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Options liquidation can be costly
How costly?

Options liquidation can be costly. How costly?

New model uses open interest and volume data to calculate the expense of selling an options portfolio during times of stress, writes *Ravi K Jain*

The options trading boom shows little sign of fizzling out. Average daily volumes of cleared options are more than double pre-pandemic levels, and continue to rise, according to data from the Options Clearing Corp.

When bets go sour, dealers are sometimes forced to liquidate options portfolios. This process can result in slippage and additional losses due to lack of liquidity. So, firms often hold a liquidity add-on component to the margin or capital requirement, which is meant to cover the risk of such losses.

Working out the add-on is hard enough for cash equity portfolios. It's even harder for options.

One common method is to compare the delta of a portfolio against a measure of liquidity, such as average daily volume of the stock. Delta is the sensitivity of an option's price to changes in the price of the underlying asset. However, this method has low informational value, and does not fully capture the risk of liquidation.

At the minimum, the portfolio should be shocked by applying an appropriate underlying shift and possibly an implied volatility shock to calculate delta under stress. Comparing this simulated delta against a liquidity measure has some value. When the portfolio is under stress, the delta at the stress level defines the immediate exposure to a continued move in the underlying, and thus represents the first-order risk that ought to be covered with margin or capital requirements. If the delta is large compared with the chosen metric for liquidity, it will result in potential slippage to the hedge, and thus a liquidity add-on based on this delta would be appropriate.

But this measure alone overlooks the cost of liquidation of the actual options in the portfolio.

Here, we propose a model for estimating the liquidation cost of options that uses open interest and volume data to account for the way that dealers adjust their quotes during periods of market stress.

A liquidation cost model: the challenges

Measuring liquidity for a stock position is easy, as there is only one real measure: stock volume. Firms can use this volume to develop an appropriate statistic to compare the position to.

Options on a given stock have multiple strikes and multiple expirations, for both calls and puts. Each option has its own traded volume and open interest, both of which could vary significantly. Comparing each option position in a portfolio to the liquidity for that particular strike and expiration is not a good measure of available liquidity, as other related contracts could have much higher liquidity. Thus, the true overall liquidity available needs to incorporate the liquidity across multiple strikes and expirations.

"We propose a model for estimating the liquidation cost of options that uses open interest and volume data to account for the way that dealers adjust their quotes during periods of market stress"

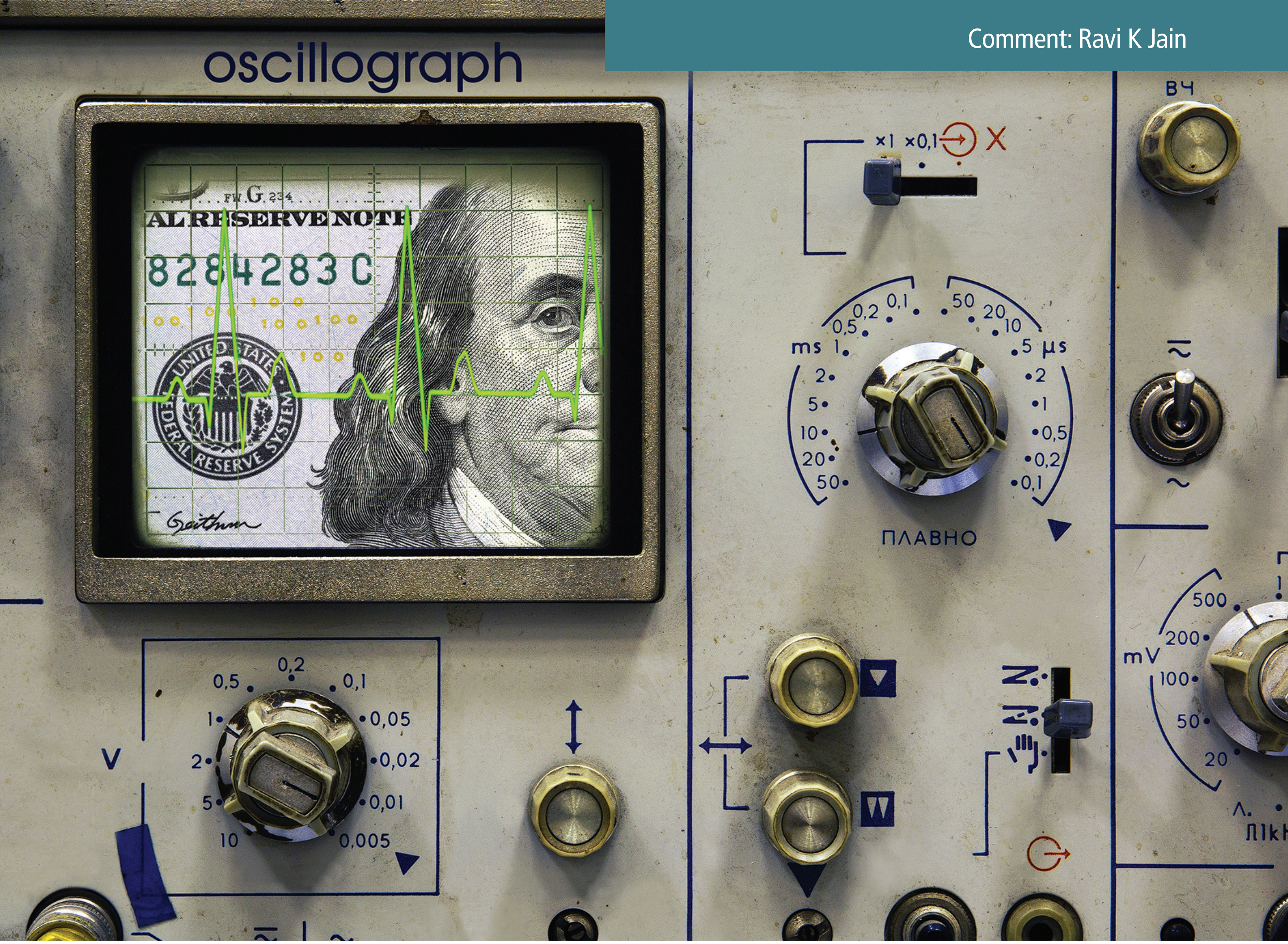
As an example, consider the following options chain on June 27, 2022, for Tesla.

