The Convexity Maven

at

Simplify Asset Management

A Commentary by Harley Bassman

March 16, 2021

"Lurking at the Scene"

Antonio Prohias, Mad #60, January 1961

As detailed in "Seeking Treasure with Convexity" – February 23, 2021, an investment is convex if its payoff is asymmetric for equally opposite outcomes. So, if there's the potential to earn a profit of three versus a loss of two, the game (investment) is positively convex. If you risk losing five versus making only four, it is negatively convex. That's it. The rocket scientists are called upon to help (fairly) price the cost (value) of such unbalanced returns.

Investors have a conflicted relationship with Convexity. It has been observed that the unpleasantness of losing one dollar is greater than the joy of making a similar sum; a social economist would say that people are not risk neutral. Yet incongruously, investment managers display a bias to being short Convexity; a payoff profile where the losses can be greater than the gains. Thus, it may not be a coincidence that when financial markets implode, short Convexity can be found lurking near the scene of the crime.

I am loath to use the word "always", but over the course of my professional career, there always seems to be a concentration of short Convexity positioning at the core of extreme market turbulence.

To name a few, consider:

1) October 19, 1987, known as "Black Monday", when (synthetic) Convexity hedging drove the Dow Jones Industrial Average (DJIA) down 22.6% in a single day. An investment consultant sold the cleverly named notion of "Portfolio Insurance" to pension fund advisors, but a look under the hood revealed it was simply <u>Convexity hedging by hand</u> where managers accelerated stock sales as the market continued to decline. In a classic *Convexity Vortex*, selling begat more selling as risk limits were breached. This is why circuit breakers were instituted in January 1988, to at least temporarily halt these mechanical sales and allow the system to reset.

2) A surprise Federal Reserve (FED) rate hike in February 1994 jolted the market and jumped volatility that soon led wealthy Orange County, CA, to declare bankruptcy. The lowest interest rates since the early 1960s lured investment managers to buy <u>negatively convex Structured Notes</u> to earn a higher yield. These Structured Notes were awash with embedded (short) options such that the Note's price declined much faster than it increased.

3) Long-Term Capital Management (LTCM), required a FED coordinated rescue in September 1998 when nearly their entire $4.7bn of capital was wiped out. Chock full of PhD's with clever theories, they would buy older bonds and sell (short) newer securities. The return profile of this strategy could be modeled as a high likelihood of earning a quarter point versus a small chance of losing five points. <u>This is a classic negative Convexity profile</u>. They called it "Risk Arbitrage", but it was closer to the oxymoron of "Jumbo Shrimp" which tasted fine until they were skewered.

4) The Great Financial Crisis of 2008 was sourced from a decline in housing prices bleeding into the market for Mortgage securities. While it all seems related, in actuality, the first national decline in residential real estate since the 1930's was not the reason that Bear Stearns, Lehman Brothers, and Merrill Lynch collapsed. Rather, their risk management strategy could be summarized as buying only one option for every five they sold; <u>they were extremely short Convexity</u> and imploded when Volatility rose.

Convexity is the measure of unbalanced risk so, almost by definition, a negatively convex portfolio will be unstable. **Markets become disturbed when the instability of negative Convexity becomes greater than the market's liquidity**. Convexity is not the match, but rather the accelerant.

The curiosity is why a risk averse investor might construct a portfolio with an excessively negative Convexity profile ?

Convexity (option) sellers are paid up front, either via the coupon (Mortgage bonds - MBS), or in cash (the option premium). We can also include Corporate (Investment Grade and High Yield) bonds since they can be modeled as a USTreasury plus the sale of a Credit Default option (CDS).

Not to cast aspersions on some investors, but often their greed outweighed their fear; which makes me think they do not fully appreciate the mechanics of negative Convexity.

