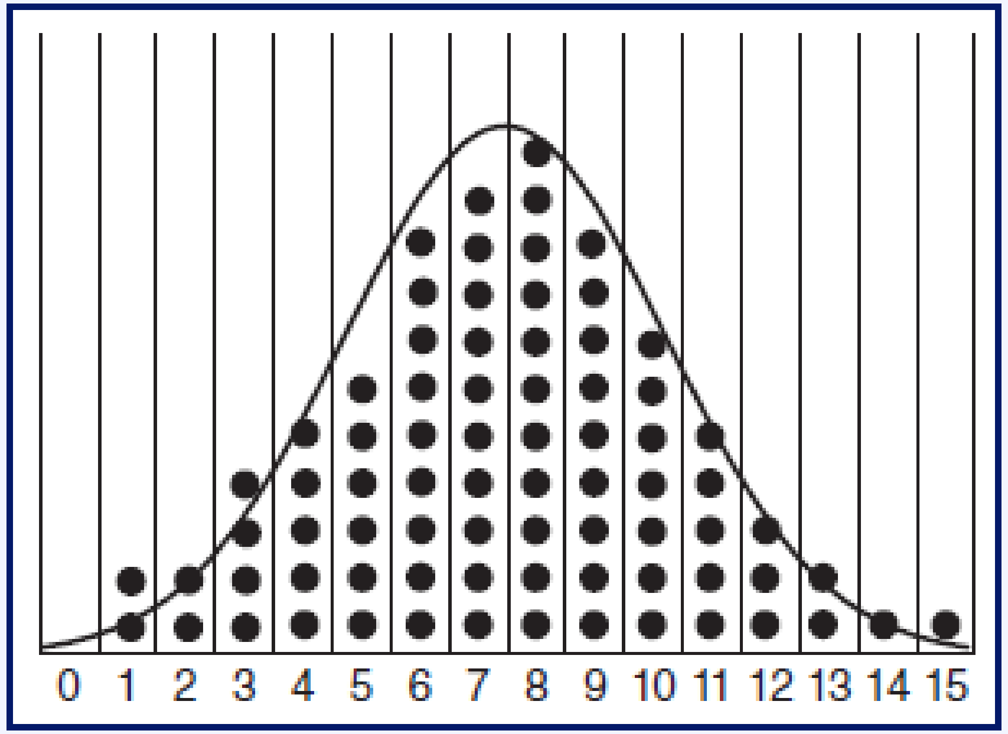
- Random Walks and Normal Distributions
- Mean and Standard Deviation
- Forward Price as the Mean of a Distribution
- Volatility as a Standard Deviation
- Scaling Volatility for Time
- Volatility and Observed Price Changes
- A Note on Interest-Rate Products
- Lognormal Distributions
- Interpreting Volatility Data

VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

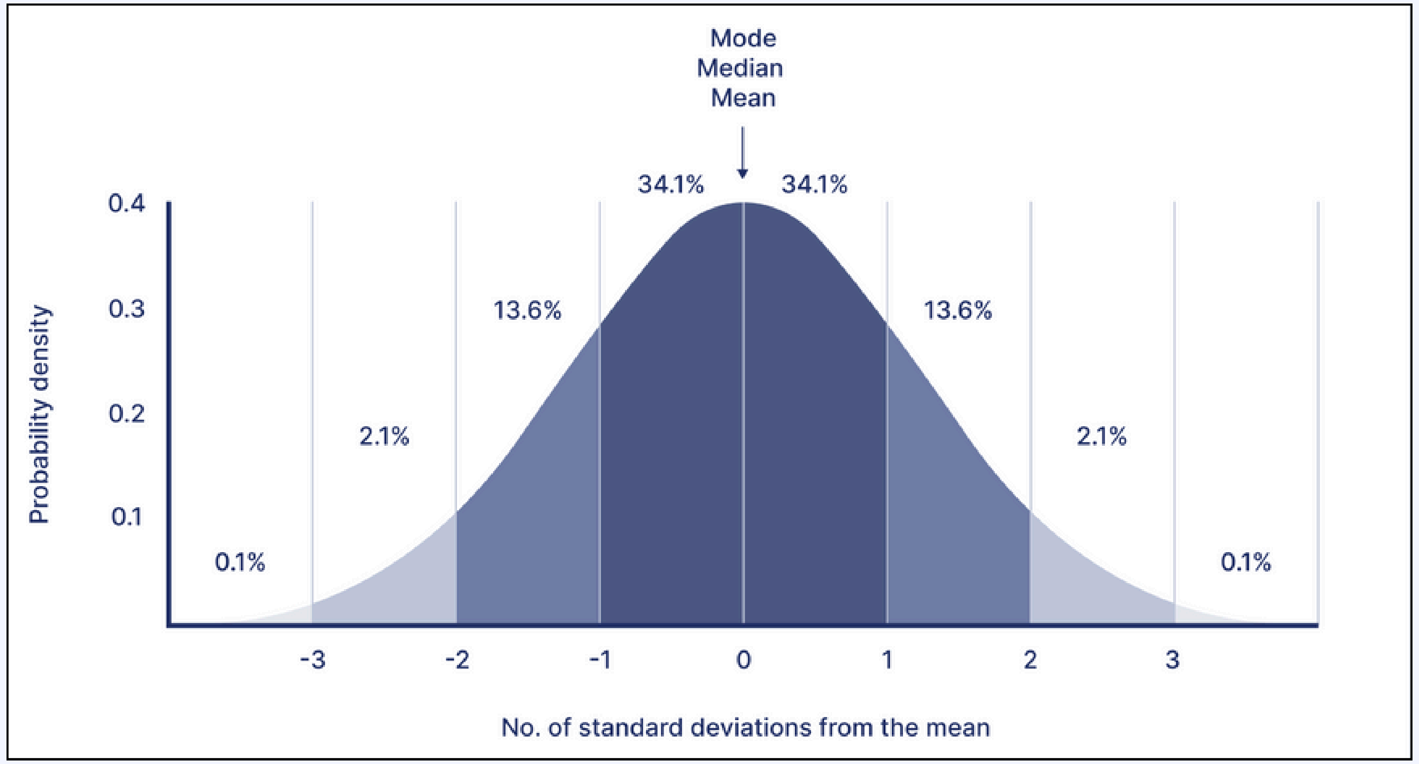


Random walks produce normal distributions…



- *Normal distributions are symmetrical*
- *Described by mean & standard deviation*
- *Mean = price (or forward)*
- *Standard Deviation = volatility*

