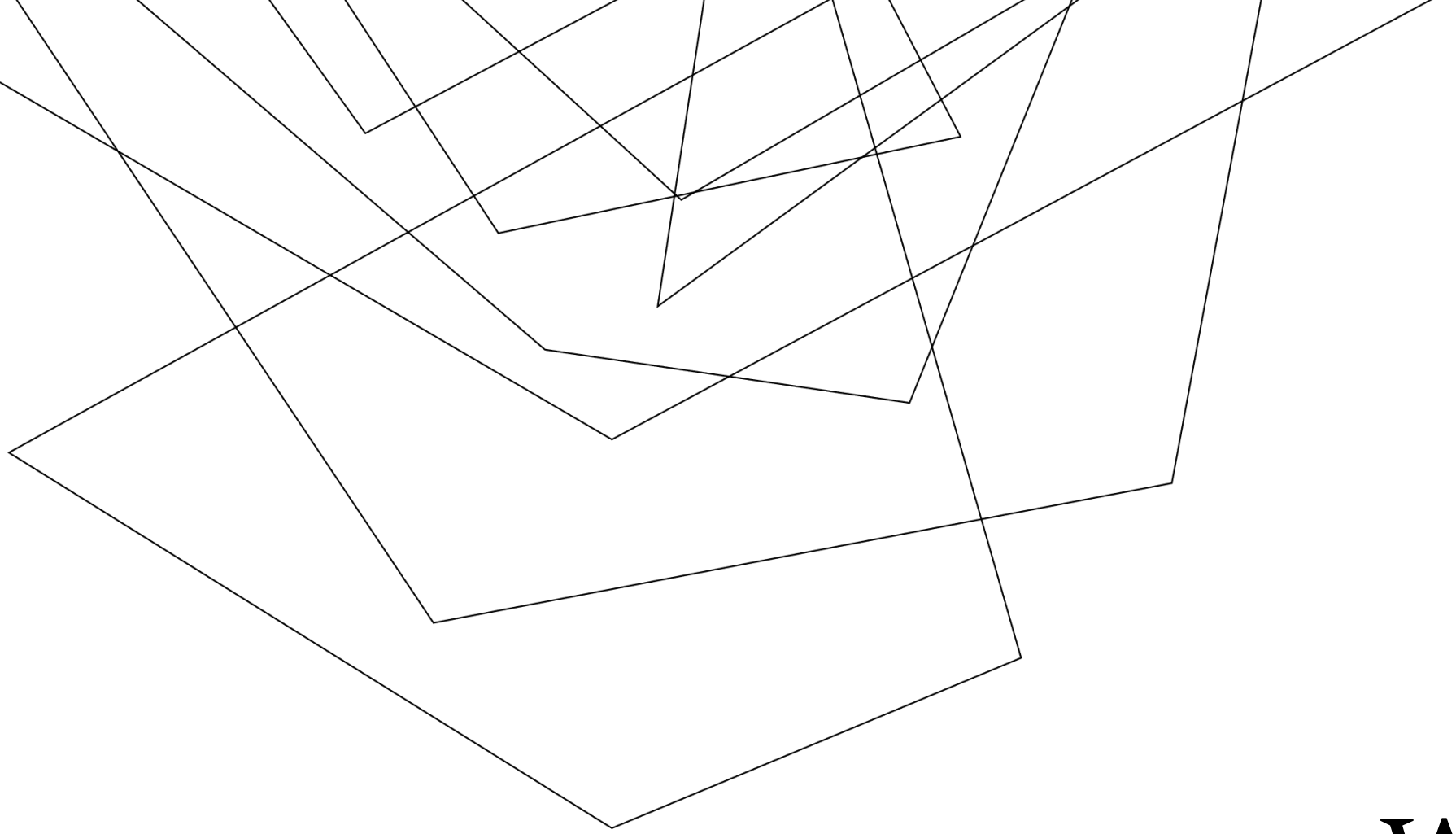

CWRU Quants
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Welcome!
Please, have a seat.