To remedy this problem, let's do a practical examination of Convexity which will reveal why sometimes even the most sophisticated investment managers can be brought to ruin. **[Note: Masochists can check the Appendix for a deeper dive]**

Practical Convexity (I promise this won't hurt…)

Assume the price of XYZ stock is $100, it pays no dividend, and the Implied Volatility (IVol) used to price an option is 25%. An IVol of 25% means:

1) Option traders think XYZ will move 1.56% ($1.56), close to close, every day until expiry. That is the 25% IVol divided by 16. **[Apdx #1]**
2) Option traders think there is a 68% chance that XYZ will close between $75 and $125 one year hence. That is the $100 price plus or minus the 25% Volatility. **[Apdx #2]**

That's about all you need to know about option pricing; and it works for all asset classes. Let's try a another example:

Gold is currently at $1720, and its options have an Implied Volatility of 18.5%.

1) Option traders think Gold will move $19.89 per day. (IVol of 18.5% divided by 16 = 1.156%; and 1.156% times $1720 = $19.89 per day)
2) Option traders think there is a 68% chance that Gold settles between $1402 and $2038 one year from now. ($1720 plus or minus 18.5%)

From 30,000 feet, professional option traders decide if they think an asset will move more or less than what is implied by its Volatility. While not quite true **[Apdx #3]**, when the VIX is trading at 23%, that sort of means the S&P500 will move 1.44% a day, or about 56 points on its current value of 3895.

While this is a vast over-simplification, it is all you need to know to impress your friends at a cocktail party (remember those ?).

Convexity mechanics

Don't be rattled by the table below, there will not be too much math to swallow. Let's again consider XYZ stock and its three-month options with an Implied Volatility of 25%. Focus on the -myrtilos column- delta for the call options, and the – kokkino column- delta for the put options.

	XYZ Stock			
Price	**Call** Price	Delta	**Put** Price	Delta
120	$20.45	93.7%	$0.45	6.3%
115	$15.85	88.2%	$0.85	11.8%
110	$11.65	79.6%	$1.65	20.4%
105	$7.95	67.5%	$2.95	32.5%
100	**$4.95**	**52.5%**	**$4.95**	**47.5%**
95	$2.75	36.3%	$7.75	63.7%
90	$1.30	21.6%	$11.30	78.4%
85	$0.50	10.7%	$15.50	89.3%
80	$0.15	4.2%	$20.15	95.8%

I am taking a lot of poetic license, but here is what is important to notice:

1) The at-the-money call and put prices (strike = $100) are the same;
2) The call and put deltas add up to 100%;
3) The at-the-money call delta (52.5%) is higher than the put delta (47.5%) because XYZ stock can go up a lot, but only down to zero;
4) It is not a coincidence that the in-the-money option equals the amount it is in the money plus the price of the other option. [Apdx #4]

As a reminder, the "delta" is the amount the option price changes as the asset price changes. In the table above, the 100 and 105 calls have deltas of 52.5% and 67.5% respectively, for an average of 60%. Notice when XYZ stock advances from 100 to 105, the call option price rises from $4.95 to $7.95, or $3.00; which is 60% of the XYZ price move.

In a rhyming fashion for the put option, its average delta of 40% (47.5% ~ 32.5%) times the $5 XYZ price move matches its $2 change in price.

To be clear, I have taken a lot of liberties, but this captures the essence.

Extra Credit: What does one call the change in the call "delta" from 52.5% to 67.5% ? It is the change of the change, or "gamma". So, in this example, the gamma would be 12.0% (67.5% minus 52.5%).

Practical Convexity management

Citadel Securities is one of the largest listed-option market makers. They do not speculate on the direction of stocks, just the relative value of their options. They buy and sell options of different strikes and expirations that offset each other; it is functionally a Sports Book. (This is what I did at Merrill Lynch for much of my career, except it was OTC options on bonds instead of listed options on stocks.)

Let's imagine that Citadel sells 10 contracts of the XYZ three-month calls at $4.95, with a -melani column- delta of 52.5%. Ten options are the right to buy 1000 shares, so they are effectively short 525 shares to the option buyer (1000 times 52.5%). Citadel immediately buys 525 shares at $100. So, at that exact moment, they are short the equivalent of 525 shares via the option, and long 525 of stock as an offset – this is call being "delta hedged".

