QUANTITATIVE
FINANCE
SOCIETY

Intro To Volatility

February 20, 2018

BRAINTEASER

8 Quants from different banks are getting together for drinks. They're all interested in knowing the average compensation for the group. Since they aren't investment bankers, each person prefers not to disclose how much they make to the group. Come up with a strategy for the group to find the average salary without knowing any individual's salary.

BRAINTEASER - ANSWER

Multiple solutions possible, here's one:

1st Quant adds random number to his salary and whispers it to 2nd. 2nd Quant adds his salary to that number and whispers it to 3rd. Goes around in circle until back to 1st Quant, who deducts the random number and divides by 8.

Practical application of funds who want to know total market positioning without giving away their individual positions.

Market Update

- Expansion of Bridgewater European Equities Short throughout February from 1 BN to now 22 BN
- People are worried about Treasury Issuance
  - ~180 BN of Debt sold this week, demand will be key
- Wednesday's Weird Inflation
  - Slight beat, driven by apparel and energy
  - Stocks initially fell on news before recovering, now down about 4% from records
- Yellen's Last Minutes Tomorrow

FAREWELL YELLEN

Janet Yellen's Subtle Message To America

by Tyler Durden
Tue, 02/24/2015 - 17:15

Presented with no comment...

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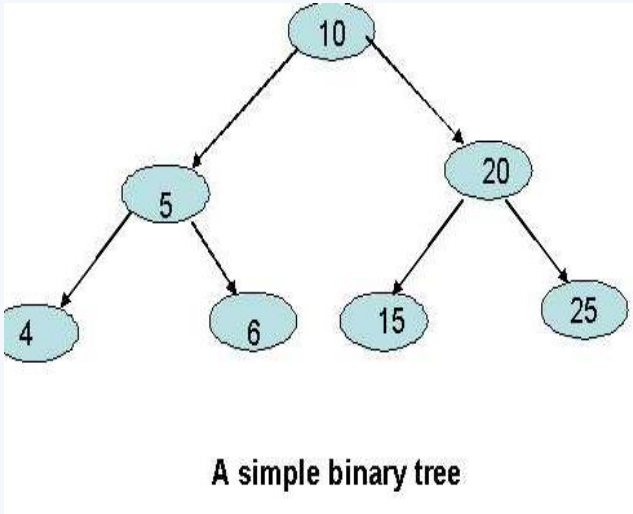
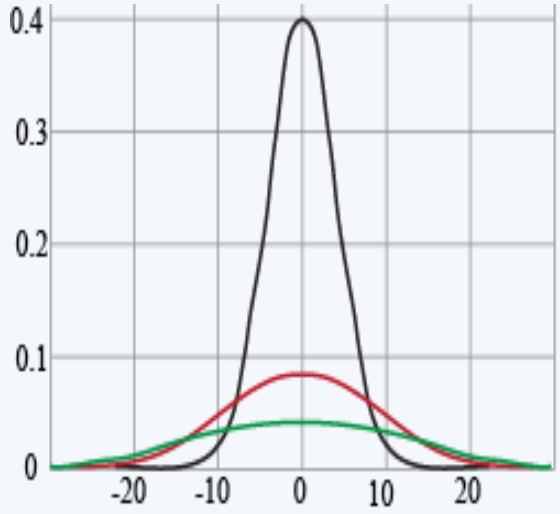
EXPECTATIONS

1. Intellectual Honesty
   - Raise your hand if you don't know what's going on – it's okay!
2. Participation
   - The tangent conversations we have from your comments can be more valuable than our scripted content
3. Less Math / More Intuition
4. Call us out
   - We'll respect you more if you try to prove us wrong
5. Purposeful Approximation

TIME & VOL EFFECTS



A simple binary tree



• 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?

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BLACK SCHOLES

- There are five inputs to the B-S Model

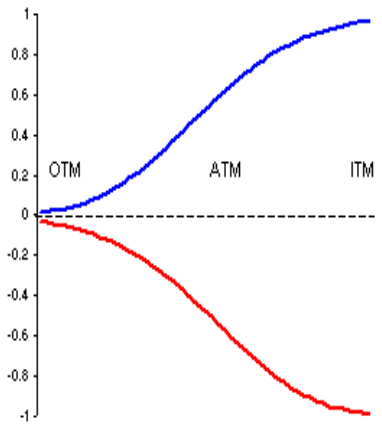
- **Stock Price**
- Part of Intrinsic Value

- **Strike Price**
- Part of Intrinsic Value

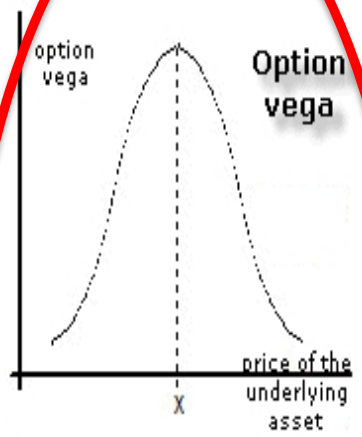
- **Time**
- More Time = More Extrinsic Value

- **Interest Rates**
- More IR = Affects Puts and Calls differently

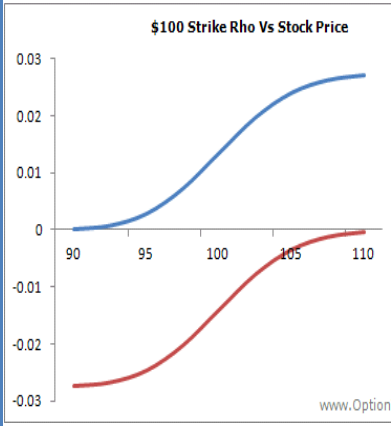
- **Implied Volatility**
- Volatility is good. But what does implied mean?



