Applying 'Gamma Exposure' to Individual Stocks

It has been established that an aggregated metric that models net dealer 'gamma exposure' for the S&P 500 has the ability to forecast volatility and signal opportunities for options traders.

We believe that a similar metric can be applied to individual stocks and provide the same opportunities for trading.

Introduction:

It has been already established that an aggregated 'gamma exposure' metric on the S&P 500 is a fantastic model to forecast and explain SPX volatility. While the concept of option market maker hedging activity influencing underlying asset prices is not new, the first calculated 'net' gamma exposure metric was published in 2017 by Prior Analytics LLC, or 'Squeeze Metrics'.

The idea was simple: by a few simplifying assumptions, one could "measure" dealer's gamma exposure on the S&P 500. By knowing the gamma exposure, you could estimate how many dollars of hedging, and in which direction, would have to come to market for every 1-point move in SPX. Therefore, you would essentially know when the market is more conducive to volatility, and when hedging dollars would stifle it.

The main assumptions in crafting this metric were:

- All options trades are facilitated by a delta hedging party
- All calls are sold to market makers, and all puts are bought from market makers

Armed with these assumptions, you could assign all call option open interest gamma to the market maker and subtract all put option open interest gamma from the market maker to get a net metric. A simple summation. Although these assumptions are not grounded in reality, they are well understood and make a statistically significant model.

Furthermore, this model has only been **successfully applied** to the S&P 500 index, not its constituents. One could imagine that due to the successes of this metric in explaining S&P realized volatility, it would be a worthwhile to pursuit to see if a similar model could be developed for individual equities.

Is applying 'GEX' to stocks possible?

The efficacy of the gamma exposure model as a statistical predictor of volatility requires hedging volume sufficient enough to impact the price of the underlying security. These hedging volumes are derived from the delta neutralization of outstanding, unsettled options contracts on the underlying held by market participants who are averse to taking directional positions (liquidity providers aiming to be delta neutral).

Just as SPX option delta can be hedged through the purchase of E-Mini futures, Facebook option delta can be vanquished with an offsetting stock position. As a leader in average daily option volume, FB is an attractive candidate for analysis.

Looking at the plot below for FB, which is based on the vanilla assumptions, the collection of points around +$200M necessitate an offsetting sale of ~980,000 shares (FB priced at roughly $204) for every point rise in the stock. Thus, a 1% increase in FB ($2.04) will 'trigger' the sale of nearly 8.3% the average daily volume in FB stock (~2M/24M).

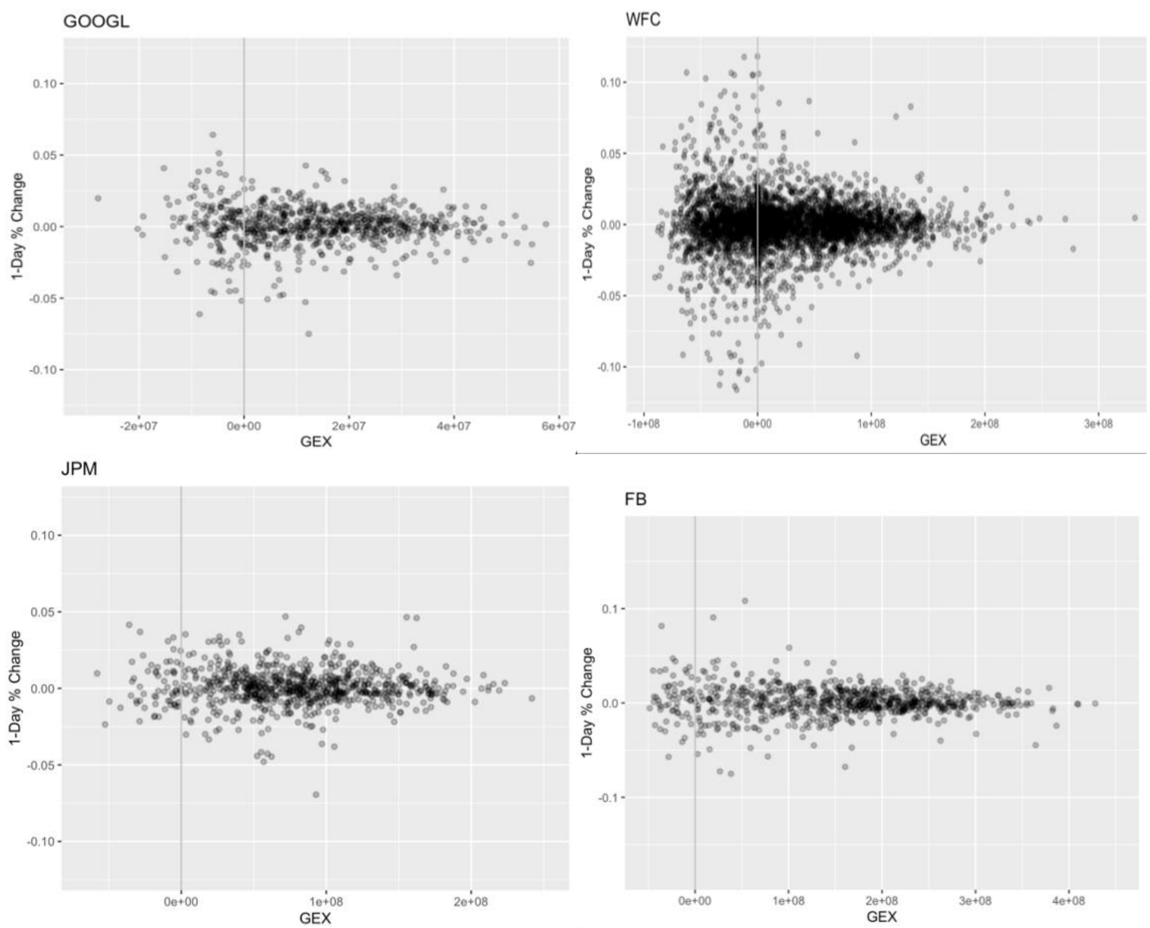
This is analogous to what we see in SPX. Consider at 2800, a $1,000,000,000 net gamma exposure will compel market makers to buy/sell ~7150 E-minis, or around 11% the average daily volume per 1% move in the underlying (using a daily volume of 1.8M).

