

Volatility as a Tradable Asset:

*Using the VIX[®] as a market signal, diversifier
and for return enhancement*

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Equity Product Strategy

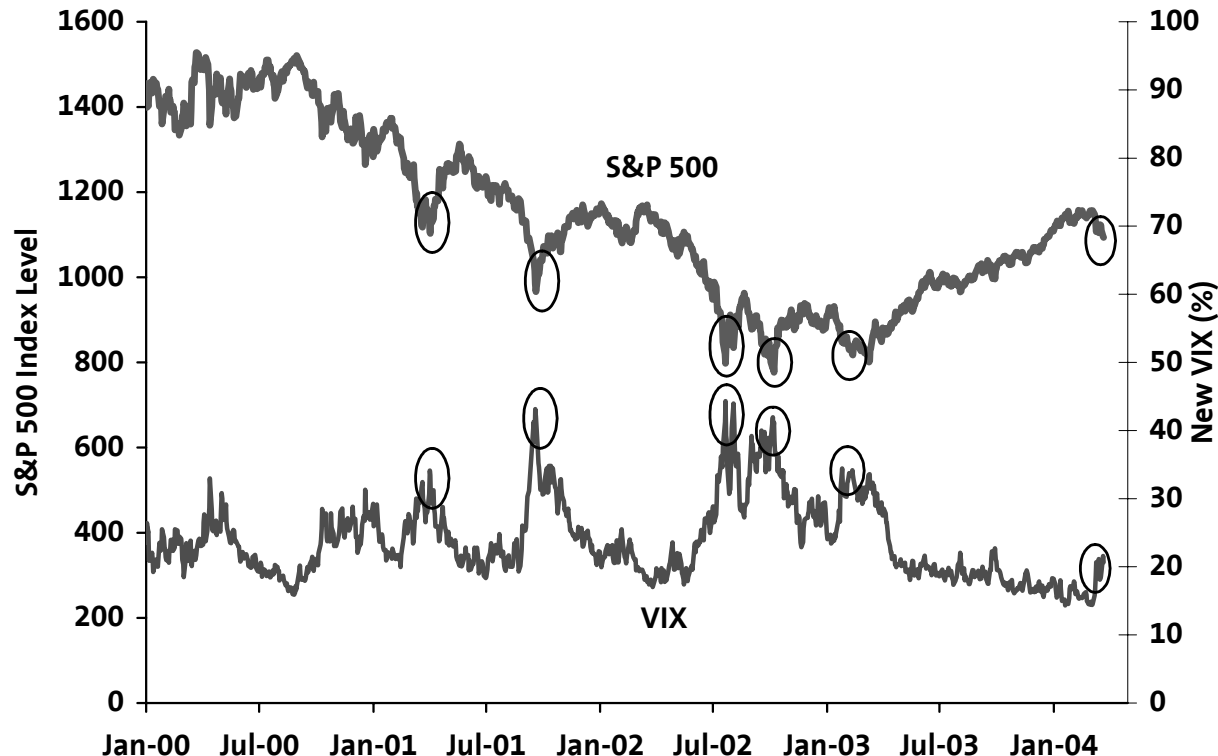
Goldman, Sachs & Co.

March 25, 2004

VIX as a timing tool

Spikes in the VIX appear to coincide with troughs in the market

- Typically, VIX spikes occur during macro driven environments and tend to coincide with equity market troughs.
- The VIX recently moved above its 95th percentile over the last three months, providing a short-term buy signal on the S&P 500.



NOTE: Based on methodology tested in the paper "The New VIX[®] as a market signal – It still works!" by Sandy Rattray and Venkatesh Balasubramanian, Goldman Sachs Equity Derivatives Strategy, September 5, 2003.

The VIX has been a successful market timing indicator, and has shown quite strong mean reversion itself

VIX Signal for 1-2 Month Horizon								
Percentiles	S&P 500 Tot. Ret Next		7-10 yr. Bond Ret Next		# times Equity Ret > Bonds		Mean S&P 500 Tot. Ret.	
	1 Mth	2 Mths	1 Mth	2 Mths	1 Mth	2 Mths	1 Mth	2 Mths
Above 95th	1.59	3.54	0.50	1.06	21/34	24/34	0.87	1.78
Above 90th	1.53	3.68	0.60	1.14	22/41	25/41		
Above 85th	1.80	4.08	0.74	1.32	25/47	33/47		

VIX Signal for 1-2 Month Horizon				
Percentiles	Change in VIX After Event		# Times VIX Decreased	
	1 Mth	2 Mths	1 Mth	2 Mths
Above 95th	-1.87	-2.72	22/34	24/34
Above 90th	-1.28	-2.41	26/41	29/41
Above 85th	-1.41	-2.53	29/47	32/47

