Volatility surfaces, stress testing and OCC portfolio margin

Ravi K. Jain

Volatility surfaces and stress testing

Calculating the current implied volatility of an option or the entire options chain of listed options is quite straightforward. However the use of these implied volatilities in risk measurements has varying implications.

One of the most common and effective risk measures is a stress test or a scenario (which is also the basic building block for VaR). Option traders constantly look at their stress tests of PL and greeks for changing market prices.

When running a stress test on an options portfolio, the most common stress factor is the underlying price. But as the underlying price changes, so does the volatility and possibly the shape of the implied volatility curve. Thus to get a reasonable measure of risk due to the stress of the underlying, a decision still has to be made on how to handle the volatility surface. This is regardless of whether the volatility is being stressed (i.e. vega risk is being analyzed) or not.

The simplest and most transparent method is to "attach" the current market implied volatility to the strike of the option. This method is called "sticky strike" and it applies the price shock keeping the current volatility for a given strike unchanged. This method is easy to understand and deploy within a risk system. However this method *may* give significantly misleading results in the case of a large implied volatility "smile". If the implied volatility curve is pretty much flat, i.e. similar across all strikes for a given expiration, then the sticky strike method would work perfectly fine.

Another method is to fix the current implied volatility to the money-ness of each strike – which is referred to as "sticky money-ness". This method moves the volatility surface along with the move in the underlying price, completing preserving the shape of the curve. The rationale is simple – as the market moves, the shape of the implied volatility surface typically remains similar.

The most complex method, and least transparent, is using some form of a "stochastic volatility" model. In this case, based on the move in the underlying, the entire volatility surface is shifted. A simple implementation of this could be to use sticky money-ness but augment it with the at-the-money volatility moving to the current implied volatility for the projected at-the-money strike. So if the underlying is being stressed from price X to price Y, then the new at-the-money volatility will be the current volatility for an option with strike price Y.

While there are many variations of these methods used by traders and risk managers, for this article, these three give us a good idea of the various methods. Each of these can produce very different risk numbers. Let's take some examples.

Chart1 shows the implied volatility surface on Oct 14th for AMZN options expiring on 11/14/2014. The market price was $310.

Chart 2 shows the various volatility surfaces that would be used for the 3 different methodologies if the price of AMZN was stressed to $292.50

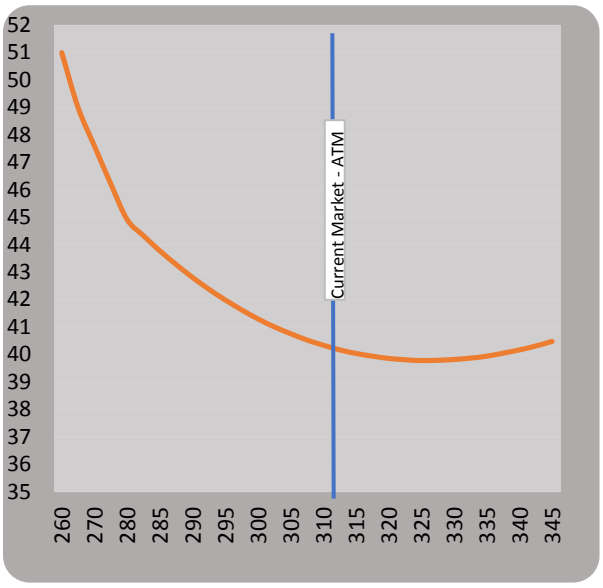


Chart 1: current IV surface

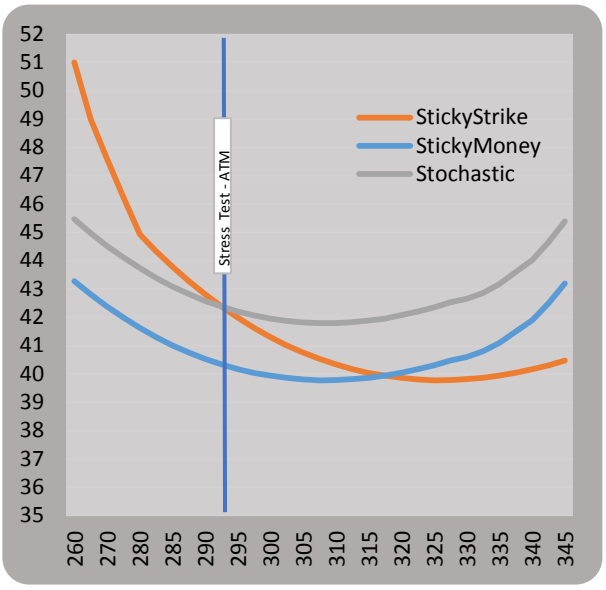


Chart 2: IV surfaces for different methodologies at the stress point

Table 1 shows the stress test PL for several different options using the three methods.