Standard Normal Distribution: Mean & Standard Deviation

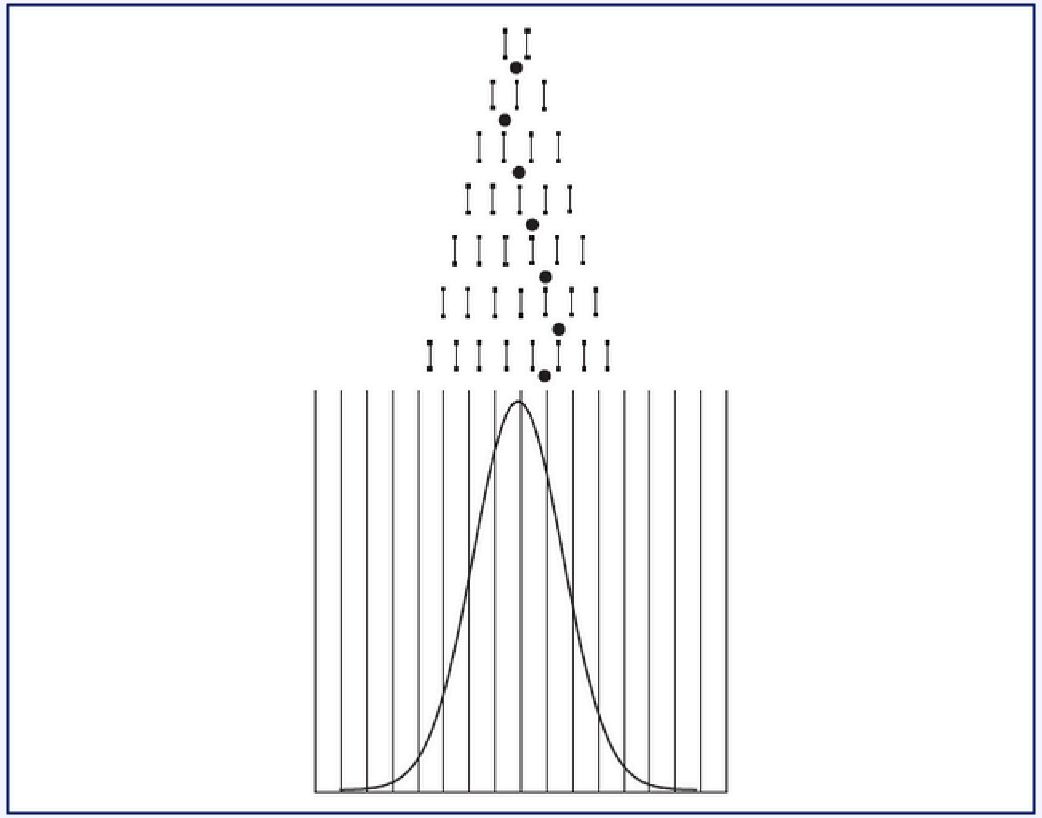


The mean, median and mode are equal- and exist in the center of the distribution.

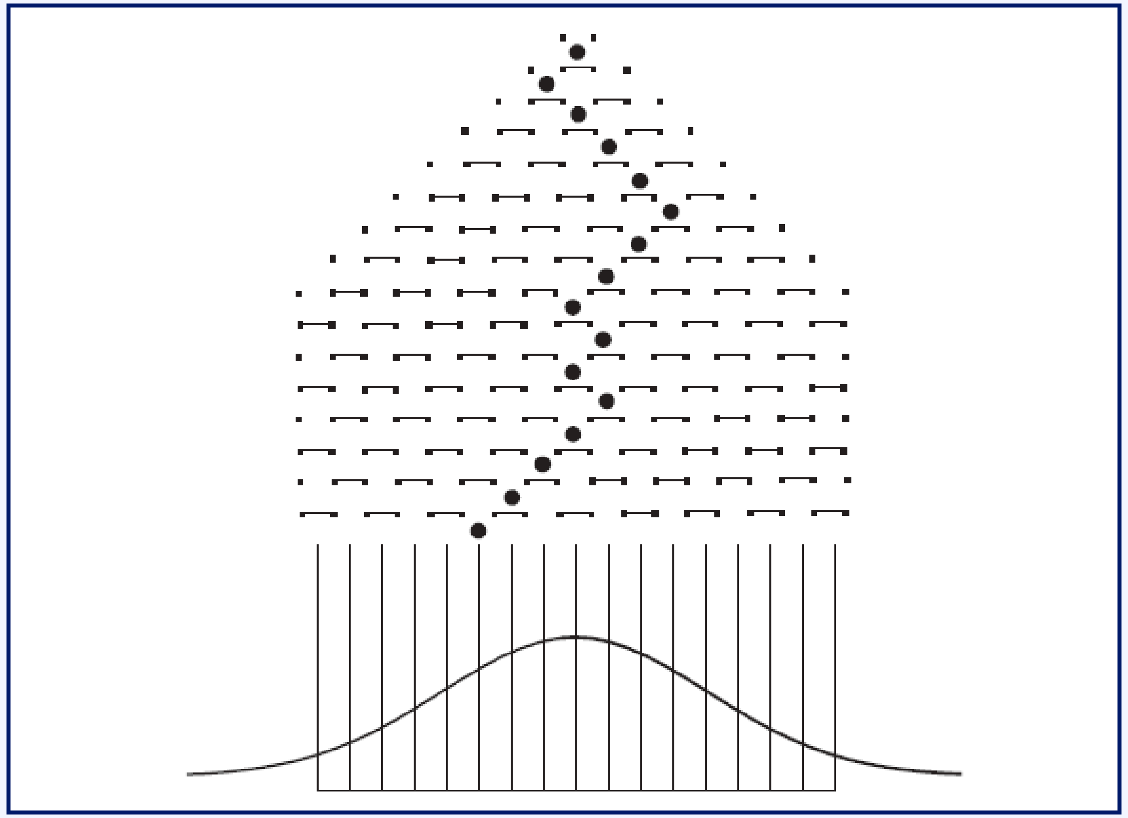
VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