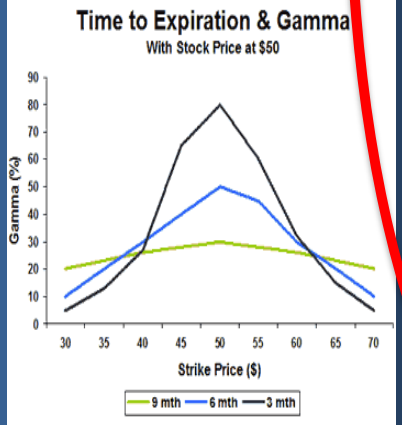
- Gamma



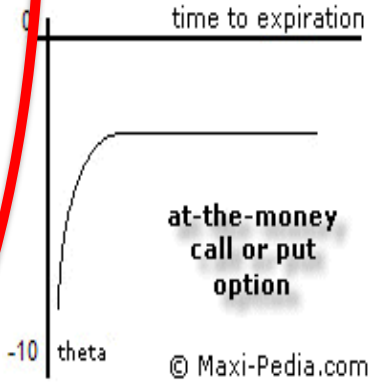
- Theta
- $\frac{\Delta V}{\Delta T}$
- where V = Value of Option
- and where
- T = Time (in days)



- Delta



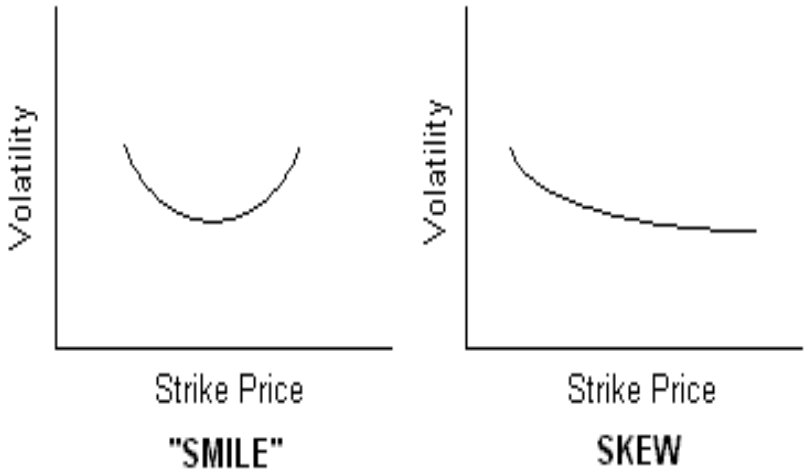
- Vega



- Rho

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.