Date	Stock	Price	Strike	CP	Expiration	Vol	Shocklevel	StickyStrike	StickyMoney	Stochastic
14-Oct	AMZN	310	280	P	14-Nov	46.20%	292.5	-$47,700	-$34,500	-$41,200
14-Oct	AMZN	310	335	C	14-Nov	39.94%	292.5	$29,500	$27,300	$23,200

Each position is short 10,000 shares (100 contracts) of the option

As is clear, the 3 methods will price the options with significantly different implied volatility on the stress test, which results in very different stress test results. The difference in risk can be quite large.

So which is more accurate? While most traders would reject Sticky strike and prefer either Sticky money-ness or a stochastic method – as they are closest to how the market actually prices volatility – we decided to look as some empirical numbers.

We randomly selected several days when a random set of stocks had a price move in excess of 4% (excluding earnings dates). For each day the risk of the price move using the 3 different methods is compared to the actual PL that would have occurred for the same positions. To proxy this, all that needed to be checked is:

- Initial Implied volatility of the option , which will be the same as the stress test point volatility in the case of Sticky strike
- The stress point volatility for the option if Sticky money-ness was used and if Stochastic was used
- The actual implied volatility in the market the next day (i.e actual volatility after the move)

Table 2 shows the results of this test.

					Projected volatility			
Stock	***Date***	***Option***	***Stock Price Change***	***Vol Before***	***StickyStrike***	***StickyMoney***	***Stochastic***	***Actual***
NFLX	4/24/2014	May 270P	$344 to $322	51%	51%	46.30%	48.50%	46%
FB	3/5/2014	Apr 55P	$65.89 to $60.39	44%	44%	40%	42%	39%
XOM	7/30/2014	Aug 90P	$103.25 to $98.94	17%	17%	12%	13.00%	18%
AMZN	5/5/2014	May 260P	$310.05 to $297.38	44%	44%	38.50%	40%	37%
AMZN	4/9/2014	Apr 290P	$331.8 to $317.11	44%	44%	39.00%	43%	43%
HAL	10/10/2014	Dec 47.5P	$54.29 to $50.26	42%	42%	40%	42.50%	43%

The volatilities shown are best estimate using closing implied volatilities

Surprisingly there is no clear winner. The only conclusion that can be drawn is that the Sticky strike method is the least accurate is estimating the volatility post a large move and thus would be the least desirable to use in stress testing. This supports the assertion that traders would prefer to use a Sticky money-ness or stochastic method over the sticky strike.

The OCC and Portfolio Margin

Several years ago, Customer Portfolio Margin was introduced for equity options positions. The margin calculations are performed by The Options Clearing Corp ("OCC") using their TIMS methodology, which is the only SEC approved method for customer portfolio margin calculations.

The methodology is stress test based, where each underlying is shocked by various percentage moves, typically about 8% for indices and 15% for single stocks. The worst case loss for each underlying is calculated and aggregated using some aggregation logic.

Since it is stress test based, clearly, based on the discussion above, the implied volatility surface used to perform the simulations is important. The OCC does not fully disclose details of their methodology, stating it is proprietary, however they publish their stress results and volatilities for each option each day.

The OCC has chosen to use the "sticky strike" method in their stress tests. While our analysis shows that "sticky strike" is probably the least accurate, on the flip side, it is the most transparent and defendable – so the choice to use this, by the OCC, is understandable.

Volatility smoothing: impact on stress tests and portfolio margin

The OCC uses the end of day calculated implied volatilities. However many times there exists bad option price settlements often due to a very wide bid/ask spread at the close. This can result in unreasonable "kinks" in the implied volatility smile and in some case even create arbitrage conditions from one strike to another - e.g. a further out of the money option be priced higher than the adjacent strike that is less out of the money. Every option trader knows that such simple arbitrage conditions do not really exist in the market.