Visualizing different distributions…



Low Volatility

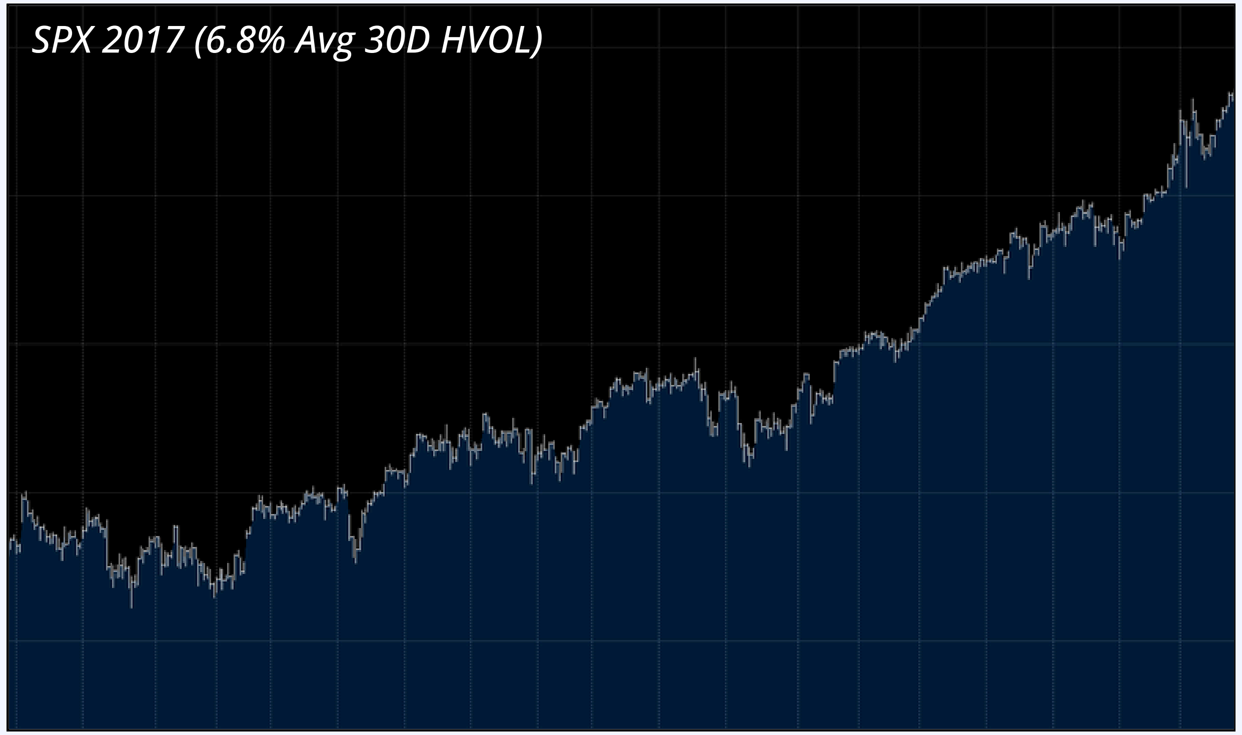


High Volatility

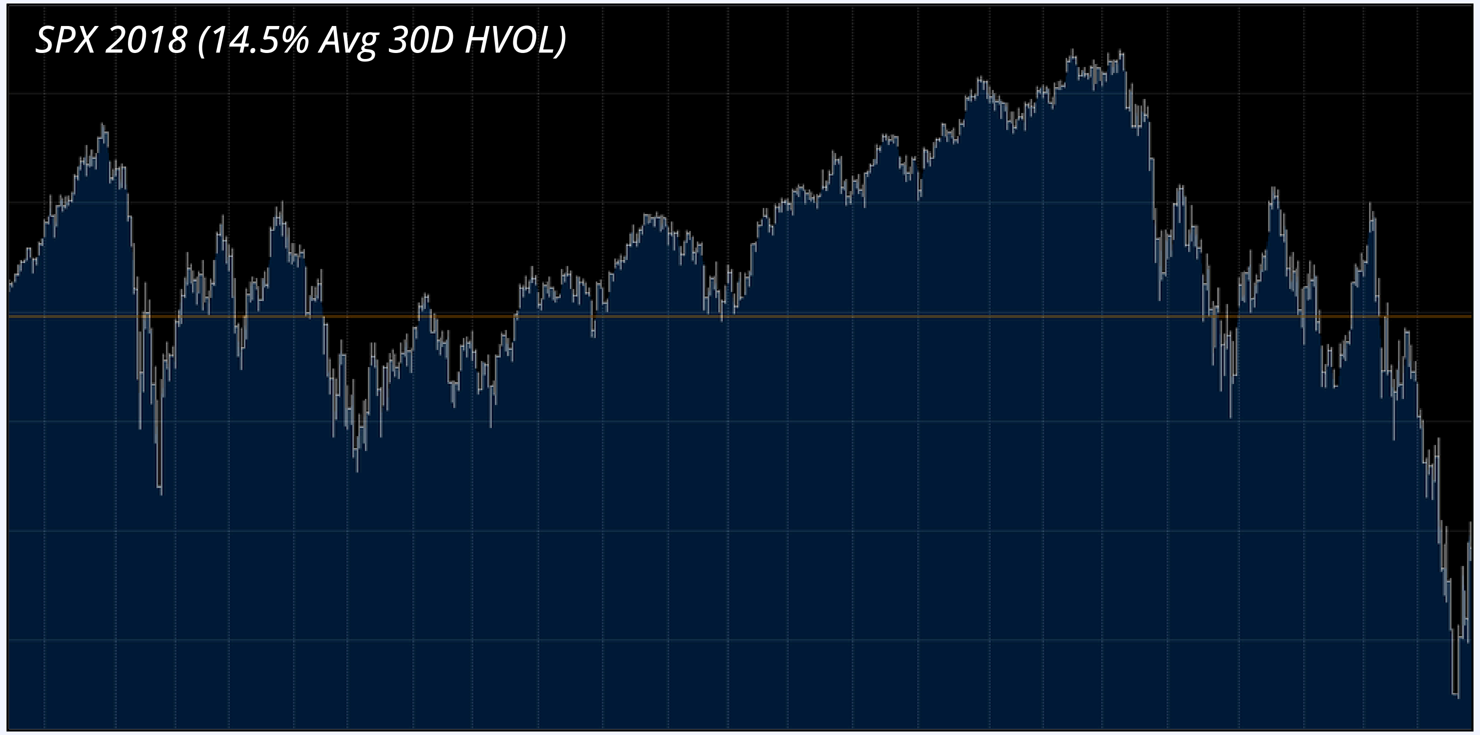
VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

