Allianz Global Investors: Understand

Risk Analysis of the Structured Alpha 250 – September 30th, 2019

With estimates around 5-7 bn dollars, the losses at the Structured Alpha funds of Allianz Global Investors during February-March 2020 will count among the largest losses in the history of derivatives trading.

Allianz's clients were institutional investors, representing thousands of retirees and future pensioners. Among the most hurt pension funds already announced, we find:

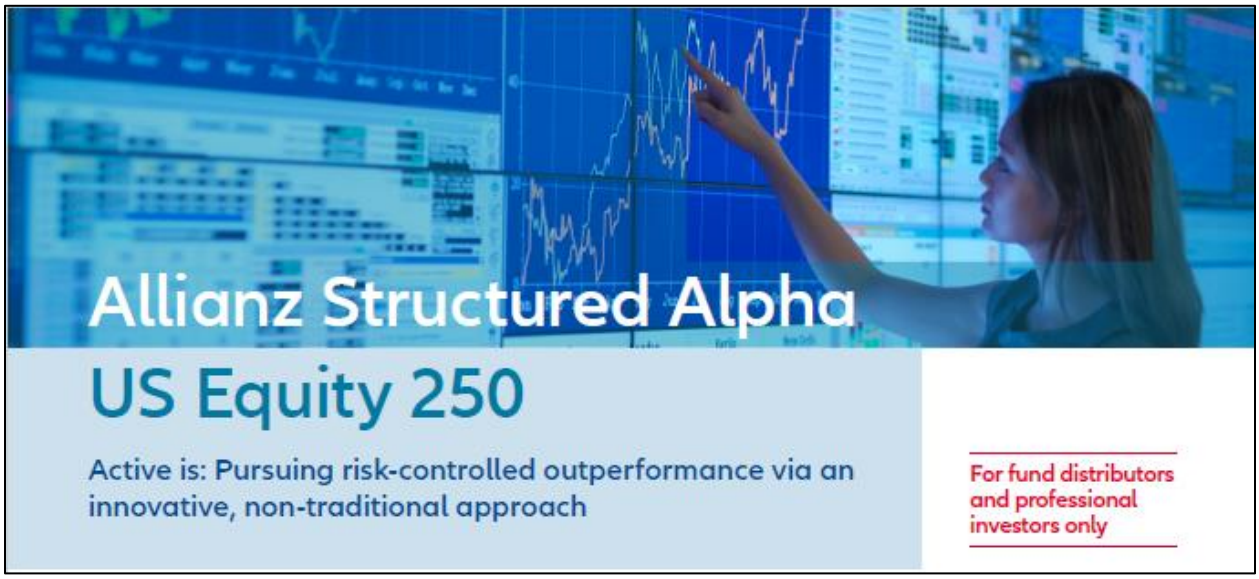
- Blue Cross Blue Shield's pension fund, said to have lost more than half of its $5 bn employee retirement, already underfunded. Implicitly, the loss is bigger than $2.5 bn.
- Arkansas Teachers Retirement System, with an estimated $925 million out of a $15.3 bn fund.
- San Diego Employees, which has lost more than $200 m, out of a $9 bn fund.

The loss comes from the same strategy, declined with multiple leverage and incorporated in several Allianz funds:

- Allianz Structured Alpha US Equity 250 LLC, targeting to outperform the S&P 500 by 2.5% per year net of costs and management fees. With a ~30% fees on the outperformance, the gross target needs to be ~3.75% per year.
- Allianz Structured Alpha Global Equity 350 LLC, targeting a net outperformance above the MSCI ACWI of 3.5% per year.
- Allianz Structured Alpha Global Equity 500 LLC, targeting to outperform the MSCI ACWI by 5% per year after costs.
- Allianz Structured Alpha 1000 and Allianz Structured Alpha 1000 Plus, with net outperformance of 10% per year.

Now, anybody in the portfolio management business knows that extracting even a single percent of outperformance to a benchmark in a consistent manner is a hard feat to accomplish. Selling to investors a fund with up to 10% of consistent alpha - after fees - seems too good to be true. At the minimum, if you use derivatives to reach that level of return, it is very likely that you are taking some significant risks.

To verify this statement and "understand" how much risks Allianz Global Investors was taking, this article will calculate a risk analysis for the Allianz Structured Alpha US Equity 250, based on the inventory positions publicly available for the date of September 30th, 2019. That date is the last date where the positions are available for the fund before the crash, until legal discovery or investors provide a more recent position.



General inventory description

The Allianz Structured Alpha US Equity 250 fund's objective is to outperform the S&P 500 by 2.5% net of fees. Unsurprisingly, it contains:

- a stock inventory similar to the S&P 500, to the extent that only 450 shares are included, while we find a few foreign shares and some REITS:

	# Shares	Notional
Shares	498	391,507,462.90
Bermudas	1	179,004.54
Ireland	6	4,942,457.20
Switzerland	3	1,857,985.87
Other	8	3,763,614.98
USA	450	368,244,785.18
REITS	31	12,519,615.13
SPX Dec 2019 Futures	30	4,465,880.49
All Equity + Fututures		408,492,958.52

- S&P futures, albeit for a small notional of $4m (assuming these are the e-mini futures[1], not the big futures). They are aggregated into the share inventory for risk purposes.

[1] The positions seem to contain a few errors or imprecisions:

- We do not know if the futures are the S&P 500 or the e-minis. A subsequent inventory indicates the fund uses e-minis, so we are assuming these futures are e-minis as well. They are modest in notional anyway.
- Options maturities are only described by year and month, while there are multiple expiries in each month, so we assume that the dates correspond to the third Friday, historically the most liquid. An error on those dates would not materially skew the general results.
- There are still September 2019 options positions indicated in the report dated on the last day of that month. Either they are posted for accounting purposes, or they are month-end options. Either way, they have no influence on the risk analysis and can be ignored.
- There are options, which do not seem to exist at that time:
  - XSP Oct19 306.5 calls. We have used the 307.5 calls, which existed at the time.

- Index options. Here are the main takes on the inventory:

Index option notionals		Long		Short		Net		|Long| + |Short|			
		Calls	Puts	Calls	Puts	Calls	Puts	Calls	Puts	C & P	%
RUT	Russell 2000	$0.0	$0.0	-$7.3	-$8.8	-$7.3	-$8.8	$7.3	$8.8	$16.1	1%
SPX	S&P 500	$33.9	$1,551.4	-$54.2	-$667.8	-$20.2	$883.6	$88.1	$2,219.2	$2,307.4	83%
XSP	Mini S&P 500	$68.4	$22.4	-$356.0	-$17.3	-$287.6	$5.1	$424.4	$39.7	$464.1	17%
	Total	$102.3	$1,573.8	-$417.5	-$693.9	-$315.2	$879.9	$519.8	$2,267.7	$2,787.6	100%

  - The S&P 500 and its mini-version the XSP are predominant. There are a few lines of Russell 2000, but they are symbolic.
  - There are both long and short positions, in both calls and puts. Puts seem in much larger notionals than calls, especially in the long positions. Actually, the long puts represent more than half of the notional.
  - The overall net delta of these options remains small – a long of $17.2m. which is surprising, considering the imbalance of calls and puts. This would indicate that the long puts have little deltas.
  - All the options are exchange-listed, of short maturities, typically 1-3 months, with a few longer exception (Jan/Feb/Mch 2020).
- There are VIX and VXX options.

VIX option notionals		Long		Short		Net		|Long| + |Short|			
		Calls	Puts	Calls	Puts	Calls	Puts	Calls	Puts	C & P	%
VIX	CBOE VIX Index	$0.0	$0.0	-$176.5	$0.0	-$176.5	$0.0	$176.5	$0.0	$176.5	69%
VXX	VIX ETF	$0.0	$0.0	-$78.6	$0.0	-$78.6	$0.0	$78.6	$0.0	$78.6	31%
	Total	$0.0	$0.0	-$255.1	$0.0	-$255.1	$0.0	$255.1	$0.0	$255.1	100%

  - All these options are short upper calls.
  - All options are exchange-listed, of short maturities (Oct/Nov 2019), with a few lines in Dec 2019.
- Cash for $7.6 m.
- A small forward FX for $1 Mn in November 2019 (short Eur, long USD), which doesn't seem to match the foreign equity notionals.

The fund had $397.3 Mn at the time, so it runs a slightly long delta 104.0% = (391.5 equity + 4.5 futures + 17.2 options) / 397.3 invested capital.

Risk analysis objectives and hypothesis.

Here are the assumptions and objectives of the in the risk calculations.