This is a simple but intuitive example. Furthermore, this is an aggregated measure. When one homes in specifically on different strikes, the hedging volume % becomes even more prominent. For example, if significant negative gamma exposure is concentrated around 1-2 strike prices, as you approach those strike prices, the hedging flows account for a higher percentage of "average" volume, making this effect even more pronounced.

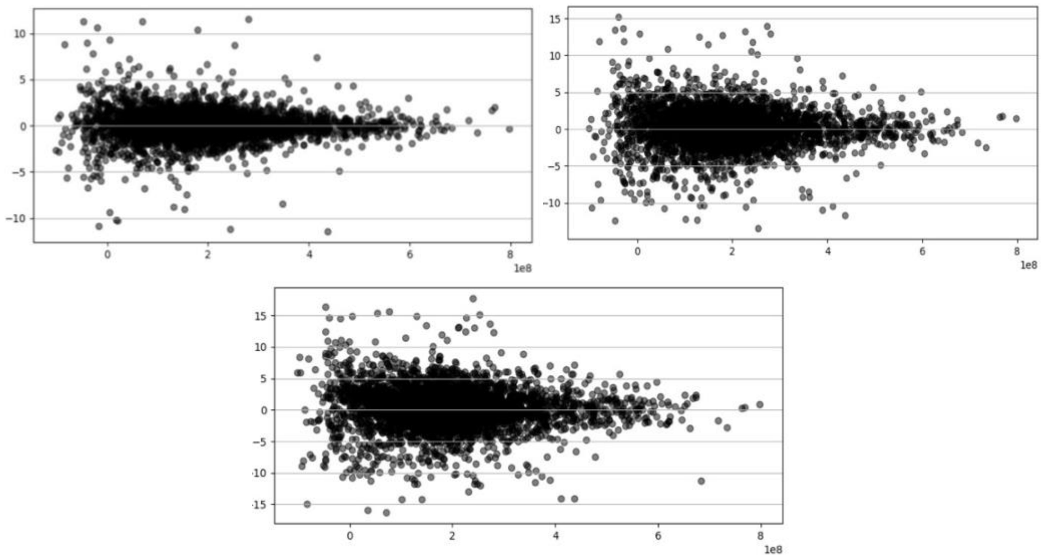
Each optionable security will exhibit unique characteristics and reflect different assortments of dominant trading techniques, but from a survey of literature (referenced below) and simple analogous comparisons to the metric, it stands to reason that not only does the option market have an impact on an individual stock price, but an aggregated gamma exposure metric **could be applied to an individual stock. But how?**

Original 'GEX' calculation on stocks - not a successful metric:

What is the first approach one would take, logically, in calculating net gamma exposure for stocks? Use the same simplifying assumptions used on the index! Not surprisingly, these simple assumptions aren't helpful on stocks, even those with large open-interest and ample liquidity.



Furthermore, the calculation isn't telling on more than 1-day returns. Below is Microsoft 1-day, 3-day, and 5-day returns (notice the 1-day is a -10% to +10%)



Not so great, and understandably. Stocks and their options are subjected to more variable and cyclical patterns of trading when contrasted with an index. Stock option behavior is incredibly variable, especially during earnings, leadership changes, corporate events, or product innovation. There are clear periods dominated by call buying, call overwriting, and other strategic and prominent behavior. Indices are more robust to these events by design. Large volume, large open interest indices of 500 stocks better irons out this cyclicality.