Agenda

Intro to Volatility

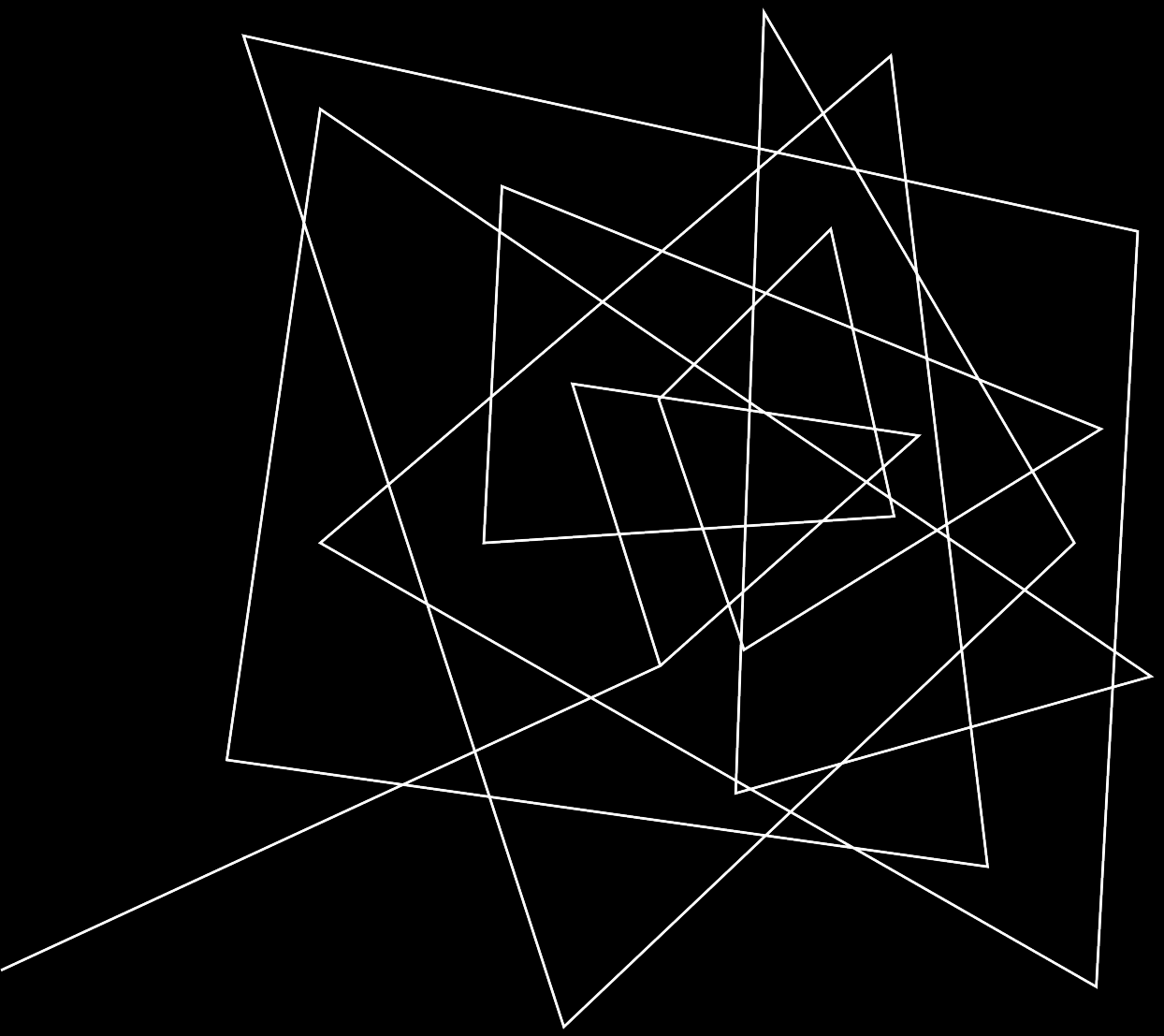
“Implied” Volatility

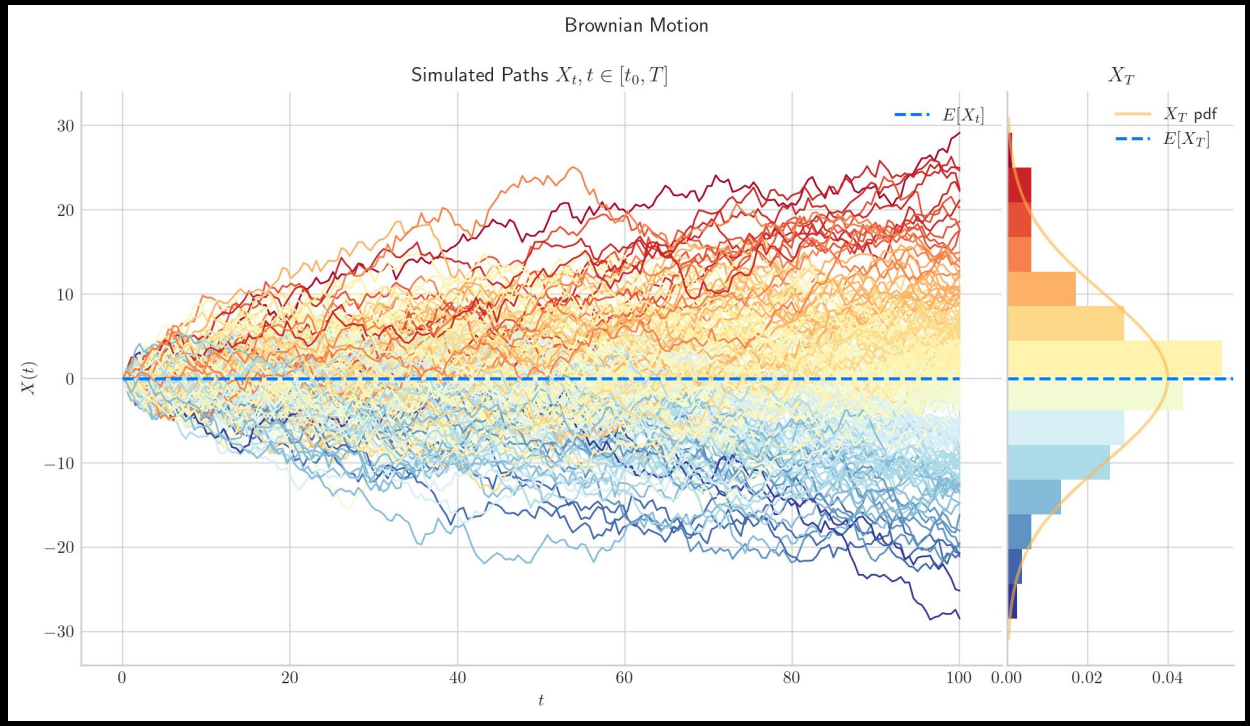
Volatility Risk Premia

Volatility Activity

Attendance | CampusGroups

Intro to Volatility

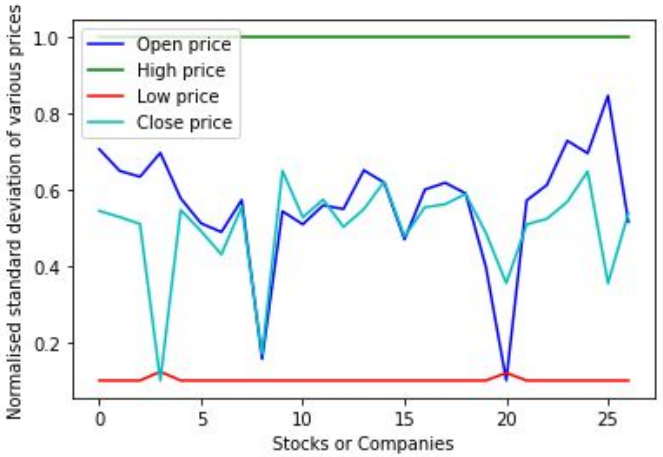




volatility (**n**)**:** Volatility often refers to the amount of uncertainty or risk related to the size of changes in a security's value. Volatility represents how greatly an asset's prices swing around the mean price. *(Investopedia)*

What is volatility?

- Volatility in finance measures the rate at which the price of an asset, such as a stock or commodity, fluctuates over time.



Why is volatility important?

- Helps investors and portfolio managers gauge the risk associated with an asset. Assets with higher volatility are typically considered riskier, as they have larger price swings.

Applications of volatility?

- **Risk Management:** Portfolio managers use volatility measures to determine Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR), which estimate potential losses.
- **Hedging:** Investors can hedge against adverse price movements. For example, an investor may buy a put option to offset potential losses if the underlying asset becomes more volatile.