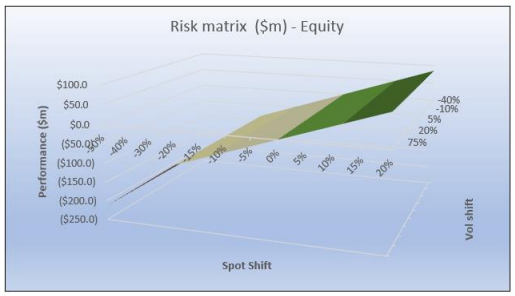
- We assume at this stage that the stock portfolio is beta neutral to the S&P, with no factor loading. This is probably optimistic, but the meat of the risks is not in the stock inventory and its tracking error to the benchmark – it resides in the derivatives.

  - VXX Oct19 29.5, 30.5 and 31.5 calls. Their properties are interpolated from the surrounding strikes.
  - VXX Sept19 34.5 calls. The option being in September, it is ignored as well.

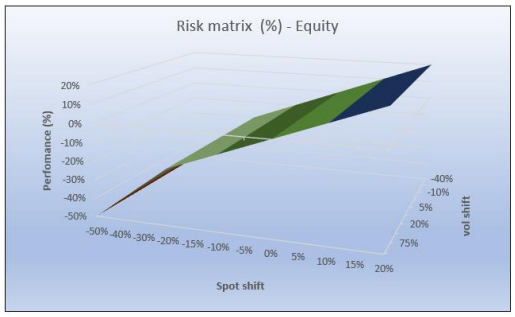
- The REITs are probably there for the yield, and their low beta is probably compensated by the equity exposure slightly long 104% delta.
- The fund is sensitive to both index spot (namely the S&P) and volatility (S&P volatility and VIX), so we will run risk matrices based on these dimensions. Those risk matrices will be the key metric for risk analysis.
- For the derivatives part, we will also look at the distribution of the options by buckets of strike% and maturities.

Equity risk analysis

The exposure is vanilla, and we can easily calculate a risk matrix, which is actually linear in spot shift, with no sensitivity to volatility or VIX:



Equity ($)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	-50%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	-20%	-25%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	-10%	-10%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	0	0	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	5%	10%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	10%	25%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	20%	50%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	50%	100%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	75%	200%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	100%	300%	($213.2)	($170.5)	($127.9)	($85.3)	($64.0)	($42.6)	($21.3)	$0.0	$21.3	$42.6	$64.0	$85.3
	Vol	Vix												



Equity (%)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	-50%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	-20%	-25%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	-10%	-10%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	0	0	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	5%	10%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	10%	25%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	20%	50%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	50%	100%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	75%	200%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	100%	300%	-50.0%	-40.0%	-30.0%	-20.0%	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
	Vol	Vix												

The choice of spot shifts is arbitrary. It is in line with both the movements of February-March 2020, and the option inventory. The volatility and VIX shifts are defined later.

Option risk analysis

Option Bucket analysis

As a first step, we look at the notional of options by maturity and strike % of the spot[2]:

Notionals ($m) by buckets		Percentage from current spot												Total	>=75%
		60%	65%	70%	75%	80%	85%	90%	95%	100%	105%	110%	115%	120%	
Maturity	18-Oct-19	431	817	0	-4	-18	75	-263	45	-87	-35	0	0	0	963	-285
	15-Nov-19	9	0	0	-22	-28	-71	-26	0	7	-163	-7	0	0	-301	-310
	20-Dec-19	0	0	0	-2	-10	-32	0	0	1	-24	0	0	0	-67	-67
	17-Jan-20	0	0	0	-5	-7	0	0	0	0	0	0	0	0	-13	-13
	21-Feb-20	0	0	0	-7	-1	0	0	0	0	0	0	0	0	-8	-8
	20-Mar-20	0	0	-1	0	-7	0	0	0	0	0	0	0	0	-9	-7
	Total	440	817	-1	-41	-71	-27	-289	46	-80	-222	-7	0	0	565	-691

We see that

- there are indeed a long put positions, but the strikes are below 70%!!!! This would explain why they had no influence in the deltas.
- Furthermore, they are all in the first-month maturity. In other words, such a put protection would only start to generate a positive exposure after the market has dropped by more than 30-40%, but only during the next three weeks[3]. *This put exposure is too far down to protect for tail risk. It is a symbolic position with no economic benefit*.
- We see that the book is overall short strikes in slightly upper calls (100%-110% in 1M & 2M), as well as slightly long in the 85%-90% 1M and 95%-100% 1M areas, but net a massive short puts from 100% down to 80%. *This book is essentially short puts and short tail-risk.*
- Also, it is net short options in all maturities, if you exclude the symbolic puts in the 60-70% 1M area.

As for vegas by buckets[4], we see that:

Vega ($/pc) by buckets		Percentage from current spot												Total
		60%	65%	70%	75%	80%	85%	90%	95%	100%	105%	110%	115%	120%	
Maturity	18-Oct-19	1,048	2,580	0	-66	-720	10,128	-56,513	21,037	6,279	-817	0	0	0	-17,045
	15-Nov-19	183	0	0	-2,638	-6,103	-31,448	-17,243	547	12,204	-47,886	-1,092	0	0	-93,476
	20-Dec-19	0	0	0	-820	-5,259	-26,564	0	0	1,376	-9,888	0	0	0	-41,154
	17-Jan-20	0	0	0	-2,638	-5,699	0	0	0	0	0	0	0	0	-8,338
	21-Feb-20	0	0	0	-5,254	-1,208	0	0	0	0	0	0	0	0	-6,462
	20-Mar-20	0	0	-967	0	-8,595	0	0	0	0	0	0	0	0	-9,562
	Total	1,230	2,580	-967	-11,416	-27,584	-47,883	-73,756	21,584	19,859	-58,591	-1,092	0	0	-176,037

- The book is short vega for all maturities, meaning that the portfolio is guaranteed to lose if the market volatility rises. It is a directional bet on volatility.z
- Most of the vega comes from lower puts as well as the slightly higher calls, with a slight long vega in the 1M 95%-105%.
- The book is short vega outside of that range – a butterfly/condor position but with very big wings in comparison to the body size.

[2] This analysis is called a 'notional by buckets' The bucket title is the lower limit of the bucket ("90%" means all the options between 90% and 95%).

[3] Unless the options are constantly rolled.

[4] These are the vegas calculated at the current spot of 2977.25 in the SPX, simply spread apart by their strikes - not the vegas if the SPX was going down to these levels.

The Gamma by bucket analysis is similar to the vegas by buckets:

SPX Gamma by buckets		Percentage from current spot													
		60%	65%	70%	75%	80%	85%	90%	95%	100%	105%	110%	115%	120%	Total
Maturity	18-Oct-19	0.0	0.0	0.0	0.0	-0.5	9.2	-53.3	22.9	-1.9	-1.6	0.0	0.0	0.0	-25.3
	15-Nov-19	0.0	0.0	0.0	-0.8	-2.0	-11.5	-6.8	0.3	8.2	-41.1	-0.6	0.0	0.0	-54.3
	20-Dec-19	0.0	0.0	0.0	-0.2	-1.0	-5.8	0.0	0.0	0.4	-4.7	0.0	0.0	0.0	-11.2
	17-Jan-20	0.0	0.0	0.0	-0.4	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2
	21-Feb-20	0.0	0.0	0.0	-0.6	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
	20-Mar-20	0.0	0.0	-0.1	0.0	-0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.9
	Total	0.0	0.0	-0.1	-1.9	-5.3	-8.1	-60.2	23.2	6.8	-47.5	-0.6	0.0	0.0	-93.8

The delta by buckets explain the call/put balance:

Delta ($m) by buckets		Percentage from current spot													
		60%	65%	70%	75%	80%	85%	90%	95%	100%	105%	110%	115%	120%	Total
Maturity	18-Oct-19	-0.1	-0.3	0.0	0.0	0.1	-1.9	11.6	2.6	-5.6	-0.1	0.0	0.0	0.0	6.3
	15-Nov-19	0.0	0.0	0.0	0.3	0.7	4.5	2.8	0.2	3.4	-6.3	-0.1	0.0	0.0	5.5
	20-Dec-19	0.0	0.0	0.0	0.1	0.6	3.2	0.0	0.0	0.3	-0.9	0.0	0.0	0.0	3.4
	17-Jan-20	0.0	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
	21-Feb-20	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
	20-Mar-20	0.0	0.0	0.1	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
	Total	-0.1	-0.3	0.1	1.0	2.8	5.8	14.4	2.8	-1.8	-7.3	-0.1	0.0	0.0	17.2

- The book is short of calls on the upside, short puts on the downside.
- The very low strike puts have no influence on the delta.