If we are discussing sweeping assumptions, they best apply to the index where differences have many opportunities (OI) to iron themselves out. To say, at all times, AAPL's option activity is similar enough to a new bio-tech's option activity in which a model can be derived is dangerous. There is little room for error, and the model must accommodate this need for precision.

The new method:

First, a brief checkpoint: We know a measure of dealer gamma positioning has a pervasive impact on realized volatility which prevents numerous opportunities for traders. We know that, while this has only been successfully applied to the S&P, it can be successfully applied to stocks, but the simple assumptions won't cut it (we know this both intuitively and quantitatively).

It should be clear why this is a worthwhile endeavor.

This begs the question: How does one do it?

Since sweeping assumptions just don't cut it for stocks, you have to dive deep into trade data in order to assign dealer gamma. If you want to model market maker inventory exposure, you must monitor it through analyzing price quotes and liquidity on all U.S. option exchanges.

Of course, this brief is not intended to be one of exploring endless examples of trade prints, nor the accompanying thousands of lines of code to sort, map, and flag them, only to furthermore bore the reader who came to learn about trading with an in-depth discussion of the algorithms used to place dealer delta and gamma based on (in some cases) over 100,000 trades a day.

What may be better is a simple example of how we derive and track dealer gamma exposure on individual stocks.

Example (actual trade feed with minor alterations (names and dates):

Time	Underlying	Option	Units	Price	Exchange Filled	Exchange A Best Bid	Exchange A Best Ask	Exchange A Best Bid Size	Exchange A Best Ask Size
12:51:01:01	**AAPL**	**April 17 290 Call**	**300**	**2.19**	**A**	**2.16**	**2.20**	**1200**	**1680**
12:51:01:49	AAPL	April 17 290 Call	100	2.20	A	2.17	2.21	1242	1560
12:51:02:00	AAPL	April 17 290 Call	14	2.20	C	2.18	2.22	1300	1710

This is a simple example of how we can assign gamma to the market maker. The first order appears to 'eat' ask liquidity on exchange A. Notice the quote and accompanying size before and less than a second after the order. After the 300-contract order, the ask is 'raised' to 2.20 and with less offered.

For more clarification on why our program would flag this trade specifically as a buy, see the excerpt below from Trades, Quotes, and Prices by Bouchaud, Bonart, Donier, & Gould. Note b = bid, a = ask, m is the midpoint, and s(tx) is the spread at time t for order x.

Arriving order x	Values before arrival (USD)				Values after arrival (USD)			
$(\varepsilon_x, p_x, v_x, t_x)$	$b(t_x)$	$a(t_x)$	$m(t_x)$	$s(t_x)$	$\overline{b}(t_x)$	$\overline{a}(t_x)$	$\overline{m}(t_x)$	$\overline{s}(t_x)$
$(+1, \$1.48, 3, t_x)$	1.50	1.53	1.515	0.03	1.50	1.53	1.515	0.03
$(+1, \$1.51, 3, t_x)$	1.50	1.53	1.515	0.03	1.51	1.53	1.52	0.02
$(+1, \$1.55, 3, t_x)$	1.50	1.53	1.515	0.03	1.50	1.54	1.52	0.04
$(+1, \$1.55, 5, t_x)$	1.50	1.53	1.515	0.03	1.50	1.55	1.525	0.05
$(-1, \$1.54, 4, t_x)$	1.50	1.53	1.515	0.03	1.50	1.53	1.515	0.03
$(-1, \$1.52, 4, t_x)$	1.50	1.53	1.515	0.03	1.50	1.52	1.51	0.02
$(-1, \$1.47, 4, t_x)$	1.50	1.53	1.515	0.03	1.48	1.53	1.505	0.05
$(-1, \$1.50, 4, t_x)$	1.50	1.53	1.515	0.03	1.49	1.50	1.495	0.01

Note specifically how the arrival of orders affects the subsequent market quotes.

Knowing this is a buy, we can compute the gamma for this trade (we like to do this in-house for consistency) and assign the market maker **300 calls short this gamma.** We are now accounting for contracts within open interest better than a sweeping assumption.

Of course, not all trade feeds are this clean. The system we built also looks for:

- Fill prices compared to quotes, specifically discerning quote noise and intentional quote adjustments
- Watching for trade inventory adjustments on specific exchanges
- Tracking liquidity (quoted size) patterns for individual contracts
- Analyzing quote spreads and adjustments, again at times of trades to better infer "noisy" quotes from actual information flows
- Tracking trades that happen off-exchange between counterparties (trade reporting)

We are always open to discussing the methodologies in this space (trade flagging and monitoring), as it is one we continue to debate, adjust, and innovate on.