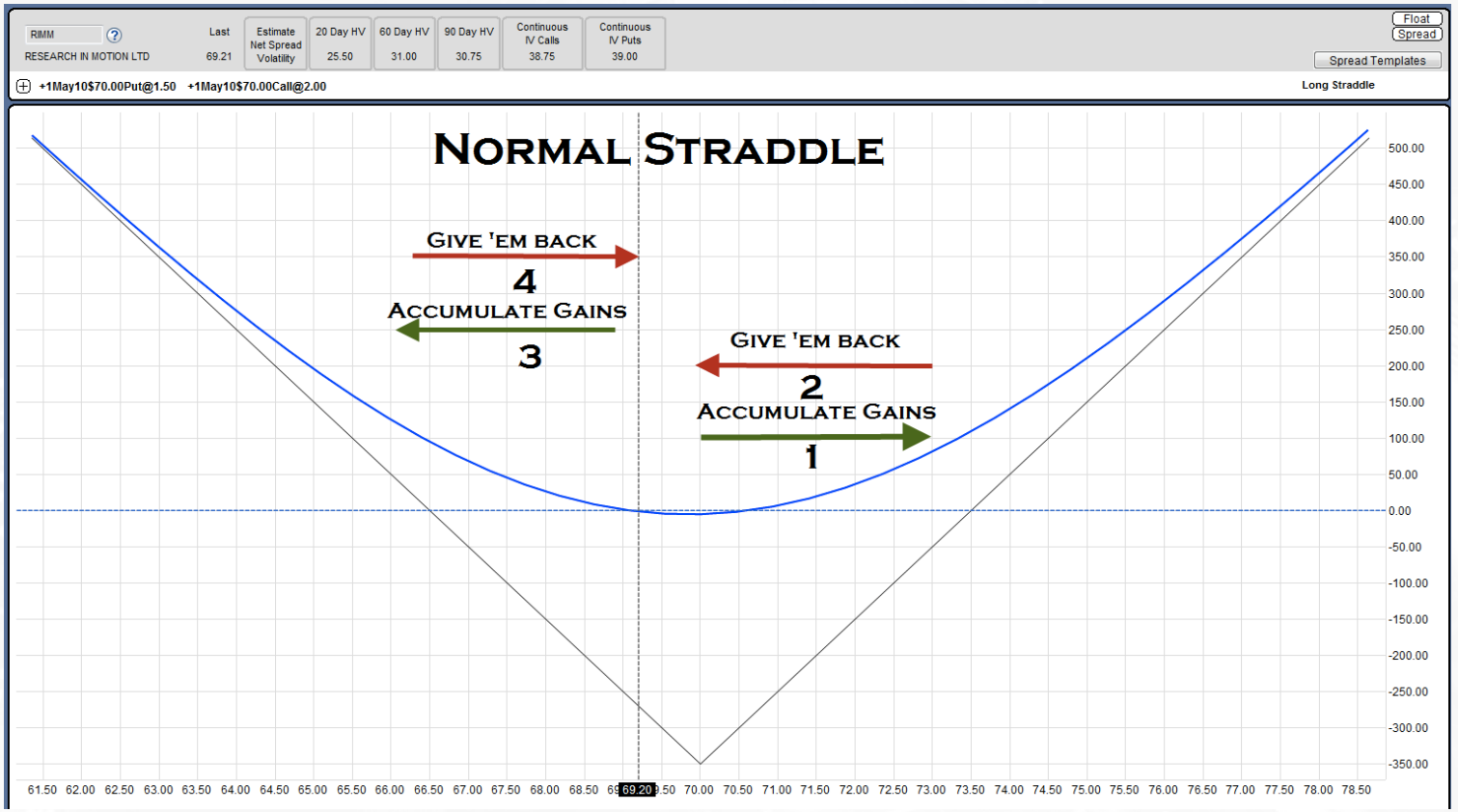
3 **Put Skew Persists in some Markets**

Why are puts generally more expensive than calls?