This book's main characteristic is

- a short put position, in all maturities, from 95% all the way down to 75%, as well as the short of the upper calls 105%-110%.
- A slight long ATM calls & puts in the front month, but not enough to bring a positive gamma.
- The "long put" protection is big in notional, but far too low to have any economic benefit.

Option risk matrices

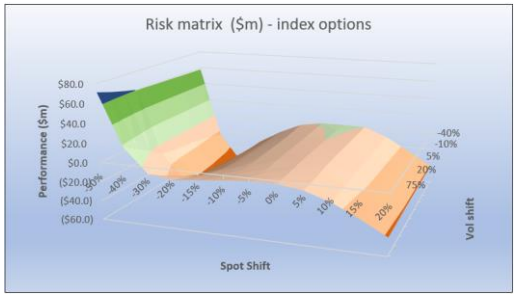
The following risk matrix has been calculated using option parameters and prices included in the Option SpiderRock CloseMarks Dataset[5]. SpiderRock is an institutional provider of option execution and data, well recognized in the options trading industry.

The calculation approach has been assuming

- that all indices move down in sync.
- That the vol shift is proportional[6] (each volatility is multiplied by 1 + XX%), which has the benefit of impacting the lower strikes more than the ATM, therefore amplifying the skew on the way down, which is a fair assumption for crash risk analysis.

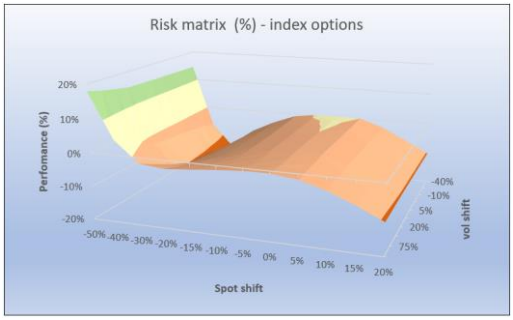
[5] Reference: SpiderRock Option CloseMarks Dataset – www.spiderrock.net/data-analytics/

[6] By opposition to an absolute vol shift, where all volatilities gain 25%, whatever the strike. A risk analysis based on a flat volatility shift gives a qualitatively similar result.



Index Vol ($)		Spot Shift											
		-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	$57.9	($25.0)	($56.2)	($29.3)	($14.8)	($3.6)	$0.6	$0.7	$0.0	($9.9)	($24.9)	($40.6)
	-20%	$58.1	($20.5)	($49.9)	($29.5)	($15.9)	($5.2)	($0.5)	$0.5	($0.7)	($10.3)	($25.0)	($40.6)
	-10%	$58.4	($17.8)	($46.5)	($29.1)	($16.4)	($6.1)	($1.1)	$0.3	($1.1)	($10.6)	($25.1)	($40.6)
	0	$58.7	($15.0)	($43.1)	($28.5)	($16.6)	($6.8)	($1.7)	$0.0	($1.5)	($11.0)	($25.2)	($40.6)
	5%	$59.0	($13.5)	($41.3)	($28.1)	($16.7)	($7.2)	($2.1)	($0.2)	($1.8)	($11.1)	($25.2)	($40.6)
	10%	$59.3	($12.0)	($39.5)	($27.6)	($16.7)	($7.5)	($2.4)	($0.4)	($2.1)	($11.3)	($25.3)	($40.7)
	20%	$60.0	($8.9)	($35.9)	($26.3)	($16.5)	($8.0)	($3.0)	($0.8)	($2.6)	($11.8)	($25.5)	($40.7)
	50%	$63.1	$0.9	($25.0)	($21.4)	($14.7)	($8.4)	($4.1)	($2.2)	($4.4)	($13.1)	($26.2)	($41.0)
	75%	$66.8	$9.4	($15.9)	($16.0)	($11.7)	($7.3)	($4.1)	($2.8)	($5.7)	($14.3)	($26.9)	($41.4)
	100%	$71.3	$18.0	($6.8)	($10.0)	($7.7)	($5.0)	($3.0)	($2.7)	($6.3)	($15.0)	($27.4)	($41.7)
	Vol	Credit: SpiderRock - www.spiderrock.net											

Using the indicated $397.3 notional of the fund, we have the following risk matrix in % for the index option positions:



Index Vol (%)		Spot Shift											
		-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	14.6%	-6.3%	-14.1%	-7.4%	-3.7%	-0.9%	0.1%	0.2%	0.0%	-2.5%	-6.3%	-10.2%
	-20%	14.6%	-5.2%	-12.6%	-7.4%	-4.0%	-1.3%	-0.1%	0.1%	-0.2%	-2.6%	-6.3%	-10.2%
	-10%	14.7%	-4.5%	-11.7%	-7.3%	-4.1%	-1.5%	-0.3%	0.1%	-0.3%	-2.7%	-6.3%	-10.2%
	0	14.8%	-3.8%	-10.8%	-7.2%	-4.2%	-1.7%	-0.4%	0.0%	-0.4%	-2.8%	-6.3%	-10.2%
	5%	14.8%	-3.4%	-10.4%	-7.1%	-4.2%	-1.8%	-0.5%	0.0%	-0.5%	-2.8%	-6.3%	-10.2%
	10%	14.9%	-3.0%	-9.9%	-6.9%	-4.2%	-1.9%	-0.6%	-0.1%	-0.5%	-2.9%	-6.4%	-10.2%
	20%	15.1%	-2.2%	-9.0%	-6.6%	-4.2%	-2.0%	-0.8%	-0.2%	-0.7%	-3.0%	-6.4%	-10.3%
	50%	15.9%	0.2%	-6.3%	-5.4%	-3.7%	-2.1%	-1.0%	-0.5%	-1.1%	-3.3%	-6.6%	-10.3%
	75%	16.8%	2.4%	-4.0%	-4.0%	-2.9%	-1.8%	-1.0%	-0.7%	-1.4%	-3.6%	-6.8%	-10.4%
	100%	18.0%	4.5%	-1.7%	-2.5%	-1.9%	-1.2%	-0.7%	-0.7%	-1.6%	-3.8%	-6.9%	-10.5%
	Vol	Credit: SpiderRock - www.spiderrock.net											

Conclusion on the index option risks:

The analysis for the index options is consistent with

- A significant short tail position on the downside,
- with a reduced short gamma around the ATM, but insufficient to generate a positive gamma.
- This portfolio of options is generating income by selling crash-risk, a strategy akin to picking-up pennies in front of a steamroller and playing the Russian roulette.
- The portfolio has no decent downside risk protection.
- The volatilities would have to rise significantly for the tiny puts to start playing their vomma benefit (increase vega in a rising vol).
- The losses due to index options should remain around 5-10% in a scenario where the index goes down ~20% and volatilities spike 50% or 100% in relative terms. At first sight, this bargain seems an acceptable deal considering the likely theta to collect from the short gamma.

VIX / VXX options.

The notional by bucket shows a large sale of upper strike calls, all the way up to 40 in the VIX

Notionals ($m) by buckets		Percentage change from current & VIX equivalents																
		100%	110%	120%	130%	140%	150%	160%	170%	180%	190%	200%	210%	220%	230%	240%	250%	260%	
		18.60	20.46	22.33	24.19	26.05	27.91	29.77	31.63	33.49	35.35	37.21	39.07	40.93	42.79	44.65	46.51	48.37	Total
Maturity	16-Oct-19	0.0	-9.2	-49.5	-32.9	-11.5	-6.3	-6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-115.7
	18-Oct-19	0.0	-1.0	-16.7	-14.6	-1.6	-4.2	-12.7	-2.0	0.0	-6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-59.6
	15-Nov-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.7	0.0	-5.0	-7.4	0.0	0.0	0.0	0.0	0.0	-15.0
	20-Nov-19	0.0	0.0	-3.0	-17.4	-6.0	-11.8	-13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-51.5
	18-Dec-19	0.0	0.0	0.0	0.0	0.0	-6.0	-3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-9.3
	20-Dec-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.0	0.0	0.0	0.0	0.0	0.0	-4.0
	Total	0.0	-10.2	-69.3	-64.8	-19.0	-28.3	-35.7	-2.0	-2.7	-6.7	-5.0	-11.4	0.0	0.0	0.0	0.0	0.0	-255.1

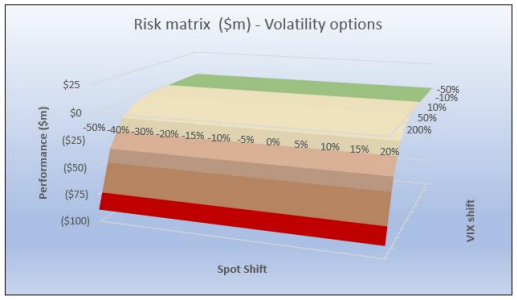
The vega by buckets (we are talking delta in VIX here) is corroborating this analysis.