How is volatility measured?

- From a statistical perspective, volatility can be measured as the standard deviation of logarithmic returns over a time period.
- Using standard deviation as a measure of volatility requires the implicit assumption that stock returns are **normally distributed** – we'll get to that later
- There are different types of volatility, but they all are speaking the same language – they all tell you something about the standard deviation of log returns

$$\sigma = \sqrt{\frac{\Sigma(x_i - \mu)^2}{N}}$$

σ = Standard Deviation

N = Number of Trading Days

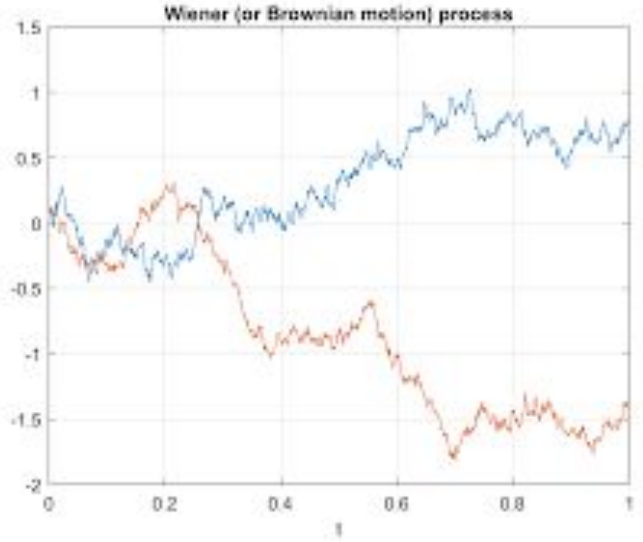
x_i = Daily Stock Price

μ = Mean of Prices

What does this look like?

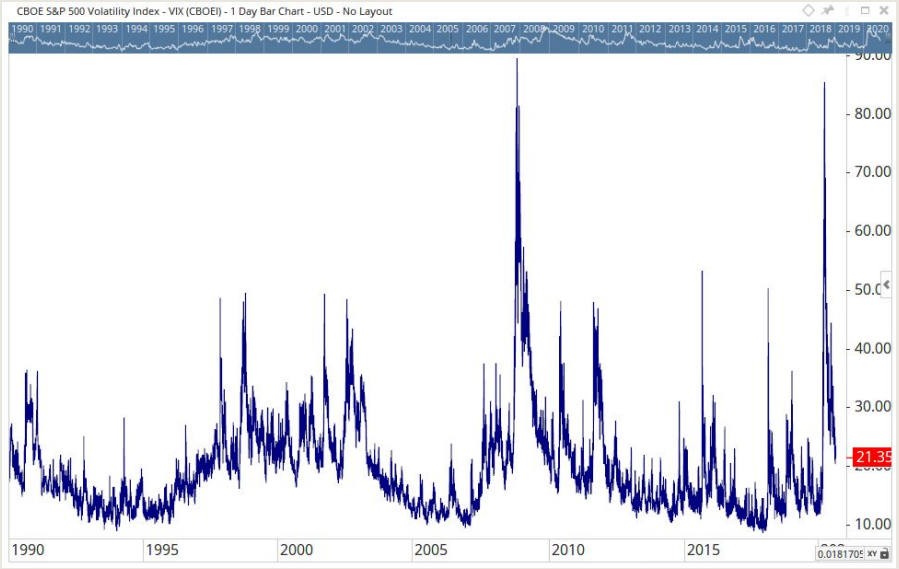
Wiener Processes

- The Wiener process is a continuous-time stochastic process often used to model the price action of securities
- For every point on the chart, points in the future will differ by a normally-distributed value, where the variance of the distribution comes from how far in the future that point is
- This comes from the concept of Brownian motion, which sees widespread use across the field of applied mathematics