2001-2003								
Percentiles	S&P 500 Tot. Ret Next		7-10 yr. Bond Ret Next		# times Equity Ret > Bonds		Mean S&P 500 Tot. Ret.	
	1 Mth	2 Mths	1 Mth	2 Mths	1 Mth	2 Mths	1 Mth	2 Mths
Above 95th	2.36	3.89	0.50	0.80	4/7	4/7	-0.59	-1.35
Above 90th	-0.34	1.20	0.86	1.34	2/7	3/7		
Above 85th	-0.23	1.75	1.28	1.47	4/8	4/8		

2001-2003				
Percentiles	Change in VIX After Event		# Times VIX Decreased	
	1 Mth	2 Mths	1 Mth	2 Mths
Above 95th	-4.90	-6.32	6/7	6/7
Above 90th	-1.39	-3.56	2/7	6/7
Above 85th	-1.14	-3.64	4/8	6/8

The Basics

What's special about implied volatility?

Some of the characteristics of implied volatility, which make it attractive to trade, are:

- 1. It tends to be mean-reverting**
- 2. It is often negatively correlated to stock prices**
- 3. It grows when uncertainty and risk increase and can then remain high for a while**

What would clients use products the VIX for?

The features of implied volatility mean that investors might use products based on the VIX® to:

- 1. Speculate on the future level of implied volatility in a pure manner, “uncontaminated” by the stock price path, e.g. by going short the New VIX futures when the New VIX is high and going long New VIX futures when it is low**
- 2. Hedge against a high correlation environment, which typically makes stock selection more difficult**
- 3. Certain classes of investors such as convertible bond arbitrage funds and structured product issuers can use New VIX derivatives to hedge their structural exposure to implied volatility (albeit with a maturity mismatch)**
- 4. Diversify against long equity exposure**
- 5. Use a long position in the New VIX to hedge against transaction costs and possible tracking error penalties – both of which tend to increase in times of uncertainty**

The Old VIX

- **Based on at-the-money volatility**
- **Based on S&P 100 (OEX) options prices**
- **Technical errors in volatility interpolation**
- **Very broad following – constantly quoted as a “market fear” indicator in popular financial press – CNBC, Barrons, Wall Street Journal etc**
- **Impossible to accurately replicate with a static hedge. Because of vagaries of the calculation, products would have wide spreads**
- **Despite success, no products had been launched on the index by 2003. Almost unique amongst equity indexes – all the popular ones have had products launched on them**

The New VIX is more representative

- **New VIX calculated using all nearby and second nearby SPX options**
- **Uses all non-zero option bids at all strikes, typically ~100 options**
- **So it's much less sensitive to individual options prices**
- **Calculation based on variance swap reference levels (more to come on this)**
- **No assumption of market level (unlike Old VIX which was only ATM)**
- **No requirement for an option pricing model (unlike Old VIX which used Black-Scholes)**
- **VIX² products can be hedged with a static strip of options. VIX products require dynamic hedging with the strip of options which is much more complicated**

The New VIX (1/21/04 – 1/22/04)

GRAB

Index **GIP**

Monitoring enabled.

2-DAY CHART VIX -- CBOE SPX VOLATILITY INDX **9:30-16:15** USD

14:10

Hi 14.75 Lo 14.01 Op 14.20 #Ticks 1120 14:10 **↑ 14.65**

+ .31



2004 Jan 21 2004 Jan 22

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410

Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2004 Bloomberg L.P.

3 22-Jan-04 14:10:52

The Old VIX (1/21/04 – 1/22/04)

