Liquidity considerations in estimating implied volatility

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Do we need a new implied volatility estimation methodology?

- The first method: ATM options, equally weighted. (CBOE VXO)
- New method: ATM+OTM options, weights are free of a specific option pricing model. (CBOE VIX)
- Why search for a new method?
Liquidity matters

- Financial markets deliver good prices when liquidity is robust.
- Recently, there have been instances of market liquidity freezing up (e.g., 6th May Flash Crash; Sep 2008, Global Financial crisis).
- Market prices are particularly crucial then; but they have to be adjusted for vanishing liquidity.
- Even more constant, cross-sectional variation in liquid for futures and options is high.
- This is a global phenomenon, not one restricted to emerging economies.
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NIFTY Call options for September 2007

NIFTY Call options for September 2008
An approach adjusting for cross-sectional liquidity

- Use all options that gives a current market price.
- Near-month and next-month maturities.
- Weight is a simple inverse of percentage spread.
- The liquidity adjusted VIX, \( SVIX \) is estimated as:

\[
\sigma_{tj} = \frac{\sum_i w_{it,j} \sigma_{it}}{\sum_i w_{it,j}}
\]

\[
w_{it,j} = \frac{1}{s_{it,j}}
\]

Where, \( s_{it,j} \) is the spread of the \( j^{th} \) option at time \( t \), and \( i \) is the maturity of the option, varying between near and next-month.

This weight incorporates cross-sectional variation in liquidity, automatically adjusts the lower weights for illiquid options.
Performance evaluation

Candidates competing with $SVIX$:

1. $VXO$,
2. Vega-weighted VIX ($VVIX$),
3. Elasticity-of-volatility-weighted VIX ($EVIX$)

Benchmark: Realised volatility (RV) using intra-day returns at one-minute intervals, scaled up to a daily volatility measure.
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Performance evaluations

Evaluations based on:
1. Forecasting regressions (Christensen and Prabhala, 1998)
2. MCS methodology (Hansen et al, 2003)

Forecasting regressions:
- LHS: log of the volatility candidate
- RHS: RV

MCS: log of the volatility candidates against each other.
Forecasting regression results

<table>
<thead>
<tr>
<th>Volatility Indexes</th>
<th>$a_0$</th>
<th>$a_1$</th>
<th>Adj.$R^2$</th>
<th>$\chi^2$</th>
<th>DW</th>
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</thead>
<tbody>
<tr>
<td>LVXO</td>
<td>-0.83</td>
<td>1.17</td>
<td>0.62</td>
<td>731.1</td>
<td>1.38</td>
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<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
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<td>LVVIX</td>
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<td>1.01</td>
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<tr>
<td>LEVIX</td>
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<td>1.05</td>
<td>0.43</td>
<td>269.0</td>
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<tr>
<td>LSVIX</td>
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<td><strong>0.95</strong></td>
<td><strong>0.59</strong></td>
<td>153.5</td>
<td>1.39</td>
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### MCS results

<table>
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<tr>
<th>VIX</th>
<th>MSE</th>
<th>$p_{Tr}$</th>
<th>MCS($p_{Tr}$)</th>
<th>$p_{TSQ}$</th>
<th>MCS($p_{TSQ}$)</th>
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<tbody>
<tr>
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<td>LEVIX</td>
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<tr>
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<td>0.019</td>
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<tr>
<td>LSVIX</td>
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<td>-</td>
<td>1.000</td>
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</table>

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The liquidity adjusted VIX, $\text{SVIX}$, shows the
1. Smallest bias vis-a-vis the $RV$,
2. The second best $R^2$ value in the forecasting regression, and
3. The best performance in the MCS tests.

The vega-weighted $\text{VVIX}$ has the second best MCS performance, but has the lowest $R^2$ in the forecasting regression.

The $\text{VXO}$ has the largest bias and the worst MCS performance, but shows the best $R^2$ fit.

Thus, the $\text{SVIX}$ can be taken as an improvement, with
- relatively good performance, and
- the advantage of being easier to implement compared to other existing methods that restrict the set of options used to calculate the VIX value while accounting for illiquidity.