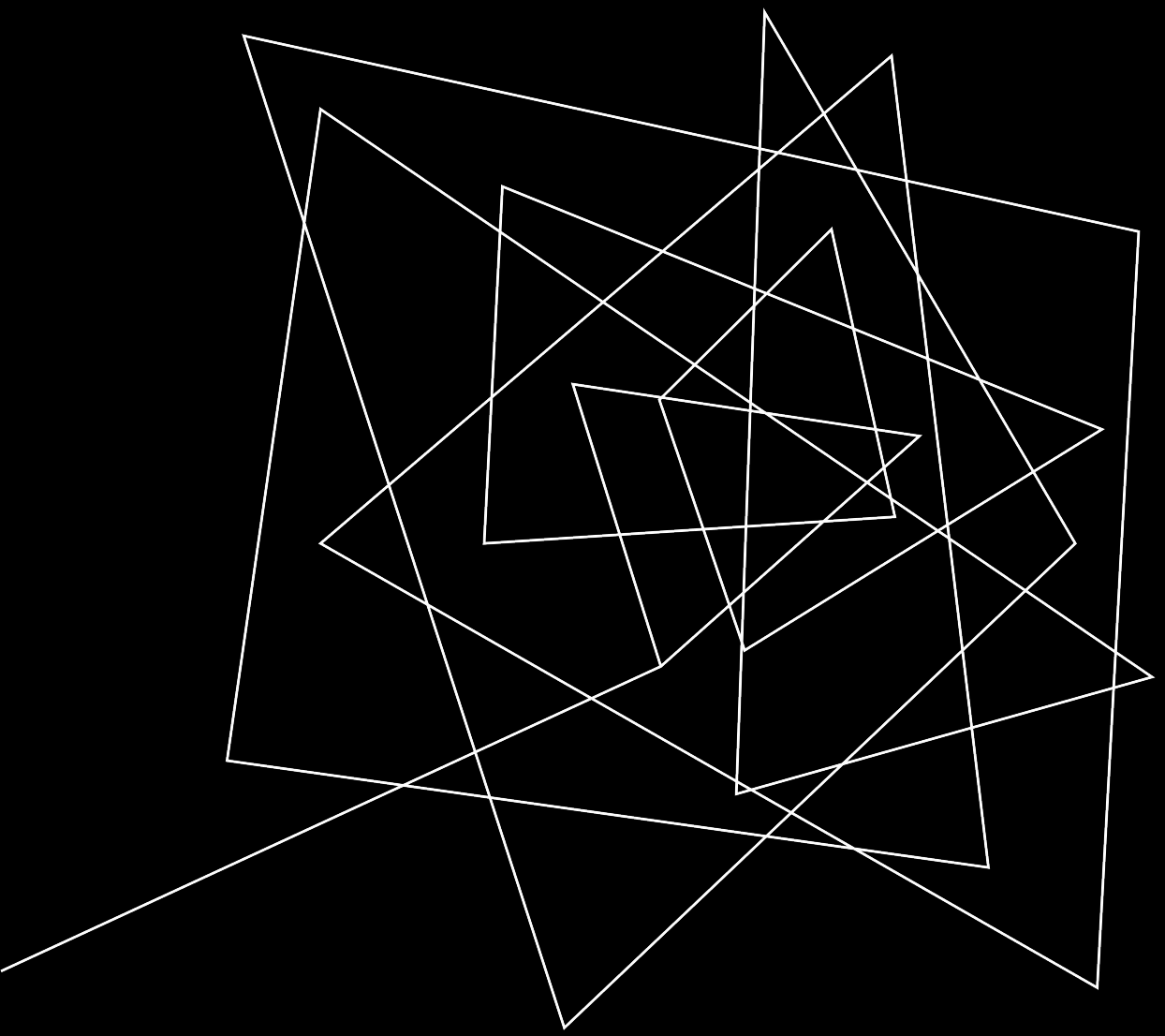


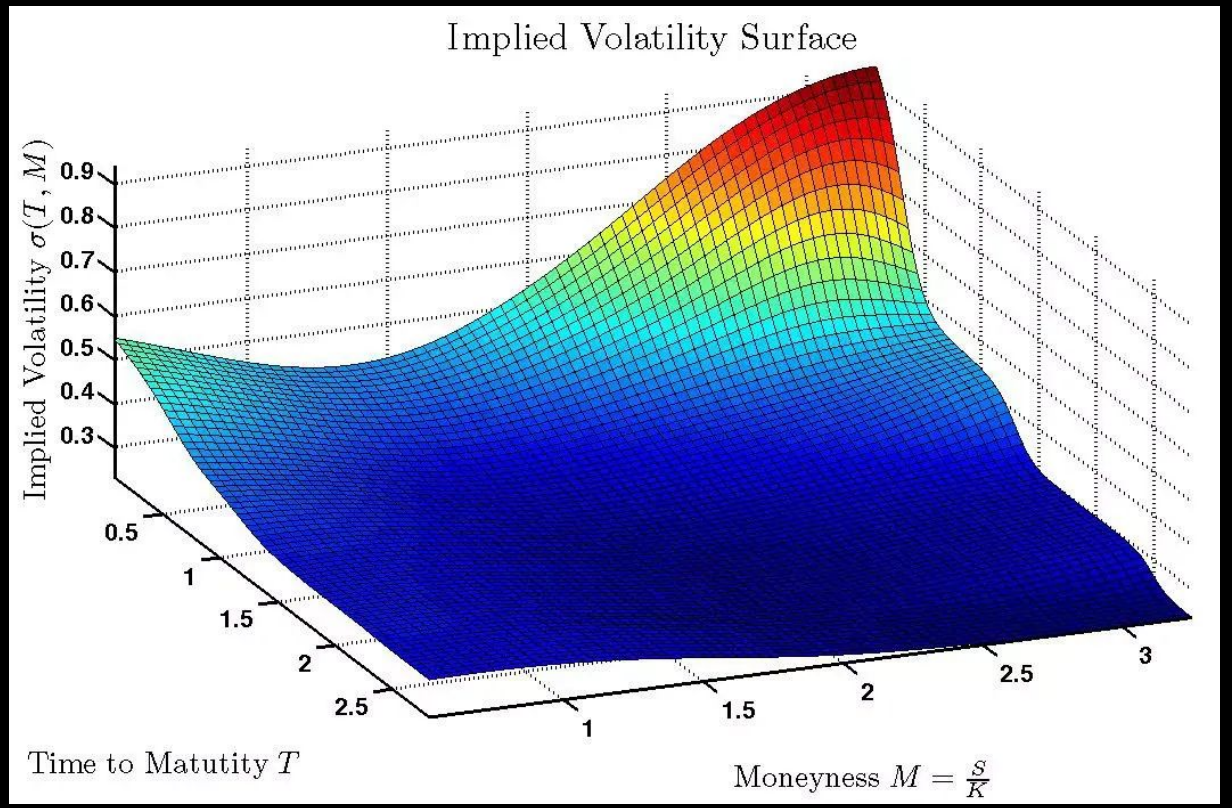
Types of Volatility

- **actual** volatility – standard deviation of the last n periods, with the nth period being in the…
  - **current** volatility – present
  - **historical** volatility – past
  - **future** volatility – future
- **implied** volatility – the output of backsolving an option pricing model for volatility given the option's price, with financial instrument price data from the
  - **current** implied volatility – present
  - **historical** implied volatility – past
  - **future** implied volatility – future



“Implied” Volatility





The Black-Scholes Model

- What we need to know is that the Black-Scholes model is of the form

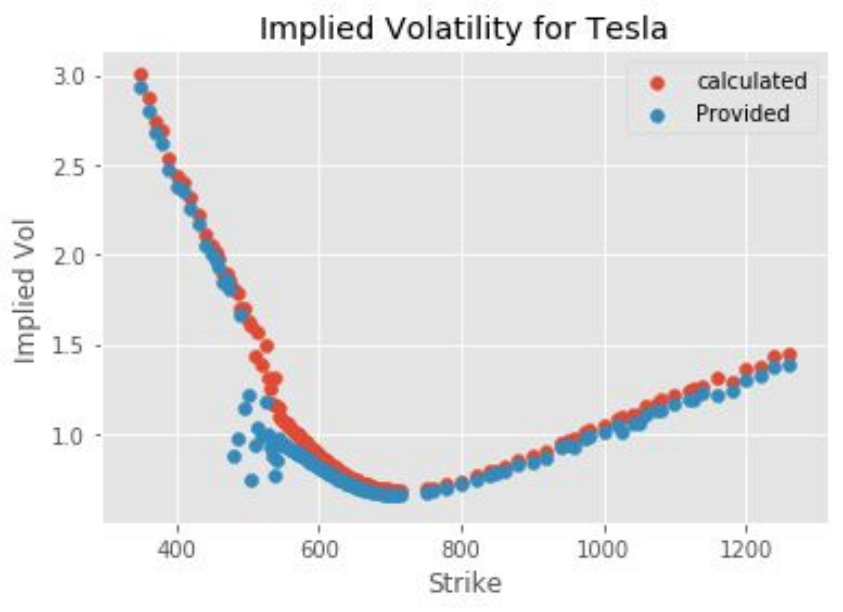
  $C = f(\sigma, \ldots)$

  where C is the price of the option, f represents the model, and the inputs are several parameters, one of which is the future volatility of the option's underlying asset
- There is one problem… we don't know the future volatility of the underlying asset!