GRAB

Index **GIP**

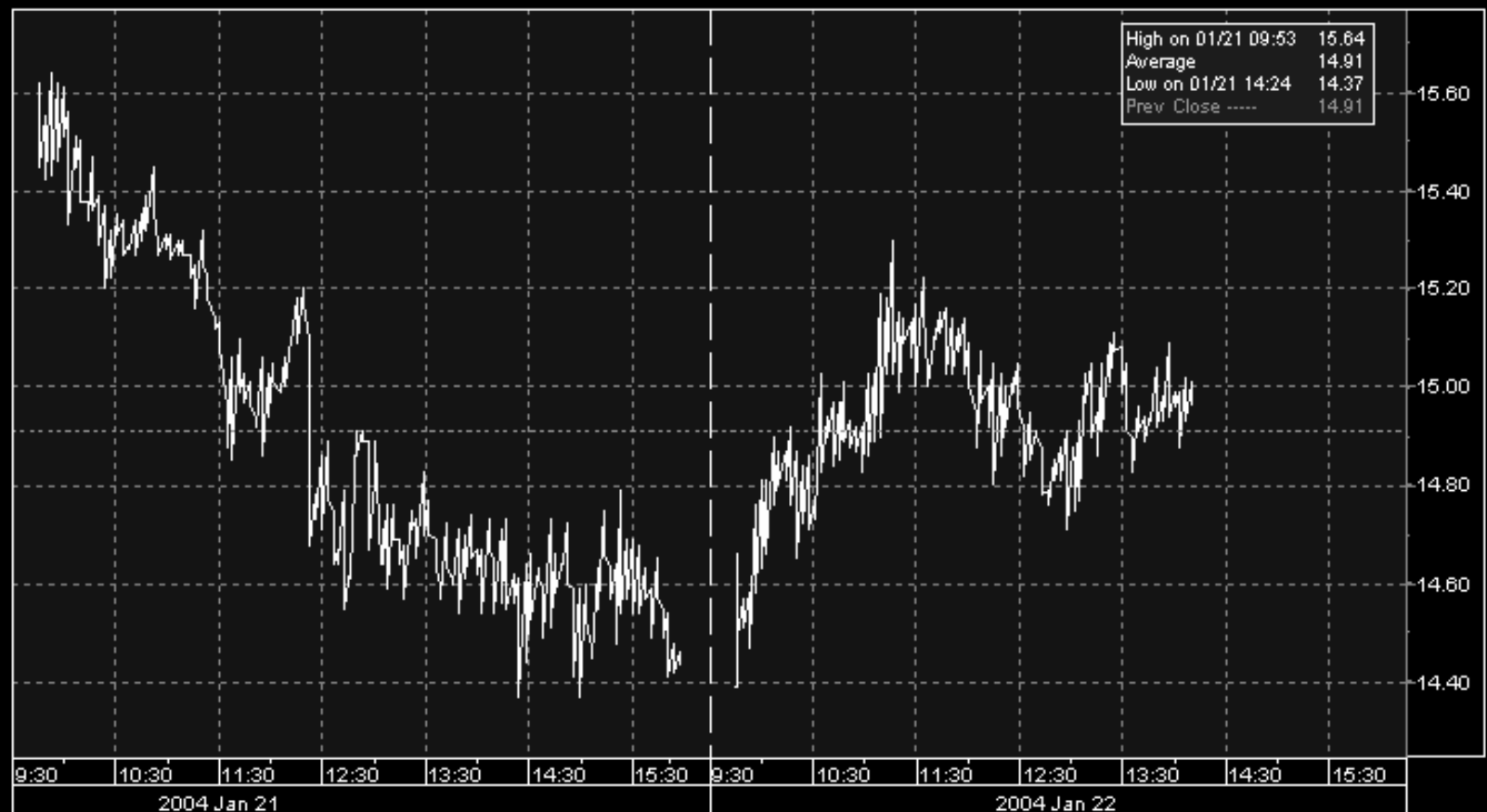
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2-DAY CHART VXO -- CBOE OEX VOLATILITY INDX **9:30-16:15** USD

14:11

Hi 15.30 Lo 14.39 Op 14.39 #Ticks 266 14:11 ↓ **14.96**

+ .53



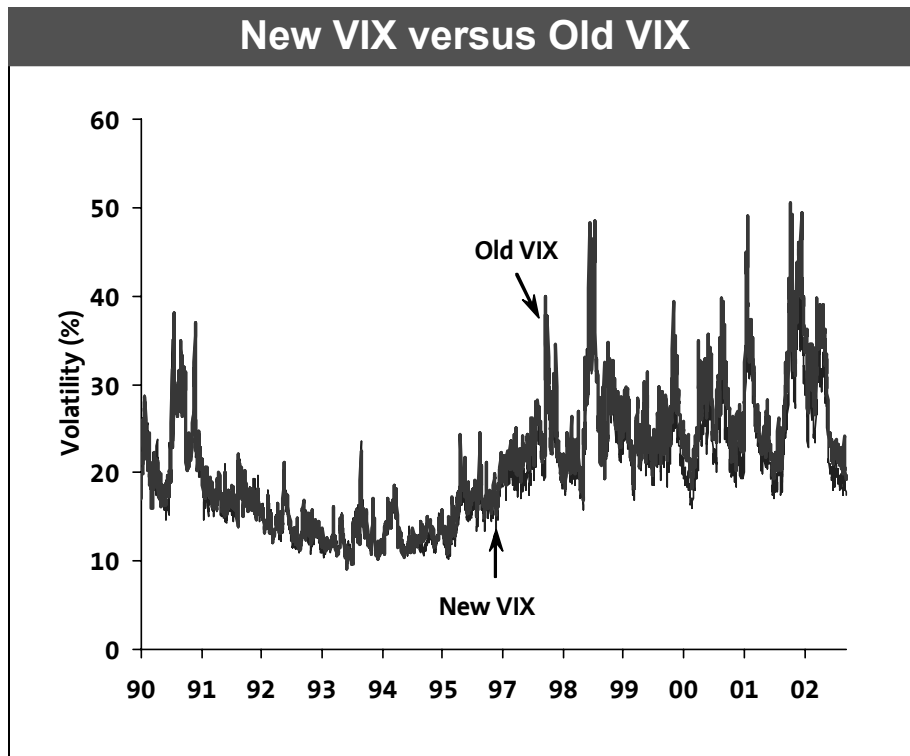
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Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2004 Bloomberg L.P.
3 22-Jan-04 14:11:16