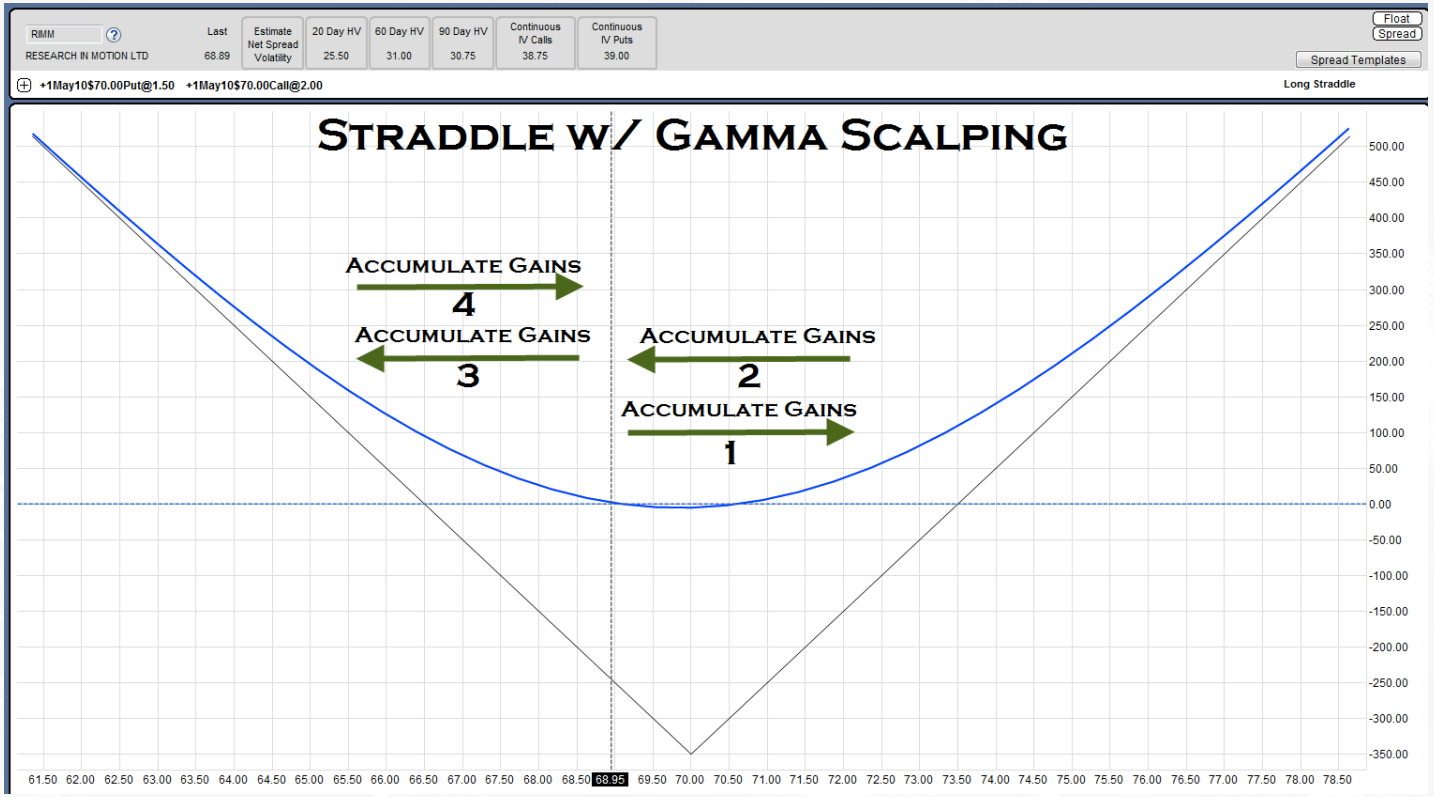
4 **Spot-Vol Correlation**

Market makes assumptions about volatility behavior

Without Gamma Scalping



With Gamma Scalping

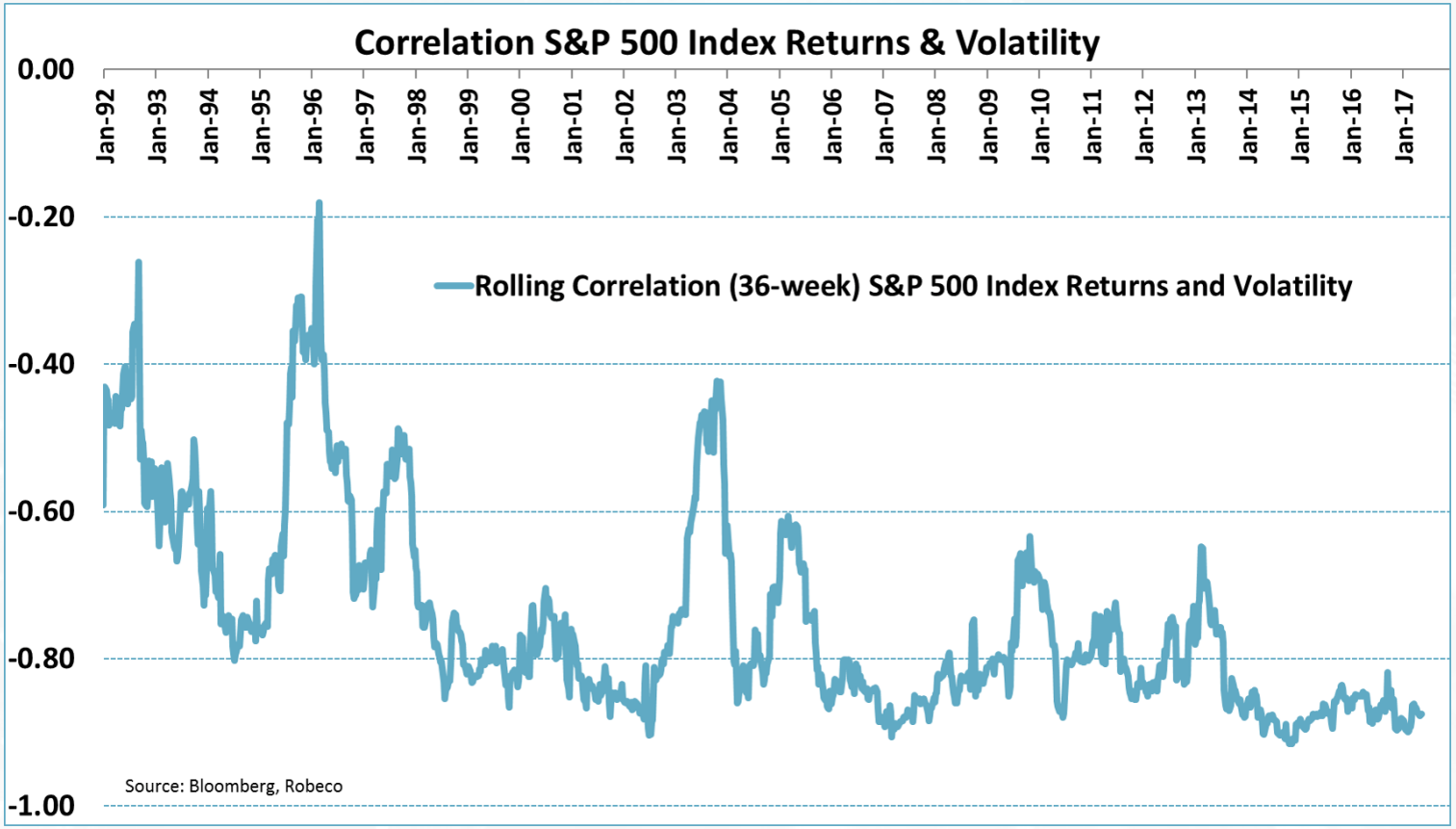


VIX Calculation Mechanics

$$\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2$$

σ is the VIX/100.
T is how much time there is until options expiration
F is the forward index level. This is basically what people are predicting the S&P 500 index will be at in the future, based on options prices.
Ko is the first strike below the forward index level.
Ki is also a strike price, but of the ith out-of-the-money option.
ΔKi is just the interval or difference between strike prices around Ki.
R is the risk-free interest rate until expiration.
Q(Ki) is the quote or the price of the Ki option. It is the average of the bid and the ask.