Backsolving for Volatility

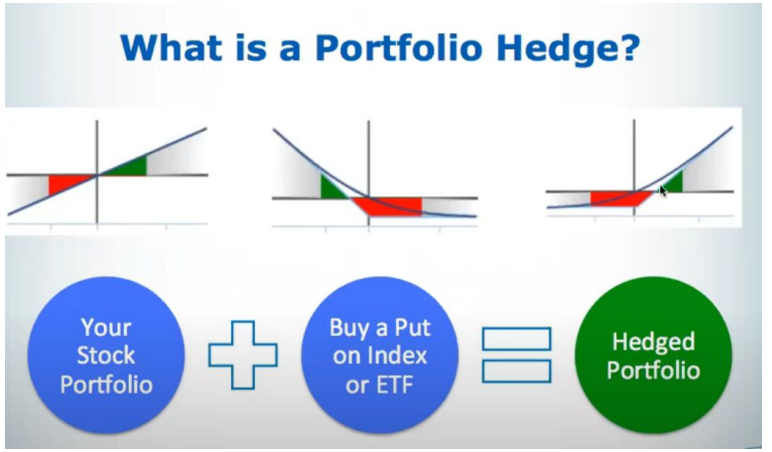
- Options are contracts that are traded on live markets – we know their prices and we don't need a model to tell us option prices
- Because of this and the fact that the BSM has a continuous and non-zero derivative for all positive values of volatility, there must be some function f^{-1} such that
  $\sigma' = f^{-1}(C', \ldots)$
  where C' is the option's market price and σ' is the future volatility **implied** by the option's price!
- For the BSM, there is no closed form for f^{-1} so it must be evaluated numerically for each input

Implied Volatility “Smile”



- When an option pricing model is used in the “forward” direction (that is, to find option prices), only one value of future volatility can be used (since the asset can only have one value of volatility over a period)
- When an option pricing model is used in the “backward” direction (option prices known, solving for volatility), multiple volatility values are outputted (because an asset never has just one option, it has multiple strikes and dates).
- When these volatilities are plotted, they form a “smile” (2d) or a “surface” (3d)

Options as Insurance



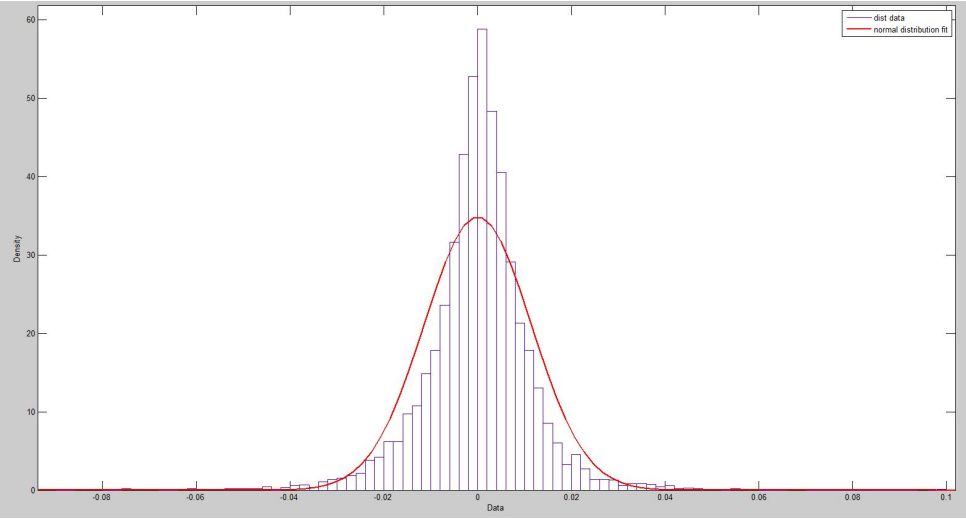
Explaining the volatility smile

- It might seem nonsensical that different options on the same underlying are implying different volatilities. An asset can't have 15%, 20%, and 25% volatility all at once!?
- You may have noticed that options that are very far from the spot price of the underlying have very high implied volatility. This is a byproduct of them having very high prices. Why are they so expensive?
- Most investors use options as a **hedge** against volatility expansions that would harm another position they have on the same security

Why are investors buying overpriced hedges?