The New VIX uses option prices only

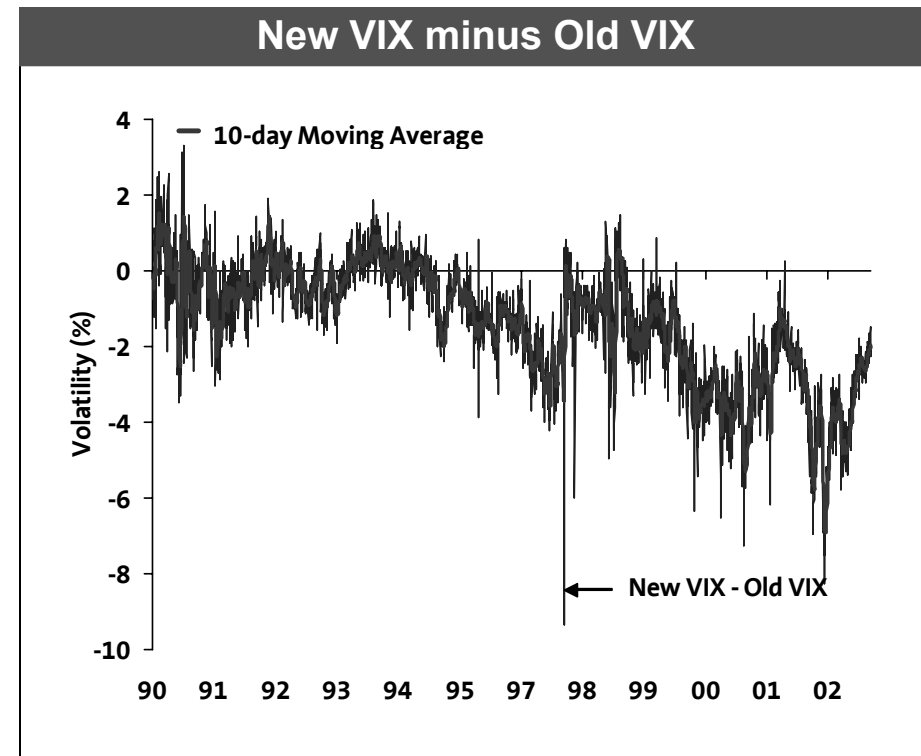
- **No need for an option pricing model**
- **No worries about parameters (the only external input is the 1-month risk-free interest rate)**
- **Can be calculated, back-calculated and replicated by anyone with access to options prices**

How different is the New VIX?

Not that different – from 21st August 2000 to 21st August 2003 the New VIX was on average 3.4 volatility points below the Old VIX.