VIX and S&P Returns Correlation



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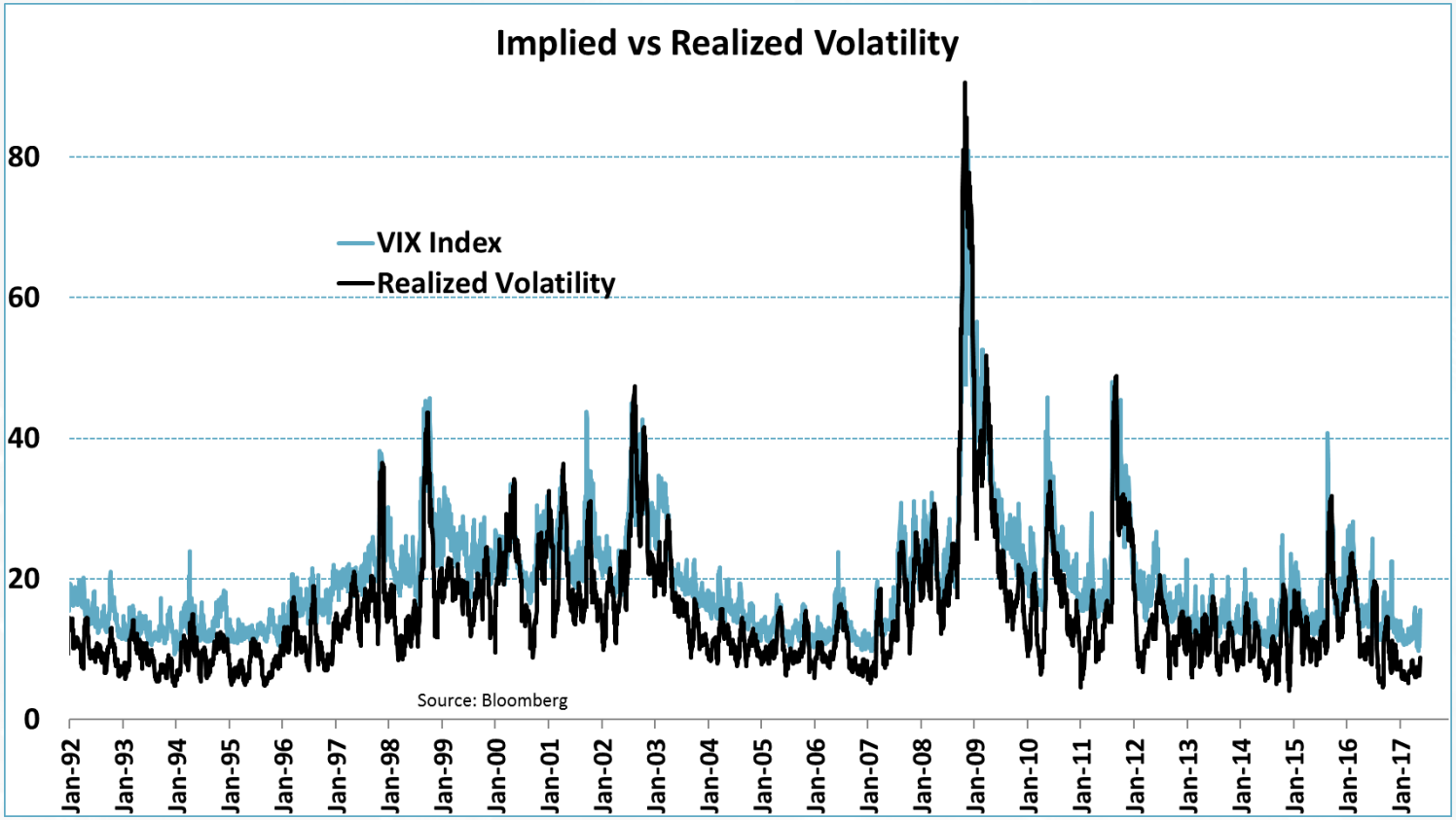
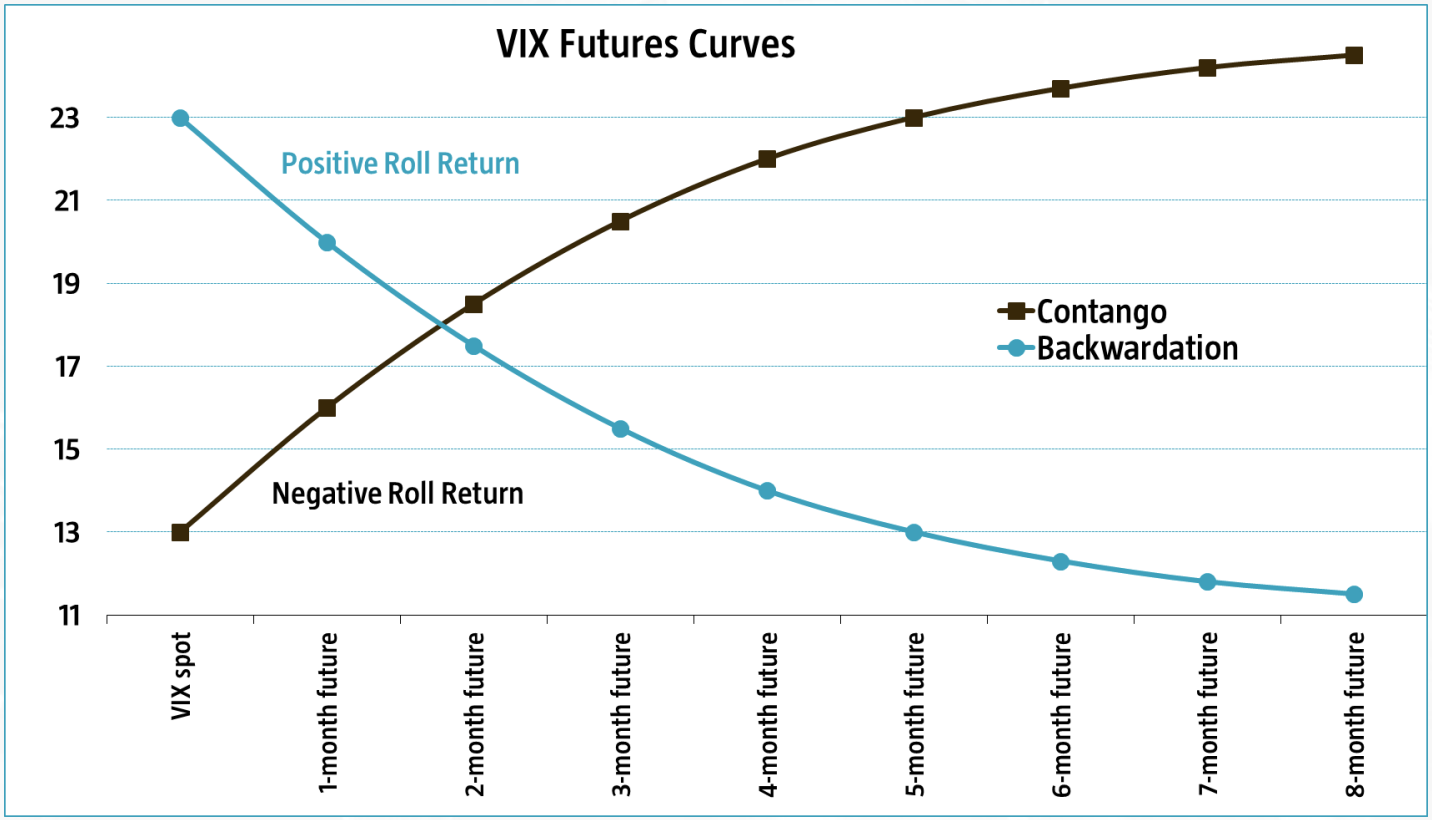
VIX vs Realized Vol