Soon, the stock rises to $105, and as shown, the delta increases to 67.5%. The option's "risk" is now equivalent to being short 675 shares, but Citadel is only long 525 shares, so they need to go into the market and buy 150 more shares at $105. Now they are back in balance, they are "delta hedged".

The process would, of course, be reversed if Citadel was long the option. They would be synthetically long the stock via the long call position, and they would sell 525 shares at $100 at the inception of the trade; and they would sell an additional 150 shares at $105, to maintain their "delta hedge".

In practice, the option buyers (longs) and sellers (shorts) would hedge somewhat in tandem, so their "delta hedging" activity would offset, and thus not impact the price of the underlying stock. <u>But what if only one side hedged ?</u>

The GameStop Convexity Vortex

Similar to how Netflix eviscerated the Blockbuster movie rental business, GameStop was circling the drain as a brick and mortal seller of video games. Their stock traded near $4.00 a share for most of 2020 as high-speed internet was "water boarding" their franchise.

"Barstool" investors were birthed as an unintended consequence of the COVID lock-down; anathema to value investors, the Barstool crowd engaged in day trading stocks with the support of commission-free Apps such as RobinHood.

While Boomer dinosaurs scratched Lotto tickets, Millennials realized that they had much better odds with the purchase of options. As per our prior example where $1,000 could buy ten shares of XYZ stock, that same sum could control 200 shares via the purchase of 2 call options with spare change for a Starbucks.

For most of 2020, GameStop (GME) traded near $4.00 per share. Starting in early September, the price slowly rose to close out the year near $20. On January 13, it jumped to $40; explained as a temporary "short squeeze".

For most of this time, Implied Volatility for GME options traded near 125%.

Let's imagine an avaricious professional option trader. The (soon to be bankrupt) GME opened at $42.59 on January 22, and a "buy" order comes in for 10,000 March 19 calls (53 days), struck at $100; nearly double and a half higher.

Licking his chops, he makes a -stafyli line- offer of $4.53 using an IVol of 225%, which implies an everyday close to close move of 14% (225% divided by 16).

Hedging GameStop (GME) Options [10,000 options = 1mm shares]

March 19, 2021 Expiry

	GME Price	Call Price	Call Delta	*Hedging Action Required*
Jan 22 open	**42.59**	**$4.53**	**28.9%**	**Buy 289,000 shares**
Jan 22 close	65.01	$13.19	47.4%	Buy 184,000 shares
Jan 25 open	96.73	$30.41	64.8%	Buy 175000 shares
Jan 25 close	76.79	$18.49	54.2%	Sell 106,000 shares
Jan 26 open	88.56	$24.99	60.6%	Buy 64,000 shares
Jan 26 close	147.98	$68.03	81.3%	Buy 206,000 shares
Jan 27 open	354.83	$258.77	97.4%	Buy 162,000 shares
Jan 27 close	347.51	$251.64	97.3%	Take a breath
Jan 28 high	483.00	$384.73	99.0%	My troubles are over
Jan 28 low	**112.25**	**$40.01**	**70.9%**	**Sell 289,000 shares**

Using the "delta hedging" math described prior, he purchases 289,000 shares at $42.59; but the stock continues to rise and soon he needs to buy an additional -polemiko line- 184,000 shares before GME closes at $65.01. **[Apdx #5]**

Here is where the "fun" starts; well, not fun for the option dealer.

It is likely that the dealer did not fully cover his entire position and hoped for a seller the next day. But Barstool-type investors don't hedge, they just HODL and YOLO; so, when the dealer tried to buy the open on January 25, he drove the price even higher to $96.73, which then forced a -ouranos line- purchase of another 175,000 shares. **[Apdx #6]**

<u>This became a classic Convexity Vortex</u>, where the hedging actions of the option traders extends the move (in either direction), which then causes the need for additional hedging activity.