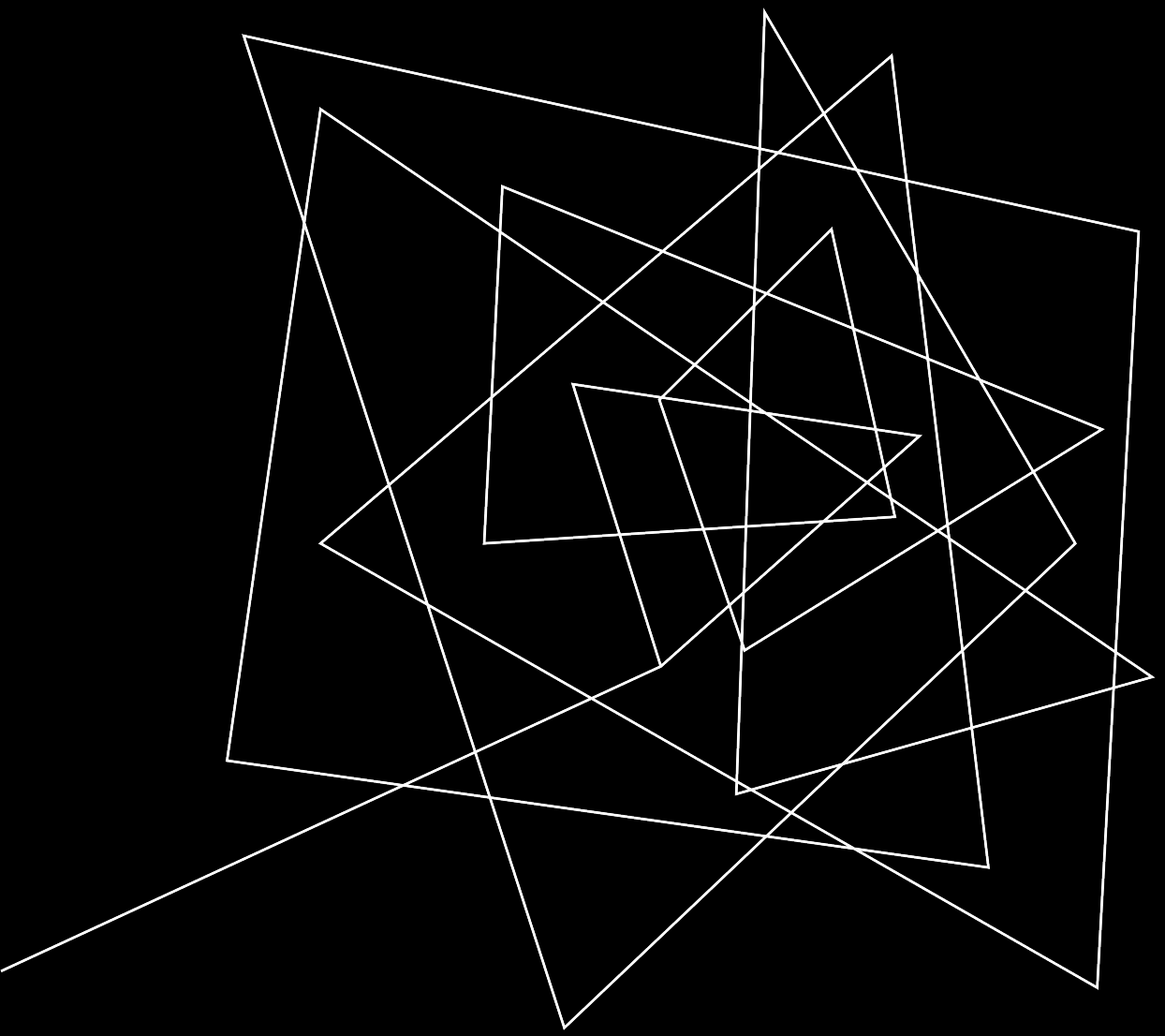
Are they really overpriced?

- Remember the normal assumption we made earlier? We need to question that
- It turns out that market returns are not normally distributed, but are instead **skewed to the left** and **leptokurtic**
- ***Kurtosis:*** Measure of a tails 'fatness'



Back to statistics

- A distribution that is skewed to the left will have its mean on the right side and the most extreme outliers on the left side. In market returns, this means that the mean return is positive while the most volatile events tend to be downward moves.
- A leptokurtic distribution will have extreme events be overrepresented relative to a normal distribution.



Volatility Risk Premium

BARCLAYS

Implied Volatility vs. Realized Volatility

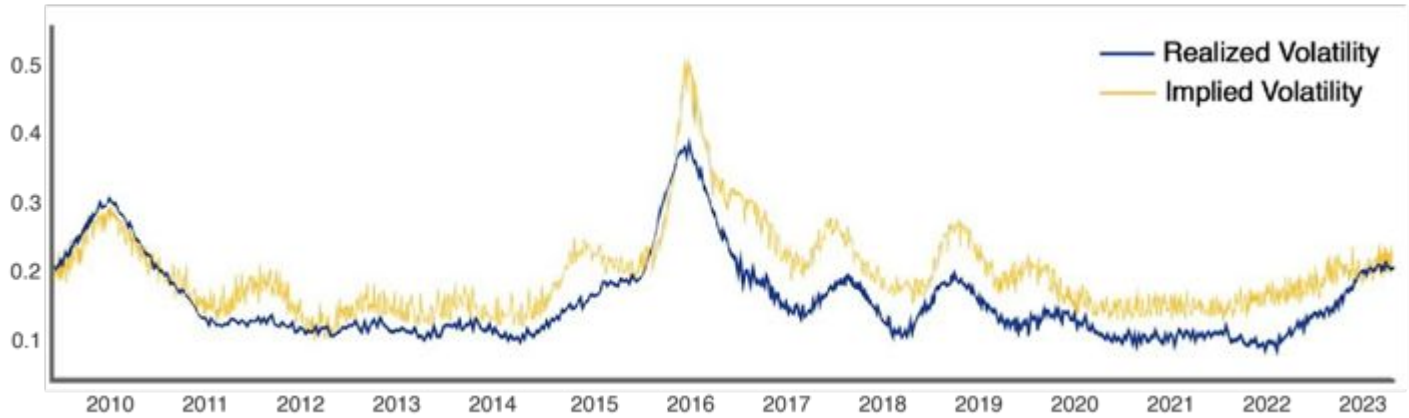
- Remember that implied volatility is derived from option prices, while realized volatility is derived from the underlying. Those are two different assets that might trade differently!
- If realized volatility is higher than implied volatility for some options, then the option is "**undervalued**" – it is costing you a small amount to insure you against an event that happens relatively often (volatility is high -> large swings are likely to happen), therefore the option is favorable to the **buyer**.
- On the flip side, if implied volatility overstates realized vol, the option is "**overvalued**" – it is costing a large amount to insure the investor against something that doesn't happen that often (low vol -> swings don't happen that often), therefore the option is favorable to the **seller.**