Visualizing different distributions…



Low Volatility

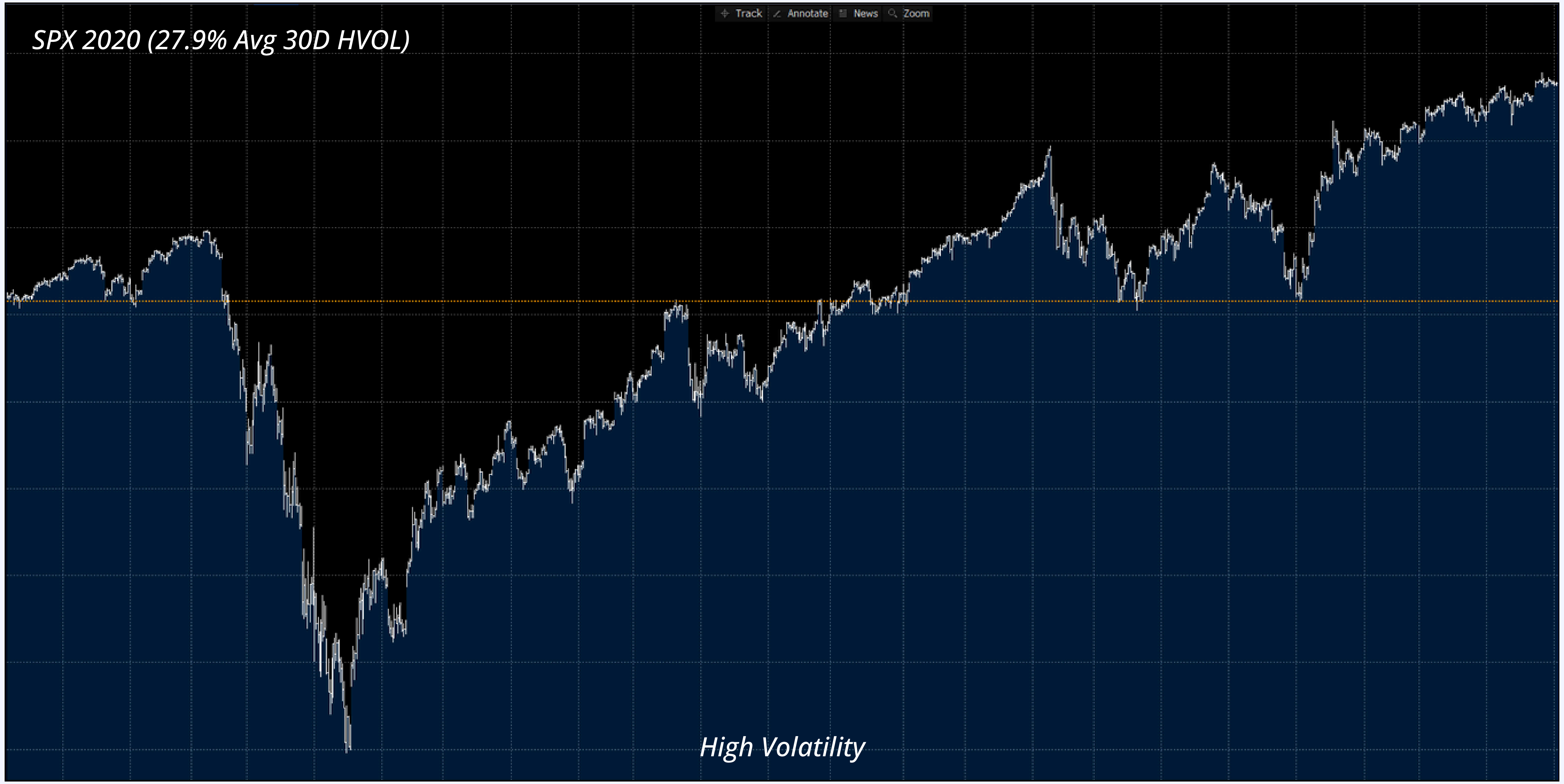


"Average" Volatility

VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

Visualizing different distributions...