As noted, **markets become unstable when Convexity hedging demands exceed the market's liquidity.** This rarely happens in larger markets like SPY (the S&P500 – ETF) where the liquidity is much greater than the options volume; but here the negative Convexity created by large option purchases overwhelmed the underlying liquidity of GME. Soon, the delta hedging drove the market as dealers effectively chased their own tails. **[Apdx #7]**

As long the GME price is near the strike price, the Convexity is in play, both ways. Notice the GME purchase at $96.73 in the morning was -milo line- sold at $76.79 near the close. **[Apdx #8]**

The -vromia line- gap open at $88.56 drew purchases of 64,000 shares, but the killer was the late day -prasinos line- crossing of the strike. Surely the risk manager was apoplectic and bought 206,000 shares on the close at $147.98.

Tears of pain -portokali line- were shed when GME more than doubled to $354.83 on the January 27 open; where another 162,000 shares were acquired.

The option dealer thought the -kitrinos line- movie was over as the Convexity washed out of the GME option. **[Apdx #9]** But the movie was a financial "Carrie" that reached from the grave; soon GME purchases made near $350 were -aima line- liquidated at $112 when the stock cratered into the close.

Leverage is not Convexity

This is hard core stuff, even with minimal math. Convexity is neither good nor bad, it's simply another risk metric. The tricky part is the asymmetry, which is why Convexity is different than leverage, where risk exposure is fixed. The key point is how rapidly one's risk exposure can change. This is an important distinction that is only fully appreciated after tragedy.

I know how this movie ends, it is just unclear if I have time to buy another bucket of popcorn before the guy with a chainsaw arrives. FED policy is encouraging Moral Hazard as desperate investors reach for yield by selling Convexity in various forms; I am happy to buy those options.

Harley S. Bassman
March 16, 2021
@ConvexityMaven

SIMPLIFY

Program Note: As noted in my title page, I have joined Simplify Asset Management [https://www.simplify.us/investment-philosophy]

I will not become a corporate shill, and I will continue to write independently; that said, Simplify has an investment philosophy that mirrors mine. Moreover, they presently offer a suite of ETFs with options added for positive Convexity.

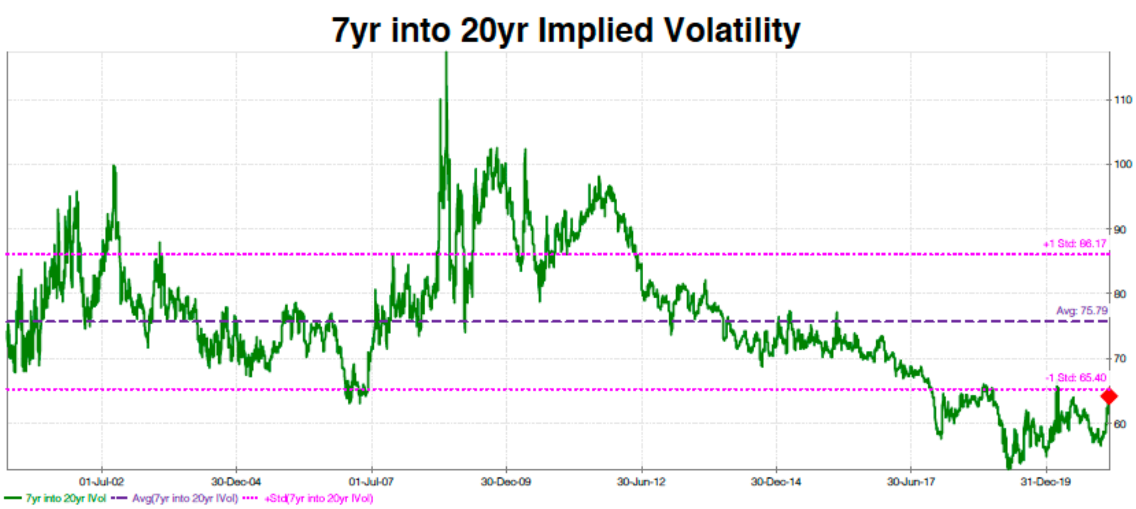
Careful readers will recall that I have hinted at finding a platform to offer my best ideas to the non-professional (civilians)…. **this is it**.

