Liquidity considerations in estimating implied volatility

Rohini Grover   Susan Thomas

Presentation at the 7^{th} conference of
Asia-Pacific Association of Derivatives

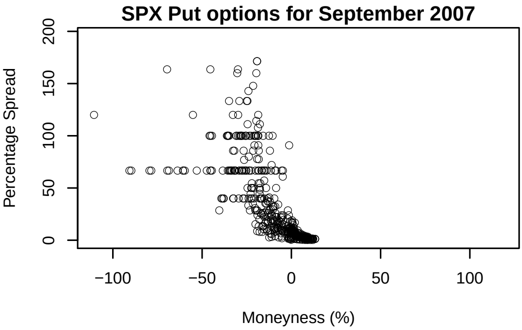
26 August, 2011

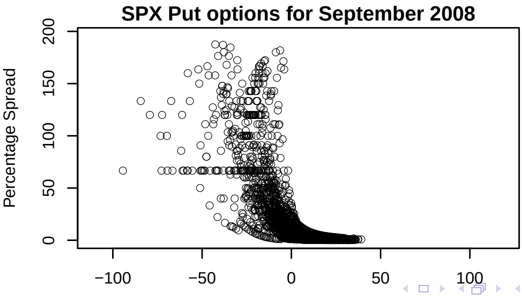
Do we need a new implied volatility estimation methodology?

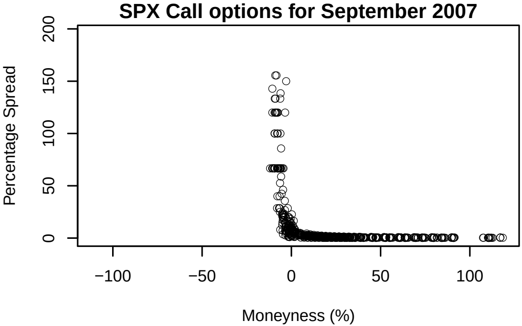
- The first method: ATM options, equally weighted. (CBOE VXO)
- New method: ATM+OTM options, weights are free of a specific option pricing model. (CBOE VIX)
- Why search for a new method?

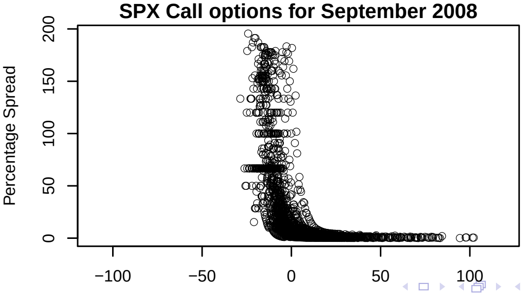
Liquidity matters

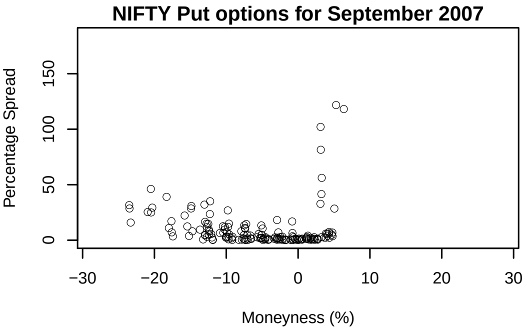
- Financial markets deliver good prices when liquidity is robust.
- Recently, there have been instances of market liquidity freezing up (eg. 6^{th} May Flash Crash; Sep 2008, Global Financial crisis).
- Market prices are particularly crucial then; but they have to be adjusted for vanishing liquidity.
- 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

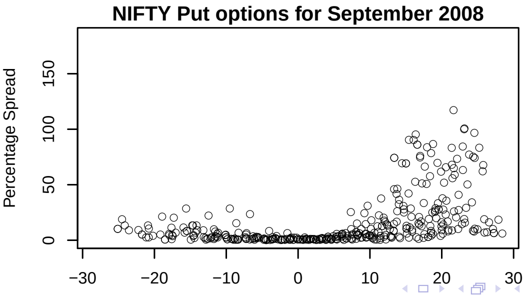

SPX Put options for September 2007
Percentage Spread
0
50
100
150
200
−100
−50
0
50
100
Moneyness (%)

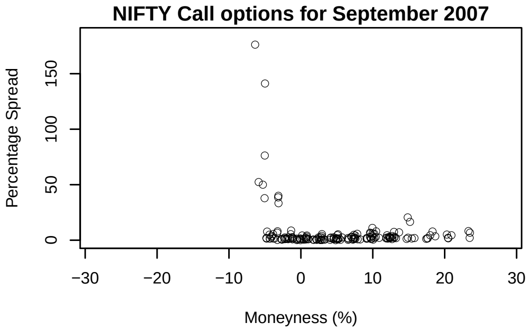

SPX Put options for September 2008
Percentage Spread
0
50
100
150
200
−100
−50
0
50
100