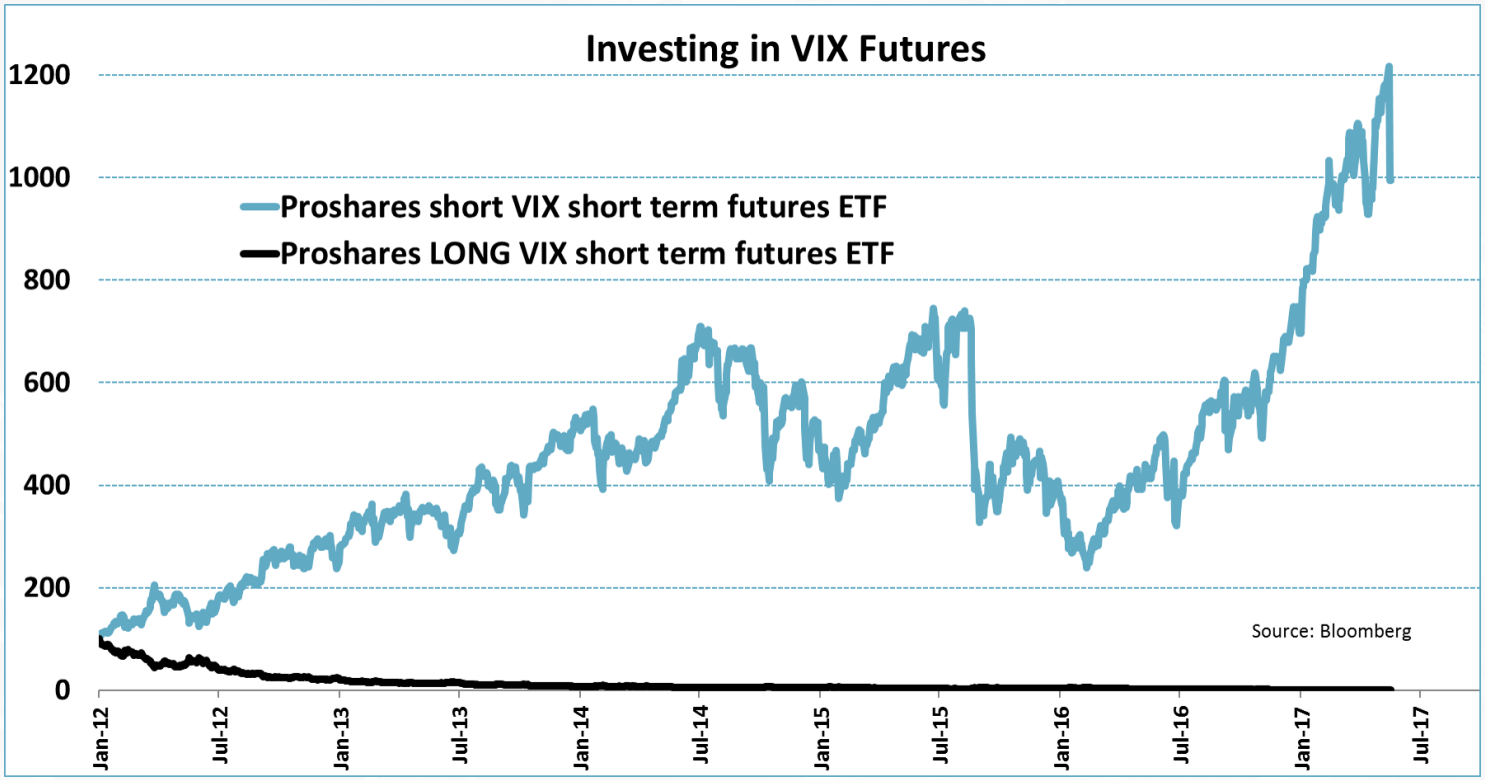
VIX Term Structure



Some Volatility Products

- Direct VIX Exposure (VIX Futures)
- VIX ETNs (VXX, VXZ)
- Leveraged VIX ETNs (XIV, TVIX, TVIZ)
- Leveraged VIX ETFs (SVXY, UVXY)
- Vol of vol (VIX options, VVIX Index)

Leveraged ETF Rebalancing



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What is XIV?

- Credit Suisse's VelocityShares Daily Inverse XIV Short-Term ETN)
- 1.35% management fee
- Credit Suisse has the right to shut down XIV if it loses 80% of its value in one day
- CS sells you a short vol position, and hedges themselves by selling VIX futures
- Daily rebalancing to achieve inverse returns

FEBRUARY 5, 2018

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VelocityShares Daily Inverse VIX Short-Term ETN
120
100
80
60
40
20
5.10
0
-119.80
-95.92%
31
01
02
05
06
07
08

UNDERSTANDING XIV

- The prospectus says, bold and underlined, that "**the long term expected value of your ETNs is zero**."
- Even if the VIX goes down, the XIV -- which is a bet on the VIX going down! – will lose money over time

Leveraged ETF Rebalancing

Day 1		Level	ETF's Exposure Before Reset	ETF's Exposure After Reset
	Index	100		
	-2x ETF	100	-200	-200
Day 2	**Index Up 10%**	**ETF Loses 20**		
	Index	110		
	-2x ETF	80	-220	-160
Day 3	**Index Down 10%**	**ETF Gains 16**		
	Index	99		
	-2x ETF	96	-144	-192

