

Title: Volatility, Variance, Dispersion, Oh my!

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****Introduction****

I have been asked to jot down some thoughts on variance by u/gherkinit and u/Criand

Variance/co-variance/volatility/simple variance/synthetic variance swaps, a year ago I had no idea what these were, over the past 3 months I and others have been diving into this black hole. u/MauerAstronaut has dug as deep on this as I have he is my VOLquant wanna be twin and a good friend, he has already had some post on the subject I highly recommend reading them before reading this. This subject is broad and extremely complex, the more reading the better here, without further delay let me share some thoughts.

Let me preface by first saying this post may not be for everyone, some of it may be slight speculation based off of actual events and or positions reported. Even though I will go into detail about being "long variance" it is hard to find breadcrumbs of long variance because the portfolio of options to be built as a hedge are in fact sold, or in common terms "short", meaning these positions are usually not reported limiting the evidence left. That being said those that are "short variance" do leave similar hedging breadcrumbs, that is what has led me here. Obligatory "this isn't advice" if you think it is, I feel terribly sorry for you.

****Brief Breakdown and Effects****

First thing is first, what is a variance swap? In simple terms it is a bet on volatility. The seller is going to receive a fixed payment called the "fair variance strike as vol" which is a fancy way of saying annualized implied volatility over a period of time (usually 30,60,90 days). The volatility strike is going to be calculated and agreed upon inception, that is going to be the fixed payment that the seller receives upon maturity. The opposite side of the trade is the buyer, the buyer is going to receive "realized variance" payment on maturity, meaning that it is going to get paid based on the volatility realized during the agreed upon period.

Here is an illustration showing the "vanilla" variance trade. Note the word "vanilla" not all trades are done this way:

<https://preview.redd.it/08ncdf576mx71.jpg?width=892&format=pjpg&auto=webp&s=fe0ceb134c323771924505c7447b6bbb289abd74>

The above came from this [paper]([http://quantlabs.net/academy/download/free_quant_institutional_books/_/\[JP%20Morgan\]%20Variance%20Swaps.pdf](http://quantlabs.net/academy/download/free_quant_institutional_books/_/[JP%20Morgan]%20Variance%20Swaps.pdf)). Now to me this image illustrates a variance trade pretty well, it shows that the Market Maker buys variance as an insurance type play to their short options, then they also sell the replicating portfolio into the market to hedge against the long variance position. Easy peasy right? The buyer, especially when a Market Maker or a Broker Dealer, is pretty shielded here due to their role in the market. They basically get to roll with the tide, at the expense of their counterparty, since the effect of them delta hedging the replicating they sold as a hedge lets them stay flexible:

<https://preview.redd.it/lep5uera6mx71.png?width=936&format=png&auto=webp&s=9914d0d28c658fb18e35c0824eef13b06963fc42>

<https://preview.redd.it/6k7kyw2c6mx71.png?width=724&format;=png&auto;=webp&s;=202e93311abb15a6e24ba42673da3465a9c3f634>

What about the seller? The sellers are usually multi-strategy hedge funds whom themselves buy and sell variance on different securities and index(s). Dispersion trading is the name of this practice, it is the practice of going short index variance and long any number of constituent stocks. Or vice versa, like anything of course. This makes a pseudo basket effect, and is thus a CORRELATION TRADE. How many stocks does GME track? Aren't they all volatile? Aren't all the index(s) and ETF(s) they are in ODD to say the least?? Picture perfect dispersion set up. Irony isn't it..... A quick illustration to help:

<https://preview.redd.it/d7w8zygg6mx71.png?width=721&format;=png&auto;=webp&s;=c4a8e795d85f3dcff4e74b72ea4d965d60053107>

<https://preview.redd.it/q29uiwvr6mx71.png?width=630&format;=png&auto;=webp&s;=59258fe700b40e11eb39e3e2a7cd17dfb92b4aa2>

I am not going to go in depth about co-variance swaps/dispersion/correlation trades in this post as it will get rambling like and there just isn't enough room. We are in the process of really breaking this down and trying to model it better. This is just to shed light on the correlation effects we've seen and a reason outside of portfolio swaps, basket shorting, etc that the strong correlation is there.