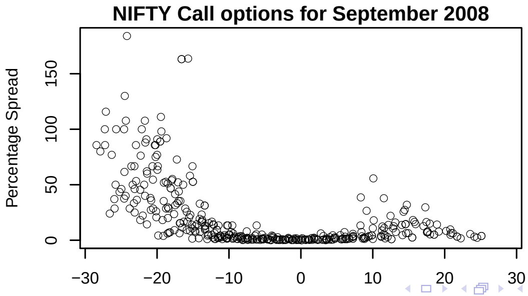

SPX Call options for September 2007
Percentage Spread
0
50
100
150
200
−100
−50
0
50
100
Moneyness (%)


SPX Call options for September 2008
Percentage Spread
0
50
100
150
200
−100
−50
0
50
100


NIFTY Put options for September 2007
Percentage Spread
0
50
100
150
−30
−20
−10
0
10
20
30
Moneyness (%)


NIFTY Put options for September 2008
Percentage Spread
0
50
100
150
−30
−20
−10
0
10
20
30


NIFTY Call options for September 2007
Percentage Spread
0
50
100
150
−30
−20
−10
0
10
20
30
Moneyness (%)


NIFTY Call options for September 2008
Percentage Spread
0
50
100
150
−30
−20
−10
0
10
20
30

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 :

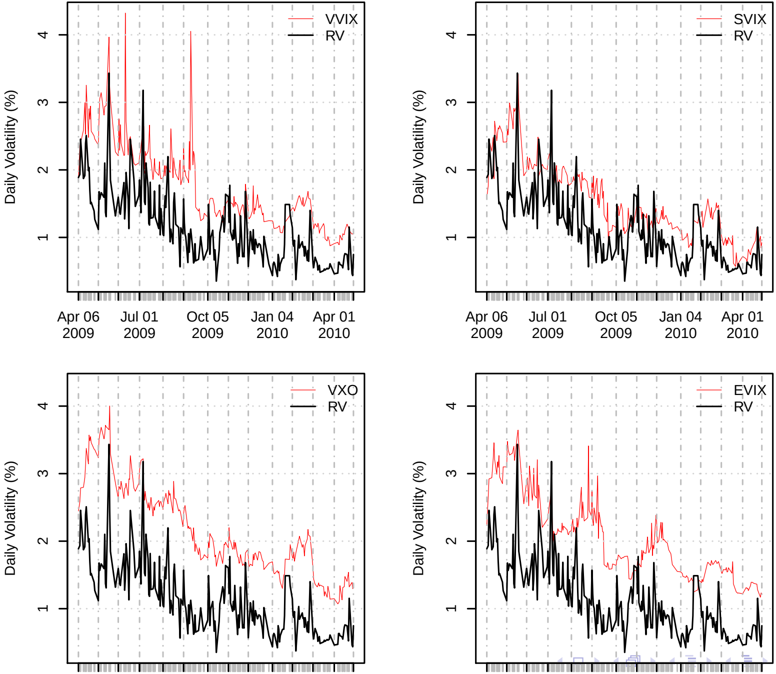
$$\sigma_{tj} = \frac{\sum_i w_{it,j}\sigma_{it}}{\sum_i w_{it,j}}$$

$$w_{it,j} = \frac{1}{s_{it,j}}$$

- 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 competiting 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.


VVIX
RV
SVIX
RV
VXO
RV
EVIX
RV
Daily Volatility (%)
1
2
3
4
Apr 06 2009
Jul 01 2009
Oct 05 2009
Jan 04 2010
Apr 01 2010

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

Volatility Indexes	a_0	a_1	Adj.R^2	χ^2	DW
LVXO	-0.83	1.17	0.62	731.1	1.38
	(0.00)	(0.00)		(0.00)	
LVVIX	-0.50	1.01	0.57	249.1	1.23
	(0.00)	(0.00)		(0.00)	
LEVIX	-0.69	1.05	0.43	269.0	0.99
	(0.00)	(0.00)		(0.00)	
LSVIX	**-0.33**	**0.95**	**0.59**	153.5	1.39
	(0.00)	(0.00)		(0.00)	

MCS results

VIX	MSE	p_{T_r}	MCS(p_{T_r})	$p_{T_{SQ}}$	MCS($p_{T_{SQ}}$)
LVXO	0.392	0.019	0.019	0.000	0.000
LEVIX	0.304	0.011	0.019	0.000	0.000
LVVIX	0.201	0.006	0.019	0.006	0.006
LSVIX	**0.112**	-	**1.000**	-	**1.000**

Conclusion

- The liquidity adjusted VIX, 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 VVIX has the second best MCS performance, but has the lowest R^2 in the forecasting regression.
- The VXO has the largest bias and the worst MCS performance, but shows the best R^2 fit.
- Thus, the 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.