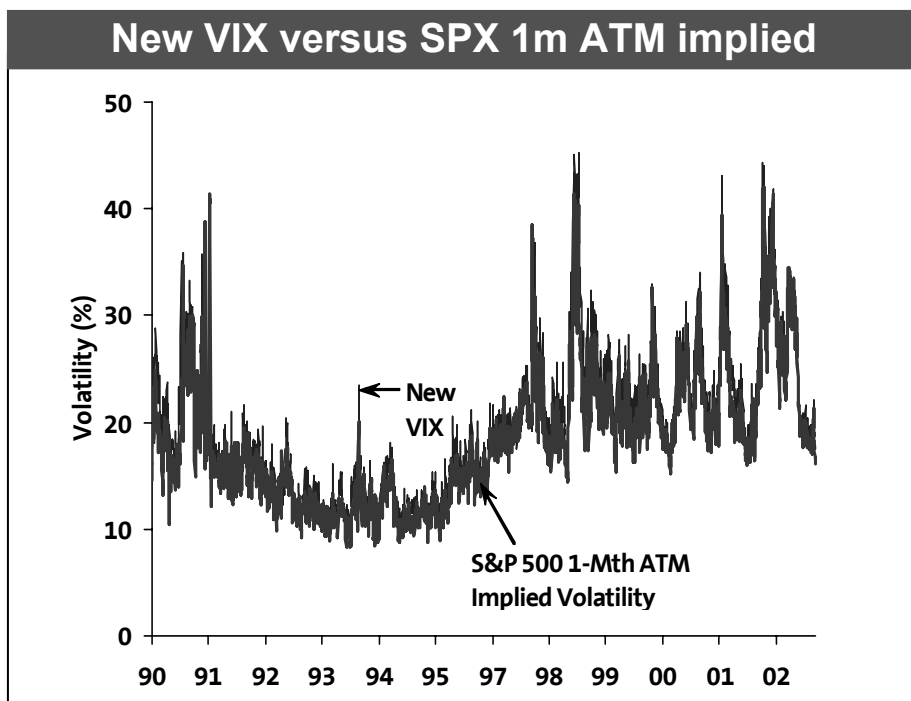
Source: CBOE



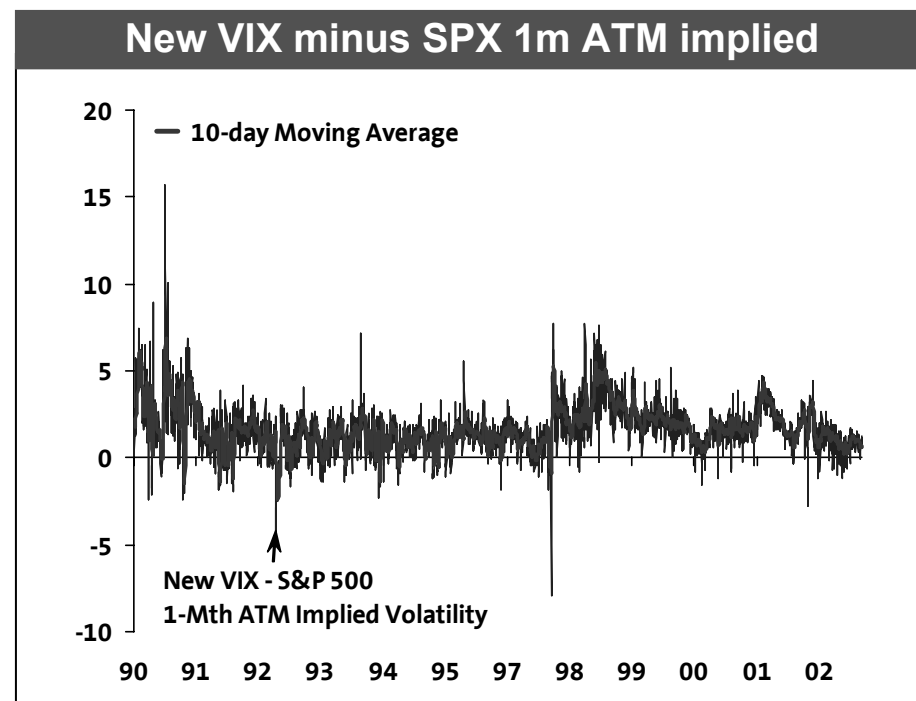
Source: CBOE

How different is the New VIX from ATM implied?

Not that different – from 21st August 2000 to 21st August 2003 the New VIX was on average 1.7 volatility points over SPX 1-month ATM implied volatility.