VIX Delta ($m/pt) by buckets		Percentage change from current & VIX equivalents																	
		100%	110%	120%	130%	140%	150%	160%	170%	180%	190%	200%	210%	220%	230%	240%	250%	260%	
		18.60	20.46	22.33	24.19	26.05	27.91	29.77	31.63	33.49	35.35	37.21	39.07	40.93	42.79	44.65	46.51	48.37	Total
Maturity	16-Oct-19	0.00	-0.13	-0.56	-0.27	-0.08	-0.04	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.10
	18-Oct-19	0.00	-0.01	-0.11	-0.07	-0.01	-0.01	-0.02	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.23
	15-Nov-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.03
	20-Nov-19	0.00	0.00	-0.05	-0.25	-0.08	-0.13	-0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.64
	18-Dec-19	0.00	0.00	0.00	0.00	0.00	-0.07	-0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.11
	20-Dec-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01
	Total	0.00	-0.14	-0.72	-0.59	-0.16	-0.25	-0.22	0.00	-0.01	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	-2.12

This VIX portfolio of option is the exact definition of a short sale of upper calls. Since VIX gaps ups when the S&P gaps down, this VIX strategy is exactly equivalent to selling puts on the S&P. Furthermore, there is no protection for large moves whatsoever.

This VIX option position is the textbook example of selling the tail risk, aka again, picking up pennies in front of a steamroller and playing Russian roulette. You win small and regularly when the market is quiet, but the losses are big and painful when you lose the bet.

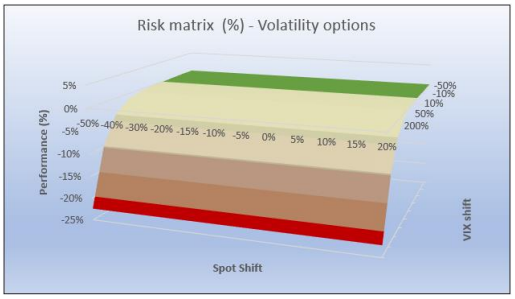
We can also calculate a risk matrix for this portfolio of VIX options.



VIX Vol ($)		Spot Shift											
		-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-50%	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8
	-25%	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7
	-10%	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4
	0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
	10%	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)	($0.6)
	25%	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)	($1.9)
	50%	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)	($5.2)
	100%	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)	($14.8)
	200%	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)	($38.6)
	400%	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)	($89.1)
	Vix	Credit: SpiderRock - www.spiderrock.net											

The steps of the vol shifts have been chosen to represent the February/March 2020 events, where the VIX reached an intraday high of 83.56 and a close high of 82.69, against a level of 18.60 on 9/30/19. This is equivalent to 450% and 445% of its value of September 30th, 2019.

With the same notional of $397.3 m, we obtain the following risk matrix in percentage for the VIX derivatives book.



VIX Vol (%)	Spot Shift											
	-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
-50%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
-25%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
-10%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
25%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
50%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
100%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%	-3.7%
200%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%	-9.7%
400%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%	-22.4%
Vix	Credit: SpiderRock - www.spiderrock.net											

> This VIX strategy is a massive seller of catastrophic risk, with no protection.

Aggregation of the Volatility and VIX risk matrices

We have risk matrices for both index options and VIX options. It would be tempting to sum these matrices together, but it is not exactly possible, since they do not refer to the same volatility metric.

Volatility and VIX are related but different concepts. Because the VIX is very sensitive to lower strike puts and therefore skew[7], it is usually higher than ATM volatility. It moves up to much higher levels and much faster speed than a standard volatility. Unfortunately, there is no direct way to link vol changes to VIX changes – we can only say that they move in synch.

Vol	VIX
-40%	-50%
-20%	-25%
-10%	-10%
0	0
5%	10%
10%	25%
20%	50%
50%	100%
75%	200%
100%	400%

This being said, we can assume some comparison in vol and VIX, which should make sense for an option trader[8]. This assumed relation could be verified through statistical analysis of historical evolution in a more accurate fashion[9].

As a consequence, adding the risk matrices of the index options and of the VIX options becomes only qualitative. There is no guarantee that a world where spot goes down by X%, vol uniformly shifts up by Y% and VIX shifts by Z% would be accurately represented in the matrix.

Moreover, it has to be reminded that the main assumption underlying such risk calculation is that all implied volatilities are shifted in unison (by X%). In the real world, this is a crude assumption, as the volatility surface deforms rather than simply translate or homothecies up/down. The events of February/March 2020 are actually the case in

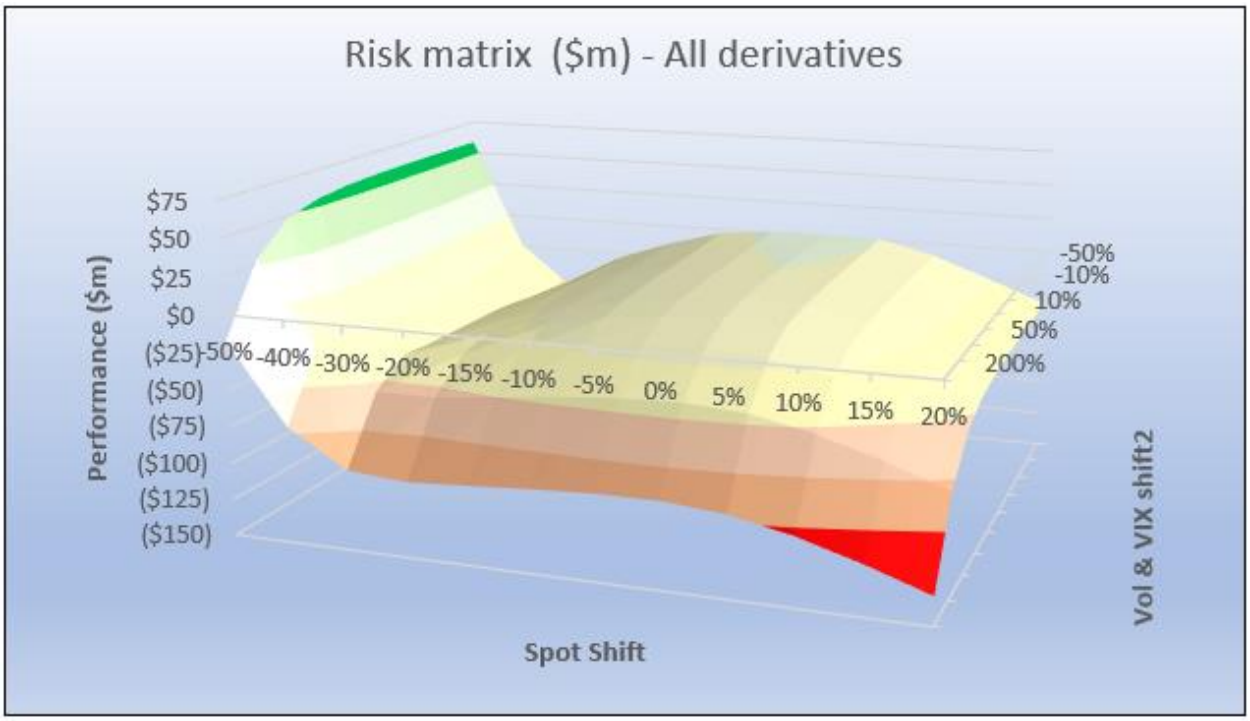
[7] The VIX is calculated with a complex formula using the $ prices of options. In this equation, puts have a much more important weight than the calls, and their implied volatility levels have significant impact on the value of the index.

[8] In other words, if vol goes up by 20%, there is no guarantee that VIX would go up by 50% as implicit in the table. The VIX could go very well go up by 30% (or 75%). Please note that the levels of March 2020 are unprecedented, so there is no historical comparison.

[9] There is no mathematical relation between vol and VIX, so the co-dynamic should remain modest in accuracy.

point of such non-linear deformations, as we saw during the first month and a half of the crisis that lower strike puts in the 2M/3M maturity[10] did not rise much, while the rest of the S&P curve tended to go up.

