Volatility Index (VIX) and S&P100 Volatility Index (VXO)

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Volatility Index (VIX)

- The Chicago Board Options Exchange (CBOE)
- based on real-time option prices
- reflects investors' consensus view of future expected stock market volatility
- measures market expectation of near term volatility conveyed by stock index option prices

How has VIX changed over time?

New VIX (VIX)	Original VIX (→VXO)
uses a wide range of strike prices in order to incorporate information from the volatility skew	used only at-the-money options
uses a new formula to derive expected volatility directly from the prices of a weighted strip of options	extracted implied volatility from an option-pricing model
uses options on the S&P500 Index, which is the primary U.S. stock market benchmark	based on S&P 100 Index (OEX) option prices

Original VIX

- S&P100 Volatility Index (VXO)
- established in 1993
- constructed using implied volatilities of 8 different S&P100 option series
- represents: implied volatility at-the-money OEX option
- exactly 30 days to expiration from an *option-pricing model*

New VIX

- In 2003, modified original VIX to VXO
- New VIX uses new methodology
- Based on an up-to-the-minute market estimation of expected volatility
- Calculate continuously in real time throughout the trading day
- Using real-time S&P500 (SPX) options
- Using nearby and second nearby options
  - bid/ask quotes
  - a wider range of strike prices rather than just at-the-money

New VIX (2)

- In 2006, began trading
- First listed on an SEC-regulated securities exchange
- World's premier barometer of investor sentiment and market volatility
- Very powerful risk management tool
- VIX is quoted in % points, like SD of rates of return

New VIX procedure

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

where:

σ is VIX / 100 → VIX = σ x 100

F Forward index level derived from index option prices (based on at-the-money option prices: the difference between call and put prices is smallest); where:

F = strike price (at-the-money) + e^{RT} x (Call price – Put price)

R Risk-free interest rate is assumed to be 3.01% (For simplicity, the government T-bills 3 month contract interest rate is used because the Thailand options contract is a 3 month contract)

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

T Time to expiration (in minutes), that is:

$$T = \{M_{\text{current day}} + M_{\text{settlement day}} + M_{\text{other days}}\}/\text{Minutes per year}$$

where:

- $M_{\text{current day}}$ = # of minutes remaining until midnight of the current day
- $M_{\text{settlement day}}$ = # of minutes from midnight until 9:45 am on TFEX settlement day
- $M_{\text{other days}}$ = Total # of minutes in the days between Current day and the settlement day

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

K_i Strike price of i^{th} out-of-the-money option; a call if $K_i > F$ and a put if $K_i < F$

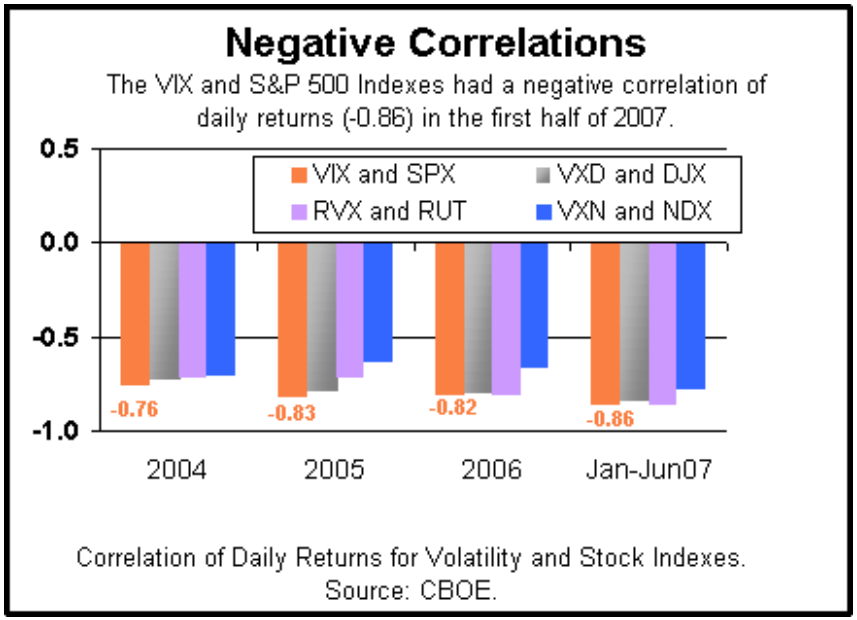
ΔK_i Interval between strike prices - half the distance between the strike on either side of K_i

[Note: ΔK_i for the lowest strike is simply the difference between the lowest strike and the next higher strike. Likewise, ΔK for the highest strike is the difference between the highest strike and the next lower strike).]