Source: CBOE, Goldman Sachs

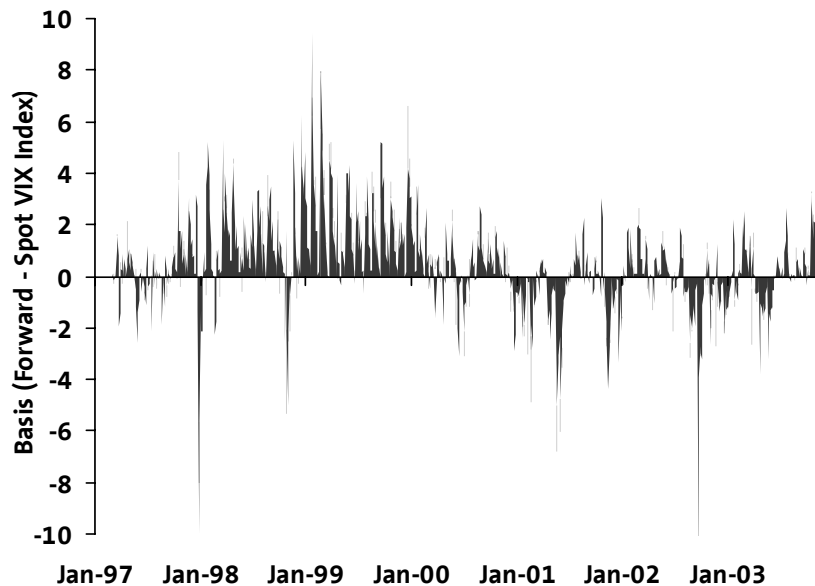


Source: CBOE, Goldman Sachs

- The New VIX® captures volatility across all strike prices and thus reflects the option skew
- The extra skew means it is higher than ATM implied

Products on the New VIX based on the forward VIX

Basis of New VIX forward to New VIX



Source: Goldman Sachs

- The Forward VIX level can be calculated as:
$$2 \times (2 \text{ month variance swap volatility})^2 = 1 \times \text{VIX}^2 + 1 \times \text{VIX}^2 \text{ Forward}$$
- If the term structure of volatility is upward sloping, then the forward level for the New VIX will tend to be higher than the current spot level
- The basis (forward – spot index level) for one-month VIX / VIX2 forwards has been above or below the current VIX depending on market environment

Products on the New VIX are different from variance swaps

Variance swaps

- **Payoff at maturity based on *realized* volatility:**
 - $P/L = (\text{Realized volatility}^2 - \text{Reference level}^2) \times \text{Notional}$
- **Instantaneous payoff based on change in option prices**
 - $P/L = (\text{New reference level}^2 - \text{Old reference level}^2) \times \text{Notional}$

VIX products

- **Products on the New VIX will be based on *implied* volatility**
 - $P/L = (\text{VIX level at expiration}^2 - \text{VIX forward level set at trade initiation}^2) \times \text{Notional}$
- **The connection between the two products is that the New VIX calculation is based on variance swap fair volatility**

The VIX

Links to manager outperformance

When do equity managers add alpha?

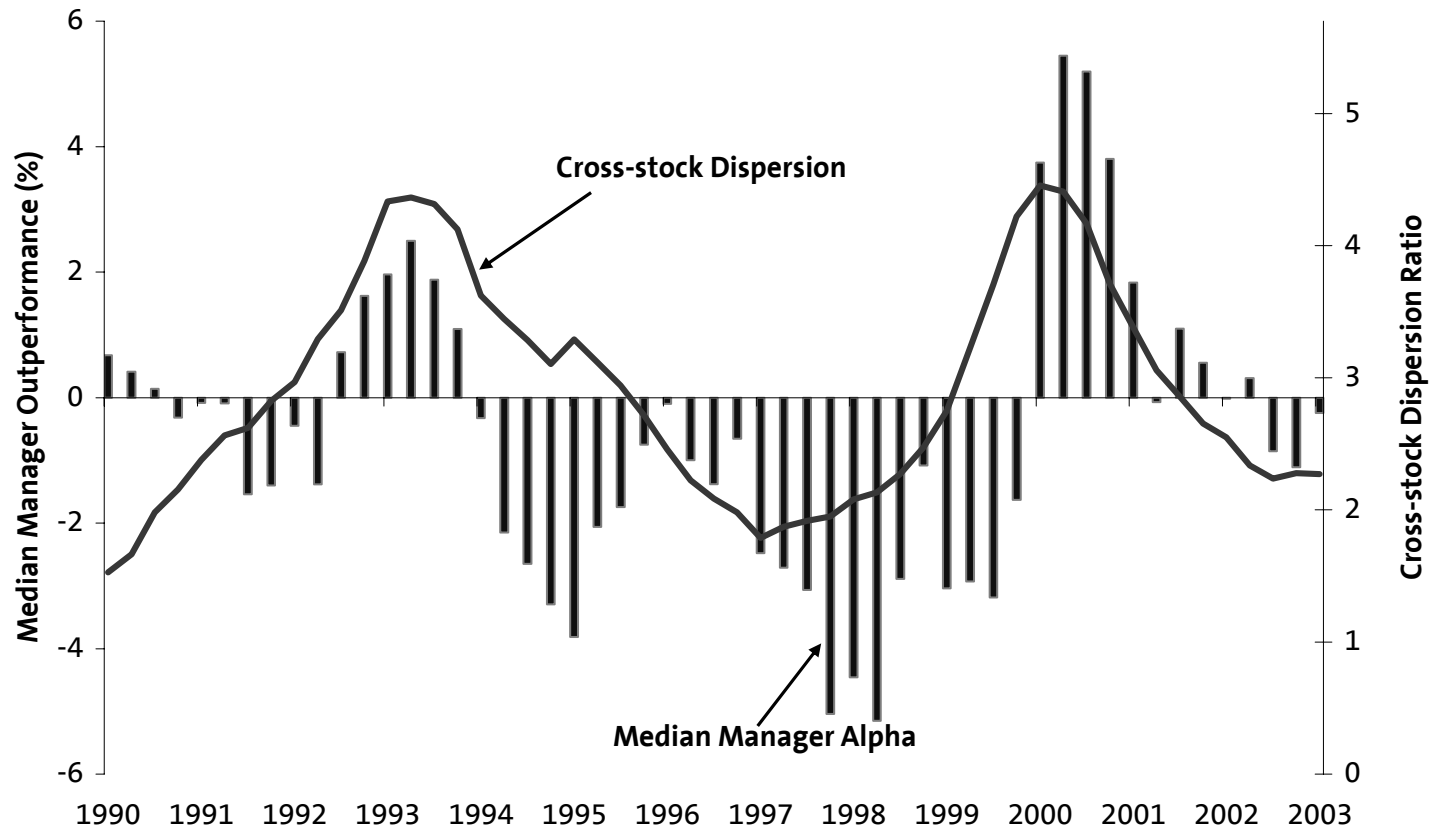
- **Market environments characterized by low dispersion (high correlation) across stocks make it more difficult for active managers to extract value from stock selection.**
- **Empirical results show that the returns to taking alpha risk rise as dispersion rises, especially for value stocks.**
- **Over the last 5 years, the level of cross-stock dispersion has been the factor that accounts for the largest portion of average long/short and market neutral hedge fund returns.**