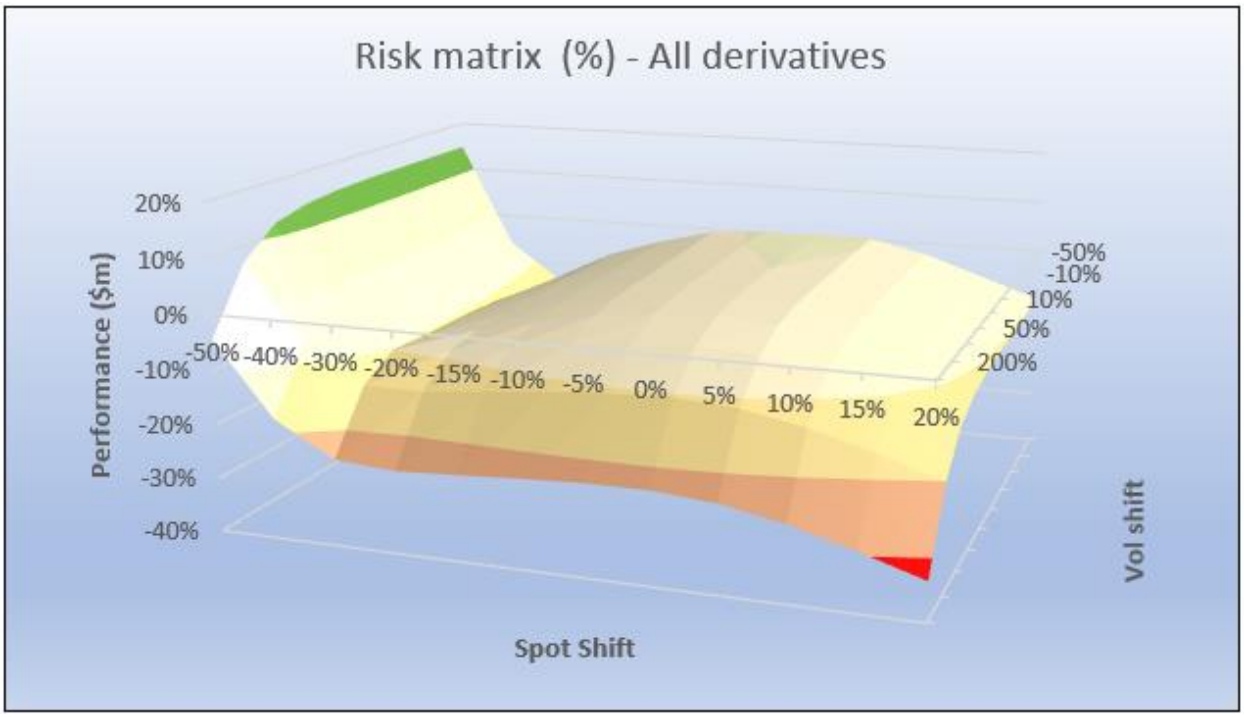
We obtain nevertheless the following risk matrices in $ and %, with their corresponding graphs:



Index + VIX Vol ($)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol & VIX Shift	-40%	-50%	$58.7	($24.3)	($55.4)	($28.5)	($14.0)	($2.8)	$1.3	$1.5	$0.8	($9.1)	($24.1)	($39.8)
	-20%	-25%	$58.8	($19.8)	($49.2)	($28.8)	($15.2)	($4.5)	$0.2	$1.2	$0.0	($9.7)	($24.3)	($39.9)
	-10%	-10%	$58.7	($17.4)	($46.1)	($28.7)	($16.0)	($5.7)	($0.7)	$0.7	($0.7)	($10.2)	($24.7)	($40.2)
	0	0	$58.7	($15.0)	($43.1)	($28.5)	($16.6)	($6.8)	($1.7)	$0.0	($1.5)	($11.0)	($25.2)	($40.6)
	5%	10%	$58.4	($14.1)	($41.9)	($28.6)	($17.3)	($7.8)	($2.7)	($0.8)	($2.4)	($11.7)	($25.8)	($41.2)
	10%	25%	$57.4	($13.9)	($41.4)	($29.4)	($18.6)	($9.4)	($4.3)	($2.3)	($4.0)	($13.2)	($27.2)	($42.6)
	20%	50%	$54.8	($14.1)	($41.1)	($31.5)	($21.7)	($13.2)	($8.2)	($6.0)	($7.8)	($16.9)	($30.7)	($45.9)
	50%	100%	$48.3	($13.8)	($39.8)	($36.1)	($29.5)	($23.2)	($18.9)	($17.0)	($19.2)	($27.9)	($41.0)	($55.8)
	75%	200%	$28.3	($29.1)	($54.5)	($54.6)	($50.3)	($45.9)	($42.6)	($41.4)	($44.2)	($52.8)	($65.4)	($80.0)
	100%	400%	($17.8)	($71.1)	($95.9)	($99.1)	($96.8)	($94.1)	($92.1)	($91.8)	($95.4)	($104.1)	($116.5)	($130.8)
	Vol	Vix	Credit: SpiderRock - www.spiderrock.net											

[10] Those options that Allianz seems massively short of…

Once adjusted for the notional:

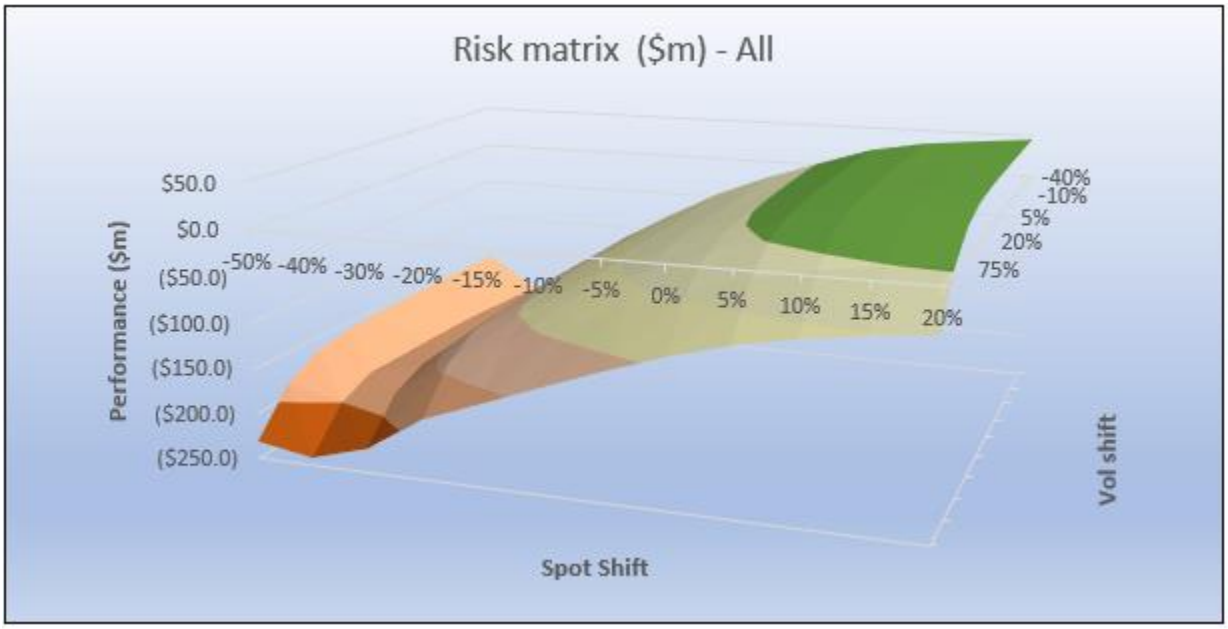


Index + VIX Vol (%)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol & VIX Shift	-40%	-50%	14.8%	-6.1%	-13.9%	-7.2%	-3.5%	-0.7%	0.3%	0.4%	0.2%	-2.3%	-6.1%	-10.0%
	-20%	-25%	14.8%	-5.0%	-12.4%	-7.2%	-3.8%	-1.1%	0.1%	0.3%	0.0%	-2.4%	-6.1%	-10.0%
	-10%	-10%	14.8%	-4.4%	-11.6%	-7.2%	-4.0%	-1.4%	-0.2%	0.2%	-0.2%	-2.6%	-6.2%	-10.1%
	0	0	14.8%	-3.8%	-10.8%	-7.2%	-4.2%	-1.7%	-0.4%	0.0%	-0.4%	-2.8%	-6.3%	-10.2%
	5%	10%	14.7%	-3.5%	-10.5%	-7.2%	-4.3%	-2.0%	-0.7%	-0.2%	-0.6%	-3.0%	-6.5%	-10.4%
	10%	25%	14.4%	-3.5%	-10.4%	-7.4%	-4.7%	-2.4%	-1.1%	-0.6%	-1.0%	-3.3%	-6.8%	-10.7%
	20%	50%	13.8%	-3.5%	-10.3%	-7.9%	-5.5%	-3.3%	-2.1%	-1.5%	-2.0%	-4.3%	-7.7%	-11.6%
	50%	100%	12.2%	-3.5%	-10.0%	-9.1%	-7.4%	-5.8%	-4.8%	-4.3%	-4.8%	-7.0%	-10.3%	-14.1%
	75%	200%	7.1%	-7.3%	-13.7%	-13.7%	-12.7%	-11.5%	-10.7%	-10.4%	-11.1%	-13.3%	-16.5%	-20.1%
	100%	400%	-4.5%	-17.9%	-24.1%	-24.9%	-24.4%	-23.7%	-23.2%	-23.1%	-24.0%	-26.2%	-29.3%	-32.9%
	Vol	Vix	Credit: SpiderRock - www.spiderrock.net											