K_0 First strike below the forward index level, F

$Q(K_i)$ Midpoint of the bid-ask spread for each option with strike K_i

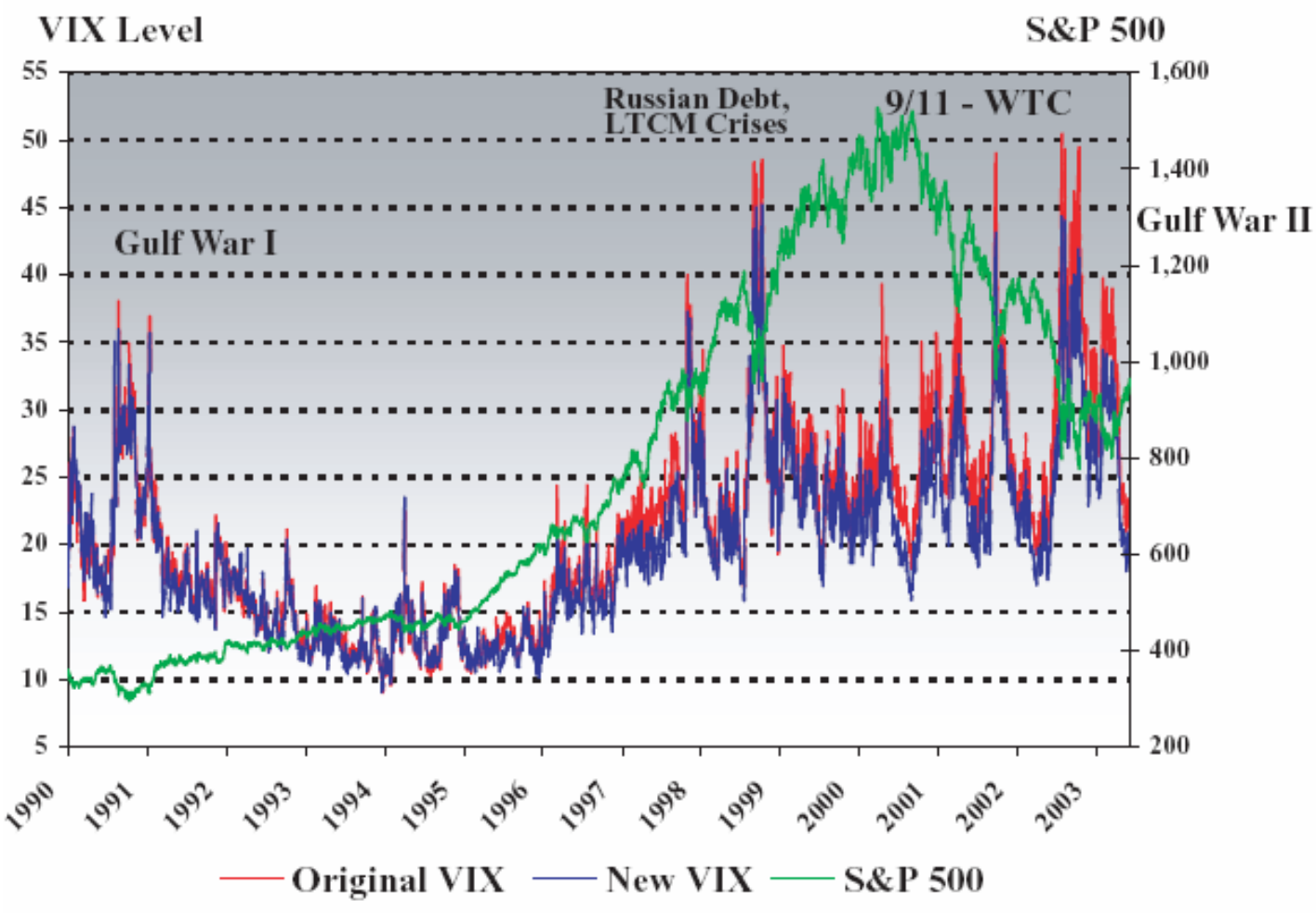