Bottom Line:

- **Cross-stock dispersion has become the most dominant driver of returns with increased dispersion providing an increased opportunity set.**
- **Managers concerned about their exposure to dispersion could consider using derivatives strategies to immunize this exposure.**

Source: Goldman Sachs

Excess performance of large-cap core managers has moved in line with stock dispersion

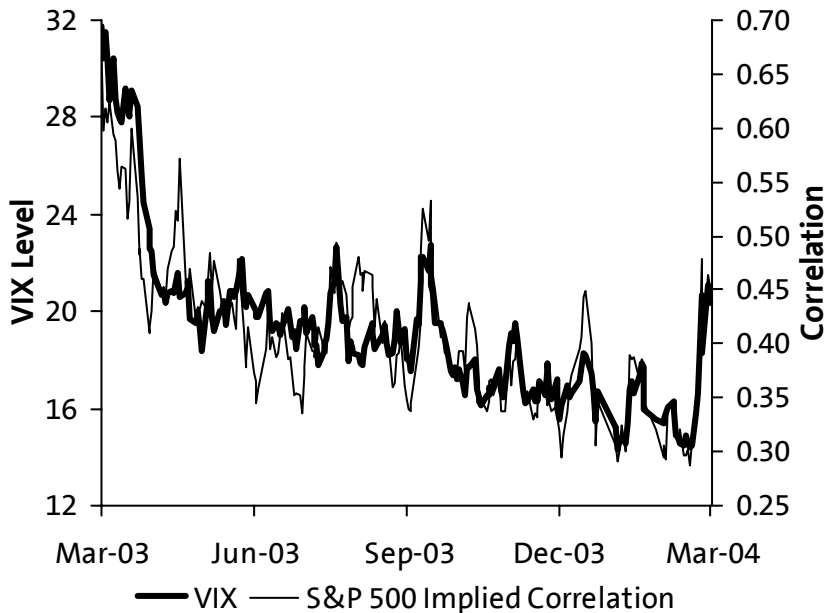


Notes: Outperformance is measured over the past 4 quarters. Dispersion is averaged over the past 4 quarters.