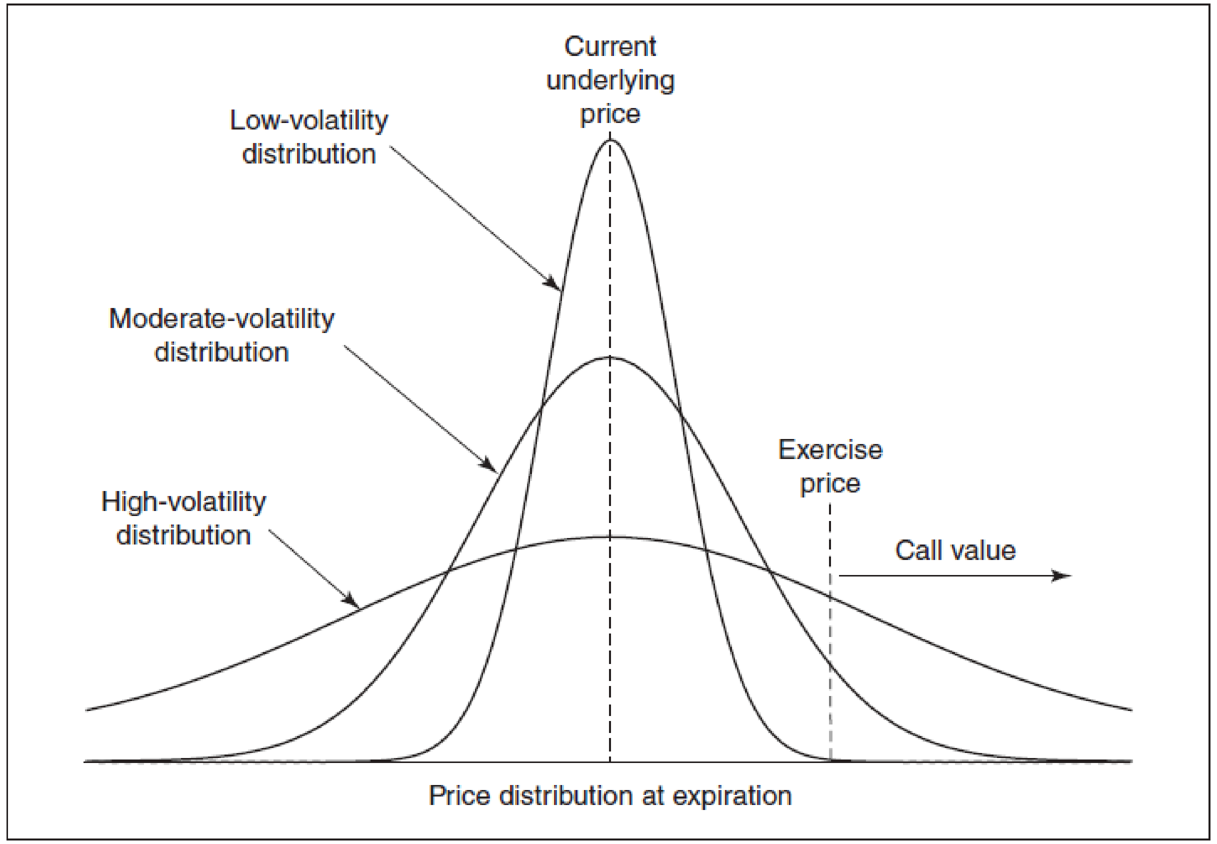
VolSignals

VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

From distributions to dollars…

Figure 6-5



Higher volatility = wider distribution of terminal outcomes

As volatility increases, the range of possible prices at expiration grows…

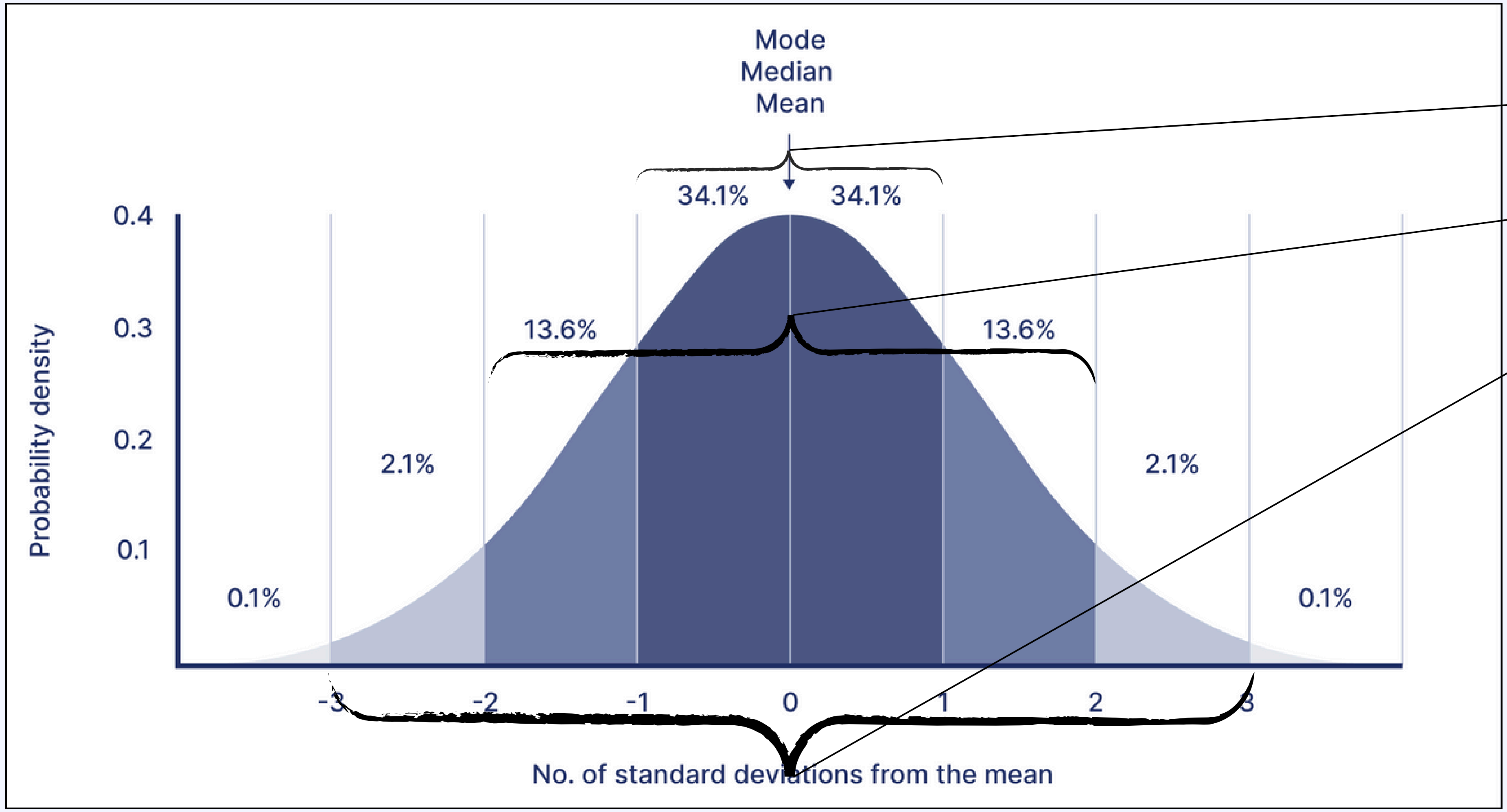
Options on every strike become more valuable, since expected payoffs grow in both