Negative Correlations



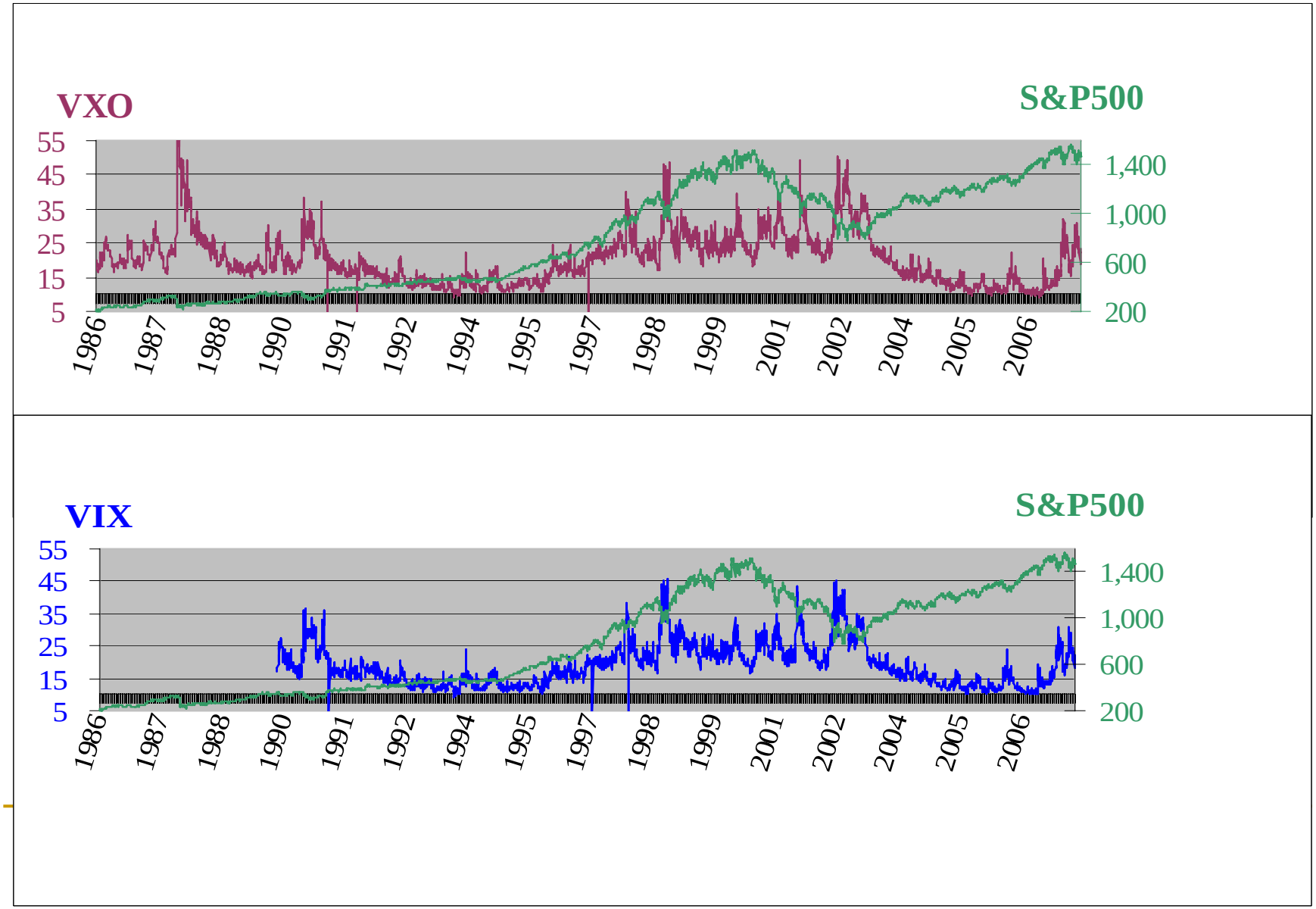
- the volatility indexes all have negative correlations with the daily returns of the related stock indexes:

Volatility Index	Index Options	Correlations
VIX = New Volatility Index	SPX = S&P500 Index Options	-0.86
VXD = DJIA Volatility Index	DJX = DJIA Index Options	-0.85
RVX = Russell 2000 Volatility Index	RUT = Russell 2000 Index Options	-0.86
VXN = Nasdaq-100 Volatility Index	NDX = Nasdaq-100 Index Options	-0.78

New VIX vs Original VIX and S&P500



Original VIX and S&P500



Negative Correlations

(March 28, 2004 - Dec. 30, 2005)

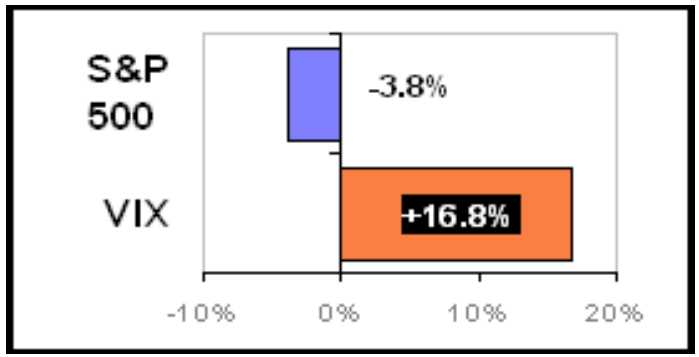
	S&P 500	VIX	VIX Futures'
S&P 500	1.00		
VIX	-0.78	1.00	
VIX Futures'	-0.49	0.48	1.00

Sources: CBOE and Bloomberg

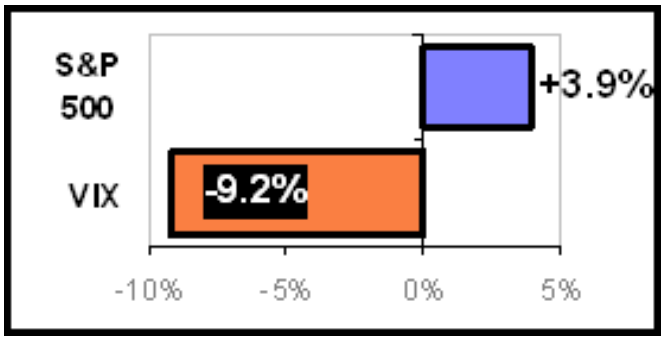
* Represented by the prices of VIX futures for nearby month

- The price of VIX often moves in the opposite direction from S&P500
- For example, when stock prices drop, implied volatility often rises
- Investors might explore whether VIX options could be a "catastrophic hedging" tool for stock portfolios