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Effects of Rebalancing

March VIX Futures

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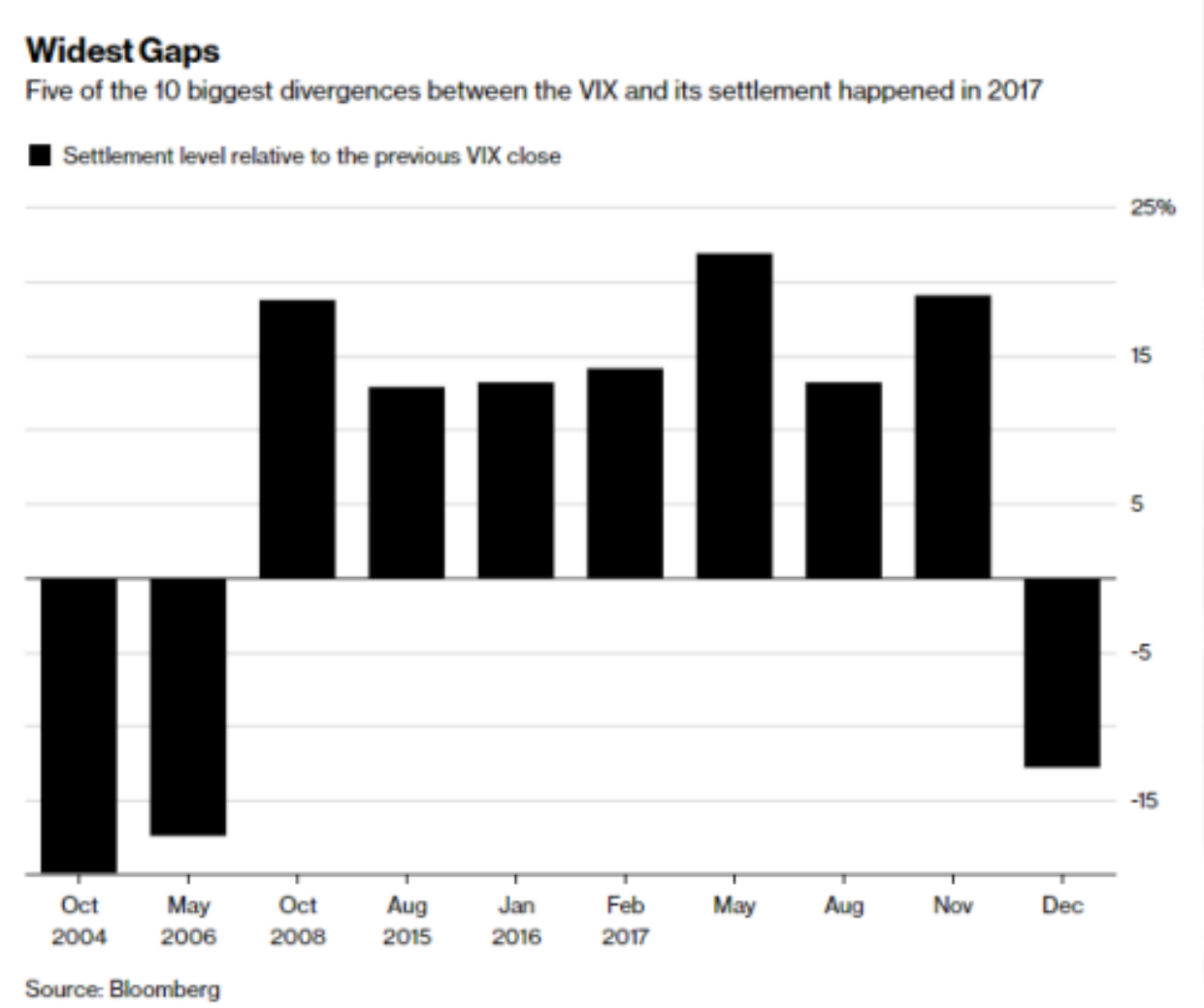
VIX Manipulation?

- John M. Griffin and Amin Shams. "Manipulation in the VIX?" May 24, 2017.
- Move VIX settlement by bidding up illiquid option strikes (deep OTM).
- On monthly expirations, settlement occurred outside the VIX's same-day trading range 42% of the time last year
- Whistleblower letter from Zuckerman Law

VIX Manipulation?



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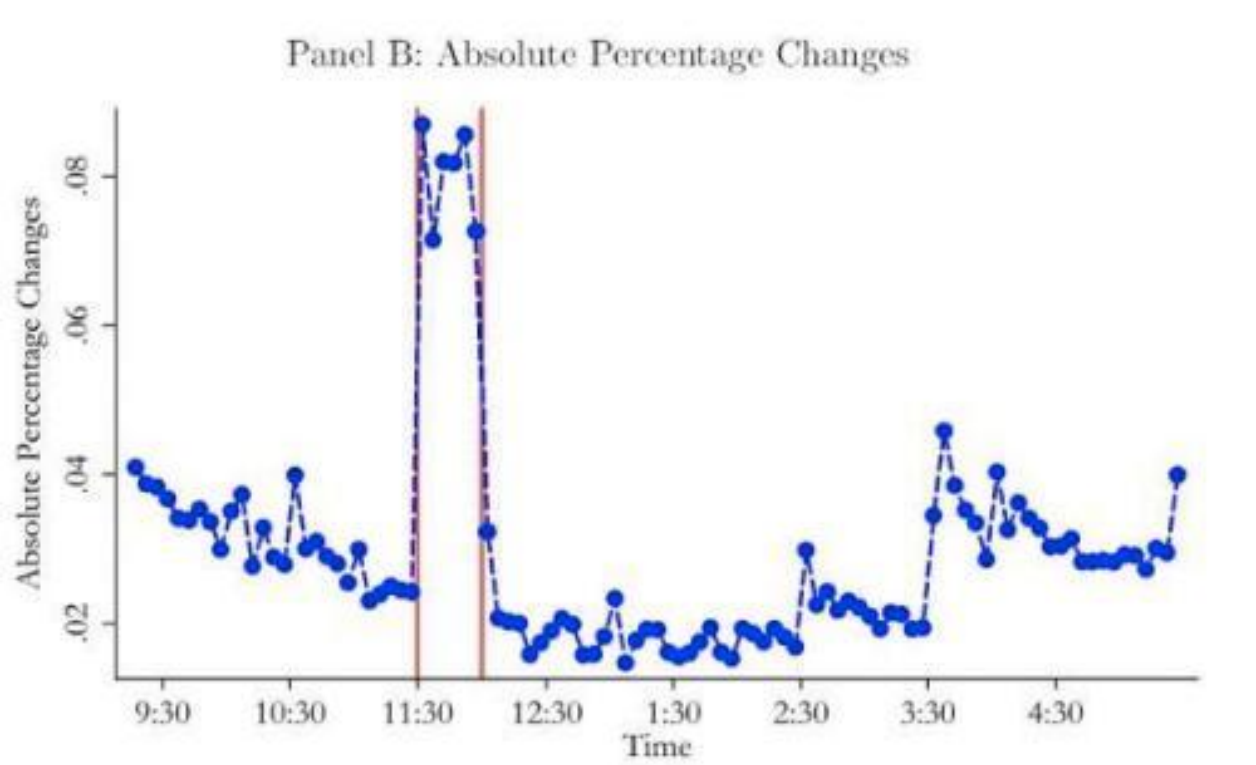
VIX Manipulation?