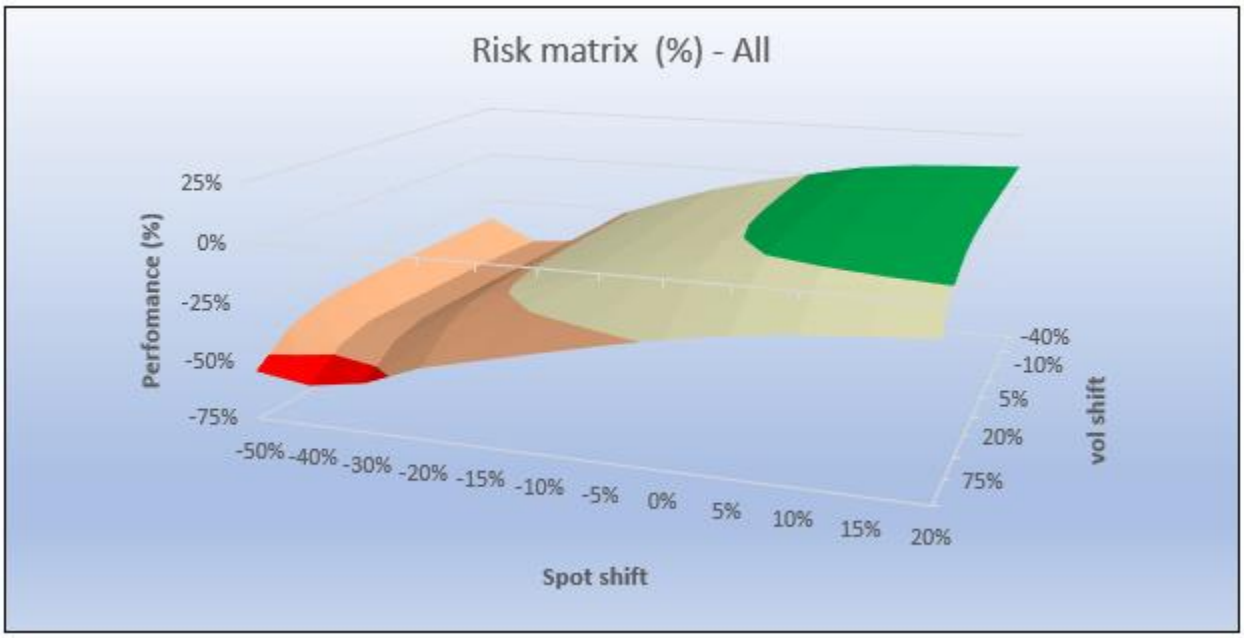
> This is not a pretty risk matrix for market crashes.

Overall risk analysis

Under the same Vol/VIX aggregation caveats, we can now aggregate equity, index volatility, and VIX exposures together:



All ($m)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	-50%	($154.5)	($194.8)	($183.3)	($113.8)	($78.0)	($45.4)	($20.0)	$1.5	$22.1	$33.6	$39.8	$45.5
	-20%	-25%	($154.4)	($190.4)	($177.1)	($114.1)	($79.2)	($47.2)	($21.1)	$1.2	$21.3	$33.0	$39.7	$45.4
	-10%	-10%	($154.4)	($188.0)	($174.1)	($114.0)	($79.9)	($48.3)	($22.0)	$0.7	$20.6	$32.4	$39.3	$45.1
	0	0	($154.4)	($185.5)	($171.0)	($113.8)	($80.6)	($49.5)	($23.1)	$0.0	$19.8	$31.7	$38.8	$44.6
	5%	10%	($154.8)	($184.6)	($169.8)	($113.9)	($81.2)	($50.4)	($24.0)	($0.8)	$18.9	$30.9	$38.1	$44.0
	10%	25%	($155.8)	($184.4)	($169.3)	($114.7)	($82.5)	($52.0)	($25.6)	($2.3)	$17.4	$29.4	$36.8	$42.7
	20%	50%	($158.4)	($184.6)	($169.0)	($116.8)	($85.7)	($55.9)	($29.5)	($6.0)	$13.5	$25.7	$33.3	$39.4
	50%	100%	($164.8)	($184.4)	($167.7)	($121.4)	($93.4)	($65.8)	($40.3)	($17.0)	$2.1	$14.7	$23.0	$29.4
	75%	200%	($184.9)	($199.7)	($182.4)	($139.9)	($114.2)	($88.5)	($64.0)	($41.4)	($22.9)	($10.2)	($1.5)	$5.3
	100%	400%	($230.9)	($241.6)	($223.8)	($184.4)	($160.7)	($136.7)	($113.4)	($91.8)	($74.1)	($61.5)	($52.5)	($45.5)
	Vol	Vix	Credit: SpiderRock - www.spiderrock.net											



All (%)			Spot Shift											
			-50%	-40%	-30%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Vol Shift	-40%	-50%	-35.2%	-46.1%	-43.9%	-27.2%	-18.5%	-10.7%	-4.7%	0.4%	5.2%	7.7%	8.9%	10.0%
	-20%	-25%	-35.2%	-45.0%	-42.4%	-27.2%	-18.8%	-11.1%	-4.9%	0.3%	5.0%	7.6%	8.9%	10.0%
	-10%	-10%	-35.2%	-44.4%	-41.6%	-27.2%	-19.0%	-11.4%	-5.2%	0.2%	4.8%	7.4%	8.8%	9.9%
	0	0	-35.2%	-43.8%	-40.8%	-27.2%	-19.2%	-11.7%	-5.4%	0.0%	4.6%	7.2%	8.7%	9.8%
	5%	10%	-35.3%	-43.5%	-40.5%	-27.2%	-19.3%	-12.0%	-5.7%	-0.2%	4.4%	7.0%	8.5%	9.6%
	10%	25%	-35.6%	-43.5%	-40.4%	-27.4%	-19.7%	-12.4%	-6.1%	-0.6%	4.0%	6.7%	8.2%	9.3%
	20%	50%	-36.2%	-43.5%	-40.3%	-27.9%	-20.5%	-13.3%	-7.1%	-1.5%	3.0%	5.7%	7.3%	8.4%
	50%	100%	-37.8%	-43.5%	-40.0%	-29.1%	-22.4%	-15.8%	-9.8%	-4.3%	0.2%	3.0%	4.7%	5.9%
	75%	200%	-42.9%	-47.3%	-43.7%	-33.7%	-27.7%	-21.5%	-15.7%	-10.4%	-6.1%	-3.3%	-1.5%	-0.1%
	100%	400%	-54.5%	-57.9%	-54.1%	-44.9%	-39.4%	-33.7%	-28.2%	-23.1%	-19.0%	-16.2%	-14.3%	-12.9%
	Vol	Vix	Credit: SpiderRock - www.spiderrock.net											

This Allianz Structured Alpha US Equity 250 is constructed to sell catastrophic ("tail") risk and to collect insurance premia. It has no decent protection against market crashes.

The strategy is actually a typical example of "selling the small puts". This strategy works well and generates excellent returns and Sharpes… as long as the world remains calm. If/when the Earth shakes or California burns[11], the insurance contracts suddenly transform from a stream of regular premia to large liabilities. This event happened in February/March 2020, when an unexpected virus wrought havoc on the world's economy.