Tesla options chain, June 27, 2022

Symbol	Expiration	Strike		Bid	Ask	Volume	OI	IV
TSLA	19/08/22	735	Call	79.60	80.70	87	98	71.27%
TSLA	19/08/22	740	Call	77.35	78.20	157	487	71.32%
TSLA	19/08/22	745	Call	74.80	75.70	70	123	70.83%
TSLA	19/08/22	750	Call	72.40	73.35	3,378	1,722	70.70%
TSLA	19/08/22	755	Call	70.05	70.85	33	94	70.28%
TSLA	19/08/22	760	Call	67.90	68.75	180	942	70.29%
TSLA	19/08/22	765	Call	65.75	66.45	44	87	70.06%
TSLA	19/08/22	770	Call	63.45	64.05	43	629	69.56%

While there is little volume on the 745 or 755 strike, there is significant volume on the 750 strike. If a risk manager needed to liquidate a large position in strikes near 750, market participants with interest in the 750 strike would take the trades.

Another difficulty is that many portfolios have option spreads: long an option of a particular strike or expiration against a short option in a different strike or expiration. It is common to take the gross number of



option contracts in a portfolio and compare that against some measure of liquidity. But this will often result in an exaggerated cost of liquidation. Firms can usually execute options spreads near mid-market, as opposed to paying the bid/ask on each leg of the spread, and thus incur a lower cost of liquidation.

The mechanics of options

To build an appropriate model, it is also necessary to understand how the options market – and its liquidity providers – work in practice. For the sake of this model, we assume that option market-makers are short options – as they usually are.

When the market is under stress from a large and often sudden or unexpected move in stock prices, market-makers end up with a large delta position, and thus need to hedge using the underlying stock. If there is a lack of liquidity in the underlying, the cost of hedging increases which can lead to the phenomenon known as a 'gamma squeeze'. Here, firms have to sell (or buy) in a falling (or rising) market and due to lack of liquidity, the market is pushed further, making them sell (or buy) more. When this happens, options market-makers naturally have to widen out their option quotes, and overall options liquidity is compromised, raising the liquidation costs for others. However, if stock liquidity is high, then delta-hedging is not an issue, and market-makers can continue to make normal option spreads and offer normal liquidity.

Another phenomenon is based on options volume. When the market is under stress, options traders seek to trade out of positions or move positions around. If there is ample trading volume in various strikes, it allows lower friction trading of options against a portfolio and thus option spreads do not widen. However, if volumes dry up, then option spreads will widen.

In times of stress, the two main factors that determine the slippage cost to liquidate an options portfolio are the volume of the underlying and net volume of the options. The best comparison for these factors is open interest (OI), which represents how many live contracts exist in the market. A high OI indicates a larger number of options held by market-makers that will thus need stock and options liquidity. A low OI is the opposite.

Options liquidity model

Given the above market dynamics, we propose the model below.