Who Wins

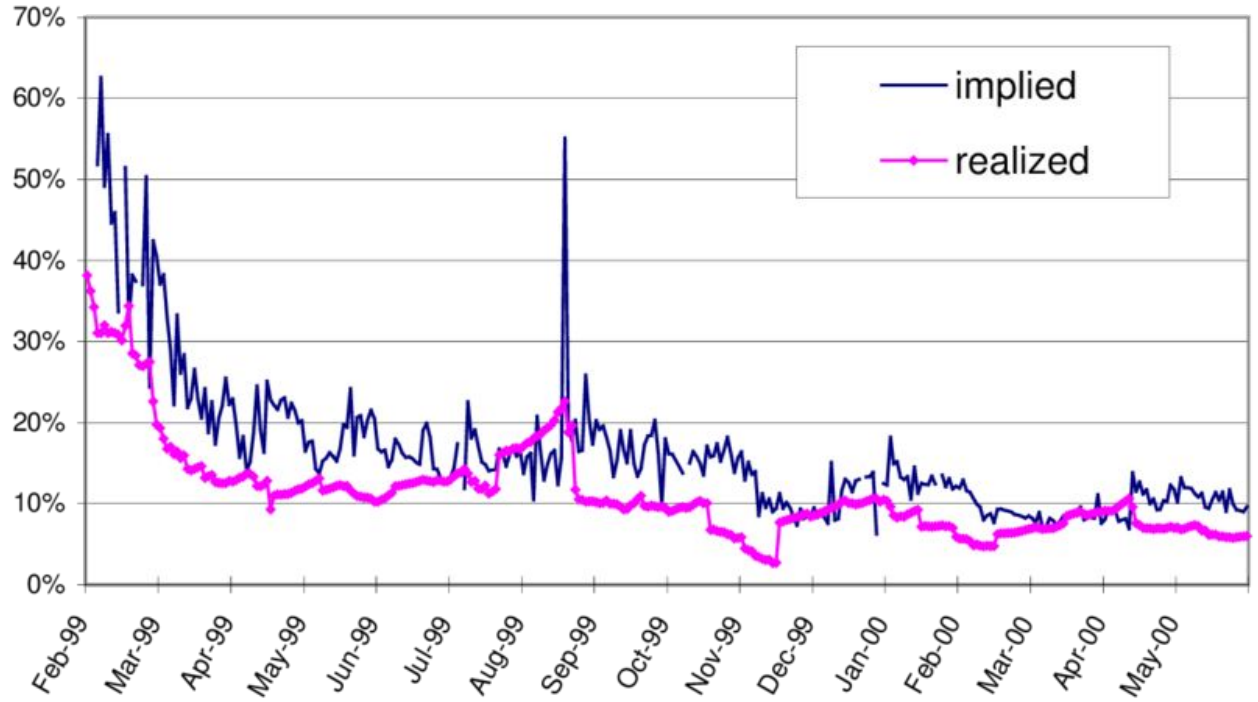
- This is **important.** Implied volatility tends to *overstate* realized volatility, meaning that option sellers tend to have +EV and option **buyers** tend to have -EV.
- This is called the **volatility risk premium**: a seller of a diversified basket of options

Examples

DJI

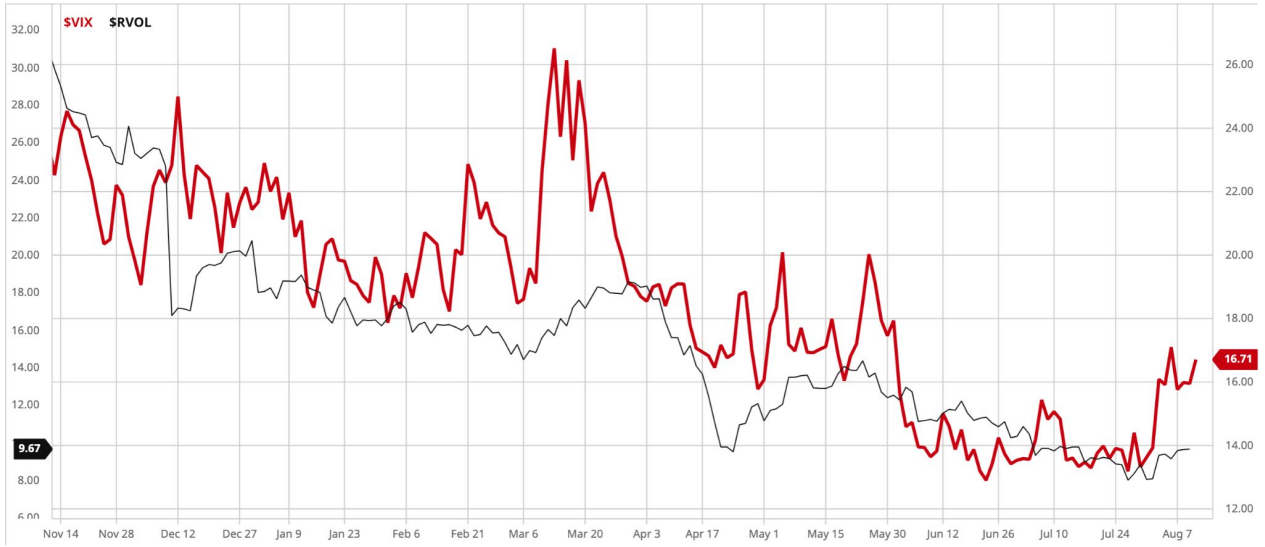


USD



More Examples

SPX



Fuel:

Case Study: Barclays

- It's January 2021. Remember any… events that happened in the financial markets around that time?
- Of course, the **GME Short Squeeze** was underway. Internet communities were trading millions of options contracts based on online speculation.
- Remember that when something is suddenly bought in mass quantities without enough sellers to meet the demand, price **skyrockets**
- Also recall that options prices imply a level of volatility, so an increase in options prices corresponds to an increase in implied volatility

FOCUS

BARCLAYS

Equity Research
14 September 2020

U.S. Equity Derivatives Strategy

Impact of Retail Options Trading

DERIVATIVES

U.S. Equity Derivatives Strategy

U.S. Equity Strategy

We show that retail investors have been driving a significant increase in option (mostly short-dated calls) volumes for large-cap tech stocks. We use several unique data sets and detailed analysis to show that this activity has had a material impact on option prices and is large enough to potentially affect the underlying stock prices. We recommend two option strategies to monetize the resulting distortions.

Single stock option volumes have increased 3x on a YoY basis. The increase in volume is concentrated in short-dated (less than 2-week maturity) calls and particularly in large-cap tech stocks. Increase in volume has been much more significant than the increase in open interest, which indicates that this is speculative intraday activity.

We provide evidence that the increase in option volume is being driven by retail investors. This spike appeared when major retail brokerages cut commissions to zero in October 2019. Buy orders for small-lot call trades (a proxy for retail orders) has increased significantly, and they now represent 40% of overall call volume. 2020 Q2 13F data shows that Direct Retail investors have been the major buyers of large-cap equities.