- *magnitude (distance from mean) and*
- *frequency (proportion of "in-the-money" outcomes)*

VolStudies | Option Volatility & Pricing

Chapter 6 — Volatility

***Mean** and **Standard Deviation** describe normal distributions.*
Recall…



Given a standard normal distribution-

- *~68.3% of all outcomes fall within 1 SD of the mean*
- *~95.4% of all outcomes fall within 2 SD of the mean*
- *~99.7% of all outcomes fall within 3 SD of the mean*

Standard deviations are additive

- *The mean of a distribution is the forward price (no arb).*
- *The standard deviation is the volatility (σ)**
  - *σ = 1 st. dev price change (%) over 1y (annualized)*

VolSignals

Scaling Volatility for Time...

Volatility (σ) is always going to be an annualized number in our context (like an interest rate).

While interest rates are proportional to time...

...volatility is proportional to the square root of time.

$$\sigma_t = \sigma_{annual} \times \sqrt{t}$$

$$\text{Volatility}_{\text{daily}} = \text{volatility}_{\text{annual}} \times \sqrt{1/256} = \text{volatility}_{\text{annual}} \times 1/16 = \frac{\text{volatility}_{\text{annual}}}{16}$$

Example approximating the number of trading days in a year to back into an implied daily 1SD change

Volatility and Observed Price Changes…

Have you ever heard anyone refer to "vol performing" or "underperforming"?

*Implied volatility levels can be used to evaluate an option's *performance**

Previously, we estimated that for a $45 stock with an annual volatility of 37 percent, a one standard deviation price change is approximately $1.04. Suppose that over five days we observe the following daily settlement price changes:

+$0.98, –$0.65, –$0.70, +$0.25, –$0.85

Are these price changes consistent with a 37 percent volatility?

Lognormal Distributions…

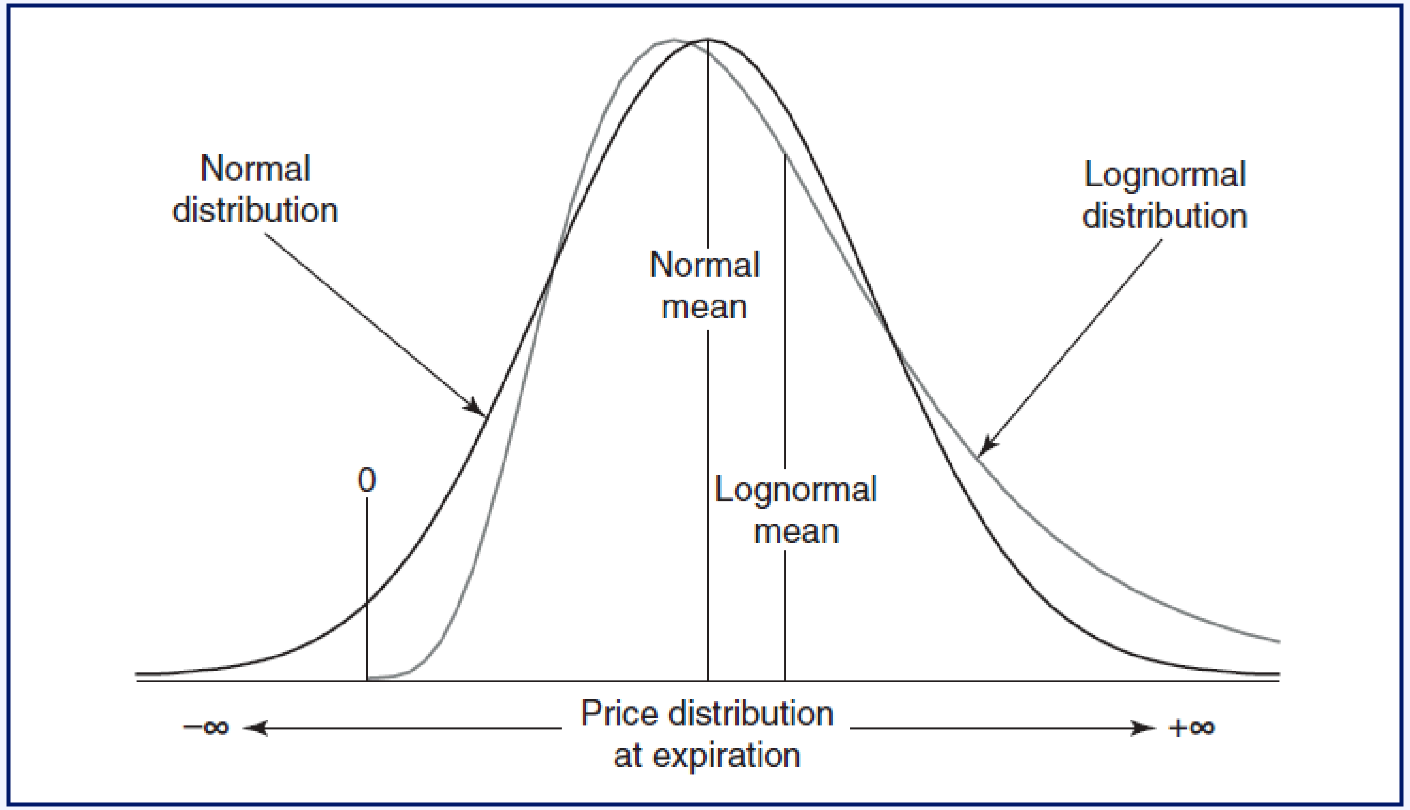
Black Scholes is a "continuous time" model,
*compounding both UP and DOWN percentage changes to the asset **continuously** at the **annualized volatility***

*When these changes are normally distributed, this produces a **lognormal distribution…***

Skew emerges-

Greater right tail than left
(0-boundary vs. compounding)

Mean is now to the right of the peak
(mode)



Lognormal Distributions…

Contract	Value if Price Distribution Is Normal	Value if Price Distribution Is Lognormal
90 put	4.37	4.00
110 call	4.37	4.74

…is this consistent with observed option pricing?

