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

Michael McAleer
School of Economics and Commerce
University of Western Australia
and
Faculty of Economics
Chiang Mai University
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?

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

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

where:

\[ \sigma \text{ is } VIX / 100 \quad \Rightarrow \quad VIX = \sigma \times 100 \]

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); \textbf{where:}

\[ F = \text{strike price (at-the-money)} + e^{RT} \times (\text{Call price} - \text{Put price}) \]

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

\[ T = \frac{M_{\text{current day}} + M_{\text{settlement day}} + M_{\text{other days}}}{\text{Minutes per year}} \]

where:

- \( M_{\text{current day}} = \# \text{ of minutes remaining until midnight of the current day} \)
- \( M_{\text{settlement day}} = \# \text{ of minutes from midnight until 9:45 am on TFEX settlement day} \)
- \( M_{\text{other days}} = \text{Total} \# \text{ of minutes in the days between Current day and the settlement day} \)
\[ \sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2 \]

\( K_i \) Strike price of \( i \)th out-of-the-money option; a call if \( K_i > F \) and a put if \( K_i < F \)

\( \Delta K_i \) Interval between strike prices - half the distance between the strike on either side of \( K_i \)

[Note: \( \Delta K_i \) for the lowest strike is simply the difference between the lowest strike and the next higher strike. Likewise, \( \Delta K \) 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:

<table>
<thead>
<tr>
<th>Volatility Index</th>
<th>Index Options</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIX = New Volatility Index</td>
<td>SPX = S&amp;P500 Index Options</td>
<td>-0.86</td>
</tr>
<tr>
<td>VXD = DJIA Volatility Index</td>
<td>DJX = DJIA Index Options</td>
<td>-0.85</td>
</tr>
<tr>
<td>RVX = Russell 2000 Volatility Index</td>
<td>RUT = Russell 2000 Index Options</td>
<td>-0.86</td>
</tr>
<tr>
<td>VXN = Nasdaq-100 Volatility Index</td>
<td>NDX = Nasdaq-100 Index Options</td>
<td>-0.78</td>
</tr>
</tbody>
</table>
New VIX vs Original VIX and S&P500
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)
  - S&P 500: -3.8%
  - VIX: +16.8%

- Average price change on the 33 days when S&P500 rose by 3% or more (1990 - 2005)
  - S&P 500: +3.9%
  - VIX: -9.2%
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)