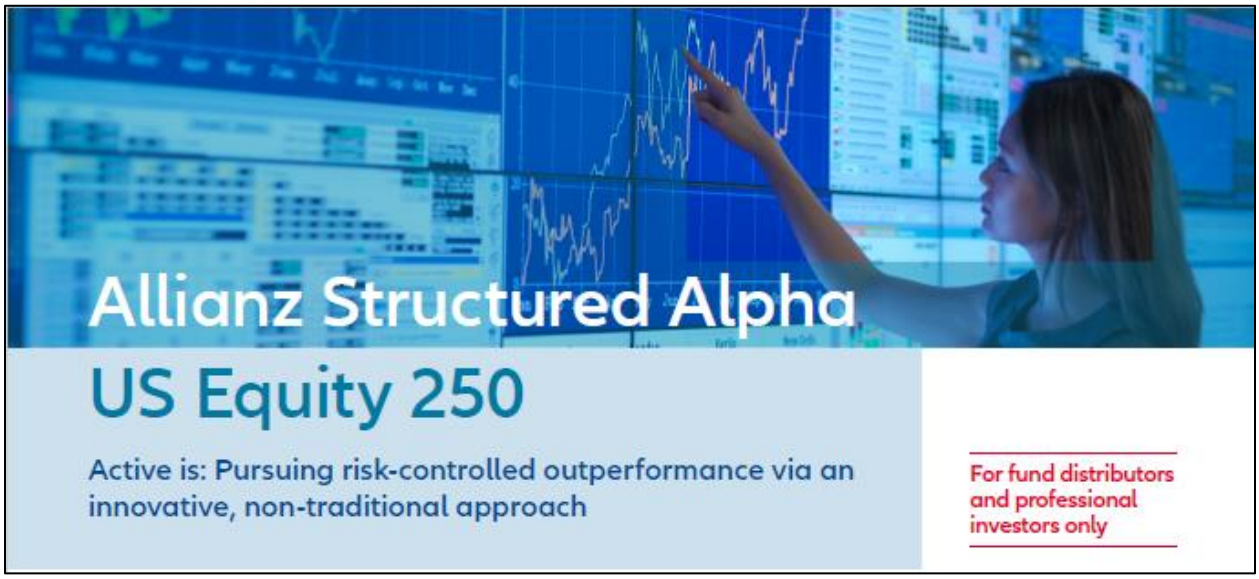
As importantly, if the portfolio has structurally remained the same in late January 2020 as it was in September 2019, the losses and underperformances of February/March would be consistent with the risks calculated here – about a 45% loss when the S&P 500 is down 25% and when the VIX gains over 300%.

[11] And these events tend to happen with a very high frequency – see previous articles on http://navesinkinternational.com/Articles/Default.html

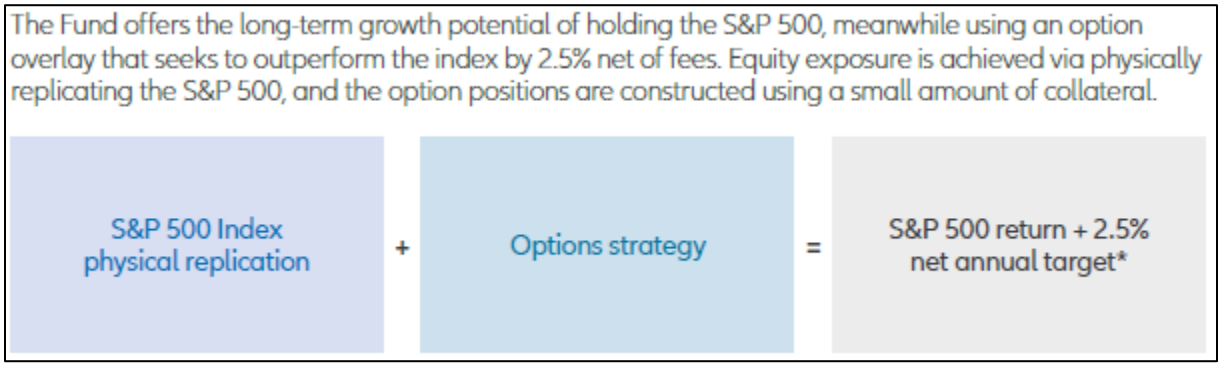
Review of a marketing document for the fund.

The private placement memoranda, side letter agreements, and all the marketing documents are not available to the writer at this time, except for a fund flyer. It contains the following content:

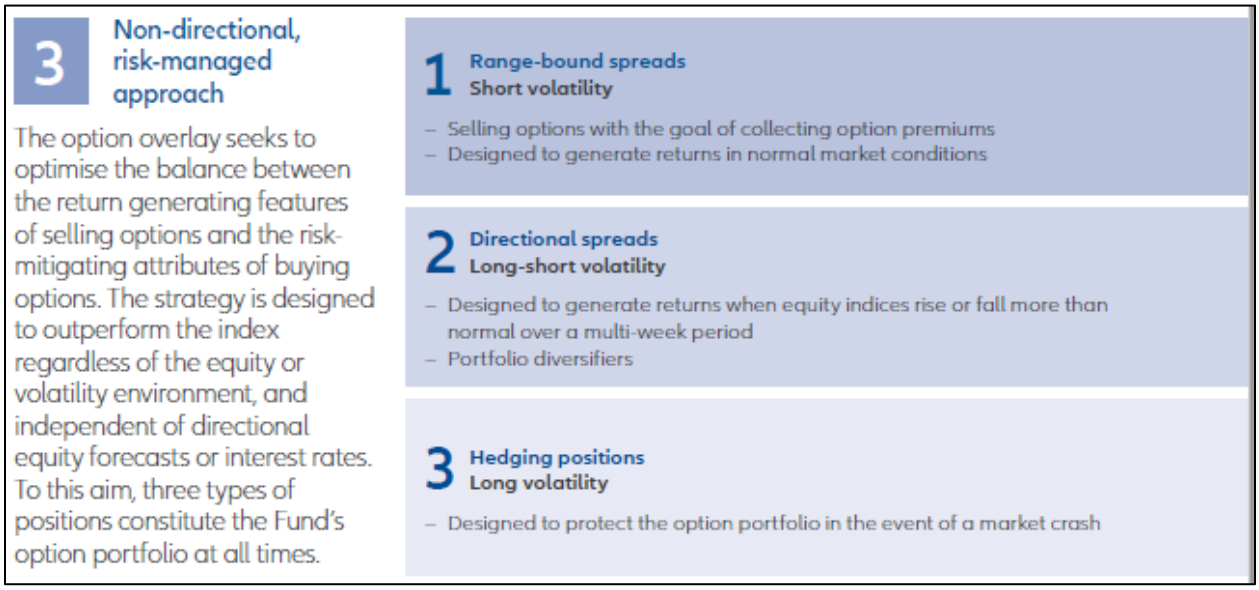
- "*Pursuing risk-controlled outperformance*"



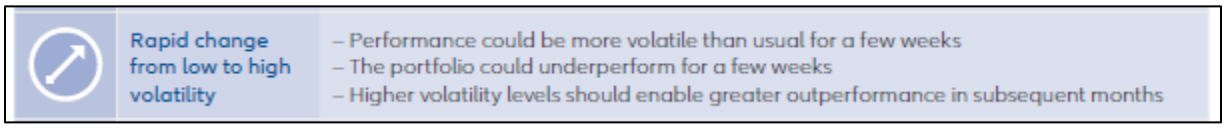
- "*Physically replicating the S&P 500*" (the fund does not have a perfect replication)



- "*Outperform the index regardless of the equity or volatility environment*", "*portfolio diversifiers*" and "*Hedging positions/ Long volatility / designed to protect the option portfolio in the event of a market crash*":

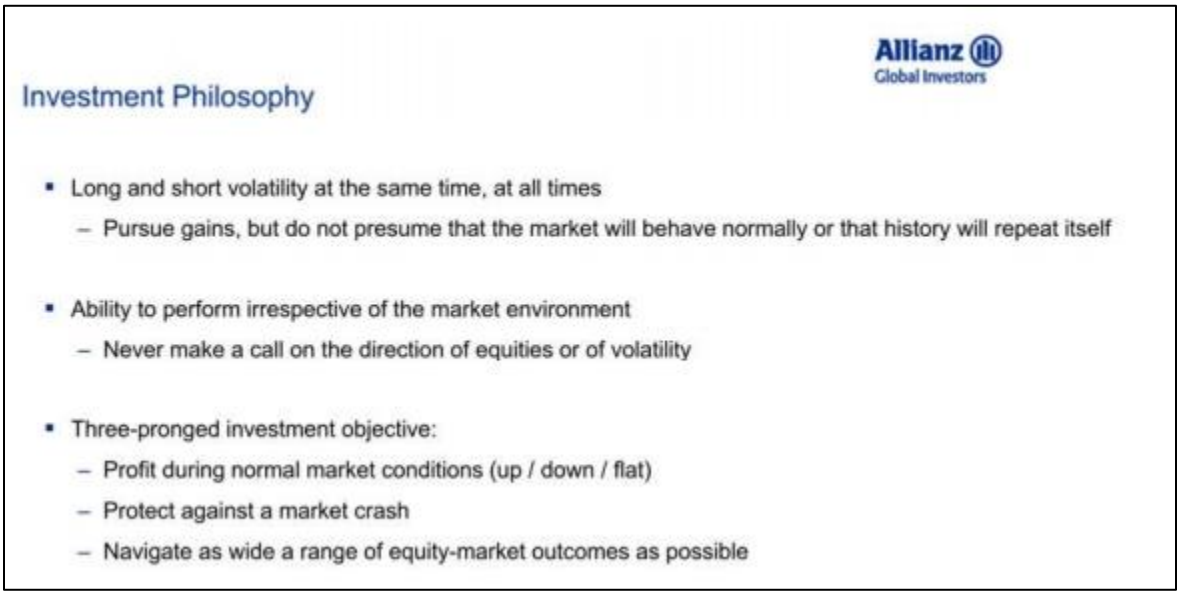


- The assertion that "*Higher volatility levels should enable greater outperformance in subsequent months*"… is only true as long as you can keep playing. The volatility rise would generate immediate losses and can lead to fund closure, which is what happened in March.