If you want to torture the GME shorts on Robinhood, have at it; but don't bother me. If you want to build a long-term investment portfolio that accelerates the gains and dampens the losses with a low fee structure, then ping Simplify.

I am placing my name on Simplify – That is a statement by itself.

If you want to invest in a manner similar to mine, this is a terrific start.

And as a teaser, stay tuned as I am noodling a way for non-professionals to soon own -celeriac line- ultra-long-dated Volatility.



Your comments are always welcome at: harley@bassman.net
If you would like to be added to my distribution, just ping me.

For reference literature on the financial markets - particularly about options and derivatives - I will immodestly direct you to my educational archive at:

http://www.convexitymaven.com/themavensclassroom.html

If you still have kids in the house, please take a vacation that is more interesting than the Four Seasons, Costa Rica – life is not a dress rehearsal. Turn off the Crackberry (did I just date myself ?) and explore with the family. You don't need to break the bank, rent an RV and see the U.S. We traveled with our four kids on five incredible RV trips.

http://bassman.net

Appendix:

#1 – Implied Volatility is quoted as an annual number. To convert it to a daily value, one must divide by the square root of 252, which is the number of trading days per year. The actual result is 15.87, but for simplicity, street convention is to use 16.

#2 – A "Bell Curve" is often used to as a distribution where the Implied Volatility describes "one standard deviation"; and by definition, one standard deviation will capture 68% of the outcomes. So, in our example, 68% of the outcomes can be found between +/- 25% of the asset price.

#3 – Contrary to common intuition, the VIX is NOT the Implied Volatility for an at-the-money one-month option of the S&P500 Index. Rather, it includes a wide range of the out-of-the-money options. Since there is usually "skew", where the OTM options trade at a higher IVol than the ATM options, the VIX is usually 3 to 5 points higher than the ATM Implied Volatility. As an extra note, this differs from the MOVE Index which only uses ATM one-month options.

#4 – This entire section is based upon the Black-Scholes option model that defines Put-Call Parity. A discussion of this is beyond the scope of this Commentary, but as a tease, Put-Call Parity details how an in-the-money call must have the same time value (theta) as an out-of-the-money put.

#5 – To maintain the proper "delta hedge", the option dealer will buy or sell the difference between the starting delta (28.9%) and the ending delta (47.4%). Of special note, the option short is always buying higher prices, and selling lower prices, locking in small losses each time. In contrast, the option buyer sells higher prices and buys lower prices, locking in small gains each time. The "game" is whether these small gains and losses exceed the option price, which occurs if the Implied Volatility at the outset is more or less than the Actual Volatility over time.

#6 – Careful readers might ask why the hegding of option buyers does not offset the hedging of the sellers, and indeed this often occurs; except where it doesn't. The buyers of GME calls did not hedge. Another example would be the case of the MBS meltdown in 2008/09 where the homeowners of the prepayment option did not hedge (after all, is hard to sell half of your house. Nor do corporations hedge the default risk embedded in their bonds.

#7 – What happened here is that the act of buying the GME stock to hedge pushed the market higher, which increased the delta, and then necessitated the purchase of even more stock. <u>The hedging demands were greater than the liquidity of the underlying stock</u>. And the reverse happened on the way down.

#8 – Convexity (gamma) is greatest when an option is at-the-money. As such, hedging became most difficult as GME neared the strike ($100). Thus, it is no coincidence that the largest hedging trades occurred when GME crossed the strike on January 26. This was the key insight of the Barstool Investors - if they could buy enough out-of-the-money options to push GME through the strike, it would act like an uncontrolled nuclear pile and explode higher.

#9 – With the option so far in-the-money, the gamma was almost zero when the delta was at 99.0%, near its 100% limit. However, as hinted in #4, the dealers were functionally short 10,000 of the GME $100 strike puts, which came back to life as the stock crashed on January 28.

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