The OCC volatility methodology recognizes this and they typically "smooth" the option prices and the volatility surface to avoid such conditions. Their methodology involved certain price adjustment logic to remove any consecutive strike arbitrage and then further to smooth the volatility surface by fitting a fifth order polynomial function.

However since June 13th, 2014, we notice that the OCC volatilities are ***not*** being smoothed. We believe this is quite dangerous and in some cases can produce some very unrealistic portfolio margin numbers. A specific example (taken from the published OCC end of day file) is the AAPL volatility surface for out of the money calls for expiration 11/22/2014 on the close of business on 10/16/2014.

The implied volatility for the 135 call is clearly wrong due to a bad settlement.

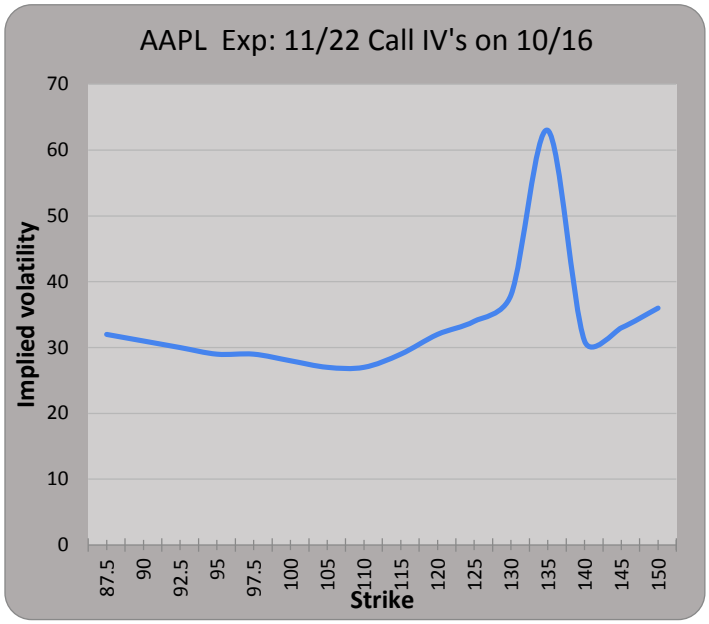


Chart 3: IV for AAPL on 10/16/2014

Now assume a portfolio of Long 125 Calls and Short 135 Calls – a simple call spread – in 10,000 shares

Table 3: Call spread margin

Date	Stock	Price	Strike	CP	Expiration	Position	Volatility	Shocklevel +15%	PL
16-Oct	AAPL	96.26	125	C	22-Nov	10000	34.00%	110.699	$8,000
16-Oct	AAPL	96.26	135	C	22-Nov	-10000	63.00%	110.699	-$16,500
								Tot Port Margin	***-$8,500***

The portfolio margin for this position would have been calculated at $8,500 – for a long call spread – which should have no portfolio margin at all! The margin is solely due to the wrong volatility for the 135 call. If the implied volatilities were smoothed, the risk would be calculated correctly, and no margin requirement be shown.

This clearly demonstrates the need for proper smoothing, in particular for deep out of the money options.

Volatility wing clipping: impact on stress tests and portfolio margin

Implied volatility for very deep out of the money options are quite meaningless. After some point, all the options are essentially worth nothing, and thus the calculation of implied volatility for these will result in very high numbers.

When using "sticky strike" for stress testing, these very high implied volatilities can cause a major problem, as they will make the value of these options rise dramatically when the underlying price is stressed closer to these strikes – at which point they are no longer deep out of the money. We saw this effect in the first section when using different volatility methods.

As simple technique to fix this, is to "clip" or flatten out the implied volatilities curve at some point. Thus eliminates the extremely large and meaningless volatility numbers.

Chart 3 shows a volatility surface with and without clipping for AAPL on July1, 2014.