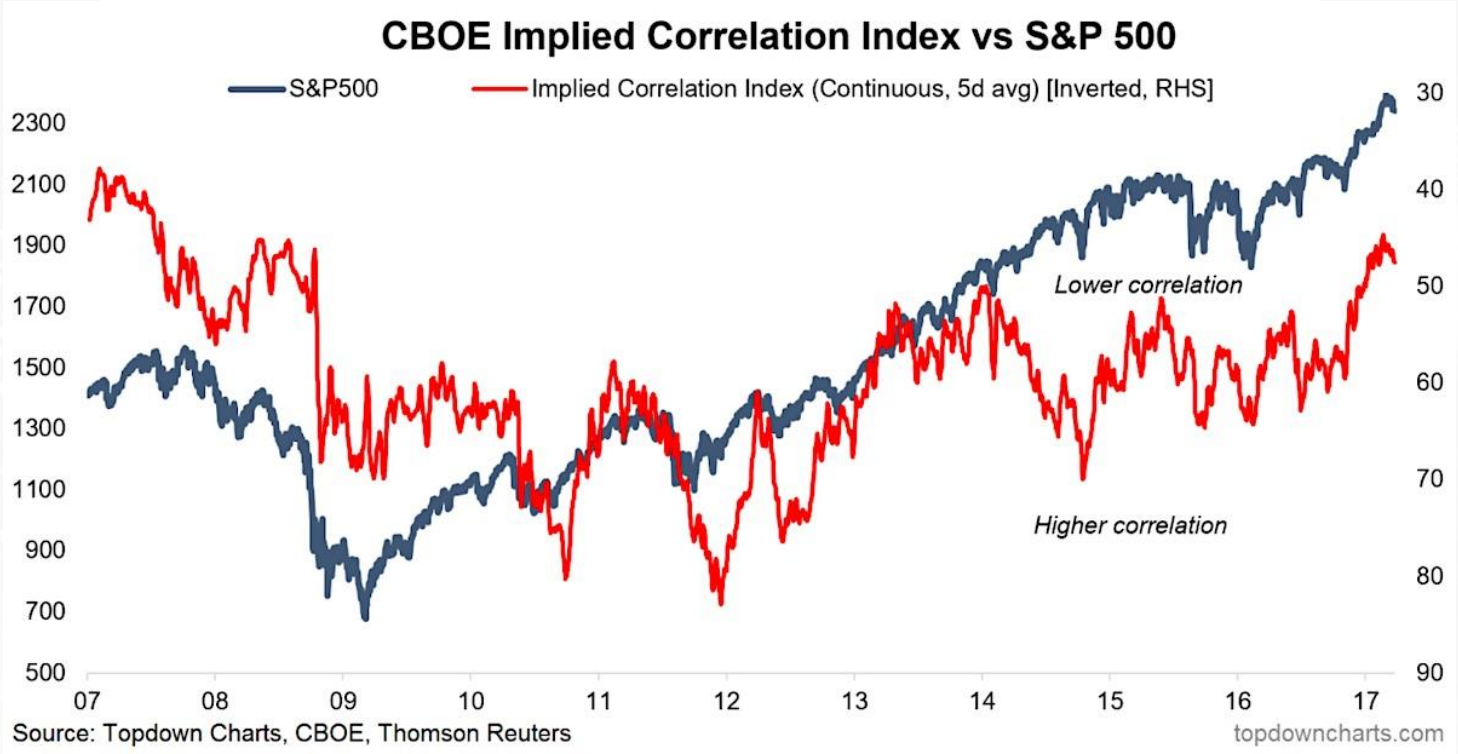


The size of VIX futures with open interest at settlement is on average 5.7 times the size SPX options traded at settlement, and it is 7.3 times for VIX options that are in-the-money at settlement.

By influencing a change in VIX through S&P options, you can influence a much larger position in the derivatives.

Correlation Trading

$$\sigma_p = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$



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General Announcements

- Make sure to swipe in
- Goldman Sachs and JP Morgan?!
- If you want to learn more about a topic we presented, get help with recruiting, or just chat
  - Tinyurl.com/QFS-Coffee-Chat

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