Chapter 6 — Volatility

Interpreting Volatility…

Realized Volatility (RV, RVOL, "Realized Vol", HVOL, "Historical Vol")
…is the annualized standard deviation of percent price changes of an underlying contract over some period of time (usually logarithmic price changes)

Realized Volatility should specify both the interval & number of intervals

- *30-Day Historical Volatility | Interval = Daily, #Intervals = 30*
- *52-Week realized vol | Interval = Weekly, #Intervals = 52*

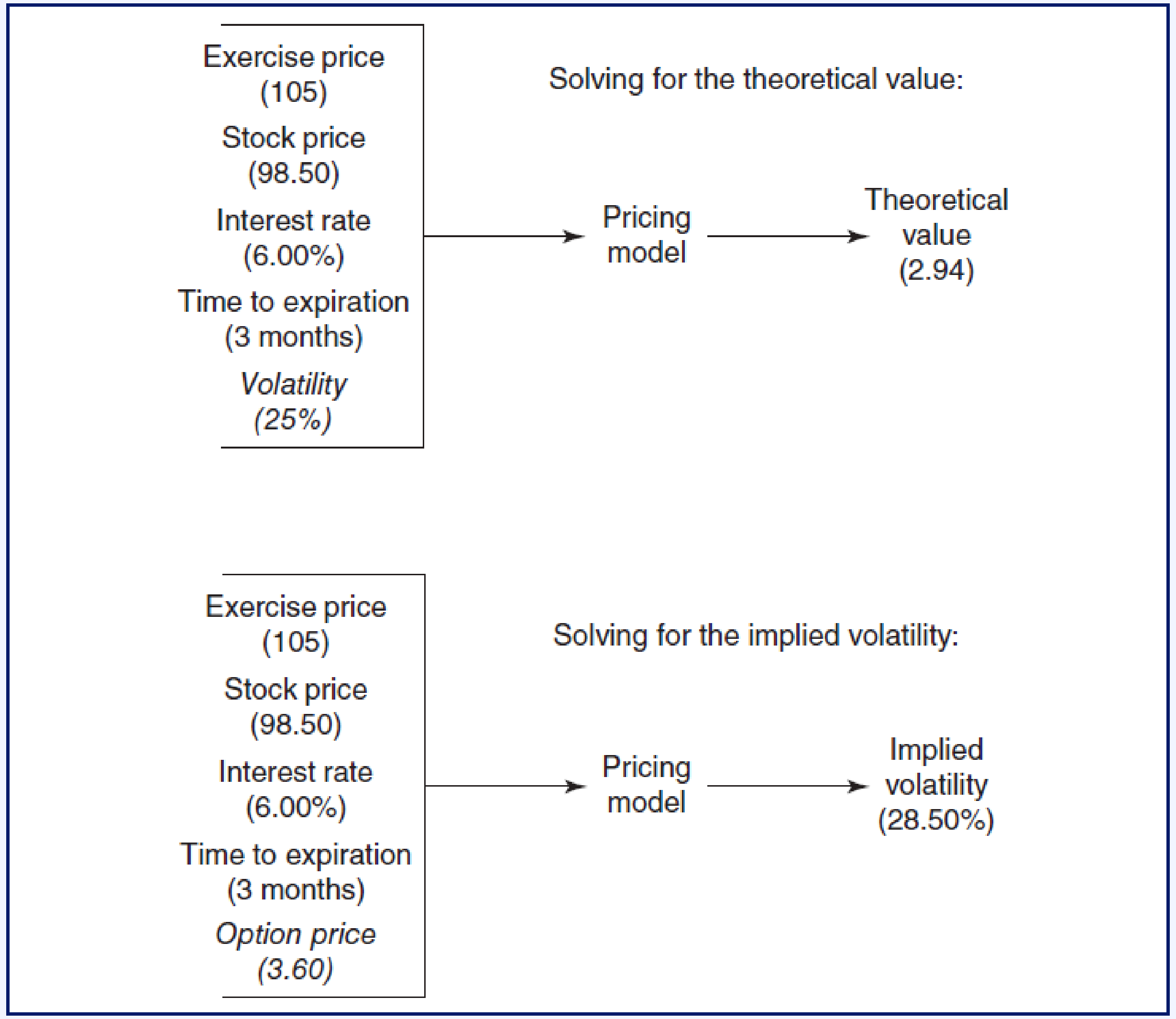
Implied Volatility (IV, IVOL, "Implied Vol", "vol")
…is derived from (or "backed out of") the market price of an option, and represents what the equilibrium expectation is for the future realized volatility of that option over its life.

This is how MMs price options in practice…

Every option price (especially traded price) is ***information***

Start with actual observations and use interpolation to "fill in" the volatility surface…

"Easy" in deep, liquid, & (especially) transparent markets.
Not so easy when the market is illiquid- and trading is your only real source of information



On Changes in Implied Volatility…

Greatest "dollar for dollar" change is always AT-THE-MONEY (peak Vega)