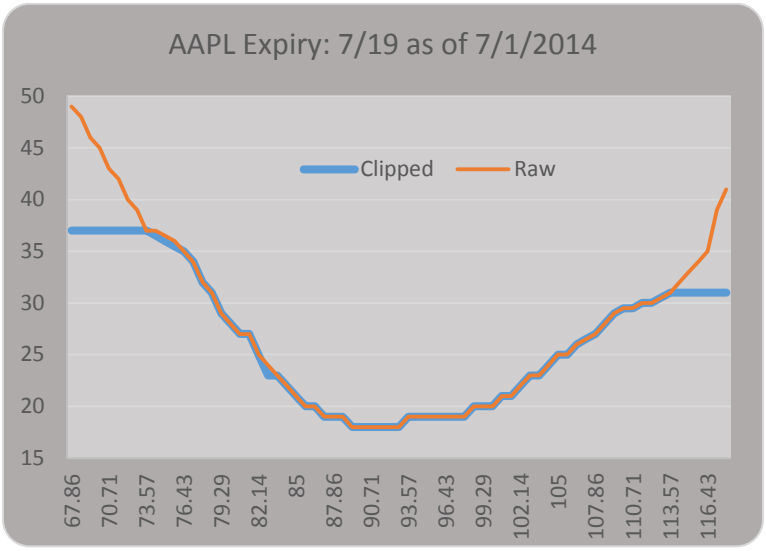
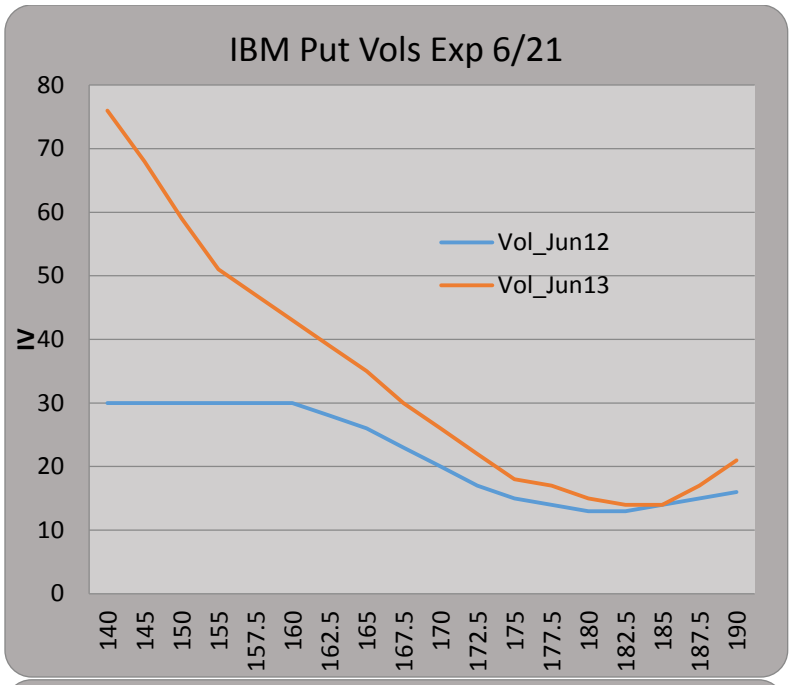
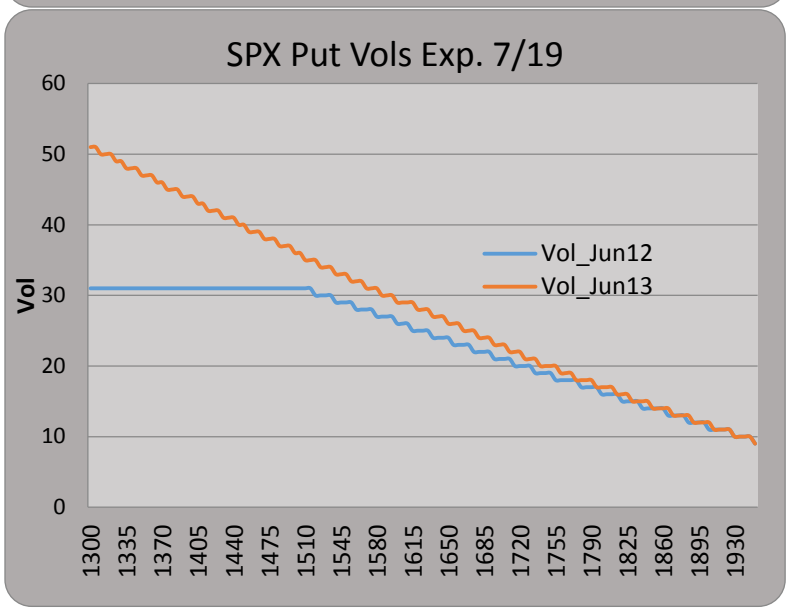