We define:

V = average volume of the underlying stock, for example average daily volume or median volume

OV_c = Average volume of all call options. Again, can be replaced with the median or any other similar statistic

OV_p = Average volume of all put options

OI_c = sum of open interest of all call options

OI_p = sum of all open interest for all put options

We calculate a metric X_c and X_p, for calls and puts respectively, which represents the expected slippage of the option premium on liquidation of options. An option portfolio is usually marked to market based on the mid-point and thus normal slippage would be the difference between the ask and the mid when buying an option.

$$X_c = \max\left(\min\left(z * \log\left(q * \frac{OI_c}{V}\right), z * \log\left(\frac{OI_c}{OV_c}\right)\right), m\right)$$

$$X_p = \max\left(\min\left(z * \log\left(q * \frac{OI_p}{V}\right), z * \log\left(\frac{OI_p}{OV_p}\right)\right), m\right)$$

Where:

z = 50% of the typical bid/ask spread of the options market for a given underlying, which is the normal slippage

q = the contract size for options; in the US, this is 100

m is the minimum value for our metric X, thus representing the minimum expected change in the option slippage when liquidation occurs. For options prices, that are quoted in 'pennies' we would recommend setting m to 0.01 or 0.02, while for those quoted in 'nickels', m could be set to 0.05 or 0.10.

The setting for z can be problematic. Different options for a given underlying can have different bid/ask spreads. For the purpose of this article, z is the average bid/ask spread for a reasonable set of options. This can be calculated by capturing the bid/ask spread of a set of options (some at-the-money and some out-of-the-money, at different expirations) each day at a liquid time of the market and taking the average of the spreads for each underlying.

Alternatively, z can be assumed to be a percentage of the underlying price of the stock, such as:

$$z = S * 10^{-4}, \text{ where } S \text{ is the underlying price}$$

This tends to work well for stocks with an active options market, but not so well for less active markets.

The final liquidity add-on or cost of liquidation is:

$$\textit{Liquidation Cost} = q * ((N_c * \max(X_c, z)) + (N_p * \max(X_p, z)))$$

Where N_C = net number of short call options contracts in the portfolio and N_P = net number of short put options contracts in the portfolio.

Note that we take the maximum of our calculated slippage and the z value. This is because for cases where is there very high stock liquidity or very high options volume, the calculations from 1 and 2 above can result in values less than half of the current bid/ask spread.

The model may look counterintuitive at first glance. It is not uncommon to use options open interest as a direct indicator of liquidity in the market. However, in our model, it is an inverse indicator. The logic to this is that large options OI compared to underlying volume and/or options volume sets up an unstable condition in a market that is under stress, and will result in option prices widening, and an increase in the cost of liquidation.

Testing the model

It is difficult to test the model with real data from liquidation events as the availability of such event data is limited and often kept private to an organisation. However, it is possible to determine the validity of the model by comparing bid/ask spreads in the options market before and during a large move in the price of the underlying. The change in the half-spread in the market should correspond to the X values in formula 1 and 2 of the model.

> "Comparing each option position in a portfolio to the liquidity for that particular strike and expiration is not a good measure of available liquidity, as other related contracts could have much higher liquidity"

We took five large moves in stocks over the last few years, where there was sizeable options interest, and where a brokerage firm might have had to liquidate a client's portfolio.

In each case, we consider call options only and use average spread data from the first few expirations as well as strikes that are between 40% and 60% delta. For the open interest and volume data, a 10-day average is used.

Test results of model using real market events

Symbol	Event date	z prior to event	OI calls	OV calls	V	Xc	Actual average slippage
TSLA	09/03/20	0.280	834,645	16,542	1,200,142	1.10	0.600
GME	13/01/21	0/040	388,639	15,813	1,943,454	0.12	0.100
MRNA	09/08/21	0.650	276,048	133,233	18,598,024	0.26	0.500
CCL	09/11/20	0.014	1,116,700	105,309	37,458,826	0.02	0.015
NVDA	04/11/21	0.060	1,185,220	393,870	27,255,668	0.07	0.080

For TSLA, the model suggested a slippage charge of $1.1 compared to the prior market slippage of $0.28, while the actual slippage after the event was an average of $0.60. Thus, the model was conservative and would have resulted in an excess liquidity charge.

For GME, the slippage rose from $0.04 to $0.10, while the model suggested $0.12, once again on the conservative side, but quite close to what happened.

For MRNA, given the high liquidity of the stock and high call volume, the model predicted no additional slippage compared to the initial market of $0.65. Sure enough, the actual slippage during the event would have been only $0.50, thus the model correctly suggested the lack of need for a higher liquidity charge.

For CCL, the model suggested a small increase in slippage, once again conservative compared to actual movements. In the case of NVDA, the model underestimated the cost of slippage, but still was reasonable as it did suggest an additional liquidation charge.

In conclusion, the model presents a unique method for calculating a liquidity add-on charge for large option portfolios. Unlike simple approaches, the model incorporates the nuances of the options market, accounting for the way market-makers hedge their options books, which can have serious implications for liquidity. It can serve as a starting point for further refinement as well as analysis using a broader set of historical data, as the initial testing was performed on a small dataset. However, it does show promise as a measure of slippage cost in the liquidation of an options portfolio. ■

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