This option trading activity has significantly impacted the volatility surface for affected stocks. Due to the increased demand, implied volatility for shorter-dated calls has increased relative to puts and longer-dated options for stocks with a large increase in option volume. Interestingly, the volatility risk premium (VRP; implied volatility versus subsequent realized volatility) has not increased meaningfully, indicating that realized volatility has also increased in tandem due to more speculative trading and hedging activity of market makers. Our single stock (SS) option strategy, which sells options based on our VolScore methodology, has outperformed the corresponding SPX option benchmark.

We show that option activity is large enough to potentially impact the underlying stock prices. While stocks with a large increase in option volumes have outperformed over the past year because of better fundamentals, we show that call option demand might have exacerbated this move. Increased call buying demand directly leads to buying pressure on stocks as market makers hedge their risk, and we estimate that the resultant volume is now ~30% of overall stock volume. We show that the correlation of stock returns with normalized option volume has increased this year.

We propose two option strategies to monetize the dislocation caused by the spike in retail activity: We believe that the outperformance of our VolScore strategy will likely continue and hence recommend it as an attractive way to monetize the VRP. These resilient stocks are trading at a significant valuation premium and are therefore prone to drawdowns similar to what we saw over the past few days; hence it is more prudent to go long these names using call spreads, which are especially attractive given fair volatility and flat skew. We screen for flat skew, attractive VRP and elevated option volumes and recommend eight stocks for this strategy.

Barclays Capital Inc. and/or one of its affiliates does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

PLEASE SEE ANALYST CERTIFICATION(S) AND IMPORTANT DISCLOSURES BEGINNING ON PAGE 22.

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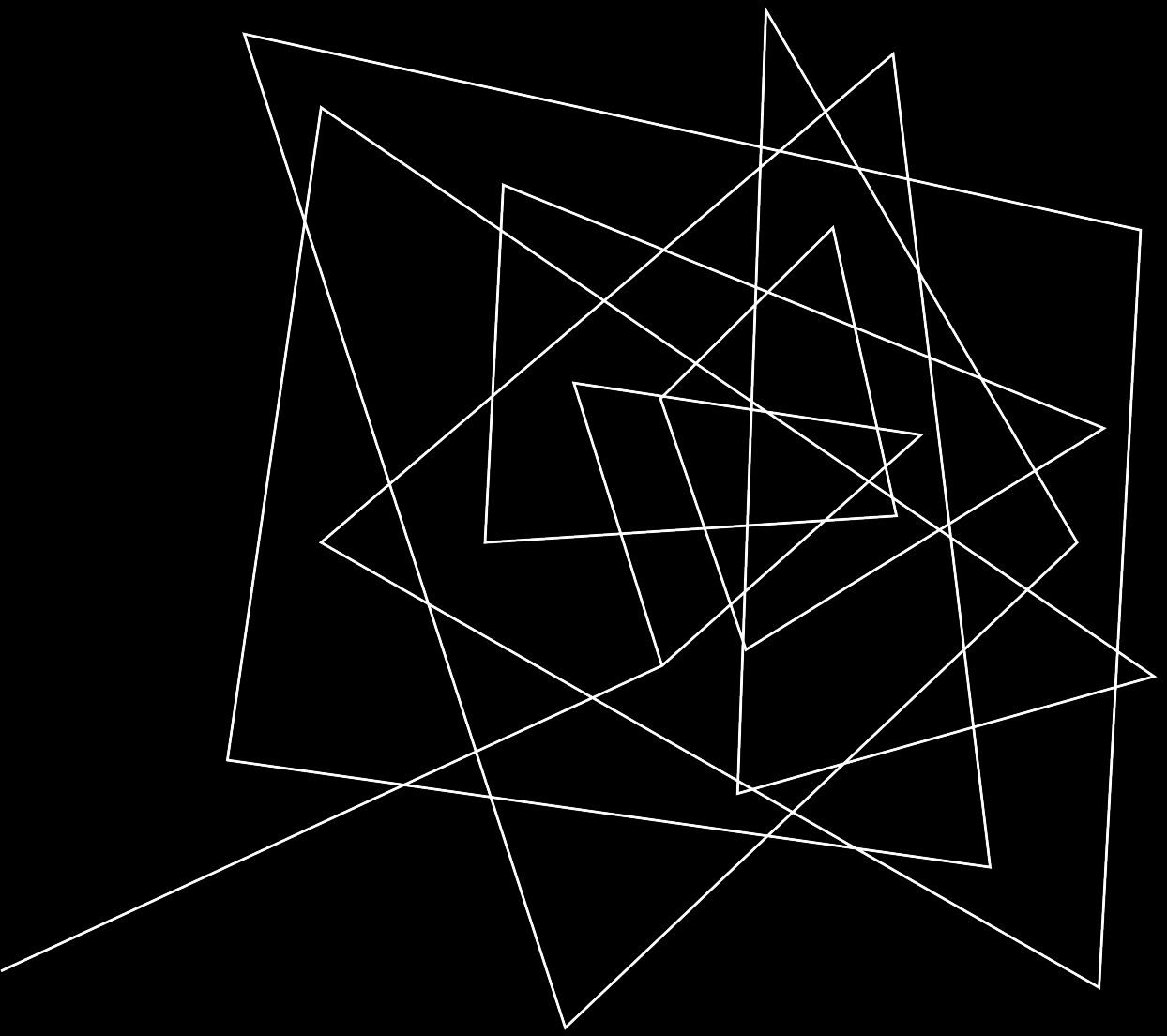
cont'd

The thesis

- What Barclays found was that for many stocks in US equity markets, the difference between implied volatility and realized volatility expanded dramatically in the months following the short squeeze due to new retail traders buying options with no real rationale
- This provided an opportunity for the following trades…

The trades (Barclays did both)

- **Mean Reversion**: If the mean implied volatility tends to be above the mean realized volatility, we can wait for a period where realized volatility spikes in anticipation of a decline in rvol OR we can wait for realized volatility to pass implied vol in anticipation of a reversion to the trend.
- **Statistical Arbitrage:** If an equity has one option that's overstating realized vol and one option that's understating it, short the overstating one and long the understating one



VOLATILITY ACTIVITY

Activity (10m)

Can you think of an outlier?

- As previously discussed, implied volatility tends to overstate realized volatility…
- But not always on all assets, and not at all on some assets. There are assets with realized volatility higher than implied volatility. Can you think of what those might be?
- I will use the tool linked to verify the attempts.

Sites:

https://marketchameleon.com

PROJECT GROUPS!

QUESTIONS AND ANSWERS

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Attendance