Chart 4: "wing clipping" example

The OCC did employ clipping as part of their volatility smoothing logic, thus correcting the issue of massively overvaluing the risk of deep out of the money options. However once again we notice that the OCC has removed this clipping since June 13th,2014– thus causing very deep out of the money options to have an enormous margin impact. Below are several volatility curves from the OCC comparing Jun 12th and Jun 13th.


IBM Put Vols Exp 6/21
IV
80
70
60
50
40
30
20
10
0
Vol_Jun12
Vol_Jun13
140
145
150
155
157.5
160
162.5
165
167.5
170
172.5
175
177.5
180
182.5
185
187.5
190


SPX Put Vols Exp. 7/19
Vol
60
50
40
30
20
10
0
Vol_Jun12
Vol_Jun13
1300
1335
1370
1405
1440
1475
1510
1545
1580
1615
1650
1685
1720
1755
1790
1825
1860
1895
1930

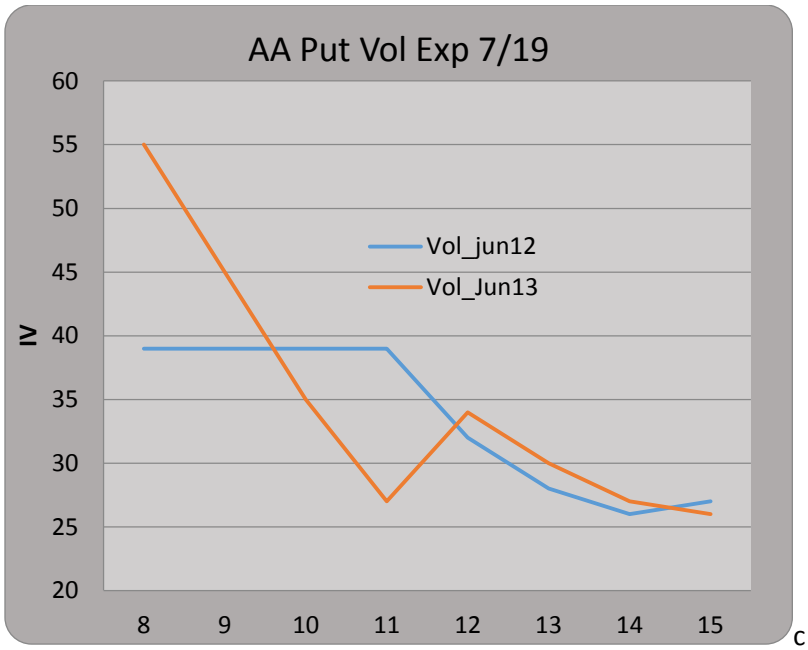


Table 5 below shows the portfolio margin number on June 12th and that on Jun 13th for the same position. The difference is all due to the change in volatility surface smoothing and clipping from June 12th to June 13th.

Stock	Strike	CP	Margin Jun12th	Margin Jun13th	Change	Reason
IBM	150	P	$115	$206	79%	No clipping, thus unrealistic IV for deep OTM puts
SPX	1500	P	$244	$418	71%	No clipping, thus unrealistic IV for deep OTM puts
AA	11	P	$20	$3	-85%	No smoothing, thus using bad IV for the 11 strike

Table 5: OCC margin requirements Jun 12th vs Jun 13th

In all these cases, the underlying stock price change was very small, thus the margin number change should have been small from one day to the next.

In summary: The intent of this paper is not to disparage the OCC, as we value their expertise and recognize the challenge in providing accurate risk calculations. The purpose is to highlight the fact that recently we have noticed some irregularities in the risk calculations provided by the OCC which should be addressed – as many clients rely on accurate information from them.

Ravi Jain is an independent consultant in the area of risk management, derivative modeling and financial technology and specializes in volatility modeling. He can be reached at ravi@savitarconsulting.com and welcomes comments and feedback on the article