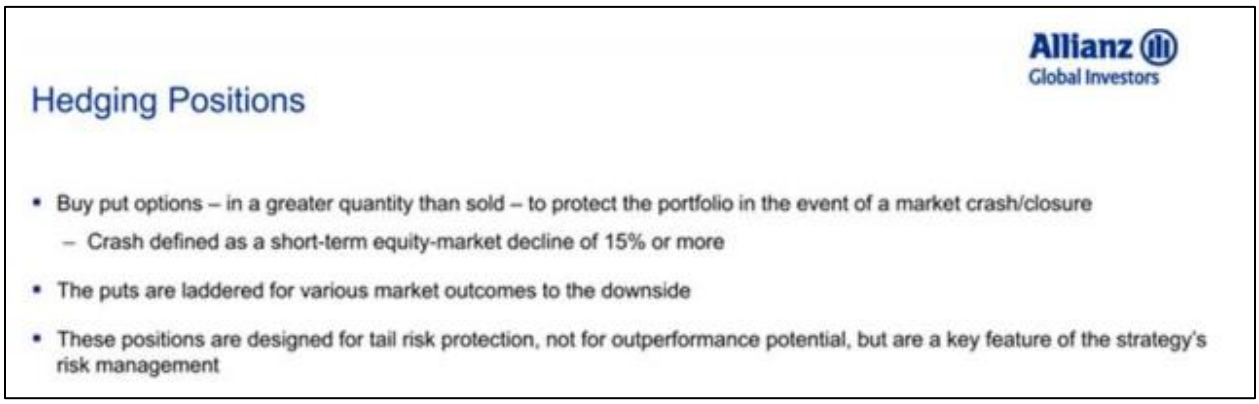


At the time of this writing, Arkansas Teacher Retirement System has filed a lawsuit for negligence, breach of fiduciary duty, and breach of contract against Allianz Global Investors[12]. The claim includes additional investor-related statements, of which:

- "*Never make a call on the direction of equities or of volatility*" and "*protect against a market crash*". That cannot be true when you are short vega in index vol and short naked calls on the VIX, as well as short puts all the way down to the 75% strikes.

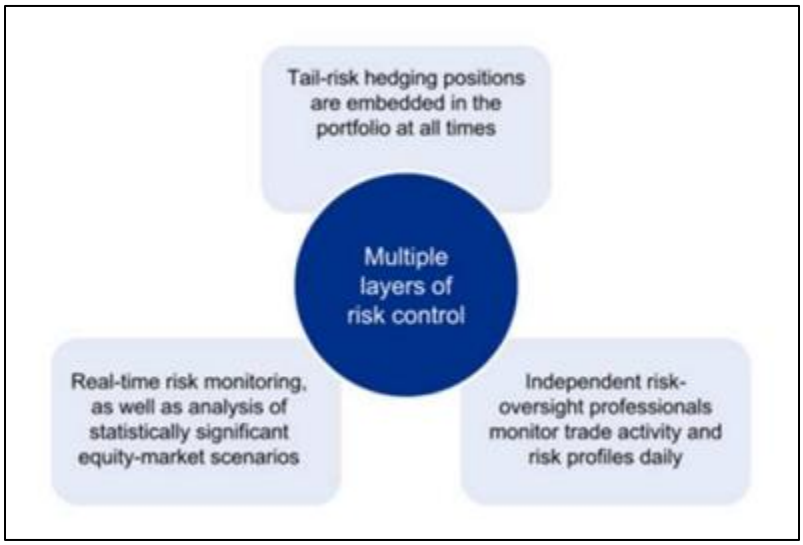


- "*Buy put options – in a greater quantity than sold – to protect the portfolio in the event of a market crash/closure. Crash defined as a short-term equity market decline of 15% or more".*
- "*These positions are designed for tail risk protection, not for outperformance potential*"
- Please explain how you protect against a 15% crash with puts whose strikes are below 70%.



[12] https://www.courtlistener.com/docket/17366198/arkansas-teacher-retirement-system-v-allianz-global-investors-us-llc/

- "*Tail-risk hedging positions are embedded in the portfolio at all times*"
- "*Analysis of statistically significant equity market scenarios*"



> This risk analysis refutes many of the statements made in prospectus and marketing materials.

Next steps

It would be valuable to

- review the other funds of the Allianz Structured Alpha suite of products in a similar fashion,
- run similar risk analysis at anterior and posterior dates,
- to review the full marketing and contractual material under the outcomes of these risk analysis,
- look at the trades executed by the portfolio managers during the crisis,
- and look at the risk reports and conversations held internally at the firm

to complement this first review.

Conclusion

Large derivatives losses usually happen when at the conjunction of the following factors13:

- too much concentration into / not enough diversification from a specific risk,
- a misunderstood/under-estimated risk, or inappropriate risk metrics,
- insufficient consideration to extreme scenario,
- 'doubling up' positions and risks to 'make it up' when things get tough,
- skewed incentives for the fund manager ("Heads, I win. Tale, you lose")

We definitely have some of these factors here.

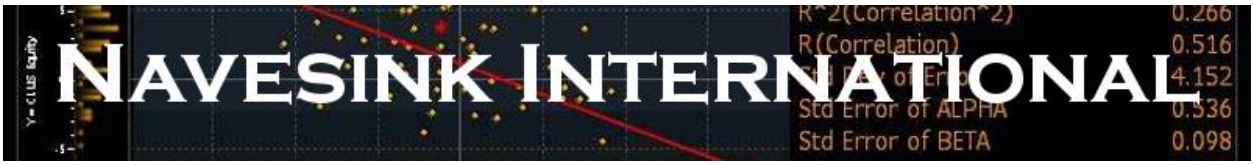
As for an initial review, the risk analysis run on the portfolio the Allianz Global Structured Alpha US Equity 250 of September 2019 indicates that

- **The positions and risks of the fund pre-crash are consistent with the losses** met during the crash.
- **The positions and risks of the fund pre-crash are inconsistent with the fund's marketing flyer** and some publicly available marketing documents.

The courts will review more documents & risk analysis, and eventually opine on what the portfolio managers knew, as well as the firm's responsibilities in the losses.

But in the meantime, this risk analysis should bring some first solace to the many fire-fighters, nurses, and teachers, whose savings and future income were bestowed to these funds.

[13] How to Lose Money in Derivatives: Examples from Hedge Funds and Bank Trading Departments, Sebastien Lleo, William T Ziemba, London School of Economics.
https://www.researchgate.net/publication/270318633_How_to_Lose_Money_in_Derivatives_Examples_from_Hedge_Funds_and_Bank_Trading_Departments



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Gontran de Quillacq, consultant / expert witness

Gontran de Quillacq has 25 years of experience in portfolio management, derivatives trading, proprietary trading, structured products and investment research. He has worked with top-tier banks and hedge funds in both London and New York.

Background Experience - After his European and US education, Mr. de Quillacq traded derivatives for two decades, from vanillas to exotics, both proprietary and client-facing, at top-tier banks in the square mile and on Wall Street. As a portfolio manager, he researched and managed investment strategies, delivered both in hedge fund and in structured note formats. He initiated the distribution of investment strategies through derivatives, an activity now called 'portable alpha' and 'smart beta'. For the following five years, Mr. de Quillacq ran due diligence on investments strategies and selected senior investment personnel as an executive recruiter for some of the world's most famous and most demanding hedge funds and asset managers. In 2017, he co-founded an investment approach deploying the latest machine learning techniques in global long/short equities. In 2019, Mr. de Quillacq joined a hedge fund deploying volatility trading strategies for institutional investors as a quantitative analyst.

Litigation Support - Mr. de Quillacq's own investment experience and his cross-sectional review of other professionals give him unique experience on what can be done, what should be done, what should not be done, and the grey areas in-between. Following a personal case in 2012-15, his activity as an expert witness and consultant has progressively moved from peripheral to center stage. Mr. de Quillacq is now a FINRA/NFA arbitrator, a member of the Securities Expert Roundtable and an IMS Elite Expert. He has consulting affiliations with Ankura, Barrington Financial Consulting Group, The Bates Group, Global Economics Group, Moskalev Consulting and SEDA Experts.

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