Of course, flagging the trade and assigning the gamma is only the beginning. The gamma must be recalculated to keep an updated picture, and trades continually matched to account for all inventory. Open interest and volume in every contract must be continually tracked to account for option exercise and other unique features that don't occur with index options.

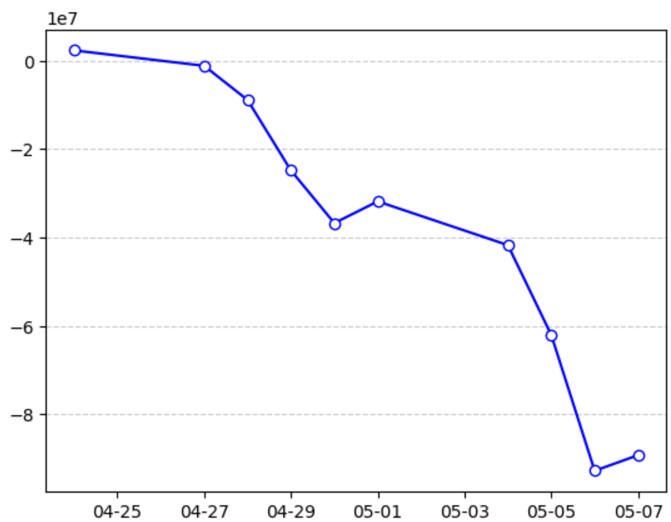
It's through this that you can model equity gamma exposure on stocks (as discussed in the above sections) that are prone to this influence.

At the end of the day, it probably also makes sense to label this gamma exposure by strike price in order to get a more microscopic view to which strikes are "slippery" (where there is large negative gamma exposure) and which strikes are "sticky" (where there is ample positive gamma exposure - think back to pinning), you can begin to see at which prices stocks are more prone to volatility and which prices will stifle volatility.

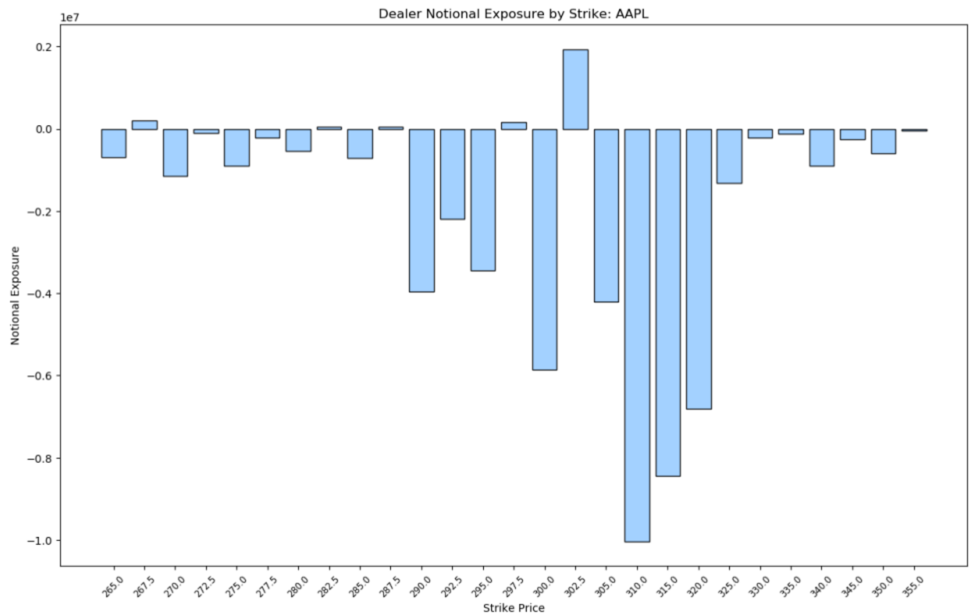
What we are most excited about? These analytics allow for improved trading and volatility forecasting in ANY environment- from high volatility to low volatility to earnings season to summer doldrums. Furthermore, there are ways to trade dealer gamma on **baskets** of stocks. The construction of a portfolio seeking to profit from 'dispersion trading' and other correlation strategies is more informed in light of these techniques relating index to constituent volatility forecasts.

Armed with this information, an options trader can find many opportunities, in all markets, to trade. Please visit hauvolaility.com to learn more.

AAPL Net Gamma Exposure



AAPL Gamma Exposure by Strike



References & Related Resources:

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Bouchaud, J., Bonart, J., Donier, J., & Gould, M., Trades, quotes and prices (pp. 45-72) (2018). Cambridge University Press.

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