Asymmetric Correlations between VIX and S&P500

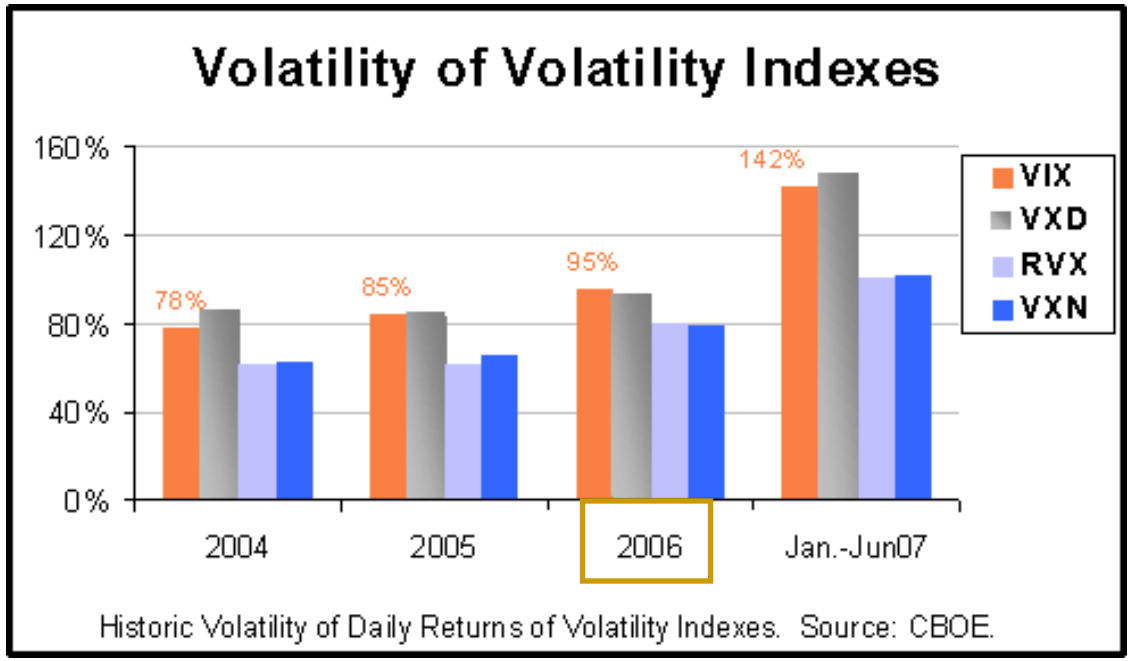


- Average price change on the 26 days when S&P500 fell by 3% or more (1990 - 2005)



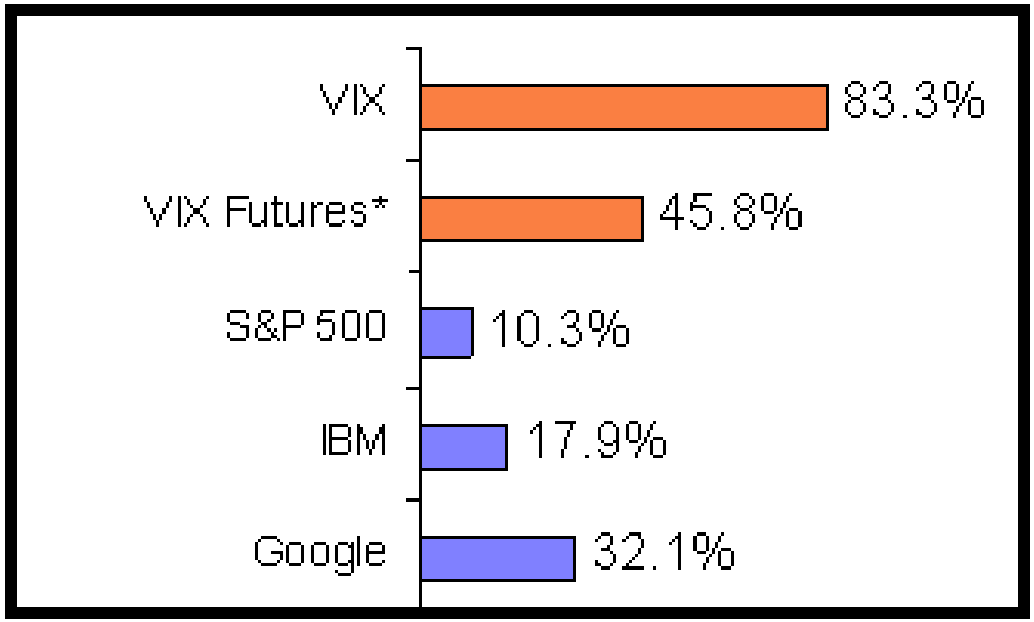
- Average price change on the 33 days when S&P500 rose by 3% or more (1990 - 2005)

Volatility of Volatility Index (Volvol)



- Historic volatilities of daily returns in 2006:
  - 95% VIX (spot index)
  - 94% VXD: DJIA Volatility Index
  - 80% RVX: Russell Volatility Index
  - 79% VXN: Nasdaq-100 Volatility Index

High Volatility of Volatility Indexes



- Historic volatilities of the VIX Index
- Near-term VIX futures prices generally have been higher than those of the S&P 500 Index and most stocks in the index

Options for Future Research and Application:

1. Analyse the effects of alternative volatility measures and option pricing models on alternative volatility indexes (indirect approach).

2. Construct an index of volatilities directly.

Note:

(1) is a volatility index

(2) is a risk index (≡ an index of volatilities)