****How is this GME related?****

We ran across this link [SDR Services - CFTC Ticker (dtcc.com)](<https://pddata.dtcc.com/gtr/cftc/tracker.do>) Which included these:

<https://preview.redd.it/sxxz4h6s7mx71.jpg?width=1125&format;=jpg&auto;=webp&s;=27818c1219e439a0657708fa284d9c6cf92d820>

<https://preview.redd.it/2s8hbi6s7mx71.jpg?width=1125&format;=jpg&auto;=webp&s;=c668524a47cb68f51d7bf24c05c49d0ab9b21c38>

There were more, but I think you get the point, this caught our interest so the next logical thing to do was search "GameStop Variance" that resulted in [GameStop, Variance Swaps, and Related Failures of Hedge Fund Risk Management (northinfo.com)](<https://www.northinfo.com/documents/993.pdf>) Well that really got me excited so then I went on to learn what this was all about.

****The Replicating Portfolio****

After reading [(PDF) More Than You Ever Wanted to Know About Volatility Swaps (researchgate.net)](https://www.researchgate.net/publication/246869706_More_Than_You_Ever_Wanted_to_Know_About_Volatility_Swaps) I learned the the replicating portfolio is quite important in the world of variance swaps. Two main reasons, it is the way a variance swap is priced so the two parties can come to an agreement on "fair variance" as the "variance strike", it also acts as a hedge for the forward contract the actual variance swap is. So what is it? Without getting all "mathy" it is a portfolio of OTM options (both calls and puts) that are used to best capture variance. Here is something to illustrate.

<https://preview.redd.it/h6v0x5gjcmx71.png?width=683&format;=png&auto;=webp&s;=1765a70d37f92910c7681ecd3ed8e8fd191e966e>

This illustrates it pretty well, it highlights the "weights" or number of contracts needed at each strike to build this replicating portfolio of options to price and hedge a swap on an underlying with a spot of about 100.

You can always tell where the spot of the underlying is on one of these by identifying where the puts and calls "meet". Here you can tell it is 100 because it is the only strike that it tells you to buy both calls and puts on. *Cool.* Another thing to note is it says European style options, all that means is here in America you hold till maturity. It is needed for correct payoff.

Looking at this I noted, jeez they put a **lot** of emphasis on that lower strike put in this scenario don't they? That made a lightbulb turn on somewhere, I thought man GME sure does have a strange amount of open interest on lower strike puts like that, it also carries odd open interest in the higher strike ranges on the same expiry. Then I read more papers and I learn that GME's option chains, especially on monthly expiry's are the perfect situation for someone long variance. So naturally I decided to look at options OI on January 21 2022:

<https://preview.redd.it/43zha5z3fmx71.png?width=1351&format;=png&auto;=webp&s;=38a73b51033e9038c2fc3dff972924754e2640f6>

<https://preview.redd.it/tmamm1z2fmx71.png?width=1358&format;=png&auto;=webp&s;=2f1201a6acd3876e70895b5b0c7ae325b63da797>

That just seems oddly familiar to the example above doesn't it? Almost textbook how wide this option chain is, and the OI spread across strikes just as the papers recommend. If only I knew what this looked like for GME:

<https://preview.redd.it/fxbc9hilfmx71.png?width=266&format;=png&auto;=webp&s;=545792ce7f692f7d181d7ab795672f43fe460ca3>

This example replicating portfolio of GME was made by me approximately 2 weeks ago, as well as the pictures of the OI was around the same time, so the OI may have moved some, nothing to deter the point its just worth noting. This is for a 90 swap ending Jan 21 2022 it recommends a replicating portfolio, and gives a fair variance as volatility which is used for the "variance strike".

So just to recap, hedge funds sell variance making them short, which in turn requires them to hold a portfolio of long OTM options to hedge the short swap. This should be making lightbulbs turn on, if it doesn't go check Citadel Advisors, Susquehanna, Simplex holdings and see they hold not only puts but calls come back and stare at the replicating above, it will click eventually. If not, never fear u/MauerAstronaut is making a post about the options OI and how it relates to the replicating in more depth soon.

****Dynamic and Imperfect Hedging****

Variance swaps require a log contract and would thus need an infinite amount of strikes to be perfectly hedged, without going into all the mathy details this means that narrow strike options chain = **bad** for them. Illustrations:

<https://preview.redd.it/wltipe1wlmx71.png?width=932&format;=png&auto;=webp&s;=eb423c1aa1c2b4cc51d5e97c041f9e091c254ddf>

<https://preview.redd.it/n5kqme1wlmx71.png?width=887&format;=png&auto;=webp&s;=2d45b6087888712905c09a3943070fce9531c3a6>

<https://preview.redd.it/gkuqme1wlmx71.png?width=760&format;=png&auto;=webp&s;=9388148709db5389d83e617d5469b89593580b60>

I will now attempt to explain the above illustration (figure 3) in ape speak as well as one can.