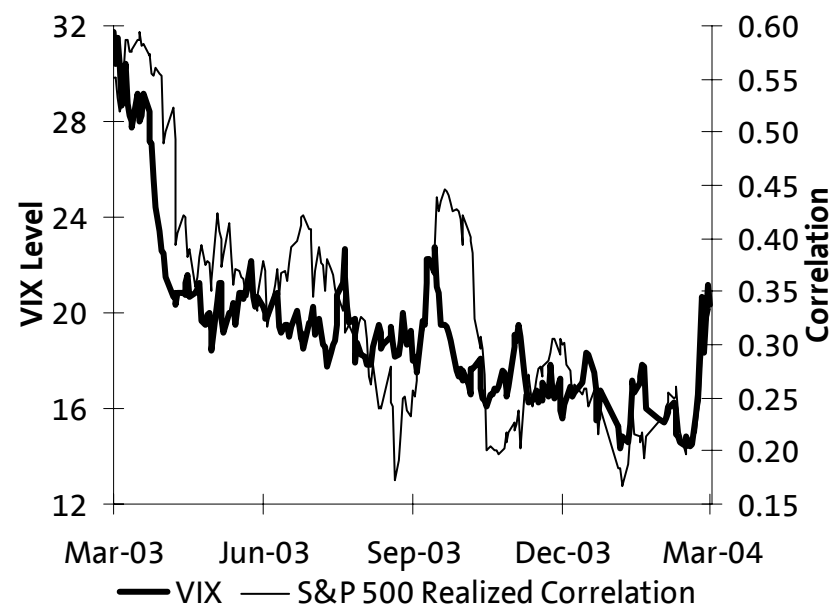
The VIX tracks correlation/dispersion

- During periods of high correlation, when active stock picking could be tough, a long VIX position which profits from an increase in volatility could be a good hedge.

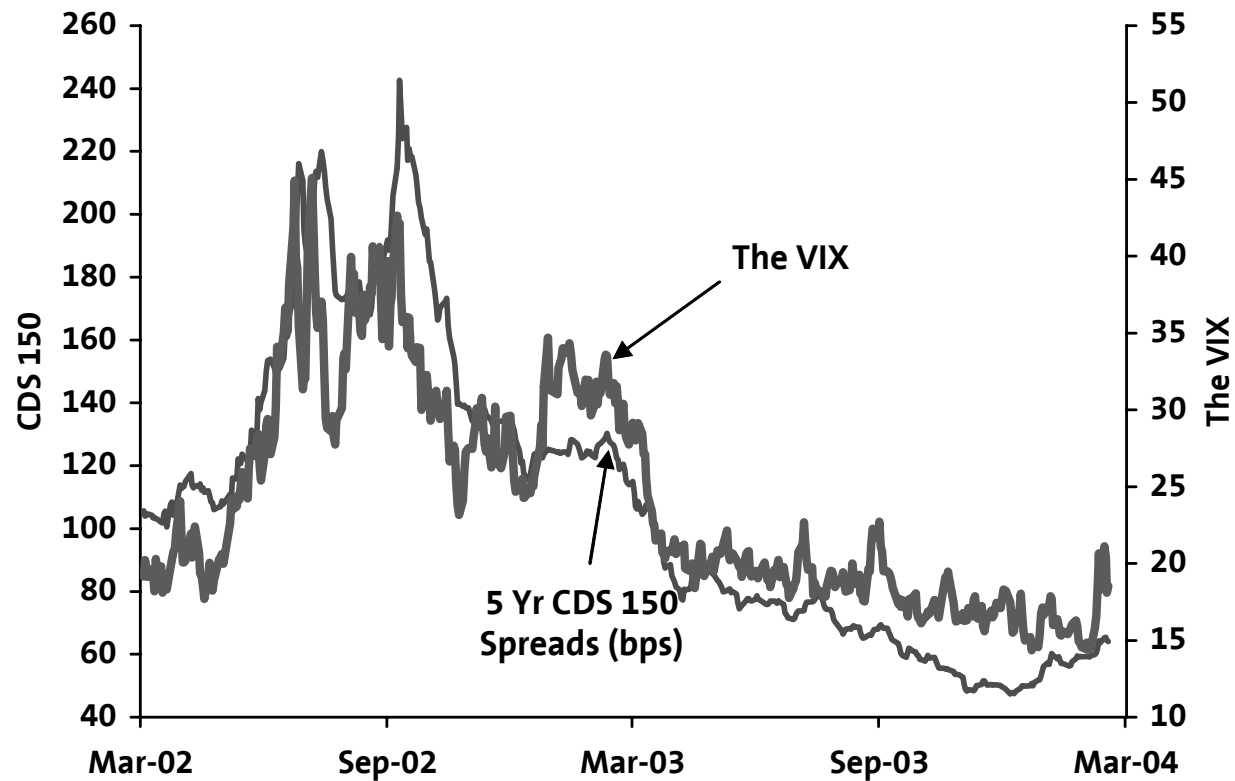
VIX vs. S&P 500 Implied Correlation



VIX vs. S&P 500 Realized Correlation



The VIX tracks aggregate credit spreads very closely



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