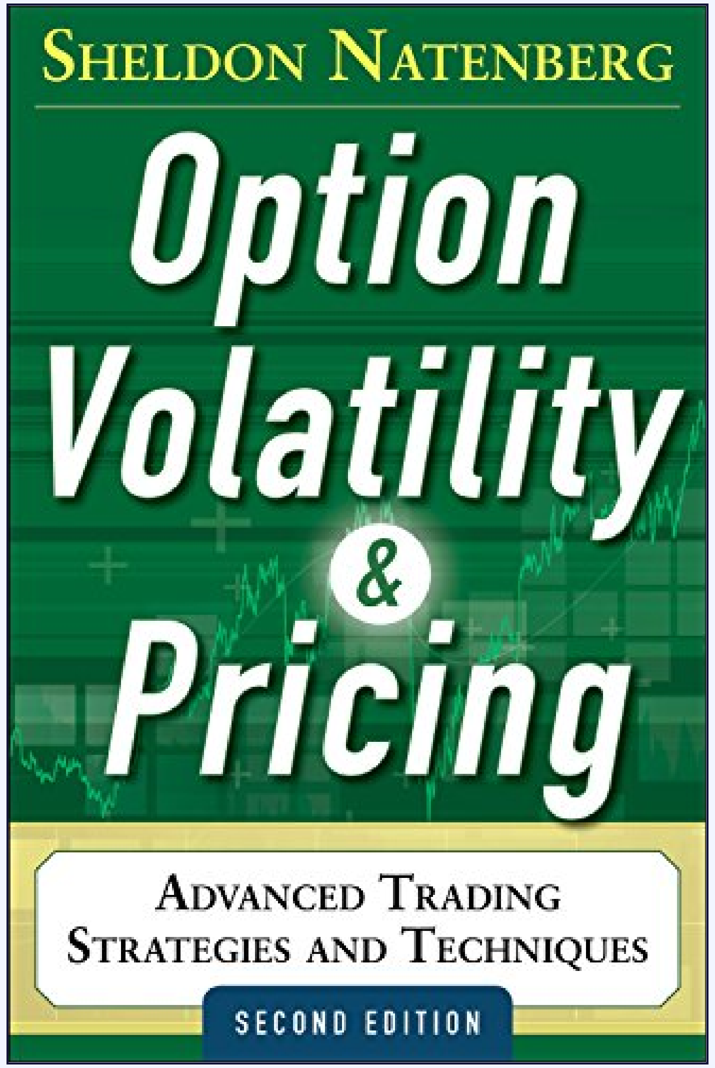
Greatest "percentage" change happens with OUT-OF-THE-MONEY options

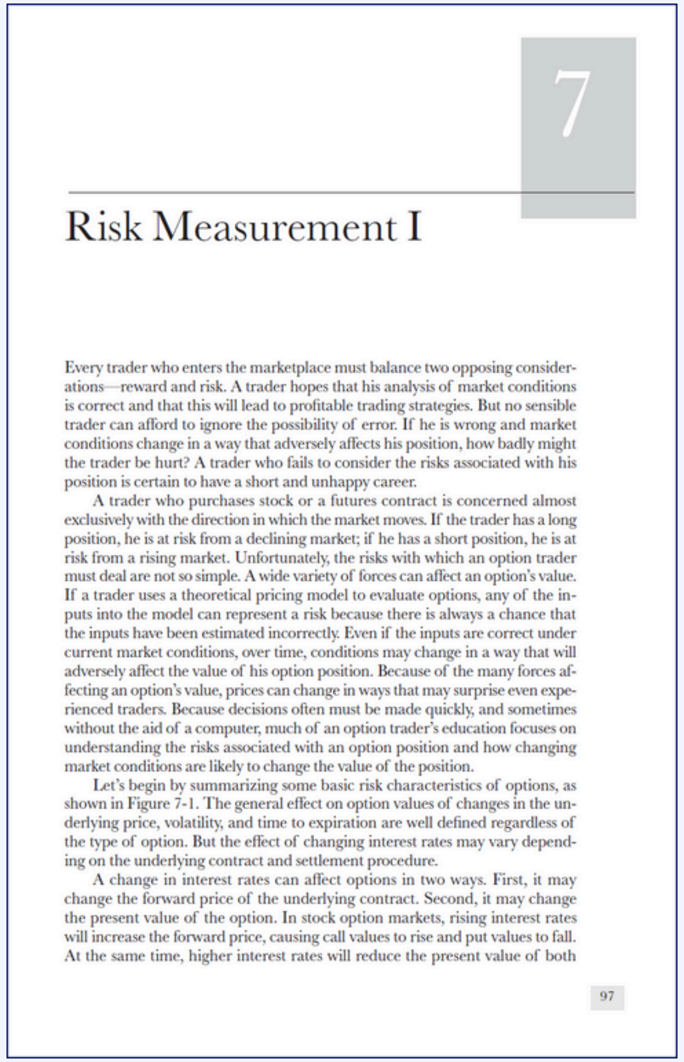
This is mostly a function of premiums, as Natenberg explains it
The smaller denominator is the main point behind Natenberg's explanation- but I'd caution against this line of thought… why?

Implied Volatility changes have greater impacts on longer-dated options

VolStudies | Option Volatility & Pricing

Next up...





7

Risk Measurement I

Every trader who enters the marketplace must balance two opposing considerations—reward and risk. A trader hopes that his analysis of market conditions is correct and that this will lead to profitable trading strategies. But no sensible trader can afford to ignore the possibility of error. If he is wrong and market conditions change in a way that adversely affects his position, how badly might the trader be hurt? A trader who fails to consider the risks associated with his position is certain to have a short and unhappy career.

A trader who purchases stock or a futures contract is concerned almost exclusively with the direction in which the market moves. If the trader has a long position, he is at risk from a declining market; if he has a short position, he is at risk from a rising market. Unfortunately, the risks with which an option trader must deal are not so simple. A wide variety of forces can affect an option's value. If a trader uses a theoretical pricing model to evaluate options, any of the inputs into the model can represent a risk because there is always a chance that the inputs have been estimated incorrectly. Even if the inputs are correct under current market conditions, over time, conditions may change in a way that will adversely affect the value of his option position. Because of the many forces affecting an option's value, prices can change in ways that may surprise even experienced traders. Because decisions often must be made quickly, and sometimes without the aid of a computer, much of an option trader's education focuses on understanding the risks associated with an option position and how changing market conditions are likely to change the value of the position.

Let's begin by summarizing some basic risk characteristics of options, as shown in Figure 7-1. The general effect on option values of changes in the underlying price, volatility, and time to expiration are well defined regardless of the type of option. But the effect of changing interest rates may vary depending on the underlying contract and settlement procedure.

A change in interest rates can affect options in two ways. First, it may change the forward price of the underlying contract. Second, it may change the present value of the option. In stock option markets, rising interest rates will increase the forward price, causing call values to rise and put values to fall. At the same time, higher interest rates will reduce the present value of both

97

Chapter 7 — Risk Measurement I

VOLSIGNALS

VolSignals

VolStudies