****A)**** Perfect hedge if an infinite number of strikes existed, doesn't exist so its for reference

****B)**** This is what happens when you have a narrow strike range, you are not as hedged because of it.

****C)**** This is when you have more strikes available in a wider range. It mimics the reference one in a) much better.

More Illustrations:

<https://preview.redd.it/oom1m8iymmx71.png?width=938&format;=png&auto;=webp&s;=13c7209e7c94eaf1a71fcf9424ce69f8232dfbc2>

<https://preview.redd.it/up0n4269nm71.png?width=755&format;=png&auto;=webp&s;=47aa301a76363ce3608d3e4cc65d46860bf303ab>

Ok all that just to say that dynamic hedging tail risk is hard without those **really** deep OTM puts. It forces whomever is short the swap to buy more calls to get the exposure needed, which could force the stock upward which is usually not wanted. I will attempt to illustrate this with GME now:

<https://preview.redd.it/yxx3fyovnm71.png?width=844&format;=png&auto;=webp&s;=e1ef4f5dbcda8fec11bce087bd7476e4af0ced59>

The above is an illustration I made to try to show what I described above in practice. I chose these historical "as of" dates (gathered from Market Chameleon) because they were the beginning of a snowball tumbling down a mountain that turns into a bigger snowball later. Basically they are the start of any major run up that we have had this year excluding February, it had a very wide options chain yet totally took off. February is an anomaly in many ways so I ignore it. Fuck February.

If you look you will see that every one of these run ups had a limited chain, comparatively to what GMEs monthly chains look like. After each run up gets started (just like this most recent) the option chain(s) get expanded into more strikes, for several reasons, I just note this to why I picked these dates to capture what they were before expansion. This is key, especially as of the latest run ups, because it forces them to buy more calls for their dynamic hedge vs puts because that's where the vega and IV exposure lies to get their portfolio greeks where they need to be at the close every day since everything is measured close to close.

To illustrate this I put a theoretical 7 day swap in my model using the 10/29/2021 chain:

<https://preview.redd.it/jh1rz2mcqmx71.png?width=376&format;=png&auto;=webp&s;=3d6d8bc511946b8ebec239914c5479031b6af425>

****OOF**** that's a lot of 2's as well as some weights behind them. As you see from the graphic I posted above it was the same the week after (this week) and you see what has happened. When I made this I needed to confirm my bias even stronger and pull up the OI for the week I just made this and it was:

<https://preview.redd.it/c6op0dm9smx71.png?width=1432&format;=png&auto;=webp&s;=cb4036b70a31f3a4a95c9a8d97b6dad99de50d0c>

Note, this was OI before the run up matching the tail risk replicating I modeled. It was pretty clear upward movement was coming.

****Citadel and Volatility****

Anyone could do a quick duck duck go containing "Citadel Volatility" scroll through and see, he has been hiring volatility talent for a while. No one more actually. More images:

<https://preview.redd.it/j5jqnxgitmx71.png?width=666&format;=png&auto;=webp&s;=0594c6a712d2524870ccec7f38b565654f46c403>

The timing and the context of this article someone transcribed for me is quite telling. A good dispersion trading strategy is going short credit (fixed income) vol and go long equity vol. So just to be clear Citadel has entities whom systematically short volatility (Citadel Advisors) one whom is buying volatility (Citadel Securities) and also one for credit volatility (Citadel RVFIF) its almost like Citadel is ***built*** around volatility and dispersion trading, hint: it is. They have a history in it, shown [here](<https://volquant.medium.com/epic-failures-lessons-from-volatility-funds-blow-ups-6f4226c8334f>), and considering how they have expanded into a broad spectrum as pointed out above have learned how to get a grasp on it.

****Conclusion****

Variance swaps, or volatility based swaps in general, seem to play a key role in this trade. Considering Citadel's entrenchment with it, it's easy to see to me anyway, how he was cocky enough to take on Melvin's position. Thinking he could hedge it away, internalizing all the risk and profiting off of dispersion trading and systematic variance shorting until everyone got bored and they could get out cheap.

The problem is growing for them, people have held and bought more, making the risk that got/gets internalized much heavier to carry, meaning they have to release that risk back into the market sometime causing unwanted and unmanageable tail risk to hedge away which can in turn make the problem worse (see this week). DRS is having an affect simply because it basically marks registered shares as insider shares thus removing them circulation making delta hedging (which is daily on replicating portfolios) much harder and more costly.

This is my short, and probably not only, thoughts on variance. I have had a lot of help from u/turdfurg23, u/sweatysuits, and u/atlasmxz I cannot thank them enough. There have been many others I am sure that I'm forgetting, know ahead of time I'm sorry. Thank you for your time.